OPTION 2F
ETHANOL BLEND (E10)

Summary

This paper examines the use of ethanol as a blending component in California gasoline for projected gasoline demand through 2025. Business–as-Usual and Aggressive Ethanol Blending Scenarios are analyzed and petroleum displacement results reported for three gasoline price projections.

Under the Business-as-Usual base case scenario, annual ethanol demand is about 900 million gallons per year, providing petroleum displacement of about 5 percent of projected gasoline demand by 2025. The Aggressive Scenario assumes 10 percent ethanol blending with a resultant demand of 1.4 billion gallons per year and 9 percent petroleum displacement. This is about 40 percent of California's 2020 alternative fuel use goal, and about 30 percent of the 2030 goal, by 2025.[1]

In the Business-as-Usual Scenario, California blends ethanol under current state and federal regulations consistent with base case on-road gasoline demand projections under California's greenhouse gas (GHG) standard[2]. The Aggressive Scenario assumes that 10 percent ethanol blending, as opposed to the current 5.7 percent becomes standard practice and remains at that level through 2025.

Background and Description

The following subsections focus on the status and maturity of ethanol use as a blending component in California gasoline. Subsequent analyses and projections of ethanol demand towards achieving the *2003 Integrated Energy Policy Report* recommended alternative fuel use goals rely heavily on recent ethanol blending practices in California in a post Methyl Tertiary Butyl Ether (MTBE) world.

MTBE Phase-Out

California reformulated gasoline with MTBE (CaRFG2) was found to be unsuitable for use in California due to environmental risks associated with groundwater contamination from leaking underground gasoline storage tanks.
Governor Gray Davis ordered the removal of MTBE from California gasoline through Executive Order D-5-99, issued on March 25, 1999. With the complete phase-out of MTBE by December 31, 2003, CaRFG3 became the only oxygen-containing gasoline available to California consumers and businesses.

At its peak use, 104,000 barrels per day of MTBE (nearly 4.4 million gallons per day), on average, were blended to make CaRFG2. This volume represents 10.8 percent of the CaRFG2 produced by California refiners for the third quarter of 2000[3]. ConocoPhillips was the first refiner to eliminate MTBE in its gasoline in 2002, more than a year ahead of the phase-out deadline. Companies completing the phase-out process in the fourth quarter of 2003 included Tesoro and ChevronTexaco at their northern California refineries, and two Valero refineries in northern and southern California. In 2003, fourth quarter daily average MTBE use plummeted to just 1.1 percent of CaRFG, or 11,500 barrels (483,000 gallons) per day prior to the December 31, 2003 deadline[4]. CARB regulations limit MTBE residual volume in CaRFG beginning January 1, 2004. This level decreases over time to 0.05 volume percent after 42 months.[5]

Federal Clean Air Act and National Ambient Air Quality Standard

Under the federal Clean Air Act (CAA), California and other states are subject to federal reformulated gasoline requirements in air basins that do not meet national air quality standards (non-attainment regions). Since several regions within California do not comply with the 8-hour National Ambient Air Quality Standard (NAAQS) for ozone, California's gasoline must contain 2 percent (weight) oxygen year-round until these regions come into, and maintain, compliance with the standard[6].

In 2004, 80 percent of California gasoline became subject to the federal requirements as a result of the re-designation of San Joaquin Valley as a "severe" ozone non-attainment region. The San Joaquin Valley joined the Los Angeles area South Coast Air Basin (SCAB) as another geographical region subject to the federal requirement. The SCAB has until 2021 to come into attainment for the NAAQS for ozone, given its higher "extreme" designation, while the San Joaquin Valley has until 2013, under its "severe" designation.

Assuming that the San Joaquin Valley comes into compliance in 2013, about 60 percent of California's gasoline would then be required to contain oxygen based on gasoline demand in the SCAB through 2021. However, California's 1999 request for waiver from the oxygen provisions of the CAA may ultimately be granted by the U.S. Environmental Protection Agency (EPA) or, alternatively, proposed federal energy legislation may replace the oxygen requirement with a Renewable Fuels Standard (RFS). Thus, it is not clear that federal requirements for oxygen in gasoline can be counted on to assure continued use of ethanol through the year 2025 in California[7]. On the other hand, limited segregation capability of the distribution infrastructure, need for adequate levels of octane in gasoline, combined with long term contracts for ethanol delivery by the railroads to refiners, currently limits the desire and ability of refiners to produce and market non-oxygenated gasoline on any significant scale in the near term[8].

Gasoline and Ethanol Demand in 2004

California gasoline consumption in 2004 was 15.9 billion gallons, over 97 percent of which was California Blendstock for Oxygenate Blending (CARBOB) blended with 5.7 percent ethanol to create CaRFG3[9]. About 2.5 percent of the gasoline consumed was non-oxygenated CaRFG produced and distributed in the San Francisco Bay Area[10].

Ethanol use in 2004 is estimated at 900 million gallons, up from 623 million gallons in 2003 and 112 million gallons in 2002[11]. While 20 percent of California gasoline could have been produced and sold without an oxygenate in 2004, nearly all California refiners chose to produce a CARBOB suitable for ethanol blending[12].

The Business-as-Usual Scenario assumes that refiners will retain the current aggregated industry CaRFG3 production trends to meet contracted gasoline volume commitments, CARBOB/CaRFG trading agreements with partners and federal oxygen requirements simultaneously, blending 90 percent of CaRFG with ethanol through 2025. The other 10 percent of the gasoline is assumed to be non-oxygenated fuel in non-federal gasoline regions[13]. This 90/10 percent split is assumed to remain at the same level due to distribution and infrastructure constraints.

Petroleum Infrastructure Improvement Trends

Beginning in 2002, about 70 petroleum products terminals were upgraded with additional storage capacity, ethanol receiving capability, and modifications to loading racks to facilitate CaRFG3 blending and truck loading for delivery to retail outlets. These upgrades cost the California refiners and terminal operators about $700 million and involved modest upgrading at some California refineries.[14] These investments complemented the nearly $3.5 to 4 billion in major refinery upgrades that occurred in 1995 through 1996 to comply with the California Air Resources Board's (CARB's) Phase II reformulated gasoline regulations.

The rail system delivering ethanol to California from the Midwest was upgraded in 2003 by directing rail deliveries to major receiving terminals in the state. In October 2003, the Burlington Northern Santa Fe railroad company created dedicated 95-car unit trains that deliver 2.9 million gallons of ethanol to the Lomita Rail Terminal in Watson on a continuous basis. Four trains deliver ethanol sequentially every 3.5 days, returning to a Midwest gathering location[15]. Union Pacific Railroad Company instituted a combination of single car, multiple car, and unit trains providing a flexible method of moving ethanol from a central location in Nebraska to northern and southern California storage yards[16]. Staff has assumed that such improvements will continue and keep pace with any level of increased ethanol

demand in the future, including 10 percent ethanol blending in CaRFG3 through 2025[17].

In 2004, about 10 percent of the ethanol used in CaRFG3 was delivered by ship from Caribbean Basin Initiative (CBI) countries as well as Brazil. Under the terms of the CBI, up to 7 percent of the previous year's U.S. domestic ethanol production may be imported into the U.S. tariff free. Even though southern California port maritime traffic is projected to become more congested in coming years, ethanol deliveries by ship are relatively infrequent compared to daily traffic in and out of the ports. Staff expects that ethanol deliveries by ship will continue at 10 percent of demand (or less) under any future ethanol blending practice in California.

U.S. Ethanol Supply and Price Trends

Ethanol Supply

By early 2006, 17 new ethanol production facilities and 2 expansions at existing Midwest ethanol plants will add about 700 million gallons of new capacity, bringing domestic production capacity up to 4.4 billion gallons per year[18]. The 2004 through 2005 capacity growth trends of just under 20 percent per year are consistent with Energy Commission surveys of U.S. ethanol production capacity[19]. In 2004, 11 new plants with 409 million gallons of capacity started production. There were four plants with rated capacity of 45 million gallons per year; three in Iowa and one in South Dakota. On average, plant rated capacity is 40 million gallons per year[20], with each producing enough ethanol to blend with about 700 million gallons of CaRFG3 (at 5.7 percent ethanol concentration), supplying two weeks of CaRFG3 demand at 2004 gasoline consumption rates. Thus, California ethanol demand could be supplied by the equivalent of 20 Midwest ethanol plants representing about one-quarter of all U.S. plants in operation today.

This ethanol production capacity growth trend in the Midwest is enough to support an increase in ethanol use to 7.7 to 10 percent in California, as well as, increased discretionary ethanol blending in other U.S. markets[21]. Ten percent blending, under early implementation of an aggressive 2010 ethanol blending scenario, would increase California's ethanol demand to about 1.5 billion gallons a year in 2005 through 2006, assuming that the current practice of supplying 97 percent of the state with ethanol blended CaRFG3 is retained over the next two years[22]. This new demand of about 630 million gallons would absorb most of the 700 million gallons of capacity scheduled to come on-line in 2005 and early 2006. Assuming these plants achieve nameplate capacity[23] and the price of ethanol (net tax incentive) remains favorable to CARBOB and other blending components, California could attract as much new ethanol supply as it requires in the near future[24].

Ethanol Price Trends

While ethanol prices have fluctuated over the years, refiners and marketers who buy and blend ethanol in gasoline receive an incentive in the form of partial forgiveness of the federal fuel excise tax applicable to gasoline currently amounting to 51 cents per gallon of ethanol blended. Enacted in 1978, the federal incentive had the effect of roughly equalizing the cost of ethanol to refinery gasoline blending components, thus making ethanol an economic blending component in gasoline. Traditionally, ethanol has been sold on a long-term cash contract basis[25]. In 2005, the Chicago Board of Trade and the Chicago Mercantile Exchange offered corn-based ethanol futures contracts as an alternative means for both producers and buyers to hedge against ethanol price fluctuations.

With a projected 700 million gallons of additional ethanol production available by early 2006, the prospects for competitively-priced ethanol to sustain existing and emerging blending markets are high. In fact, current market conditions indicate an excess of ethanol with few new markets identified in 2005[26]. Absent opportunities in new reformulated gasoline or other mandated markets, excess ethanol supply will be absorbed through new discretionary blending in gasoline or as E-85 (85 percent ethanol with 15 percent gasoline) in Fuel Flexible Vehicles (FFVs). The current 71 to 81 cent per gallon discount for ethanol in California relative to wholesale non-oxygenated gasoline and CARBOB indicates excess supply of ethanol, where ethanol production is growing faster than its demand for blending into gasoline on the West Coast and other regions. Thus, current refinery blending economics are favorable to maximize ethanol blending, absent other considerations such as the need to offset higher oxides of nitrogen (NOx) emissions from greater use of ethanol when blending gasoline using CARB's predictive model.

Key Assumptions

In this analysis, the key assumptions driving increased levels of ethanol blending in CaRFG3 for Business-As-Usual and Aggressive ethanol blending scenarios include:

- The price of ethanol remains favorable relative to gasoline and gasoline blending components (e.g., alkylate) needed to make CaRFG3 through 2025[27].

- All regulatory fuels issues related to ethanol blending in California are resolved before 2010 and result in the ability of California refiners to more easily produce CARBOBs suitable for ethanol blending up to 10 percent (volume).[28]

- Ninety percent of California's gasoline market is supplied with CaRFG containing 10 percent ethanol.

- Assumes non-mandated (discretionary) blending of ethanol under a waiver from the federal oxygen-in-gasoline requirement, and creation of regional renewable fuel credit trading that may result under a federal RFS that does not appreciably impact ethanol use in California.[29]

- Existing petroleum infrastructure can accommodate an increase in ethanol movement through the system up to 10 percent ethanol with no significant additional costs through 2025.

- Delivery of ethanol from the Midwest by rail and a small increment of foreign ethanol supplies will account for most of California's needs, with an additional 200 to 400 million gallons per year provided by in-state producers by 2025.[30]

- A fuel economy loss in the California fleet of 1.3 percent in the transition year is assumed. This corresponds to the energy loss when blending ethanol at 10 percent rather than 5.7 volume percent.

Results

Table 1 displays the results of the analysis for base case (5.7 percent ethanol blending) and aggressive scenarios involving 10 percent ethanol blending to 2025. As discussed in the preceding sections, recent trends in the supply and price of ethanol make continued ethanol blending an attractive strategy before 2010, and on through 2025 subject to caveats and uncertainties discussed in the following section.

Table 1. Ethanol in California Reformulated Gasoline*

Scenario Description	2005		2025	
With GHG standard	*Ethanol Use*		*Ethanol use*	
5.7 % Blending (Base Case)	*Million Gallons*	*Percent of Gasoline Demand*	*Million Gallons*	*Percent of Gasoline Demand*
Low Price	*900*	*5.5*	*815*	*5.1*
High Price			*800*	*5.1*
Very High Price			*790*	*5.1*
10 % Blending (Aggressive)				
Low Price			*1450*	*9.0*
High Price			*1420*	*9.0*
Very High Price			*1400*	*9.0*
Without GHG standard				
5.7 % Blending (Base Case)				
Low Price	*900*	*5.5*	*977*	*5.1*
High Price			*934*	*5.1*
Very High Price			*910*	*5.1*
10 % Blending (Aggressive)				
Low Price			*1740*	*9.0*
High Price			*1660*	*9.0*
Very High Price			*1620*	*9.0*

*Ethanol volumes based on 90 percent of California's gasoline market in 2025, 97.5 percent of market in 2005.

Given the state GHG standard and Base Case ethanol blending, gasoline demand is forecast to peak in 2009-2010, and then slowly decline through 2025 resulting in a decrease in ethanol use by 2025 relative to 2005. For the high price scenario, 800 million gallons of ethanol are consumed, thus, about a 100 million gallon per year decline relative to 2005. Under the 10 percent aggressive blending scenario, ethanol use jumps to about 1.4 billion gallons per year or 9 percent of CaRFG on-road demand. This scenario would require a modest 400 million gallons of new ethanol supply over 20 years.

Without the state GHG standards, significantly higher volumes of ethanol are needed to meet the increasing on-road CaRFG demand, primarily in the aggressive scenario. For Base Case blending under the high price scenario, ethanol use is within 1 to 2 percent of 2005 demand, while aggressive blending would require just over 800 millions gallons of new ethanol supply over 20 years.

Table 2. Petroleum Reduction and Benefits for Ethanol Blends at 5 Percent Discount Rate

Petroleum Reduction and Benefits for Ethanol Blends at 5 Percent Discount Rate							
Alternative Fuel Scenario	**Displacement in 2025, Billion Gallon/Year Gasoline Equivalent**	**Reduction from Base Case Demand, Percent**	*Costs and Benefits, Present Value, 2010-2025, 5 percent discount rate, Billions $2005*				
			A	**B**	**C**	**D**	**A+B+C+D**
			Direct Non-Environmental Benefits	**Change in Government Revenue**	**Direct Environmental Net Benefit**	**External Cost of Petroleum Dependency**	**Direct Net Benefits**
E10 Blending ($1.78 per gallon gasoline)	0.50	2.6	0.0	(2.6)	2.1	0.6	0.1
E10 Blending ($1.92 per gallon gasoline)	0.49	2.6	0.0	(2.5)	2.0	0.6	0.1
E10 Blending ($2.15 per gallon gasoline)	0.48	2.6	0.0	(2.5)	2.0	0.6	0.1

Table 3. Petroleum Reduction and Benefits for Ethanol Blends at 12 Percent Discount Rate

Petroleum Reduction and Benefits for Ethanol Blends at 12 Percent Discount Rate							
Alternative Fuel Scenario	**Displacement in 2025, Billion Gallon/Year Gasoline Equivalent**	**Reduction from Base Case Demand, Percent**	*Costs and Benefits, Present Value,2010-2025, 12 percent discount rate, Billions $2005*				
			A	**B**	**C**	**D**	**A+B+C+D**
			Direct Non-Environmental Benefits -	**Change in Government Revenue**	**Direct Environmental Net Benefit**	**External Cost of Petroleum Dependency**	**Direct Net Benefits**
E10 Blending ($1.78 per gallon gasoline)	0.50	2.6	0.0	(1.3)	1.0	0.3	0.0
E10 Blending ($1.92 per gallon gasoline)	0.49	2.6	0.0	(1.3)	1.0	0.3	0.0
E10 Blending ($2.15 per gallon gasoline)	.048	2.6	0.0	(1.2)	1.0	0.3	0.1

The costs and benefits analysis in Tables 2 and 3 indicate positive Direct Net Benefits for the E-10 option relative to base case ethanol blending at 5.7 volume percent. In this analysis, consumer cost impact (Direct Non-Environmental Benefits) was set to zero implying a drop in the price of E-10 relative to E 5.7 of about 2.5 cents per gallon. Gasoline pool swelling effects would further reduce imported gasoline blending component demand and market-clearing price, thus further reducing cost impact on the consumer.[31]

Key Drivers and Uncertainties

Several outstanding issues and uncertainties could limit the potential for increased use of ethanol blending in CaRFG by 2025. However, because of minimum octane requirements, commitments and investments to date by refiners, terminal operators, independents and gasoline wholesalers, California's common carrier pipeline operator, and the railroads; and nascent investment in ethanol production; the likelihood of continuation of a significant level of ethanol blending through 2025 is likely. Some of the uncertainties and challenges are:

- The availability and price of ethanol relative to other gasoline blending components.

  Comment: The increased demand for ethanol to meet California's blending requirements is expected to raise the market-clearing price for ethanol, relative to the Base Case. No additional analysis has been performed to quantify this change. Supplies of ethanol over the forecast period are expected to be adequate to meet demand.

- The availability and price of gasoline imports.

  Comment: The increased concentration of ethanol in gasoline from 5.7 to 10 percent by volume is assumed to occur over a short period of time (less than one year). Not only will his transition increase the demand for ethanol, but at the same time, the demand for gasoline needed to blend with ethanol will decline. It is assumed that this one-year decline in gasoline demand will result in a temporary decrease of gasoline imports. Relative to the Base Case, the market-clearing price of gasoline imports is expected to temporarily decline.[32] No additional analysis has been performed to quantify this change. Supplies of gasoline imports over the forecast period are expected to be adequate to meet demand.

- Change in fuel economy.

  Comment: Increasing the concentration of ethanol in California's gasoline to 10 percent will lower energy content by 1.3 percent. As a result, motorists

would need to consume a slightly greater quantity of gasoline to travel the same distance, compared to the Base Case. Therefore, the transition from 5.7 to 10 percent ethanol blends will result in an additional one-year jump in gasoline demand of 1.3 percent above the normal forecasted demand increase. The additional increase in demand translates to an additional cost for the transition year only.

- The outcome of the CARB review and update of the Predictive Model.

  Comment: Given data in hand and recent changes in refinery operations allowing some blending at higher oxygen levels, higher level ethanol has been demonstrated using the current (1999) version of the Predictive Model. Some ethanol blending above 7 percent is now occurring in Northern California. If review and updating of the Predictive Model result in changes that show predicted emissions of NOx are not as great at higher oxygen levels, blending gasoline with ethanol at concentrations of 10 percent by volume will be easier, compared to the Base Case.

- The outcome of CARB's effort to quantify[34] the impact that permeation emissions from vehicles using CaRFG containing ethanol and identification of mitigation approaches to assure that air quality benefits of CaRFG2 are retained.

  Comment: Since CARB is obligated to preserve the air quality benefits of CaRFG achieved under Phase 2 gasoline regulations, staff believes that mitigation measures will be identified and implemented.

- The likelihood that California is granted a waiver from federal Clean Air Act oxygen requirements, in combination with a nationwide RFS with a regional credit trading option.

  Comment: A Federal Minimum Oxygen Requirement could result in a California gasoline market with a 50/50 split between non-oxygenated and ethanol blended gasoline, notwithstanding infrastructure constraints and fungibility/segregated storage issues in pipelines and terminals. This scenario would result in a decreased quantity of ethanol blended with California's gasoline, relative to today.

- The impact on ethanol price from the creation of a 200 to 400 million gallon per year in-state ethanol production industry.

  Comment: Creation of the in-state industry will provide local supplies of ethanol and could place downward pressure on the price of imported ethanol while contributing to the state's economic growth.

Endnotes

[1]Given the uncertainty of future ethanol and gasoline prices, reformulated gasoline regulations, pending federal actions regarding renewable fuels, and disposition of Congress towards extension of the federal blenders' tax credit post 2010, only qualitative discussions of confidence in projected market volumes of ethanol as a blending component in gasoline are included in this analysis. No formal risk analysis has been included.

[2] Staff Report *Forecasts of California Transportation Energy Demand, 2005-2025* Report Pub No.: 600-2005-008, April 2005.

[3] Staff Report, *Quarterly Report Concerning MTBE Use in California Gasoline* July 1 through September 30, 2000, Report to the Legislature, Report No. P300-00-005v3, November 2000. http://www.energy.ca.gov/mtbe/documents/2000-12_MTBE_3RD_QTR_REPORT.PDF.

[4] Staff Report *Quarterly Report Concerning MTBE Use in California Gasoline* October 1 through December 30, 2003, Report to the Legislature, Report Pub. No.: P300-03-001v4, February 2004. http://www.energy.ca.gov/mtbe/documents/2003_MTBE_4TH_QTR_REPORT.PDF.

[5] Personal communication with Steve Brisby, May 16, 2005.

[6] U.S.E.P.A. link to NAAQS for ozone is http://www.epa.gov/air/criteria.html. Oxygen requirements in federal gasoline regulations that are applicable to all states not in compliance with the NAAQS for ozone can be found at http://www.epa.gov/otaq/rfg.htm.

[7] Since CARB gasoline regulations are permissive with regard to the oxygen content in gasoline, it is assumed that refiners would choose to blend ethanol at "economic levels," meaning that the availability and costs of gasoline blending components would determine the oxygen content. The national renewable fuel standard (RFS currently envisioned by Congress would mandate renewable fuels (e.g., ethanol and biodiesel) to be used at increasing volumes to the year 2013. Credit trading would allow companies to meet their obligations by buying and/or selling RFS credits with/ without producing or selling renewable fuels.

[8] Staff recognizes that the outcome of California's request for waiver from the CAA oxygen in gasoline requirement could have a large influence on the use of ethanol in future years. However, staff assumes that CARBOB movement to terminals, CaRFG3 distribution (including inability to use California's common carrier pipeline system) and a lack of segregated storage at terminals constrains refiners, distributors and independent marketers from offering multiple CARBOBs or non-oxygenated CaRFG and a single CARBOB for ethanol blending. The exception to this is that some refiner's may choose to offer some non-oxygenated gasoline or RFG at their refinery truck racks or proprietary terminals (with direct pipeline link) when blending economics are favorable.

[9] Summary of 2004 taxable gasoline sales provided by the California Board of Equalization (with the exception of the month of December). December 2004 gasoline volume sales are estimated based on gasoline sales trends for the months of November and December in prior years.

[10] CEC Petroleum Industry Information Reporting Act (PIIRA) database.

[11] Staff assumed that refiners blended ethanol at between 5.8 and 5.9 volume percent to assure compliance with the federal minimum 2 percent weight oxygen requirement (5.7 volume percent ethanol). Staff used 5.7 percent (volume) ethanol blending for all projections in the Business as Usual Scenario.

[12] The most important factor leading to almost exclusive production of CARBOB for ethanol blending in 2004 was the transition process from multiple grades of two different California reformulated

gasolines (CaRFG2 with MTBE and CaRFG3 with ethanol) in the petroleum pipeline, storage, and retail distribution infrastructure. The complexity of adding a third non-oxygenated CaRFG in the transition process would have overwhelmed segregated storage capacity at terminals and pipeline delivery capability. California refineries are also limited in their ability to store three different CaRFGs or CARBOBs prior to scheduled shipments in the common carrier (Kinder Morgan) pipeline system.

[13] Over time, staff has assumed that refiners will begin to produce a third non-oxygenated CaRFG (to replace CaRFG2) but that the volume of this additional "flavor" of gasoline will be limited because of segregated storage and related infrastructure issues as well as limitations imposed on the practice due to CARBOB trading obligations between refiners. Staff assumes that this practice may largely manifest itself as distribution from refinery truck racks or proprietary petroleum products terminals, but that it will never exceed ten percent of California's gasoline demand. Non-oxygenated CaRFG can be moved through the pipeline system.

[14] California Energy Commission Petroleum Industry Information Reporting Act (PIIRA) data base.

[15] Burlington Northern Santa Fe Railroad (BNSFR), http://www.thesoydaily.com/BiodieselBiobased/bnsf10012004.asp

[16] Union Pacific Railroad, http://www.uprr.com/customers/ag-prod/faq.shtml

[17] According to BNSF sources, current deliveries of ethanol to southern California represent only 2 percent of the rail traffic in the region, and they do not anticipate problems in delivering adequate ethanol to meet needs in the future. Union Pacific Railroad advertises their commitment to adequate service to meet the needs of ethanol clients in California.

[18] Staff estimate based on review of existing construction projects as summarized by the Renewable Fuels Association and BBI international. http://www.ethanolrfa.org/eth_prod_fac.html and http://www.bbiethanol.com/plant_production/

[19] See http://www.energy.ca.gov/reports/2003-10-21_600-03-017F.PDF Energy Commission staff updated its survey in August, 2004.

[20] In 2004, five plants in Iowa, two in Nebraska, two in Wisconsin, and one each in Illinois and South Dakota began production. Average capacity of these plants was just under 40 million gallons per year. In 2005, average capacity for 14 plants coming on line by year end is estimated to be the same, though one plant at 110 million gallons per year capacity will be the largest dry mill in the U.S. when it starts producing ethanol.

[21] In 2004, discretionary blending (as opposed to mandatory blending under federal or state regulations) amounted to 29 percent of all ethanol blended in gasoline in the United States. Refinery economics, free market competition, and the price of ethanol drive this type of blending. When trends in ethanol prices are low and/or gasoline blending component prices are high, opportunities for new "discretionary blending" markets materialize. Many of these markets are in Midwest states where incentives are provided either for blending ethanol into gasoline or for ethanol production (producer's incentive).

[22] Production of CARBOB for 10 percent ethanol blending is not feasible using the current version of California's Predictive Model (PM). Limited ethanol blending at 7.7 percent is possible. Staff is aware of two California refiners who have the ability to produce a complying CARBOB for this higher level of ethanol blending. Staff has confirmed that one refiner in northern California is currently blending and distributing 7.7 percent ethanol CaRFG from the refinery truck rack in full compliance with CARB California reformulated gasoline requirements. In 2005, CARB staff will be updating the PM to include emissions data from 1999 - 2005 model year vehicles as well as other needed updates. CARB staff will make additional changes as well and establish criteria defining "preservation of Air Quality

benefits" as required by SB 989 (Sher, 1999). This updating process of the PM may provide additional flexibility for refiners to blend at higher ethanol concentrations (up to 10 percent by volume).

[23] Staff has found that the new dry mills being constructed in the Midwest typically have the ability to produce at 105 to 120 percent of design capacity relatively soon after plant start-up. (for example, see Broin Inc. plant performance statistics: http://www.broin.com/partners.asp)

[24] California gasoline prices are the highest among all regions of the continental U.S. http://www.eia.doe.gov/oil_gas/petroleum/data_publications/wrgp/mogas_home_page.html. Given the price of CaRFG relative to other U.S. markets, California RFG represents the highest value market for ethanol blending in the U.S., with perhaps the exception a few low gasoline demand states with mandated ethanol use and generous state incentives. Incremental ethanol production capacity that comes on-line in the future is likely to find California the most attractive market through 2025, if CaRFG retains its position as the highest priced gasoline in the U.S. for most of the next 20 years.

[25] Typical contracts for ethanol between Midwest producers and California clients come in several forms. They are either indexed to CaRFG spot wholesale prices, to NYMEX gasoline prices, or come at a fixed price. Ethanol prices under these types of contracts are typically at a discount to gasoline ranging anywhere from 20 to 80 cents after taking the federal fuel excise tax credit into consideration. Typically, the contract is six months in duration roughly corresponding to winter and summer gasoline specifications in California's ozone non-attainment regions. Ethanol contract prices closely follow spot ethanol market trends and can be compared with gasoline blending component prices; See http://www.energy.ca.gov/gasoline/graphs/component_prices.html. This price chart shows ethanol at a 37 cent discount to CARBOB, on average, in 2004. The relative ethanol price advantage in early 2005 has risen to 80 cents as a result of a steep upward trend in CARBOB price combined with a declining ethanol price. Ethanol contracts indexed to the NYMEX were at minus (-10) cents per gallon in early 2005 (personal communication with a California wholesale ethanol broker, March 1, 2005).

[26] With CaRFG spot prices at a premium of 10 to 20 cents over New York RFG in February and March of 2005, the resultant price advantage for a California blender of ethanol in gasoline can be seen to be 51 (federal fuel excise tax forgiveness) + 10 (10 cent discounted contract price indexed to NYMEX) + 10 or 20 cents (differential between CaRFG and NYMEX RFG) = 71 to 81 cents. Should this price differential persist, new discretionary blending is expected, or in mandated markets such as California's, blending above 5.7 percent may emerge to absorb some of the excess supply.

[26] Ethanol marketers have advised Energy Commission staff that ethanol has rarely been priced at the full value of the federal excise tax incentive (as high as 53 cents; in 2005 it is 51 cents) in typical indexed contracts. If ethanol was fully valued by refiners/blenders at gasoline value, then an indexed contract would include a + 51 cent adder, the value of the excise tax credit in 2005.

[27] These activities include updating California's Predictive Model by CARB staff, successful identification of measures that mitigate permeation emissions associated with ethanol use in CaRFG3, specification changes or creation of a California Phase 4 (CaRFG4) gasoline the generates additional air quality benefits, and actions that assure retention of air quality benefits achieved with CaRFG2 as required by SB 989 (Sher, 1999).

[28]California's request for a waiver from the oxygen provisions of the Clean Air Act, and enactment of a national RFS requirement could impact the degree of ethanol blending in future years. According to recent modeling using a generic California refinery model, an oxygen waiver could provide an opportunity for a 50/50 split of non-oxygenated and oxygenated in the CaRFG market based on refinery economics and certain assumptions about the price of ethanol and competing hydrocarbon (gasoline) blending components, however, the report author cautioned that the model can "over-optimize" since it does not capture individual refinery capabilities and octane position, and limitations within California's petroleum products delivery infrastructure. Thus, staff assumes these factors lead

to continued use of ethanol at 90 percent of the gasoline market through 2025. Source: “Analysis of the Production of California Phase 3 Reformulated Gasoline With and Without an Oxygen Waiver,” MathPro Inc., prepared for the U.S. EPA, Contract EPA P.O. 0W-2026-NASX, January 19, 2001.

[29] Assumes capital investments by the railroads to improve service to California will be recovered in their freight rate structures in future years. However, rates for ethanol delivery are anticipated to continue on a downward trend as additional efficiencies are realized with higher ethanol volumes, and general capital improvement projects system wide.

[30] While potential gasoline pool swelling in a California refinery has not been verified through use of a generic California refinery model, staff believes that swelling up to 1 percent may be possible as a result of dilution effects, additional octane and possibly other effects associated with increased ethanol use beyond 5.7 percent blending.

[31] “Market-clearing price” is phrase common in economics referring to a price that causes supply and demand to be equal.

[32] At the November 18, 2004, hearing of the Air Resources Board, CARB staff acknowledged responsibility to return to the Board in about a year with optional measures to offset the effects of permeation emissions, as required by law. Staff formally reviewed the findings of the Coordinating Research Council’s Permeation study, and acknowledged that analysis would be required to “find an appropriate temporal and spatial distribution of emissions” based on vehicle activity and fuel temperature data. See CARB transcript at www.arb.ca.gov/board/mt/mt111804.txt, pages 120-129.