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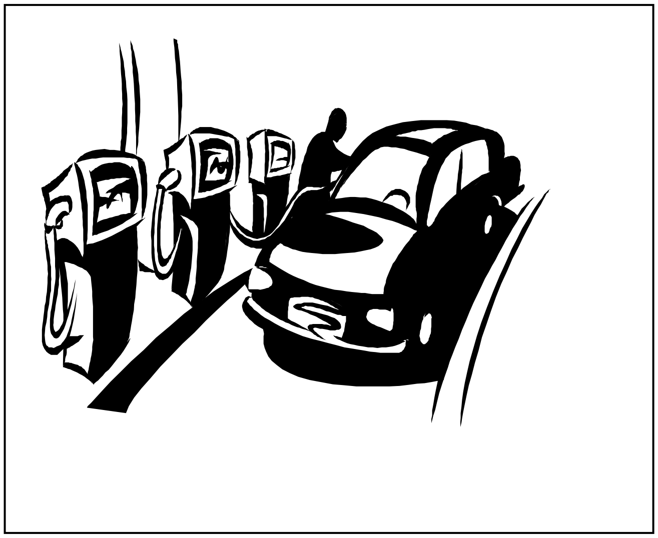
FORECASTS OF CALIFORNIA TRANSPORTATION ENERGY DEMAND 2005-2025
In Support of the 2005 Integrated Energy Policy Report



Staff Report

April 2005
CEC-600-2005-008

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FORECASTS OF CALIFORNIA TRANSPORTATION ENERGY DEMAND

Introduction

This staff report presents forecasts of energy demand in California for on-road car and truck travel, commercial aviation, and transit. Besides base case forecasts of transportation demand for electricity, jet fuel, and natural gas, the report includes six forecast cases for diesel and gasoline demand, depending on projected changes in fuel price and vehicle fuel economy. On-road travel, commercial aviation, and transit energy uses account for about 87 percent of the state's transportation energy demand. The largest other use, residual fuel for shipping, typically accounts for 5 to 10 percent of energy demand in transportation.

Senate Bill 1389 (SB 1389, Bowen, Chapter 568, Statutes of 2002) requires the California Energy Commission (Energy Commission) to adopt an Integrated Energy Policy Report (Energy Report) every two years. The 2005 report is due to the Governor and Legislature in November 2005. SB 1389 requires the Energy Commission to conduct transportation forecasting and assessment activities, including forecasts of transportation energy demand to support preparation of the Energy Report.

Key Factors Affecting Future Transportation Energy Demand

Economic conditions and population growth are the primary drivers of transportation energy demand. The California Department of Finance projects California's population will grow over the next 20 years by an average annual rate of 1.15 percent, translating to 9.5 million more Californians by 2025. This is below the average annual rate of 1.76 percent for the last 20 years, reflecting reduced immigration rates and lower overall birth rates with the aging of the large "baby boom" generation. Staff projects the average household size will increase so that total households grow at a slower rate than population. The number of households will grow an average rate of 1.01 percent per year. The staff's analysis assumes that real per-household income will grow over the next 20 years at an average annual rate of about 1.25 percent, somewhat lower than the 1.55 percent annual growth rate for the previous 20 years.

Forecast Methodology

The staff used the models and assumptions discussed below (1) to project vehicle miles traveled (VMT), the number and characteristics of on-road vehicles, and commercial aviation passenger trips and (2) to develop a transportation energy demand forecast based on these projections. Appendix A identifies critical assumptions made in the forecasts.

Forecasting Models

The Energy Commission uses the California conventional alternative fuels response simulator (CALCARS) model to forecast vehicle stock, VMT, and fuel consumption for cars and light duty trucks in California. Currently, the model can accommodate up to 45 classes of vehicles and 17 model years. The CALCARS model was recently re-estimated to incorporate diesel and electric hybrid vehicles using vehicle choice data that the Energy Commission collected in the California Vehicle Survey. Staff also recently modified CALCARS to be able to forecast both personal and commercial use.

The freight model projects the volume of freight transported by truck, vehicle stock, VMT, as well as the truck consumption of gasoline and diesel. The model is driven by projections of industrial activity in a given region or statewide, by economic sector.

The transit forecast includes transit activity and energy demand for urban bus and rail systems, intercity bus and rail systems, school buses, and other buses (charter, church, etc.). Transit fuel use is projected for diesel, gasoline, electricity, and natural gas.

The commercial aviation model projects annual commercial jet fuel demand; this forecast is driven by projections of commercial airline passenger trips which are specified as a function of population, personal income, and average cost of airline travel per mile.

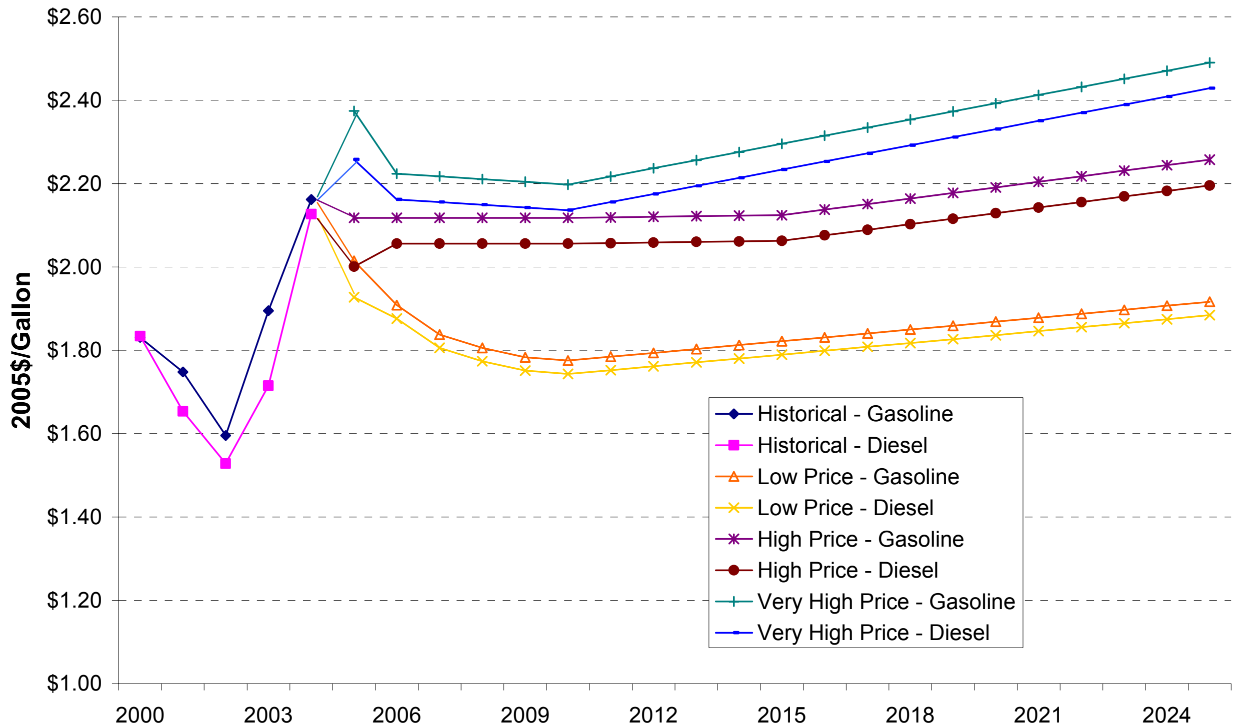
Assumptions Underlying the Demand Forecasts

The staff has prepared six cases of gasoline and diesel demand forecasts. Forecasts are produced for three different projections of fuel prices. For each price projection, two future light duty vehicle (LDV) fuel economy levels are considered: one with and the other without the California Greenhouse Gas (GHG) standards which the California Air Resources Board (CARB) recently adopted. The fuel price projections are based on the federal Energy Information Administration's recent projections of crude oil prices. Figure 1 presents the projections of the average long-term fuel prices used in the demand forecasts. For this report, the staff projected the following levels of 2025 gasoline (regular grade) prices per gallon in constant 2005 dollars:

- low price case, $1.92
- high price case, $2.25
- very high price case, $2.49

Appendix B provides supporting discussion on prices and world oil markets. The staff has designated the high fuel price, GHG standard case as the base case forecast.

Figure 1
California Gasoline & Diesel Price Cases



In 2004, the CARB adopted the California GHG standard for LDVs (AB 1493, Pavley, Chapter 200, Statues of 2002). The standard requires a gradual reduction of GHG equivalent emissions beginning in 2009, which by 2016 results in approximately a 30 percent reduction in emissions per mile for the average new vehicle as compared to today's new vehicles. The levels of fuel economy used in this report for the three forecast cases considering the GHG standard are based on staff estimates of the levels of average fuel economy improvement which could allow compliance with the standard.

K.G. Duleep, Energy and Environmental Analysis, Inc., provided the historical and projected vehicle characteristics used in the CALCARS model. The vehicle characteristics include purchase price, miles per gallon, and acceleration (seconds to 60 miles per hour). The staff's analysis assumes significant availability and use of hybrid-electric gasoline and diesel vehicles. Hybrid-electric vehicle penetration levels are assumed to be consistent with the CARB advanced technology partial zero emission vehicle (ZEV) requirements, part of the ZEV program adopted by CARB on April 24, 2003. The staff assumed sales in California of new diesel light duty vehicles (LDV) would restart in 2008.

Without the GHG standards, fuel efficiency (by class) for gasoline LDVs is projected to remain nearly constant until about 2010 and then begin gradually to increase. As an example, for the high fuel price case, the on-road fuel economy for new compact cars goes from 26.6 to 26.7 miles per gallon (mpg) between 2003 and 2009 and then gradually reaches 28.9 mpg by 2025.

In addition, while the growth in sales of sport utility vehicles has flattened, the staff projects that the smaller cross utility vehicles, such as the Toyota RAV4 and Ford Escape, will continue to increase as a percentage of new LDV sales for the next ten years.

The forecast of jet fuel demand is based on projecting that the number of arrivals and departures of commercial aviation passengers in California will increase from 159 million in 2003 to 287 million in 2025, including use of aviation trends from the Federal Aviation Administration. Commercial aviation passenger trips in California jumped about 9 percent in 2004 to pre-9/11/01 levels, offsetting the precipitous drop in airline travel after the attack, and are expected to resume historical growth rates beginning in 2005.

Base case projections for electricity and compressed natural gas (CNG) demand include transit as well as light duty applications.

From the 2003 base year, the forecasts were adjusted to reflect the estimated demand growth in 2004 of about 1.5 percent for gasoline, 8 percent for diesel, and 9 percent for commercial jet fuel associated with economic recovery in California and rebound of air travel following the 9/11/01 attack.

Forecasting Results

The analysis for the base case with high fuel prices and the GHG standard yields the following results for total on-road VMT (LDVs, freight, and transit):

- 314 billion miles in 2003
- 356 billion miles in 2010
- 460 billion miles by 2025

As shown is Table 1, this projection represents an average increase from 2003 to 2025 of 1.76 percent per year.

Table 1

Total Vehicle Miles Traveled
(Billions of miles)

		2025--No GHG Standard				2025--With GHG Standard		
2003 Base Year		Low Fuel Prices	High Fuel Prices	Very High Fuel Prices		Low Fuel Prices	High Fuel Prices	Very High Fuel Prices
314.3		457.6	450.6	446.4		469.6	460.9	455.9
Growth Rate %:		1.72	1.65	1.61		1.84	1.76	1.70

The VMT for LDVs is expected to increase from 295 to 436 billion miles over the forecast period as shown in Table 2. This growth rate is 1.80 percent per year using the high fuel price projections with the GHG standard case. LDVs account for about 95 percent of the total VMT of all on-road vehicles. Figure 2 shows the projected trend in VMT for LDVs and all uses combined for this case.

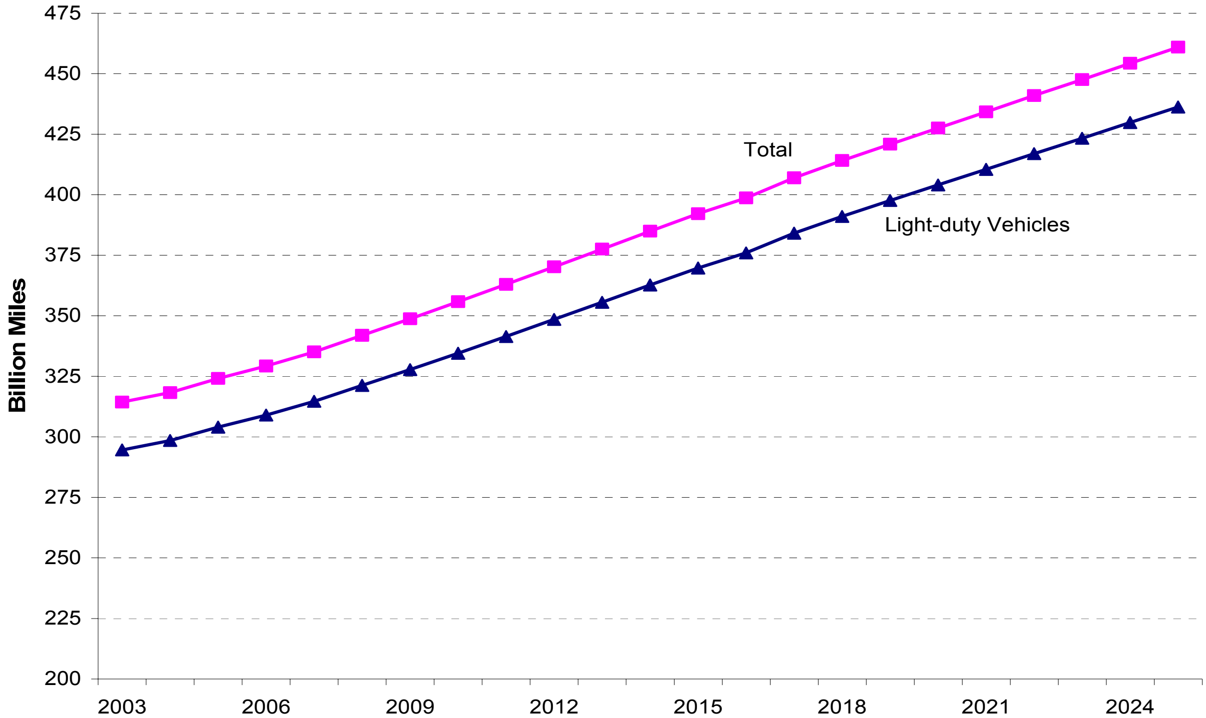
Table 2

Total Light Duty Vehicles Vehicle Miles Traveled
(Billions of Miles)

		2025--No GHG Standard				2025--With GHG Standard		
2003 Base Year		Low Fuel Prices	High Fuel Prices	Very High Fuel Prices		Low Fuel Prices	High Fuel Prices	Very High Fuel Prices
294.6		432.9	425.9	421.8		444.9	436.2	431.3
Growth Rate %:		1.76	1.69	1.65		1.89	1.80	1.75

Figure 2

Projected On-Road Vehicle Miles Traveled (2005-2025) Using High Fuel Price Projection with GHG Standard



Staff projects the number of on-road vehicles in California will reach about 35.6 million by 2025, up from about 25.6 million in 2003. This reflects an average growth rate of 1.5 percent per year (Table 3). LDVs constitute about 97 percent of the on-road vehicles.

Table 3

On-Road Vehicles (Millions)

		2025--No GHG Standard				2025--With GHG Standard		
2003 Base Year		Low Fuel Prices	High Fuel Prices	Very High Fuel Prices		Low Fuel Prices	High Fuel Prices	Very High Fuel Prices
25.65		35.65	35.64	35.63		35.63	35.63	35.62
Growth Rate %:		1.51	1.51	1.50		1.50	1.50	1.50

Primarily because of the continued growth in cross utility vehicles, light trucks are projected to increase as a fraction of LDV stock in California from 42 percent in 2003 to over 52 percent by 2025. Despite this growth, the LDV fleet-average fuel economy (Table 4) increases as shown in Table 4 by about 11 percent from 20.4 mpg in 2003 to 22.6 in 2025 in the no GHG standard, high fuel price case, based on key assumptions as described in Appendix A. For the base case with the GHG standard, the average on-road fuel economy for the LDV fleet improves to about 23.6 mpg by 2015 and 27.2 mpg by 2025, a total increase of 33 percent.

Table 4

Light Duty Vehicle Fleet Average On-Road Fuel Economy (Miles per Gasoline Equivalent Gallon)

		2025--No GHG Standard				2025--With GHG Standard		
2003 Base Year		Low Fuel Prices	High Fuel Prices	Very High Fuel Prices		Low Fuel Prices	High Fuel Prices	Very High Fuel Prices
20.43		21.91	22.57	22.95		27.16	27.19	27.28
Growth Rate %:		0.32	0.45	0.53		1.30	1.31	1.32

For the high fuel price projection with GHG standard case, the staff's forecast projects the annual on-road gasoline demand to increase from 15.1 billion gallons in 2003 to a peak of 16.2 billion gallons in 2010, and then to decrease to 15.6 billion gallons by 2025, translating to an average increase of about 0.1 percent per year as shown in Table 5.

Table 5

On-Road Gasoline Demand (Billions of Gallons)

		2025--No GHG Standard				2025--With GHG Standard		
2003 Base Year		Low Fuel Prices	High Fuel Prices	Very High Fuel Prices		Low Fuel Prices	High Fuel Prices	Very High Fuel Prices
15.11		19.05	18.21	17.74		15.89	15.56	15.33
Growth Rate %:		1.06	0.85	0.73		0.23	0.13	0.07

Diesel demand is projected to increase from about 2.7 billion gallons in 2003, to about 3.3 billion gallons in 2010, and to 5 billion gallons by 2025, which translates to an average increase of about 2.8 percent per year as shown in Table 6.

Table 6

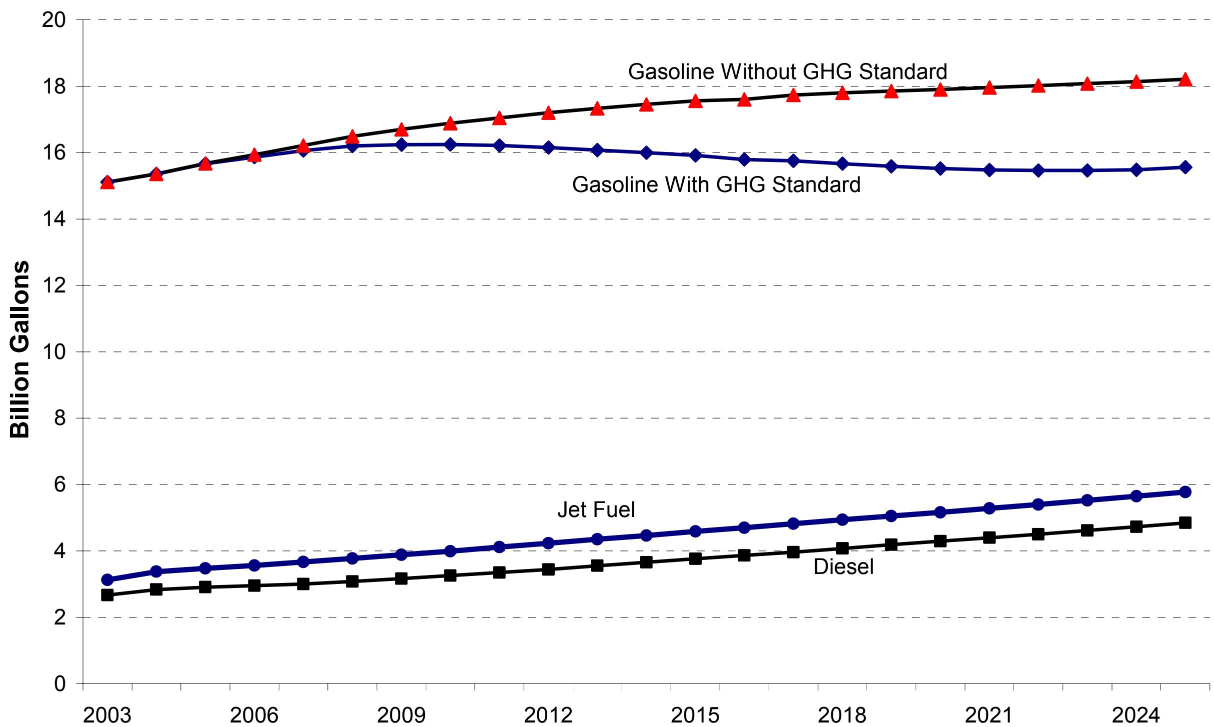
On-Road Diesel Demand (Billions of Gallons)

2003 Base Year		2025--No GHG Standard: Low Fuel Prices	2025--No GHG Standard: High Fuel Prices	2025--No GHG Standard: Very High Fuel Prices		2025--With GHG Standard: Low Fuel Prices	2025--With GHG Standard: High Fuel Prices	2025--With GHG Standard: Very High Fuel Prices
2.67		5.04	5.00	4.98		4.85	4.85	4.84
Growth Rate %:		2.93	2.89	2.87		2.75	2.75	2.74

Figure 3 presents projected demand for on-road gasoline with and without the GHG standard for the high fuel price case, on-road diesel, and jet fuel. Jet fuel demand is projected to increase from 3.1 billion gallons in 2003 to 4.0 billion gallons in 2010, and to 5.8 billion gallons by 2025, an average increase of 2.86 percent per year.

Consistent with the ZEV mandate, electric hybrid vehicles sales are projected to increase over time from 12,000 in 2003 to 140,000 in 2010, and to 200,000 for 2015 and later years (about 9 percent of total sales). For diesel LDVs, sales are projected to reach 60,000 in 2010, 140,000 by 2015, and 330,000 by 2025 (about 12 percent of sales). Figure 3 comprises the fuel demand with the hybrid and diesel sales. By the end of the forecast period, the fleet penetration of hybrids and diesel LDVs reduces gasoline demand projections by about 1.9 billion gallons per year, as shown in Figure 4, for the high fuel price case without the GHG standard. Without hybrids and diesel LDVs, the projected growth rate for gasoline demand from 2003-2025 for this case would average 1.31 percent per year. For this case the penetration of diesel LDVs increases diesel use by 1.2 billion gallons by 2025 beyond the diesel demand of heavy trucks and transit.

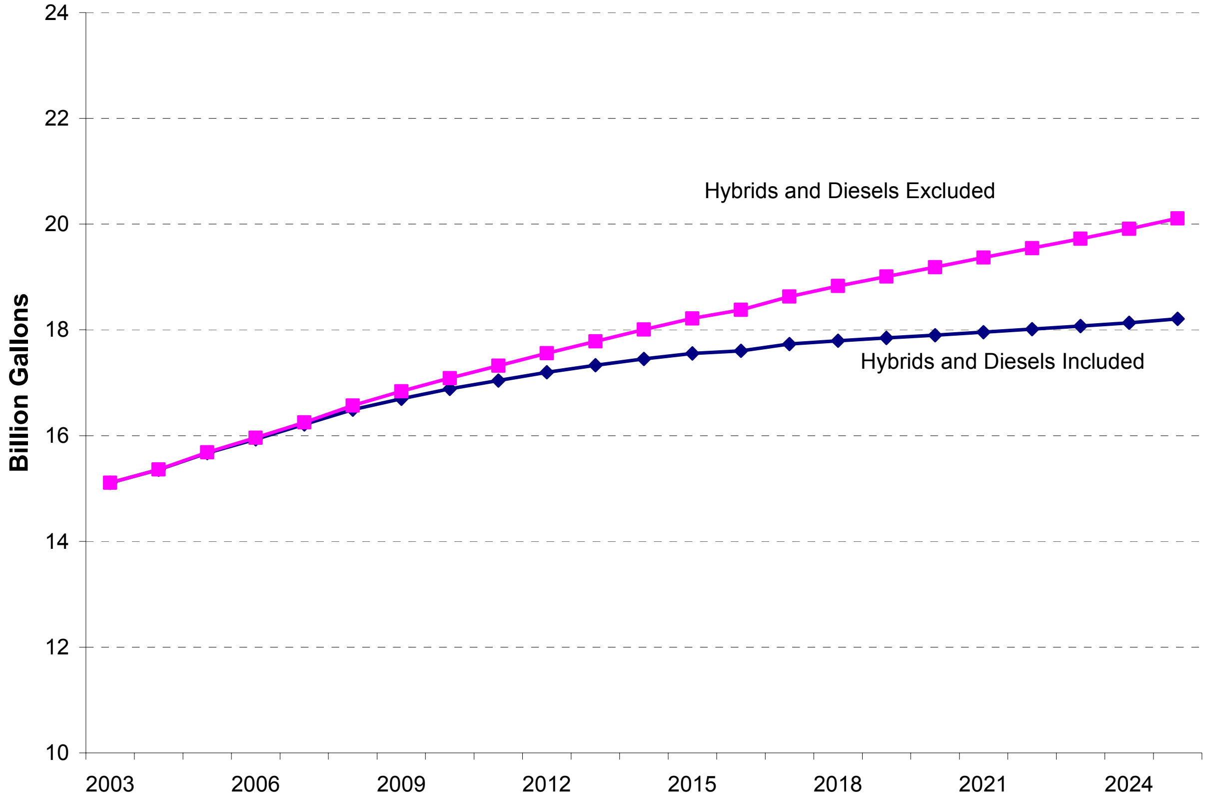
Figure 3
Projected Transportation Fuels Use



In the transportation sector, the annual demand for electricity, primarily for transit, is expected to grow from 590 to 1,800 million kilowatt-hours between 2002 and 2025. During the same period, the staff projects demand for natural gas in vehicles will increase from 75 to 200 million therms per year. The projected values for 2025 are about 1 percent of current electricity and natural gas demand.

Figure 4

Impact of Hybrids and Light Duty Diesels on Projected Gasoline Use [Using High Fuel Price Projection without GHG Standard]



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APPENDIX A

Critical Assumptions Made in the Forecasts

- For California over the next 20 years, the average annual growth will be 1.15 percent for population, 1.01 percent for total number of households, and 1.25 percent for real per-household income.

- Forecasts are produced for three different projections of fuel prices, ranging from $1.92 to $2.49 per gallon by 2025 for regular gasoline in constant $2005.

- Two future light-duty vehicle fuel economy levels are considered: one with the California greenhouse gas standard which CARB recently adopted and the other without the standard using projections from K.G. Duleep.

- Hybrid-electric vehicle penetration levels will be consistent with the CARB advanced technology partial zero emission vehicle (ATPZEV) requirements. In the forecasting of vehicle sales by the CALCARS model, a key factor is the number of makes and models for each class of vehicles. The projections of makes and models provided by the consultant K.G. Duleep for the hybrid-electric classes were sufficient for the sales forecasts of CALCARS to match the ATPZEV requirements through 2014. From 2014 to 2015, the sales of hybrid-electrics necessary to meet the requirements for ATPZEVs increase by 60,000. To cause the CALCARS model to forecast this increase in sales, the number of makes and models of hybrid-electric was assumed to be 50 percent higher than the projections of Duleep for 2015 and later years.

- Sales in California of new light duty diesel vehicles will restart in 2008. The CALCARS model then forecast diesel sales for 2008 and later years based on the inputs for vehicle prices, fuel economy and other data.

- The LDV fleet-average fuel economy increases for the forecasts without the GHG standard despite a projected increase in light trucks as a fraction of LDV stock. The assumptions causing the increased fleet-average fuel economy include the slight fuel economy improvement in conventional gasoline vehicles after 2009, the achievement of penetration levels projected for electric hybrids, and the availability of diesel LDVs.

APPENDIX B

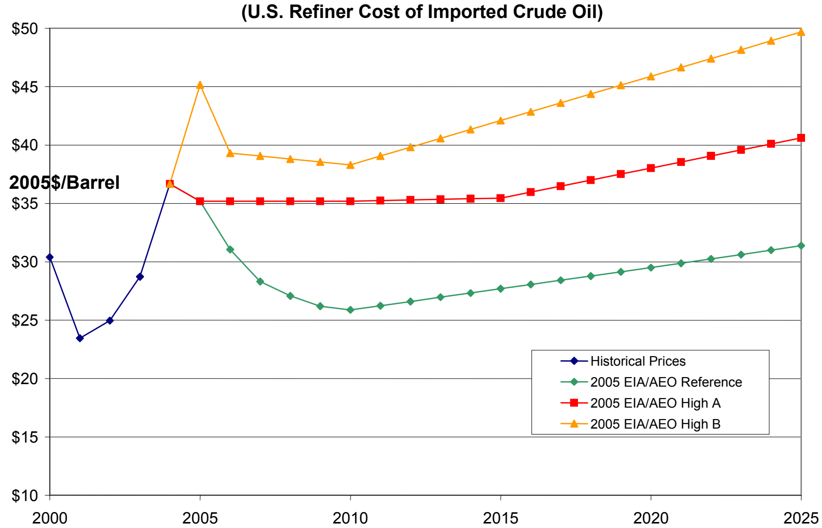
Crude Oil and Transportation Fuel Price Forecasts

Crude Oil Prices

The Energy Commission staff requires long-term transportation fuel price projections to carry out several analytical tasks associated with transportation energy policy assessment. Fuel prices affect the attributes of vehicles offered to consumers by manufacturers, long-range forecasts of transportation energy demand, and assessments of transportation sector strategies. The staff provided transportation fuel price projections for these tasks based on the Energy Information Administration (EIA) *2005 Annual Energy Outlook* long-term crude oil price forecasts.[1]

The staff generated three California transportation fuel price cases using three different EIA oil price cases as the starting point.[2] The Energy Commission's low fuel price case was developed from the EIA reference case. The Energy Commission's high fuel price case uses the EIA "high-A" oil price case and the Energy Commission's very high fuel price case is based on the EIA "high-B" oil price case. In summary, these three EIA oil price cases vary primarily in their assumptions on the Organization of Petroleum Exporting Countries (OPEC) market management strategies. In the EIA reference case, the OPEC is assumed to restrain production modestly so that prices do not remain high enough to encourage competing energy sources or conservation. In this case, OPEC market share of world oil production would grow steadily. In the EIA "high-A" case, OPEC tightens its production and exports to raise prices and revenues, but in the process starts to constrain oil demand growth and encourage other primary energy sources. In this case, OPEC market share remains relatively steady. In the EIA "high-B" case, OPEC tightens its production even more to raise prices and revenues further, but begins to lose market share. Figure B-1 illustrates these three oil price cases. The index used by the EIA in these forecasts is for the U.S. average refiner cost of imported crude oil.[3]

Figure B-1
EIA 2005 AEO Oil Price Forecasts
(U.S. Refiner Cost of Imported Crude Oil)



In the *2003 Energy Report*, the Energy Commission recommended that staff closely monitor world oil markets "to provide advance planning opportunity to respond to significant changes in world oil production".[4] In response, staff contracted with ICF Consulting to address questions related to future world supply, availability, and price of both conventional and non-conventional petroleum resources (e.g., oil or tar sands, shale oil, natural gas and other related hydrocarbons). Their report assesses world energy resources and provides modeling results for a range of estimates of population growth, GDP growth, energy resources, technology costs, and global climate change policies. The results reported include potential peaking dates of conventional and unconventional oil production and oil price projections under various supply and demand conditions. ICF Consulting also identified several other parameters that may affect crude oil markets, including inventory and strategic reserve levels, spare production capacity, investment levels, dollar devaluation, hedge funds, market structure, and geopolitics. In general, the reported findings with respect to potential long-term oil price trajectories are consistent with the Energy Commission's oil price cases used in its fuel price forecasts.[5]

Transportation Fuel Prices

To convert the crude oil price projections previously discussed into resulting California transportation fuel prices, the staff estimated the average margins of crude oil prices to rack prices and rack prices to retail prices for reformulated regular-grade gasoline and highway diesel over the periods 2002-2004 and 2003-2004. The average margins of the prices for the 2003-2004 period were the higher of the two periods and were used in both the Energy Commission's high and very high fuel price cases. The lower margins for the 2002-2004 period were used in the low fuel price case. An adder for diesel prices was included to account for the low sulfur rules going into effect in 2006. Appropriate taxes were added to the sum of the projected per gallon crude oil price and the average historical margins (including the low-sulfur adder for diesel) to develop final retail price projections for the three cases.[6] Figure B-2 and Table B-1 show projected retail transportation fuel prices for California for these three cases.

Figure B-2
California Gasoline & Diesel Price Cases

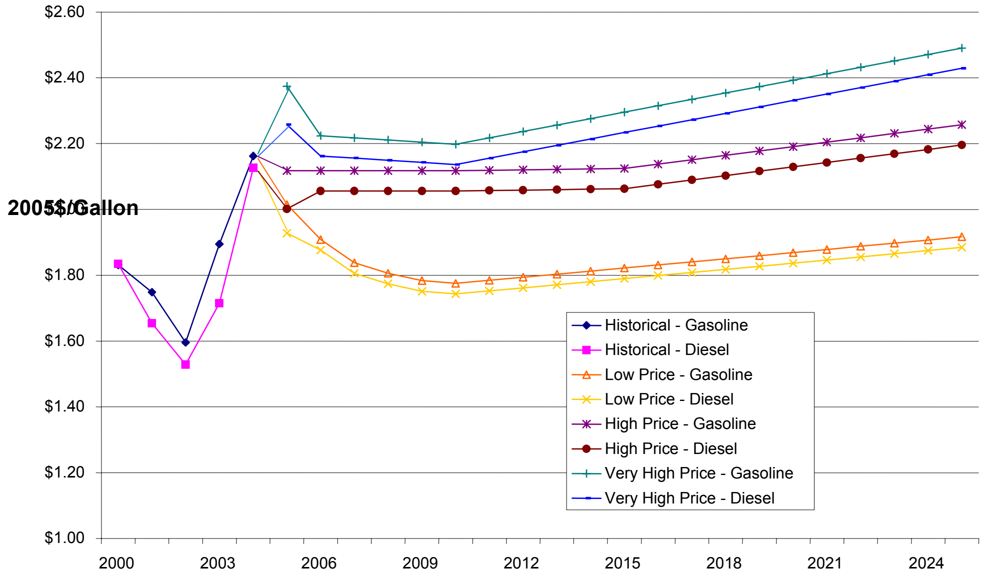


Table B-1
Projected California Transportation Fuel Prices

2005$/Gal

Year	Low Price - RFG	Low Price - Diesel	High Price - RFG	High Price - Diesel	Very High Price - RFG	Very High Price - Diesel
2004	2.16	2.13	2.16	2.13	2.16	2.13
2005	2.01	1.93	2.12	2.00	2.37	2.26
2006	1.91	1.88	2.12	2.06	2.22	2.16
2007	1.84	1.81	2.12	2.06	2.22	2.16
2008	1.81	1.77	2.12	2.06	2.21	2.15
2009	1.78	1.75	2.12	2.06	2.20	2.14
2010	1.78	1.74	2.12	2.06	2.20	2.14
2011	1.78	1.75	2.12	2.06	2.22	2.16
2012	1.79	1.76	2.12	2.06	2.24	2.18
2013	1.80	1.77	2.12	2.06	2.26	2.19
2014	1.81	1.78	2.12	2.06	2.28	2.21
2015	1.82	1.79	2.12	2.06	2.30	2.23
2016	1.83	1.80	2.14	2.08	2.31	2.25
2017	1.84	1.81	2.15	2.09	2.33	2.27
2018	1.85	1.82	2.16	2.10	2.35	2.29
2019	1.86	1.83	2.18	2.12	2.37	2.31
2020	1.87	1.84	2.19	2.13	2.39	2.33
2021	1.88	1.85	2.20	2.14	2.41	2.35
2022	1.89	1.86	2.22	2.16	2.43	2.37
2023	1.90	1.87	2.23	2.17	2.45	2.39
2024	1.91	1.87	2.24	2.18	2.47	2.41
2025	1.92	1.88	2.26	2.20	2.49	2.43

Endnotes for Appendix B

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[1] The EIA *2005 Annual Energy Outlook* documents these forecasts and can be found at: [http://www.eia.doe.gov/oiaf/aeo/index.html].

[2] Background material on world oil markets, analysis of data, and the rationale for decisions on which EIA forecast cases were used to develop California fuel price scenarios is provided in the Energy Commission staff's paper "Overview of Proposed Transportation Fuels Analyses for the 2005 Energy Report" http://www.energy.ca.gov/papers/2005-02-24_600-04-039.PDF], staff workshop presentation slides [http://www.energy.ca.gov/2005_energypolicy/documents/2004-11-29_workshop/2004-11-29_STAFF_PRES.PDF], and workshop testimony [http://www.energy.ca.gov/2005_energypolicy/documents/2004-11-29_workshop/2004-11-29_TRANSCRIPT.PDF]. Much of this earlier staff work utilized oil price cases from the previous EIA *2004 Annual Energy Outlook* because they were the latest available at the time. At the Energy Report Committee's direction, the staff delayed finalizing the transportation fuel price scenarios until 2005 EIA forecasts were available.

[3] This index is lower than commonly reported commodity price indexes for high quality crude oils, such as for the New York Mercantile Exchange light sweet crude oil (West Texas Intermediate oil) or the International Petroleum Exchange benchmark (Brent oil). Most available crude oils used by refiners are of substantially lower quality and are more difficult and costly to refine into clean petroleum products than these premium oils.

[4] See *Transportation Fuels, Technologies, and Infrastructure Assessment Report* – December 2003; Publication #100-03-013F. Available at:[http://www.energy.ca.gov/reports/100-03-013F.PDF].

[5] See *Long-Term Oil Supply and Price Forecast*, ICF Consulting, May 2005 at: (website address to be determined).

[6] Details of these steps are provided in the Energy Commission staff's paper "*Overview of Proposed Transportation Fuels Analyses for the 2005 Energy Report*" [http://www.energy.ca.gov/papers/2005-02-24_600-04-039.PDF].