FINAL REPORT

BENEFIT AND COST IMPACTS OF IMPLEMENTING COMMUTER CARS IN CALIFORNIA

FOR THE

INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, BERKELEY

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1.0 INTRODUCTION

The California Department of Transportation (Caltrans) is sponsoring a study to explore market and infrastructure issues related to an innovative, narrow-lane commuter car under development by a major auto manufacturer. In sufficient numbers, this vehicle offers an opportunity to increase the capacity of the existing transportation infrastructure, reduce the state's dependence on foreign petroleum, and lower emissions of air pollutants. Under contract to the Institute of Transportation Studies at the University of California, Berkeley, Booz·Allen & Hamilton has been examining commercialization issues related to the commuter car. In August 1992, a report was prepared on road infrastructure requirements for the vehicle. In this follow-up report, the focus is on operational costs and benefits. This report presents the results of our analyses on the ownership costs of the commuter car, the degree to which the vehicle is projected to penetrate the current automotive market, and its societal benefits in terms of congestion, fuel consumption, and air pollution.

2.0 DESCRIPTION OF THE VEHICLE CONCEPT

The commuter car is an innovative vehicle concept that is comparable to a motorcycle in size but offers advantages similar to an automobile in comfort, utility and safety. The commuter car is a three-wheel, rear axle drive vehicle that is highly aerodynamic and may accommodate a driver and perhaps one passenger, depending on the configuration. The vehicle is less than 4 feet wide, shorter than 12 feet long and approximately 4 feet high. Production vehicles are projected to weigh 500 to 700 pounds, depending on selected options and final design. Passenger amenities similar to those available in standard automobiles, including climate control systems, high quality stereo systems, and passenger restraint devices, would be available as options on the commuter car. At this time, there are no immediate plans to manufacture this vehicle, and only functional prototypes exist. **Exhibit 1** is an illustration of the vehicle concept. **Exhibit 2** compares the projected physical characteristics and performance of the commuter car to a standard compact automobile.

EXHIBIT 1
Commuter Car Concept

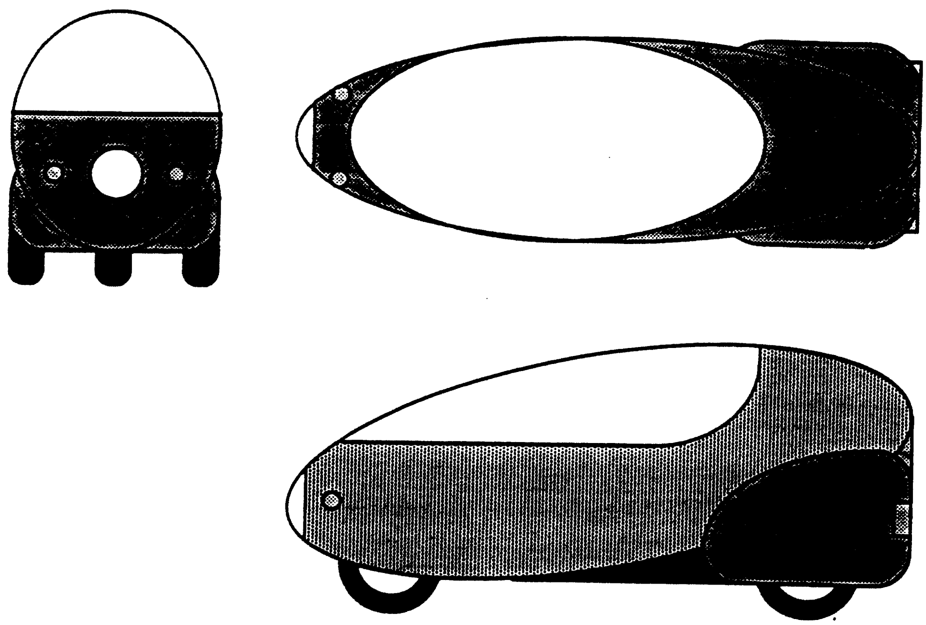


EXHIBIT 2
Commuter Car Vs. Standard Compact Automobile

	Commuter Car (Projected)	Conventional Compact Car	Commuter Car as a Percentage of Compact Car
Width	3.5 feet	6.5 feet	54%
Length	9 feet	15 feet	60%
Weight	500 to 600 lbs.	2000 to 2500 lbs.	20% to 30%
Occupants	1 or 2	4	25% to 50%
Fuel Economy	120+ mpg	40 mpg	300%
Price	$8500	$6000 to $10,000	85% to 142%

The commuter car concept offers consumers several advantages that are inherent in its design. Driving the commuter car is an experience comparable to skiing, since the passenger compartment of the vehicle leans into turns to reduce the centrifugal force on the driver and passenger (if any) and to reduce or minimize the turning radius of the vehicle. Furthermore, the fixed rear axle provides a measure of safety by ensuring vehicle stability through turns to prevent rolling the car—only the front wheel rotates off vertical as the passenger compartment leans into the turn. Operating and capital cost savings are estimated to be fairly significant for the commuter car, since the vehicle would be smaller and lighter than a full-size automobile. A new commuter car is projected to cost about $8500. Operating costs are expected to be lower due to projected fuel economy of 120 miles per gallon and reduced servicing and maintenance costs inherent in a small vehicle. Additional cost incentives for ownership may be provided through lower registration and licensing fees.

3.0 APPROACH

The objective of this assignment is to gather and analyze information on small vehicles, generate possible market penetration rates, and derive the benefits and costs to the public that would result from the sale of the commuter car. In addition to assessing the commercial potential of the vehicle, public investments to stimulate the commuter car markets were explored to determine a basis for public sector costs and likely returns on investment.

Four tasks were performed to meet the study objectives:

- Review Information on Small Vehicles
- Estimate California Market for the Commuter Car
- Develop Broad Benefit-Cost Analysis
- Suggest Action Plan for Caltrans

Our approach to each of these tasks is described briefly below.

3.1 Review Information on Small Vehicles

The objective in this task is to collect and analyze existing information on small vehicles. There are a number of studies produced at the University of California, Berkeley, by consulting firms and by the federal government that describe innovative, small vehicle concepts and issues concerning their introduction into the market. Several reports and papers were useful in developing the analyses contained in this report. Booz·Allen reviewed academic papers that describe methodologies to estimate the market for small vehicles. Consulting reports and survey data that summarized the results of informal surveys on the commuter car (conducted in 1989 at the EPCOT Center in Disneyworld) were also studied.

3.2 Estimate California Market for the Commuter Car

Estimating the market for the commuter car, a vehicle unlike any other car sold in recent memory, proved to be a challenging task. Without the benefit of a comprehensive market study or detailed public opinion surveys, we were forced to extrapolate available data and rely on business judgment to characterize customers that may be attracted to the commuter vehicle. In view of the uncertainty inherent in this task, our approach here was to develop three different market penetration scenarios based on three different methodologies. From these three scenarios, high and low market cases were generated to model the range of penetration rates likely for the commuter car.

3.3 Develop Benefit-Cost Analysis

The benefit-cost analysis illustrates the impact that the commuter car may have in California upon introduction and at selected time intervals during the phase-in period. Public benefit-cost analyses were conducted in three areas:

- Energy consumption
- Environmental effects
- Congestion/traffic levels

The results of the analyses are directly dependent on the market size estimate, current congestion and traffic levels, established emission inventory models, and the fraction of commuter cars driving in and around major cities.

3.4 Suggest Action Plan for Caltrans

The final task is to develop an action plan for the State of California. The suggested action plan represents a proactive approach for developing the required research information, public agency initiatives and strategies to promote the concept—from the consumer as well as the government perspective. The action plan is intended to balance public sector investments against achieved returns to society.

4.0 FINDINGS

4.1 Analysis of Information on Small Vehicles

A partial list of documents reviewed for this report can be found in the References section. The information reviewed included preliminary market surveys, market estimating techniques for small vehicles, and automobile market data for the State of California.

Using the existing information, a profile of the commuter car customer can be developed. The commuter car, as its name implies, offers substantial benefits to those who travel to work by automobile and who typically drive alone. A small vehicle is far more maneuverable than a full-size automobile and, like a motorcycle, can accelerate and brake quickly. These factors can reduce travel time for a small vehicle compared to a full-size car. Furthermore, the economics of the vehicle—i.e., low purchase price and low operating costs—will attract an economy-minded vehicle owner.

The commuter car is also well suited to multi-car households. The commuter car may be able to replace that second or third vehicle used to drive to a train station or to run errands around town. Second and third cars in a household are often older, used cars which have higher emissions and lower fuel economy than more recent models.

Overall, preliminary market surveys suggest that the commuter car appeals to a fairly mainstream segment of buyers. These buyers are generally economy minded and commute both short and long distances—but not too long. The results of surveys conducted at EPCOT indicate that about half the visitors to the theme park would consider purchasing the vehicle if it became commercially available. The acceleration and high speed of the vehicle could attract drivers who demand high levels of performance, and the outstanding projected fuel economy offers a significant incentive to purchase one of these vehicles for driving to and from work. The survey results reveal that the characteristics of the commuter vehicle appeal particularly to young families, especially in the 25 to 34 demographic group.

4.2 Life-Cycle Cost Comparison

One of the main attributes of the commuter car is its lower ownership costs compared to standard width automobiles. The commuter car is projected to cost about $8,500 and will have lower operating costs due to its high fuel economy, low weight and mechanical simplicity.

A life-cycle cost analysis was performed to compare the specific advantages of the commuter car. In order to make the comparison, certain assumptions were used concerning the life, maintenance costs, insurance charges, and registration fees of the commuter car. These assumptions are summarized in **Exhibit 3.**

EXHIBIT 3

Summary of Assumptions Used in Life-Cycle Cost Analysis

Assumptions Unique to Each Car Type	
Conventional Passenger Car	Commuter Car
1. Achieves 24 mpg fuel economy	1. Achieves 120 mpg fuel economy
2. Average vehicle purchase price: $15,000	2. Average vehicle purchase price: $8,500
3. Registration fee: 3% of car's value per year	3. Registration fee: 1.5% of car's value per year
Assumptions Common to Both Car Types	
1. Vehicle life: 12 years	
2. Average annual inflation rate: 3.0% per year	
3. New vehicle loan interest rate: 7.5% per year	
4. Gasoline price: $1.35 per gallon	
5. Auto loan terms: 4-year loan with 20% down payment	
6. Mileage accumulation: 10,000 miles per year	

Note that to make the operating costs more comparable, parameters such as mileage accumulation and vehicle life were assumed to be identical for both the commuter and conventional cars. An important factor included in the analysis is fuel economy, with the commuter car consuming five times less fuel than the standard automobile. Moreover, if financial incentives—including reduced registration and parking fees, and waiver of bridge and road tolls—are adopted by state regulators, the operating costs of the commuter car would be further reduced. For this analysis, only reduced registration fees were considered. We assumed that the costs of registering a commuter car would be 50 percent lower than for a conventional automobile.

Using the listed assumptions for each scenario, capital and operating expenses were calculated for each vehicle. A summary of vehicle ownership expenses is presented in **Exhibit 4**.

EXHIBIT 4
Summary of Vehicle Ownership Expenses

Expense	Conventional Car	Commuter Car
Purchase Price	$15,000	$8,500
Maintenance Cost/Mile	$0.09	$0.08
Registration Fee	3%	1.5%
Annual Insurance	$750	$750

Note: 1. Passenger car maintenance costs are from MVMA Facts & Figures '92.
2. Commuter car maintenance costs are taken from data contained in MVMA Facts & Figures '92, for motorcycles.
3. Insurance costs for both vehicles are assumed to be comparable, although the commuter car may actually have lower premiums (similar to motorcycles).

Our estimates for maintenance and insurance costs as shown in **Exhibit 4** are conservative for the commuter car; the actual costs for commuter car are likely to be even lower than the values used in this analysis. Total lifetime registration fees were calculated based on the sum of annual fees as a percentage of the depreciated value of the vehicle. An accelerated depreciation schedule was used for the 12-year life of each vehicle type. These expenses were added to the amortized purchase price to obtain the total lifetime vehicle expenses. The present value of each expense was then calculated using an average annual inflation rate of 3 percent. The results of the analysis are very favorable for the commuter car, as shown in **Exhibit 5**.

The results reveal that the commuter car enjoys a great advantage in total fuel costs, with an 80 percent cost savings. The capital cost comparison also yields a distinct, though less dramatic advantage, for the commuter car, with a 43 percent savings in today's dollars. On a cost per mile basis, the commuter car is 36 percent less expensive per mile compared to a passenger car—$0.23 per mile versus $0.36 per mile total cost for the conventional car. ***The results of this analysis show that the economics of the commuter car provide considerable incentive for ownership.***

EXHIBIT 5
Net Present Value of Total Life-Cycle Cost of the Commuter Car Compared to a Conventional Full-Width Automobile

	Conventional Car	Commuter Car	% Cost Savings for Commuter Car
Expense			
Capital	$18,210	$10,319	43%
Fuel	$5,533	$1,107	80%
Maintenance	$8,952	$7,869	12%
Other	$10,452	$8,095	23%
Total Expenses	$43,147	$27,544	36%
Total Mileage	120,000	120,000	—
Total Cost/Mile	$0.36	$0.23	36%

4.3 Development of Market Share

The objective of this task is to estimate the potential market of the commuter car in California. A sound first step in the analysis is to characterize the customer likely to purchase the product and the environment in which the product will compete. Based on the profile of the customer and the marketplace, selected approaches to generating market estimates were developed.

In order to characterize the customer, we asked ourselves several questions to identify the potential commuter car buyer:

- What drives the market? Is it multi-car families or personal lifestyles? Commute distance? Public sector accommodations?
- Is energy consumption a market driver?
- What infrastructure incentives exist, and what are their effects?
- To what extent will licensing fees and parking costs enhance the market potential of the concept?

The following information on the California automobile market was used to perform the analysis:

- Selected California demographic data
- Demographic data on new car buyers
- Registered vehicle owners in California
- Licensed California drivers
- California sales of selected vehicle models

Although many factors drive the commuter car market, infrastructure incentives will probably have the greatest effect on consumer interest in the commuter car. Several infrastructure modifications and incentives were tested during the preliminary market surveys. In general, potential consumers were interested by incentives that reduced trip time, eased parking constraints and lowered overall vehicle operating costs. Road network modifications such as dedicated freeway and arterial lanes and increased parking availability are detailed in References 1 and 2. Other incentives related to infrastructure include discounted license tags and registration fees and reduced parking costs.

Our approach to estimating the market involves developing three independent assessments of the market potential based on different approaches:

- Method 1: Preliminary Market Survey Estimate
- Method 2: California Sales Estimate
- Method 3: Market Segmentation Estimate

4.3.1 Method 1: Preliminary Market Survey Estimate

Our approach in this method is to develop a market estimate from information on the potential customer as revealed in the preliminary market surveys, and to relate that information to documented travel and demographic information about the California driver. The data sources used for this method include reports issued by the State of California (reference 2), Federal Highway Administration (reference 3) and US Census Bureau (reference 4).

By characterizing the potential commuter car buyer, an estimate of the market can be derived based on driver registration and census data. The analysis relies on the assumption that the segment of the population that commutes to work is most likely to purchase a commuter car. The first filter applied to the population is the number of licensed drivers between 25 and 44 years old. We learned from the preliminary market surveys that the vehicle appeals particularly to younger, college-educated adults. Therefore, the 25 to 44 demographic group represents a likely segment of the population to purchase this vehicle. The surveys indicate that drivers older than 45 would not be attracted to the vehicle because of their presumably higher income and therefore lower sensitivity to operating costs. Younger drivers under 25 typically own only one car, and the commuter car with its limited interior space may not be able to fulfill all of their transportation needs.

The next filter applied is the percentage of drivers that commute to work. We used California census data indicating that 67 percent of all residents 16 years and older commute to work by car or truck and applied this percentage to the number of 25 to 44 year-old drivers. This is a conservative estimate since the percentage of commuters in the 25 to 44 subpopulation is probably much higher than in the larger 16 and above population.

The last filter is the percentage of people among 25 to 44 year-old commuters likely to purchase the commuter vehicle. The EPCOT market survey information indicates interest from a maximum of about 55 percent of the target segment of the driving population. In turn, the minimal appeal would be approximately 20 percent of the target segment. **Exhibit 6** summarizes the assumptions used in developing a market estimate based on consumer identification and population data.

EXHIBIT 6

Commuter Car Market Estimate Based on Market Survey Population

Market Definition	Filter	Resultant Segment
Licensed California drivers ages 25 to 44	not applicable	12,022,017[1]
Subpopulation with at least a college degree	23.4%[2]	2,813,152
Percent of population that works	67%[2]	1,884,812
Percent of working population that commutes	86.2%[2]	1,624,708
High Market Estimate	55%[3]	893,589
Low Market Estimate	20%[3]	324,942

Notes: 1. Federal Highway Administration, Highway Statistics, 1991
2. 1990 census data for California
3. Based on preliminary market survey data conducted for the vehicle developer and data collected at EPCOT.

Estimating the commuter car market using this approach yielded a high estimate of the potential market at saturation of 893,589 commuter cars and a low vehicle population estimate at saturation of 324,942 commuter cars. These values represent about 5 and 2 percent, respectively, of the entire vehicle population in California.

4.3.2 Method 2: California Sales Estimate

This method relies on production data on new passenger cars and available demographic data on new car buyers. An approach similar to that developed in Method 1 was used in that filters are applied to the baseline dataset to obtain the market estimate.

The number of vehicles produced for sale in California is the starting point for this methodology. The Air Resources Board (ARB) reports that 810,113 vehicles were produced for sale in California in 1992 (reference 5). General data on new car buyers published by MVMA (reference 6) were applied as filters to this data. Assuming that all of the vehicles produced for sale were actually sold, roughly 43 percent of the customers that purchased new vehicles were 25 to 44 years of age—the target demographic group for the commuter car. We had also defined the customer as economy-minded, so the estimate must be refined to capture economy-minded drivers within the 25 to 44 age group. Median household income was used to filter the group further. Buyers with median household income of less than $50,000 annually would clearly represent a segment of the buying population that is interested in purchasing a low-cost car. That income range encompasses 53 percent of all new car buyers.

At this point in this analysis, the buying public in California has been segmented into 25 to 44 year old buyers with median income of less than $50,000 to yield a total market potential of 184,625 or 22.8 percent of the buyers in California. Clearly, the commuter car would not fulfill the transportation requirements of all of these consumers, so we must estimate a range of market potential based on other information. It is reasonable to assume based on the preliminary survey data that interest among the drivers in the buying group is at most 55 percent. Therefore, our market high estimate for this analysis was 101,544 vehicles potentially purchased in 1992. To derive the low end of the range, we utilized an estimate of 20 percent to yield 36,925 vehicles purchased in the first year. **Exhibit 7** summarizes the analysis. Assuming a 12 year vehicle life, the saturated market potential would be 443,100 and 1,218,528 vehicles for the low and high cases, respectively.

EXHIBIT 7

Commuter Car Market Estimate Based on California Sales Data

Criteria	Filter	Resultant Population
Number of vehicles produced for sale in California in 1992	not applicable	810,113
Percentage of buyers of new cars within ages 25 to 44	43%[2]	348,349
Percentage of new car buyers with income less than $50,000 per year	53%[2]	184,625
High Market Estimate	55%[3]	101,544
Low Market Estimate	20%[3]	36,925

Notes:
1. MVMA Motor Vehicle Facts and Figures, 1992
2. MVMA Motor Vehicle Facts and Figures, 1992
3. Based on preliminary market survey data conducted for the vehicle developer and data collected at EPCOT.

4.3.3 Method 3: Market Segmentation Estimate

In Method 3, a broad analysis was performed utilizing existing vehicle sales and demographic data to determine the substitute potential of the commuter car plus its market expansion potential. Because there are no statistics available to substantiate the appeal of the commuter vehicle in the market segments considered in this approach, the method relies heavily on "best estimate" projections. These projections are based on our knowledge of the automotive market and the characteristics of the commuter car, as well as preliminary market surveys. The projections are not intended to be definitive; rather, they represent only one informed estimate of the potential market for the commuter vehicle.

As revealed during the initial market surveys, the commuter car has four major characteristics that may attract car buyers:

- High fuel economy
- Low initial cost
- Sporty handling and performance
- Access to preferential lanes and parking

Each of these characteristics represents a market segment for the commuter car. The approach in Method 3 is to estimate the appeal of the commuter car in each segment and then sum together all the estimates to obtain the total potential market for the commuter car.

High Fuel Economy. The size of the market for highly fuel-efficient vehicles can be estimated by examining current sales of the cars with the highest fuel economies. In 1992 five passenger car models had an average combined fuel economy (city + highway) greater than 37.5 miles per gallon. **Exhibit 8** lists these models, together with their fuel economy and the 1992 California retail sales of the 2-door coupe versions. In some cases, the vehicles also come in 4-door versions, but these vehicles were excluded from this analysis. The 4-door sedans generally had lower fuel economy, and people purchasing 4-door vehicles are likely to want to carry more passengers or cargo than would be possible in the commuter car.

EXHIBIT 8
California Sales of High Fuel Efficiency Cars, 1992
2-Door Coupe Sales Only

Make/Model	City/Hwy	1992 Sales
Geo Metro	53/58	5,262
Suzuki Swift	46/50	468
Honda Civic	42/48	12,818
Daihatsu Charade	38/42	619
Ford Festiva	35/41	2,202
TOTAL		21,369

As shown in **Exhibit 8**, the total market for 2-door, high fuel efficiency autos was 21,369 units in 1992. Since retail sales of cars in California totaled 505,309 units in 1992 (reference 7), sales of 2-door, high fuel economy autos represented about 4.2 percent of total retail sales that year. Note that retail sales include only those cars sold directly to individual end-users and exclude fleet vehicles (including daily rental fleets). It is possible that some fleet operators may choose to buy the commuter car, but for the purposes of this analysis, sales to fleet owners were not considered.

The commuter car has an estimated fuel economy of about 120 miles per gallon, more than two times higher than the top-ranked vehicle in the market today (the Geo Metro). Thus, the market share of the commuter car among consumers primarily attracted to high fuel economy is likely to be substantial. We estimated that a commuter car can capture a maximum of 50 percent of total sales in this market segment (10,685 units), or 15 percent (3,205) at a minimum.

Low Initial Cost. According to statistics published by MVMA (reference 6), the median price of a new car in 1990 was $15,760. Seven percent of the new cars purchased that year were priced below $10,000. This figure can be used to estimate the market share of the most price-conscious car buyers in California: 7 percent of the 505,309 non-fleet cars sold in California in 1992 is equal to 35,372 low-cost cars.

A listing of the lowest priced models and their 1992 California retail sales is provided in **Exhibit 9**. It can be seen from the Exhibit that all of the high fuel economy cars identified in **Exhibit 8** are included on the low cost list. Therefore, to avoid double-counting, the number of high fuel economy cars was subtracted out to yield an estimated California market size of 14,003 cars that were purchased only for their low costs (35,372 - 21,369 = 14,003).

Although the selling price of the commuter car has not been firmly established, its initial cost will likely be about $8,500. At $8,500, the vehicle would be priced similarly to popular subcompacts like the Toyota Tercel and Geo Metro and higher than models like the Hyundai Excel and Ford Festiva. We estimate that at a minimum, the commuter car would garner 10 percent of the low-cost segment for a total of 1,400 vehicles. If fuel and maintenance savings are factored in by the consumer, the commuter car might capture a maximum of 50 percent of this market segment (7,001 units).

EXHIBIT 9
1992 MY Low-Cost Vehicles
California 2-Door Coupe Sales

Make/Model	1992 Sales
Yugo GV	6
Subaru Justy	167
Mitsubishi Precis	173
Hyundai Excel	3,472
Daihatsu Charade	619
Suzuki Swift	468
Ford Festiva	2,202
Toyota Tercel	13,616
Geo Metro	5,262
Mazda 323	1,051
Dodge Colt	1,082
Eagle Summit	404
Mitsubishi Mirage	507
Volkswagen Fox	705
Honda Civic	12,818
Plymouth Sundance	979

Sporty Handling and Performance. Another attribute of the commuter car identified in the initial market surveys is its fun-to-drive nature. Its sporty handling, quick acceleration, and ability to maneuver in and out of traffic may attract some performance-oriented consumers. The commuter car may therefore have appeal as a substitute vehicle among motorcyclists and sports car enthusiasts.

In 1992, 42,270 on-highway motorcycles were produced for sale in California. The commuter car improves upon several attributes of a motorcycle. Compared to a motorcycle, the commuter car has higher fuel economy (120 vs. 50 mpg), can be driven under all weather conditions, and is safer in crash situations. However, it cannot duplicate the open-air experience, convey the same social image, or quite match the maneuverability of a motorcycle. We estimated conservatively that the commuter car could capture from 5 to 30 percent of the motorcycle sales per year (2,114 to 12,681 units).

Low and moderately priced sports cars, ranging from the Honda Civic CRX to the Ford Mustang, accounted for nearly 12 percent of total retail car sales in California in 1992 (**Exhibit 10**). The portion of this market that the commuter car can capture will likely be very small. While the commuter car can equal or exceed the performance of conventional sports cars, it has very limited interior space and may not carry the same status as some of the pricier sports cars in this segment. As such, we estimated that the commuter car could capture only 1 to 10 percent of the low and moderately priced sports car segment for a total of 585 to 5,852 vehicles.

Access to Preferential Lanes and Parking. If infrastructure incentives are implemented, the market for commuter vehicles may increase substantially. In addition to being a substitute for low-cost, high fuel economy and sporty cars or motorcycles, providing infrastructure incentives may ***expand*** the new vehicle market. If the infrastructure incentives resulted in greatly reduced commute times or costs, it is possible that the commuter car would be purchased in place of a new or used car solely to take advantage of the incentives. Infrastructure incentives for the commuter vehicle could range from access to carpool lanes and reduced parking fees, to dedicated freeway lanes and flyovers at intersections.

To estimate the possible effect of infrastructure incentives, we examined data on the number of vehicles per household in California. According to the 1990 Census (reference 4), 8.9 percent of all California households have no vehicles, 33.2 percent have one vehicle, and 57.9 percent have two or more vehicles. If only a low level of infrastructure incentives was implemented (such as the ability to use carpool lanes), we roughly estimated that only 1 percent of households with no vehicles or one vehicle would purchase a commuter car, while up to 5 percent of households with two or more vehicles would do so. If a high level of infrastructure incentives was implemented (such as flyover lanes dedicated to commuter vehicles), then up to 5 percent of households with none or one car and up to 25 percent of households with two or more vehicles may purchase a commuter car. The results of these estimates are summarized in **Exhibit 11**.

EXHIBIT 10
Low and Moderately Priced Sports Cars
1992 California Retail Sales

Make/Model	1992 Sales
Chevrolet Camaro	5,183
Geo Storm	4,921
Dodge Daytona	318
Eagle Talon	985
Ford Mustang	4,112
Ford Probe	4,446
Honda Civic CRX	899
Honda Prelude	4,668
Hyundai Scoupe	1,741
Isuzu Impulse	500
Mazda MX3	2,675
Mitsubishi Eclipse	3,608
Nissan NX1	850
Nissan NX2	539
Nissan 240SX	3,311
Plymouth Laser	1,087
Pontiac Firebird	1,618
Saturn SC	3,239
Subaru XT	3
Subaru XT6	2
Toyota Celica	3,863
Toyota MR2	1,056
Toyota Paseo	5,985
Volkswagen Corrado	476
TOTAL	**58,520**

EXHIBIT 11
Summary of Commuter Car Estimates
Based on California Household Data

Total CA Households	10,381,206
Households w/no vehicles	923,927
Households w/one vehicle	3,446,560
Households w/two+ vehicles	6,010,718
Low Scenario	
1% of households w/no vehicles	9,239
1% of households w/one vehicle	34,466
5% of households w/two+ vehicles	300,536
Total Low Scenario	**344,241**
High Scenario	
5% of households w/no vehicles	46,196
5% of households w/one vehicle	172,328
25% of households w/two+ vehicles	1,502,680
Total High Scenario	**1,724,204**

The values highlighted in **Exhibit 11** reflect the total saturated market for the commuter vehicle, unlike the previous analyses for substitute cars and motorcycle which were in terms of annual sales. The values derived from the household data represent our estimates of the total population of commuter vehicles that would result from the phase-in of infrastructure incentives for commuter vehicles.

Results of Method 3. Our estimates of the total minimum and maximum sales of commuter vehicles using the market segmentation approach are summarized in **Exhibit 12.** To calculate equivalent annual sales resulting from the infrastructure incentives market segment, we assumed an annual commuter car purchase rate of 7 percent, which is equivalent to the average vehicle retirement rate in California. Further, the portion of the market already attributed to people buying commuter cars for their high fuel economy, low cost, and sporty handling as a substitute for existing cars was subtracted from the total annual sales to avoid double-counting (the market share for substituting motorcycles was not subtracted since this segment represents an expansion of the car market, and no double-counting occurs). These calculations result in ***average*** annual sales ranging from 26,210 to 133,165 commuter cars per year. The average annual sales shown in **Exhibit 12** are presented only for comparison with Methods 1 and 2, and are not used for any subsequent benefit calculations.

EXHIBIT 12
Total Commuter Vehicle Market Projections
Range of Potential Sales per Year

Market Segment	Low Case	High Case
Fuel Economy	3,205	10,685
Low Cost	1,400	7,001
Sporty Performance - motorcycles - sports cars	 2,114 585	 12,681 5,852
Infrastructure Incentives	18,906	96,946
TOTAL	**26,210**	**133,165**

4.3.4 Summary of Market Estimates

The three approaches for estimating the commuter car market yielded a range of potential market sizes. The estimates ranged from 324,936 vehicles to 1,721,204 at market saturation. **Exhibit 13** summarizes the results of each approach.

EXHIBIT 13
Summary of Market Estimation Methodologies

	Method 1	Method 2	Method 3	Average
Average Annual Sales				
High	74,466	101,544	144,277	106,762
Low	27,078	36,925	28,834	30,946
Average	50,772	69,235	86,556	68,854
Saturation				
High	893,592	1,218,528	*1,731,324*	1,281,148
Low	*324,936*	443,100	346,008	371,348
Average	609,264	830,814	1,038,666	826,248

Exhibit 13 illustrates several critical points in understanding the market. Method 1 was developed using existing licensed population information for the target demographic group. The estimates were lower than those developed using the other two approaches, which we would expect since there are potential buyers under 25 and over 44 and without a college education excluded from the market estimate. Furthermore, in Method 1 no attempt was made to develop the incremental market expansion that might develop from the introduction of such an innovative vehicle.

Like Method 1, Method 2—the California sales method—did not account for market expansion; however, it did capture many potential buyers by including all 1992 car buyers who make less than $50,000 per year. There will remain a portion of the market that is unaccounted for due to unusual buying preferences not included in the filters. By and large, however, the bulk of the potential market should be accounted for within this estimating technique.

Using Method 3—the substitute vehicle approach, the highest saturated market estimate was produced. This approach includes fairly conservative estimates of the market produced by infrastructure incentives. The approach also encompasses market share predictions concerning economical, low price, inexpensive and sporty automobiles, motorcycles and second cars in multi-car households segments that can be captured by the commuter car. The high estimate from this method represents the upper bound to the market potential since it considers the best case of success for the commuter car in several existing market segments, as well as expansion of the new vehicle market.

It is appropriate to present a market range for use in the benefit/cost estimations. The low case in Method 1 which did not include new market estimations is the lower bound while the high case in Method 3 provides the upper bound of the market projection. To calculate the benefits of the commuter car, models of the potential annual sales and population growth over a 20 year period were developed. Because little is known about how quickly consumers will accept the commuter vehicle, very simplified market models were used.

For the low-case scenario of Method 1, we assumed that the annual population growth of the commuter car would be linear, and that the commuter vehicle would be purchased as a replacement for new and used cars in equal proportions. The total California vehicle population was assumed to remain constant at 17,000,000 units per year, and the commuter car market would reach saturation after 15 years.

For the high-case scenario of Method 3, sales of the commuter car were assumed to remain constant for the first five years after introduction as economy and performance conscious consumers purchase the vehicle as a substitute for existing cars and motorcycles. After the fifth year, sales of the commuter vehicle would increase linearly as substantive infrastructure incentives begin to phase in. Beginning in the sixth year, 40 percent of commuter car buyers would buy the commuter car in place of a new car, while 60 percent would purchase it instead of a used car or motorcycle. Commuter car substitution for motorcycles would remain constant at 30 percent of motorcycle sales per year. Except for the expansion of the vehicle market caused by substitution of the commuter car for motorcycles, the total vehicle population was assumed to remain constant at 17,000,000 units per year.

Exhibit 14 illustrates the total commuter car population growth for the two market scenarios developed. **Exhibits 15** and **16** illustrate the annual sales projections of our models. ***While we recognize that the models may not accurately reflect the likely penetration rates of the commuter car, t hey do represent a***

reasonable approximation for use in calculating the societal impacts of the vehicle Sensitivity analysis performed for the cost-benefits calculations indicates very little changes in the overall results for reasonable deviations from our market growth scenarios.

EXHIBIT 14
Estimated Commuter Car Population for High and Low Market Scenarios

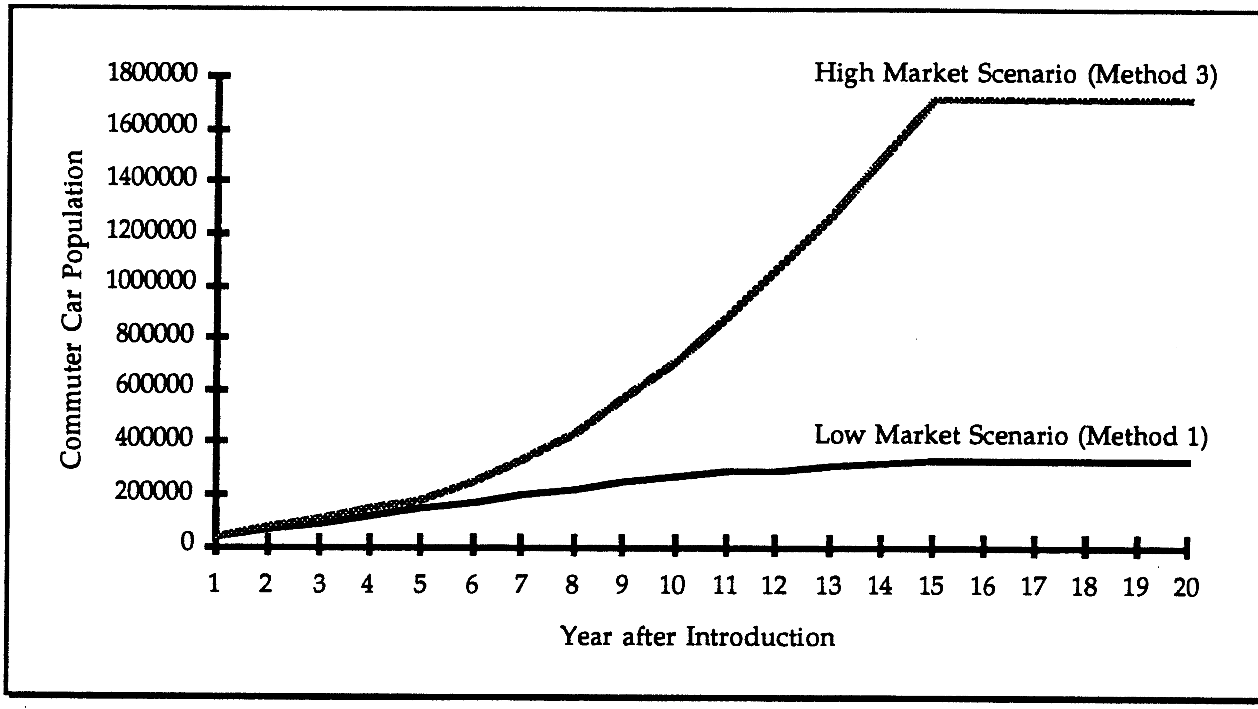


EXHIBIT 15
Sales Scenarios Assumed for Low Market Case (Method 1)

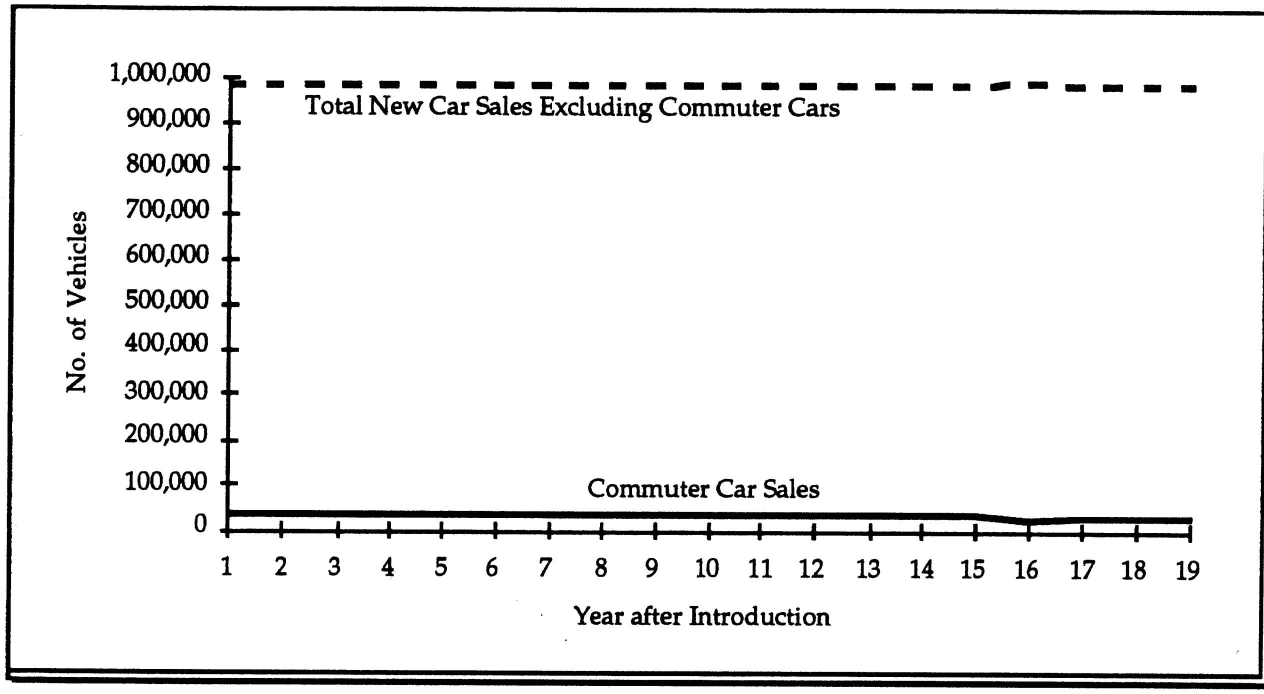
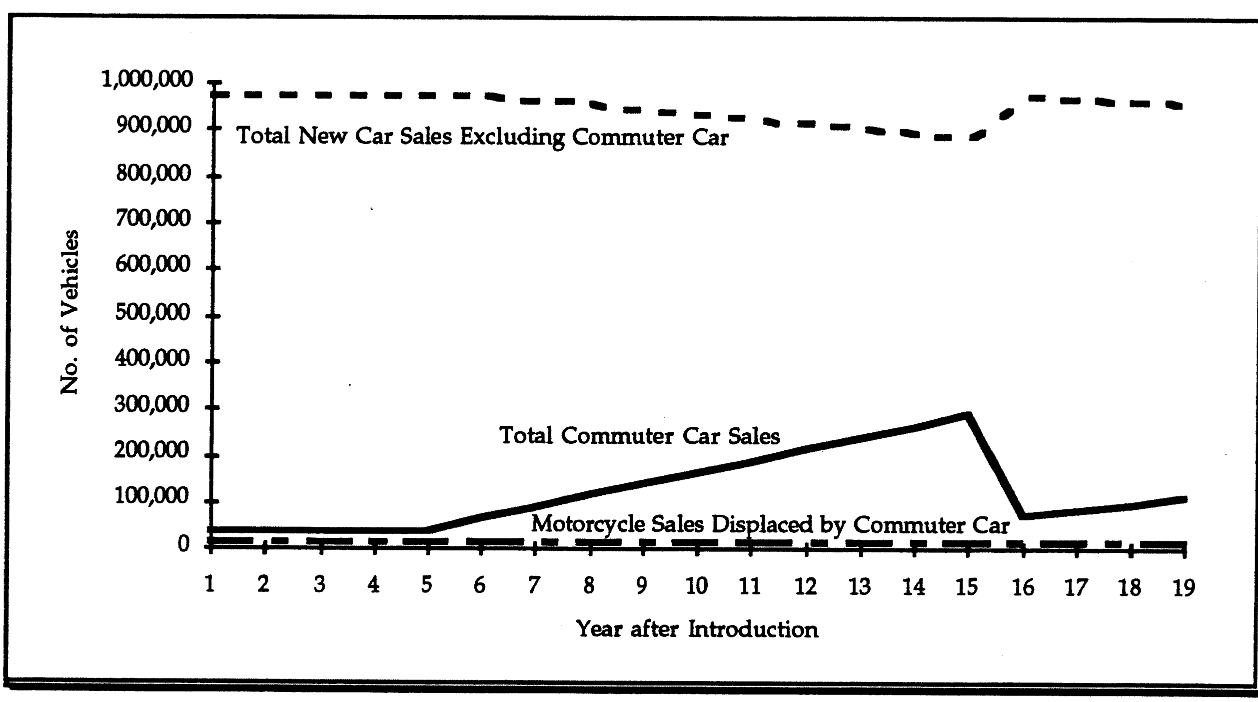


EXHIBIT 16
Sales Scenarios Assumed for High Market Sales (Method 3)



4.4 Benefit-Cost Analysis

This section summarizes the results of the benefit-cost analyses performed for the commuter car. The magnitude of societal benefits is driven directly by the size of the market and other assumptions used in the analysis. Sensitivity analysis was conducted to test the potential effects of changes to the baseline market estimates used for the analysis. The benefits of the commuter car were calculated in three areas:

- Energy use/fuel economy
- Emissions effects
- Traffic flow/freeway congestion

4.4.1 Energy Use/Fuel Economy

The United States currently imports approximately 70 percent of petroleum fuels required for transportation use. In 1991, the State of California consumed approximately 13 billion gallons of gasoline. Clearly the high fuel efficiency of the commuter car offers an opportunity to reduce California's dependence on foreign petroleum.[1] The commuter car offers considerable improvements in fuel economy compared with even the most fuel efficient automobiles available today. The projected fuel economy of 120 miles per gallon of gasoline is well above the average fleet fuel economy of 23.7 miles per gallon projected by the ARB for California catalyst-equipped passenger cars (reference 8), and about twice as high as the most efficient subcompacts—the Geo Metro and Honda Civic. The magnitude of the gasoline savings achieved by the commuter car will be driven directly by the success of the commuter in penetrating the automotive market.

In order to evaluate the public sector benefits, a comparison was performed for three market scenarios:

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1 For this analysis, we have assumed that the commuter car operates on gasoline. If the vehicle was designed to run on an alternative fuel such as methanol, the total petroleum savings would be more substantial. However, it does not appear likely that a comprehensive refueling infrastructure will be developed for an alternative fuel within the next decade. Thus, we have chosen to model the fuel savings benefits of the commuter car based solely on gasoline operation.

- Baseline: No Commuter Car
- Low Commuter Car Market Growth
- High Commuter Car Market Growth

The projected vehicle penetration rates shown in **Exhibit 14** for the low and high commuter car market growth scenarios were used. For the baseline case, we assumed that the total car population would remain constant at 17,000,000 units (this assumption was basically used in all three scenarios), while the population of motorcycles would remain constant at 1,000,000 units. 1993 was assumed to be the first year of introduction for the commuter car. Using average daily vehicle miles traveled (VMT) and gasoline consumption data published by the ARB, the average fuel economy of the total California fleet of passenger cars and motorcycles was calculated for the baseline case. The results of this calculation are presented in **Exhibit 17.**

EXHIBIT 17
ARB Projections for Fuel Economy
Catalyst-Equipped Automobiles and Motorcycles

	Passenger Cars (w/catalysts)		*Motorcycles*	
Year[1]	**Av. Daily VMT**	**Fuel Economy**	**Av. Daily VMT**	**Fuel Economy**
1993 (1)	34.03	23.73	5.20	47.90
2000 (8)	33.60	26.86	5.19	48.06
2005 (13)	33.48	28.48	5.19	48.06
2010 (18)	33.41	29.19	5.18	48.06

Note: 1. The number in parenthesis represents the number of years after the commuter car has been introduced.
2. The results in the table were calculated from Reference 8.

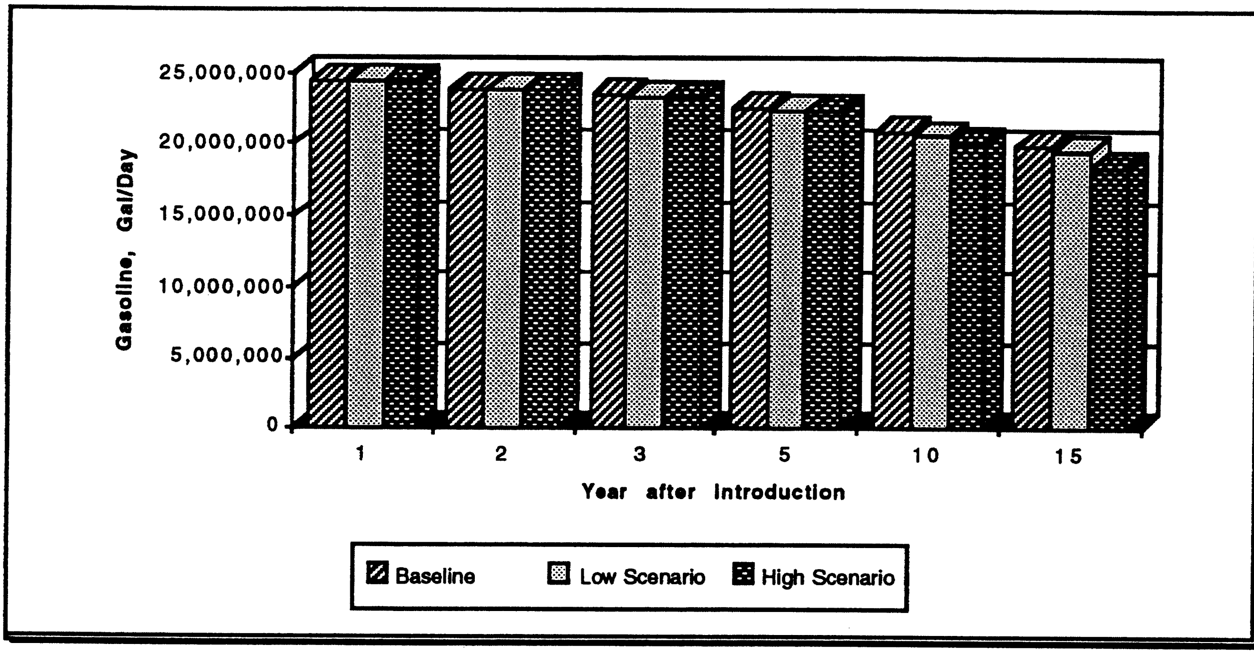
The ARB projects that the fuel economy of passenger cars will improve 23 percent, from 23.73 miles per gallon in 1993 to 29.19 miles per gallon per vehicle in 2010, while the efficiency of motorcycles will remain relatively constant at 48 miles per gallon. The total amount of gasoline used by motorcycles is very low, about 0.5 percent of the amount consumed by passenger cars. Overall, our calculations yielded total gasoline consumption ranging from 24.5 million gallons per day in 1993 to 19.6 million gallons per day in 2010 for the base case passenger car and motorcycle fleet.

The gasoline savings from implementing the commuter car were calculated using the vehicle penetration rates illustrated in **Exhibit 14.** In the low case scenario, the commuter car population was modeled as increasing linearly at about 30,000 units per year up to year 15, where market saturation was reached at 325,000 units. For this case, we assumed that the commuter car would have a fuel economy of 120 miles per gallon and the same average daily VMT as a conventional passenger car. In the high case scenario, the commuter car population was modeled as increasing by about 36,000 units per year up to the fifth year, and then ramping up more quickly after that, leveling out at 1.7 million units in year 15. In this high case scenario, the commuter car was assumed to displace a portion of the motorcycle population. Therefore, to calculate the gasoline savings, we assumed that the majority of commuter cars would have the same average daily VMT as conventional passenger cars, while those commuter cars which were substituted for motorcycles would experience the average daily VMT rates typical for motorcycles. A fuel economy of 120 miles per gallon was used for all the commuter cars.

Exhibit 18 summarizes the results of our fuel consumption calculations. The gallons of gasoline consumed per day by the California car and motorcycle population in each scenario are shown in the exhibit for the first, second, third, fifth, tenth and fifteenth year after introduction of the commuter car.

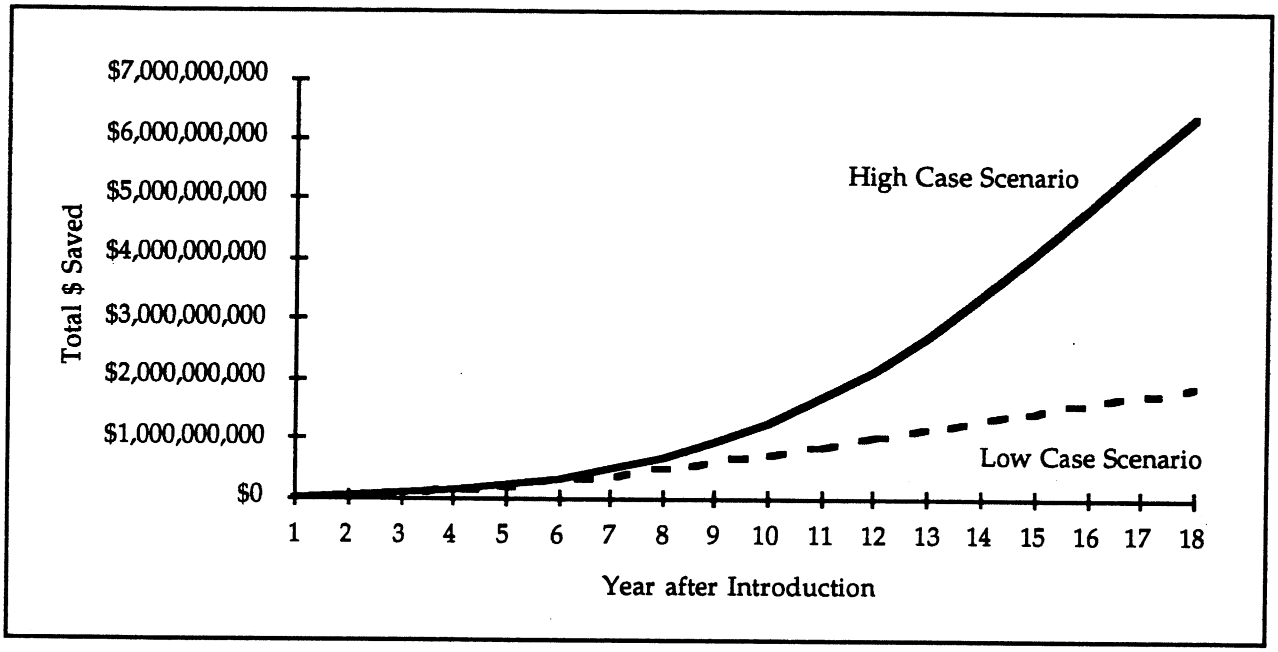
EXHIBIT 18

Comparison of Annual Fuel Consumption



Not surprisingly, the analysis indicates that the benefits of the commuter car are very slight in the first few years after introduction while the commuter car population is very low. The benefits become more substantial after the tenth year. In year 10, the daily gasoline savings range from 252,000 gallons in the low case to 662,000 gallons in the high case. When the commuter car population becomes fully saturated by year 15, the gasoline savings are 302,000 to 1,526,000 gallons per day. Using a constant gasoline price of $1.35 per gallon, **Exhibit 19** summarizes the accrued cash savings from introducing the commuter car into the vehicle population. At market saturation in year 15, the accumulated savings in fuel expenditures are estimated at $4.1 billion in the high market growth scenario, which includes the effect of infrastructure and other public incentives, compared to $1.4 billion per day in the low market growth scenario.

EXHIBIT 19
Accumulated Savings in Fuel Expenditures



4.4.2 Emissions Effects

Substitution of the commuter car for used vehicles and motorcycles can lead to substantial emission reductions on a per vehicle basis. With its small, highly efficient engine, it should be possible for the commuter car to be among the lowest-polluting automobiles in California, able to meet the most stringent emission standards adopted for combustion engine-equipped vehicles. However, the low market penetration rates of the commuter car, together with the dramatic reductions expected in the future car fleet, limit the impact of the commuter vehicle on the total motor vehicle inventory.

The California Low-Emission Vehicle Program. Emission levels of new California cars will decline precipitously in the late 1990's as large numbers of "low-emission vehicles" begin penetrating the vehicle market. Four types of low-emission vehicles have been established:

- Transitional Low-Emission Vehicles (TLEVs)
- Low-Emission Vehicles (LEVs)
- Ultra-Low-Emission Vehicles (ULEVs)
- Zero-Emission Vehicles (ZEVs)

The 50,000 mile certification standards for each of the four low-emission vehicle categories plus the standards applicable to 1992 and 1993 cars are summarized in **Exhibit 20.**

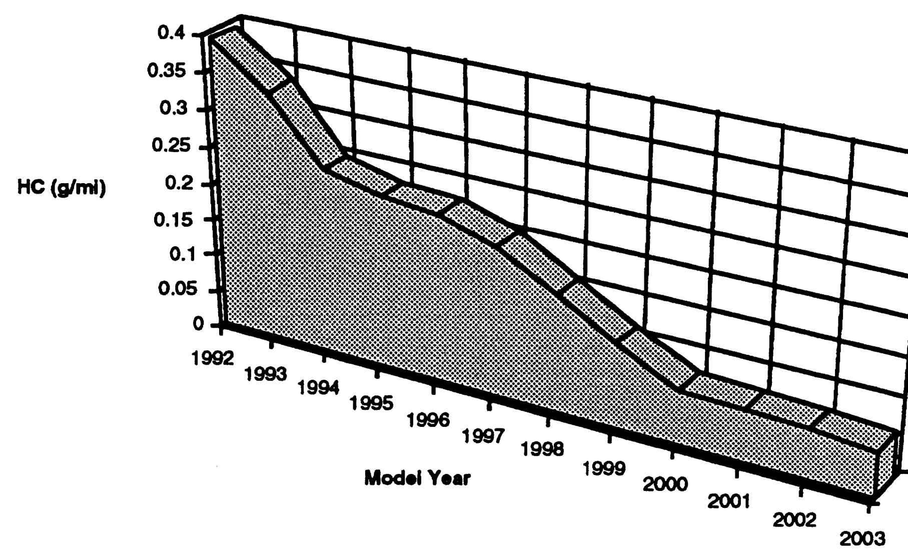
EXHIBIT 20
Summary of 50,000 Mile Emission Standards for New Passenger Cars Sold in California

Vehicle Type	Hydrocarbons (g/mi)	Carbon Monoxide (g/mi)	Nitrogen Oxides (g/mi)
1992 Passenger Cars	0.39	7.0	0.4
1993 Passenger Cars	0.25	3.4	0.4
TLEVs	0.125	3.4	0.4
LEVs	0.075	3.4	0.2
ULEVs	0.040	1.7	0.2
ZEVs	zero	zero	zero

Note: 1. The hydrocarbon (HC) standard is in terms of non-methane hydrocarbons for 1992 and 1993 passenger cars, non-methane organic gases for the low-emission vehicle categories.

The low-emission vehicles will be implemented under a categorized fleet averaging system. Manufacturers will be allowed to sell any combination of vehicles certified to the low-emission vehicle or 1993 passenger car standards as long as the average hydrocarbon emissions of the fleet do not exceed the fleet average requirement established for that year. Manufacturers that come in below the fleet average requirement will earn emission credits which can be saved for use in offsetting future fleet average requirements or sold to other vehicle manufacturers. The fleet average requirement begins at 0.25 g/mi HC in 1994 and drops to 0.062 g/mi HC in 2003, a 75 percent decrease over a ten year period. **Exhibit 21** illustrates the steep decline in allowable hydrocarbon emission levels from new cars over the next decade. Emissions of other pollutants such as carbon monoxide and nitrogen oxides will also be sharply controlled.

EXHIBIT 21
Fleet Average Hydrocarbon Emissions from New Cars, 1992-2003



With the addition of advanced fuel controls and an effective exhaust aftertreatment system, the commuter car is a good candidate for certification as an ULEV, the most stringent low-emission vehicle category achievable by combustion engine vehicles. (The ZEV standards can only be achieved by electric or fuel cell vehicles which do not rely on fuel combustion as the power source.) While some prototype full-size cars have demonstrated the ability to meet the ULEV standards, it will be easier and less costly to equip the commuter car, with its smaller and inherently lower polluting engine, as an ULEV. Certifying the commuter car to the ULEV standards would be a cost-effective means of meeting California's stringent fleet average requirements.

Modeling the Emission Benefits of the Commuter Car. The emission benefits under the high and low market penetration scenarios were calculated to determine the range of impacts that may result from commercializing the commuter car. Consistent with the analyses for congestion and fuel consumption, sales of the commuter car would begin in 1993. Emission factors for new and used cars and motorcycles from the ARB's EMFAC7E and EMFAC7F models were used[2]. The commuter car was modeled as an ULEV, and emission impacts were calculated for the years 2000 and 2010. The emissions of the commuter vehicle over 100,000 miles are plotted in **Exhibit 22** compared to motorcycles and new cars sold in 1993 and 2000.

Under the low-case scenario developed in Method 1, the commuter car would be purchased as a substitute for new and used cars. In the high-case scenario of Method 3, sales of the commuter car would displace new cars, used cars, and motorcycles. Emission benefits would result from substituting the commuter car for used cars and motorcycles, but not for new cars. The fleet averaging approach adopted by the ARB allows a manufacturer the flexibility to offset emissions of vehicles certified to higher emission standards by certifying a portion of its sales fleet to very low standards, as long as the overall emissions of its sales fleet are at or below the fleet average requirement. Therefore, a manufacturer who produces a large number of ULEVs could also produce a similarly large number of higher-emitting TLEVs, thereby negating the benefits of the ULEVs. ***In this analysis, we assumed that there would be no air quality benefits from purchasing the commuter car in place of another new automobile.***

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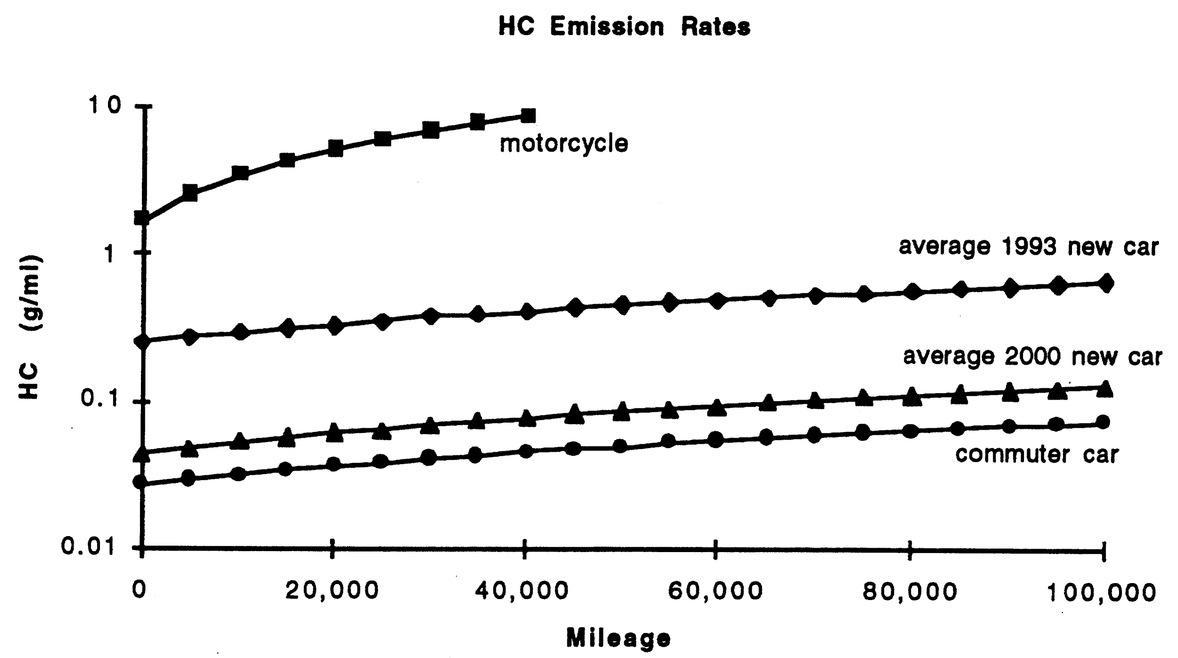
2 When this report was written, EMFAC7F, the ARB's latest emission factor model, was available only in draft form. We used the previous version of the model, EMFAC7E, for nearly all of the emission calculations contained in this report, including those involving registration fractions and average odometer readings. The only exceptions were the zero-mile and deterioration rates for new passenger cars. Because EMFAC7E did not include the effects of the California low-emission vehicle program, the draft EMFAC7F factors were used to model the emission impact of the new passenger cars.

EXHIBIT 22
Emissions of the Commuter Car
Compared to Motorcycles and New Cars Sold in 1993 and 2000
(Based on EMFAC 7E and EMFAC 7F)



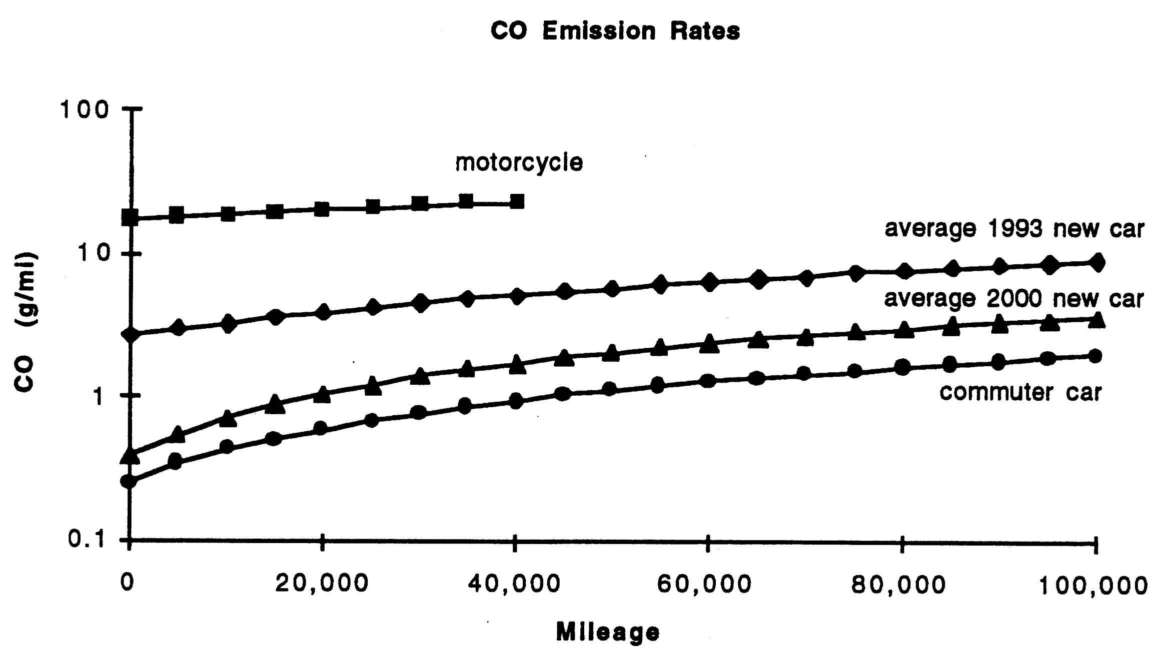
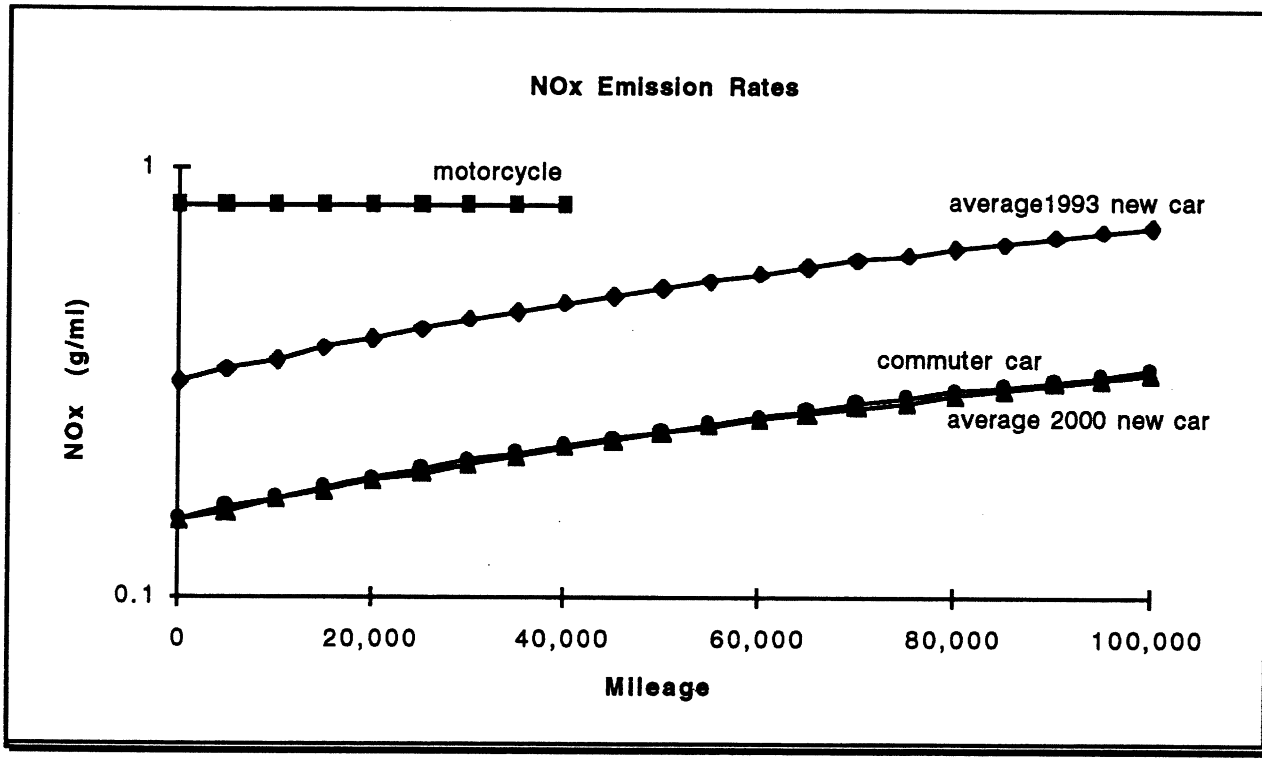


EXHIBIT 22 (continued)



Compared to passenger cars, motorcycles are virtually uncontrolled for emissions. Current standards for motorcycles are very lax, and motorcycles have been designed to maximize performance rather than minimize emissions. As such, the benefits of a commuter vehicle are very dramatic compared to a motorcycle. Based on the ARB's EMFAC models, at 20,000 miles a motorcycle would emit 143 times more hydrocarbons, 34 times more carbon monoxide, and 4 times more nitrogen oxides per mile traveled than a commuter car at the same mileage.

To calculate the effect of replacing motorcycles under the high-case scenario, a commuter car penetration rate of 10.5 percent of the total motorcycle population was used for the year 2000. For 2010, commuter cars were assumed to comprise 12.1 percent of the motorcycle population. These penetration rates were calculated by assuming that commuter cars made up 30 percent of new motorcycle sales beginning in 1993, which is consistent with the assumption used in Method 3 to derive the high-case market scenario. The assumptions used to calculate the benefits of replacing motorcycles with commuter cars are summarized in **Exhibit 23.**

EXHIBIT 23
Assumptions for Calculating Benefits of Replacing Motorcycles
High Market Penetration Scenario Only

	Year 2000	Year 2010
Total population of motorcycles	992,657	1,195,512
Avg. odometer reading (mi) of motorcycles	13,458	13,458
Avg. hydrocarbon emissions (g/mi)	3.96	3.96
Avg. carbon monoxide emissions (g/mi)	19.65	19.65
Avg. nitrogen oxides emissions (g/mi)	0.82	0.82
Commuter car substitution	94,716	144,180
% penetration of commuter cars	9.54%	12.1%
Avg. odometer reading of commuter car (mi)	18,234	20,384
Avg. hydrocarbon emissions (g/mi)	0.035	0.036
Avg. carbon monoxide emissions (g/mi)	0.58	0.61
Avg. nitrogen oxides emissions (g/mi)	0.19	0.19

As previously described, the California fleet of passenger cars is getting cleaner every year as old cars retire and are replaced by low-emission vehicles. Therefore, the model year of the used car replaced by the commuter car will be important to determining the magnitude of the emission reductions obtained. The median age of an automobile in the total vehicle population today is just under 7 years. To calculate the benefits in 2000, we assumed that the substituted used car would be a 1993 model; in 2010, the used car would be first purchased in 2003. The odometer readings of the used vehicles would be just over 80,000 miles in both cases. To check our assumption on the age of the used car, we also calculated the emission benefits assuming that the commuter vehicle replaced an average *new* car in 2000 and 2010. The results indicated less than a 1 percent difference in the emission inventory attributed to passenger cars by assuming the replaced vehicle was 7 years old compared to a brand new car.

A summary of the assumptions used in calculating the emission benefits of the commuter vehicle is presented in **Exhibits 24** and **25**. These assumptions were either derived or obtained directly from the ARB's inventory models, or calculated based on the assumptions outlined previously for determining the market penetration of the commuter vehicle.

EXHIBIT 24
Assumptions for Calculating Benefits of Replacing Used Vehicles
Low Market Penetration Scenario

	Year 2000	Year 2010
Total population of catalyst-equipped cars	16,204,511	18,608,397
Avg. odometer reading (mi) of substituted car	80,408	80,408
Avg. hydrocarbon emissions (g/mi)	0.59	0.095
Avg. carbon monoxide emissions (g/mi)	7.89	2.65
Avg. nitrogen oxide emissions (g/mi)	0.65	0.27
Total commuter car substitution	110,894	162,468
% penetration of commuter cars	0.68%	0.87%
Avg. odometer reading of commuter car (mi)	54,711	69,401
Avg. hydrocarbon emissions (g/mi)	0.052	0.059
Avg. carbon monoxide emissions (g/mi)	1.21	1.47
Avg. nitrogen oxides emissions (g/mi)	0.25	0.28

EXHIBIT 25
Assumptions for Calculating Benefits of Replacing Used Vehicles
High Market Penetration Scenario

	Year 2000	Year 2010
Total population of catalyst-equipped cars	16,204,511	18,608,397
Avg. odometer reading (mi) of substituted car	80,408	80,408
Avg. hydrocarbon emissions (g/mi)	0.59	0.095
Avg. carbon monoxide emissions (g/mi)	7.89	2.65
Avg. nitrogen oxide emissions (g/mi)	0.65	0.27
Total commuter car penetration	124,684	879,329
% penetration of commuter cars	0.77	4.73%
Avg. odometer reading of commuter car (mi)	43,825	67,486
Avg. hydrocarbon emissions (g/mi)	0.047	0.058
Avg. carbon monoxide emissions (g/mi)	1.02	1.43
Avg. nitrogen oxides emissions (g/mi)	0.23	0.28

Results. The results of the emission benefits analysis are summarized in **Exhibits 26** and **27** for the low and high market penetration scenarios, respectively, for reactive organic gases (ROG), CO, and NOx. Note that in the year 2010, the results show that NOx emissions would actually increase slightly from the commuter vehicle in both scenarios. All vehicles including the commuter car would be certified to the same NOx standard beginning in the late 1990's. Additionally, zero-emission vehicles or ZEVs which have no NOx emissions would comprise a small portion of the California fleet. Including the ZEVs, the average NOx emissions of a used car in 2010 (which we modeled as an average new car purchased in 2003) would be slightly lower than for the commuter car.

EXHIBIT 26
Summary of Commuter Car Emission Benefits
Low Market Penetration Scenario

	Year 2000 Emission Reductions (tons per day)		
	ROG	CO	NOx
New Cars	0	0	0
Used Cars	1.56	18.97	1.65
Motorcycles	0	0	0
Total Reductions	**1.56**	**18.97**	**1.65**
Total Vehicle Inventory	728.09	5924.61	1327.83
% of Total Vehicle Inventory Reduced	0.21%	0.32%	0.12%

	Year 2010 Emission Reductions (tons per day)		
	ROG	CO	NOx
New Cars	0	0	0
Used Cars	0.71	8.44	-0.12
Motorcycles	0	0	0
Total Reductions	**0.71**	**8.44**	**-0.12**
Total Vehicle Inventory	723.58	4568.24	1471.59
% of Total Vehicle Inventory Reduced	0.10%	0.18%	-0.01%

EXHIBIT 27
Summary of Commuter Car Emission Benefits
High Market Penetration Scenario

	Year 2000 Emission Reductions (tons per day)		
	ROG	CO	NOx
New Cars	0	0	0
Used Cars	1.77	21.94	1.95
Motorcycles	1.44	6.99	0.46
Total Reduction	**3.21**	**28.93**	**2.41**
Total Vehicle Inventory	728.09	5924.61	1327.83
% of Total Vehicle Inventory Reduced	0.44%	0.49%	0.18%

	Year 2010 Emission Reductions (tons per day)		
	ROG	CO	NOx
New Cars	0	0	0
Used Cars	3.94	46.97	-0.40
Motorcycles	2.29	11.25	0.69
Total Reductions	**6.23**	**58.22**	**0.29**
Total Vehicle Inventory	723.85	4568.24	1471.59
% of Total Vehicle Inventory Reduced	0.86%	1.27%	0.02%

Although substitution of the commuter car for motorcycles and used vehicles can have substantial emission benefits on a one-to-one basis, **Exhibits 26** and **27** reveal that the impact of the commuter vehicle on the overall motor vehicle inventory is very slight, on the order of 1 percent or less. The reason for the small emission impact is due to the relatively low penetration rate of the commuter vehicle, together with the rapid decline in emissions of the overall vehicle fleet as a result of the low-emission vehicle program.

4.4.3. Traffic Flow/Freeway Congestion

The objective of this task is to develop a broad benefit-cost analysis concerning the effects of the commuter car on congestion. Once again, the magnitude of the effects is driven directly by the size of the market that is projected; the accrued benefits become larger as the commuter car market reaches saturation. Since the commuter car will probably be used for going to work or to a train station and for running errands, most commuter car buyers will live in urban areas that experience congested roadways. This discussion of congestion effects is organized as follows:

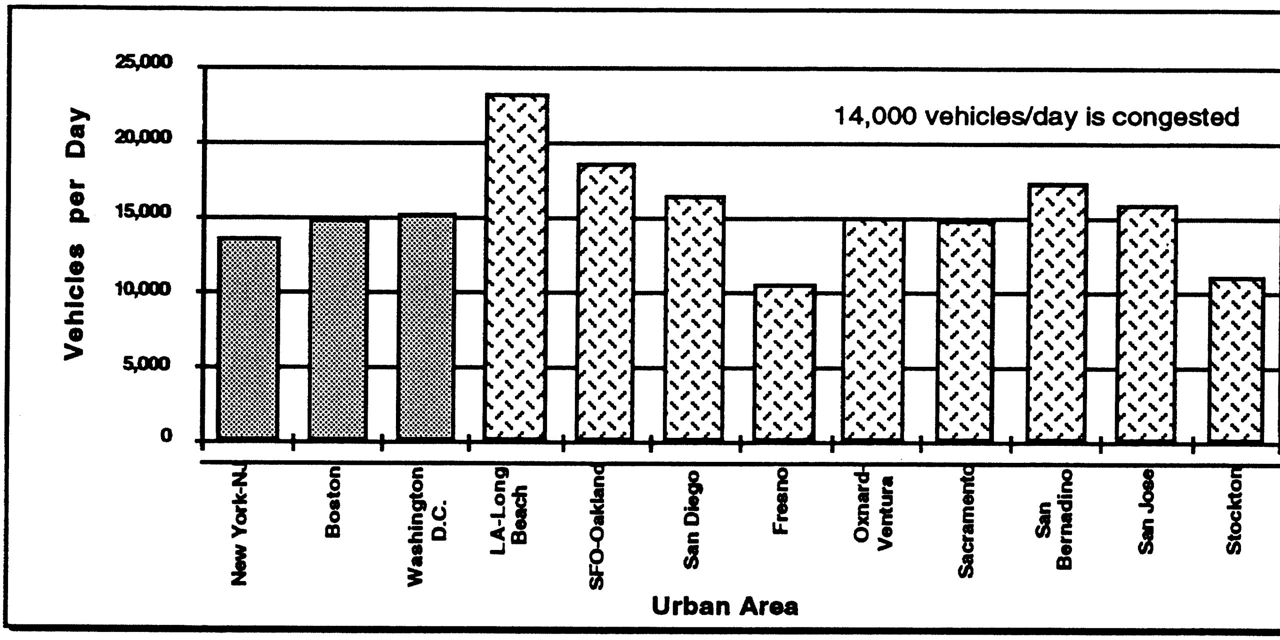
- The Current Situation
- Benefit Calculation
- Public Investment Calculation

The Current Situation. It is appropriate to survey the United States and the State of California to characterize congestion levels. Typically the major East Coast cities of New York, Boston and Washington D.C. are believed to be highly congested. However, as **Exhibit 28** illustrates, many of the most highly congested cities are located in California.

Several urban areas in California exhibit high traffic levels. The Los Angeles-Long Beach Metropolitan Statistical Area at 23,000 daily vehicles per freeway lane tops the selected cities; this represents an average traffic volume of approximately 1,500 vehicles per hour, but peak travel periods are certainly higher—probably by 50 per cent (2,250 vehicles per hour). The Bay Area in northern California also exhibits high traffic congestion, belying the existence of a major public transit system and significantly greater public transit usage than in southern California. San Francisco/Oakland is at 17,000 vehicles per day per lane. In addition, the area is constrained by bottlenecks at bridges throughout the Bay Area. In these situations, infrastructure incentives such as exclusive lanes for commuter cars become particularly important to transportation planners and commuter car owners.

EXHIBIT 28

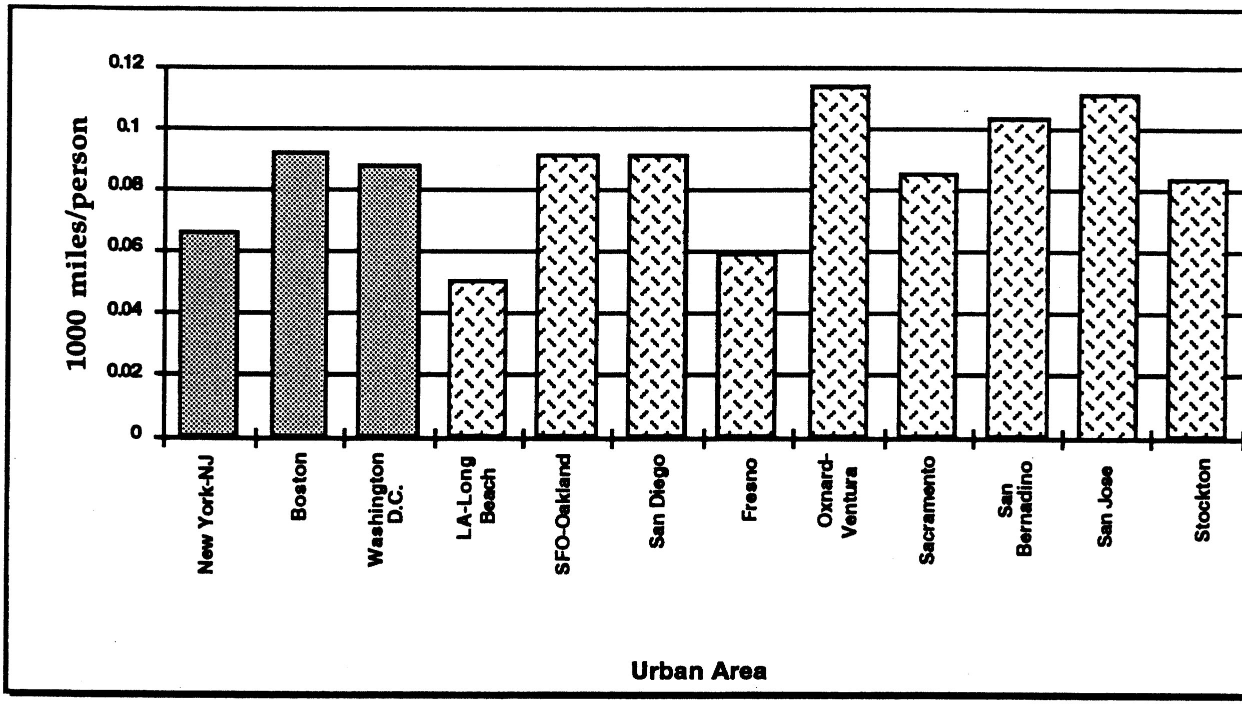
Average Daily Traffic per Freeway Lane



Source: 1991 Federal Highway Administration, Booz·Allen analysis

It is beneficial to obtain an understanding of demand for highway capacity to estimate public benefits. A useful statistical comparison is measuring existing highway infrastructure against the number of residents in the region. From **Exhibit 29**, it can be seen that Los Angeles has a fairly low number of freeway miles relative to its population. Increasing highway mileage clearly would reduce congestion levels in Los Angeles, but much of the area is already built to capacity on existing rights-of-way. Furthermore, as shown in the Study of Road Infrastructure Requirements Report, August 1, 1992, adding capacity is expensive in elevated sections, if existing right-of-way is built to capacity for at-grade roadway.

EXHIBIT 29
Freeway Miles Per Capita



Source: 1991 Federal Highway Administration, Booz·Allen analysis

To evaluate the benefits of the commuter car on congestion, we examined the two major urban areas in California with the highest congestion levels—Los Angeles and the Bay Area. Surveys have been taken that quantify some critical travel statistics for both Bay Area and Los Angeles commuters (references 10 and 11). The reports confirm several factors that may favor the success of the commuter car. First, the drive-alone rate in the Bay Area is nearly 75 percent for commuters. For drivers that normally drive alone, carpooling is the most popular alternative. The average commute to and from work in Northern California is under 30 minutes—or about 17 miles each way. Average vehicle ridership was 1.35 drivers per vehicle in 1992. Survey participants indicate that use of a high occupancy lane for traveling to work reduces the trip time by an average of approximately 40 percent. The Bay Area as defined in this survey encompasses Napa, Sonoma, and Marin counties to the North, Solano, Alameda, and Contra Costa counties to the east, Santa Clara county to the south, and San Francisco and San Mateo counties to the west.

The results of the commuter survey in Southern California are similar and even more favorable to success of the commuter car. One of the most important market factors in Southern California is the multiple origins and destinations of the commuter. The Los Angeles metropolitan area developed much differently from many east coast cities in that there are many "urban centers" where people work. Furthermore, travel times are longer and public transportation options are more limited. The average vehicle occupancy for all trips in Southern California is 1.46, but trips to and from work are quite low at 1.10 people per vehicle. Like the Bay Area, the average commute time in Southern California is approximately 30 minutes. One reason why most people choose to drive to work by personal automobile is because the average commute time by public transit is approximately 50 minutes. The Southern California survey covers Los Angeles, Orange, Riverside, San Bernadino, and Ventura counties.

The most important factors to a commuter in California include flexibility and convenience. These factors become driving forces of mode choice when the additional factors of multiple destinations and ride time are considered.

Traffic Flow. Traffic flow benefits are significant if commuter cars are mixed into traffic at substantial levels. Traffic flow benefits are accrued at bottlenecks in the city road networks, where the average speed falls below 40 miles per hour and throughput is reduced below 2000 vehicles per hour. At congested roadways, the increase in vehicle throughput resulting from commuter cars will depend on the available infrastructure accommodations. Introduction of the commuter car will result in slight throughput increases even without any infrastructure changes due to the size and maneuverability of the vehicle. More significant increases will occur upon re-striping of additional lanes, and significant capacity increase will result if "dedicated lanes" are developed.

The ability to improve traffic flow is related to the fraction of commuter cars in the population. According to Reference 12, the capacity of a lane with only commuter cars driving in a single file would be about 2260 vehicles per hour (vph), a 13 percent increase over the capacity of a lane with conventional vehicles (2000 vph). If commuter vehicles could share a lane, driving side-by-side, the capacity would be twice 2260 or 4520 vph. Therefore, the capacity of a roadway with both commuter and conventional cars can be expressed as:

$$\text{capacity in vph} = \mu \cdot 2260\, i + (1-\mu) \cdot 2000 \qquad \text{Equation (1)}$$

where μ is the fraction of commuter cars to total vehicles and i is the number of effective lanes—i is equal to 1 if the commuter vehicles are driven single-file, and is equal to 2 if driven side-by-side within a single lane. This equation holds true if the average speed is about 30 miles per hour (mph), which roughly approximates the average running speed of highly congested roadways during the peak travel period. At higher speeds, the capacity increase from operating commuter vehicles will be lower.

For our analysis, two major urban areas were chosen for study using Equation 1: the Los Angeles and San Francisco metropolitan areas. The counties defined in each of these areas are identical to those defined in the commute surveys. The number of automobile registered in each county are summarized in **Exhibit 30.**

Commuter fractions in both the Los Angeles and Bay Areas can be calculated using our high and low market penetration scenarios for the commuter car. It is reasonable to assume that sales of commuter cars will be distributed across California in accordance with the number of vehicles registered in a particular county. Therefore, we have assumed that 47 percent of all commuter car sales per year would be in the Los Angeles area, while 22 percent would go to the Bay Area. Because the ability to shorten commute times is a primary attribute of the vehicle, we assumed that 60 percent of the commuter cars would be driven during peak traffic periods.

EXHIBIT 30
Vehicle Registrations by County, 1991

County	1991 Auto Registrations	Registrations as % of State Total
Los Angeles	4,860,169	0.28
Orange	1,511,296	0.09
Riverside	622,201	0.04
San Bernardino	732,482	0.04
Ventura	402,537	0.02
TOTAL LOS ANGELES	*8,128,685*	*0.47*
Alameda	737,486	0.04
Contra Costa	517,764	0.03
Marin	167,767	0.01
Napa	67,402	0.00
Santa Clara	965,141	0.06
San Francisco	328,832	0.02
San Mateo	508,540	0.03
Solano	193,943	0.01
Sonoma	242,392	0.01
TOTAL BAY AREA	*3,729,267*	*0.22*
TOTAL CALIFORNIA	*17,204,246*	

Source: Reference 2

To calculate the number of conventional vehicles on the road, we used 1990 Census data to determine the number of people who work and who commute to work by car, truck, or van within each of the counties. The Bay Area and Los Angeles surveys (references 10 and 11) provide information on the percentage of commute trips that occurs during various hours of the day. The Bay Area survey identifies the "peak hour" as between 8:00 and 9:00 a.m.; 30.8 percent of survey respondents arrive at work during that time period. The information in the Los Angeles survey is for departure time. The Los Angeles survey results indicate that roughly 32 percent of all commuters leave for work between 7:00 a.m. to 8:00 a.m., which is the peak commute travel period.

The results of our calculations for the commuter car fraction (μ) are summarized in **Exhibit 31**

EXHIBIT 31
Results of Commuter Vehicle Fraction (μ) Calculations
(Commuter Vehicles as a Percentage of Conventional Vehicles at Peak Commute Hour)

	Year	High Market Scenario	Low Market Scenario
Los Angeles	1	0.49%	0.40%
	2	0.97%	0.80%
	3	1.45%	1.19%
	5	2.38%	1.95%
	10	9.61%	3.56%
	15	23.24%	4.39%
Bay Area	1	0.57%	0.47%
	2	1.13%	0.93%
	3	1.68%	1.38%
	5	2.76%	2.26%
	10	11.16%	4.14%
	15	26.98%	5.09%

Using Equation (1), the results of the capacity calculations are presented in **Exhibit 32**. The results indicate that, by the fifteenth year after implementation of the commuter vehicle, capacity increases of up to 29 percent in Los Angeles and up to 34 percent in the Bay Area can be expected if sales of the commuter vehicle match our high market scenario and the vehicles are allowed to pair-up on highway lanes. If forced to travel single-file, the maximum capacity increases would be approximately 3 percent for both areas. Under the low market scenario, capacity increases would be about 1 and 6 percent for 1 and 2 effective lanes, respectively, for both Los Angeles and the Bay Area.

EXHIBIT 32
Capacity Increase Resulting from Implementing Commuter Cars (vph)
During Peak Commute Hours
(Capacity is equal to 2000 vph if no commuter cars are on the road)

	Year	High Market Scenario		Low Market Scenario	
		1 eff. lane	2 eff. lanes	1 eff. lane	2 eff. lanes
Los Angeles	1	2001	2012	2001	2010
	2	2003	2025	2002	2020
	3	2004	2037	2003	2030
	5	2006	2060	2005	2049
	10	2025	2242	2009	2090
	15	2060	2586	2011	2111
Bay Area	1	2001	2014	2001	2012
	2	2003	2028	2002	2023
	3	2004	2042	2004	2035
	5	2007	2070	2006	2057
	10	2029	2281	2011	2104
	15	2070	2680	2013	2128

It is important to note that benefits from the commuter vehicle would be greatest on the most congested roadways with the lowest average operating speeds. Our analysis considered only averages for the population. As discussed in our previous report on infrastructure (reference 1), the most benefits will be achieved if the commuter network is studied carefully to choose routes for commuter car accommodations in order to improve the fraction of commuter cars in the commuting population. Specific travel routes, where bottlenecks exist for example, will be the most valuable areas for achieving significant returns on investment and should be studied in detail to develop an investment plan.

4.4.4 Public Transit

The effect of implementing the commuter car on public transit ridership levels is an issue worth examining. The commuter car would be ideal for driving to and parking at commuter rail or bus stations, particularly if special parking spaces and/or rates were available. To the extent that commuters are deterred from using trains or buses because of parking problems, the commuter car can increase ridership levels on public transit systems. It is unclear how many commuters would fall into this situation. We suspect that the expected increase in transit levels would be very small, especially since use of the commuter car would be limited to solo drivers or two-person carpools. However, survey data would be needed to conduct a more comprehensive analysis of this issue.

4.5 Summary of Benefits for the Commuter Car

The results of our cost-benefit calculations can be summarized as:

- The fuel economy improvement of the commuter car is substantial, even compared to highly efficient current subcompact cars. Based on our high case market scenario, an 8 percent reduction in daily gasoline usage can be achieved 15 years after introduction of the commuter car. This amount of gasoline savings would result in a total cost savings of $4.1 billion. With a low market penetration rate, the fuel savings would be about 1.5 percent, equivalent to $1.4 billion.

- Because of dramatic improvements in the new car fleet as the ARB phases in its low-emission vehicle program, the overall emission impact of the commuter car is relatively small, less than 1 percent of the total motor vehicle inventory in nearly all cases. Although the emission reduction potential is substantial compared to motorcycles, motorcycle emissions account for only a small fraction of total mobile source emissions.

- As a result of implementing commuter cars, congestion in urban California cities will decrease, particularly if dedicated commuter car lanes were built. Vehicle throughput is estimated to increase from 1 to 34 percent in the Bay Area for the low and high market penetration scenarios, respectively. In Los Angeles, the equivalent vehicle throughput increases are 1 and 29 percent.

4.6 Suggested Action Plan/Strategy Development

The findings presented above demonstrate that implementation of the commuter vehicle would have significant benefits in reducing congestion and gasoline consumption and, to a lesser extent, emissions of air pollutants. However, additional efforts are needed to ensure that commuter vehicle can successfully penetrate the motor vehicle market. To this end, we recommend that Caltrans consider the following tasks:

- Conduct a detailed market study to determine consumer response to the commuter car. Such a study could take the form of telephone or mail surveys, or interviews of focus groups. This information is need to accurately estimate the market potential of the commuter car. Additional data would also be needed to gauge the impact of the commuter car on public transit ridership levels.

- Without infrastructure incentives, the market for the commuter car will be very small. In consultation with officials from all levels of state and local government and academia, a detailed study of the costs and timeframes for phasing-in infrastructure incentives for the commuter car should be performed.

- Coordinate with the Air Resources Board (ARB), the California Energy Commission (CEC), and the California Legislature to ensure that state officials at the highest levels are aware of the benefits of the vehicle and will take the necessary steps to promote its implementation. In particular, ARB assistance will be needed to ensure that the commuter car can be certified as a passenger vehicle rather than as a motorcycle. Certification as a passenger vehicle would provide incentives that could entice auto manufacturers to build the car. Specifically, certification as a passenger vehicle would allow manufacturers to lower their corporate average fuel economy (CAFE) values. This incentive could be worth hundreds of dollars to a car manufacturer. Furthermore, certification as a passenger vehicle could qualify the commuter car for various tax credits and exemptions that have already been adopted for low-emission vehicles.

- Coordinate with local air pollution control districts to ensure that the commuter car will be given appropriate credit in any fleet or trip reduction rules promulgated. Inform city and regional planners of the infrastructure changes that would be needed.

- Work with a vehicle manufacturer to produce two to five working prototypes of the commuter car. Such prototypes could be used as a marketing tool to educate state officials and the general public on the attributes and benefits of the commuter car. If the prototypes are successfully received, additional vehicles should be built for placement in demonstration programs.

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