OVERVIEW OF PROPOSED TRANSPORTATION ENERGY ANALYSES FOR THE 2007 INTEGRATED ENERGY POLICY REPORT

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STAFF PAPER

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SUMMARY OF PROPOSED TRANSPORTATION ENERGY ANALYSES

Background

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 the *Integrated Energy Policy Report* (*IEPR*), adopted 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 (PRC §25302[d]).

Purpose of Transportation Energy Analyses

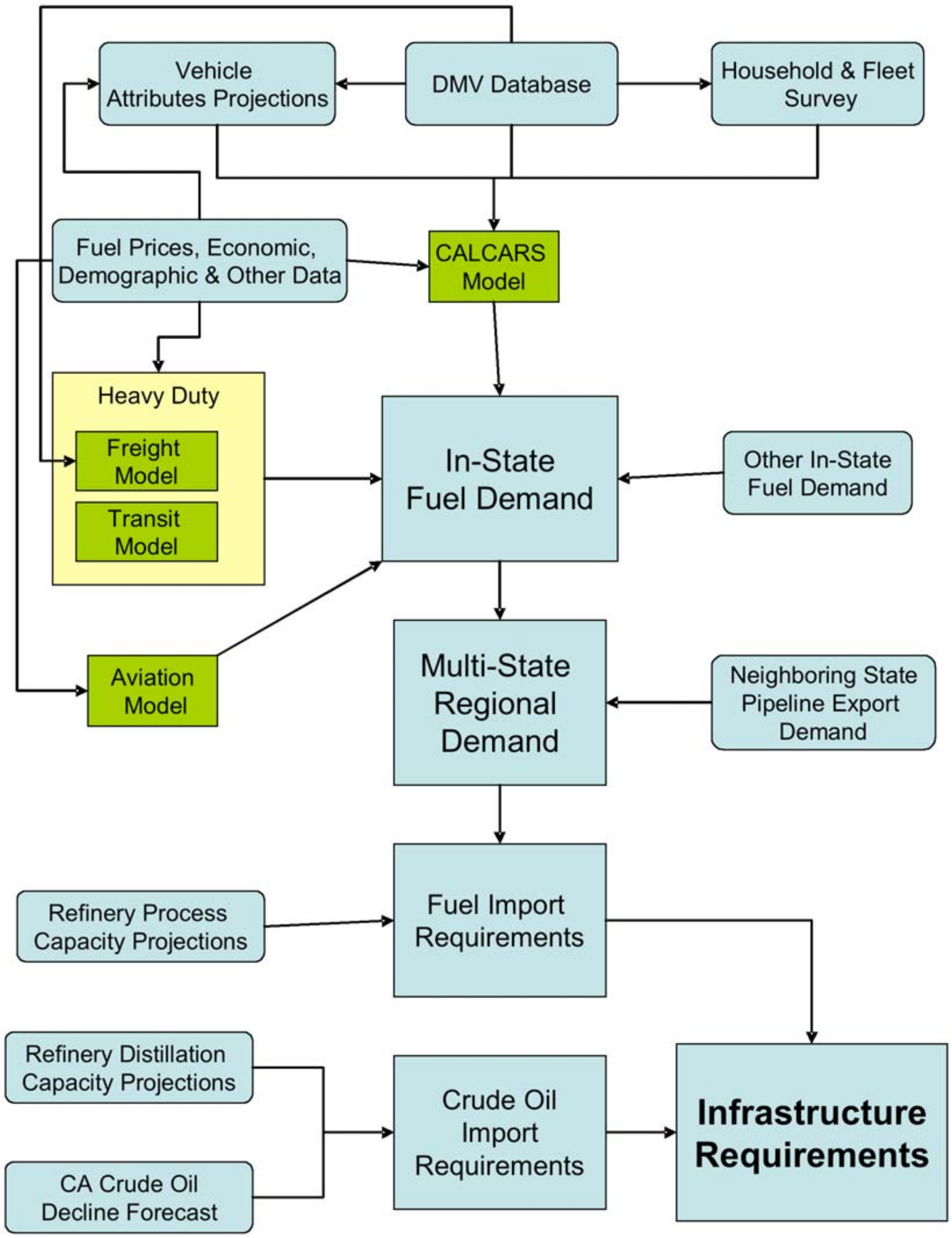
The Energy Commission develops forecasts and analyses of the transportation fuels industry and related markets. Transportation energy demand and fuel price forecasts support several energy policy and program activities, including the alternative vehicle and fuel technology analysis mandated by Assembly Bill 1007 (Pavley), Chapter 371, Statutes of 2005; petroleum use reduction assessment; and petroleum infrastructure requirements assessment.

Inputs to the transportation energy demand forecasts include: 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. 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 infrastructure 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. Figure 1 illustrates the flow of data, forecasts, and other information for these transportation energy analyses.

Organization of This Report

The intent of this staff report is to provide information for the *2007 IEPR* on work products that are in various stages of development. This report includes the staff's proposed transportation fuels price forecasts, methods for producing the transportation energy and travel demand forecasts, and methods used to assess potential fuel and crude oil import requirements. The Energy Commission will present and discuss these and other related materials at the May 8 staff workshop to be held at the Energy Commission.

Figure 1: Information Flow for Transportation Energy Analyses



Source: California Energy Commission Fuels and Transportation Division

PROPOSED CALIFORNIA TRANSPORTATION FUEL PRICE FORECASTS

Summary

Staff has developed High, Base, and Low Case price forecasts for California highway fuels based on the United States (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 gasoline and $2.99 for diesel in 2007, dips to $2.51 and $2.58, respectively, in 2014, and then rises to $2.71 and $2.78 by 2030, expressed as inflation-adjusted 2007 dollars.[1] The 2030 prices for gasoline and diesel in the High Case are $3.85 and $3.97, respectively, per gallon and $2.06 and $2.07 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 2 for comparison of these 2007 oil price forecasts and those EIA forecasts used in 2005 for the Energy Commission's *2005 IEPR*).[2] 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.[3]

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 EIA's weekly world oil price index (calculated free-on-board, or FOB, from all exporting nations) and EIA's 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

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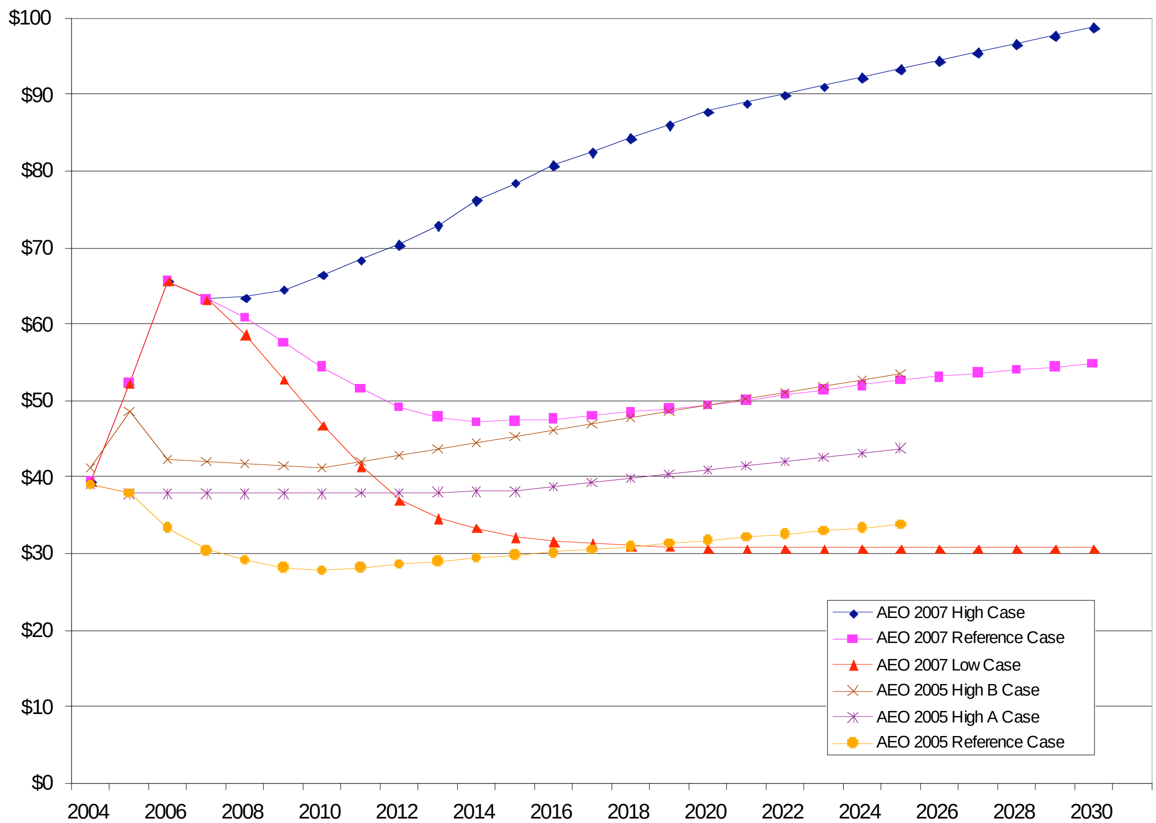
[1] All prices used in this work are in 2007 dollars, using the May 30, 2006, California Energy Commission deflator series.

[2] Due to the volatility of oil markets at the time, the United States Energy Information Administration (EIA) *2005 Annual Energy Outlook* (AEO) 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*.

[3] 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.

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 2: 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. The last step in generating a final retail price forecast for each of the fuels is to add excise and sales taxes and fees.

Table 1 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 1: 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

California Transportation Fuel Price Forecasts

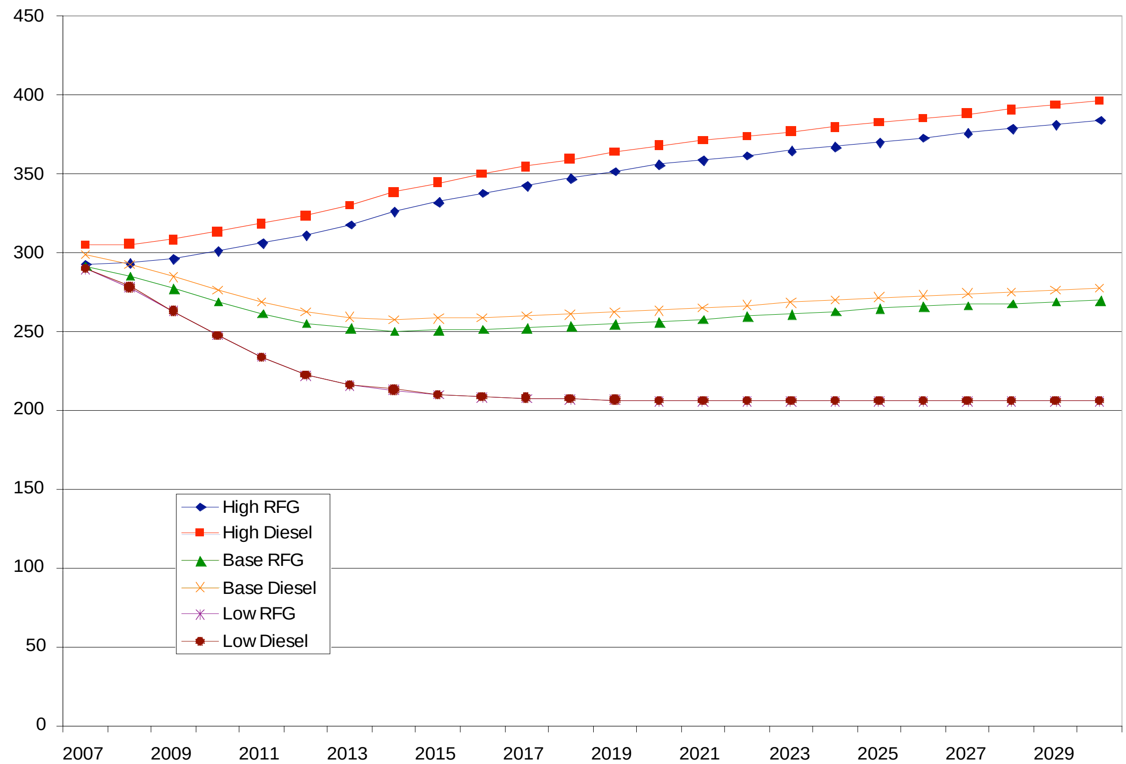
Table 2 and Figure 3 show the proposed retail fuel price projections for regular-grade California gasoline and California diesel using the assumptions outlined above.

Table 2: 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	301.6	313.6	269.5	276.6	247.8	248.1
2011	306.6	318.6	262.0	269.1	234.0	234.2
2012	311.6	323.6	255.9	262.9	222.5	222.7
2013	318.3	330.3	252.6	259.6	216.3	216.6
2014	326.6	338.6	250.9	258.0	213.3	213.5
2015	332.6	344.5	251.5	258.5	210.3	210.5
2016	338.4	350.4	252.0	259.1	208.6	208.9
2017	342.9	354.9	253.1	260.2	208.0	208.3
2018	347.5	359.5	254.3	261.4	207.5	207.8
2019	352.0	364.0	255.4	262.5	206.9	207.2
2020	356.5	368.5	256.5	263.6	206.3	206.6
2021	359.3	371.3	258.2	265.3	206.3	206.6
2022	362.1	374.1	259.9	267.0	206.3	206.6
2023	365.0	377.0	261.6	268.7	206.3	206.6
2024	367.8	379.8	263.3	270.4	206.3	206.6
2025	370.6	382.6	265.0	272.1	206.3	206.6
2026	373.4	385.4	266.1	273.2	206.3	206.6
2027	376.3	388.2	267.3	274.4	206.3	206.6
2028	379.1	391.1	268.4	275.5	206.3	206.6
2029	381.9	393.9	269.5	276.6	206.3	206.6
2030	384.7	396.7	270.7	277.7	206.3	206.6

Source: California Energy Commission Fuels and Transportation Division

Figure 3: California Gasoline & Diesel Price Projections (2007 cents per gallon)



Source: California Energy Commission Fuels and Transportation Division
Note: Low Case gasoline and diesel price tracks are largely superimposed.

Table 3 provides the underlying EIA *2007 AEO* crude oil price forecasts for the average U.S. refiner acquisition cost of imported crude for the three cases discussed above and graphed in Figure 2.

Table 3: EIA *2007 AEO* Oil Price Projections
(2007 dollars per barrel)

	High Case	Base Case	Low Case
2004	39.43	39.43	39.43
2005	52.30	52.30	52.30
2006	65.65	65.65	65.65
2007	63.25	63.25	63.25
2008	63.51	60.84	58.78
2009	64.54	57.64	52.81
2010	66.49	54.43	46.85
2011	68.43	51.55	41.48
2012	70.37	49.14	37.01
2013	72.96	47.86	34.62
2014	76.20	47.22	33.43
2015	78.52	47.43	32.26
2016	80.80	47.65	31.61
2017	82.55	48.08	31.40
2018	84.31	48.53	31.18
2019	86.08	48.96	30.96
2020	87.82	49.41	30.73
2021	88.92	50.06	30.73
2022	90.02	50.72	30.73
2023	91.12	51.39	30.73
2024	92.21	52.04	30.73
2025	93.31	52.70	30.73
2026	94.41	53.13	30.73
2027	95.51	53.58	30.73
2028	96.60	54.01	30.73
2029	97.70	54.45	30.73
2030	98.80	54.89	30.73

Source: U.S. Energy Information Administration

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 modeling of these cases is further described later in Model Cases and Assumptions.

The outlook for pricing of alternative transportation fuels is uncertain and highly dependent on policy making and implementation. After extensive consultation with colleagues in 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 to the task of developing vehicle attribute projections.

In the case of E-85, two principles are proposed 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. In the case of aggressive alternative fuel penetration, new incentives and greater availability are assumed to drive the E-85 price down to gasoline equivalence on an energy basis.[4] 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.

Table 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	269.5	269.5	269.5	201.1
2011	262.0	262.0	262.0	195.6
2012	255.9	255.9	255.9	190.9
2013	252.6	252.6	252.6	188.5
2014	250.9	250.9	250.9	187.2
2015	251.5	251.5	251.5	187.7
2016	252.0	252.0	252.0	188.1
2017	253.1	253.1	253.1	188.9
2018	254.3	254.3	254.3	189.8
2019	255.4	255.4	255.4	190.6
2020	256.5	256.5	256.5	191.4
2021	258.2	258.2	258.2	192.7
2022	259.9	259.9	259.9	194.0
2023	261.6	261.6	261.6	195.2
2024	263.3	263.3	263.3	196.5
2025	265.0	265.0	265.0	197.8
2026	266.1	266.1	266.1	198.6
2027	267.3	267.3	267.3	199.5
2028	268.4	268.4	268.4	200.3
2029	269.5	269.5	269.5	201.1
2030	270.7	270.7	270.7	202.0

Source: California Energy Commission

For electric rates applicable to plug-in hybrids, staff is still developing appropriate forecasts. Currently, the marginal rates that plug-in hybrids would pay vary widely among utilities, depending on their structure across rate tiers and baseline allowances. The range for the Base Case has been tentatively estimated at between 16 and 24 cents per kilowatt-hour (kWh) as a statewide average. Prices for the Aggressive Alternatives Case are estimated to be closer to the lowest current residential rates, in the range of 7–12 cents per kWh. Final estimates intended for use in the vehicle attributes projections were not ready in time for publication in this staff report.

[4] 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.

METHODOLOGY OF LONG-TERM FUEL DEMAND FORECAST

Introduction

As part of the *2007 IEPR*, the staff will produce a long-term fuel demand forecast involving four forecasting models: the California conventional alternative fuels response simulator (CALCARS), the Freight model, the Transit model, and the Aviation model. Each model forecasts demands for different transportation sectors and has been used in past *IEPRs* to varying degrees.

Purpose of California Petroleum Demand Forecast

The California petroleum demand forecast is one crucial step in developing and assessing the adequacy and needs of the state's fuel infrastructure over the next 20 years. The demand forecast will provide California with another tool to measure and potentially mitigate the state's growing need for petroleum-related imports.

In past *IEPRs*, the demand forecast has allowed the Energy Commission to evaluate new alternative fuels and efficiency policies needed to reach petroleum and greenhouse gas (GHG) emission reduction goals. The forecast will continue to play a role in evaluating the state's activities to measure the success of reaching reduction goals through emerging technologies and impacts on GHG emissions.

In general, the demand forecast assists with the evaluation of state transportation-related policies. By developing a petroleum demand forecast, staff better understands the transportation energy sector and can better evaluate the implications of future state policies.

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.
- Department of Motor Vehicles (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 timely completion of the 2007 California Vehicle Survey.

California Freight Energy Demand Model

The California Freight Energy Demand (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 these two 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, average rail carloads, and truck survival rates.

California Transit Energy Demand Model

The California Transit Energy Demand (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, and so forth, 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 Model

The California Civil Aviation Jet Fuel Demand (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*. The Aviation model uses econometric, demographic, and technology projections to estimate jet fuel demand including:

- Forecasts of California demographics, such as 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.

Modeling Cases and Assumptions

Modeled Price Forecast Cases

With the exception of vehicle technology attribute and consumer preference data, Energy Commission staff, working with other agencies, will provide all of the input data required for the forecasts, including current vehicle counts, fuel price forecast scenarios, and base case projections of demographic/economic growth, consistent with the values used for other sectors in the *2007 IEPR*. Historic and projected vehicle technology attribute data, such as price and fuel economy by model year and vehicle class, will be developed by contract using Energy Commission inputs and assumptions. Consumer preference data will be collected through the 2007 California Vehicle Survey.

Based on these input data, staff proposes to develop fuel demand forecasts for gasoline, diesel, hybrid, flex-fuel, and plug-in hybrid vehicles for the first six cases identified in Table 5, based on the fuel efficiencies assumed for light-duty vehicles and on the long-term fuel prices. For fuel prices, the cases assume either staff's Low Fuel Price forecast, Base Fuel Price forecast, or High Fuel Price forecast. These fuel demand cases will provide a range of fuel demand projections, with Case 1 forecasting the highest fuel demand and Case 6 forecasting the lowest fuel demand.

An additional Aggressive Alternative Fuels case (Case 7) will be forecast using Base Case gasoline and diesel prices but with lower alternative fuel prices. This alternative case will provide an opportunity to evaluate potential future policy impacts. The magnitude of policy changes simulated in Case 7 may lead to the lowest demand forecast but will be representative of the specific policies modeled, not necessarily the most likely demand forecast.

Table 5: *2007 IEPR* Fuel Demand Forecast Cases

Policy Scenario	Low Fuel Price	Base Fuel Price	High Fuel Price
Reference	Case 1	Case 2	Case 3
Higher Fuel Efficiency	Case 4	Case 5	Case 6
Aggressive Alternatives	-	Case 7	-

The first six price forecast cases will provide staff with a range of plausible petroleum demand forecasts based on current price forecast conditions. In addition to the petroleum price forecasts, E-85 and transportation electricity price forecasts will be used as inputs to the models. The alternative price forecast will provide staff an opportunity to evaluate such impacts as the potential introduction of emerging vehicle technologies and the successful deployment of non-petroleum transportation fuels.

Model Assumptions

The following forecast assumptions reflect the uncertainties associated with the proposed demand forecast.

Current consumer-stated preference will represent future consumer choices.

The updated 2007 California Vehicle Survey will be the basis of the CALCARS model. The current survey, although updated with a range of possible vehicles and vehicle characteristics, does not represent all future potential vehicles. For example, none of the survey questions asked of consumers represented a choice to purchase and use a diesel or pure ethanol-fueled hybrid electric vehicle. Therefore, the CALCARS model cannot directly indicate the future preferences of these potential vehicles. Similarly, as market conditions and consumers' preferences change, so too may vehicle choices.

Recent trends in the transportation energy sector are mathematically representative of future trends.

All current Energy Commission forecasting models are mathematical in nature and based on historic data. As such, the developed forecasts will represent recent trends in transportation energy usage. Large changes to the transportation energy sector such as the adoption of future, unforeseeable legislation or technologies are not represented in the forecasts. Similarly, impacts of low probability but high impact events, which change the use of transportation energy in California and worldwide, are not represented in the existing models. Therefore, in the context of the demand forecasts, it is assumed the modeled mathematical equations adequately describe potential future trends given the trends in input historical data.

Fuel economy values used in the CALCARS demand forecast are representative of typical on-road driving fuel economies.

The U.S. Environmental Protection Agency (EPA) is currently revising the method for evaluating fuel economies of new vehicles. The fuel economy values used in the CALCARS model are based on current fuel economy estimates but are revised to reflect true driving conditions. It is anticipated the change in EPA fuel economy evaluation methodologies will bring the published EPA fuel economy numbers closer to the CALCARS fuel economy values.

Recent vehicle sales trends will continue from the most recent DMV data file pass to the first modeled base year.

The current light-duty demand model will utilize vehicle counts from the DMV's 2005 registration database data file pass. The vehicle counts represent the DMV's most current data but do not directly correspond to the existing consumers' purchase choices. However, given that survey preferences are more current than the vehicle counts, there will be little impact on projected vehicle counts.

Demographic and economic data from the California Department of Finance is adequately representative of California.

The Department of Finance's demographic and economic data is consistent with other Energy Commission evaluations and is the best representative data set to use. This does not preclude the evaluation of other data sets in the forecasts, given time.

METHODOLOGY OF TRANSPORTATION FUEL IMPORT FORECASTS

Overview

The quantity of California's transportation fuel imports is the interaction among consumer demand, California refinery output, and exports of petroleum products to neighboring states. The trends for all three of these factors will determine at what rate the imports of transportation fuels will increase for California during the forecast period. This section contains a discussion of the specific factors that will be 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).
- 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 additional quantities of crude oil are processed each year, the quantity of petroleum products 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 proposes to use a range of distillation capacity growth rates as part of the analysis to forecast imports of transportation fuels. The lower distillation capacity growth rate of 0.41 percent per year will be used 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 will be a factor contributing to a Low Case of imported transportation fuels.

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. Staff will assess the changes in process unit capacity at California refineries over the last decade to derive a range of process unit capacity growth. The low range obtained through this methodology will be a factor used to calculate the High Case of the transportation fuel import forecast, while a higher capacity growth rate will be a factor in the Low Case import forecast.

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 the Low Case development, staff will assume that all of the recent announcements to expand output of California refineries will be completed within the near-term period of the forecast. For the High Case, staff will assume that all of these projects are delayed or eventually cancelled.

Exports of Transportation Fuels to Neighboring States

Nevada and Arizona do not have any refineries that can produce transportation fuels. As a consequence, all of the transportation fuels consumed in these states must be imported 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).

Nearly 100 percent of the transportation fuels consumed in Nevada are provided by pipelines that originate in California. 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 4 depicts the KMP petroleum product pipeline system in the Southwest United States.

Figure 4: 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.

Staff will use a lower estimated population growth rate for Nevada and Arizona as a factor associated with the Low Case transportation fuels import forecast, while also assuming that additional quantities of pipeline shipments to Arizona will preferentially occur on the East Line over the forecast period. For the High Case, staff will assume a higher population growth rate for the two neighboring states, along with the assumption that the majority of incremental demand growth in Arizona will be achieved through pipeline shipments on the West Line portion of the KMP system.

Additional Factors with Potential for Impact

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

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 barrels per day (BPD) of crude oil and natural gasoline that would be converted to 85 thousand barrels per day (TBD) of gasoline, 35 TBD of diesel fuel, and 30 TBD 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.

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 qualitative assessments will be 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.

Increased Use of Alternative Fuels – AB 1007 and the LCFS

The Energy Commission and the California Air Resources Board (ARB) are actively involved in 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 unaffected. The development of staff’s transportation fuel import forecast will include an assessment of different ethanol scenarios, such as E-10 and E-20, to address one of the possible outcomes of the AB 1007 and LCFS regulatory process.

Summary Matrix

The following table 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 6: Transportation Fuels – California Import Forecast

Primary Forecast Factor	Low Case	High Case
California Demand	Low Growth	High Growth
Distillation Capacity	High Growth	Low Growth
Process Unit Capacity	High Growth	Low Growth
Refinery Expansion	Projects Completed	Projects Cancelled
Pipeline Exports	Lower Demand Maximum East Line Shift	Higher Demand Minimal East Line Shift

Additional Factors

New Arizona Refinery	Project Completed	Project Cancelled
AB 32	Minimal Refinery Creep	Capacity Declines
LCFS	E-20 B-20	E-10 B-5

CALIFORNIA CRUDE OIL IMPORTS FORECAST

Overview

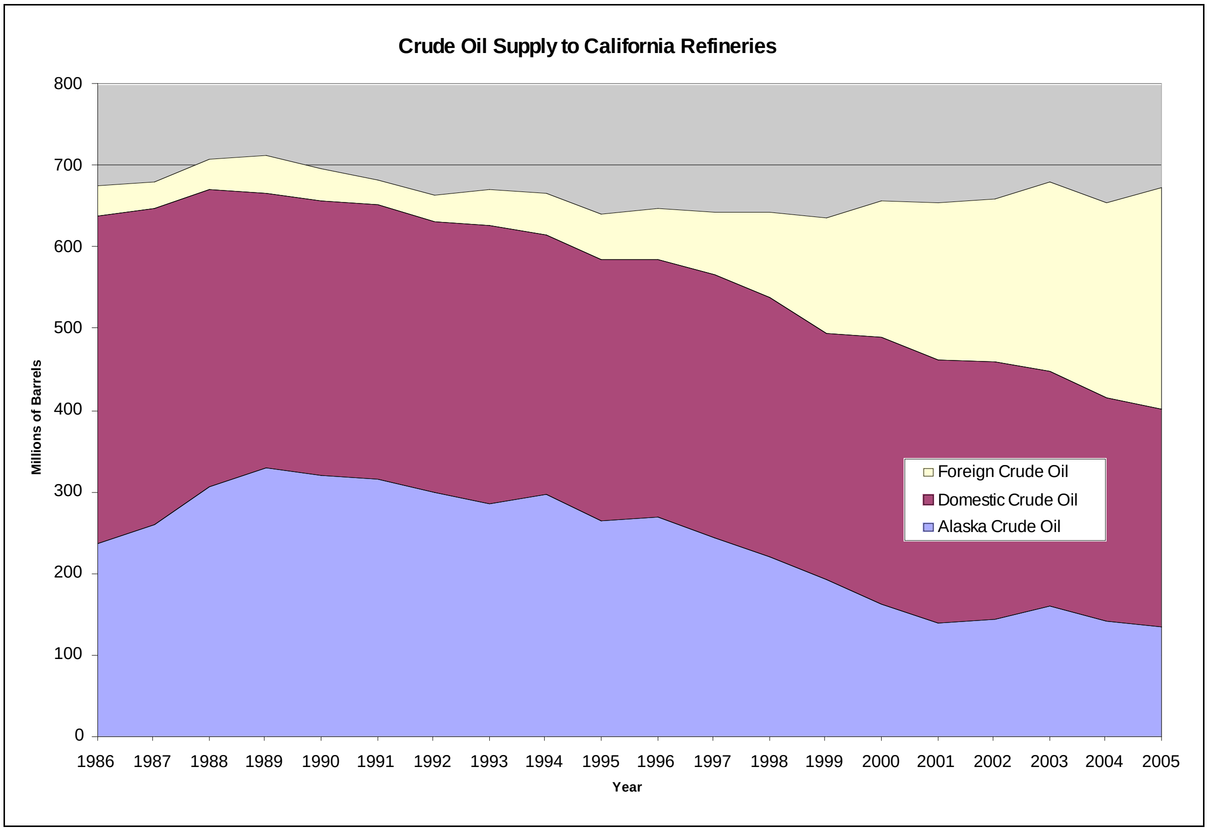
Two factors primarily determine the quantity of crude oil imported into California: the declining production from California crude oil fields and the gradual expansion of refining capacity in the state. The forecast of crude oil imports for the state was developed by analyzing trends for both of these factors over the last decade or so 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 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 BPD) 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) and the balance from Alaska (20.2 percent). Figure 5 illustrates the various sources of crude oil used in California refineries since 1982.

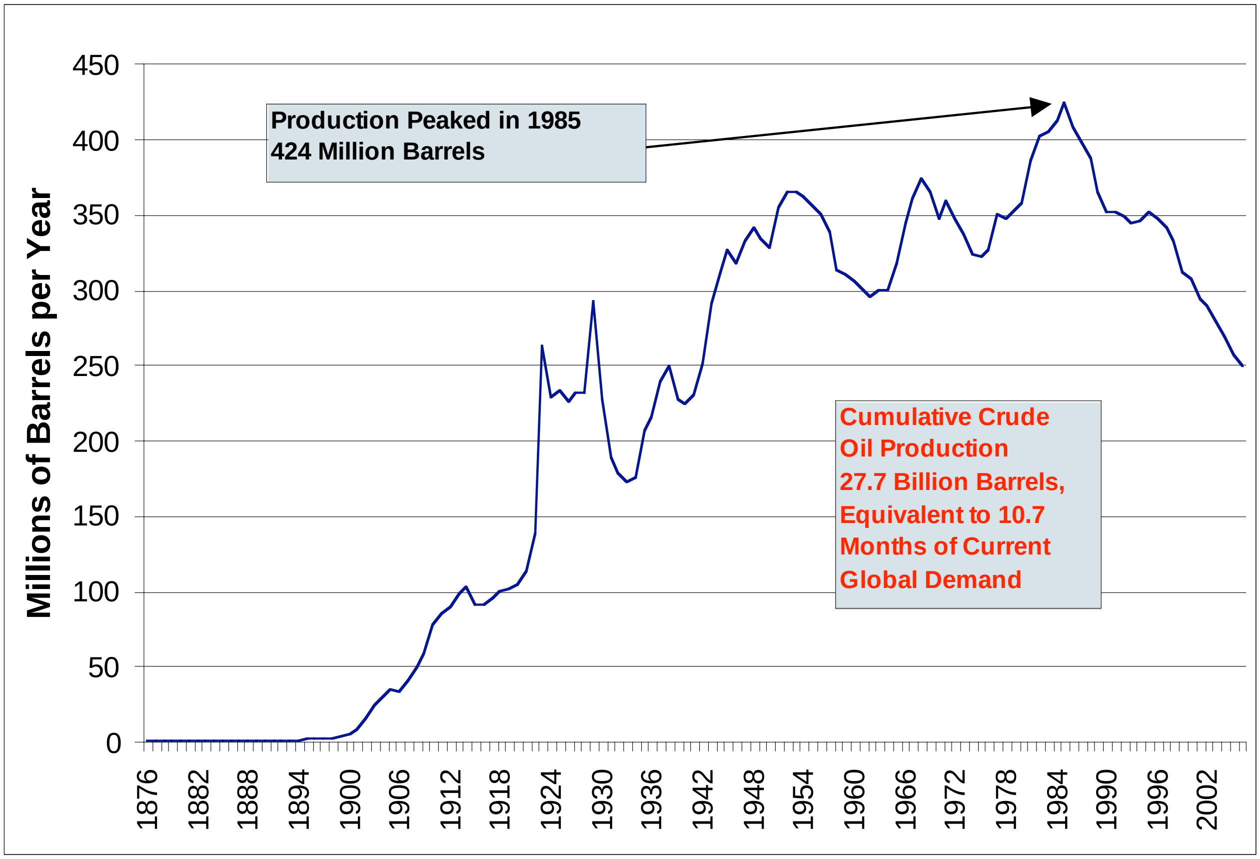
Figure 5: Crude Oil Supply to California Refineries



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

Figure 5 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 6 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 6: California Oil Production, 1876 to 2006

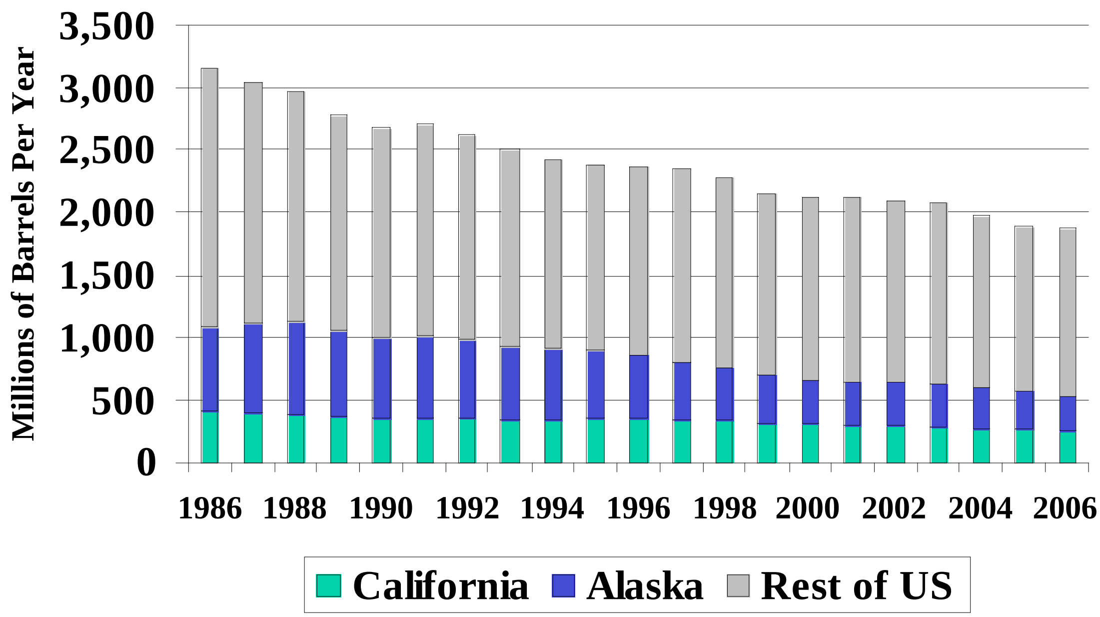


Sources: California Division of Oil, Gas, and Geothermal Resources and California Energy Commission

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 BPD. California's annual crude oil production was approximately 250 million during 2006, averaging 685,000 BPD. Figure 7 breaks down crude oil production for the U.S. between 1986 and 2006.

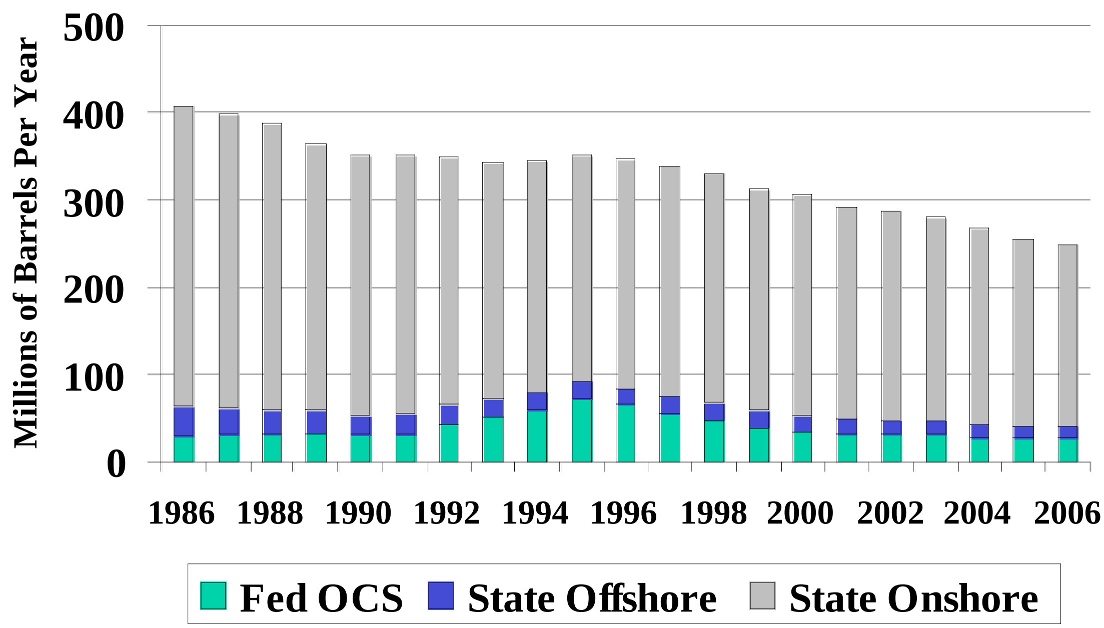
Figure 7: U.S. Crude Oil Production (1986 - 2006)



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

Figure 8 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 8: California Crude Oil Production (1986 - 2006)



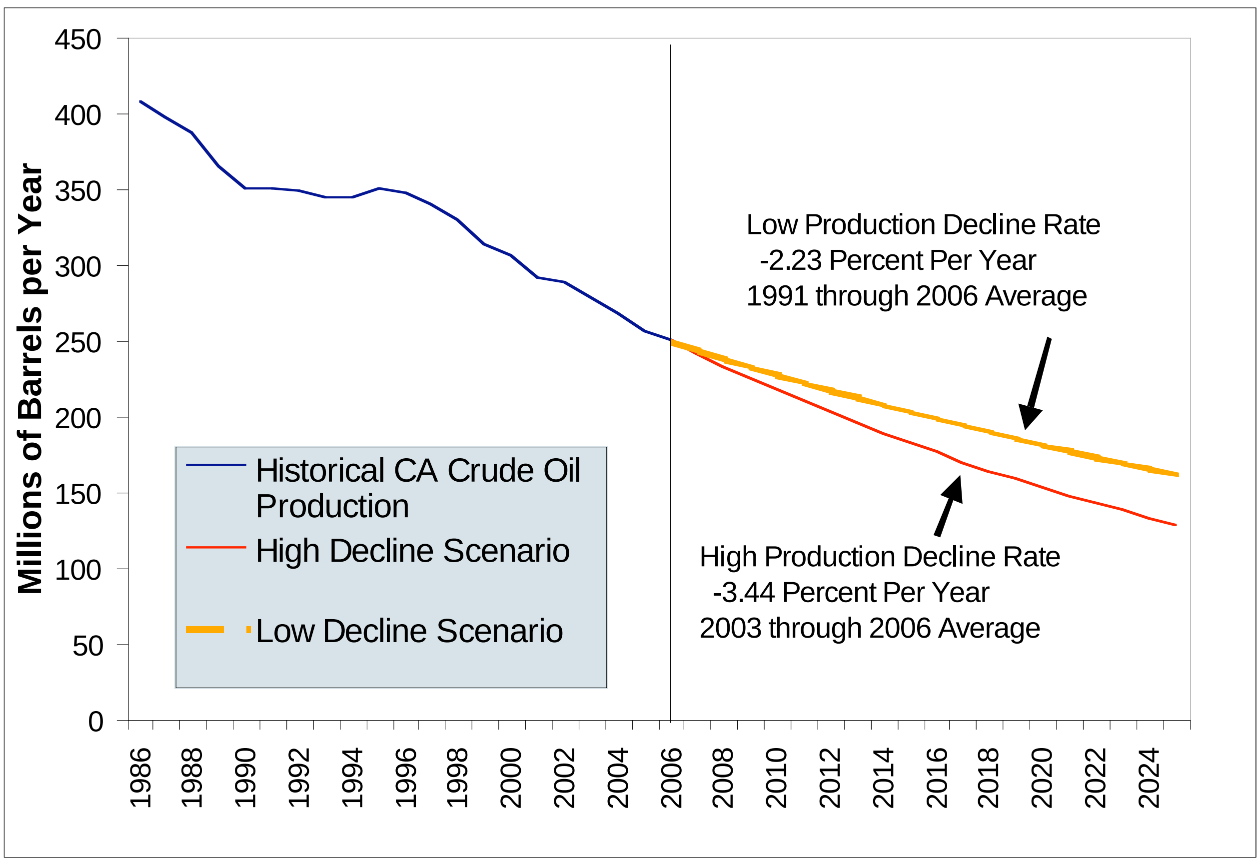
Source: California Division of Oil, Gas, and Geothermal Resource

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 of the state. Since Alaska crude oil production has declined at an even greater rate than California, 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 9 extrapolates the two previously mentioned decline rates over the next 20 years.

Figure 9: California Crude Oil Production Decline Forecast 2007–2025



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

California Refinery Crude Oil Processing Capacity

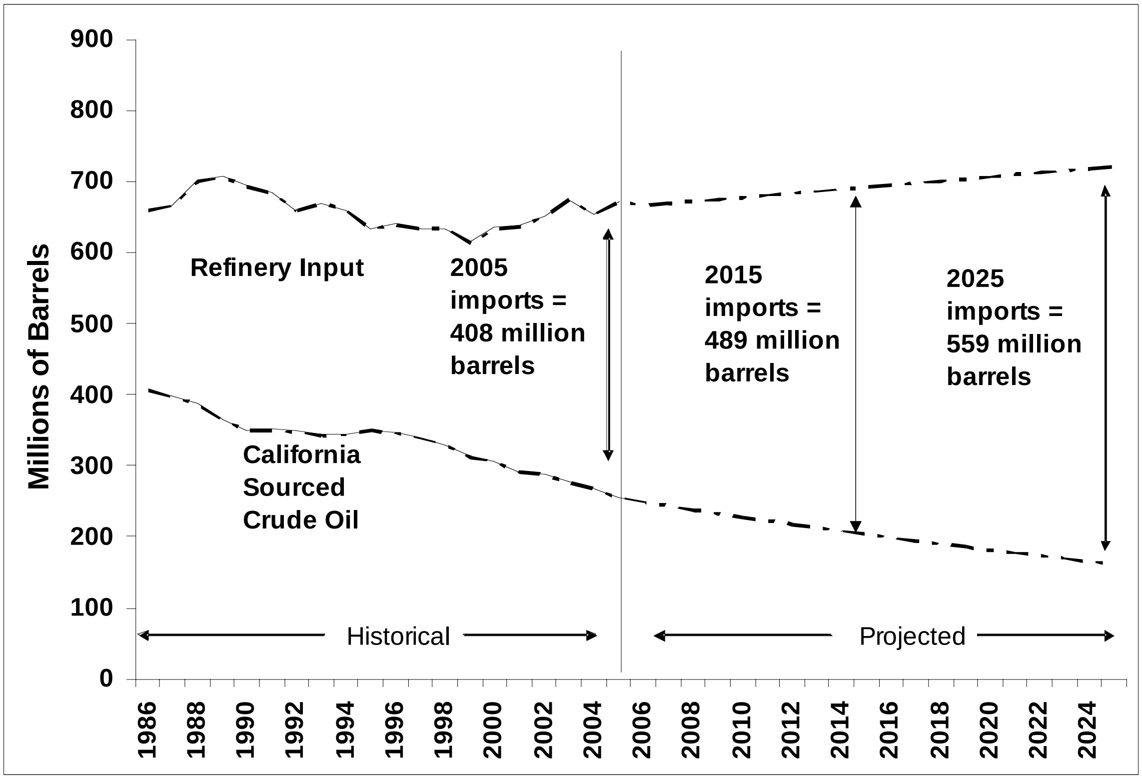
There are 22 refineries operating in California that process an average of 1.8 million BPD of crude oil. Distillation process units are the initial step in converting crude oil to a variety of petroleum blendstocks that are combined to form gasoline, diesel, and jet fuel. Most refiners normally perform periodic maintenance at their facilities during the winter months. Occasionally, a refiner may elect to slightly expand 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 is referred to as “refinery creep” and 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 nearly 1 percent per year (0.98 percent). Between 2003 and 2006, the refinery creep rate is less than half (0.4 percent per year). These two ranges were used to create 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 due to 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 10 depicts the Low Case.

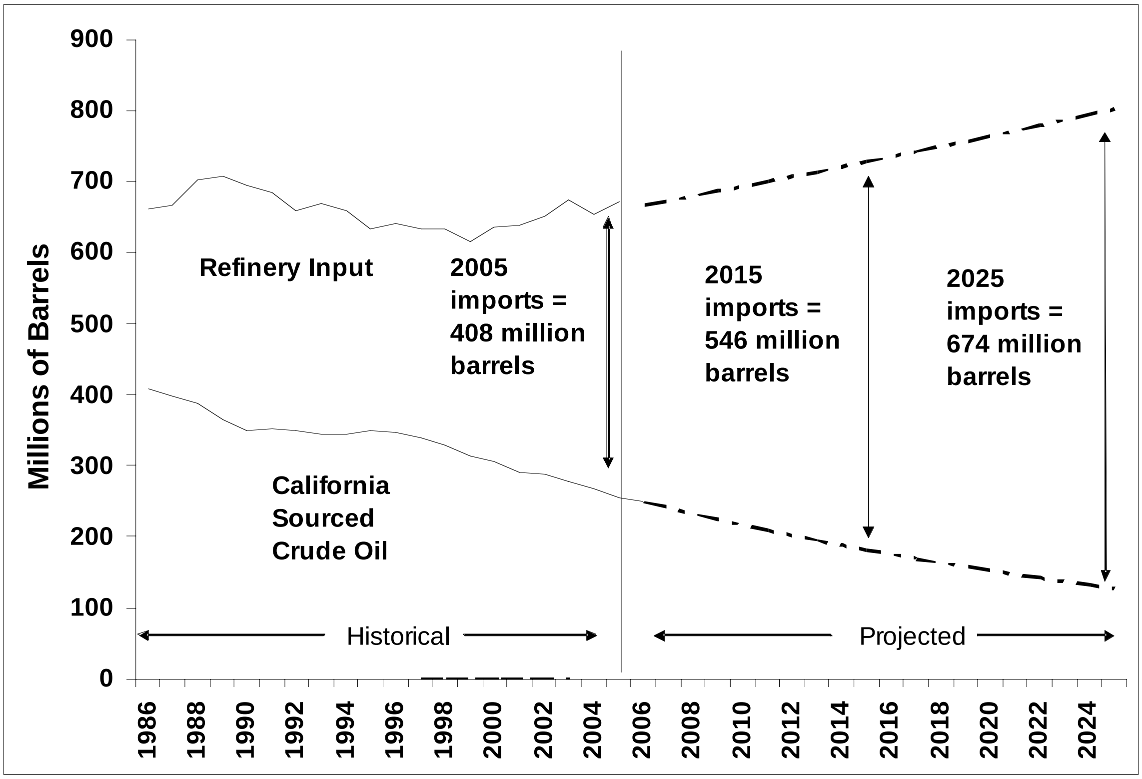
Figure 10: Low Case Forecast for California Crude Oil Imports



Source: California Energy Commission 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). The assumptions used to obtain these projections were 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. If higher rates for both crude oil production decline and refinery creep are used, crude oil imports are forecast 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 11 illustrates the High Case projection for California crude oil imports.

Figure 11: High Case Forecast for California Crude Oil Imports



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

As each of the two previous figures indicate, 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 7 combines the various rates into a single table for both the near-term (2015) and longer-term (2025) periods of the forecast.

Table 7: 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 what portion of the incremental crude oil imports for the entire state would be delivered to Northern and Southern California, respectively. Based on recent historical trends, it was assumed that 60 percent of the incremental crude oil imports over the forecast period will be delivered to marine terminals in Southern California, with the balance (40 percent) handled by marine berths in the Bay Area. Table 8 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 8: 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

Next Steps

Staff will be conducting an assessment of the industry's marine import infrastructure to identify potential bottlenecks for increased imports of crude oil. Although it is quite obvious that 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, a more precise estimate of timing for expansion has yet to be completed. In addition, 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 to this on-going analysis, staff will be taking input from interested stakeholders regarding the assumptions and methodologies used to create the imported crude oil forecast.