G A O
Accountability * Integrity * Reliability

United States General Accounting Office
Washington, DC 20548

February 27, 2002

The Honorable Dianne Feinstein
United States Senate

Subject: U.S. Ethanol Market: MTBE Ban in California

Dear Senator Feinstein:

In response to your request, we obtained information on (1) U.S. ethanol consumption, supply, and prices, as well as factors that could potentially contribute to ethanol price spikes in California, and (2) the structure of the U.S. ethanol market and conditions that could conceptually affect competition. On February 22, 2002, we briefed your staff on the results of our analysis. The enclosed slides formed the basis of the briefing we presented.

The 1990 amendments to the Clean Air Act (CAA) requires that an additive (oxygenate) be added to the gasoline used in areas with excessive carbon monoxide or ozone pollution to help mitigate these conditions. The CAA specifically requires those areas with "severe" ozone pollution to use reformulated gasoline, which contains at least 2 percent oxygen by weight. In California, like most other areas of the country, oil refining companies predominantly use the oxygenate methyl tertiary butyl ether (MTBE) to meet the CAA requirement. However, because MTBE has been detected in ground water, the governor of California issued an executive order in March 1999 to ban MTBE in the state's gasoline by the end of 2002.

In summary, if California decides to use ethanol to replace MTBE, ethanol production capacity from 2003 through 2005 could likely satisfy U.S. consumption, according to available ethanol industry projections. However, if other states also banned MTBE and moved to ethanol, consumption could increase significantly and potentially affect the industry's ability to meet demand. Moreover, production capacity projections could be overstated because they include not only existing plants and plants under construction, but also new plants being planned, which may or may not materialize. According to our analysis of average monthly data from 1993 through May 1998 (the latest data available), U.S. ethanol prices generally ranged from $1 to $1.20 per gallon. While prices have been relatively stable to this point, ethanol price spikes could occur in California if supplies were disrupted by either production or distribution problems. Structurally, the U.S. ethanol industry is currently highly concentrated, as measured by the Herfindahl-Hirschman Index (HHI), a standard measure of market concentration. According to the guidelines of the Federal Trade Commission and the

U.S. Department of Justice, an HHI above 1800 is highly concentrated. Our analysis of January 2002 data from the Renewable Fuels Association shows that the U.S. ethanol industry's HHI is 1866. According to economic theory, while high market concentration could conceptually limit competition in an industry, this factor alone is not necessarily sufficient to determine competitiveness of an industry. In addition to market concentration, competition in the ethanol market could conceptually be affected by the interaction of a variety of other factors, including the cost of initial investment and the availability of substitute products.

Please note that information on future ethanol consumption and supply contained in this report reflects the potential implications of the proposed ban on MTBE in California by the end of 2002. We did not examine the potential impacts of switching to ethanol on California's gasoline market or on U.S. corn prices, both of which could ultimately be affected by the MTBE ban.

This quick snapshot of the industry, based largely on data from other federal agencies and industry sources, does not allow us to draw conclusions or predict with accuracy the ethanol industry's capability to meet changing demands. As agreed earlier, we will work with your staff to address any remaining questions you may have.

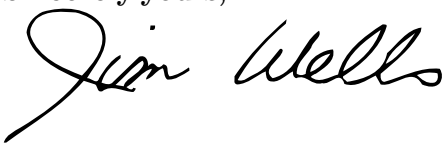
We discuss our methodology in the enclosed slides. We provided portions of the statistical information to the relevant federal agencies from which we obtained data and they reviewed and verified the data. We performed our work in February 2002 in accordance with generally accepted government auditing standards.

- - - - -

As agreed with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 7 days after the date of this letter. At that time, we will send copies to interested Members of Congress. This letter will also be available on GAO's home page at http://www.gao.gov.

If you have any questions about this letter or need additional information, please call me at (202) 512-3841. Major contributors to this letter included Godwin Agbara, John Furutani, Mike Hartnett, John Karikari, Mehrzad Nadji, Barbara El Osta, Amy Stewart, and Lynn Wasielewski.

Sincerely yours,



Jim Wells
Director, Natural Resources
and Environment

Enclosure

U.S. Ethanol Market: MTBE Ban in California

Briefing for Senator Feinstein's Office

February 22, 2002

Objectives, Scope, and Methodology

- Objectives
  (1) To what extent would ethanol supplies be available to satisfy consumption if California bans MTBE after 2002, and what factors could potentially contribute to ethanol price spikes in California?

  (2) What is the current structure of the U.S. ethanol market and what conditions could conceptually affect competition in the ethanol market?

- Scope
  - Review focuses on ethanol market and does not analyze impact on gasoline or corn markets, both of which could ultimately be affected by the MTBE ban and replacement with ethanol as an oxygenate.

- Methodology
  (1) Interviewed officials, reviewed relevant documents, and analyzed data from the ethanol industry and trade organizations, consulting firm, petroleum industry, fuel-transportation industry, DOE/EIA, USDA, DOT, CRS, the California Energy Commission (CEC). We also estimated future U.S. and California ethanol consumption because we did not find projections reflecting the MTBE ban in California for this period.

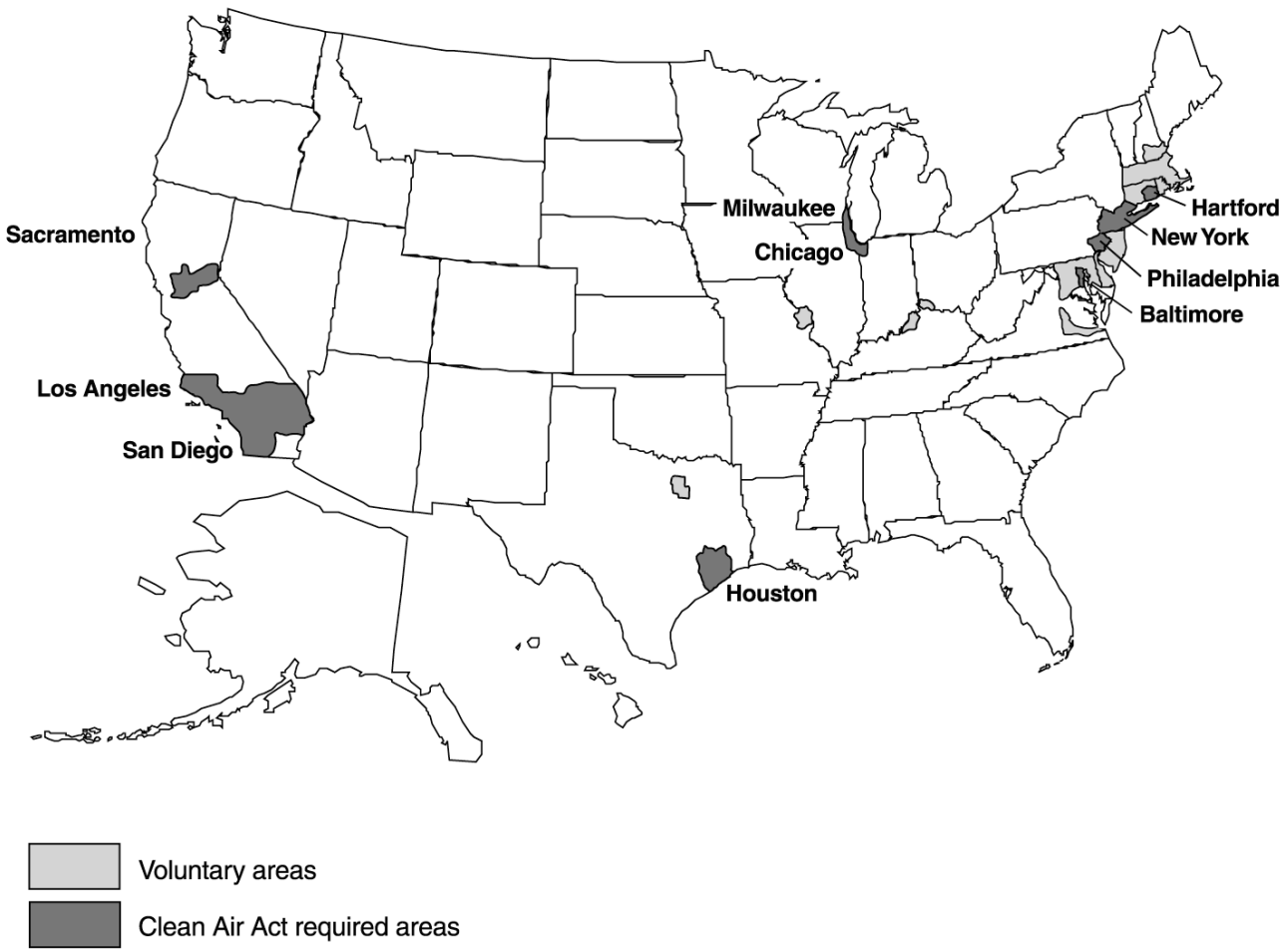
  (2) Reviewed relevant economic literature and interviewed officials from the ethanol and petroleum industries as well as academia.

  - We verified portions of the statistical information with relevant federal agencies.

Background

- The 1990 amendments to the Clean Air Act (CAA) requires that an additive (oxygenate) be added to the gasoline used in areas with excessive carbon monoxide or ozone pollution to help mitigate these conditions.
- The CAA specifically requires those areas with “severe” ozone pollution to use reformulated gasoline, which contains at least 2 percent oxygen by weight.
- In addition, several areas have voluntarily chosen to use reformulated gasoline to help achieve their clean air goals.

Figure 1: Reformulated Gasoline Program Areas



Source: U.S. Environmental Protection Agency.

Background

- Under the CAA, about 80 percent of the gasoline used in California would require oxygenate by 2003.[1]
- In California, like most other affected areas of the country, oil refining companies predominantly use the oxygenate methyl tertiary butyl ether (MBTE) to meet the CAA requirement.[2]
- Because MTBE has been detected in ground water, the governor of California issued an executive order in March 1999 to ban MTBE in the state's gasoline by the end of 2002.

[1]California already uses a special gasoline formulation, called California Air Resources Board gasoline (CARB), that is more stringent than the federally mandated specifications.

[2]MTBE is a chemical compound that is manufactured by the chemical reaction of methanol and isobutylene. MTBE is produced in very large quantities (over 200,000 barrels per day in the U.S. in 1999) and is almost exclusively used as a fuel additive in motor gasoline.

.

Background

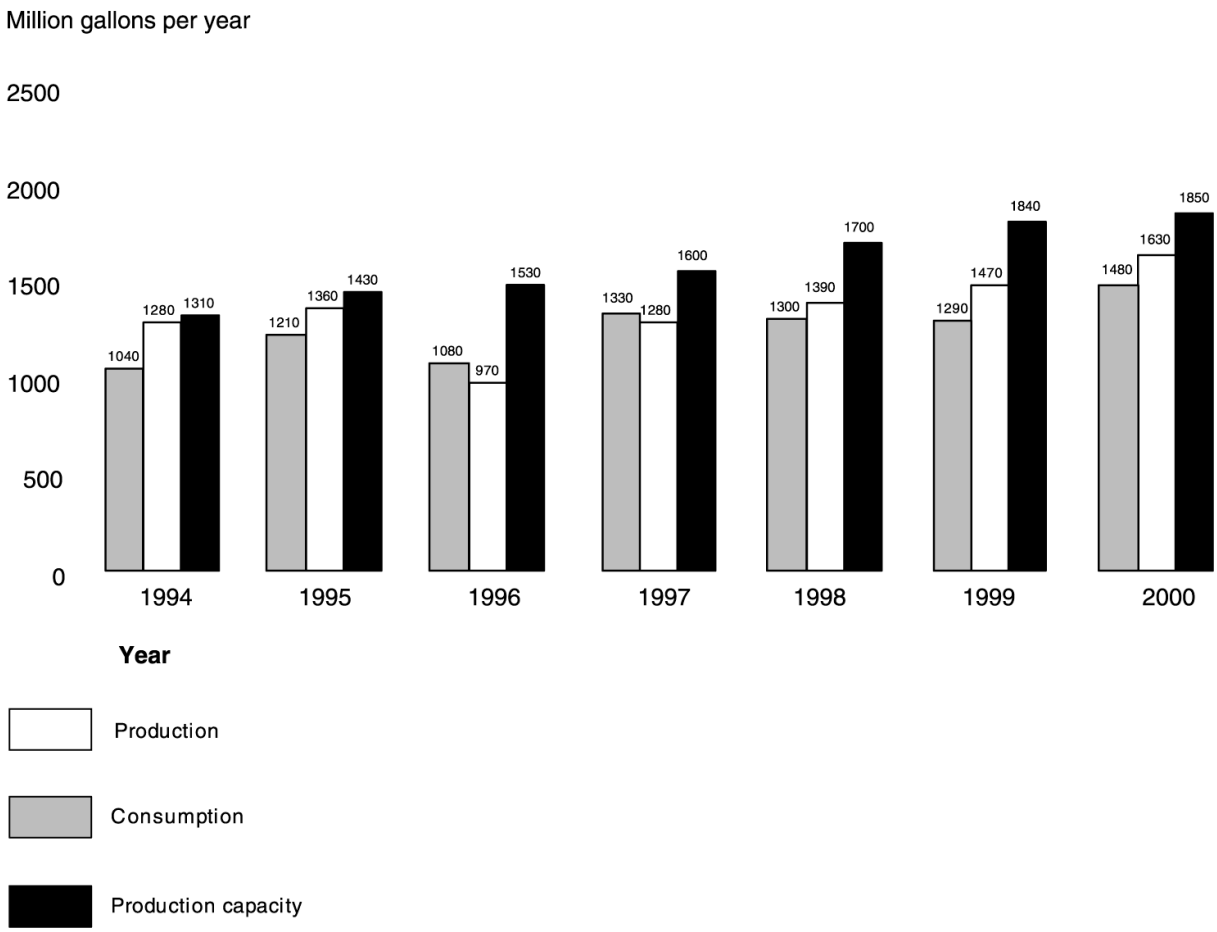
- According to oil industry officials, ethanol, which is primarily produced and used in the Midwest, is expected to become the predominant oxygenate used if the ban goes into effect.
- Other areas of the country where MTBE is currently used may subsequently eliminate MTBE, as recommended by a blue-ribbon panel commissioned by the U.S. EPA.
- In addition to its use as a gasoline oxygenate, other fuel-related uses of ethanol in the U.S. include use as: a gasohol blend, an octane booster, and, to a smaller extent, a straight fuel for ethanol-fueled vehicles.[3]

[3]Gasohol is a motor fuel that is blended with up to 10 percent ethanol and 90 percent gasoline. Octane in gasoline helps to improve the combustion properties of the fuel.

Ethanol Consumption, Supply, and Price

- U.S. ethanol supply, historically mostly from domestic production, has been generally sufficient to satisfy consumption.
- While consumption increased from about 1,040 million gallons per year (mg/y) in 1994 to about 1,480 mg/y in 2000, domestic production increased from about 1,280 mg/y to about 1,630 mg/y. On average, domestic production exceeded consumption in 5 of the 7 years.
- Moreover, data on production capacity—the combined quantity of ethanol that all existing U.S. plants would be capable of producing–show producers could have produced more during that period, if needed. Production capacity exceeded both consumption and production for each of the 7 years from 1994 to 2000.

Figure 2: U.S. Ethanol Consumption, Production, and Production Capacity (1994-2000)



Note: Production capacity numbers are not necessarily as of the end of the year.

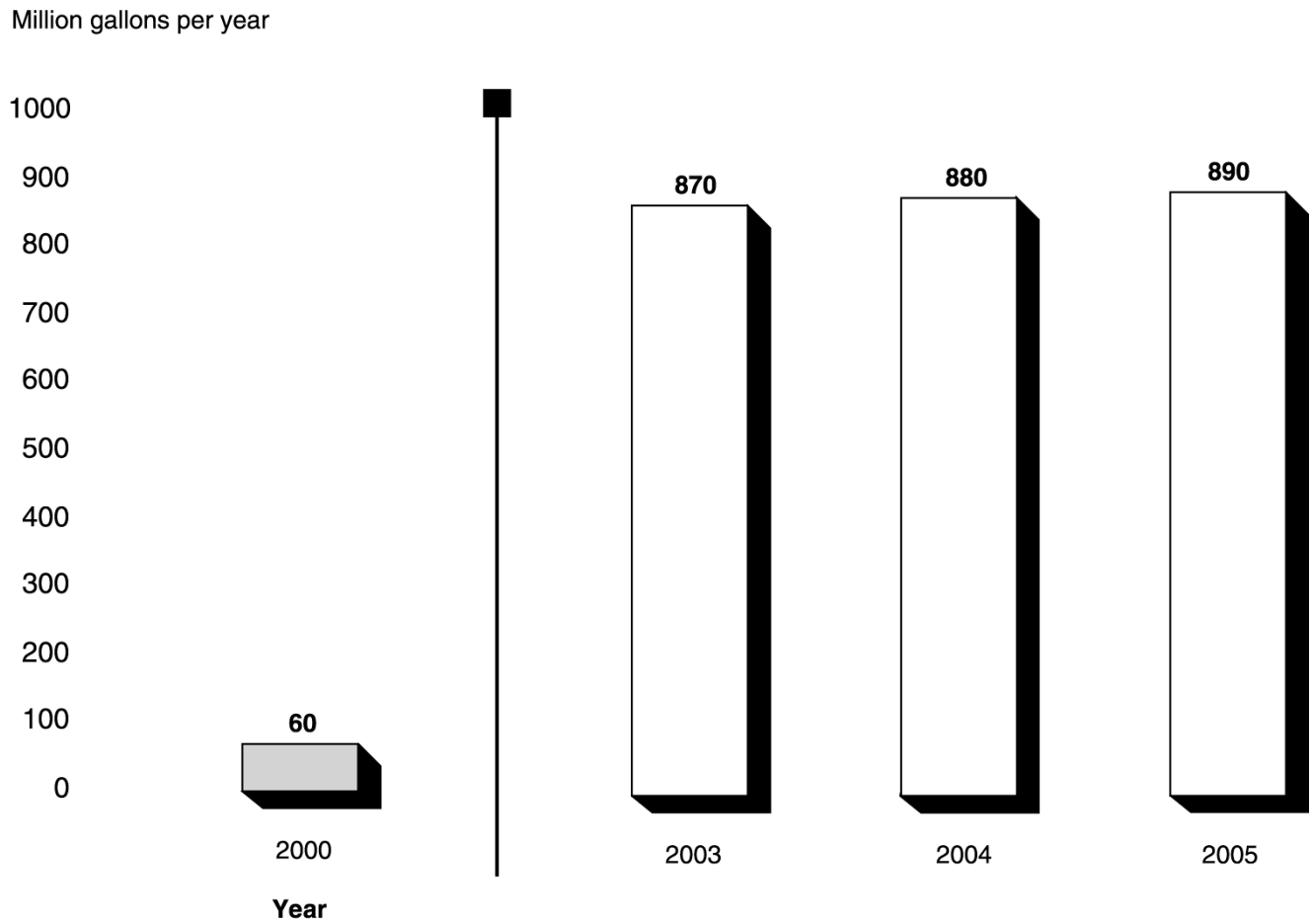
Sources: U.S. Department of Transportation, U.S. Department of Agriculture, and BBI International.

Ethanol Consumption, Supply, and Price

California Consumption

- Banning MTBE in California and switching to ethanol by the end of 2002 would result in significant increases of ethanol consumption in California.
- We estimate, based on its projected gasoline consumption, that California would consume an average of about 880 mg/y of ethanol from 2003 through 2005, as compared with only about 60mg/y in 2000.[4]

Figure 3: California Ethanol Consumption (2000, 2003-2005)



Sources: U.S. Department of Transportation and GAO estimates.

[4] California's ethanol consumption projections are based on historical and an annual growth of 1.1 percent for gasoline (using data from 1990 to 2000) and 5.7 percent volume of ethanol requirement.

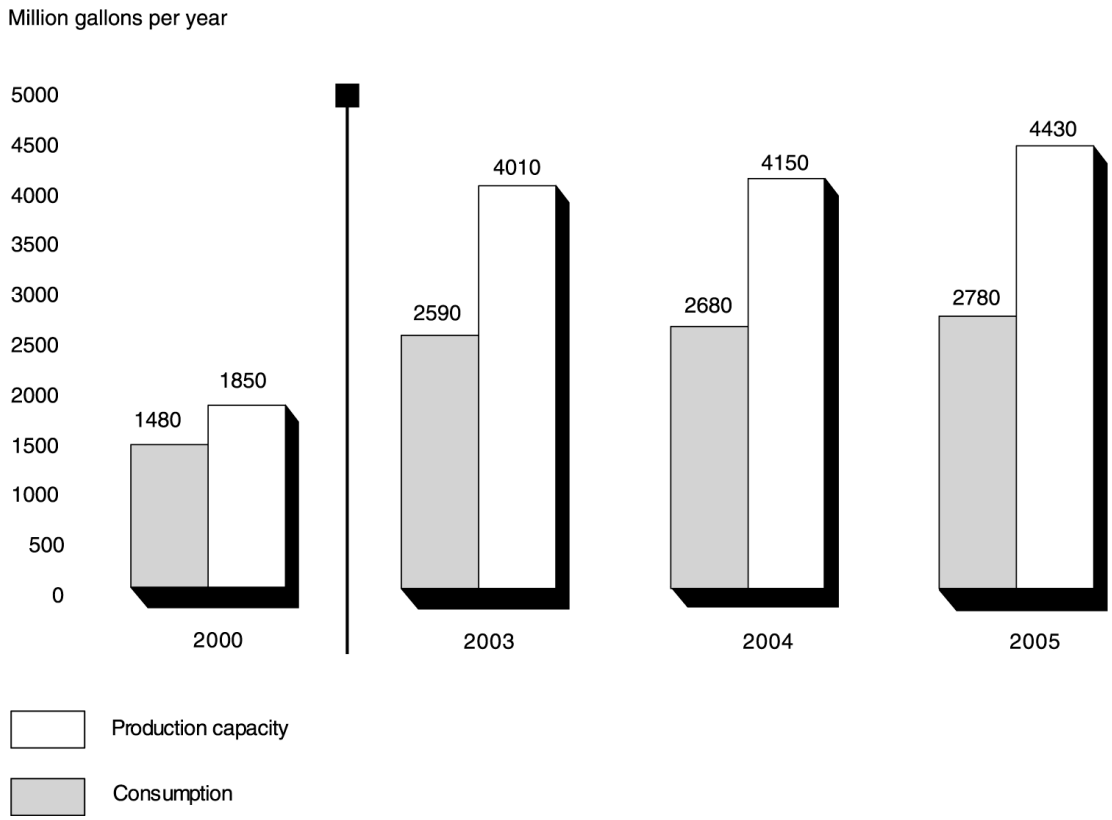
Ethanol Consumption, Supply, and Price

U.S. Market

- We estimate aggregate U.S. consumption of ethanol would increase under the ban from about 1,480 mg/y in 2000 to about 2,780 mg/y in 2005.[5]

- Although a 2001 survey by the California Energy Commission (CEC) showed that domestic ethanol producers could build up significant capacity that far exceeds the projected consumption between 2003 and 2005, there are some major caveats.[6]

Figure 4: U.S. Ethanol Consumption and Production Capacity (2000, 2003-2005)



Sources: U.S. Department of Transportation, California Energy Commission, BBI International, and GAO estimates.

[5] U.S. ethanol consumption projections are based on historical and an annual growth rate of 5.1 percent of ethanol for the rest of the U.S., excluding California (using data from 1993 to 2000), plus the projections for California's ethanol consumption.

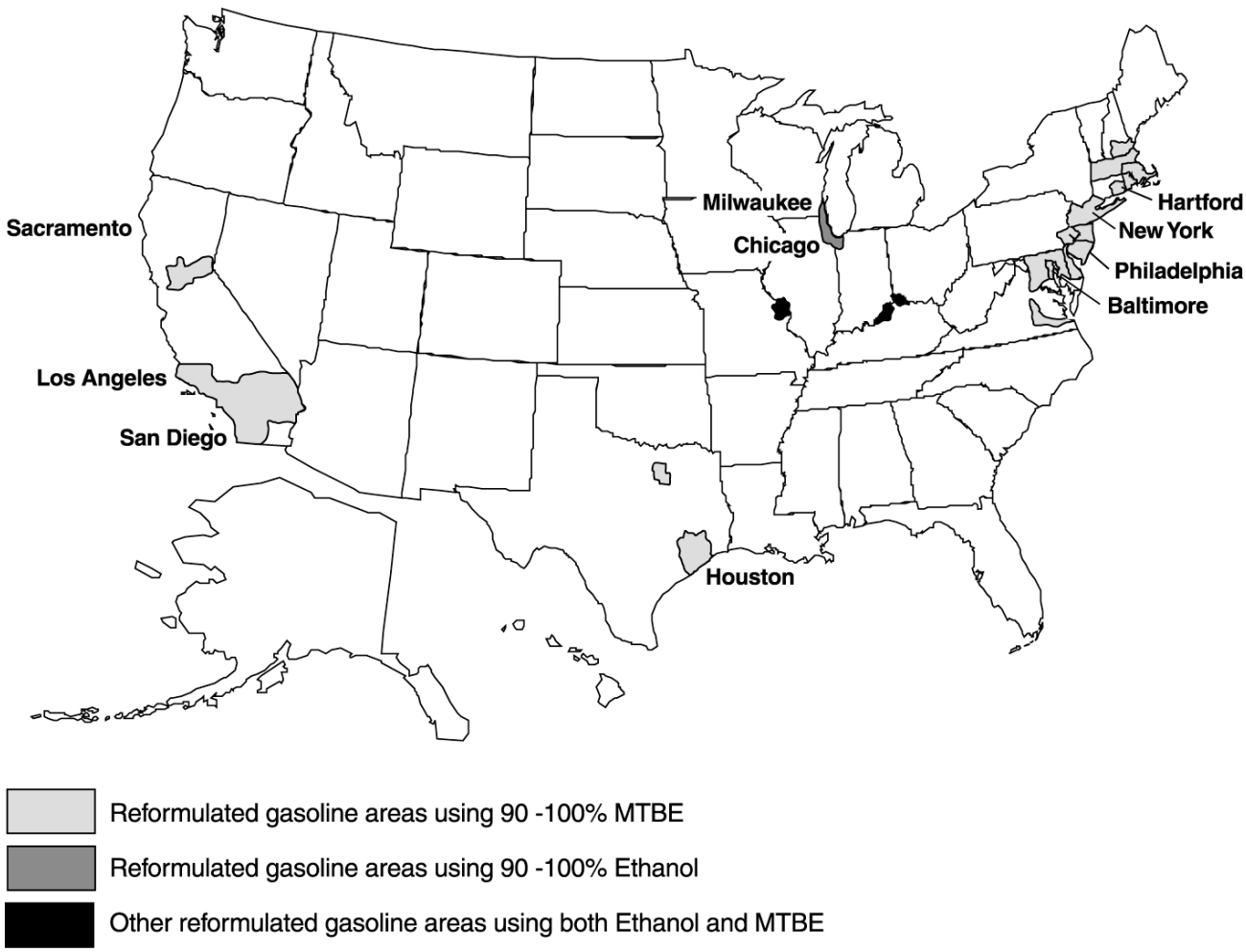
[6] According to the CEC, the results of this survey, including the production capacity projections, represent the most complete inventory of current and likely near-term U.S. ethanol producers available as of August 2001.

Ethanol Consumption, Supply, and Price

Caveats

- Consumption projections assume that only California would ban MTBE and switch to ethanol during 2003 through 2005. If other states also ban MTBE and switch to ethanol, U.S. ethanol consumption could be significantly higher.

Figure 5. Oxygenate Use in Reformulated Gasoline Areas (2000)



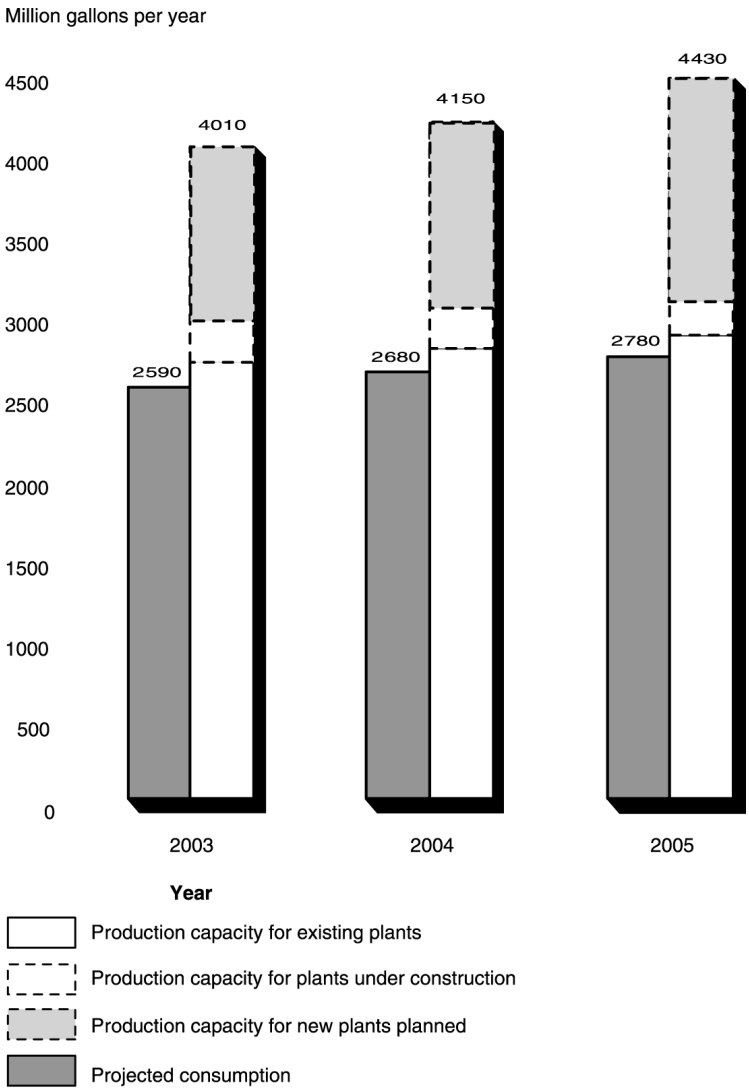
Source: U.S. Environmental Protection Agency.

Ethanol Consumption, Supply, and Price

Caveats (cont.)

- Projected production capacity includes existing plants, those under construction or new plants planned. Projected capacity may be lower if some existing plants cease production, plants under construction do not come on line in time, or some new plants planned do not materialize.

Figure 6: Ethanol Consumption and Existing and Future Production Capacity (2003-2005)



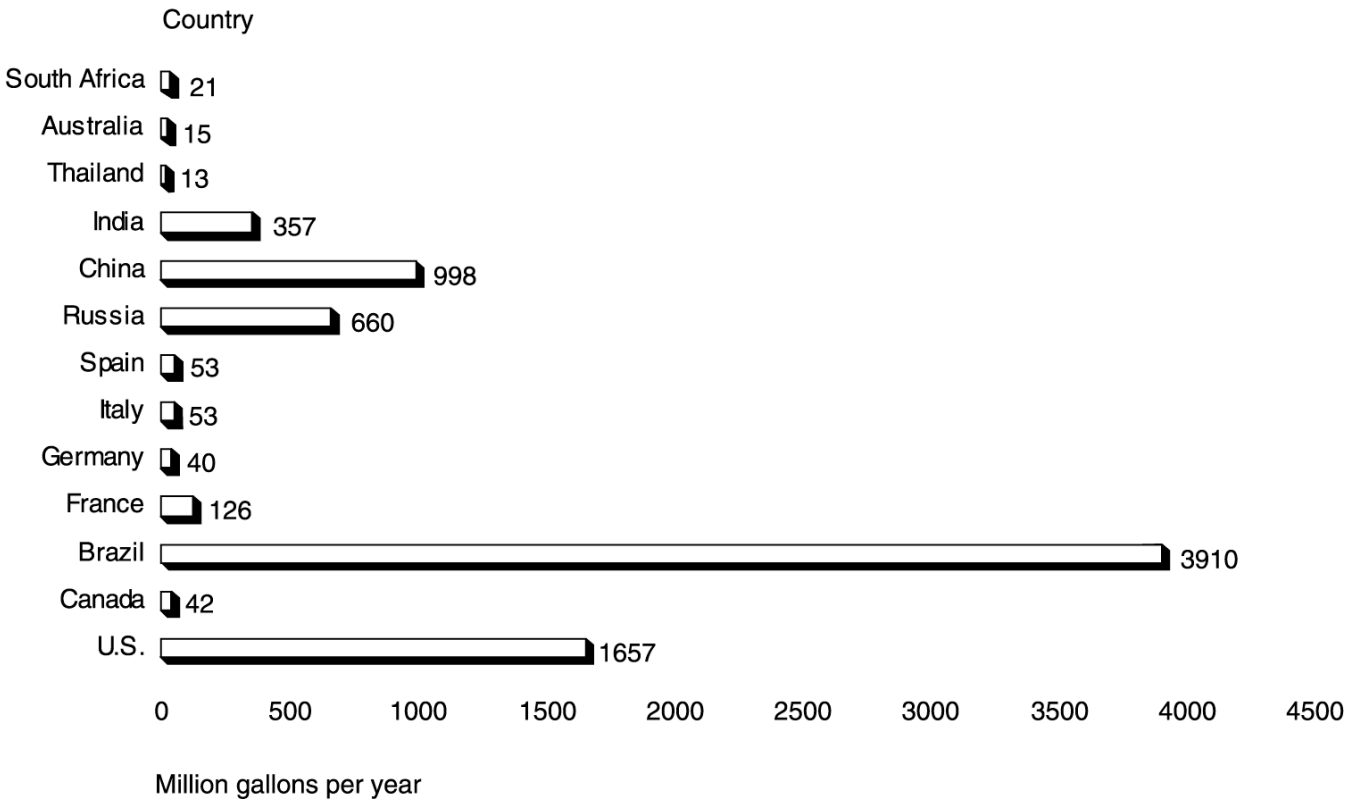
Sources: U.S. Department of Transportation, California Energy Commission, and GAO estimates.

Ethanol Consumption, Supply, and Price

Caveats (cont.)

- The future role of imports is unclear.
  - Currently, ethanol imports do not play a significant role in U.S. ethanol supplies.
  - Brazil is the world's largest producer of ethanol, but about 85 percent of its production capacity cannot be exported.
  - The U.S. generally has a 54 cents/gallon tariff, which discourages ethanol imports.

Figure 7: World Ethanol Production (1998)

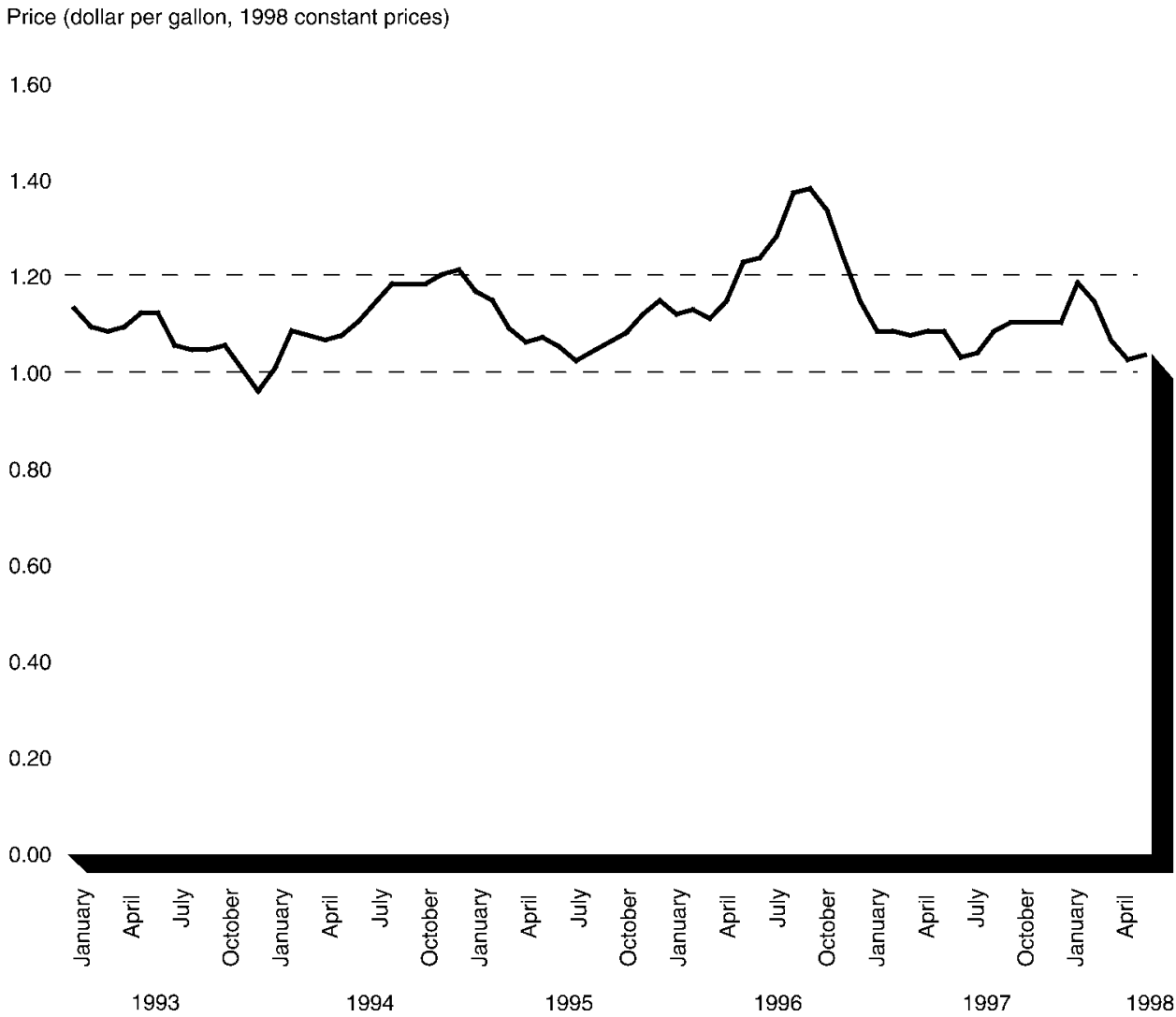


Source: California Energy Commission.

Ethanol Consumption, Supply, and Price

- Based on average monthly data from January 1993 through May 1998 (the last year we found data on U.S. ethanol price), the U.S. ethanol price has been generally stable, staying approximately within the range of $1.00 to $1.20 per gallon, except during a period in 1996 when it exceeded this range.[7]

Figure 8: U.S. Ethanol Prices (January 1993 through May 1998)



Source: California Energy Commission.

[7]According to an agricultural economist at USDA whom we interviewed, ethanol prices spiked during this period because of production declines caused mostly by unusually sharp increases in the price of corn, which is a major input into ethanol production.

Factors That Could Potentially Contribute to Ethanol Price Spikes in California

- While difficult to predict with certainty, ethanol price spikes may occur in California or elsewhere in the U.S. if a disruption at any point in the supply system causes a temporary supply shortfall relative to demand.[8]

- Oil company officials based in California who plan to use ethanol for oxygenate raised concerns about:

  - Availability of excess capacity
  - Inventory
  - Transportation

[8]There is no standard definition of price spikes. However, in a previous report—U.S. General Accounting Office, *Motor Fuels: California Gasoline Price Behavior* GAO/RCED-00-12 (Washington, DC: April 28, 2000)—we defined gasoline price spike as a price increase of at least 6 cents a gallon in a relatively short period of time—from 4 to 21 weeks.

Factors That Could Potentially Contribute to Ethanol Price Spikes in California

Availability of Excess Capacity

- In general, if sufficient excess production capacity is not available, ethanol producers may not be able to increase production to make up for disrupted supplies, a situation that could exacerbate potential price spikes.

- While officials from one oil company stated the ethanol industry has estimated that there is currently an estimated 15-20 percent excess capacity, future projected excess capacity is, in part, dependent on plans for new plants that may or may not materialize.

Factors That Could Potentially Contribute to Ethanol Price Spikes in California

Inventory

- If ethanol inventory is not sufficient to provide an immediate source of supply, it could exacerbate price spikes during supply disruptions.

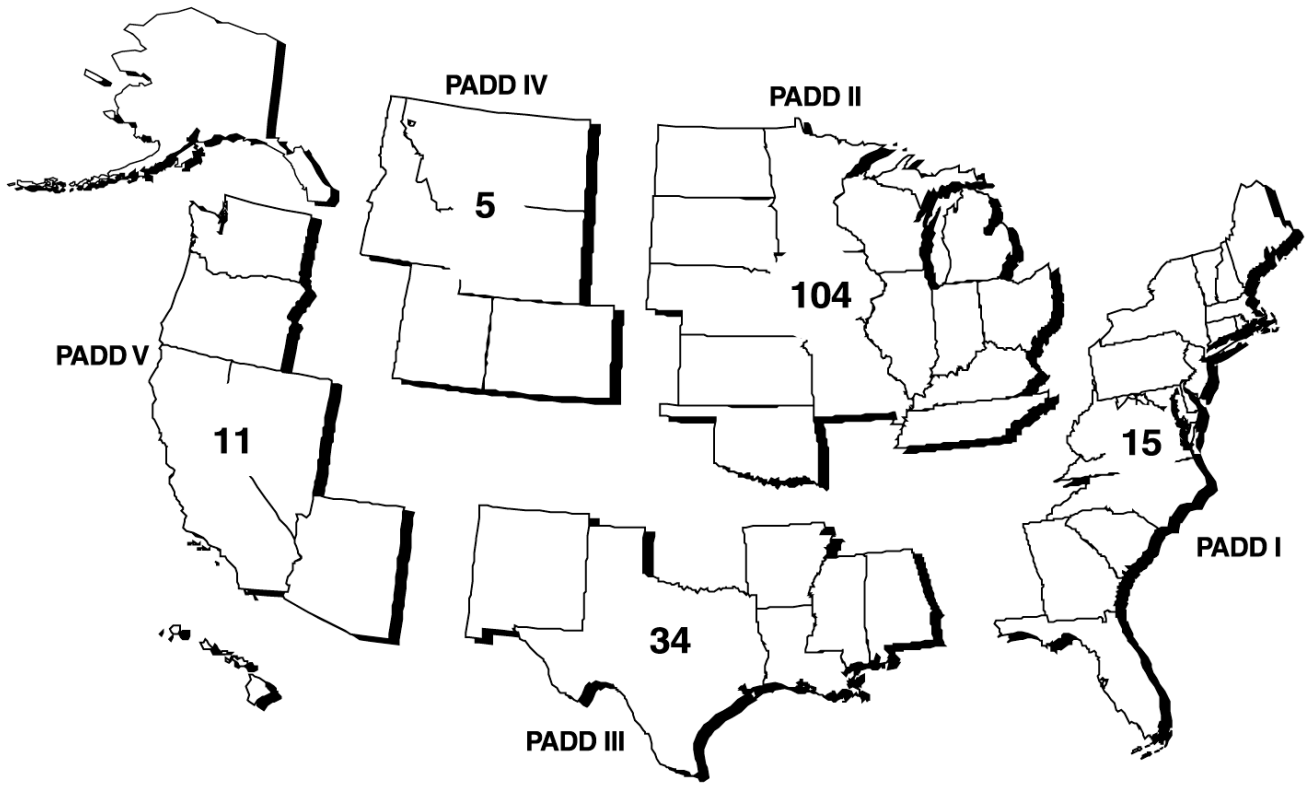
- Some officials of oil companies in California told us they plan to keep a 10-day inventory in storage but expressed concern about potential storage infrastructure constraints in California, such as scarcity of land to build storage.

Factors That Could Potentially Contribute to Ethanol Price Spikes in California

Inventory (cont.)

- About 62 percent of U.S. ethanol inventory available as of December 2001 was located in the Midwest.
- Storage in California would be more effective in helping to mitigate potential price spikes in the state than out-of-state storage because of potential delay in transit.

Figure 9: Ethanol Stocks by Petroleum Administration for Defense Districts (PADD) in Millions of Gallons (December 2001)



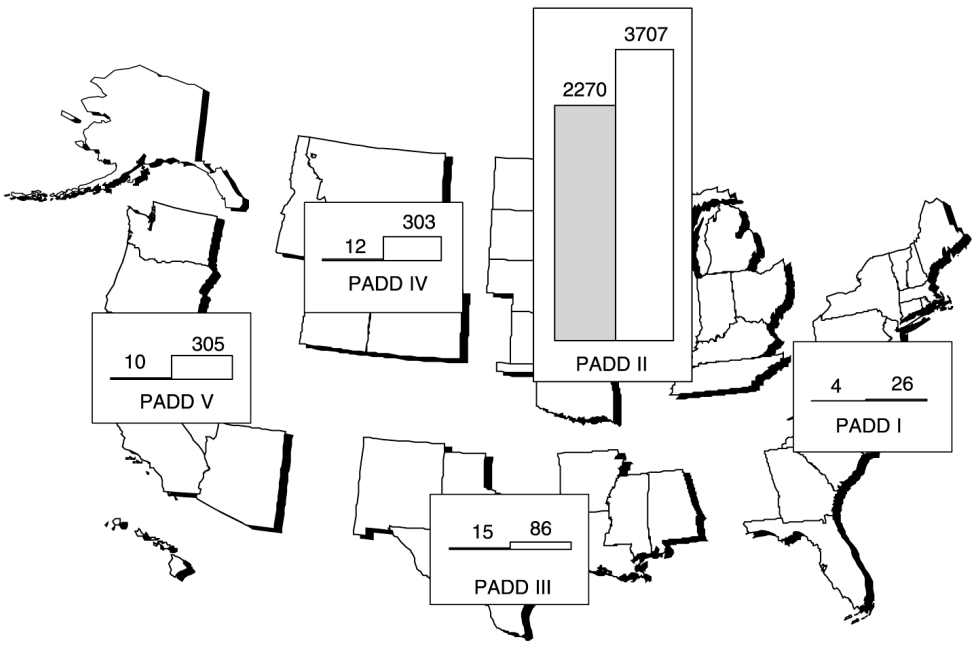
Source: U.S. Department of Energy, Energy Information Administration.

Factors That Could Potentially Contribute to Ethanol Price Spikes in California

Transportation

- Ethanol imports from other regions are vital. However, any potential price spike could be exacerbated if it takes too long for supplies from out-of-state (primarily the Midwest, where virtually all the production capacity is located) to make their way to California.[9]

Figure 10: U.S. Ethanol Plants and Production Capacity (Mg/y) by Petroleum Administration Defense Districts (PADD)[10] (2002 & 2005)



	PADD I	PADD II	PADD III	PADD IV	PADD V	Total
Existing Plants as of January 2002	1	47	1	6	3	58
Plants by the end of 2005	2	81	4	9	8	104

Production capacity by the end of 2005

Existing production capacity 2002

Sources: Renewable Fuels Association and California Energy Commission.

[9]U.S. ethanol is produced largely in the Midwest corn belt because it is generally less expensive to produce ethanol close to the feedstock supply. About 90 percent of ethanol is produced from corn.

[10]According to EIA, PADD is the geographic aggregation of the 50 states and the District of Columbia into five districts originally defined during World War II for purposes of administering oil allocation.

Factors That Could Potentially Contribute to Ethanol Price Spikes in California

Transportation (cont.)

- Inability to move ethanol quickly from areas where supplies are readily available to where it is needed would exacerbate price spikes during supply disruptions

- According to oil and ethanol industry officials whom we talked to, transportation of ethanol from the supply areas of the Midwest to California would be mostly by rail and barges, which can take about 1 to 3 weeks in transit.[11]

- While rail and barge industry officials believe that they have sufficient transportation capacity to move ethanol from the Midwest to California, some oil industry officials have raised the concern that because of Jones Act restrictions, there may not be sufficient vessels to move as much ethanol to California as may be needed during supply disruptions.[12]

[11]A pipeline would be the fastest and most economical mode of transporting ethanol, but shipping ethanol by pipeline is not feasible because of insufficient volume and technical problems associated with such shipments. Moreover, there is currently no pipeline connecting the Midwest to California.

[12]The Jones Act, 46 U.S.C., appendix 883, requires the use of American vessels to transport merchandise between points in the United States.

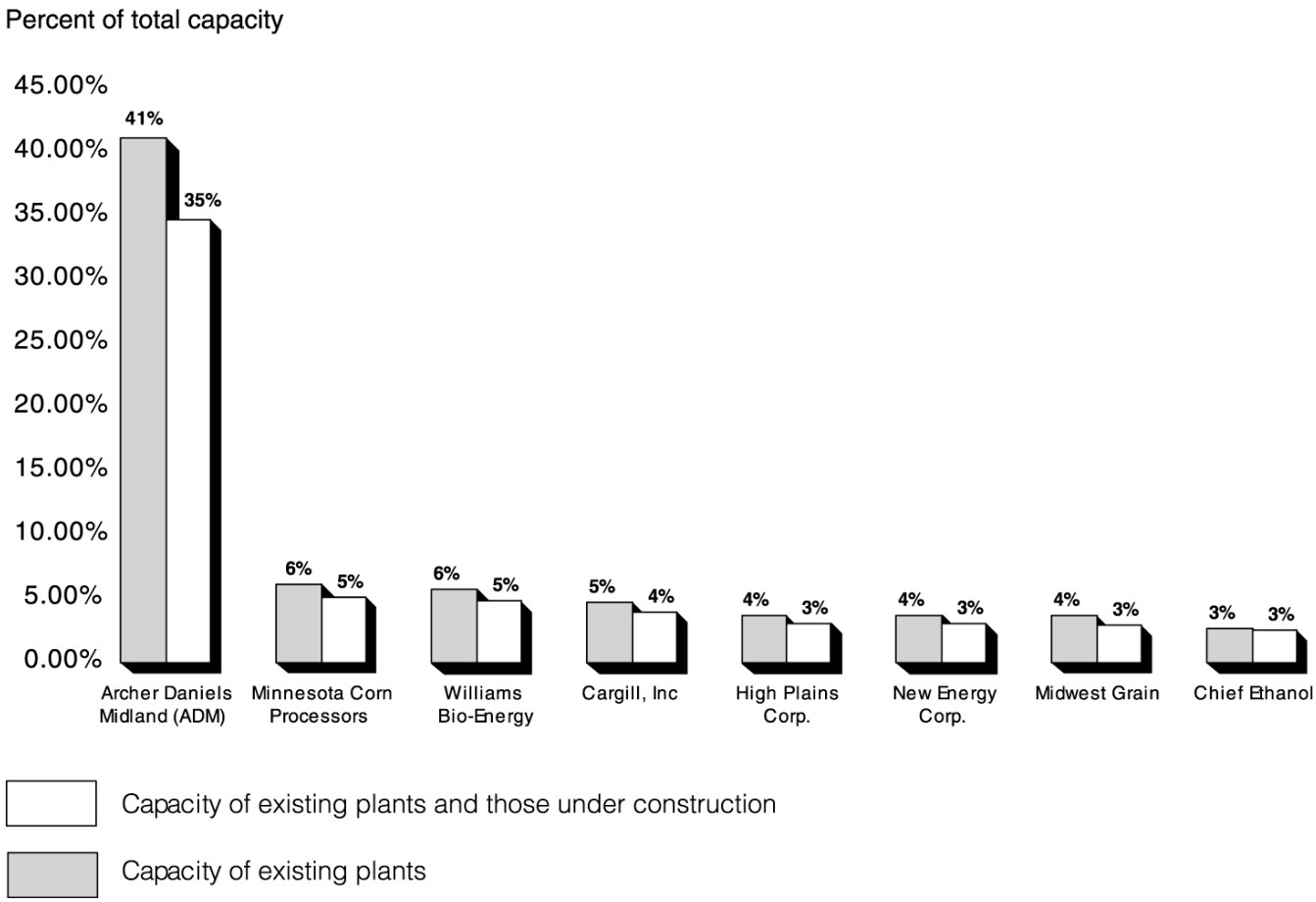
U.S Ethanol Market Structure and Conditions That Could Conceptually Affect Competition

- As of January 2002, the U.S. ethanol market consisted of:
  - 44 producers, using 58 plants in19 states, with total existing production capacity of more than 2,311 million gallons per year, and
  - 16 new producers with new plants under construction, with a total capacity of 427 million gallons per year, which will slightly lower future market shares of large incumbent firms.

U.S Ethanol Market Structure and Conditions That Could Conceptually Affect Competition

- Market share of the largest eight ethanol producers is currently 71 percent and is projected to decline to 60 percent as new producers complete new plants under construction.

Figure 11: Top Eight U.S. Ethanol Producers by Production Capacity (2002)



Note: Percentages are rounded to the nearest whole number.

Source: GAO analysis of Renewable Fuels Association data.

U.S. Ethanol Market Structure and Conditions That Could Conceptually Affect Competition

Table 1: Factors That May Enhance or Limit Competition in the U.S. Ethanol Market[a]

Conceptual Market Structure and Firms' Behavior Factors[13]	Existing Market Structure and Firms' Behavior in Ethanol Market[14, b]
Market concentration	
• Pricing coordination is easier if few firms control most of the market shares. The FTC/Justice 1992 Horizontal Merger Guidelines regard markets with an HHI (Herfindahl-Hirschman Index)[c] above 1800 as "highly concentrated."	• High industry concentration of production capacity based on these standard measures of industry concentration for 2002:[d] -- HHI = 1866 -- CR4 (Market shares of top 4 firms) = 58% -- CR8 (Market shares of top 8 firms) = 71% -- Largest firm has 41% market share
• High concentration would tend to limit competition.	• Some large producers may have partnered with smaller producers or farm coops to market the smaller producer's supplies of ethanol; thus, the concentration ratio may underestimate the actual market concentration. However, the market share of the large producers is projected to decline.

[13]The conceptual market structure and firms' behavior factors are based on economic theory. See for example, "Economics of Strategy", by David Besanko, David Dranove, and Mark Shanley (New York: John Wiley & Sons, Inc. 1996), p.376.

[14]The existing market structure and firms' behavior are based on analysis of data for ethanol producers, discussions and interviews with oil companies, relevant trade associations, other federal government agencies, and relevant economic literature.

U.S. Ethanol Market Structure and Conditions That Could Conceptually Affect Competition

Conceptual Market Structure and Firms' Behavior Factors	Existing Market Structure and Firms' Behavior in Ethanol Market
Product characteristics	
• Product substitutability – more available close substitutes for product will enhance competition.	• MTBE and ethanol are the two primary oxygenates; however, MTBE is being phased out in California. There are other oxygenates, but because of environmental concerns about some of these, the extent to which they can substitute ethanol is not clear.[e]
• Product homogeneity – When products that are supplied by different competitors are perceived by customers not to be qualitatively different competition will be enhanced.	• Ethanol products are generally homogeneous. From the customer's point of view, ethanol produced from different plants are identical. Costumers buy the products primarily based on the price.
• Switching costs – Low costs of switching to other suppliers would enhance competition.	• Some customers we interviewed indicated that switching from one ethanol vendor to another was not feasible for them. Other customers typically have contracts with multiple ethanol suppliers (about 2 to 3 suppliers) and do not incur significant costs in switching to other suppliers.

U.S. Ethanol Market Structure and Conditions That Could Conceptually Affect Competition

Conceptual Market Structure and Firms' Behavior Factors	**Existing Market Structure and Firms' Behavior in Ethanol Market**
Entry-related conditions	
• Economies of scale or scope[f] – could lower per unit costs, potentially lowering prices and discourage entry by smaller suppliers.	• One agricultural economist we interviewed stated that dry-mill plants reach economies of scale at about 30-40 million gallons per year, while wet-mill plants require about 100 million gallons per year. Dry-mill plants can be economical at a smaller scale than wet-mill plants.[g] • Firms can realize economies of scope from producing fuel-grade, beverage-grade, or industrial-grade ethanol. Production of other corn by-products together can lower per unit production costs to millers.
• Capital Costs: -- *Expansion vs. new plants* – Higher costs of new plants as opposed to expansion of existing plants discourages entries by new firms. --*Initial investment costs* – A higher initial cost of investment discourages new entry.	• Incumbent firms have a cost advantage over new entrants because an expansion costs substantially less than a new dry-mill plant. • For a dry-mill plant, the costs are estimated to be between $1.50 - $2.50 per annual gallon. A wet-mill plant can be built for about $3.00 per gallon. According to some experts, the initial capital costs of a dry-mill plant would not be prohibitive. These costs, however, do not include capital costs for distribution infrastructure.

U.S. Ethanol Market Structure and Conditions That Could Conceptually Affect Competition

Conceptual Market Structure and Firms' Behavior Factors	Existing Market Structure and Firms' Behavior in Ethanol Market
Entry-related conditions (cont.)	
• Entry time – Shorter entry time can enhance competition. According to FTC Merger Guidelines, entry time that is less than 2 years would not be a barrier to entry.	• It takes about 15 to 20 months to build a new dry mill corn ethanol plant. With available financing the time can be reduced to 1 year.
• Excess capacity – Excess capacity used as a strategy to deter entry would limit competition.	• The average capacity utilization rate in this market was about 84% over the years 1994-2000. According to the California Energy Commission, this spare capacity was concentrated among the largest producers.
• Marketing/technological barriers - Incumbents marketing or technological advantages could inhibit competition.	• Some large suppliers (e.g., ADM) have strong name recognition in the ethanol market. On the other hand, according to ethanol engineering and construction firms, there are no technical and engineering constraints to expanding ethanol construction capacity.

U.S. Ethanol Market Structure and Conditions That Could Conceptually Affect Competition

Conceptual Market Structure and Firms' Behavior Factors	Existing Market Structure and Firms' Behavior in Ethanol Market
Market rivalries	
• Uniformity of firm size - Asymmetric/different sizes of suppliers may encourage aggressive pricing behavior by some suppliers; on the other hand, it could promote tacit coordination among suppliers through price leadership.	• Based on capacity, the ethanol market has one dominant and many smaller or fringe suppliers.
• Contracting - Transaction prices based on private contracts could facilitate competitive pricing by suppliers.	• In general, ethanol market prices are based on 4-6 months contracts with terms that are not made public.

[a]This table is intended to discuss several market structure and behavioral factors as applied to the ethanol market. However, the overall competitive conditions or price implications for the U.S. ethanol market will depend on the interplay of all these factors and cannot be determined by any one factor alone.

[b]Each factor is discussed assuming all other factors as well as state and federal regulations affecting ethanol production remain the same.

[c]The Herfindahl-Hirschman index is a measure of firm concentration that describes the size-distribution or the relative importance of both small and large firms in an industry. It is defined as the sum of the squares of the market shares of the firms in an industry.

[d]Market shares are based on GAO's analysis of Renewable Fuels Association data.

[e]Although about 95% of oxygenates in gasoline consist of MTBE and ethanol, there are also other oxygenates approved for blending. These include TAME (tertiary amyl methyl ether), ETBE (ethyl tertiary butyl ether), DIPE (di-iso propyl ether), and TBA (tertiary butyl alcohol). Since the first three also contain ethers, they also, like MTBE, raise environmental concerns.

[f]Economies of scale refers to the reduction in production costs per unit as the firm size increases. Economies of scope exist when it is less costly for one firm to produce two separate products than two firms to produce them separately.

[g]There are two main production processes in the ethanol industry: wet milling and dry milling. Plants using wet milling have greater production capacities, are more capital intensive, and produce a greater variety of products than dry milling plants. The dry milling process traditionally generates only two products—ethanol and DDG, an animal feed product.

U.S Ethanol Market Structure and Conditions That Could Conceptually Affect Competition

- Other Factors That May Enhance or Limit Competition in the U. S. Ethanol Market:
  - High market power of customers relative to suppliers tends to lower the purchase price.
  - Frequent orders by customers enable rival suppliers to react faster to each others' price.
  - Volatile demand or costs make it difficult for suppliers to detect other suppliers that are offering low prices.
  - Vertical relationships by suppliers across the different production and distribution levels (e.g., between corn and ethanol productions, ethanol producers and transportation modes, etc.) could make it difficult for smaller firms to compete in the ethanol production market. On the other hand, the vertical relationships could lower costs to buyers.
  - Import competition from other international ethanol producers is limited.