CALIFORNIA ENERGY COMMISSION

TRANSPORTATION ENERGY FORECASTS FOR THE 2007 INTEGRATED ENERGY POLICY REPORT

DRAFT STAFF REPORT

JULY 2007
CEC-600-2007-009SD

Arnold Schwarzenegger, *Governor*

CALIFORNIA ENERGY COMMISSION

Gordon Schremp, Jim Page, and Malachi Weng-Gutierrez
Principal Authors

Jim Page
Project Manager

Charles Mizutani
Manager
FOSSIL FUELS OFFICE

Rosella Shapiro
Deputy Director
FUELS AND TRANSPORTATION DIVISION

B.B. Blevins
Executive Director

ABSTRACT

For the *2007 Integrated Energy Policy Report*, California Energy Commission staff has developed long-term forecasts of transportation energy demand as well as projected ranges of transportation fuel and crude oil import requirements. The transportation energy demand forecasts make assumptions about fuel prices forecasts, projections of demographic and economic growth, existing fleets, and future vehicle cost and performance data. Consumer preference data is collected through surveys. The transportation fuel and crude oil import requirement assessments build on assumptions about California crude oil production decline, state refining capacity growth, California transportation fuel demand growth, and exports to neighboring states. The forecasts and analysis indicate a growing need for expanded import infrastructure, particularly marine import facilities, to offset declining in-state oil production and growing demand in California, Nevada, and Arizona for transportation fuels.

KEYWORDS

California demand forecasts, transportation energy, gasoline, diesel, jet fuel, crude oil production, fuel imports, crude oil imports, marine import infrastructure, refining capacity, consumer preference, pipeline exports, Kinder Morgan, Arizona refinery

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Background and Findings

Senate Bill 1389 (Bowen), Chapter 568, Statutes of 2002, requires the California Energy Commission (Energy Commission) to conduct "assessments and forecasts of all aspects of energy industry supply, production, transportation, delivery and distribution, demand, and prices to develop policies for its *Integrated Energy Policy Report."* The Energy Commission develops long-term projections of California transportation energy demand to establish the quantitative baseline to support its analysis of petroleum reduction and efficiency measures, introduction and commercialization of alternative fuels, integration of energy use and land use planning, and transportation fuel infrastructure requirements. This report summarizes the transportation energy demand forecasts, quantifies the petroleum and petroleum product supply needs to meet the forecasted transportation energy demand, and identifies emerging constraints on California's transportation fuels infrastructure to meet California's future transportation fuel demand. California's petroleum infrastructure is comprised of the import and export system for petroleum and petroleum products; in-state refineries; and the distribution and storage network, made up of pipelines, trucks, rail, and storage tanks, that move petroleum and petroleum products to and from in-state refineries and to the retail markets. Assessments of the petroleum infrastructure indicated that imports of petroleum and petroleum products through California's marine port infrastructure will constrain the necessary supply to meet California's demand.

The outlook for the adequacy of California's transportation fuel import infrastructure has worsened slightly since the *2005 Integrated Energy Policy Report*. Staff projections indicate that overall demand for transportation fuels will continue to increase at rates marginally greater than projected in the *2005 Integrated Energy Policy Report*.

Several general findings from staff's *Assessment of California's Petroleum Infrastructure Needs* prepared in support of the *2005 Integrated Energy Policy Report* remain valid today.

- Important segments of the state's existing fuels infrastructure are already being used at or near their capacity.
- The current capacity of existing marine infrastructure, particularly in the Los Angeles Basin, could decline as a result of pressure to remove petroleum facilities and from requirements to meet seismic standards implemented by the State Lands Commission.
- Petroleum marine terminal capacity, marine storage, and gathering pipelines that connect marine terminals with refineries will have to expand to meet expected demand for fuels. Most of this expansion would occur in the Los Angeles Basin.

- Expansion of transportation fuel marine infrastructure will become more difficult in the Los Angeles Basin as available land becomes increasingly scarce and subject to competing uses and because residents, community groups, and local authorities have expressed substantial resistance to such expansion.

In support of the *2007 Integrated Energy Policy Report*, staff has generated forecasts of transportation fuel demand that vary depending on factors such as fuel prices, technology developments, greenhouse gas reduction regulations, and other variables. Staff has also assessed trends in crude oil production, refinery and pipeline expansion projects, port and marine terminal capacities, and neighboring state fuel demand to determine potential requirements for importing fuels into the state. The following points highlight findings from these forecasts and analyses.

- Staff expects on-road gasoline use in California to increase steadily through 2010 to between 17.1 billion and 17.6 billion gallons (407 to 419 million barrels) per year from 2005 levels of 15.9 billion gallons, an increase of 7.5 to 10.7 percent. After 2010, demand in the highest demand case rises 15.7 percent from 2005 to 18.4 billion gallons (438 million barrels) in 2030, while in the lowest demand case, it falls steadily to 14.5 billion gallons (or 345 million barrels), a decrease of 8.8 percent.

- Staff estimates that total gasoline, diesel, and jet fuel demand will grow to between 26.8 billion and 32.9 billion gallons (638 to 783 million barrels) per year by 2030, an increase of 16.5 to 43 percent, from 2005 levels of 23 billion gallons per year.

- By 2015, imports of crude oil into California are expected to rise 19.9 to 33.8 percent (81 million to 138 million barrels per year) from 2005 levels and 37 to 65.2 percent (151 million and 266 million barrels per year) by 2025.

- Staff expects combined imports of gasoline, diesel, and jet fuel to increase by 87 million barrels per year by 2015 and 67 million barrels per year by 2025 in the low fuel demand case. Combined fuel imports are estimated to increase by 288 million barrels per year by 2015 and 478 million barrels per year by 2025 in the high fuel demand case.

- To meet neighboring state demand for transportation fuels, pipeline exports to Nevada will grow by 28.7 to 36.3 million barrels per year by 2025, an increase of 50.4 to 63.7 percent. Exports to Arizona are expected to increase by 29 million barrels per year (59 percent).

- Assuming planned capacity additions are built, crude oil import capacity in the Los Angeles Basin will be sufficient through 2015, but in the higher imports case, more capacity is required by 2025.

- Incremental imports of ethanol could grow by as much as 666 million gallons (15.9 million barrels) per year by 2025, compared to 2006, with high gasoline demand and limited in-state growth of ethanol production (an increase of 74 percent). Conversely, assuming lower gasoline demand and higher state ethanol production, ethanol imports would grow by only 72 million gallons (1.7 million barrels) per year by 2015 and could actually decrease by 98 million gallons (2.3 million barrels) barrels by 2025 (ranging from an increase of 8 percent to a decrease of 11 percent compared to 2006).

Recommendations

Staff offers the following recommendations to the 2007 Integrated Energy Policy Report Committee.

- Energy Commission representatives should participate whenever possible in transportation-related workshops and public forums to provide information and stress the role of transportation energy infrastructure in the health of the California economy.

- The Energy Commission should involve local and state agencies to a greater degree during the *Integrated Energy Policy Report* process for transportation energy infrastructure planning efforts, including expansion projects as well as mitigation of lease denials.

- The Energy Commission should stress to local and state authorities the connection between infrastructure expansion requirements and measures that reduce demand for petroleum fuels, as shown in this report by the impact of the greenhouse gas regulations.

- To help ensure that independent traders are not unfairly denied access to the California fuels market, the Energy Commission should propose an arbitration mechanism for the state, backed by decision-making authority, to resolve access issues.

- The Energy Commission should propose a new requirement for incorporation into law that allows state appeals in the petroleum marine infrastructure lease renewal process at the Ports of Los Angeles and Long Beach.

- The Energy Commission should monitor the impact of the State Lands Commission Marine Oil Terminal Engineering and Maintenance Standards, especially on clean fuels marine terminals in the Ports of Los Angeles and Long Beach.

- The Energy Commission should press for a firm federal funding mechanism to maintain an adequate depth in the Pinole Shoal in San Francisco Bay.

CHAPTER 1: INTRODUCTION TO CALIFORNIA TRANSPORTATION ENERGY FORECASTS

Purpose of Transportation Energy Analyses

As required by Senate Bill 1389 (Bowen), Chapter 568, Statutes of 2002, the California Energy Commission (Energy Commission) conducts "assessments and forecasts of all aspects of energy industry supply, production, transportation, delivery and distribution, demand, and prices." The Energy Commission uses these assessments and forecasts to develop transportation energy policies for its *Integrated Energy Policy Report* (*IEPR*), which it adopts every odd-numbered year. In even-numbered years, the Energy Commission produces an energy policy review to update analysis from the previous *IEPR* or to examine energy issues that have emerged since the previous report (Public Resources Code [PRC] §25302[d]).

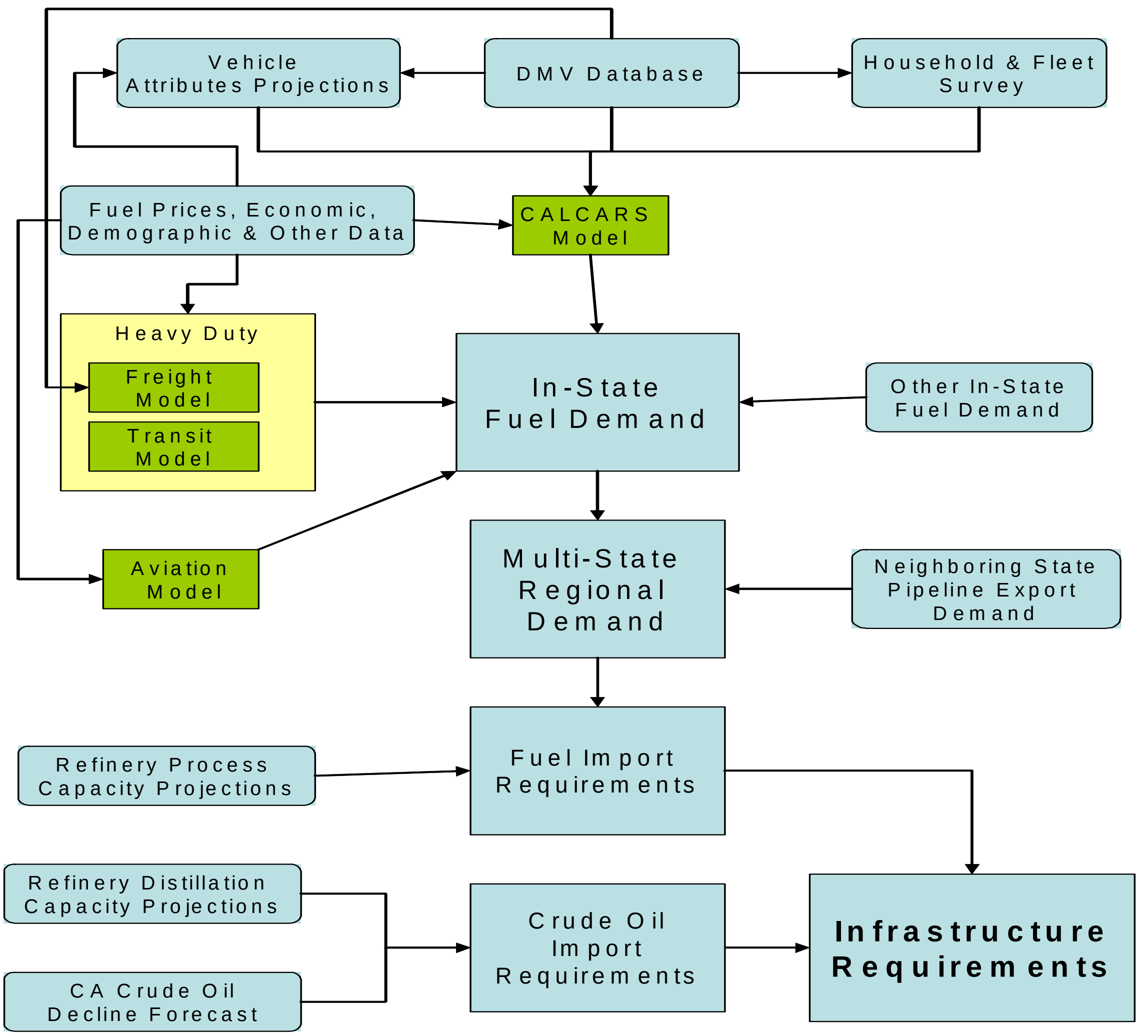
Transportation energy demand and fuel price forecasts support several energy policy and program activities, including the alternative vehicle and fuel technology analysis mandated by Assembly Bill (AB) 1007 (Pavley), Chapter 371, Statutes of 2005; petroleum use reduction and efficiency assessments; land use planning; and petroleum infrastructure requirements assessment. The Energy Commission has separate processes, reports, and workshops they will use to present analyses in the areas of alternative fuel use, petroleum reduction, and land use planning to stakeholders.

This report primarily focuses on the implications of future transportation energy demand for California's transportation fuels marine import infrastructure. It will provide preliminary forecasts for the *2007 IEPR.* The Energy Commission will present and discuss these materials and findings at the July 12, 2007, joint committee workshop at the Port of Los Angeles. Much of this material was discussed previously at the May 8, 2007, staff workshop in Sacramento.

Organization of This Report

This report provides results from Energy Commission staff forecasts of transportation energy demand in California and projected requirements for additional crude oil and transportation fuel imports into the state. Figure 1 illustrates the flow of data, forecasts, and other information for these transportation energy analyses. A variety of input data populates the demand models used by staff including: transportation fuel price forecasts, economic and demographic data and projections, surveys of vehicle purchase and use by residential households and commercial fleets, vehicle registration data, and projections of vehicle manufacturer offerings. Outputs from these models and other related analyses generate the forecasts of in-state transportation energy demand reported in the next section. As presented in Chapter 2, the Energy Commission develops assessments of future petroleum import infrastructure requirements from historic data and projections for regional transportation fuel demand, refinery distillation and process capacity, and rates of crude oil production decline in California. The focus of the analysis will primarily be on marine import infrastructure. However, information on rail-borne imports and pipeline and truck-borne exports is also necessary to determine interstate energy flows. Chapters 3 and 4 discuss forecasts of the state's requirements for crude oil and transportation fuel imports. In Chapter 5, staff discusses the implications of these levels of imports on emissions from marine vessels. The appendices provide the fuel price forecasts and a description of the demand models.

Figure 1 - Information Flow for Transportation Energy Analyses



Source: California Energy Commission Fuels and Transportation Division

Summary of Staff Findings

The outlook for the adequacy of California's transportation fuel import infrastructure has worsened slightly since publication of the *2005 IEPR*. Staff projections indicate that overall demand for transportation fuels will continue to increase at rates marginally greater than indicated in that document. Staff expects that this growing demand will exceed likely infrastructure capacity expansions currently under construction or to which the industry is committed. Numerous uncertainties can affect these estimates of future import infrastructure needs, including fuel prices; rates of adoption of new technologies and alternative fuels; demand for fuels in California and neighboring states; decline rates of California oil production; refinery and other infrastructure capacity expansions; and greenhouse gas (GHG) reduction rules and standards. However, this potential shortfall in the ability to provide transportation fuels leads staff to conclude that certain specific kinds of infrastructure capacity expansions must occur to prevent substantial economic losses to state consumers.

Several general findings from staff's *Assessment of California's Petroleum Infrastructure Needs*[1] prepared in support of the *2005 IEPR* remain valid today.

- Important segments of the state's existing fuels infrastructure are already being used at or near their capacity.
- The current capacity of existing marine infrastructure, particularly in the Los Angeles Basin, could decline as a result of pressure to remove petroleum facilities and of the requirements to meet seismic standards implemented by the State Lands Commission.
- Petroleum marine terminal capacity, marine storage, and gathering pipelines that connect marine terminals with refineries must expand to meet expected demand for fuels. Most of this expansion would have to occur in the Los Angeles Basin.
- Expansion of transportation fuel marine infrastructure will become more difficult in the Los Angeles Basin as available land becomes increasingly scarce and subject to competing uses and because residents, community groups, and local authorities have expressed substantial resistance to such expansion.

In support of the *2007 IEPR*, staff generated three hypothetical demand scenarios, or cases, with differing levels of forecasted transportation fuel consumption ("high," "base," and "low") and several variable factors such as fuel prices, technology developments, and GHG reduction regulations. In the summary findings below, only the highest and lowest levels are reported. On the supply side, staff developed high and low cases of fuel import requirements that vary according to assumptions about crude oil production, refinery and pipeline expansion projects, port and marine terminal capacities, and California and neighboring state fuel demand. Staff also identified and attempted to quantify other factors that will affect the forecast of imports requirements. Eleven findings resulted from the development of these forecasts and analyses.

---

[1] See publication number CEC-600-2005-009, available at www.energy.ca.gov/2005 publications/

- Staff expects on-road gasoline use in California to increase steadily through 2010 to between 17.1 billion and 17.6 billion gallons (407 to 419 million barrels) per year from 2005 levels of 15.9 billion, an increase of 7.5 to 10.7 percent. After 2010, demand rises 15.7 percent from 2005 in the highest demand case to 18.4 billion gallons (438 million barrels) in 2030, while in the lowest demand case, it falls steadily to 14.5 billion gallons (or 345 million barrels, a decrease of 8.8 percent). GHG standards, higher fuel prices, and increasing numbers of diesel light duty vehicles contribute to the projected reduced future gasoline use in the lowest demand case.

- Staff estimates that total gasoline, diesel, and jet fuel demand will grow to between 26.8 billion and 32.9 billion gallons (638 to 783 million barrels) per year by 2030, an increase of 16.5 to 43 percent, from levels of 23 billion gallons per year in 2005.

- Imports of crude oil into California are expected to rise 19.9 to 33.8 percent (81 million to 138 million barrels per year) from 2005 levels by 2015 and 37 to 65.2 percent (151 million and 266 million barrels per year) by 2025.

- Staff expects combined imports of gasoline, diesel, and jet fuel to increase by 87 million barrels per year by 2015 and 67 million barrels per year by 2025 in the low fuel demand case. Combined fuel imports are estimated to increase by 288 million barrels per year by 2015 and 478 million barrels per year by 2025 in the high fuel demand case.

- To meet neighboring state demand for transportation fuels, pipeline exports to Nevada will grow by 28.7 to 36.3 million barrels per year by 2025, and increase of 50.4 to 63.7 percent. Exports to Arizona are expected to increase by 29 million barrels per year (59 percent).

- Staff expects California refinery capacity growth ("refinery creep") to produce between 20 million and 48 million barrels per year of additional transportation fuels by 2015 compared to 2006 levels (an increase of 3.3 to 8.1 percent). By 2025, the increased output of transportation fuels is forecast to increase by 43 million to 107 million barrels per year compared to 2006 (an increase of 7.2 to 17.9 percent).

- Staff estimates that the number of additional product tanker arrivals in California per year by 2025 could range from as few as 81 to as many as 1,164 depending on assumptions about product demand and size of tanker loads. Estimates of the number of additional crude oil tanker arrivals in the state range from 76 to 380 per year depending on assumptions about vessel loads, state oil production, and refinery capacity additions.

- Staff estimates additional storage tank capacity needed to meet California product storage requirements by 2025 to be between 2.1 million and 14.7 million barrels depending primarily on assumptions about demand. Estimates of additional state crude oil storage capacity needed by 2025 range from 6.6 million to 22.2 million barrels.

- Assuming planned capacity additions are built, crude oil import capacity in the Los Angeles Basin will be sufficient through 2015, but in the higher imports case, more capacity would be required by 2025.

- Incremental imports of ethanol could grow by 2025 to as much as 666 million gallons (15.9 million barrels) per year more than 2006 import levels of 906 million gallons, with high gasoline demand and limited in-state growth of ethanol production (an increase of 74 percent). Conversely, assuming lower gasoline demand and higher state ethanol production, ethanol imports would grow by only 72 million gallons (1.7 million barrels) per year by 2015 and could actually decrease by 98 million gallons (2.3 million barrels) barrels by 2025 (ranging from an increase of 8 percent to a decrease of 11 percent compared to 2006).

- Staff review of information on the relative contribution of criteria pollutants by various marine vessels leads to the conclusion that petroleum tanker emissions are marginally less than emissions from container ships per port visit. Overall, emissions from marine tankers in 2001 represented between 1.2 and 8.2 percent of air pollution from all sources in the Port of Los Angeles, depending on type of pollutant.

Recommendations

Staff offers the following recommendations to the *2007 IEPR* Committee.

- Energy Commission representatives should participate whenever possible in energy-related and transportation-related workshops and public forums to provide information and stress the role of transportation energy infrastructure in the health of the California economy.

- The Energy Commission should involve local and state agencies to a greater degree during the *Integrated Energy Policy Report* process in transportation energy infrastructure planning efforts, including expansion projects as well as mitigation of lease denials.

- The Energy Commission should stress to local and state authorities the connection between infrastructure expansion requirements and measures that reduce demand for petroleum fuels, as shown in this report by the impact of the GHG regulations.

- To help ensure that independent traders are not unfairly denied access to the California fuels market, the Energy Commission should propose an arbitration mechanism for the state, backed by decision-making authority, to resolve access issues.

- The Energy Commission should propose a new requirement for incorporation into law that allows state appeals in the petroleum marine infrastructure lease renewal process at the Ports of Los Angeles and Long Beach.

- The Energy Commission should monitor the impact of the State Lands Commission Marine Oil Terminal Engineering and Maintenance Standards, especially on clean fuels marine terminals in the Ports of Los Angeles and Long Beach.

- The Energy Commission should press for a firm federal funding mechanism to maintain an adequate depth in the Pinole Shoal in San Francisco Bay.

CHAPTER 2: LONG-TERM TRANSPORTATION FUEL DEMAND FORECASTS

Background and Current Trends

This section provides the preliminary California transportation fuel demand forecast for the *2007 IEPR* and reflects both updated data and models.

California's transportation fuel demand is dynamic and impacted by many different characteristics or parameters, including population growth, economic growth, vehicle purchasing and driving habits, and fuel prices.

In the past 20 years California's population has increased by 40 percent, and personal income has increased by 37 percent. Over the next 20 years, the Department of Finance (DOF) forecasts a slowing of growth for both population and income, to 24 percent and 26 percent, respectively, compared to 2005.[2] On an annual basis, over the forecast period 2005 through 2030, population will increase an average of 1.05 percent. Over the same period, income will increase an average of 1.08 percent annually. This represents a decline from the annual growth rates of 1.70 percent and 1.58 percent for historic population and income growth, respectively, from 1985 to 2005.

Based on California DOF estimates, California's population will reach about 48 million by 2030, the end of the Energy Commission's forecast period. This growth constitutes an increase of 30 percent from today's population levels.

Although the forecasts of population and income are not expected to increase at historic rates, the growth will still be significant and result in substantial increases in transportation fuel demand for California.

Historic Vehicle Acquisition

Staff reviewed recent trends in California vehicle acquisitions from the Department of Motor Vehicles (DMV) Registration Database.[3] From 2001 to 2005, the number of hybrid vehicles increased annually by nearly 95 percent. This means that the number of hybrid vehicles on the road has nearly doubled each year for the five years preceding the forecast base year, 2005. The number of diesel vehicles has also increased in the state at rates substantially greater than for gasoline vehicles. Table 1 presents a summary of on-road vehicle registration data from the California DMV for 2001 to 2005. Figure 2 shows the annual growth rates for purchases of vehicles in California by vehicle type.

---

[2] Demographic data obtained from California Energy Commission Demand Analysis Office.

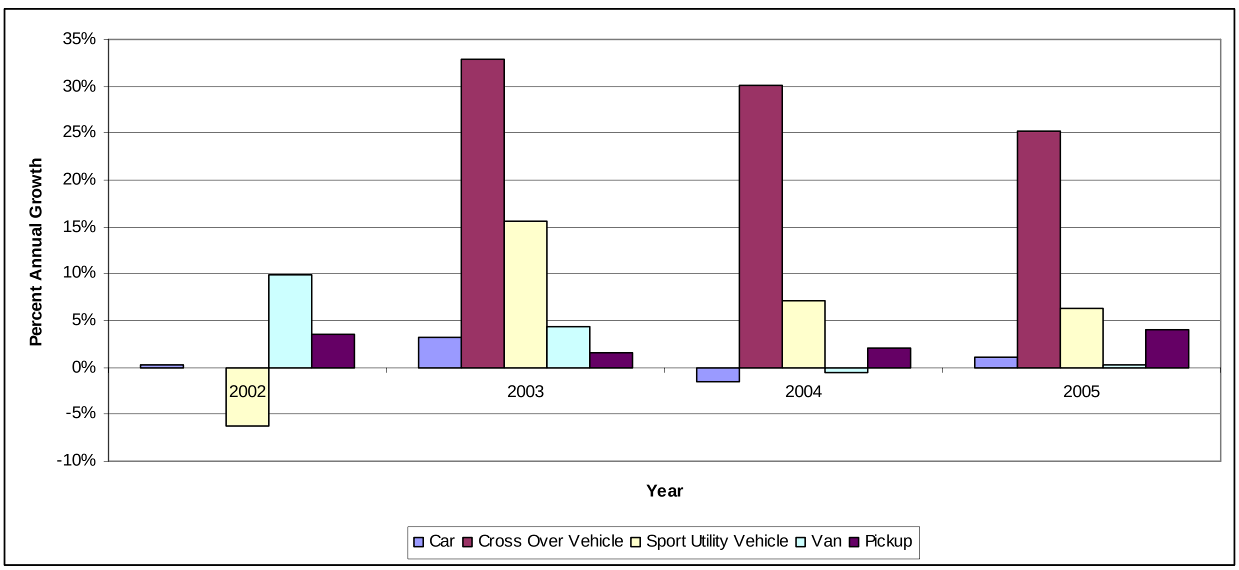
[3] DMV Registration Database, File pass for October 2005.

Table 1 - Summary of California On-Road Registered Vehicles

Year	Gasoline		Diesel		Hybrid		Flex Fuel	
	Vehicle Count	Annual Growth Rate	Vehicle Count	Annual Growth Rate	Vehicle Count	Annual Growth Rate	Vehicle Count	Annual Growth Rate
2001	22,779,246		316,872		6,609		97,611	
2002	23,384,639	2.70%	334,313	5.50%	15,159	129.40%	129,734	32.90%
2003	24,516,071	4.80%	364,411	9.00%	24,182	59.50%	183,546	41.50%
2004	24,785,578	1.10%	391,950	7.60%	45,263	87.20%	195,752	6.70%
2005	25,440,904	2.60%	424,137	8.20%	91,438	102.00%	269,857	37.90%
Average Annual Growth Rate		***2.80%***		***7.60%***		***94.50%***		***29.70%***

Source: California Energy Commission

Figure 2 - Percent of Annual Growth for California On-Road Registered Vehicles by Vehicle Type

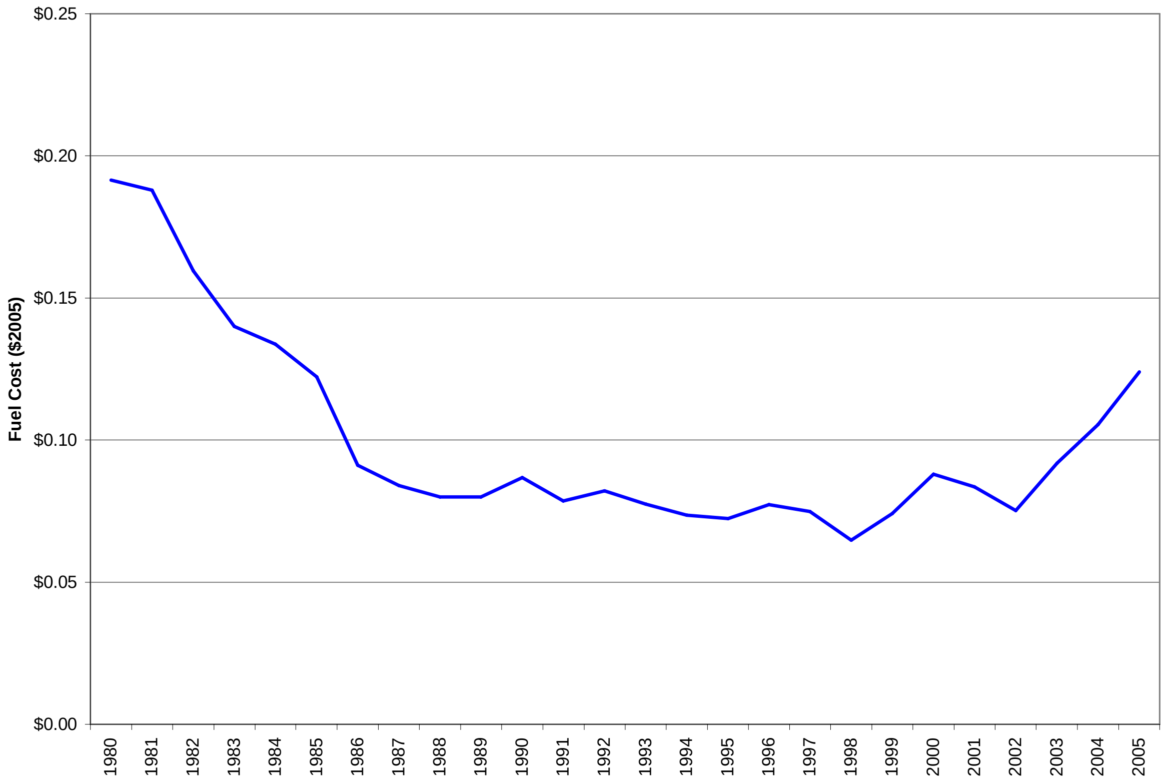


Source: California Energy Commission

Historic Cost per Mile

After the oil embargo and high oil prices of the late 1970s and early 1980s, the federal government enacted Corporate Average Fuel Economy (CAFE) standards that resulted in a substantial increase to the fuel economy of the on-road vehicle fleet. In addition, the price of transportation fuels stabilized and resulted in a significant decline in the fuel cost component of driving on a per mile basis. Figure 3 shows the historic decrease in the cost of driving from 1980 until 2002, as well as the recent trend toward higher costs.

Figure 3 - Historic California Annual Average Cost per Mile (Cents per Mile, $2005)



Source: California Energy Commission

Approach to Forecasting

The transportation fuel demand forecast encompasses four primary transportation sectors:

- Light-duty vehicles
- Medium- and heavy-duty freight vehicles
- Medium- and heavy-duty transit vehicles
- The commercial aviation sector

Each of these sectors is associated with a distinct forecasting model which estimates the demands for that individual transportation sector. The models associated with the respective transportation sectors above are the California Conventional Alternative Fuel Response Simulator (CALCARS), Freight, Transit, and Aviation models. Appendix A provides a description and list of updated information for each model. Report sections discussing the assumptions and results follow below.

Staff has developed preliminary forecasts for a range of potential fuel price forecasts and technology projections that reflect a wide range of impacts to overall transportation energy demand in California. Appendix B details all fuel price cases used in the forecasts.

In 2004, the California Air Resources Board (ARB) adopted the California GHG standard for light-duty vehicles (AB 1493, Pavley, Chapter 200, Statutes 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 light-duty vehicle demand cases considering the GHG standard are based on the levels of average fuel economy improvement which could allow compliance with the standard, as well as the Zero Emission Vehicle (ZEV) mandate. The forecast cases include:

- Three fuel price cases, excluding any GHG regulations
- Three fuel price cases, assuming GHG regulation (AB 1493) and ZEV mandate implementation
- An accelerated alternative fuels use case incorporating lower alternative fuel prices

Staff had not compiled the data necessary for the alternative fuels case or for alternative fuel demand forecasts in the other six cases in time for inclusion in this draft report but intends to incorporate these alternative fuels projections, to the extent possible, in the final report.

Assumptions

Assumptions involving the demographic and personal income data used in this analysis include:

- Updated demographic and personal income data from the DOF adequately reflect this data for the entire forecast period, from 2005 to 2030.

- Census Bureau and state projections of household worker distributions will not change over the forecast period.

- The 57 household categories used in the evaluation adequately reflect California's range of actual households.

In addition, staff assumes advanced light-duty diesel vehicles will meet the emissions standards required to enter the California new car market in 2008. The introduction of light-duty diesel vehicles will increase gradually after the models are introduced into California. As a result, no advanced light-duty diesel vehicles will be allowed to enter California's new car market before 2008.

The results of the 2007 California Vehicle Survey used to re-estimate the CALCARS model, are consistent over the entire forecast. The model does not allow changing preferences associated with the survey results. Stated another way, consumers' choices, given specific demographic and economic conditions will remain the same throughout the forecast. A consumer under the same demographic and economic conditions will react the same way regardless of the forecast year. Therefore, no long-term changes in land use or behavioral changes are captured within the CALCARS choice model. This assumption may result in either an over- or under-projection of demand depending on future fuel market activities, land-use patterns, public transportation use, and economic activity.

As with past transportation fuel demand forecasts, K.G. Duleep of Energy and Environmental Analysis, Inc. provided historic and projected vehicle characteristics used in the CALCARS model. Appendix A briefly discusses the vehicle characteristics included in the model evaluation.

Results

For this preliminary demand forecast, staff evaluated six cases, comprised of three sets of fuel prices with and without the implementation of GHG standards and ZEV mandate conditions. Of these six evaluated cases, the results from three representative demand forecasts were selected for further analyses described in a later section on fuel import requirements. Table 2 provides an overview of the six fuel and GHG standard cases and the three demand cases (high, base, and low) that staff considered representative of the range of future fuel consumption in California.

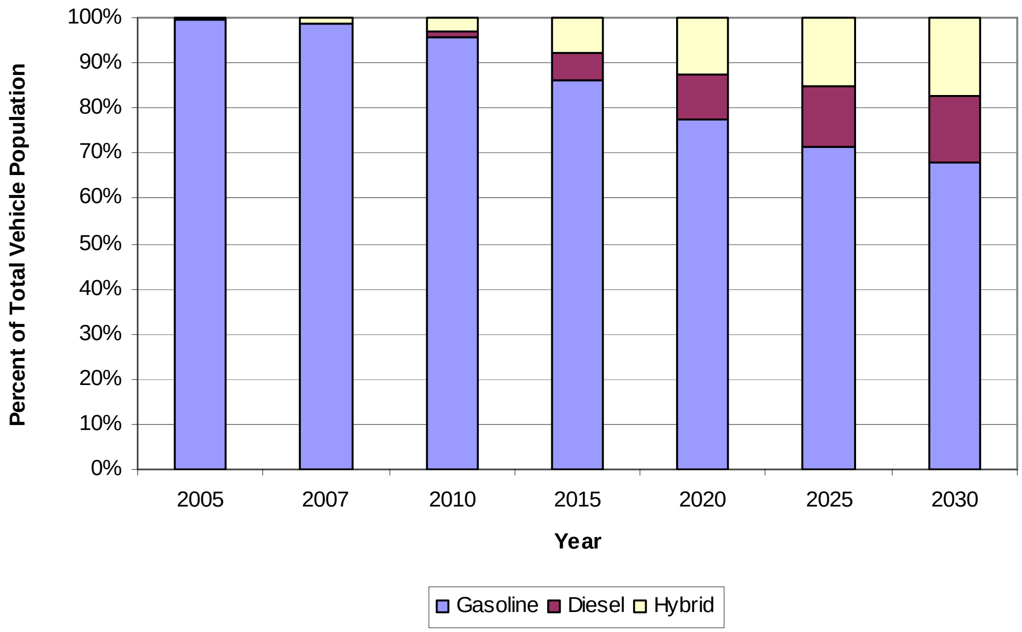
Table 2 - Summary of Fuel Demand Cases Selected for Infrastructure Evaluation

No GHG Standard			GHG Standard		
Low Fuel Price	**Base Fuel Price**	**High Fuel Price**	**Low Fuel Price**	**Base Fuel Price**	**High Fuel Price**
High Demand Case	*Demand case not selected as representative*	*Demand case not selected as representative*	*Demand case not selected as representative*	**Base Demand Case**	**Low Demand Case**

Source: California Energy Commission

In general, the analysis shows increasing on-road vehicle miles traveled (VMT), increasing fleet fuel economy, and the increasing diversification of transportation fuels and vehicles. The results of the base fuel price case with the implementation of California-specific GHG standards results in the increase of total VMT by 51 percent over the forecast period of 2005 through 2030, an average annual increase of 1.67 percent. The adoption of more hybrid vehicles and light-duty diesel vehicles results in the increase of fleet-wide fuel economies. In the final year of the forecast, the fleet is composed of 68 percent gasoline vehicles, 17 percent hybrid vehicles, and 15 percent light-duty diesel vehicles. Figure 4 shows the changing composition of California's on-road vehicles given the base fuel price and implemented GHG standards.

Figure 4 - Forecast of California's Light-Duty Vehicle Composition from 2005 to 2030, Base Fuel Price Case with GHG Regulations



Source: California Energy Commission

As a result of increasing population, household incomes, and economic activity, total state VMT continues to grow over the forecast period in all evaluated cases. Table 3 provides the VMT results of the analyses for the six general cases evaluated, which includes a portion of medium- and heavy-duty vehicles in the non-container freight sectors. For all cases, annual average growth rates for VMT are between 1.54 and 1.70 percent. Under higher price conditions, the fuel economies of the fleet actually increase as consumers choose to purchase more fuel efficient vehicles. The increased fleet fuel economy results in a corresponding increase in VMT.

Table 3 - Total Vehicle Miles Traveled (Billions of Miles)

	No GHG Standards			GHG Standards		
Year	Low Fuel Price	Base Fuel Price	High Fuel Price	Low Fuel Price	Base Fuel Price	High Fuel Price
2005	334.4	334.4	334.4	334.4	334.4	334.4
2010	358.4	372.5	374.7	374.7	374.7	374.8
2015	392.4	405.1	409.8	410.0	410.0	410.2
2020	426.1	436.8	443.7	444.8	444.8	446.1
2025	459.0	467.4	476.4	477.9	477.9	480.5
2030	489.4	494.7	505.1	506.4	506.4	510.1
Annual Average Growth	1.535%	1.579%	1.664%	1.674%	1.674%	1.704%

Source: California Energy Commission

Note: Base year 2005 results are calibrated to historic vehicle count and fuel use data in Tables 3 through 8

Annual VMT growth rates for light-duty vehicles are slightly higher than the fleet average. Table 4 presents the results for the six primary price and emission standard cases.

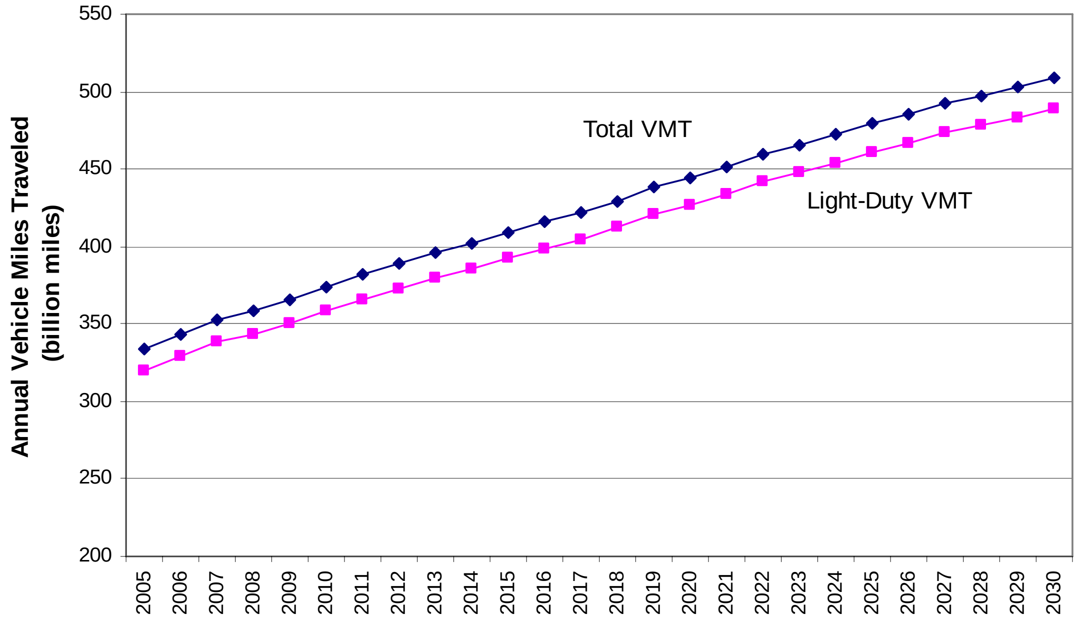
Table 4 - Total Light-Duty Vehicles Vehicle Miles Traveled (Billions of Miles)

	No GHG Standards			GHG Standards		
Year	Low Fuel Price	Base Fuel Price	High Fuel Price	Low Fuel Price	Base Fuel Price	High Fuel Price
2005	319.6	319.6	319.6	319.6	319.6	319.6
2010	341.7	355.9	358.1	345.9	358.1	358.2
2015	374.6	387.2	391.9	381.3	392.2	392.3
2020	407.1	417.9	424.8	416.5	425.9	427.2
2025	439.2	447.6	456.6	451.4	458.1	460.7
2030	468.4	473.7	484.1	481.9	485.4	489.1
Annual Average Growth	1.540%	1.586%	1.674%	1.656%	1.685%	1.716%

Source: California Energy Commission

In all cases, VMT increases are fairly linear and correspond with increasing population, workers, and economic activities. Figure 5 shows the projected on-road VMT for the base fuel price case with implemented GHG regulations over the forecast 25-year forecast period. Total VMT includes the non-container freight portion of medium- and heavy-duty annual miles traveled. Light-duty on-road VMT includes the majority of personal and commercial gasoline and diesel vehicles.

**Figure 5 - Projected On-Road Vehicle Miles Traveled (2005 – 2030)
Base Fuel Price Case with GHG Regulations**



Source: California Energy Commission

The number of on-road vehicles increases by approximately the same amount for each case, 1.5 percent annually. Table 5 shows projected results for the number of on-road vehicles over the 25-year forecast period.

**Table 5 - On Road Vehicles
(Millions)**

	No GHG Standards			GHG Standards		
Year	**Low Fuel Price**	**Base Fuel Price**	**High Fuel Price**	**Low Fuel Price**	**Base Fuel Price**	**High Fuel Price**
2005	25.64	*25.64*	*25.64*	*25.64*	25.64	25.64
2010	28.15	*28.21*	*28.22*	*28.22*	28.22	28.23
2015	30.47	*30.54*	*30.54*	*30.54*	30.54	30.55
2020	32.60	*32.67*	*32.68*	*32.68*	32.68	32.69
2025	35.15	*35.20*	*35.20*	*35.20*	35.20	35.22
2030	37.16	*37.20*	*37.21*	*37.20*	37.20	37.22

Source: California Energy Commission

The most significant changes to the fleet are reflected in the average light-duty on-road fuel economies. Under low fuel price conditions with no GHG regulations to promote fuel efficiency in vehicles, the light-duty fleet fuel economy increases only 0.5 percent annually. By contrast, the average annual fleet fuel economy improvement for the high fuel price case with implemented GHG regulations and attainment of the ZEV mandate is over 1.5 percent. In the latter case, the resulting fleet fuel economy reaches 29.82 miles per gallon by 2030.

Table 6 presents the average annual light-duty on-road fuel economy. Note that the fuel economies of both the high fuel price case without a GHG standard and the low fuel price case with GHG regulations are nearly the same. This indicates that high fuel prices can drive consumer demand toward fuel efficient vehicles in a similar way that implementing GHG standards can drive the introduction of new efficient vehicles into the market.

Given the growing popularity of economical vehicles, rising fuel prices, federal and state efforts to reduce carbon emissions of on-road vehicles, and the increased number of vehicles offered with higher fuel economies, staff expects that fleet fuel economy will increase at a faster pace than we have seen in the past decade.

Table 6 - Light-Duty Vehicle Average On-Road Fuel Economy (Miles per Gasoline Gallon Equivalents)

	No GHG Standards			GHG Standards		
Year	**Low Fuel Price**	**Base Fuel Price**	**High Fuel Price**	**Low Fuel Price**	**Base Fuel Price**	**High Fuel Price**
2005	20.35	*20.35*	*20.35*	*20.35*	20.35	20.35
2010	19.45	*20.18*	*20.95*	*20.72*	20.95	20.97
2015	19.95	*20.79*	*22.65*	*22.55*	22.74	22.80
2020	20.95	*21.75*	*24.50*	*24.85*	24.93	25.53
2025	21.83	*22.75*	*26.21*	*26.47*	26.74	27.95
2030	22.50	*23.58*	*27.64*	*27.72*	28.17	29.82

Source: California Energy Commission

Gasoline Demand Forecast

Table 7 and Figure 6 present a summary of on-road gasoline demand for six evaluated cases including implementation of GHG standards. In all cases, gasoline demand increases sharply in the short term, but then the growth rate declines or turns negative as more efficient vehicles are purchased, including substantial numbers of diesel vehicles. As anticipated, the greatest amount of on-road gasoline demand results under low fuel price conditions where no GHG standards are implemented. Under these conditions, demand for on-road gasoline grows at an annual rate of 0.5 percent. Similarly, with no GHG standards implemented, demand for gasoline is still higher in 2030 than in 2005. The high fuel price case without GHG standards results in a decrease of on-road demand over the forecast period. In all cases where GHG standards are implemented, on-road gasoline demand eventually falls below 2005 levels. The on-road demand for gasoline decreases from 15.9 to 14.5 billion gallons a year under high fuel price assumptions with implemented GHG standards. This represents an average annual decline of approximately 0.4 percent over the 25-year forecast. Fuel prices used for these cases can be found in Appendix B.

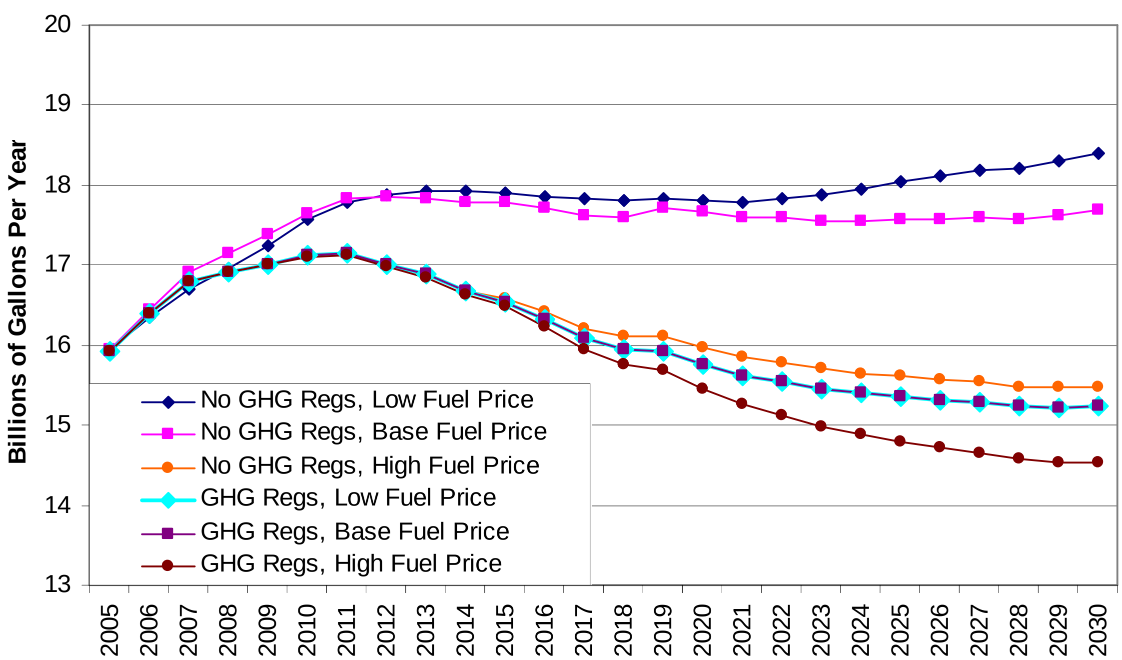
Staff found that the low and base fuel price cases with implemented GHG standards result in identical decreases in on-road gasoline demand. This result reflects the fact that these fuel prices do not result in a significant impact over and above the demand reductions produced by the implementation of GHG standards alone. The high fuel price case, when combined with the implementation of a GHG standard, does result in a further decrease of demand. Evaluated cases not involving the GHG standard were much more sensitive to fuel prices as is indicated by the relatively wide range of on-road gasoline demand associated with the three cases, from approximately 15.5 to 18.4 billion gallons. In the absence of implemented GHG standards, fuel prices still influence consumer and auto manufacturer choices.

Table 7 - On-Road Gasoline Demand (Billions of Gallons)

	No GHG Standards			GHG Standards		
Year	**Low Fuel Price**	**Base Fuel Price**	**High Fuel Price**	**Low Fuel Price**	**Base Fuel Price**	**High Fuel Price**
2005	15.93	*15.93*	*15.93*	*15.93*	15.93	15.93
2010	17.57	*17.64*	*17.11*	*17.11*	17.11	17.10
2015	17.91	*17.78*	*16.58*	*16.52*	16.52	16.49
2020	17.81	*17.66*	*15.98*	*15.76*	15.76	15.45
2025	18.03	*17.56*	*15.61*	*15.36*	15.36	14.79
2030	18.39	*17.68*	*15.48*	*15.23*	15.23	14.52

Source: California Energy Commission

Figure 6 - On-Road Gasoline



Source: California Energy Commission

Diesel Demand Forecast

Total diesel demand for California increases significantly in all cases with the acceptance of advanced light-duty diesel vehicles. Average annual growth for total diesel in California ranges from 2.27 to 3.14 percent for the six cases evaluated. Table 8 presents the total diesel demand under the six fuel and emission standard cases.

Table 8 - Total Diesel Demand (Billions of Gallons)

	No GHG Standard			GHG Standard		
Year	**Low Fuel Price**	**Base Fuel Price**	**High Fuel Price**	**Low Fuel Price**	**Base Fuel Price**	**High Fuel Price**
2005	3.77	*3.77*	*3.77*	*3.77*	3.77	3.77
2010	4.43	*4.37*	*4.29*	*4.41*	4.35	4.29
2015	5.52	*5.35*	*5.13*	*5.39*	5.24	5.12
2020	6.55	*6.21*	*5.83*	*6.29*	6.01	5.77
2025	7.33	*6.91*	*6.34*	*7.05*	6.61	6.24
2030	8.16	*7.50*	*6.73*	*7.79*	7.13	6.60
Annual Average Growth	3.143%	*2.793%*	*2.351%*	*2.950%*	2.589%	2.269%

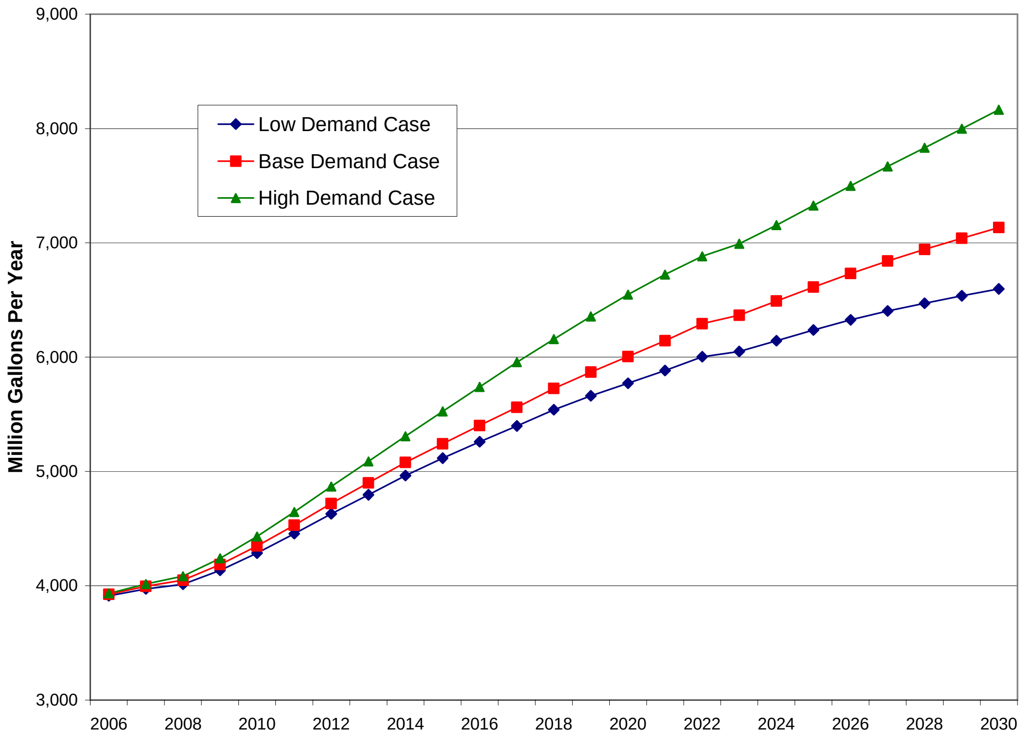
Source: California Energy Commission

Freight hauling by truck and rail is the largest element of demand for diesel fuel. Likely variations in fuel price would not significantly change freight sector diesel demand in the same way that gasoline price variation affects long-term gasoline demand in light-duty vehicles. Keeping economic and demographic factors constant, the variation in forecast demand for diesel fuel depends on growth in three areas: truck and rail movement of imported container traffic from ports, diesel use in light-duty vehicles, and off-road use of diesel (mostly in construction and agriculture). Variation in fuel prices affects diesel use in light-duty vehicles. Staff did not attempt to estimate the impact of price on non-transportation diesel consumption. Non-transportation consumption in this section refers to diesel use not on highways or rail lines, acknowledging that some of this fuel use will be for off-road vehicles.

Staff projections of diesel demand are shown in Table 8 and Figure 7. In all cases, projections from the Freight model (see Appendix A for description) are used to estimate future non-container freight diesel consumption by both truck and rail.

Staff estimated future freight diesel consumption for container movement separately. In the low demand case, the container traffic component of truck and rail diesel use increases at 3 percent annually for the entire forecast period to 2030. In the base demand case, the container traffic component grows at 5 percent annually to 2030. In the high demand case, container traffic is projected to grow at 7 percent per year. This range of estimates roughly corresponds to the range of forecasts reported for container and non-oil import growth from a variety of sources. These include South Coast Association of Governments estimates from the *RTP Update on Goods Movements*, the American Trucking Association's *U.S. Freight Transportation Forecast to 2017*, and the *Goods Movement Action Plan* of the California Business, Transportation, and Housing and Environmental Protection Agencies. Staff did not propose a higher rate than 7 percent on the assumption that traffic congestion would prohibit higher rates of traffic growth over such a sustained period.

Figure 7 - California Diesel Demand Forecast



Source: California Energy Commission

All of these cases assume that diesel use in light-duty vehicles grows at the rate forecast in the appropriate CALCARS light-duty vehicle fuel demand forecast. The CALCARS model case using high fuel prices combined with implemented GHG standard fuel economies generates the lowest light-duty vehicle diesel fuel demand growth. The CALCARS case using base case fuel prices combined with GHG standards generates the base case diesel fuel demand projection. The low fuel price case without GHG standard fuel economies creates the high light-duty vehicle diesel demand case.

According to U.S. Energy Information Administration data, non-transportation demand for diesel in California has been declining since 2000 and for the Pacific region is projected to grow at 0.5 percent per year to 2030. For Energy Commission staff's low diesel demand case, no growth is assumed from 2005 levels. For the base case, 0.5 percent per year growth is assumed. In the high demand case, 1 percent per year growth is assumed.

The transit sector constitutes a relatively small category of use for diesel. The diesel fuel share in transit in California has historically been declining in favor of compressed or liquefied natural gas. However, staff is uncertain whether this trend will continue. In the low diesel demand case, staff assumed the historical declining trend would continue. In the middle demand case, future diesel demand in transit was assumed to be relatively flat. In the high demand case, staff assumed cleaner specification diesel would replace natural gas as the natural gas vehicles are retired. These assumptions on evolving diesel share complement transit energy growth projections from the Energy Commission's Transit model described in Appendix A.

Jet Fuel Demand Forecast

Commercial jet turbines run on kerosene-type jet fuel. Staff's estimate of California's jet fuel use for 2004 balances the known supply and demand components from our most reliable state level data. Staff calibrates to this baseline demand and forecasts jet fuel use for later years using the Aviation model described in Appendix A. The number of paid passenger trip segments, or enplanements, is closely related to commercial jet fuel use. The state population projection and the Federal Aeronautics Administration (FAA) projection of revenue per passenger mile are good predictors of the historic record of enplanements. Fuel use is calculated from enplanements using the proportion of seats filled with passengers, the average length of a passenger trip, and jet fuel use per seat mile.

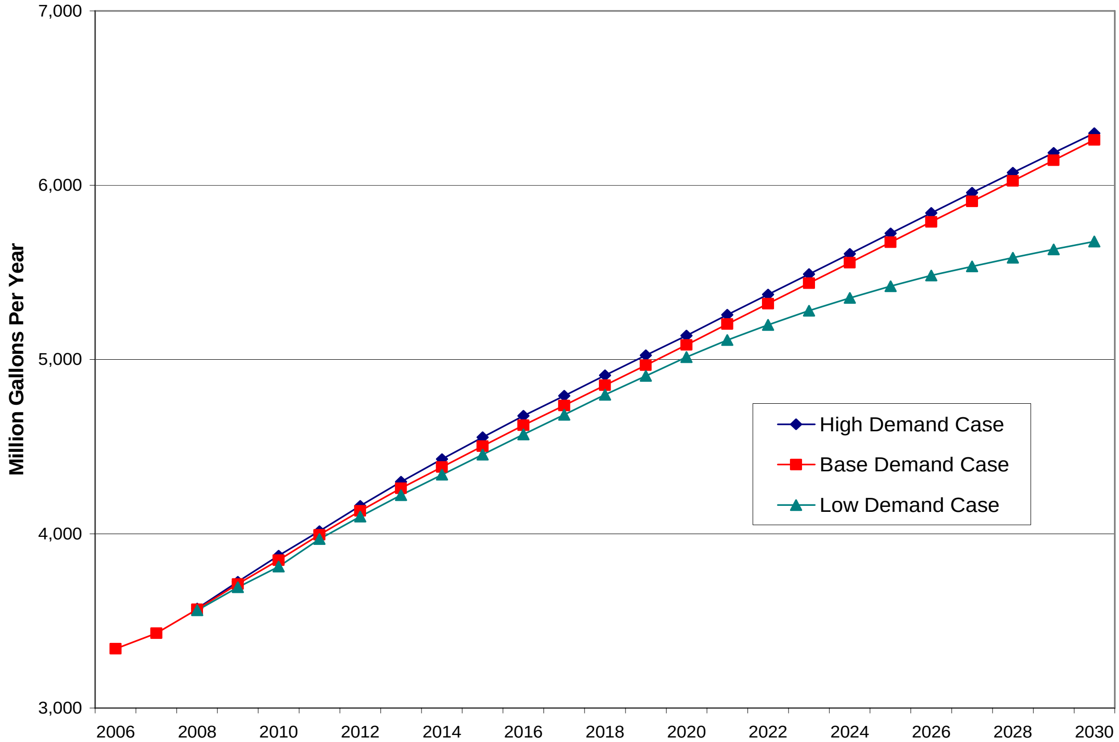
While staff acknowledges that different trajectories for future jet fuel prices may cause airlines to change the quantity of jet fuel they use, our model is not equipped to estimate this change. Instead, staff adopted the U.S. Energy Information Administration jet fuel demand forecasts from their high and low oil price scenarios proportioned to California base case demand forecast. The low price case generates the high demand case and the high price case generates the low demand case. Airport capacity constraints largely limit demand growth so that demand levels in the low and base fuel price cases do not differ very much. Staff did not attempt to project military jet fuel use, so military consumption is excluded from the forecast. Table 9 provides the commercial jet fuel demand forecast for the six evaluated cases. Figure 8 reports the projected commercial jet fuel demand for the high, base, and low demand cases.

Table 9 - California Commercial Jet Fuel Demand Forecast

	No GHG Standard			GHG Standard		
Year	**Low Fuel Price**	**Base Fuel Price**	**High Fuel Price**	**Low Fuel Price**	**Base Fuel Price**	**High Fuel Price**
2005	3.320	*3.320*	*3.320*	*3.320*	3.320	3.320
2010	3.874	*3.848*	*3.812*	*3.874*	3.848	3.812
2015	4.554	*4.503*	*4.454*	*4.554*	4.503	4.454
2020	5.137	*5.084*	*5.013*	*5.137*	5.084	5.013
2025	5.724	*5.673*	*5.421*	*5.724*	5.673	5.421
2030	6.298	*6.260*	*5.677*	*6.298*	6.260	5.677

Source: California Energy Commission

Figure 8 - California Jet Fuel Demand Forecast

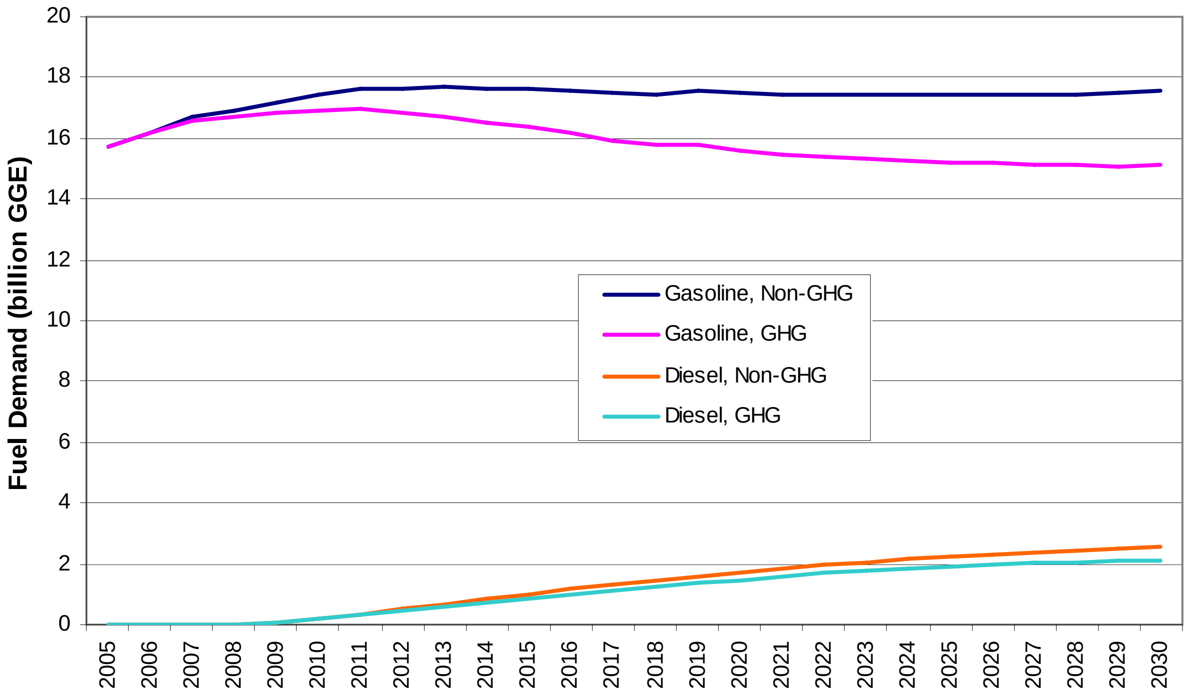


Source: California Energy Commission

Summary of Demand Forecast

The light-duty fuel demand forecast is sensitive to fuel price and GHG standards as discussed in the demand forecast results section. Demand decreases with either an increase in fuel price, the implementation of a GHG standard, or a combination of both. Figure 9 shows the effects of the impacts of the GHG standard on light-duty gasoline and diesel demand using the base fuel price forecast.

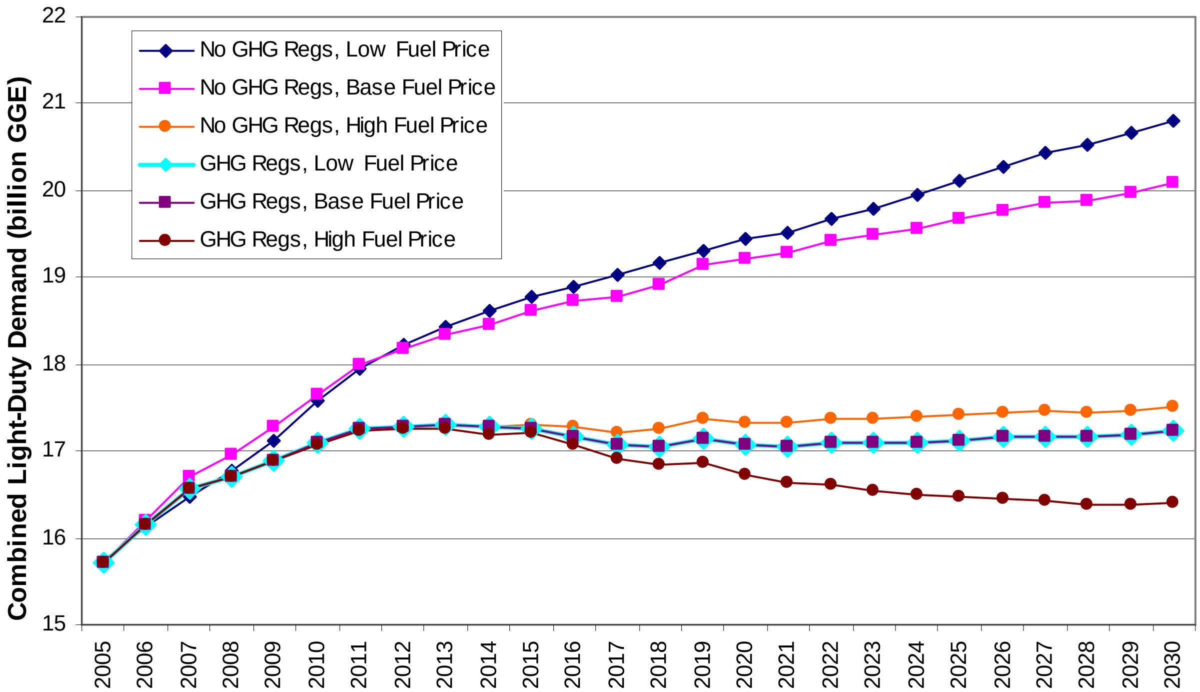
Figure 9 - Projected Light-Duty Transportation Fuel Demand, Base Fuel Price Case (Billion Gallons)



Source: California Energy Commission

Of the six evaluated cases, the low and base fuel prices without an implemented GHG standard lead to the highest transportation fuel demand, while the remaining four cases produce substantially lower demand levels. Figure 10 provides the light-duty transportation fuel demand for all fuel prices both with and without the implementation of GHG standards. For Figure 10, gasoline and diesel are combined on a gasoline gallon equivalent basis.

Figure 10 - Combined Gasoline and Diesel Light-Duty Transportation Fuel Demand, All Fuel Price Cases (Billions Gasoline Gallon Equivalents)



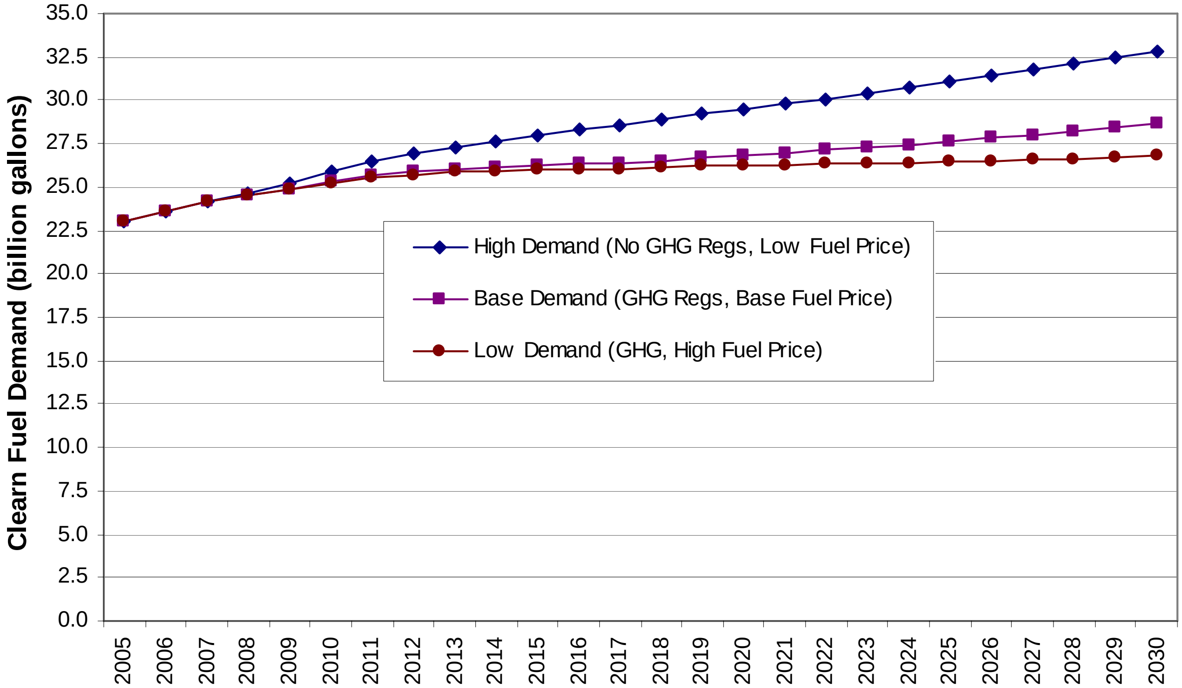
Source: California Energy Commission

The three demand cases selected to represent the range of potential demand projections for the fuel imports analysis discussed in a later section are:

- The high demand case assuming the low fuel price case without a GHG standard
- The base demand case assuming the base fuel price case with a GHG standard implemented
- The high demand case assuming the high fuel price case with a GHG standard implemented

In order to evaluate the impact to infrastructure and the consequences of these three demand cases on fuel flows within California, total demand for clean fuels (finished gasoline, diesel, and jet fuel) is determined on a volumetric basis. Figure 11 presents the combined volumes of transportation fuels for gasoline, diesel, and jet fuel projected in each of the three demand cases that are used to estimate future fuel import requirements.

Figure 11 - California Clean Fuel Demand (Billion Gallons)



Source: California Energy Commission

CHAPTER 3: CALIFORNIA CRUDE OIL IMPORTS FORECAST

Overview

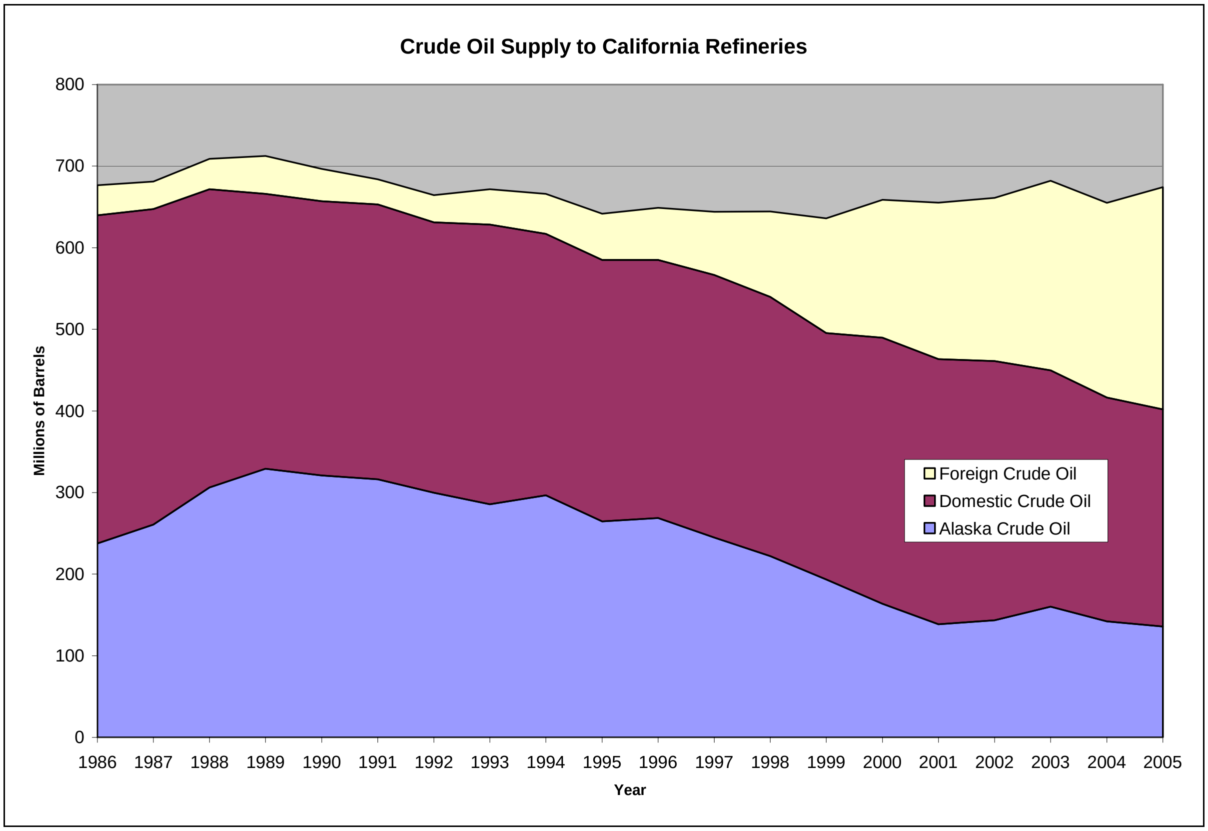
Two factors primarily determine the quantity of crude oil imported into California: the declining production from California crude oil fields and the gradual expansion of refining capacity in the state. Staff developed the forecast of crude oil imports for the state by analyzing trends for both of these factors over approximately the last decade and by making some assumptions going forward over the forecast period. Rather than working toward a single forecast, staff took the approach that a forecasted range of crude oil imports would be more useful in providing a reasonable boundary of incremental crude oil imports. This approach yielded a Low and High Case for crude oil imports.

The lower end of the forecast assumes that the decline rate of California crude oil production is less steep than the average rate of depletion experienced over the last decade. In addition, the gradual growth of California refinery capacity to process crude oil, referred to as refinery creep, is assumed to grow at a slower rate than that observed over the last several years. These two projections combine to yield a forecast for crude oil imports that is at the lower end of the spectrum. To develop a High Case crude oil import forecast, staff assumed that the depletion of California crude oil sources would continue at a higher rate and that the increase of refinery distillation capacity would be greater than the one used for the Low Case.

The Status of California Crude Oil Sources

California refineries processed 674 million barrels (1.8 million barrels per day) of crude oil in 2005. The majority of this crude oil was obtained from foreign sources (40.4 percent), followed by California sources (39.5 percent), with the balance from Alaska (20.2 percent). Figure 12 illustrates the various sources of crude oil used in California refineries since 1982.

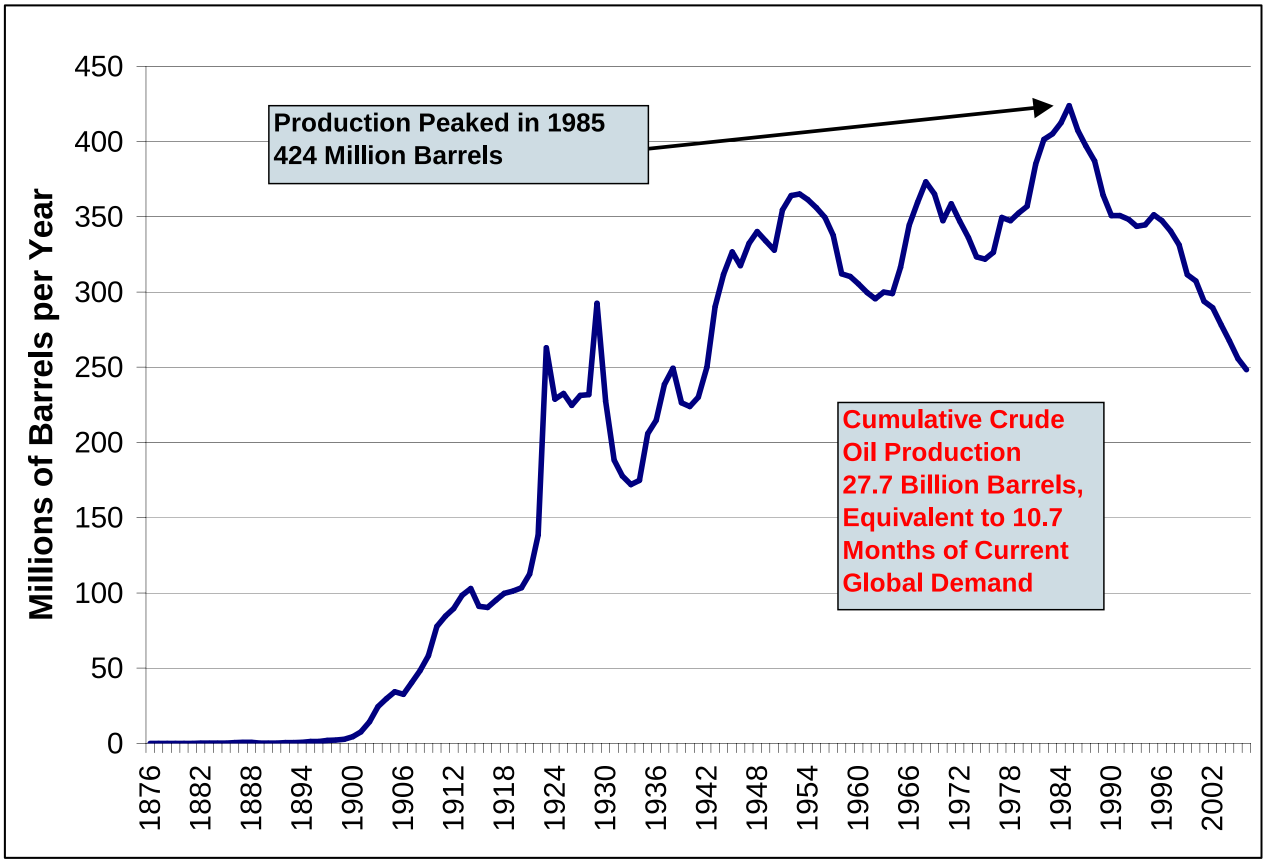
Figure 12 - Crude Oil Supply to California Refineries



Source: Annual crude oil supply data from the Petroleum Industry Information Reporting Act database

Figure 12 also shows that foreign sources of crude oil are increasing to displace declining quantities of California and Alaska crude oil sources. The decline of California crude oil production has continued since 1985, when crude oil production peaked at 424 million barrels per year. California crude oil production began in the early 1860s with "production" obtained from horizontal shafts dug into the sides of hills that contained oil seeps. The first oil producing well was drilled in Humboldt County near Petrolia. Since that early beginning, crude oil exploration and production achieved advances in technology that enabled companies to obtain crude oil from deeper reservoirs and extract nearly tar-like oil by means of thermally enhanced oil recovery (steam injection). But the majority of California's crude oil producing fields are mature, such as those in Kern County, and have been producing oil for more than 100 years. Over time, the drilling and extraction of crude oil results in diminishing output from wells. As Figure 13 illustrates, the long-term production of California crude oil has peaked and will continue to decline over the foreseeable future. The primary question is: at what rate will California's crude oil production decline over the next 20 years?

Figure 13 - California Oil Production, 1876 to 2006

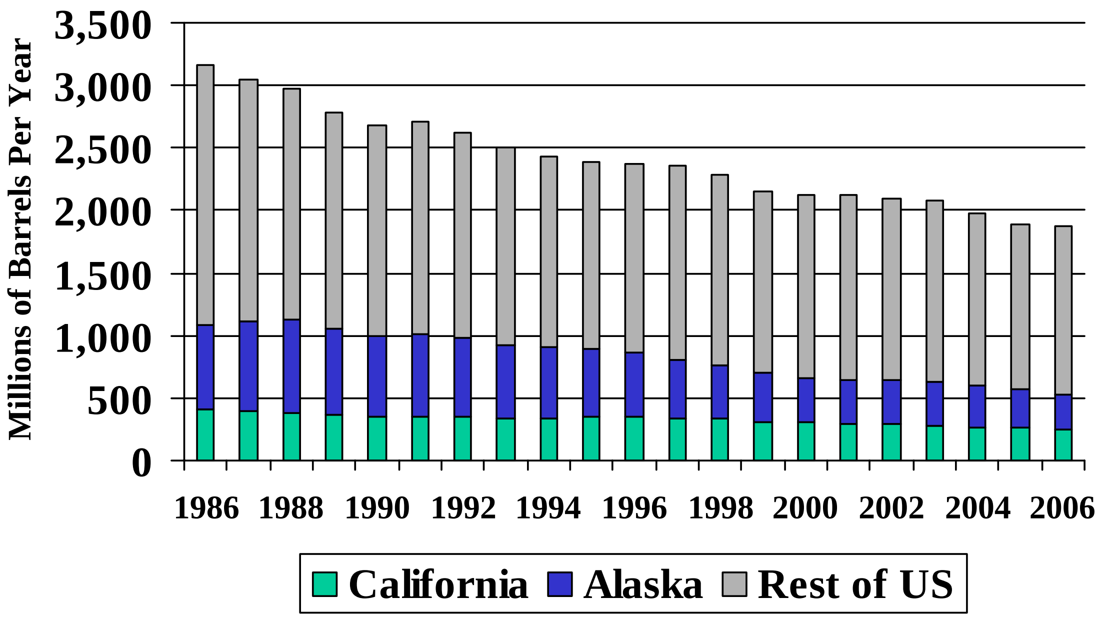


Sources: California Division of Oil, Gas, and Geothermal Resources and the California Energy Commission

Decline of U.S. Crude Oil Production

Since the late 1980s, both U.S. and California crude oil production have been declining at a steady pace. Since 1986, California crude oil production has declined by 39 percent; Alaska, by 60 percent; and the rest of the U.S., by 35 percent. As of 2006, U.S. crude oil production had declined to 1.9 billion barrels per year, or an average of 5.1 million barrels per day (BPD). California's annual crude oil production was approximately 250 million barrels during 2006, averaging 685,000 BPD. Figure 14 breaks down crude oil production for the U.S. between 1986 and 2006.

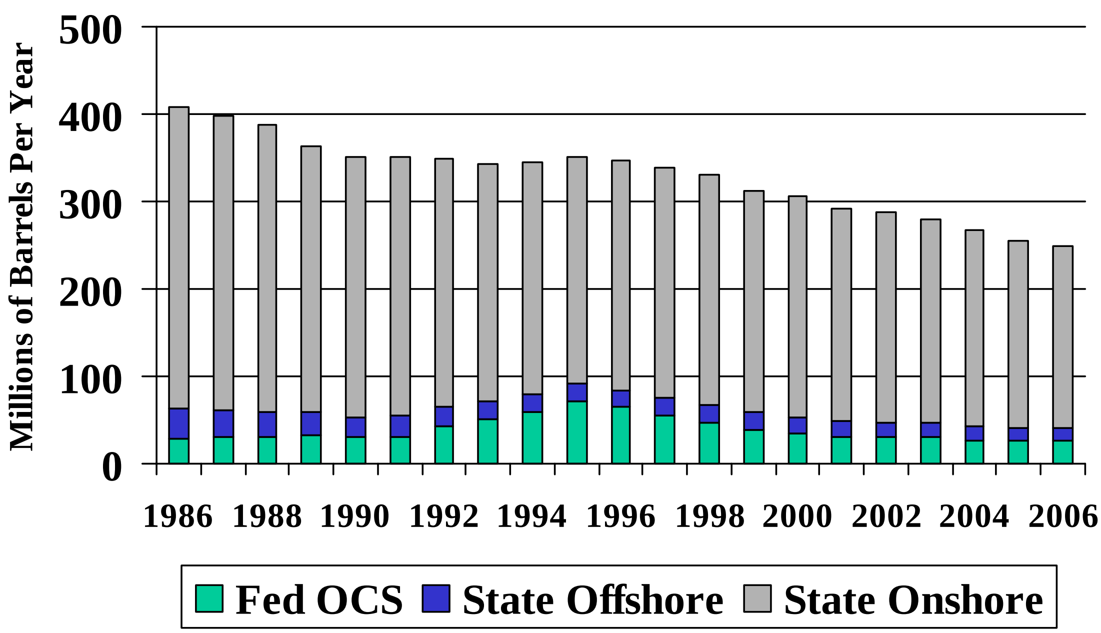
Figure 14 - U.S. Crude Oil Production (1986 - 2006)



Sources: California Division of Oil, Gas, and Geothermal Resources, Alaska Department of Revenue, and U.S. Energy Information Administration

Figure 15 illustrates California's crude oil production over the same period of time from three sources: onshore, state offshore waters, and federal Outer Continental Shelf (OCS).

Figure 15 - California Crude Oil Production (1986 - 2006)



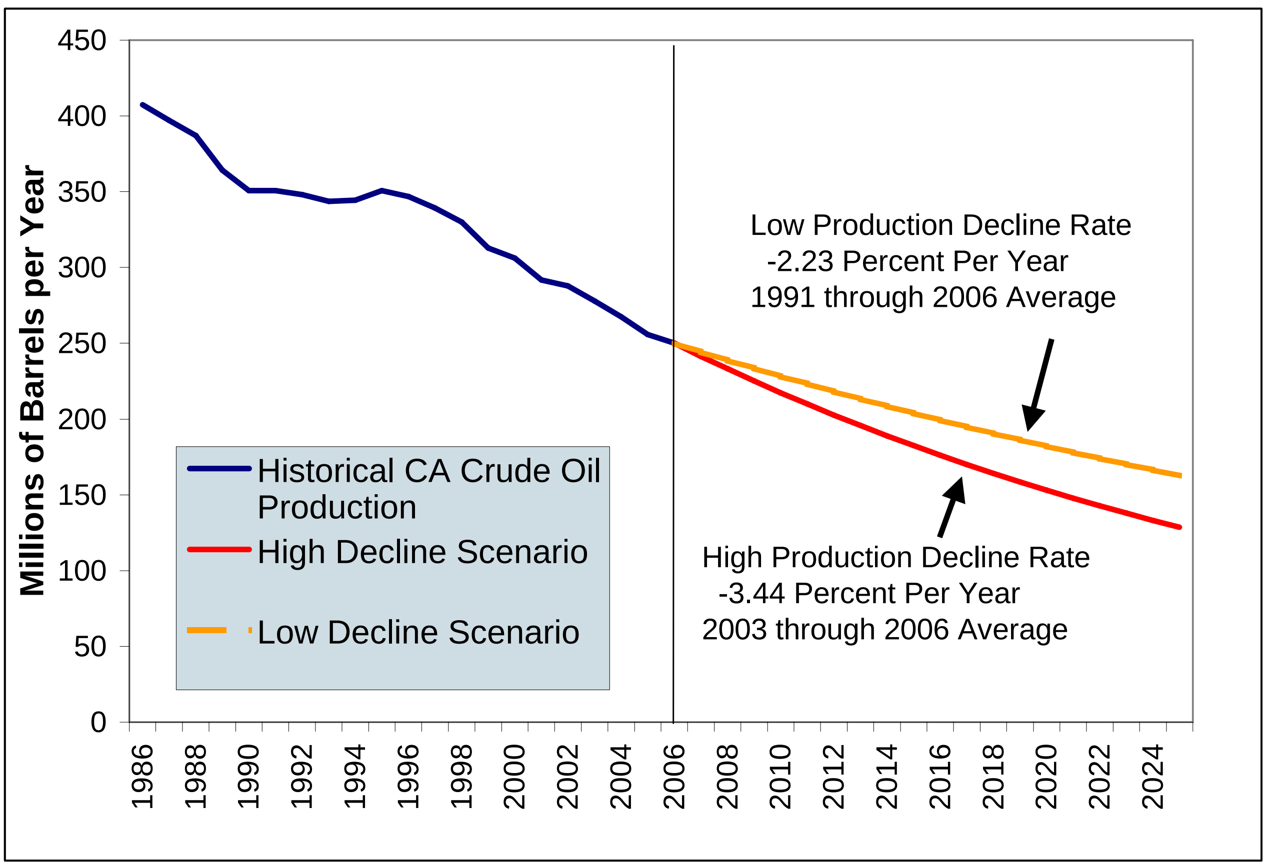
Source: California Division of Oil, Gas, and Geothermal Resource

California Crude Oil Production Decline Rates

One factor that contributes to increasing volumes of imported crude oil over time is the steady decline of California crude oil production. As local quantities of crude oil diminish, refiners must compensate by importing additional volumes from sources outside the state. Since Alaska crude oil production has declined at an even greater rate than California production, refiners must seek substitute crude oil from foreign sources.

Over the last 15 years, California's crude oil production has declined at an average rate of 2.3 percent per year. Between 2003 and 2006, the decline rate is more than 50 percent higher, averaging 3.4 percent per year. One reason for the lower decline rate over the longer historical period is the fact that output from the federal Outer Continental Shelf peaked in 1995. Figure 16 extrapolates the two previously mentioned decline rates through 2025.

Figure 16 - California Crude Oil Production Decline Forecast 2007–2025



Source: California Division of Oil, Gas, and Geothermal Resources and the California Energy Commission

California Refinery Crude Oil Processing Capacity

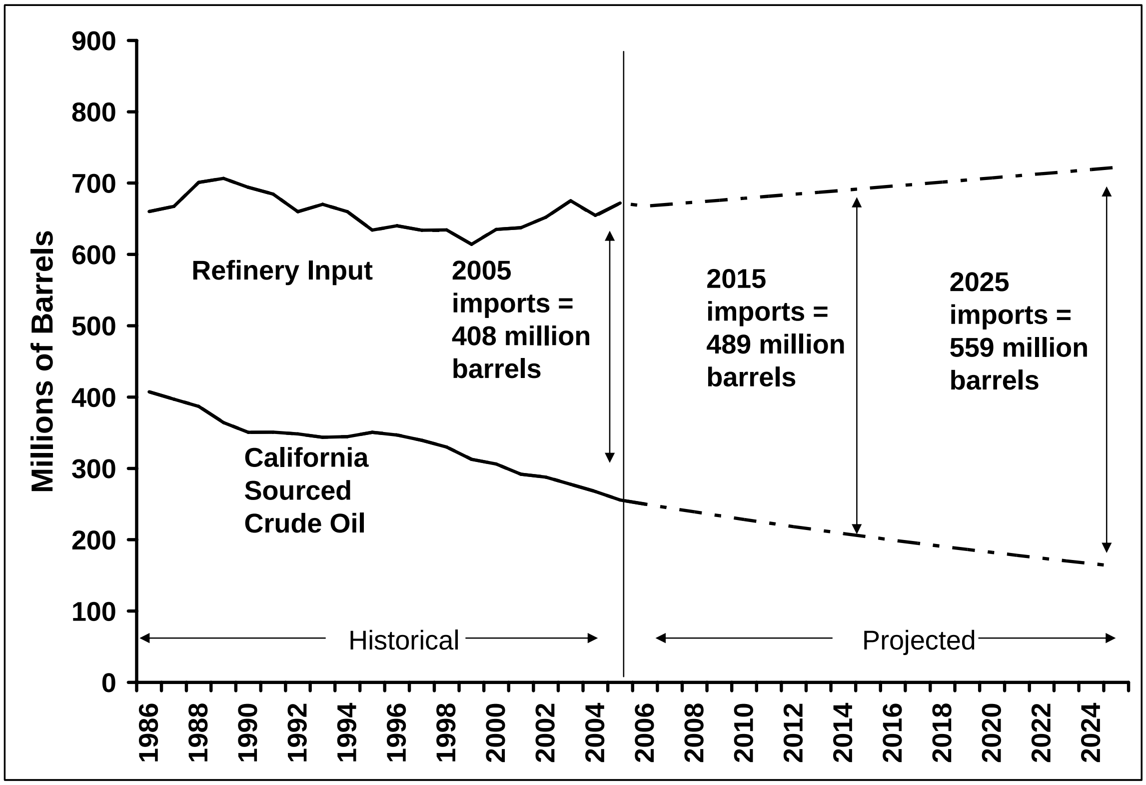
In California 22 refineries are operating; they process an average of 1.8 million BPD of crude oil. In the initial processing step, distillation process units convert crude oil to a variety of petroleum blendstocks that are combined to form gasoline, diesel, and jet fuel. Most refiners normally perform periodic maintenance at their facilities during the winter months. Occasionally, a refiner may elect to expand slightly the capacity of its crude oil distillation equipment if the project meets environmental guidelines and can be justified as having a sufficient economic return for the cost of the project. This gradual increase of distillation capacity—refinery creep—is the second primary factor that can contribute to increasing imports of crude oil for California.

Between 2001 and 2006, refinery creep for crude oil distillation capacity increased at an average rate of nearly 1 percent per year (0.98 percent). Between 2003 and 2006, the refinery creep rate was less than half (0.4 percent per year). These two rates bounded the lower and upper limits of refinery creep for this analysis. Since refineries do not process crude oil when the distillation units are undergoing maintenance or are temporarily out of service from an unplanned refinery outage, their utilization rates (a measure of crude oil processed per day relative to the maximum capacity of the equipment) will be at a level of less than 100 percent. For all of the refineries operating in California since 1999, the combined utilization rate has averaged 90.8 percent. For purposes of this work, staff assumed that this utilization rate would remain constant over the next 20 years.

Crude Oil Import Forecast

To estimate a range of incremental crude oil imports for California, staff compared the trends of crude oil production decline rates and gradual refinery distillation capacity growth to produce a Low and High Case forecast. Figure 17 depicts the Low Case.

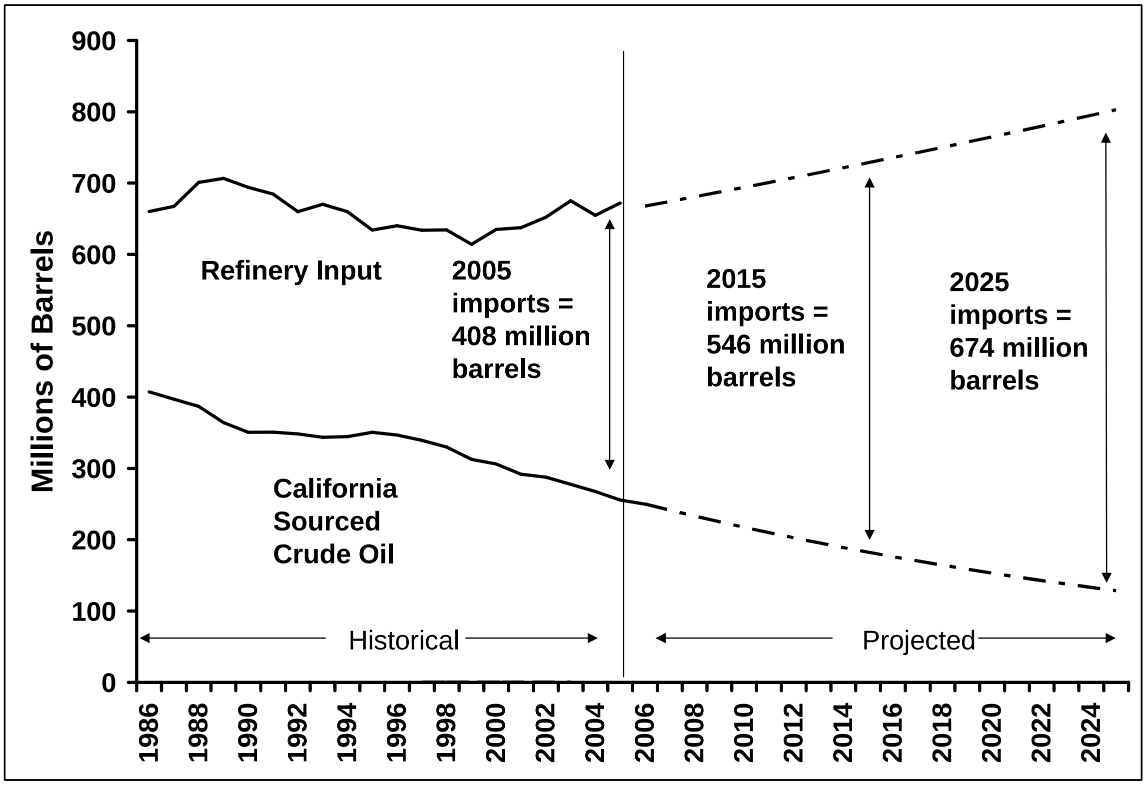
Figure 17 - Low Case Forecast for California Crude Oil Imports



Source: California Energy Commission analysis and Petroleum Industry Information Reporting Act database

Under the Low Case projection, crude oil imports are forecast to increase by 81 million barrels per year between 2005 and 2015 (19 percent increase) and by 151 million barrels by 2025 (37 percent increase compared to 2005). To obtain these projections, staff assumed that distillation capacity increases (refinery creep) would be at the lower rate of 0.4 percent per year, while the decline rate of California crude oil production would be at the lower rate of 2.2 percent per year. Using higher rates for both crude oil production decline and refinery creep, crude oil imports are expected to grow faster. Under the High Case projection, crude oil imports rise by 138 million barrels per year between 2005 and 2015 (34 percent increase) and by 266 million barrels by 2025 (65 percent increase compared to 2005). Figure 18 illustrates the High Case projection for California crude oil imports.

Figure 18 - High Case Forecast for California Crude Oil Imports



Source: California Energy Commission analysis and Petroleum Industry Information Reporting Act database

As each of the two previous figures indicates, the use of different rates for crude oil production decline and refinery creep can significantly alter the estimated range of incremental crude oil imports. Table 10 combines the various rates into a single table for both the near-term (2015) and longer-term (2025) periods of the forecast.

Table 10 - Import Rates for Entire State

Incremental California Crude Oil Imports - Millions of Barrels				
Distillation Capacity Growth Rate	Low Rate of Crude Oil Decline - 2.2%		High Rate of Crude Oil Decline - 3.4%	
	2015	2025	2015	2025
0.41 Percent	81	151	102	185
0.70 Percent	99	191	120	226
0.98 Percent	117	232	138	266

Source: California Energy Commission

The next step in the analysis involved an estimate of the portion of the incremental crude oil imports for the entire state that would be delivered to Northern and Southern California, respectively. Based on recent historical trends, staff assumed that 60 percent of the incremental crude oil imports over the forecast period would be delivered to marine terminals in Southern California, with the balance (40 percent) handled by marine berths in the San Francisco Bay Area. Table 11 shows how the incremental import projections for Southern California can vary by changing the assumed rates for crude oil production decline and refinery creep.

Table 11 - Import Projections for Southern California

Incremental **S. Calif.** Crude Oil Imports - Millions of Barrels				
Distillation Capacity Growth Rate	Low Rate of Crude Oil Decline - 2.2%		High Rate of Crude Oil Decline - 3.4%	
	2015	2025	2015	2025
0.41 Percent	49	91	61	111
0.70 Percent	59	115	72	135
0.98 Percent	70	139	83	160

Source: California Energy Commission

Crude Oil Tankers – Incremental Voyages

The increased imports of crude oil are expected to result in a greater number of marine vessels (referred to as crude oil tankers) arriving in California ports. Staff has examined recent import information to determine an average cargo size per crude oil tanker import event. For purposes of calculating additional crude oil tanker trips, staff used an upper limit of 2 million barrels of cargo capacity per import event and a lower limit of 700 thousand barrels capacity. The upper limit represents the storage capacity of a very large crude carrier (VLCC). The lower range is the capacity of typical foreign crude oil tankers, referred to as Aframax (80 to 119 thousand deadweight tonnage). This scenario assumed that the bulk of the incremental imports of crude oil over the near term will originate from foreign sources and be transported on Aframax marine vessels. Using these two estimates for crude oil tanker capacity, staff calculated 41 to 197 additional crude oil tanker arrivals by 2015, and 76 to 380 additional arrivals by 2025. The broad range for the estimate is a consequence of the large difference in capacity between the Aframax and VLCC storage capacities.

Crude Oil Storage Capacity–Anticipated Growth

The importation of incremental volumes of crude oil will not only necessitate an increased number of crude oil tanker visits, but will also require a larger storage tank capacity for the marine facilities receiving the additional cargoes. The Energy Commission staff has calculated additional storage tank capacity that would have to be constructed to handle the additional imports of crude oil. This scenario assumes that most of the existing marine terminals are at or near maximum operating capacity. Two incremental storage tank throughput rates were used to calculate the additional crude oil storage tank capacity estimates. The first rate uses a design capacity throughput similar to the proposed crude oil import project at Pier 408 in San Pedro Harbor, approximately 1 million barrels of storage capacity per 23 million barrels of imports per year. The second rate assumes a slower cycling of the storage tanks, yielding a conversion rate of about 1 million barrels of storage capacity per 12 million barrels of imports per year.

As part of ongoing analysis, staff is examining a scenario that allows for higher throughputs at most of the marine terminals prior to the need for expansion of existing storage tank capacity. This analysis should be completed during the third quarter of 2007.

Ongoing Analysis

The increasing load on the existing crude oil import facilities means that the diminishing spare import capacity could increase the risk of a significant fuel supply problem should one of the larger crude oil import terminals (such as Berth 121 in Long Beach) be temporarily out of commission for an extended period of time. In addition, the crude oil import facilities of Southern California could not accommodate the large forecasted increase of imports and would require the construction of at least one large new crude oil import facility. For these two reasons, staff will develop a more precise estimate of timing for expansion for its final staff report.

CHAPTER 4: TRANSPORTATION FUEL IMPORT FORECASTS

Overview

The effects of trends in consumer demand, California refinery output, and exports of petroleum products to neighboring states determine the rate at which California's imports of transportation fuels will increase during the forecast period. This section contains a discussion of the specific factors that staff assessed, the methodology employed when conducting the analysis, and a description of additional factors that can increase the level of uncertainty inherent in this work. The primary purpose of this analysis is to quantify a range of incremental imports of transportation fuels for the regional market and to identify any potential constraints within the distribution infrastructure that could impede supplies of transportation fuels for California consumers and businesses.

California Refinery Production Capacity

Over the last several years, production of transportation fuels from California refineries has not kept pace with consumer demand, resulting in greater quantities of imported gasoline, diesel, jet fuel, and alternative fuels. The level of transportation fuel imports over the forecast period can be influenced by the rate at which refinery capacity grows over time. Production of transportation fuels is dependent on:

- Maximum capacity to process crude oil (distillation capacity)
- The number of days refineries operate at normal rates during the year (utilization rate)
- Maximum capacity to process additional refinery feedstocks (process unit capacity)

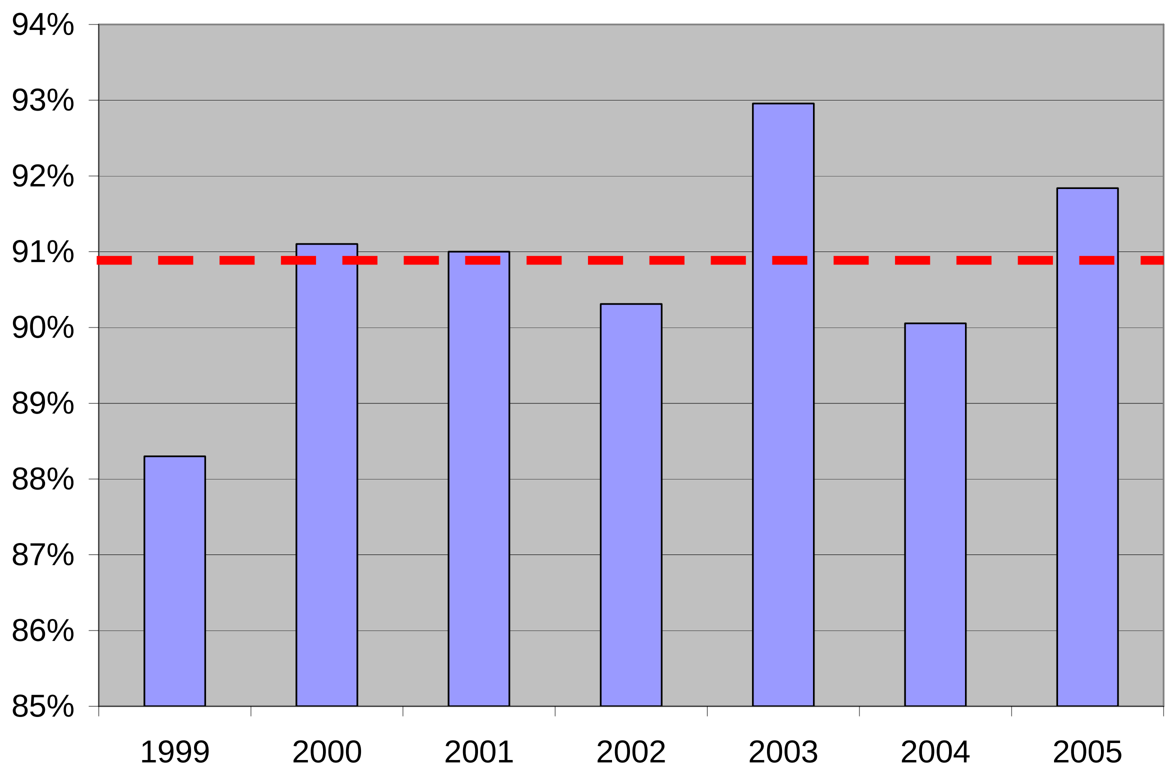
Crude Oil Processing (Distillation) Capacity

If California refineries process additional quantities of crude oil each year, the output of petroleum products from those refineries should be greater. Based on the recently revised crude oil import forecast work, staff has estimated that the capacity to process crude oil at California refineries will continue to grow at a rate of 0.70 percent per year. Staff used a range of distillation capacity growth rates as part of the analysis to forecast imports of transportation fuels. Staff used the lower distillation capacity growth rate of 0.41 percent per year to calculate the High Case of the transportation fuel import forecast because increased processing of crude oil will yield additional quantities of petroleum products, reducing the growth rate for imports of transportation fuels. A higher distillation capacity growth rate of 0.98 percent per year was used as a factor contributing to a Low Case of imported transportation fuels.

Increasing the crude oil processing capacity of California refineries over the forecast period must also include an assumption of the actual quantity of crude oil that will be processed on a daily basis, relative to the maximum crude oil distillation capacity. This calculation is referred to as the crude oil utilization rate, derived by dividing the total quantity of crude oil processed at California's refineries by the maximum capacity to process crude oil. These utilization rates will never exceed 100 percent for any given year because refiners periodically perform maintenance on their atmospheric and vacuum distillation process units, temporarily reducing the amount of crude oil processed for a period of four to six weeks.

Staff has determined that the utilization rates have been somewhat stable over the last several years (1999 – 2005) and therefore has elected to maintain a constant rate of 90.8 percent throughout the forecast period as an assumption for this portion of the analysis. Figure 19 depicts average crude oil distillation utilization rates over the last seven years.

Figure 19 - California Refineries – Crude Oil Utilization Rates



Source: California Energy Commission analysis

Process Unit Capacity Growth

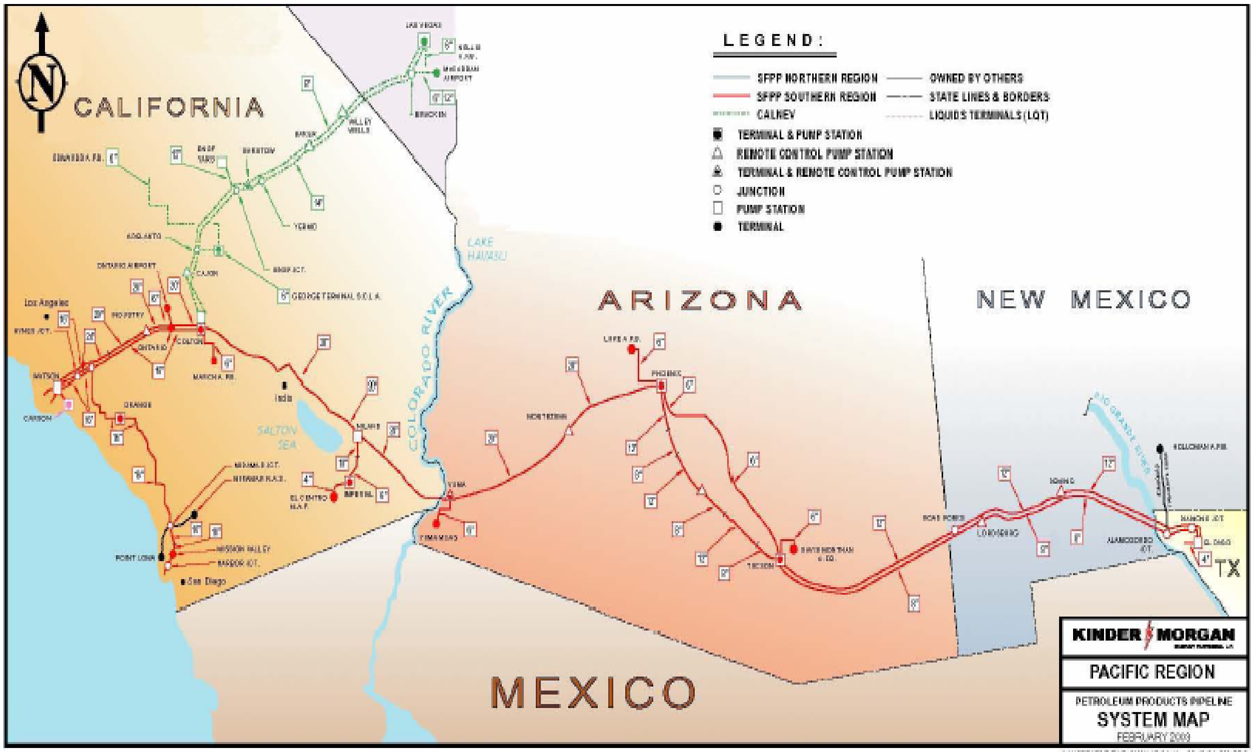
California refineries use other types of equipment to further refine the crude oil initially processed by the crude oil distillation units. These process units can also be used to convert refinery feedstocks, purchased from outside the refinery, into petroleum blendstocks suitable for creating gasoline and other transportation fuels. Over the forecast period, the process unit capacity is expected to increase at a rate that will be sufficient to accommodate the additional feedstocks generated by the continuously expanding crude oil distillation process capacity.

Exports of Transportation Fuels to Neighboring States

Nevada and Arizona do not have any refineries that can produce transportation fuels. As a consequence, these states must import all of the transportation fuels that they consume from refineries located outside their borders. Refineries located in California export petroleum products via pipelines that are linked to distribution terminals located in Reno, Las Vegas, and Phoenix. This network of interstate pipelines is owned and operated by the Kinder Morgan Pipeline Company (KMP).

Pipelines that originate in California provide nearly 100 percent of the transportation fuels consumed in Nevada. Approximately 60 percent of Arizona's demand also is met by products exported from California. The balance of transportation fuels consumed in Arizona is delivered in a petroleum product pipeline that originates in Western Texas on a section of the KMP system referred to as the East Line. Figure 20 depicts the KMP petroleum product pipeline system in the Southwest United States.

Figure 20 - Kinder Morgan Interstate Pipeline System



Source: Kinder Morgan Pipeline Company

If expansion of California refinery capacity fails to keep pace with demand growth for transportation fuels in California, Nevada, and Arizona, imports of petroleum products and alternative fuels will grow over time. Over the near- and long-term forecast periods, transportation fuel demand growth in Nevada and Arizona, taking into account East Line expansion plans, will place additional pressure on California refineries and the California petroleum marine import infrastructure system to provide adequate supplies of transportation fuels for this regional market.

Population growth rates in Arizona and Nevada have been similar to increases in consumption of gasoline and diesel fuel over the last several years. As a result, population growth is the sole factor used to estimate growth rates over the forecast period for those transportation fuels. But since Las Vegas—and to a lesser extent Arizona—are tourist destinations, the jet fuel demand growth in these states is rising at a rate greater than population increases. Therefore, staff has elected to use the forecasted growth of commercial passenger jet activity by the Federal Aviation Administration (FAA) to obtain an estimate for jet fuel demand for Arizona and Nevada. Table 12 lists the various transportation fuels' demand levels and respective growth rates for 2015 and 2025 in comparison to 2006.

Table 12 - Neighboring States' Transportation Fuel Demand

Arizona Transportation Fuel Demand
2006 & Forecast (Thousands of Barrels per Day)

	Gasoline		Diesel Fuel		Jet	Totals	
Year	Low	High	Low	High	Fuel	Low	High
2006	177.0	177.0	58.0	58.0	33.8	268.9	268.9
2015	210.4	222.2	69.0	72.9	44.8	324.2	339.9
2025	267.6	269.2	87.7	88.3	61.1	416.4	418.6

Incremental Demand (Thousands of Barrels per Day)

2015	33.4	45.2	11.0	14.8	10.9	55.3	71.0
2025	90.6	92.2	29.7	30.2	27.3	147.6	149.7

Percent Increase Compared to 2006

2015	18.9%	25.5%	18.9%	25.5%	32.4%	20.6%	26.4%
2025	51.2%	52.1%	51.2%	52.1%	80.7%	54.9%	55.7%

Nevada Transportation Fuel Demand
2006 & Forecast (Thousands of Barrels per Day)

	Gasoline		Diesel Fuel		Jet	Totals	
Year	Low	High	Low	High	Fuel	Low	High
2006	75.8	75.8	49.0	49.0	35.3	160.1	160.1
2015	88.1	103.9	57.0	67.2	47.8	192.9	218.9
2025	111.3	124.3	72.0	80.4	65.8	249.1	270.6

Incremental Demand (Thousands of Barrels per Day)

2015	12.3	28.1	8.0	18.2	12.5	32.8	58.8
2025	35.5	48.5	23.0	31.4	30.6	89.0	110.5

Percent Increase Compared to 2006

2015	16.2%	37.0%	16.2%	37.0%	35.5%	20.5%	36.7%
2025	46.8%	64.0%	46.8%	64.0%	86.7%	55.6%	69.0%

Source: California Energy Commission analysis

Staff used a lower population growth rate for Nevada and Arizona as a factor associated with the Low Case transportation fuels import forecast. For the High Case, staff assumed a higher population growth rate for the two neighboring states. Incremental pipeline shipments to the Phoenix area over the West Line from California were assumed to be similar in ratio for the respective transportation fuels as was observed during 2006. Table 13 provides a breakdown of the current level of transportation fuel exports to Nevada and Arizona via pipeline, as well as the forecasted exports for 2015 and 2025 under the Low and High Cases.

Table 13 - Pipeline Exports to Arizona and Nevada

Pipeline Exports from California - Low Case

2006 & Forecast (Thousands of Barrels per Day)

	Gasoline		Diesel Fuel		Jet Fuel		Totals	
Year	AZ	NV	AZ	NV	AZ	NV	AZ	NV
2006	63.2	71.7	38.7	49.0	31.2	35.3	133.1	156.0
2015	75.1	83.4	46.0	57.0	41.7	47.8	162.8	182.0
2025	95.5	105.3	58.5	72.0	57.4	65.8	211.4	234.7

Incremental Exports (Thousands of Barrels per Day)

2015	11.9	11.6	7.3	8.0	10.5	12.5	29.7	26.0
2025	32.3	33.6	19.8	23.0	26.2	30.6	78.3	78.6

Percent Increase Compared to 2006

2015	18.9%	16.2%	18.9%	16.2%	33.5%	35.5%	22.3%	16.7%
2025	51.2%	46.8%	51.2%	46.8%	83.8%	86.7%	58.8%	50.4%

Pipeline Exports from California - High Case

2006 & Forecast (Thousands of Barrels per Day)

	Gasoline		Diesel Fuel		Jet Fuel		Totals	
Year	AZ	NV	AZ	NV	AZ	NV	AZ	NV
2006	63.2	71.7	38.7	49.0	31.2	35.3	133.1	156.0
2015	79.3	98.3	48.6	67.2	41.7	47.8	169.6	207.1
2025	96.0	117.6	58.9	80.4	57.4	65.8	212.3	255.4

Incremental Exports (Thousands of Barrels per Day)

2015	16.1	26.6	9.9	18.2	10.5	12.5	36.5	51.1
2025	32.9	45.9	20.2	31.4	26.2	30.6	79.2	99.4

Percent Increase Compared to 2006

2015	25.5%	37.0%	25.5%	37.0%	33.5%	35.5%	27.4%	32.8%
2025	52.1%	64.0%	52.1%	64.0%	83.8%	86.7%	59.5%	63.7%

Source: California Energy Commission analysis

Recent announcements by Kinder Morgan indicate that the petroleum product pipeline capacity between Colton, California and Las Vegas, Nevada (referred to as the CalNev Line) will undergo an expansion that is slated for completion by 2010. At that future time, the pipeline capacity will reach 200,000 BPD, an increase of 44,000 BPD from the 2006 capacity of 156,000 BPD. To increase the capacity beyond the 2010 limits, Kinder Morgan could improve the pumping horsepower which should enable the maximum capacity to reach 300,000 BPD. In addition to the CalNev project, the East Line is also in the midst of the second phase of its recent expansion. This work is scheduled for completion by the end of 2007, increasing the capacity from the El Paso to Tucson section from 147,000 BPD in 2006 to 170,000 BPD in 2008. The section between Tucson and Phoenix is also undergoing expansion work that will increase the pipeline capacity from 99,000 BPD in 2006 to 155,000 BPD in 2008.

The continued growth of transportation fuel demand in Arizona and Nevada will eclipse the capacity of some portions of the Kinder Morgan pipeline distribution system during the forecast period, absent additional expansions. Table 14 shows the estimated time frames whereby product pipeline capacities would be fully utilized under various scenarios.

Table 14 - Product Pipelines – Maximum Capacity Timing
Thousand Barrels Per Day (TBD)

Pipeline Section From California	2006 Capacity TBD	2007 Capacity TBD	2008 Capacity TBD	2010 Capacity TBD	Year that Maximum Capacity Of Pipeline is Reached	
					Low Case	High Case
Sacramento to Reno	45	45	45	45	2017	2012
Colton to Las Vegas	143	156	156	200	2023	2018
Colton to Phoenix	204	204	204	204	2023	2022
Pipeline Section From Western Texas						
El Paso to Tucson	93	147	170	170	Beyond 2025	Beyond 2025
Tucson to Phoenix	99	99	155	155	Beyond 2025	Beyond 2025

Source: California Energy Commission analysis

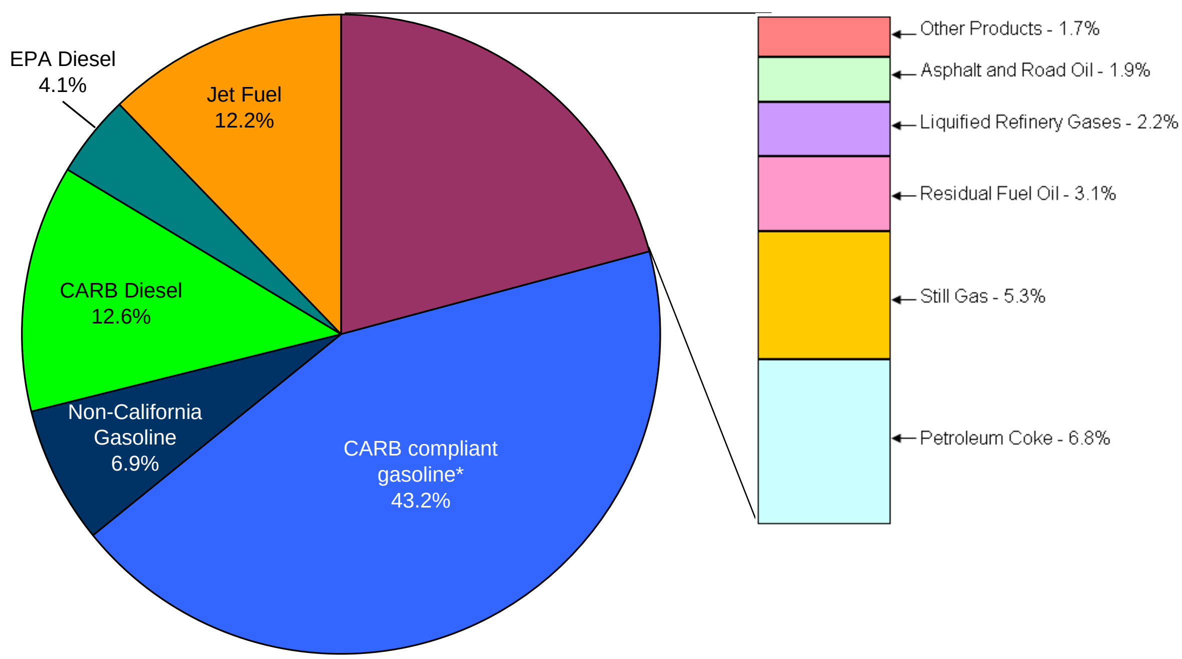
It is assumed that Kinder Morgan will continue to invest capital to expand its distribution infrastructure to accommodate future demand growth. If not, incremental demand for transportation fuels that exceed projected pipeline capacity would have to be supplied via tanker truck or rail car. This mode of transportation fuel delivery is far more expensive compared to pipeline shipments (approximately 2 to 4 times greater). As such, it is likely that additional expansions will continue to occur throughout the forecast period within the Kinder Morgan southwest system or through construction of another petroleum product pipeline system, such as the projects proposed by Pacific Texas Corporation and Holly Energy Partners.

Transportation Fuel Import Forecast

The comparison of California's demand forecast with incremental production from refineries located in the state results in the forecast of transportation fuel imports. The incremental demand outlook includes incremental pipeline exports to Arizona and Nevada. The difference between the regional demand growth for transportation fuels and additional refinery output of refined products is a forecast of incremental imports for gasoline, diesel, and jet fuel for 2015 and 2025.

California refinery production is forecast to continue growing on an incremental basis. This refinery creep of crude oil distillation capacity will yield additional refinery blendstocks that will be converted to transportation fuels for use in California and for export to neighboring states and other locations. Staff assumed that the proportion of transportation fuels produced by processing additional quantities of crude oil will be similar to the ratios that were observed during 2006. Figure 21 depicts the percentage of various transportation fuel types that were produced in 2006 for each barrel of crude oil processed.

Figure 21 - California Refinery Output in 2006 by Product Type



*Note: Does not include ethanol.

Source: California Energy Commission analysis of PIIRA data

Applying this ratio of transportation fuel output to the incremental crude oil processed, the supply of gasoline, diesel, and jet fuel produced from California refineries increased by a range of 55,000 to 293,000 barrels per day. Table 15 lays out the incremental production by each type of transportation fuel over the forecast period.

Table 15 - California Incremental Refinery Production

(Thousands of Barrels per Day)

	Low Case		Base Case		High Case	
Transportation Fuel	2015	2025	2015	2025	2015	2025
California Gasoline	29.9	64.5	51.2	112.0	72.2	160.1
Export Gasoline	4.8	10.3	8.2	17.8	11.5	25.5
California Diesel Fuel	8.7	18.8	15.0	32.7	21.1	46.8
EPA Diesel Fuel	2.9	6.2	4.9	10.7	6.9	15.3
Jet Fuel	8.4	18.2	14.4	31.6	20.3	45.1
Totals	54.7	117.9	93.7	204.9	132.0	292.8

Source: California Energy Commission analysis

Under the High Case analysis, California imports of gasoline, diesel, and jet fuel are forecast to increase by 288,000 barrels per day by 2015 and 478,000 BPD by 2025 when compared to 2006 levels. Under the Low Case analysis, California imports of transportation fuels are forecast to increase by 87,000 barrels per day by 2015 and 67,000 BPD by 2025 when compared to 2006 levels. Table 16 illustrates the growth of imports for each type of transportation fuel, excluding ethanol.

Table 16 - California Incremental Imports of Transportation Fuels

(Thousands of Barrels per Day)

	Low Case		Base Case		High Case	
Transportation Fuel	2015	2025	2015	2025	2015	2025
Gasoline	-53.9	-212.9	-27.5	-124.3	99.0	102.5
Diesel Fuel	65.9	132.3	81.4	174.7	95.5	181.9
Jet Fuel	75.5	147.5	84.4	177.3	93.6	193.9
Totals	87.4	66.9	138.3	227.8	288.1	478.4

Source: California Energy Commission analysis

Levels of imports are most influenced by California transportation fuel demand growth rates and assumptions regarding operations of the California refineries. More modest increases for refining capacity and a high demand growth rate contribute to the upper end of the transportation fuel import forecast. Lower demand projections for the state and a higher capacity creep assumption for refineries have combined to produce the Low Case import projections. These estimated levels of incremental transportation fuel imports are the first step in the primary analysis. The following sections describe the analysis that staff performed to determine the additional number of marine vessel trips and additional petroleum product storage tank capacity that may be necessary to accommodate the projected level of transportation fuel imports for 2015 and 2025.

Marine Vessels–Incremental Voyages

The increased imports of transportation fuels is expected to result in a greater number of marine vessels (referred to as product tankers) arriving in California ports bearing cargoes of gasoline, diesel, and jet fuel. Staff has examined recent import information to determine an average cargo size per product tanker import event. Petroleum tankers are constructed with multiple compartments that enable the transport of more than one type of petroleum product per voyage. In addition, some product tankers will discharge cargoes at more than one marine terminal. Finally, staff recognizes that there are instances where transportation fuels are imported via ocean-going barges that have smaller cargo capacities when compared to typical product tankers.

For purposes of calculating additional product tanker trips, staff used an upper limit of 300,000 barrels of cargo capacity per import event and a lower limit of 150,000 barrels' capacity. The upper limit is an average of the largest product tankers (top 25 percent) that were involved in a foreign import of transportation fuels in 2006. The lower range was estimated by using the average size of all of the foreign product tanker vessels for 2006. It is assumed that the bulk of the incremental imports of transportation fuels will originate from foreign sources. Using these two estimates for product tanker capacity, staff calculated the incremental number of import events that would be required over the forecast period. The results are detailed in Table 17.

Table 17 - California Incremental Product Tanker Arrivals

	Low Case		Base Case		High Case	
Marine Vessel Size	2015	2025	2015	2025	2015	2025
150,000 Barrels	213	163	336	554	701	1,164
300,000 Barrels	106	81	168	277	351	582

Source: California Energy Commission analysis

Marine Terminal Storage Capacity–Anticipated Growth

The importation of incremental volumes of transportation fuels will not only necessitate an increased number of product tanker visits, but will also require a larger storage tank capacity for the marine facilities receiving the additional cargoes. The Energy Commission staff has calculated additional storage tank capacity that would have to be constructed to handle the additional imports of transportation fuels. This scenario assumes that most of the existing marine terminals are at or near maximum operating capacity. As part of ongoing analysis, staff is examining a scenario that allows for higher throughputs at most of the marine terminals prior to the need for expansion of existing storage tank capacity. This analysis should be completed during the third quarter of 2007. Table 18 contains the incremental storage tank expansion that is estimated for 2015 and 2025.

Table 18 - California Incremental Storage Tank Capacity

(Millions of Barrels)

	Low Case		Base Case		High Case	
	2015	2025	2015	2025	2015	2025
Totals	2.7	2.1	4.2	7.0	8.8	14.7

Source: California Energy Commission analysis

It should be noted that the calculation of spare throughput capacity at marine terminals is not as precise as that of crude oil distillation utilization rates or spinning reserves for the regional power plant generation capacity. With marine voyages, anticipated times to traverse specific distances (between the Middle East and California) cannot be calculated exactly because of changing sea conditions that result in rerouting of a product tanker or altering the speed of the voyage. As a consequence, the ability to plan for the arrival of a marine vessel within an hour or two is unlikely. Anticipated dates and times of arrival can be extended several hours or days.

Other forms of delay can also extend the anticipated time to unload a cargo of transportation fuel. Some examples include lengthy inspections of vessels, processing delays for necessary paperwork, and interruption of pumping operations during the discharge of the cargo. All of these examples can increase the amount of time required to receive the vessel, fully discharge the vessel's cargo, and safely escort the ship from the vicinity of the marine terminal. All of these types of events can increase the total time to process each product tanker, reducing the total number of marine vessels that could be processed each month.

Unanticipated extensions of time for product tanker unloading in conjunction with the imprecise arrival times of marine vessels that have traveled great distances can limit the ability of any marine terminal to operate at its theoretical maximum capacity. Certainly it would be possible to increase the number of product tankers that could be processed each month by having the marine vessels wait at anchor in the harbor for their turn to unload, but this option is impractical from an economic and safety perspective.

Product tankers charge a negotiated fee for their services on a per-day basis. Any time a tanker is delayed for reasons outside the vessel operator's control, the company that is leasing the product tanker will incur additional costs to have the vessel wait in the harbor. Referred to as demurrage charges, these additional costs can vary from $30,000 to $100,000 dollars per day. With regard to safety, many harbors and waterways in California already have a significant amount of marine vessel traffic. The presence of an additional number of product tankers at anchor within or outside the harbor awaiting their opportunity to offload their cargo of transportation fuel would increase the potential risk of collision.

The capacity of any marine terminal to process product tankers would therefore be limited to a level below a theoretical maximum of 100 percent. Because of variability of ship arrivals and unanticipated processing delays, marine terminals operating with throughputs in the range of 50 to 70 percent are considered at or near their maximum economic and safe operating level.

Marine Terminals–Potential Impact on Congestion

The forecasted increase of transportation fuels will require an increased throughput of gasoline, diesel, jet fuel, and alternative fuels in California's distribution infrastructure. The magnitude of the increase and existing spare capacity of the system will dictate the time frames when expansion projects must be completed. Staff is conducting this analysis and should complete this work during the third quarter of 2007.

It should be noted that these calculations do not account for the potential loss of existing marine terminal capacity through voluntary business decisions or involuntary forced closure due to termination of an existing lease or refusal by a lease holder to grant a renewal of an existing marine terminal operating lease. In a previous report released in April 2005, Energy Commission staff raised concerns regarding the loss of petroleum marine infrastructure. Over the last 15 years, approximately 6 million barrels of storage tank capacity has been removed from Southern California. A portion of these shuttered facilities were used to handle residual fuel oil, an activity that has declined over the years as power plants shifted to natural gas as a feedstock for their boilers. Yet, the loss of the other petroleum storage tank capacity has reduced the flexibility and spare capacity for a petroleum distribution infrastructure that is continuing to grow.

Efforts to expand existing petroleum infrastructure or to create additional infrastructure have been met with stiff resistance from some local community members, elected politicians, and port representatives. Objections include concerns over increased air pollution, increased truck traffic, aesthetic objections to the sight of storage tanks, perceived safety threat to nearby communities, and competition for diminishing spare land that is coveted by community members for park/recreational development and port representatives for expansion of cargo container handling facilities.

This loss of existing infrastructure and potential loss of additional storage tank assets because of pressures from competing community and business interests in the San Pedro Harbor led staff to recommend that:

> The Energy Commission should propose incorporation into law of a new requirement that allows state appeals in the petroleum marine infrastructure lease renewal process in the Ports of Los Angeles and Long Beach.

Today, the rationale for that finding and subsequent recommendation has not diminished. If anything, the need to interject the adequacy of statewide transportation fuel supplies for consumers and businesses involving lease renewal negotiations for existing petroleum marine terminal operations in the San Pedro Harbor is even greater than it was in 2005.

Additional Factors with Potential for Impact

A number of near-term factors could increase the uncertainty of the transportation fuels import forecast, namely expansion projects for California refineries, construction of a new refinery in Arizona, new gasoline specifications, creation of a low carbon fuel standard (LCFS), increased use of alternative fuels, and adoption of regulations to decrease emissions of greenhouse gas emissions from refineries.

California Refinery Expansion Projects

Recently, a number of public announcements have been made involving plans to expand the output of some California refineries. As part of an examination of additional factors that could impact the forecast of transportation fuel imports, staff assumed that all of the recent announcements to expand output of California refineries would be completed within the near-term 2015 period of the forecast. The refinery expansion projects are estimated to increase California transportation fuel production by 58,000 BPD by 2015. The impact on the transportation fuel import forecast is provided in the summary section of this chapter.

Arizona Refinery

Arizona Clean Fuels has proposed construction of a new refinery near Yuma, Arizona. The state currently does not have any refining capacity and is completely dependent on transportation fuels that are imported via petroleum product pipelines or tanker trucks. The proposed refinery would process approximately 150,000 BPD of crude oil and natural gasoline that would be converted to 85,000 BPD of gasoline, 35,000 BPD of diesel fuel, and 30,000 BPD of jet fuel for the regional market. If this refinery is constructed some time during the forecast period, the level of imported transportation fuels for California could decline significantly as a one-time event. But the lack of pipeline access to crude oil sources for the proposed refinery and incomplete financing to date raise uncertainties concerning the timeline for this project.

To assess the potential impact of a new Arizona refinery on the supply/demand balance in the Southwest region, staff assumed that the facility could be fully operational by 2015. If so, approximately 49 to 52 percent of combined pipeline shipments to Arizona from Southern California and Western Texas would be displaced. The potential impact on California imports of transportation fuels will vary depending on what portion of the displaced out-of-state pipeline shipments occur on the West Line.

If the output from the new Arizona refinery displaced shipments solely from Southern California, California imports would drop 150,000 BPD in 2015, a decrease of 172 percent under the Low Case incremental imports scenario and a decrease of 52 percent under the High Case incremental imports scenario. On the other hand, if the output from the new Arizona refinery displaced shipments on a prorated basis from both the West and East Lines, California imports would drop 103,000 BPD in 2015, a decrease of 118 percent under the Low Case incremental imports scenario and a decrease of 36 percent under the High Case incremental imports scenario.

Revised Predictive Model

On June 14, 2007, the ARB adopted revisions to the state's gasoline regulations that are designed to reduce emissions of gasoline to compensate for the increased pollution that has occurred from the transition to ethanol in 2003 and 2004. The additional air pollution is a result of increased evaporative emissions, referred to as permeation. The regulation approved by ARB requires that refiners transition to the new gasoline specifications by December 31, 2009. The ARB requires those refiners who will have to make modifications to their facilities to fully comply to provide a temporary, alternative means of compliance, known as the Alternative Emissions Reduction Plans (AERP). This alternative compliance approach expires on December 31, 2011. Refiners who are unable to transition to the revised Predictive Model regulations will need to obtain emission offset credits. The purchase and removal of higher-polluting vehicles is an example of one form of AERP compliance. It is uncertain at this time how many vehicles would be required, if most of the refiners elect this temporary compliance option.

The Energy Commission staff believes that the majority of California's refineries will require modifications and therefore elect to use the AERP. But by 2012, staff assumes that California's gasoline market will contain an average ethanol concentration of 10 percent by volume, or E-10. The forecasted transition to greater ethanol use will increase demand in the state and could result in a greater import of ethanol via rail and marine modes of transportation. One form of uncertainty involving the quantity of ethanol imports is the degree of California ethanol production capacity expansion. That factor is examined in a later section of this chapter.

Increased Use of Alternative Fuels–AB 1007 and the Low Carbon Fuel Standard

The Energy Commission and the ARB are assessing options to reduce the use of traditional transportation fuels through the use of increased quantities of alternative fuels. AB 1007 directs the Energy Commission to formulate pathways to increase the use of alternative fuels in the transportation sector, while the LCFS rule-making by the ARB is designed to increase the use of transportation fuels that emit lower quantities of GHG emissions on a life-cycle basis.

The level of success and timing of efforts to increase the use of alternative fuels and reduce GHGs could impact demand for gasoline, diesel, and jet fuel over the longer-term period of the forecast. Ethanol is one example of a transportation fuel that could meet each of these strategies, and a potential strategy would be greater use of ethanol in transportation fuels than the current average of 6 percent by volume. For example, ethanol use could increase to 10 percent by volume (E-10), decreasing the forecasted levels of gasoline imports while at the same time increasing the forecasted level of ethanol imports. Although such a strategy may alter the mix of transportation fuel imports over the forecast period, the total volume of imports may be relatively unaffected.

The Energy Commission's transportation fuel import forecast included an assessment of different ethanol scenarios, such as E-10 and E-20, to address one of the possible outcomes of the revised Predictive Model, AB 1007, and LCFS regulatory proceedings. In addition, staff calculated the incremental supply of biodiesel over the forecast period and the impact on incremental imports of transportation fuels. Although increased use of ethanol and biodiesel will decrease the forecast for incremental imports of gasoline and diesel fuel, it is recognized that the impact on total imports of all fuels (traditional and alternative) will be relatively unchanged. This conclusion assumes that the vast majority of additional ethanol (under the E-20 scenario) and biodiesel will originate from sources outside the state. To the extent that in-state production of biofuels using local feedstocks expands beyond the forecasted levels, total imports of all fuels could see some additional reductions from the forecasts used in this report. Those results are included in the summary section of this chapter.

California Ethanol Demand, Production, and Imports

California ethanol demand is forecast to increase primarily from revisions to California's gasoline regulations (revised Predictive Model) and other efforts to increase the use of alternative fuels (such as the Low Carbon Fuel Standard). Staff believes the majority of California's gasoline market will contain E-10 by 2012. As such, ethanol demand in the state is forecast to increase from 951 million gallons in 2006 to approximately 1.7 billion gallons in 2012 (under the Base Case gasoline demand scenario), a 79 percent increase. The additional imports needed to meet this anticipated growth will depend on how many additional California ethanol production facilities are constructed over the next couple of years.

As of July of 2007, California had an ethanol production capacity of 76 million gallons per year. Based on additional projects already under construction, local ethanol production capacity is estimated to increase to at least 230 million gallons per year by 2009. If other projects in advanced stages of planning and financing are also pursued to completion, conventional ethanol production capacity could surpass 670 million gallons by 2012.

The upper range of California ethanol imports are forecast to increase by 654 million gallons by 2015 and 666 million by 2025 under the high gasoline demand growth rate, lower California ethanol production capacity expansion, and E-10 scenario. The lower range for incremental ethanol imports assumes a reduced gasoline demand outlook and more optimistic projection for California ethanol plant construction. Under this scenario, California ethanol imports are forecast to increase by 72 million gallons by 2015 and decrease by 98 million by 2025. Table 19 lists California ethanol demand, production, and import totals for the various gasoline demand forecasts.

Table 19 - California Ethanol Supply/Demand Balance

California Ethanol Demand (Millions of Gallons per Year)

Year	Low Case	Base Case	High Case
2006	951	951	951
2012	1,699	1,702	1,788
2015	1,649	1,652	1,791
2025	1,479	1,536	1,803

California Ethanol Production (Millions of Gallons per Year)

Year	Low Case	Base Case	High Case
2006	45	45	45
2012	671	231	231
2015	671	231	231
2025	671	231	231

California Ethanol Imports (Millions of Gallons per Year)

Year	Low Case	Base Case	High Case
2006	906	906	906
2012	1,028	1,471	1,557
2015	978	1,421	1,560
2025	808	1,305	1,572

California Incremental Ethanol Imports (Millions of Gallons per Year)

Year	Low Case	Base Case	High Case
2012	122	565	651
2015	72	515	654
2025	-98	399	666

Source: California Energy Commission analysis
Note: Base year 2006 is a California Energy Commission staff estimate of actual demand

If ethanol demand in California were to increase to a concentration of 20 percent per gallon of gasoline (referred to as E-20), imports would need to increase by another 1.79 billion gallons by 2015 and 1.80 billion by 2025 under the high gasoline demand growth rate and lower California ethanol production capacity expansion. The lower range for incremental ethanol imports under the E-20 scenario would equate to 1.65 billion gallons by 2015 and 1.48 billion by 2025.

The Energy Commission expects the majority of these increased ethanol imports to be delivered to California via rail cars from plants in the Midwest. The balance of ethanol imports will arrive via marine vessels from ethanol facilities located in the Caribbean, Central America, Brazil, and other foreign sources. Assuming all of the incremental ethanol imports were delivered via rail, staff calculates an additional 2,395 rail car imports per year by 2015 and a decrease of 3,251 rail cars by 2025 under the Low Case for ethanol imports. The incremental rail car imports would be significantly greater under the High Case for ethanol imports, an additional 21,787 rail car imports by 2015, and 22,210 by 2025. Table 20 provides the incremental rail car imports for all of the gasoline demand scenarios.

Table 20 – California Ethanol Import Events Via Rail

Incremental Trips (30,000 gallons per rail car)

Year	Low Case	Base Case	High Case
2012	4,058	18,817	21,686
2015	2,395	17,183	21,787
2025	-3,251	13,286	22,210

Source: California Energy Commission analysis

If all of the incremental imports of ethanol to meet California's growing demand were transported by marine tanker, the impact on product tanker activity would range from a decrease of 15 arrivals per year to an increase of 106 arrivals per year over the forecast period. Table 21 contains the estimates of incremental product tanker arrivals, as well as a forecasted increase of ethanol storage tank capacity that would be required for 2012, 2015, and 2025.

Table 21 – Ethanol Marine Vessel & Storage Forecasts

Incremental Marine Vessel Trips (6.3 million gallons capacity)

Year	Low Case	Base Case	High Case
2012	19	90	103
2015	11	82	104
2025	-15	63	106

Incremental Ethanol Storage Capacity (million gallons)

Year	Low Case	Base Case	High Case
2012	10	47	55
2015	6	43	55
2025	-8	33	56

Source: California Energy Commission analysis

There has been no attempt to quantify the relative contribution from each of these ethanol sources located outside California. The continued expansion of ethanol production capacity in the United States has been forecast by the Energy Information Administration to increase from 5.3 billion gallons in 2006 to 10.5 billion gallons by 2010. As such, incremental ethanol demand in California should be easily satiated by a combination of in-state ethanol plant expansion and additional imports from other U.S. and foreign sources.

Reduction of GHG Emissions from California Refineries

The enactment of AB 32 (Nuñez), Chapter 488, Statutes of 2006, signaled the first step in regulating the quantities of GHG emissions from stationary sources in California, such as refineries. Although the regulations associated with this legislation have yet to be drafted and finalized, it is possible that refiners may be required to reduce operations at their existing facilities as a form of compliance strategy. It is also possible that compliance with AB 32 could be achieved through the purchase of GHG emission reduction credits from other sources. It should be noted for purposes of this analysis that any definitive conclusions regarding potential impacts on California refinery operations would be premature. Therefore, only rudimentary assessments of the issue were examined in context of the aforementioned scenarios of decreased refinery operations or "business-as-usual" operations involving a "cap and trade" approach. Any reduction of refinery operations will increase the needs for additional imports of transportation fuels, at the same time reducing the forecast for imports of crude oil. One scenario examined assumed that California refineries would continue processing the same quantity of crude oil throughout the forecast period (no refinery creep). An alternative scenario assumes that California refineries will process a reduced quantity of crude oil by 2020, similar to the levels that were processed in 1990. The results of these two scenarios are included in the summary section of this chapter.

Summary Matrix

The following Table 22 lists all of the primary factors that staff assessed during the development of the transportation fuels import forecast. Additional factors have been included that could increase the uncertainty that is already inherent in any forecast. This is especially true for the longer-term portion of the forecast.

Table 22 - Transportation Fuels – California Import Forecast

Primary Forecast Factor	Low Case	High Case
CA Demand	Low Growth	High Growth
Distillation Capacity	High Growth	Low Growth
Pipeline Exports	Lower Demand	Higher Demand

Additional Factors		
Refinery Expansion	Projects Completed	Projects Cancelled
New Arizona Refinery	Project Completed	Project Cancelled
LCFS	E 20	E 10
AB 32	No Refinery Creep	Capacity Declines

Source: California Energy Commission analysis

Summary of Transportation Fuel Import Forecast

The following Table 23 contains the incremental import forecast of transportation fuels for the Low and High Cases in 2015 and 2025. The table also displays the summary of the impacts on incremental imports that could be assumed based on the additional factors examined regarding refinery operations and projects, as well as the increased use of ethanol and biodiesel.

Table 23 – Summary of Import Forecast & Additional Factors

Incremental Imports of Transportation Fuels (Thousands of BPD)

	Low Case		High Case	
	2015	2025	2015	2025
Main Cases	87.4	66.9	288.1	478.4
Refinery Projects and Operations				
New Arizona Refinery (West Line Only)	-62.6	-83.1	138.1	328.4
New Arizona Refinery (West & East Lines)	-15.6	-36.1	185.1	375.4
Refinery Expansion Projects	29.6	9.0	230.2	420.5
No California Refinery Creep	142.1	184.8	420.1	771.1
Reduced Refinery Operations	142.1	291.1	420.1	877.4
Additional Alternative Fuels*				
Increased Ethanol (E-20)	-20.1	-29.6	171.3	360.7
Increased Biodiesel (B-5)	83.5	59.3	284.2	470.6
Increased Biodiesel (B-20)	71.7	36.6	272.3	447.3

* Total imports of all fuels would be unaffected assuming incremental alternative fuels are imported from sources outside the state

Source: California Energy Commission analysis

CHAPTER 5: PETROLEUM INFRASTRUCTURE–PORT EMISSIONS

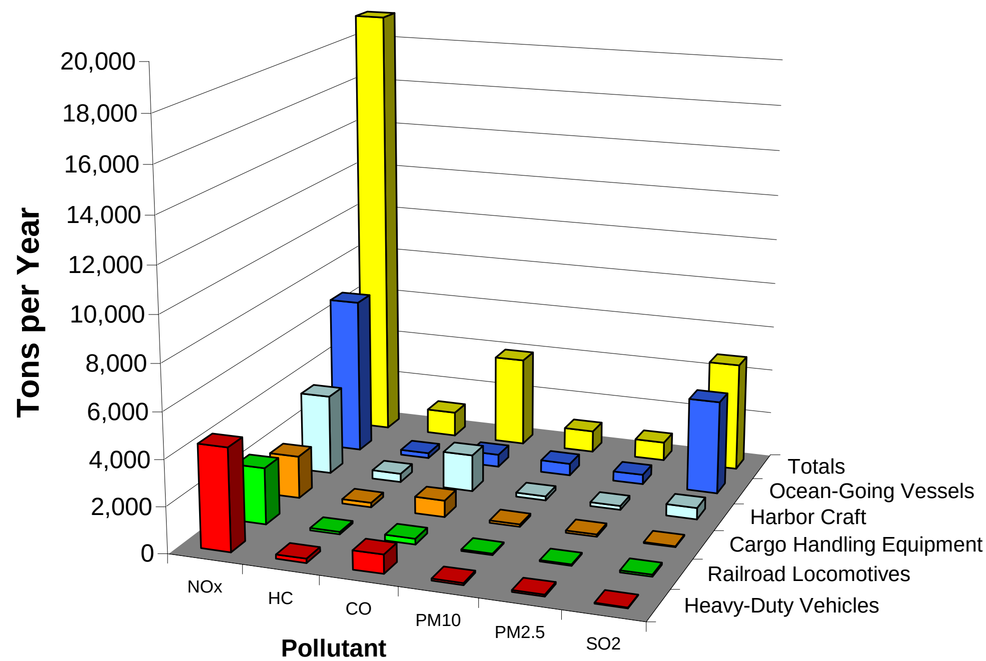
The issue of emissions from petroleum tankers was raised during the Transportation Energy Demand Forecast and Petroleum Infrastructure workshop on May 8, 2007. This section provides additional information and perspective on that topic. ***Emissions from marine tankers in 2001 represented between 1.2 and 8.2 percent of air pollution from all sources in the Port of Los Angeles, depending on type of pollutant.***

Air pollution associated with activities in the Port of Los Angeles has been studied and extensively analyzed by a number of stakeholders and consultants. Perhaps one of the best reviews to date is a document prepared by Starcrest Consulting Group, LLC, *No Net Increase of Air Emissions at the Port of Los Angeles* published in July of 2004. The statistics from this document were used to construct the figures and perform analysis that follows.

Air emission is a general term that in this context refers to six different pollutants: oxides of nitrogen (NO_x), hydrocarbons (HC), carbon monoxide (CO), particulate matter 10 microns[4] and smaller (PM_{10}), particulate matter 2.5 microns and smaller ($PM_{2.5}$), and sulfur dioxide (SO_2). The Starcrest study broke down emission sources into five different categories: ocean-going vessels, harbor craft, cargo handling equipment, railroad locomotives, and heavy-duty vehicles. Marine tankers are a subset of the ocean-going vessels category. Figure 22 illustrates the emissions from all sources by category and pollutant.

[4] Micron is a unit of measurement equivalent to one millionth of a meter.

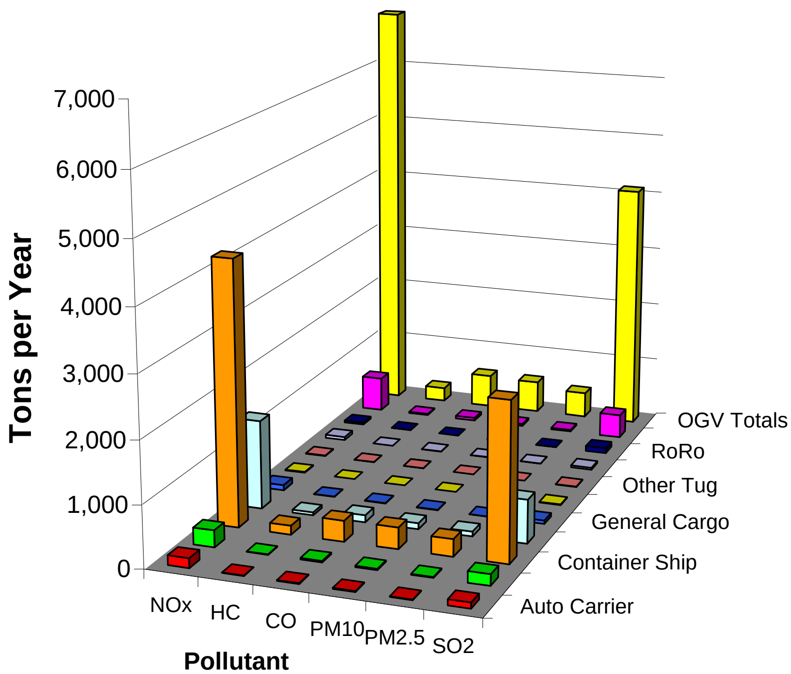
Figure 22 – Emissions from All Sources
Port of Los Angeles – 2001



Source: Starcrest Consulting Group, LLC, *No Net Increase of Air Emissions at the Port of Los Angeles* published in July 2004

Ocean-going vessels are the largest contributor to Port of Los Angeles emissions for all pollutants except HC and CO. Figure 23 depicts emissions from just the ocean-going vessels category.

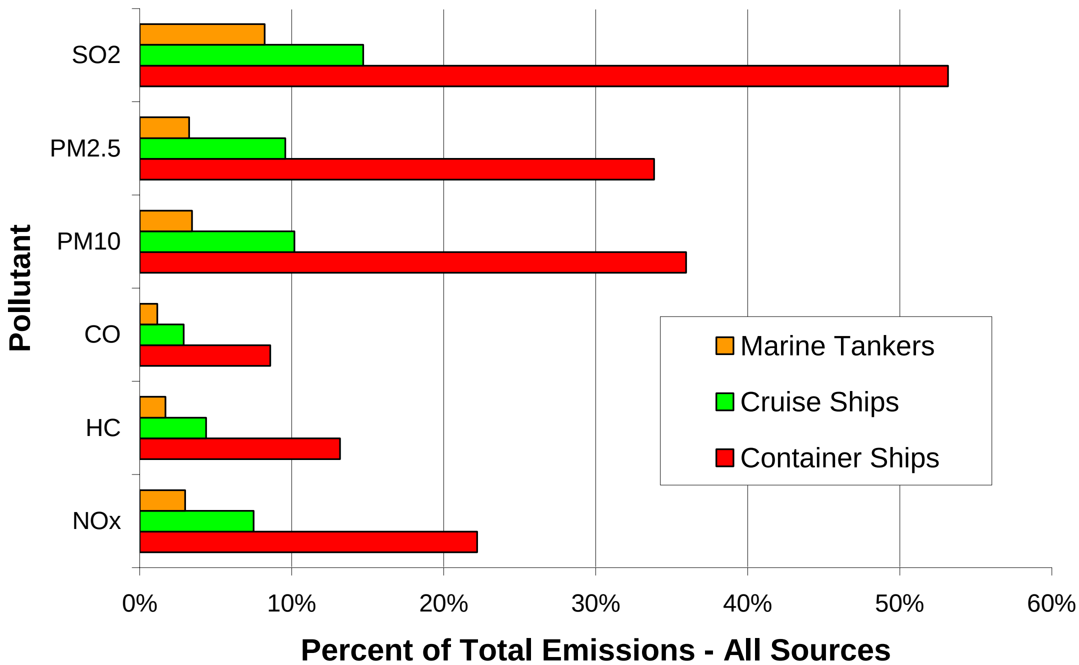
Figure 23 – Emissions from Ocean-Going Vessels
Port of Los Angeles - 2001



Source: Starcrest Consulting Group, LLC, *No Net Increase of Air Emissions at the Port of Los Angeles* published in July 2004

Tanker (this category includes product tankers and crude carriers) emissions are a smaller subset of ocean-going vessel emissions and an even smaller subset of emissions from all sources. Figure 24 depicts the percent contribution to total emissions for the three largest ocean-going vessel contributors: container ships, cruise ships, and tankers.

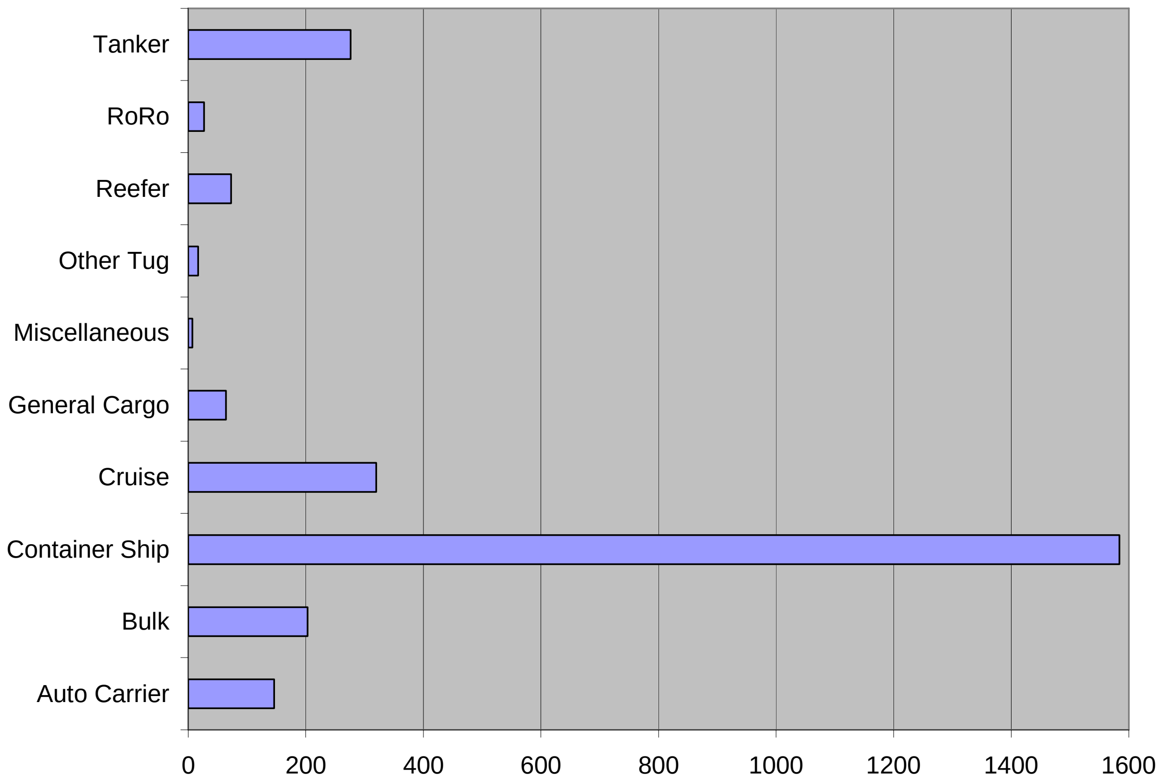
Figure 24 – Emissions from Selected Ocean-Going Vessels
Port of Los Angeles – 2001



Source: Starcrest Consulting Group, LLC, *No Net Increase of Air Emissions at the Port of Los Angeles* published in July 2004

Emissions from tankers contribute to 1.2 to 8.2 percent of air pollution from all sources, while container ship emissions contribute between 8.6 and 53.6 percent of all air pollution in the Port of Los Angeles. But do container ships and cruise ships contribute greater quantities of air pollution because they represent a greater number of vessel visits each year or because these categories of ocean-going vessels produce a greater quantity of emissions *per visit*? Figure 25 shows that container ships represent the largest number of visits, followed by cruise ships and tankers.

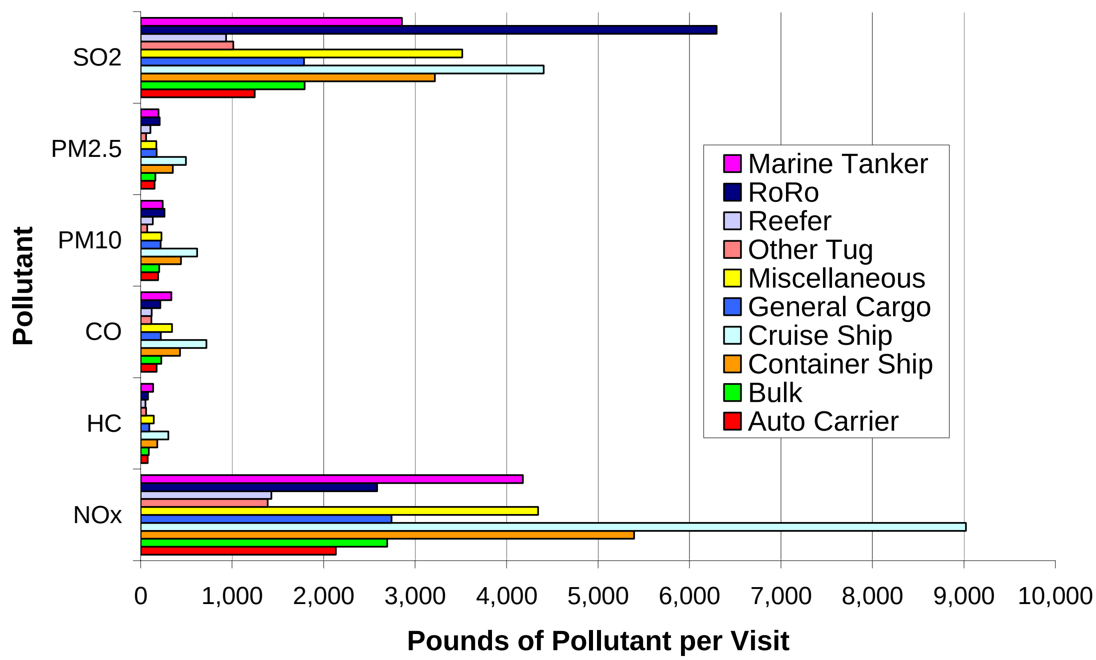
Figure 25 – Visits by Ocean-Going Vessels
Port of Los Angeles – 2001



Source: Starcrest Consulting Group, LLC, *No Net Increase of Air Emissions at the Port of Los Angeles* published in July 2004

Although container ship visits easily exceeded tanker visits by a factor of nearly 6:1, the total emissions of air pollution per visit were also greater compared to air pollution generated by each tanker visit. Figure 26 provides a comparison for each ocean-going vessel type and pollutant.

**Figure 26 – Emissions from Ocean-Going Vessels
Port of Los Angeles – 2001**



Source: Starcrest Consulting Group, LLC, *No Net Increase of Air Emissions at the Port of Los Angeles* published in July 2004

Although there has been no attempt to project additional emissions that could result from forecasted activity trends (increasing container ships and marine tankers over time), it is safe to assume that the additional number of container ship visits over the next several years is expected to be greater than the increased number of marine tanker visits. In other words, container ship emissions as a percent of total emissions will probably increase over time, especially if forecasted growth in cargo through the Ports of Los Angeles and Long Beach (doubling and tripling) come to pass as predicted. It should also be pointed out that the total emissions associated with container ship activity is greater than represented by these figures because the air pollution totals do not include the other emissions created by cargo-handling equipment, railroad locomotives, and heavy-duty vehicles. Marine tankers do not normally have any of these other types of associated emissions.

APPENDIX A

DESCRIPTION OF PETROLEUM FORECASTING METHODOLOGIES

The proposed petroleum forecasting methodologies will closely follow previous years' methodologies. However, various inputs and assumptions to the models have been updated. In some cases, the models have been changed to allow for new input values, but the forecasting methodologies have remained consistent with previous forecasts.

CALCARS Demand Model

The CALCARS model forecasts California vehicle ownership, vehicle miles traveled (VMT), gasoline and diesel demand, and the potential impacts of various government policies from discrete choice equations. These forecasts are based on data such as California demographic information, fuel prices, trends in vehicle attributes, and consumer vehicle preferences.

The current model was patterned after the Energy Commission's Personal Vehicle Model developed in 1983. The CALCARS model simulates vehicle purchase decisions and fuel use by California motorists. CALCARS was designed to evaluate impacts of public policy on overall light-duty petroleum demand. The model was intended to accommodate the development of strategies to reduce California's dependence on petroleum and help promote alternative fuels and alternative fuel vehicles. Over the past two decades, the CALCARS model has been updated with new information several times, in 1996 and for the *2003* and *2005 IEPRs*. Updated data include:

- Forecasts of light-duty vehicle fuel economy and attributes.
- Forecasts of transportation fuel prices in California.
- DMV registered on-road vehicles counts.
- Evaluated vehicle types.
- Vehicle choice coefficients from an Energy Commission 2002 vehicle survey.
- Forecasts of California demographics, such as population, employment, and personal income.

As a discrete choice model, vehicle characteristics, such as operating cost and vehicle price, are the foundation of the model and require the collection of actual ownership choice values from a sample of Californians. These choice values are collected through a statewide representative survey of consumers, which was last performed in 2002 and which is being updated now. The 2007 California Vehicle Survey is currently collecting data from 2,000 residential and 1,000 commercial vehicle owners in California and will be the basis of the

CALCARS model. The detailed information collected will incorporate demographic and commercial data together with preference data to evaluate consumer vehicle choices.

The *2005 IEPR* forecast included 45 classes of vehicles and 17 model years. Currently, staff is evaluating the addition of another 30 vehicle classes, which would expand the assessment to include flex-fuel vehicles and plug-in hybrids. The additional vehicles will be incorporated into the model using updated vehicle choice data currently being collected in the 2007 California Vehicle Survey. The addition of these vehicles and the update of the model for the *2007 IEPR* will be contingent upon the survey's timely completion.

California Freight Energy Demand (Freight) Model

The Freight model, developed in 1983, forecasts energy demand associated with truck and rail freight transportation. The Freight model projects volume of freight transported by truck and rail, truck stock, and VMT, along with truck and rail consumption of gasoline, diesel, and liquefied petroleum gas (LPG). These outputs are driven by projections of industrial activity by economic sector in the region or statewide. The Freight model analyzes rail and truck competition and produces detailed projections of activity and energy consumption within California of all trucks and rail-freight operations. The model also analyzes public policy and its effects in the following areas:

- Changes in rail and truck costs on diversion of traffic between modes.
- Fuel costs and exogenous trends on the truck and rail fuel efficiency.
- Fuel costs and other factors on the selection of gasoline or diesel-fueled trucks.
- Economic growth on the volume of truck and rail freight traffic and other truck activity.

The Freight model was built using a variety of databases; many of the underlying methodologies in the Freight model reflect energy market and regulatory environments that have changed substantially since the early 1980s. Most of the updating of the model was done in house by Energy Commission staff. Specific data and methodology requirements were updated in 1998 by the consultant who originally created the model. The 1998 improvements included:

- New data on freight operating costs.
- A new truck modal diversion model.
- New data on fuel efficiency of freight modes.
- Analysis of truck downsizing and upsizing trends.
- Updated data on average truck payloads, rail carloads, and truck survival rates.

California Transit Energy Demand (Transit) Model

The Transit model was developed to produce long-term forecasts of energy consumption by urban bus and rail transit systems, intercity bus and rail, school buses, and other buses operating in California. The model estimates the effects of changes in transit fares, service policies, automobile fuel economy, gasoline prices, population, employment, and income on transit energy consumption. The model also estimates the effectiveness of policies designed to save energy by promoting diversions from automobiles to transit.

The model was originally developed in 1983 for the Energy Commission under a contract and included data from 16 transit agencies in California, mostly from the Bay Area and Southern California. In 1991, the data was updated to include an additional 15 transit agencies from throughout the state. The data is currently being updated to include an additional 45 transit agencies, bringing the total number of agencies represented in the model to 76. The model is also incorporating expanded service areas and fuel types used by transit agencies and the data on population, income, fuel prices, etc., is being updated to 2004, the last year in which complete demographic and transit agency data are available.

As part of the current effort to update the input data files and collect current information about transit agency service characteristics and energy consumption, the transit agencies included in the model have been polled using a survey letter. Approximately 40 percent of the agencies surveyed have responded at this time.

California Civil Aviation Jet Fuel Demand (Aviation) Model

The Aviation model was developed to forecast California's civil aviation jet fuel demand. The current model was developed in the 1980s by Energy Commission staff. The Aviation model completed a suite of forecasting models that the Energy Commission uses to estimate overall California petroleum demand. The model was revised in 1991 and again between 1992 and 2003. Model equations and all input data were updated for the *2005 IEPR*. Input data was also updated for the *2007 IEPR*. The Aviation model uses econometric, demographic, and technology projections to estimate jet fuel demand including:

- Forecasts of California demographics (population and personal income).
- Federal Aviation Administration (FAA) aviation forecast data.
- Estimates of average commercial jet fuel economy and airline revenue per passenger mile.

Historic aviation travel and California annual personal income data are used to estimate annual air passenger enplanements and deplanements. The accuracy of the aviation jet fuel demand is closely related to the accuracy of the forecast estimates of population, income, average commercial jet fuel economy, and airline revenue per passenger mile.

APPENDIX B

CALIFORNIA TRANSPORTATION FUEL PRICE FORECASTS

Summary

Staff has developed High, Base, and Low Case long-term price forecasts for California highway fuels based on the U.S. Energy Information Administration (EIA) *2007 Annual Energy Outlook* (AEO) *High, Reference,* and *Low Case* oil price forecasts. The Energy Commission's Base Case starts at $2.92 per gallon for retail regular-grade gasoline and $2.99 for diesel in 2007, dips to $2.56 and $2.58, respectively, in 2014, and then rises to $2.76 and $2.78 by 2030, expressed as annual average inflation-adjusted 2007 dollars.[5] The 2030 prices for gasoline and diesel in the High Case are $3.96 and $3.97, respectively, per gallon and $2.09 and $2.07 in the Low Case. In nominal dollars, or actual prices customers would see at the pump, the 2030 price for gasoline would be $6.13 per gallon in the High Case, $4.28 in the Base Case, and $3.23 in the Low Case.

Crude Oil Price Forecast Assumptions

Staff has developed California-specific transportation fuel price forecasts for regular-grade gasoline and diesel based on the EIA *2007 AEO High, Reference*, and *Low Case* crude oil price forecasts. The EIA 2007 oil price cases used in this analysis are for the U.S. refiner acquisition cost of imported crude oil index. (See Figure B-1 for comparison of these 2007 oil price forecasts and the EIA forecasts used in 2005 for the Energy Commission's *2005 IEPR*.[6] Table B-1 provides the underlying *2007 AEO* forecast values for Figure B-1 in both 2007 dollars and nominal dollars.) This index is the average price of all imported crude oil and is roughly $5–7 per barrel less than the index for higher-quality imported light sweet oil.[7]

---

[5] All prices used in this work are in 2007 dollars, using the May 30, 2006, California Energy Commission deflator series.

[6] Due to the volatility of oil markets at the time, the United States Energy Information Administration *2005 Annual Energy Outlook* developed four oil price cases: *Low, Reference, High A,* and *High B*. The *Low Case*, however, was not used in Energy Commission fuel price forecasts for the *2005 IEPR*.

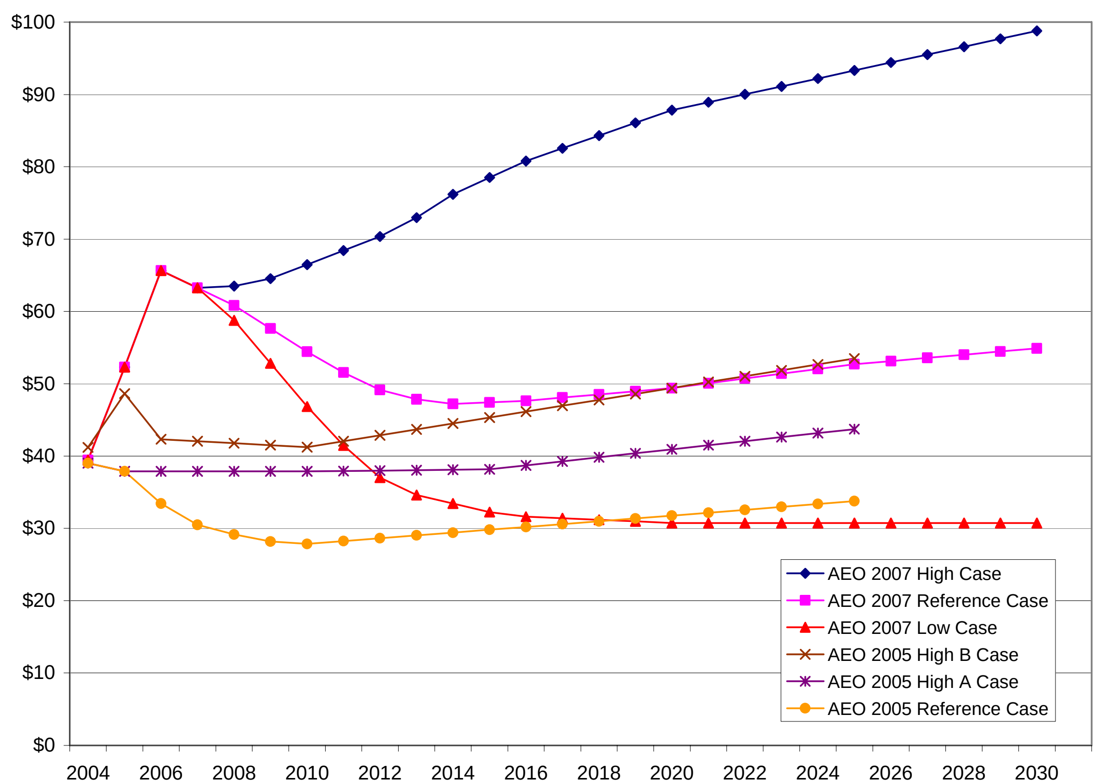
[7] The subset of premium light sweet oil constitutes a relatively small percentage of the oil actually refined in the United States or California, but prices for it are those most commonly referred to in the media.

Petroleum Transportation Fuel Price Forecast Assumptions

Staff established relationships between wholesale fuel and crude oil prices using weekly data from the EIA for world oil prices and average weekly California rack prices for gasoline and diesel from the Oil Price Information Service (OPIS). This exercise used the January 2003 to December 2006 time period because during this time, MTBE-free reformulated gasoline was the dominant gasoline refined and used in the state.

Staff first determined the historical relationship between the EIA's weekly world oil price index (calculated free-on-board (FOB) from all exporting nations) and U.S. average refiner acquisition cost (RAC) of imported crude oil, because the EIA forecasts are based on the RAC index. The RAC comes out only monthly and does not capture the most recent data. The RAC price for use on a weekly basis was therefore derived from its average differential with the world FOB oil price. The difference between this derived weekly RAC crude oil price and the OPIS California weekly gasoline and diesel rack prices is referred to as the "crude oil to rack price" margin. This margin varies over time, and the decision to use one time period's historical margin over another's makes a difference in the final retail fuel price forecast.

Figure B-1 - Comparison of EIA AEO 2007 and AEO 2005 Oil Price Forecasts (in 2007 dollars)



Source: U.S. Energy Information Administration

The next step was to determine the "rack price to retail price" margin. This was done by calculating the historical differences between the weekly OPIS rack price and the weekly EIA retail price series (excluding taxes) for both California regular-grade gasoline and diesel. Again, the decision to choose one time period's margin as representative of future expectations will affect the final retail price forecast.

Table B-2 summarizes the crude oil to rack price margins and the rack price to retail ex-tax margins proposed for use with the three EIA *2007 AEO* oil price cases. All prices are in 2007 cents per gallon and were averaged annually in all cases. The High Case margins were based on years of higher combined margins (2005–2006 data); the Base Case margins, on intermediate levels (2004–06 data); and the Low Case margins, on lower levels (2003–06 data). Note that using these calculation methods, crude-to-rack margins are increasing over recent years, while rack-to-retail margins are decreasing.

Table B-1 - EIA 2007 AEO Oil Price Projections
(real and nominal dollars per barrel)

	High Case 2007$	High Case Nominal$	Base Case 2007$	Base Case Nominal$	Low Case 2007$	Low Case Nominal$
2004	39.43	36.08	39.43	36.08	39.43	36.08
2005	52.30	49.19	52.30	49.19	52.30	49.19
2006	65.65	63.77	65.65	63.77	65.65	63.77
2007	63.25	63.25	63.25	63.25	63.25	63.25
2008	63.51	64.98	60.84	62.25	58.78	60.14
2009	64.54	67.41	57.64	60.20	52.81	55.16
2010	66.49	70.85	54.43	58.00	46.85	49.92
2011	68.43	74.41	51.55	56.05	41.48	45.11
2012	70.37	78.03	49.14	54.49	37.01	41.03
2013	72.96	82.47	47.86	54.10	34.62	39.14
2014	76.20	87.78	47.22	54.39	33.43	38.51
2015	78.52	92.18	47.43	55.68	32.26	37.88
2016	80.80	96.67	47.65	57.00	31.61	37.82
2017	82.55	100.61	48.08	58.59	31.40	38.26
2018	84.31	104.67	48.53	60.24	31.18	38.71
2019	86.08	108.84	48.96	61.91	30.96	39.15
2020	87.82	113.13	49.41	63.64	30.73	39.59
2021	88.92	116.69	50.06	65.69	30.73	40.33
2022	90.02	120.34	50.72	67.80	30.73	41.09
2023	91.12	124.09	51.39	69.98	30.73	41.85
2024	92.21	127.93	52.04	72.19	30.73	42.64
2025	93.31	131.88	52.70	74.48	30.73	43.44
2026	94.41	135.93	53.13	76.50	30.73	44.25
2027	95.51	140.08	53.58	78.59	30.73	45.08
2028	96.60	144.35	54.01	80.71	30.73	45.92
2029	97.70	148.72	54.45	82.88	30.73	46.78
2030	98.80	153.20	54.89	85.12	30.73	47.66

Sources: U.S. Energy Information Administration and the California Energy Commission

Table B-2 - Margins Used in Fuel Price Forecast Cases (2007 cents per gallon)

Case	RFG Crude-to-Rack	Diesel Crude-to-Rack	RFG Rack-to-Retail	Diesel Rack-to-Retail
High	71.1	74.6	12.1	15.0
Base	69.3	68.5	12.8	15.5
Low	66.7	59.9	13.4	15.8

Source: California Energy Commission Fuels and Transportation Division

Since the Energy Commission presented this price forecast at the May 8, 2007, staff workshop, the ARB has adopted changes in the Predictive Model to permit gasoline with 10 percent ethanol content, which we expect will raise the price of gasoline. Staff estimates the range of adders consistent with these reformulation changes will be from 2 to 10 cents per gallon. These expectations are included in the forecast calculations by adding 2 cents, 5 cents, and 10 cents, respectively, to the Low, Base, and High fuel price cases starting in 2012. For the early adoption years of 2010 and 2011, these values are divided by two and the result is added. At the last step in generating a final retail price forecast for each of the fuels, staff added excise and sales taxes and fees.

California Transportation Fuel Price Forecasts

Table B-3 shows the proposed annual average retail fuel price projections for regular-grade California gasoline and California diesel in 2007 dollars using the assumptions outlined above.

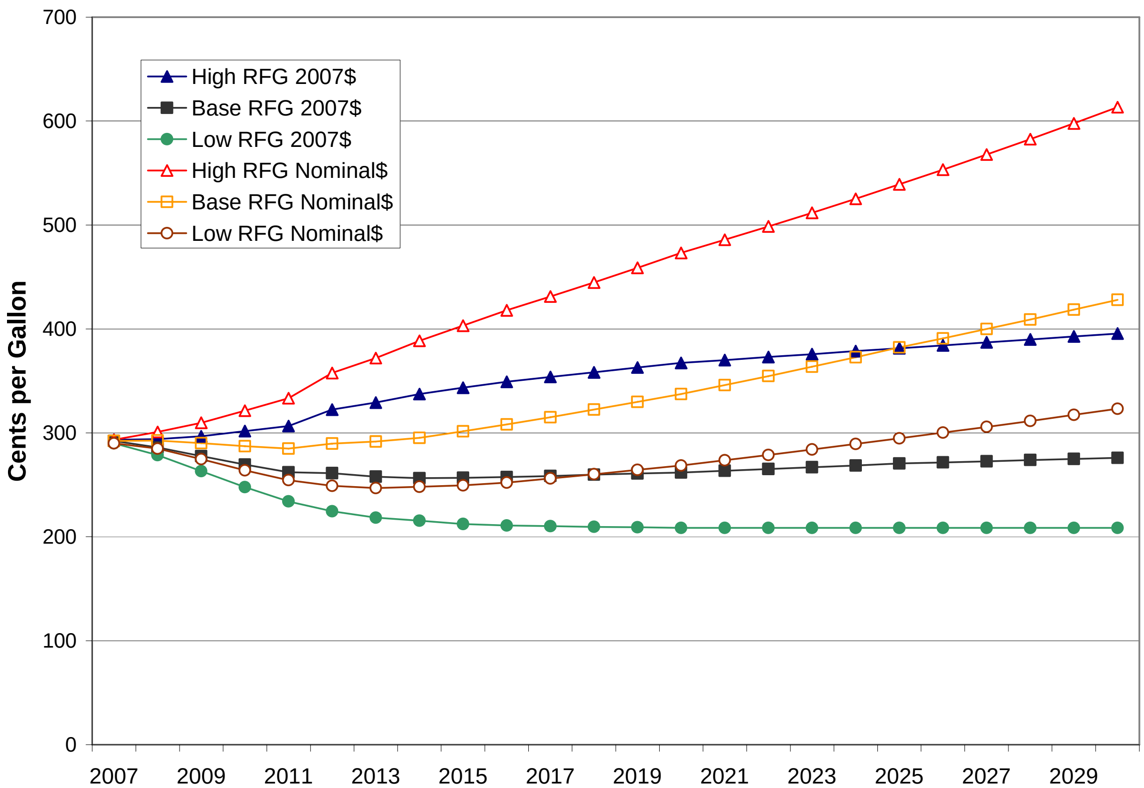
Table B-3 - Retail Transportation Fuel Price Projections (2007 cents per gallon)

	High RFG	High Diesel	Base RFG	Base Diesel	Low RFG	Low Diesel
2007	293.3	305.3	292.1	299.2	289.9	290.2
2008	294.0	306.0	286.0	293.0	278.4	278.7
2009	296.6	308.6	277.7	284.8	263.1	263.4
2010	307.0	313.6	272.2	276.6	248.8	248.1
2011	312.0	318.6	264.7	269.1	235.0	234.2
2012	322.4	323.6	261.3	262.9	224.6	222.7
2013	329.1	330.3	258.0	259.6	218.5	216.6
2014	337.4	338.6	256.3	258.0	215.4	213.5
2015	343.4	344.5	256.9	258.5	212.4	210.5
2016	349.2	350.4	257.4	259.1	210.8	208.9
2017	353.7	354.9	258.5	260.2	210.2	208.3
2018	358.3	359.5	259.7	261.4	209.6	207.8
2019	362.8	364.0	260.8	262.5	209.1	207.2
2020	367.3	368.5	261.9	263.6	208.5	206.6
2021	370.1	371.3	263.6	265.3	208.5	206.6
2022	372.9	374.1	265.3	267.0	208.5	206.6
2023	375.8	377.0	267.0	268.7	208.5	206.6
2024	378.6	379.8	268.7	270.4	208.5	206.6
2025	381.4	382.6	270.4	272.1	208.5	206.6
2026	384.2	385.4	271.5	273.2	208.5	206.6
2027	387.1	388.2	272.7	274.4	208.5	206.6
2028	389.9	391.1	273.8	275.5	208.5	206.6
2029	392.7	393.9	274.9	276.6	208.5	206.6
2030	395.5	396.7	276.1	277.7	208.5	206.6

Source: California Energy Commission Fuels

Figure B-2 illustrates the annual average gasoline price projections in both real 2007 dollars and nominal dollars. Nominal prices indicate the average prices customers would actually see at the pump during that year.

Figure B-2 - California Gasoline Price Projections (real and nominal cents per gallon)



Source: California Energy Commission

Alternative Transportation Fuel Price Projections

In the *2007 IEPR* cycle, staff is attempting to project potential future demand for ethanol-85 (E-85) in flexible-fuel vehicles (FFVs) and electricity for plug-in hybrids. To provide appropriate inputs to the vehicle manufacturer offerings forecasts and the demand forecasts, staff requires forecasts of E-85 prices and plug-in hybrid electric rates under prevailing market conditions as well as in a case where aggressive steps are taken to increase alternative fuel use.

The outlook for pricing of alternative transportation fuels is uncertain and highly dependent on policy making and implementation. After extensive consultation with other offices in the Energy Commission for both E-85 prices and electric rates for plug-in hybrids, staff set boundaries for the range of plausible future prices as inputs for developing vehicle attribute projections.

In the case of E-85, staff are proposing two principles that develop this range of prices. First, staff assumed that the ethanol blend market was setting the price of current ethanol for transportation uses and that this would lead to E-85 prices being equivalent to gasoline prices on a volume basis. This assumption was the basis for the E-85 prices used in the primary set of demand forecast cases, including the Base Case. Secondly, in the case of aggressive alternative fuel penetration, staff assumed new incentives and greater availability to drive the E-85 price down to gasoline equivalence on an energy basis.[8] Table 4 compares the gasoline and E-85 price levels that would be consistent with these assumptions for the Base Case and the Aggressive Alternatives Case. Further, since price equivalence on an energy basis might not be sufficient to stimulate E-85 use significantly, staff intends to develop Aggressive Alternatives sensitivity cases using lower E-85 prices.

Table B-4 - Gasoline and Alternative Fuel Price Projections (2007 cents per gallon)

	Base Case RFG	Base Case E-85	Aggressive Alternatives RFG	Aggressive Alternatives E-85
2007	292.1	292.1	292.1	218.0
2008	286.0	286.0	286.0	213.4
2009	277.7	277.7	277.7	207.2
2010	272.2	272.2	272.2	203.1
2011	264.7	264.7	264.7	197.6
2012	261.3	261.3	261.3	195.0
2013	258.0	258.0	258.0	192.5
2014	256.3	256.3	256.3	191.3
2015	256.9	256.9	256.9	191.7
2016	257.4	257.4	257.4	192.1
2017	258.5	258.5	258.5	192.9
2018	259.7	259.7	259.7	193.8
2019	260.8	260.8	260.8	194.6
2020	261.9	261.9	261.9	195.5
2021	263.6	263.6	263.6	196.7
2022	265.3	265.3	265.3	198.0
2023	267.0	267.0	267.0	199.3
2024	268.7	268.7	268.7	200.5
2025	270.4	270.4	270.4	201.8
2026	271.5	271.5	271.5	202.6
2027	272.7	272.7	272.7	203.5
2028	273.8	273.8	273.8	204.3
2029	274.9	274.9	274.9	205.2
2030	276.1	276.1	276.1	206.0

Source: California Energy Commission

Currently, the marginal electricity rates that plug-in hybrids would pay vary widely among utilities, depending on their structure across rate tiers and baseline allowances. For purposes of projecting vehicle manufacturer offerings, the range for the Base Case has been tentatively estimated at between 16 and 24 cents per kilowatt-hour (kWh) as a statewide average. Likewise, for the Aggressive Alternatives Case, staff estimated rates to be closer to the lowest current residential rates, in the range of 7–12 cents per kWh. For this draft report, staff was unable to finish preparing inputs to include alternative vehicle classes. Staff intends to prepare inputs and forecasts including these vehicles in time for the final staff report.

---

[8] Staff calculated by dividing the gasoline price by 1.34 to convert to E-85 price. This was based on New Vehicle Certification Executive Orders provided by vehicle manufacturers and accounts for energy in the fuel and vehicle efficiency using these fuels.