ETHYL ALCOHOL AND MIXTURES THEREOF: ASSESSMENT REGARDING THE INDIGENOUS PERCENTAGE REQUIREMENTS FOR IMPORTS IN SECTION 423 OF THE TAX REFORM ACT OF 1986

Report to Congress on
Investigation No. 332-261
Under Section 332(g)
of the Tariff Act
of 1930

USITC PUBLICATION 2161

FEBRUARY 1989

United States International Trade Commission
Washington, DC 20436

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PREFACE

On September 23, 1988, the United States International Trade Commission, as required by section 1910 of the Omnibus Trade and Competitiveness Act of 1988 (P.L. 100-418),[1] instituted investigation No. 332-261, Ethyl Alcohol and Mixtures Thereof: Assessment Regarding the Indigenous Percentage Requirements for Imports in Section 423 of the Tax Reform Act of 1986, under section 332(g) of the Tariff Act of 1930 (19 U.S.C. 1332(g)). Congress directed the Commission and the Comptroller General of the United States (who is submitting a separate report) each to undertake a study of whether the definition of indigenous ethyl alcohol or mixtures thereof used in applying section 423 of the Tax Reform Act of 1986[2] is consistent with, and will contribute to the achievement of, the stated policy of Congress to encourage the economic development of the beneficiary countries under the Caribbean Basin Economic Recovery Act (CBERA) and the insular possessions of the United States through the maximum utilization of the natural resources of those countries and possessions.

Specifically, the Commission was asked for an assessment regarding whether the indigenous product percentage requirements set forth in subsection (c)(2)(B) of section 423 are economically feasible for ethyl alcohol producers; and, if that assessment is negative, to supply recommended modifications to the indigenous product percentage requirements that will ensure meaningful production and employment in the region, will discourage pass-through operations, and will not result in harm to producers of ethyl alcohol, or mixtures thereof, in the United States. Additionally the Commission was directed to provide an assessment of the effects of imports of ethyl alcohol, and mixtures thereof, from such beneficiary countries and possessions on producers of ethyl alcohol, and mixtures thereof, in the United States.

Notice of the investigation was given by posting copies of the notice of investigation at the Office of the Secretary, U.S. International Trade Commission, Washington, DC, and by publishing the notice in the *Federal Register* (53 F.R. 38794) on October 3, 1988.[3]

A public hearing on the investigation was held on October 27, 1988, at the U.S. International Trade Commission building, 500 E Street SW., Washington, DC, and all persons who requested the opportunity were permitted to appear in person or by counsel.[4] The Commission also collected data and information from responses to questionnaires sent to certain U.S. and Caribbean Basin firms that have produced fuel ethanol.[5]

In addition, information was gathered from other sources, including various public and private sources and from on-site inspection of various U.S. and Caribbean Basin production facilities.

[1] See app. A.
[2] Ibid.
[3] See app. B.
[4] A list of witnesses appearing at the hearing appears in app. C.
[5] Ethanol is another name for ethyl alcohol.

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EXECUTIVE SUMMARY

The fuel ethanol industry began in the late 1970's as a result of high prices for petroleum products, particularly motór gasoline, and U.S. Government support for alternative energy sources. Fuel ethanol from nonpetroleum agricultural sources added to motor gasoline in a 90-percent gasoline/10-percent ethanol mixture allows for a 10-percent reduction in demand for crude petroleum, and thus a possible reduction in demand for imported crude petroleum and petroleum products. A number of tax incentives and other measures were enacted to promote U.S. fuel ethanol production from agricultural sources, principally corn.

In addition to U.S. producers of corn-based fuel ethanol, Caribbean Basin producers of sugarcane and its products, notably raw sugar and molasses (and to a lesser extent, rum), were encouraged to enter the fuel ethanol industry as a way to ease their economic problems, increase employment, and reactivate fallow sugarcane fields and idle cane processing facilities. The Caribbean Basin Initiative (CBI), enacted on August 5, 1983, as the Caribbean Basin Economic Recovery Act (CBERA), provided additional incentive for Caribbean Basin nations to produce fuel ethanol[1] for the U.S. market. The establishment of the Caribbean Basin industry has, however, caused U.S. fuel ethanol producers to question the appropriateness of the domestic content requirements associated with the CBERA and the relevance of these requirements to the Caribbean Basin fuel ethanol industry. Specifically, U.S. producers have been concerned about the possibility of the CBERA being used to transship inexpensive ethanol from secondary sources, such as the European Community, through the Caribbean Basin nations to receive preferential duty treatment and exemption from the 60 cents per gallon tax on imported ethanol. In section 1910 of the Omnibus Trade and Competitiveness Act of 1988, the Commission and the Comptroller General were directed to conduct studies of the Caribbean Basin fuel ethanol industry.

The principal aspects of the fuel ethanol market that influence the feasibility of indigenous content requirements and the effects of these requirements on the Caribbean Basin and U.S. industries are highlighted below.

1. The Caribbean Basin fuel ethanol industry.

   - *The economic feasibility of Caribbean Basin fuel ethanol production from indigenous materials is strongly influenced by the trade policies of major sugar-consuming nations, domestic sugar needs, and the world price of sugar and molasses.*

Sugarcane is the major indigenous feedstock used in the production of Caribbean Basin fuel ethanol. Currently, the preferred end use for sugarcane, at any particular time, is determined by preferential trading arrangements, domestic use, and the world price of sugar. Increases in the price of sugar will usually increase the price of indigenous fuel ethanol feedstock.

For practical purposes, molasses would most likely be the indigenous feedstock for an ethanol producer not directly associated with a sugar mill. Although molasses is a byproduct of sugar manufacture, its price is determined by the supply and demand in the markets for animal feed and rum.

Since the production of large quantities of CBERA fuel ethanol from indigenous feedstock would require purchasing molasses at world prices or acquiring sugarcane that could be processed into ethanol at prices competitive with the price of sugar, developments in the sugar and molasses markets strongly affect the price of indigenous feedstock (Chapter 2).

   - *Although the Caribbean Basin nations are major producers of sugarcane, the policies of other countries tend to limit production of this primary ethanol feedstock.*

[1] Because this investigation did not find any exports to the United States of mixtures of ethanol by CBERA countries, this report will focus only on neat fuel ethanol.

The sugar industry is the largest employer and sugar is the primary export commodity for the sugar-producing nations eligible for duty-free entry of sugar into the United States under the provisions of the CBERA. However, all of these nations faced declining U.S. sugar quota allocations, as the total quota was reduced in every year between 1983, when the CBERA was enacted, and July 1988, when the overall quota was increased to just over the 1987 level. The primary use of sugarcane is sugar, while ethanol production utilized a relatively small amount of sugarcane—less than 5 percent. As these nations lost sugar sales to the United States, their primary export market, most began to diversify away from sugarcane and toward the production and exportation of other crops (Chapter 2).

- *Imported feedstocks, principally from the European Community in the form of wine-based, partially distilled hydrous ethanol, have enhanced the competitiveness of Caribbean Basin producers by lowering overall feedstock cost.*

In 1982, the European Commission provided for distillation of excess wine production in the member nations to assist the European wine industry. Since that time, a significant stock of partially distilled hydrous ethanol from the excess wine stocks has accumulated. This wine alcohol has been available for use as an inexpensive feedstock for the Caribbean producers of fuel ethanol to use in their azeotropic distillation facilities. Once it has been processed by the Caribbean Basin producers, this product could enter the United States under the CBERA exempt from the $0.60 per gallon tax placed on imports of the wine-based alcohol. The exemption, however, is allowed only if this product is blended with fuel ethanol produced from CBERA feedstock to meet the indigenous feedstock requirements (Chapter 3).

- *U.S. imports of fuel ethanol from CBI nations from 1985 through September 1988 amounted to just over 93 million gallons. Approximately 63 million gallons of these imports were produced from surplus European wine alcohol.*

U.S. imports of fuel ethanol from CBI nations have been produced from surplus European wine alcohol, sugarcane juice, and molasses. Caribbean Basin fuel ethanol producers purchased approximately 80 million gallons of surplus wine alcohol from various European nations' surplus stocks or from various private European distilleries during 1985-88. These purchases were dehydrated to produce approximately 63 million gallons of fuel ethanol, which accounted for 68 percent of U.S. imports of this product from CBI nations during this period. This volume of fuel ethanol imports accounted for no more than 4 percent of total U.S. consumption during 1985-88 (Chapter 3).

2. The U.S. fuel ethanol industry and market.

- *The potential for ethanol's expanded use in the U.S. market as an octane enhancer has been inhibited to date by both technical difficulties and cost competitiveness problems.*

Although ethanol has an octane rating about 7 percent higher than methyl tert-butyl ether (MTBE), an octane enhancer, and produces lower levels of carbon monoxide than gasoline when combusted, there are problems associated with its use. For example, ethanol's volatility presents environmental concerns and its water-absorbing qualities result in additional costs and limitations in storage and distribution.

Unlike the cost of other octane enhancers, the cost of U.S. ethanol production is dependent on the price of corn. Without existing Federal assistance to the ethanol industry, and with corn prices at $2 per bushel, crude petroleum prices would have to be at least $40 per barrel for ethanol to be a cost-competitive octane enhancer (Chapter 4).

- *Demand for fuel ethanol, which lowers carbon monoxide emissions from combustion, may increase as efforts are made to attain air quality targets specified in the Clean Air Act.*

The attractiveness of fuel ethanol as a gasoline extender has declined in an era of lower gasoline prices. Absent higher gasoline prices or lower net corn costs, increased demand for fuel ethanol currently hinges on its role as a fuel oxygenator, which can reduce emissions of carbon monoxide (Chapter 4).

- *In 1987, shipments of U.S.-produced fuel ethanol were mainly to the Midwestern States or States granting subsidies, while imports were shipped to the Gulf and Eastern Coast States. Also, prices of Caribbean and U.S.-produced fuel ethanol during 1985-87 often differed significantly in the same quarter.*

Responses to the Commission questionnaire showed that nearly 60 percent of reported shipments of U.S.-produced fuel ethanol were to Illinois, Ohio, Indiana, Michigan, and Iowa. Fuel ethanol was also shipped to 21 other States including Texas, California, Virginia, Louisiana, and Maryland. Based on Commission questionnaire responses, transportation costs from a Midwestern plant to these Coastal States ranged from 9 to 14 percent of the delivered price. In 1987, imports of CBERA fuel ethanol were shipped mainly to Louisiana, Virginia, and Maryland. During 1985-88, the prices of CBERA and U.S-produced fuel ethanol varied from each other and frequently moved in opposite directions in the same quarter, which would seem to indicate that the two products are imperfect substitutes (Chapter 4).

3. Indigenous feedstock requirements for Caribbean producers.

- *Indigenous feedstock requirements have a significant effect on the cost of production of CBI ethanol producers.*

The 30-percent indigenous feedstock requirement in effect in 1987 is estimated to have resulted in a per gallon cost of production 12 percent higher than would have resulted with only a 35-percent value-added requirement under the CBERA. In that same year, an indigenous feedstock requirement of 60 percent would have increased costs by an additional 16 percent over that with the 30-percent indigenous requirement (Chapter 5).

- *The level of U.S. imports from the Caribbean Basin fuel ethanol producers depends not only on the indigenous feedstock requirement and its feedstock costs, but on gasoline prices and U.S. net-corn prices.*

The net cost of corn for U.S. fuel ethanol producers affects their cost of production. For example, the increase in U.S. net-corn prices since 1987 has led to an approximate increase in U.S. producers' average variable cost of production from $0.61 to $0.92 per gallon of ethanol. Based on a model of the ethanol market developed by the Commission, this change alone, all other factors held constant, would have resulted in an increase of U.S. imports from CBI-eligible countries of over 14.5 million gallons per year.

As the price of gasoline falls, ethanol becomes less attractive as a gasoline extender and octane enhancer, and hence demand for ethanol declines. For example, a decline in the prices of gasoline from $0.97 to $0.92 per gallon, as happened between the last quarter of 1987 and the first quarter of 1988, all other factors being held constant, would have led to a decline in ethanol imports of about 10 million gallons annually (Chapter 5).

- *Based on the 1987 U.S. fuel ethanol market, it is estimated that increasing the indigenous feedstock level from the mandated 30 percent to a level of 60 percent would have increased employment in the CBI-ethanol industry by approximately 4,150 workers. However, this is primarily due to shifts in employment rather than to actual gains in employment.*

Changing the indigenous feedstock requirement for CBI producers does result in the reallocation of cane workers from producing cane for sugar to producing cane for ethanol. However, the ethanol industry represents only a residual share of total demand for cane production. There is not a significant effect on employment of cane workers, but rather a reallocation of cane workers (Chapter 5).

- *Under 1987 U.S. fuel market conditions for fuel ethanol, it is estimated that increasing the indigenous feedstock level from the mandated 30 percent to a level of 60 percent would have resulted in a loss to the economies of the CBI countries of over $480,000 per year, a reduction of CBI-ethanol exports of over 6.5 million gallons, and a gain to U.S. producers of $2.7 million.*

In 1987, while under a 30-percent indigenous feedstock requirement, the CBI countries exported 29.5 million gallons of fuel ethanol, valued at $28.8 million, had 11 plants in operation or planned, and employed in excess of 6,300 workers in the ethanol industry. Under recent past market conditions, a CBI-ethanol industry of comparable size would only be feasible under a feedstock requirement of 35 percent or less (Chapter 5).

- *A single indigenous feedstock requirement cannot compensate for all of the variations that occur in gasoline prices, sugar prices, European wet ethanol prices, and U.S. net corn costs.*

A fixed indigenous content requirement cannot guarantee any given level of CBI-industry production or viability. To maintain CBI-ethanol industry viability, indigenous requirements must be varied with changes in other market conditions such as net corn costs, gasoline prices, sugar prices, and European wet ethanol prices (Chapter 5).

Chapter 1

Introduction

Congressional Request

Section 1910 of the "Omnibus Trade and Competitiveness Act of 1988" (P.L. 100-418) directed the U.S. International Trade Commission and the Comptroller General of the United States to conduct studies regarding whether the definition of indigenous ethyl alcohol or mixtures thereof used in applying section 423 of the Tax Reform Act of 1986 is consistent with, and will contribute to the achievement of the stated policy of Congress to encourage economic development of beneficiary countries under the Caribbean Basin Economic Recovery Act and of the insular possessions of the United States.[1]

Section 1910 specified that the Commission and the Comptroller General make an assessment of whether indigenous content requirements (domestic content requirements) set forth in section 423 of the Tax Reform Act are economically feasible for Caribbean Basin fuel ethanol[2] producers. If the Commission or the Comptroller General finds the requirements too restrictive, it is to recommend modifications that will (1) ensure meaningful production and employment in the region, (2) discourage pass-through operations, and (3) not harm U.S. ethanol producers. The Commission and the Comptroller General are also directed to assess the effects of imports of ethanol and ethanol mixtures from CBERA-beneficiary countries on the U.S. fuel ethanol industry.[3]

Section 1910 requires that the Commission submit a report containing the findings and conclusions of the study to the Committee on Ways and Means of the House of Representatives and the Committee on Finance of the Senate no later than 180 days after the date of enactment (August 23, 1988).

Product Definitions

Ethyl alcohol (ethanol) can be produced by fermentation or by synthesis. In this investigation, only ethanol derived from fermented organic matter and used for fuel purposes is to be considered. Following the energy crises in the late 1970's, the Federal Government and many State governments initiated tax incentives to stimulate the use of ethanol produced by fermentation in gasoline. Synthetic ethanol is not eligible for U.S. tax incentives since it is not produced from organic material. Although both fermented and synthetic ethanol are chemically identical, the tax incentives offered make the two not commercially fungible.

To be used as a fuel, ethanol must be anhydrous (without water). Fermentation and simple distillation yield a product that is approximately 96 percent ethanol and 4 percent water (192 proof ethanol). The remaining water is removed in another step usually involving either azeotropic distillation or a molecular sieve. For the purpose of this report, dehydrated Caribbean ethanol refers to ethanol dehydrated by an azeotropic distillation as defined by the U.S. Customs Service in 1985.[4]

This investigation did not find mixtures of ethanol for fuel purposes (i.e., ethanol mixed with gasoline or a significant amount of denaturant) to be exported from CBERA-beneficiary countries to the United States. As a result, this report will focus only on the production and exportation of neat fuel ethanol, i.e., ethanol not mixed or diluted with other substances.

Events Preceding the Congressional Request

Following passage of the CBERA, certain companies announced their intention to build dehydration facilities in the Caribbean to dehydrate hydrous (wet) ethanol and export the anhydrous product to the United States. Fuel-grade ethanol entering the United States is subject to a tariff of 3-percent ad valorem plus 60 cents per gallon. Under provisions of the CBERA, eligible countries can export certain products to the United States duty free if the exporting country performs a "substantial transformation" and adds 35 percent to the value at the time of entry of the final product. On September 12, 1984, the U.S. Customs Service concluded that azeotropic distillation constituted a substantial transformation and that the resulting product was eligible for value-added consideration.[5]

The National Corn Growers Association and a number of domestic fuel ethanol companies contested this decision. However, the U.S. Customs Service, on November 19, 1985, ruled

[1] For this report, only the U.S. Virgin Islands is included in this study because of its specific inclusion in section 423 of the Tax Reform Act of 1986 and section 1910 of the Omnibus Trade Act of 1988.
[2] Ethanol is the more formal nomenclature for ethyl alcohol.
[3] Clarification of legislative intent and the precise information needs of the Congress were provided by Congressional staff in a meeting with Commission staff prior to initiation of the study.

[4] U.S. Customs Service letter to Mr. Juan A. Granados on January 16, 1988 (CLA-2 CO:R:CV:G).
[5] U.S. Customs letter to Michele A. Guisiana on Sept. 12, 1984, (CLA-2 CO:R:CV:V/553209 HS).

against the petition of the domestic industry, reaffirming the original Customs classification.[1] The domestic industry then brought their petition before the Court of International Trade. On December 10, 1986, the court dismissed the domestic petition as moot due to the enactment of the Tax Reform Act of 1986 (P.L. 99-514).

Section 423 of the Tax Reform Act imposed specific domestic content requirements on CBERA ethanol producers in order for their product to receive duty-free eligibility under the CBERA. The law required that during 1987 30 percent of the value of anhydrous ethanol must be derived from ethanol produced in a CBERA-eligible country. In 1988, the percent value requirement increased to 60 percent, and on January 1, 1989, the percent requirement increased to 75 percent. However, some Caribbean firms received special consideration so that the implementation of the domestic content requirements would be delayed until January 1, 1990, and allow them to produce under the less restrictive requirements set forth in the original CBERA.

Scope of the Investigation

Section 1910 provided that the study would address three separate, though related, issues. The Commission was requested to (1) determine whether the indigenous product percentage requirements set forth in subsection (c)(2)(B) of such section 423 are economically feasible for ethyl alcohol producers; and (2) if the assessment is negative, recommend modifications to the indigenous product percentage requirements that are consistent with the CBERA, will discourage pass-through operations, and will not harm domestic producers of ethyl alcohol; and (3) assess the potential effects of importing fuel ethanol under the CBERA on U.S. fuel ethanol producers. To comply with this request, the Commission collected information on costs, prices, alternatives, and outcomes. The staff also reviewed and evaluated the existing data and papers on this subject to better explain and clarify the issues that have developed. Further, the Commission developed a methodology that allows the assessment of the effect on U.S. and Caribbean fuel ethanol producers of various "indigenous feedstock requirements," given certain prices for the major ethanol feedstock.

[1] U.S. Customs letter to Stephen L. Urbanczyk, Nov. 19, 1985, (CLA-2 CO:R:CV:V/553849 HS).

As a result, the report contains, by chapter, the following information. The second chapter of the study analyzes recent developments in the Caribbean Basin sugar industry. It also discusses sugar and molasses production and trade in the CBERA countries as well as prices for these products and the effect of changes in the U.S. and EC sugar policies for sugar from this region.

The third chapter describes the Caribbean Basin fuel ethanol industry, including a review of exports to the United States, production costs, and the production process. It also presents an overview of the major countries either producing or about to produce fuel ethanol. Information concerning the size and status of two major sources of non-CBERA hydrous ethanol—partially distilled European surplus wine stock and excess Brazilian stock—is also presented.

The fourth chapter describes the U.S. fuel ethanol industry and its market, the use of ethanol-blended gasoline, and gasoline distribution and marketing in the United States. Total imports of fuel ethanol are also discussed, as well as other competing octane enhancers and future potential demand for fuel ethanol.

The fifth chapter presents the results of calculations that related the total cost and projected import quantities of CBERA fuel ethanol to various value-added definitions and various indigenous-content requirements.

This analysis of various value-added and indigenous-content requirements was conducted under the assumption that current conditions would continue into the near future. In particular, the report assumes that crude petroleum prices will remain at approximately $20 per barrel, and that agricultural feedstock (corn, sugarcane, and molasses) will fluctuate seasonally at or around their 1987-88 prices. The demand for ethanol as a fuel is assumed to grow as ethanol gains further acceptance by the gasoline marketers. The actual demand for fuel ethanol will depend on its price competitiveness, given the relative price ranges of other gasoline extenders, octane enhancers,and oxygenators, and the wholesale price of gasoline. The study does not attempt to quantify changes in demand for ethanol that would come from future mandated ethanol use or future major environmental legislation that would modify the composition of the U.S. gasoline supply.

Chapter 2

The Caribbean Basin Sugar Industry

Introduction

Sugarcane is the largest source of Caribbean Basin indigenous feedstock that can be used to make fuel-grade ethanol. Production of ethanol thus far in the Caribbean has utilized relatively small amounts of sugarcane, less than 5 percent. However, while sufficient supplies of sugarcane are available to provide feedstock for ethanol production, the local and world demand for sugar does affect Caribbean Basin ethanol producer's feedstock cost and thus the feasibility of ethanol production in the region.

The sugar industry is the largest employer and one of the top five export industries in the Caribbean Basin. The countries of interest in this study are those sugar-producing countries in the region that are eligible for duty-free entry of sugar into the United States under the CBERA of 1983.[1] Those countries are Barbados, Belize, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Panama,[2] St. Christopher-Nevis, and Trinidad-Tobago. Data will be presented for these countries for the years 1980-88 (as available), covering the inception of the most recent U.S. sugar quota program, which began in October 1982, as well as the inception of the CBI program.

Sugarcane cultivation and harvesting practices among the CBI countries range from the traditional hand-labor-intensive methods to more modern, mechanized methods. Likewise, processing facilities range from relatively modern to those last modernized in the 1950's.[3]

Production and processing costs for sugar differ widely throughout the Caribbean Basin. The Dominican Republic and St. Christopher-Nevis are two of the most efficient sugar producers in the world, and sugar is the most important commodity produced in these two countries, as well as in Belize and Barbados. Most of the sugar produced and exported from the region comes from the Dominican Republic and Guatemala. For a more detailed discussion of the sugar industry in these two countries and other CBI-eligible countries, see app. D.

This chapter will present data on sugarcane area and harvests in the Caribbean Basin, sugar production and trade, sugarcane processing facilities, molasses production and exports, and sugar and molasses prices. Finally, the current status of U.S. and European Community sugar policies affecting the region will be discussed. These factors all have a significant effect on the production of fuel-grade ethanol in this region.

Sugar Production and Trade in CBERA-Beneficiary Countries

All sugar produced in the countries of the Caribbean Basin is derived from sugarcane, a perennial plant grown in tropical regions. In the United States, sugar is produced from sugarcane in Florida, Louisiana, Texas, Hawaii, and Puerto Rico, and the remainder is produced from the sugar beet, an annual plant, grown in more temperate regions of the country (although sugar beets are also grown in Texas).

Sugarcane usually takes about 3 years to reach the first economically feasible harvest, and can be harvested for several more years from the same plants (called rattoon crops) before having to be replanted. The products derived from sugarcane include raw sugar and molasses. Several types of both products are available which differ either in degree of processing or in sugar concentration. For purposes of this discussion, the commercially important raw sugar product is centrifugal sugar, a primary product which is further refined after export into white sugar. Final (blackstrap) molasses is the important molasses byproduct.

Sugarcane production.—The total harvested area in sugarcane in the CBI-eligible countries has averaged between 1.3 million and 1.4 million acres from 1980-81 to 1987-88 (app. F, table F-1). Approximately 30 percent of the total acreage is in the Dominican Republic, whose acreage declined from 464,000 to 420,000 acres over the period. Guatemala, with about 14 percent, and Haiti, with about 10 percent, account for the next largest sugarcane acreages.

Total sugarcane production has declined from 35.5 million short tons in 1980-81 to 31.2 million in 1987-88. The Dominican Republic's production declined from 11.6 to 9.1 million short tons, whereas production in Guatemala increased from 6.1 to 7.3 million short tons. Although third highest in sugarcane growing acreage, Haiti ranks third lowest in sugarcane production, as it has the lowest sugarcane yields per acre of the CBI-eligible countries (about one-fifth of the region's average in recent years).

Sugar production.—Production of sugar by CBI-eligible countries declined from 3.3 million

[1] The current CBI legislation provides specific duty-free quotas for sugar from the Dominican Republic, Guatemala, and Panama. All other CBI-eligible countries already receive duty-free treatment under the Generalized System of Preferences. These countries can request duty-free quotas under the CBI.

[2] Panama lost its quota allocation for sugar in the United States in 1988 for political reasons. However, as it was an important supplier for most of the period under investigation, it will be discussed as a country with CBI status.

[3] *United States and European Community Sugar Policy and the Caribbean Basin Initiative*, a staff analysis prepared for Robert L. Thompson, Assistant Secretary for Economics, U.S. Department of Agriculture, April 1986, p. 9.

short tons, raw value[1], in 1980–81 to 2.9 million short tons in 1987–88 (table F–2). The Dominican Republic accounted for more than 30 percent of the total CBI sugar production throughout the period, although its production declined from 1.3 million short tons, raw value, in 1980–81 to 882,000 short tons in 1987–88. Guatemala was the second largest producer, with more than 20 percent of the total during the last three crop years.

Domestic consumption in the CBI-eligible countries increased from 1.3 million short tons, raw value, in 1980–81 to 1.6 million short tons in 1987–88. The Dominican Republic and Guatemala each accounted for about 20 percent of the total Caribbean Basin consumption.

Sugarcane processing.—In 1987, a total of 95 sugarcane mills operated in these CBI-eligible countries (table F–3). Approximately 70 percent of the mills are located in four countries—Costa Rica, Guatemala, the Dominican Republic, and El Salvador. The total daily processing capacity of the 95 mills was 305,399 short tons, and the same four countries accounted for about 70 percent of this total capacity.

Refined sugar capacity in the region is limited. Only Costa Rica, El Salvador, Haiti, and Trinidad-Tobago have such capacity. As a result, much of the region's needs for refined sugar are met by imports; refined sugar consumption in this region is generally lower than in most industrialized nations.

Sugar trade.—The United States is the most important export market for Caribbean sugar. However, the amount of sugar destined for the United States has declined due to changes in the U.S. sugar program (table F–4). For several of the CBI-eligible countries, the Soviet Union also has become an important destination for sugar. The Soviet Union historically has imported large amounts of sugar from Cuba, the largest producer in the Caribbean, but it is increasingly taking shipments of sugar from the CBI-eligible countries. For example, the Dominican Republic signed a contract with the Soviet Union in 1987 for the sale of 50,000 tons of sugar annually for 3 years at a guaranteed price.[2] The EC was another important export destination for certain of these countries.

The United States was also the primary source of imports of sugar for most of the CBI-eligible countries (table F–5). However, such imports were small and consisted of refined sugar, which is consumed only in limited amounts in the CBI countries. Most sugar consumed in the region is either noncentrifugal sugar or less refined centrifugal sugar, products not common in the United States.

Most sugar exported by these countries traditionally has been through preferential arrangements with either the United States or the EC. Any sugar not so exported enters the free market, which is a residual market for sugar. Most other countries of the world purchase their sugar from the free market. It is this sugar production for the free market that could be diverted to the production of ethanol from sugarcane.

Information on net exports to the free market shows that 9 of the CBI-eligible countries are net exporters, with the Dominican Republic and Guatemala the largest (table F–6). The net exports of the Dominican Republic declined from 874,000 short tons, raw value, in 1980 to 647,000 short tons in 1987, whereas those of Guatemala increased from 231,000 short tons, raw value, to 330,000 short tons during the same period.

Three of the previously discussed CBI-eligible countries, Haiti, Jamaica, and Trinidad-Tobago, were net importers of sugar from the free market (table F–7). Two other CBI-eligible countries, the Bahamas and Netherland Antilles, were also net importers, but were not suppliers of sugar to the U.S. market.

Molasses production and exports.—Total molasses production by CBI-eligible countries declined slightly, from 1.3 million short tons in 1982–83 to 1.2 million short tons in 1987–88 (table F–8). The Dominican Republic and Guatemala were also the largest producers of molasses, with 27 and 25 percent, respectively, of the total in 1987–88. For purposes of this study, molasses is important as an alternative raw material feedstock for ethanol production (instead of sugarcane juice), and is currently used for the production of beverage alcohol (primarily rum) in many of these countries.

Information on exports of industrial molasses, the grade most likely to be used for the production of ethanol, is only available for a few of the CBI-eligible countries (table F–9). As with molasses production, these countries, the Dominican Republic and Guatemala, were also the primary molasses exporters. Total exports of industrial molasses from the region declined during 1982–83 to 1986–87.

Sugar and Molasses Prices

Although a more detailed analysis of the effects of sugar and molasses prices—among other factors—on the feasibility of ethanol production by the CBI-eligible countries will be presented later, some historical data on these prices are

[1] The bulk of world trade is in 96-degree raw value sugar. Sugar degrees are a measure of purity determined by polariscopic test.

[2] Ralph Ives and John Hurley, *U.S. Sugar Policy;An Analysis*, U.S. Department of Commerce, International Trade Administration, April 1988, p. 54.

presented here as an introduction. The trends in sugar prices are affected significantly by the sugar policies of both the United States and the EC.

Sugar prices.—There are two separate series of prices for raw sugar. The first is world prices, which tend to reflect the overall supply and demand conditions of the world sugar market. Yearly average world prices displayed dramatic declines during 1980–82 (table F-10) as production levels increased in most of the world. World prices continued declining through 1985, then began an upward trend in 1986 that has continued through to the present. Some of this increase in price resulted from adverse weather conditions affecting levels of production, but the increase also reflects production cutbacks that occurred in many countries faced with reduced allocations of the U.S. sugar quota.

U.S. sugar prices followed the decline of world sugar prices during 1980–82, albeit at a much higher level. However, with the initiation of the most recent U.S. sugar price-support program in October 1982, prices were maintained at relatively high levels through 1988. It is this higher U.S. price, ranging from over two times to about five times the world price, that the CBI-eligible countries receive for their sugar exports to the United States. Some of these countries receive similarly high prices on their exports to the EC.

Molasses prices.—Information on molasses prices is presented here on the basis of U.S. (New Orleans, Louisiana) prices, a representative price the CBI-eligible countries would receive on their exports to the United States. During 1980–82, these prices followed the same trend as sugar prices (table F-11)—initial decline with increases in subsequent years as U.S. sugar prices stabilized. The changes in U.S. molasses prices were more dramatic than those in U.S. sugar prices.

U.S. and EC Sugar Policies

The most important aspects of EC and U.S. sugar policies with regard to the Caribbean Basin producers were the CBI program of the United States and the Lome Agreement of the EC.

U.S. sugar policy.—The main objective of U.S. sugar policy is to protect U.S. sugar producers from long periods during which world sugar prices are below U.S. production costs. Import fees, duties, and quotas are the primary tools used to maintain domestic sugar prices at levels above world equilibrium prices.

The Agriculture and Food Act of 1981 mandated price supports for raw cane sugar through the 1985–86 crop year. The annual loan rates increased from 16.75 cents per pound to 18.0 cents per pound in 1985–86. The price of sugar produced from domestically grown sugar beets was supported at such a level as determined by the Secretary of Agriculture to be fair and reasonable in relation to the loan level for raw cane sugar. Initially, the price-support program was protected with import fees and duties. However, in May 1982, when the world raw sugar price fell below 9 cents per pound, country-by-country quotas were established to protect the domestic sugar producers from the imports of cheaper foreign sugar.

Since the establishment of these quotas, sugar production in the United States has remained relatively stable, at about 5.9 million short tons. However, during 1982–87, high fructose corn sirup (HFCS) consumption increased from 3.1 million to 5.8 million short tons and sugar consumption decreased from 8.6 million to 7.6 million short tons, refined value. Thus, import quotas have been reduced to keep the supply of sugar at a level that provides a domestic price which discourages forfeitures of sugar to the Commodity Credit Corporation (CCC). The total U.S. sugar import quota was lowered from 2.654 million short tons, raw value, in 1983 to 1.001 million short tons, raw value, in 1987.

The rise in production of HFCS in the United States and the displacement of sugar by HFCS in some uses (i.e., soft drinks) has not only affected the demand for sugar, but also the supply of ethanol. The increased investment in corn milling capacity has increased U.S. capacity to produce ethanol. The steady demand for HFCS and the demand for byproducts of the corn milling process has probably lowered the average cost of ethanol in the United States.

The Food Security Act of 1985 left the major sugar provisions of the Agriculture and Food Act of 1981 generally unchanged. During the 1986–87 to 1990–91 crop years, the loan rate for raw cane sugar has been set at no less than 18.0 cents per pound. A market stabilization price (MSP), the domestic raw sugar price needed to minimize the risk of sugar forfeitures to the CCC, of about 21.5 cents per pound will be needed to defend an 18.0-cent loan rate. The loan rate is evaluated each fiscal year and can be raised by the Secretary of Agriculture if there are changes in the cost of sugar products, sugar production costs, or other circumstances affecting domestic sugar production.

The most important difference between the 1981 and 1985 Acts is that the program must now be run at no cost to the Government. That is, the President is required to use all authorities available, as necessary, to enable the Secretary of Agriculture to operate the sugar program at no cost by preventing the accumulation of sugar acquired by the CCC. The implication for the 1986–87 to 1990–91 crops is that sugar supplies from the world market will be restricted to levels that would prevent additional forfeitures of sugar to the CCC. The 1988 U.S. sugar import quota was set at 1.055 million short tons, raw value, plus 2,000 short tons of specialty sugar imports.

The most important provision of the CBI to the sugar-producing countries of the region discussed above is the duty-free entry of sugar into U.S. markets. Although most of these sugar-producing countries already received duty-free status under the Generalized System of Preferences, the CBI set new duty-free sugar quotas for the Dominican Republic, Guatemala, and Panama.[1]

Information presented in table F-12 shows the historical allocations of the U.S. sugar quota to CBI-eligible countries. As a result of the overall quota reductions, individual allocations that are made on a percentage of the quota have been reduced. The CBI-eligible countries as a group represent approximately 34 percent of the total quota in each year.

EC sugar policy.—Since 1968, the EC has had a Common Sugar Policy (CSP) system supporting the price of sugar produced in the EC within production quota limits, providing export subsidies for sugar produced within those quotas, and restricting imports through a system of variable import levies. Following the implementation of the CSP, EC sugarbeet acreage and sugar production increased substantially as growers adjusted to the production incentives (sugarcane does not grow in the EC). By the mid-1970's, the CSP had encouraged significant growth in EC sugar production and the EC became a net exporter of sugar to the world market. Both the CSP and the U.S. price-support programs are often named as being at least partially responsible for the generally low world sugar prices during the last decade.

The CSP provides for guaranteed prices and export refunds for all sugar produced within "A" and "B" quotas. The base quota "A" is approximately the amount of sugar expected to be consumed in the EC. A supplemental quota "B" is defined simply as a percentage of the "A" quota. Sugar produced in excess of these quotas is termed "C" sugar and may not be sold in the EC, nor is it eligible for export subsidies. All "A" and "B" quota sugar is assessed a coresponsibility production levy of 2 percent; "B" quota sugar is assessed an additional production levy of 39.5 percent. These production levies are used to finance export refunds. These CSP provisions expired in July 1986; however, the CSP was extended for 5 years, with these quota and price levels remaining in place for 2 years.

The CSP has been revised several times since its inception in 1968. The revisions resulted in increases in the aggregate production quota and price-support levels, and were followed by increased EC production and exports. Beginning in 1981-82, the EC modified the CSP by increasing producer levies and reducing the "B" quotas in an attempt to reduce budgetary outlays. Production and exports have declined since these modifications became effective. The extension of the CSP means that the EC will continue to be a large exporter of sugar for another 5 years.

The enlargement of the EC in 1973 (the addition of the United Kingdom, Denmark, and Ireland) substantially expanded the domestic market for EC-produced sugar, but also obligated the EC to import 1.4 million metric tons, raw value, of cane sugar annually from former commonwealth countries in the Atlantic, Caribbean, and Pacific (ACP) regions that are signatories of the Lome Agreement. This ACP sugar receives the intervention price and is not assessed production or import levies. The EC exports a corresponding tonnage of white sugar each year to the world market at world market prices. The further enlargement of the EC in 1986 (adding Spain and Portugal) also expanded EC production and consumption levels, but has not resulted in any significant changes in the CSP.

The information provided in table F-13 provides the latest available information on allotments of the EC sugar quota to CBI-eligible countries that are also eligible as ACP exporters to the EC. As the total quota amount remains stable from year to year, it is expected that these allotments from 1984 should be close to those of the present year.

[1] *Caribbean Basin Initiative*, staff analysis for Robert Thompson, USDA, April 1986, p. 1.

Chapter 3

CBERA Fuel Ethanol Industry

Introduction

This chapter describes the Caribbean Basin fuel ethanol industry, including a review of exports to the United States, a summary of the production process, estimates of production costs associated with these facilities, and summaries of the industries in the major CBI countries with fuel ethanol production capacity. The Caribbean Basin fuel ethanol industry consists of two distinct groups—hydrous ethanol dehydration facilities and full fermentation, distillation, and dehydration plants. The fermentation segment of the industry uses agricultural feedstocks, primarily sugarcane juice and molasses. The fuel ethanol industry in the Caribbean Basin began as a result of the high gasoline prices during the late 1970's and early 1980's and various U.S. Government incentives designed to promote the use of ethanol as a gasoline substitute/extender. Congress added impetus by enacting the CBERA in August 1983, which provided preferential tariff treatment to assist the development of stronger economic bases in Caribbean Basin nations.

According to industry sources, however, U.S. statutory provisions designed to encourage U.S. investment in the Caribbean area during the past few decades were subsequently repealed at the behest of U.S. domestic interests. As a result, Caribbean Basin investors have become reluctant to take advantage of any new U.S. economic incentives such as the CBERA without additional assurance that the incentives or special access will not be terminated and the facilities rendered economically non-viable.

At present, there are fermentation and dehydration facilities capable of producing fuel-grade ethanol with a total daily capacity of about 858,000 gallons of fuel ethanol in CBERA countries. Of this capacity, about 358,000 gallons is currently not operational.[1] Capacity of the plants (fermentation or dehydration) is given on a daily basis rather than an annual basis because most plants, especially the fermentation plants, operate only during the harvest season, which may last from 90 to 180 days. Even during this time, the plants run sporadically. During this investigation, it was also found that dehydration plants operated sporadically during the year.

The following table is a summary of the major fuel ethanol plants in the Caribbean Basin by country with the approximate daily capacity.[2]

[1] Compiled from Commission questionnaires and public submissions.
[2] Ibid.

Table 3-1
Major CBERA fuel ethanol plants: Name, production process, and daily capacity, by country

Country	Plant	Operational (Y/N)	Production process: Fermentation	Production process: Dehydration	Daily capacity
					(1,000 gallons)
Costa Rica	Taboga[1]	Y	X	X	42
	CATSA[1]	Y	X	X	64
	Punta Morales[1]	Y		X	64
Jamaica	Petrojam[1]	Y	X	X	156
	Tropicana[1]	Y		X	64
Bahamas	Allied Ethanol[1]	N[2]		X	130
U.S. Virgin Islands	CFC[1]	N[2]		X	156
El Salvador	El Carmen	Y	X	X	32
La Cabana		Y	X	X	32
Guatemala	El Palo Gordo	Y	X	X	46
Haiti	HASCO	N	X	X	72
Total					858

[1] Exempt from indigenous content requirements until Jan. 1, 1990.
[2] Plant not completed.

U.S. imports of fuel ethanol eligible for duty-free entry under the CBERA began in 1985. From 1985 through September 1988, CBERA imports have been less than 4 percent of U.S. consumption. During 1985–87, fuel ethanol imports from CBERA-beneficiary countries increased from 23.2 million gallons to 29.5 million gallons, as shown in the following tabulation:[1]

Year	Quantity (1,000 gallons)	Value (1,000 dollars)
1985	23,226	21,859
1986	28,563	27,669
1987	29,468	28,755
Jan.-Sept.—		
1987	20,231	19,203
1988	11,893	12,757

From 1985 through September 1988, approximately 68 percent of the fuel ethanol imported from the Caribbean Basin countries was produced from surplus wine alcohol. In 1988, U.S. imports of CBERA fuel ethanol are expected to be less than 15 million gallons. Increased production costs for CBERA producers, combined with current low wholesale gasoline prices, limited exports to the United States in 1988. Historically, CBERA exports entered the United States through East Coast, West Coast, and Gulf Coast ports. According to Commission questionnaire responses, nearly all imports of CBERA fuel ethanol in 1987 entered in Louisiana, Virginia, and Maryland.

Process Description

The Caribbean Basin ethanol industry had its origins in the rum industry. Ethanol produced for rum is fermented slowly, and the procedure is slightly modified by each distillery so that their rum has a unique flavor. The same equipment and procedures can be used to make hydrous ethanol in larger commercial quantities for nonbeverage use. The major difference for the nonbeverage producer is the need to increase the level of production to make nonbeverage hydrous ethanol production economically feasible. This is achieved by increasing the fermentation rate (thus reducing the fermentation time) and by making no attempt to distill a palatable product. The power system might also be modified depending on the energy requirements of the system.

A typical distillery using sugarcane is based on a multiprocess operation, which can be divided into five phases—feedstock (mash) preparation, mash fermentation, yeast recovery, distillation, and dehydration. For a more detailed explanation of these phases, see app. E.

[1] Data obtained from Commission questionnaires and official statistics of the U.S. Department of Commerce.

Caribbean Ethanol Production Costs

U.S. and Brazilian engineering companies have built a number of production facilities in the Caribbean Basin and some have presented to us detailed cost analyses for the operation of these plants. Once the feedstock (e.g., molasses, sugarcane juice, or hydrous ethanol) reaches a fermentation distillation unit or a dehydration unit, most onsite costs other than energy costs would be comparable for similar sized plants throughout the Caribbean Basin. The following tabulation gives representative Caribbean Basin cost estimates (cents per gallon) for operating a full fermentation plant and a dehydration plant, each with an annual capacity of 20 million gallons.[2]

Costs	Facility: Fermentation	Dehydration
Feedstock[1]	84 - 140	60 - 80
Operation[2]	30 - 42	22 - 30
Total Production[3]	114 - 182	82 - 110
Capital	10 - 15	2 - 4

[1] The fermentation feedstock cost of 84 cents per gallon assumes the world price of sugar is 6 cents per pound; while the fermentation cost of 140 cents per gallon assumes the world sugar price is 10 cents per pound.
[2] Fermentation costs include fermentation, distillation, and dehydration. Dehydration costs include rectification and dehydration.
[3] These numbers have been constructed by the Commission staff and do not reflect the production costs of any individual producer. Total production cost might not total since companies having access to low-cost feedstock do not necessarily have the lowest production cost.

Larger plants would exhibit increasing returns to scale. For a full fermentation distillation plant, the per-gallon production costs could be decreased by maximizing capacity utilization.

While the processes of fermentation, distillation, and dehydration are well understood, there are institutional and structural cost considerations that strongly influence the total cost of Caribbean Basin fuel ethanol from any particular plant. In the Caribbean Basin, there is no one overall cost of production.

Feedstock costs, whether indigenous or foreign sourced, are the highest and most variable costs in producing fuel ethanol. For example, in a study by the Sugar Industry Research Institute of Jamaica, it was shown that within Jamaica, per acre production costs of sugarcane can vary from one region to another by nearly 46 percent.[3] When using sugarcane as a feedstock, the

[2] From questionnaire responses and conversations with engineering companies familiar with the industry.
[3] Z.H. Summers, *Sugarcane Production Cost in Jamaica*, 1986 crop year.

world price of raw sugar (relative to the price of gasoline) can be considered as the opportunity cost of sugarcane. The world price of of raw sugar, however, is influenced significantly by production quotas, import quotas, weather, and environment. The world price of gasoline has also changed in recent years. During 1984–85, when sugar prices were low (3 to 4 cents per pound) and gasoline prices were high (over $1.15 per gallon) many Caribbean ethanol plants were contemplated. It was thought that it would be more profitable to use sugarcane to make ethanol than to make sugar. By the middle of 1988, the price of gasoline had fallen significantly, and the world price of sugar had increased from 4 cents per pound to between 8 and 14 cents per pound. Responses to the Commission's questionnaire indicated that the percentage of total production costs attributed to feedstocks during 1985–88 varied greatly depending upon the type or combination of feedstocks used.

Molasses, although only a byproduct of sugar manufacturing, is sold in a number of markets, such as animal feed and rum distilling. Although the price of molasses follows trends similar to the world sugar price, it is currently more directly influenced by the price of alternative animal feeds and the demand for rum. Any attempt to make large quantities of ethanol from molasses would substantially increase the price of molasses. In 1987–88, total molasses production by CBI-eligible countries was approximately 1.2 million short tons. Assuming 75 gallons of ethanol are produced from one ton of (blackstrap) molasses, then CBI-eligible countries could produce at most 90 million gallons of ethanol from indigenous molasses. However, the increased demand for molasses would substantially increase the price of molasses and limit its use as a feedstock for ethanol.

After the cost of feedstock, a second important factor is the energy needed to operate the facility. Since most distilleries in the Caribbean Basin are associated with sugar mills, they have the potential to be energy efficient through the use of waste materials for fuel during part of each year. When cane is harvested, the residual "bagasse" is processed at the mill and burned to supply all the power and steam. When the harvest season begins, commercial fuels such as oil or coal may be used to start the mill, but after that period bagasse is the major power source. In some cases, bagasse stored from a previous season may also be used. An efficient fermentation distillation unit associated with a mill could use the mill's bagasse-fueled power plant. One limitation to this approach is the fact that cane must be processed within hours of harvest, so the sugar mill operates only as long as cane is being cut. There are periods during the harvest when the plants will operate 24 hours per day. The harvest season for cane usually runs 3 to 6 months, beginning in January and extending into May or June. A company operating a fermentation-distillation facility through the year would have to buy fuel and thus incur higher fuel costs. Some mills, however, have recently installed a machine to compress and dry bagasse to lower their fuel costs and extend use of the fermentation-distillation plants. In response to the Commission's questionnaire, fermentation facilities reported that energy costs accounted for little or no percentage of overall production costs, and dehydration facilities reported that energy costs averaged 10 to 15 percent of production costs. It must also be noted that many plants operated sporadically during this period, a behavior that tends to increase their overall production costs.

A third important variable in constructing a cost estimate for Caribbean ethanol is inland transportation. A distillery located near a cane mill is not likely to be located near a port, railroad system, or modern road system. Transporting imported molasses or hydrous ethanol to the mill and the finished product from the mill to a separated dehydration plant, or to a portside storage facility, would add approximately one to two percent to overall production costs.

A fourth important consideration is the availability of offsite storage and handling facilities. A company's fixed cost would vary depending on the construction costs and type of financing used to build facilities such as portside storage tanks and loading equipment, and to obtain access to docks that service oceangoing tankers.

Country Summaries

Costa Rica.[1]—In Costa Rica, the sugar, molasses, and ethanol producers are members of the Liga Agricola Industrial de la Cana de Azucar (LAICA), a nonprofit organization that is authorized by Costa Rican law to market all the sugar, ethanol, and molasses produced in the country. The board of this organization is composed of 6 elected representatives of the industry's 21 sugar mills and 8,000 independent sugarcane growers, and 2 representatives appointed by the government. Proceeds from the sales of anhydrous ethanol, as well as all proceeds from the sales of sugar and molasses, are combined by LAICA in a common pool and then distributed to all mill owners and growers according to the content of sugar or sugar equivalence they have contributed to LAICA. In keeping with their main directive, to ensure the maintenance of a viable, social as well as financial

[1] Much of the information in this section was obtained from Commission questionnaires and from interviews with company, LAICA, and Costa Rican government officials by the Commission during inspection of Costa Rican plants.

equilibrium between mill owners and growers, LAICA has proceeded to diversify Costa Rica's surplus sugarcane production into a viable ethanol industry through financing, contracting to purchase equipment, and constructing new facilities.

There are currently three facilities in Costa Rica that are capable of producing fuel-grade ethanol (anhydrous). Two of the facilities, CATSA and Taboga, are full fermentation, distillation, and dehydration plants annexed to sugar mills, and a third, located at Punta Morales, is a dehydration plant.

There is also a government-owned distillery, Fabrica National de Licores (FNL), which has a daily production capacity of potable hydrous ethanol of approximately 11,000 gallons. However, it is not considered to be a cost efficient source of hydrous ethanol because of its relatively high production costs due to its dependence on molasses as a feedstock and fuel oil as a source of energy.

The dehydration facility at Punta Morales is owned and operated by LAICA on behalf of the mill owners and growers. It was built at their raw sugar terminal, which has a deep-water (40-ft) channel and attendant port facilities. Construction of the ethanol facility, which used Brazilian equipment and technology, was completed in June 1986, when operations began with a daily production capacity of 64,000 gallons. Included in this construction were the attendant pipelines, pumps, and day tanks, four storage tanks for anhydrous ethanol (total capacity of approximately 4 million gallons), and one storage tank for the feedstock (capacity of approximately 2 million gallons), which had a total cost of more than $6 million. Recently, LAICA decided to add a rectifying tower at the facility to process the lower quality hydrous alcohol (around 165 proof) currently available in the market, especially from Europe. The facility it is expected to be completed by February 1989 at a cost of approximtely $1.0 million.

The CATSA facility is temporarily owned by FINTRA, a holding company, until June 30, 1989, when it will be sold to Costa Rican private cooperatives. It was designed and supplied by CODASTIL (Brazil) for approximately $15 million (using the exchange rate for 1979). Construction was completed in 1979. The plant began producing fuel ethanol in 1981 and produced sporadically until 1982. The plant was shut down until 1985, when it was reopened to produce fuel ethanol for export markets. The facility has an output capacity of 64,000 gallons per day of fuel-grade ethanol. However, the plant is only operated during the Zafre, the sugarcane harvest season, which runs from January through mid-April. During this period, the plant has readily available feedstock (sugarcane juice or molasses) and energy (bagasse). The entire facility employs approximately 1,000 to 1,500 workers, of which 500 are permanent and the remainder are seasonal (cane cutters).[1] The facility is located about 130 kilometers from Punta Morales, the main terminal for sugar and alcohol exports.

The Taboga facility, located only 50 kilometers from Punta Morales, is privately owned and was built in 1985 with Brazilian (Zanini) technology and equipment at a cost of approximately $3 million. The facility has a fuel ethanol output capacity of 42,000 gallons per day. It has produced ethanol (hydrous and anhydrous) only during the harvest season in 1986 and 1988. The entire facility employs 1,700 to 2,000 workers, of which about 400 are permanent and the remainder are seasonal (cane cutters).[2] This facility has installed closed fermentation tanks to improve its yield of ethanol and machinery to dry and compress bagasse to extend its operational period . The closed tanks enable the facility to obtain 1 percent more yield by washing the carbon dioxide gas, which contains ethanol vapors. The installed machinery that uses the "Bagatex" process for drying bagasse could provide fuel for the dehydration boilers during the off season and allow the plant to produce ethanol using blackstrap molasses produced at Taboga.

In accordance with their mandate, LAICA is constantly trying new ways to increase the efficiency of these plants and maximize the return on their products for the mill owners and cane growers. As a result, LAICA has stated that they will build a large storage tank for molasses at Punta Morales to be used as a possible feedstock for their fermentation facilities. In addition, LAICA is exploring the feasibility of increasing the efficiency of the boilers at Taboga and CATSA to increase the volume of surplus bagasse, which can be then dried for use in the off season in order to continue the production of ethanol from molasses. LAICA is also experimenting with different variations of sugarcane to increase fermentable sugars and bagasse yield. Altogether, the Costa Rican sugar industry has invested more than $22 million in this diversification program and appears to be committed to it for the future.[3]

Jamaica.[4]—There are currently two companies in Jamaica that are able to dehydrate wet ethanol—Petrojam, a Jamaican corporation and Tropicana, a U.S. corporation. The Jamaican Petroleum Company (Petrojam) has

[1] Information obtained from questionnaires submitted to the Commission and submissions to the Commission.
[2] Ibid.
[3] Testimony of Mr. Anthony Hogan at the Commission hearing, Oct. 27, 1988.
[4] Much of the information here was obtained by the Commission during an official trip to this country.

two facilities with a total daily capacity of 156,000 gallons. Both are located at the company's petroleum refinery on Kingston Harbor. As a consequence, the facility has access to storage and harbor loading facilities that are already in place. If needed, Petrojam could move the smaller unit to their newly acquired mill and distillery at Bernard Lodge, which is 14 miles outside of Kingston. At present neither dehydration unit is equipped with a rectifier, which is needed to process low-quality hydrous ethanol. To date, the Petrojam dehydration facility, which employs 29 workers, has not processed any commercial quantities of surplus wine alcohol, but has used mainly hydrous ethanol from other CBI countries.

Tropicana has a dehydration unit with a capacity of 64,000 gallons per day that is also located next to a private storage depot and situated near Kingston Harbor. It rents storage and loading facilities from the depot in addition to buying its fuel from the depot to operate the plant. The facility is equipped with a rectifier and is able to process low quality hydrous ethanol. The facility has used European surplus wine alcohol as well as hydrous ethanol from CBI countries. The plant employs 35 workers and buys materials and utilities from the local market. The plant earns $10 million per year in foreign exchange for the Jamaican Government. In 1987, since all cane production was devoted to sugar, there was no acreage available for ethanol.

In addition to their dehydration facilities both companies have leased sugar estates that the Jamaican government had previously closed down. Petrojam is developing one estate, Bernard Lodge in Jamaica, and another estate in Belize. When fully operable, these two estates could cultivate approximately 12,000 acres. Bernard Lodge currently has approximately 3,000 acres under cultivation and expects to start harvesting in the 1988-89 crop year. The Lodge directly employs 600 workers and supports a number of farms that bring their cane for processing at the mill. The private farms employ approximately 1,000 workers (cutters), while the estate supports another 500 workers, who follow and support the cutters. Bernard Lodge was equipped with a mill and a fermentation distillation unit. The equipment, however, was old, and Petrojam had to invest a substantial amount of money to refurbish the mill and repair the irrigation system. Although hurricane Gilbert did not inflict structural damage to the factory, salt carried in by the winds may have damaged the plants internally. This may in turn reduce the sugar yield per ton of cane.

Tropicana also purchased a sugar estate, Duckenfield, that contained 4,000 acres and had its own sugar mill. This estate directly employs 900 workers and indirectly supports another 1,000 workers employed by private farmers. The company has invested $6 million in restoring the fields and the mill. However, the mill was directly in the path of hurricane Gilbert, and it suffered some structural damage. The crop also was soaked with salt water carried in by the winds. The estate will nevertheless begin harvesting in the 1988-89 crop year.

When fully operational such integrated fuel ethanol plants offer the best opportunity to consistently obtain feedstock below world prices. However, to produce large quantities of ethanol from CBI feedstock during 1987-88, these companies had to purchase molasses at basically the world market price. In 1988, the landed price of molasses in the Caribbean of $80.00 per ton, which is equivalent to approximately 47 cents per gallon. Molasses has a lower concentration of sugar than sugarcane juice, therefore more molasses is required to produce a gallon of ethanol. Since approximately 2.26 gallons of molasses is required to produce 1 gallon of ethanol, the cost of molasses feedstock was $1.06 per gallon of ethanol.

Even in the near future, an integrated facility might have to purchase some of its feedstock. The reasons for this are found in the social structure of cane producers and in the relation of sugarcane to the Jamaican economy.

U.S. Virgin Islands.[1]—Currently, there is no production of fuel-grade ethanol in the U.S. Virgin Islands. Chemical Fuels Corp., VI (CFC,VI), which is a subsidiary of Keller Corporation, Inc., is constructing a dehydration facility with a daily capacity of 156,000 gallons on St. Croix. As of November 1988, the plant was approximately 90 percent completed. There are also two other facilities capable of producing ethanol, a distillery (Cruzan) and a small dehydration facility. These two facilities, however, are not considered to be viable sources of anhydrous ethanol because of their higher production costs and smaller capacities. According to an official at CFC,VI, officials of the dehydration facility received an offer to purchase some of their equipment, the molecular sieves, for CFC's facility. The purchase never took place and the dehydration facility reportedly has not produced any ethanol since that time.

The facility under construction by CFC,VI on St. Croix was purchased from a Brazilian firm, Zanini, which has sold similar units to other firms in the Caribbean. The facility consists of two distillation columns and adjacent stripper columns with a small storage tank for cyclohexane and a number of daily storage tanks. The site for this

[1] The information presented in this section was obtained either from the Commission questionnaire submitted by Chemical Fuels Corp., VI or from interviews with company officials during an official trip by the Commission to the plant.

facility was leased from Martin Marietta Corp. and is located on the site of their closed alumina plant. As a result, the basic infrastructure, such as storage and port facilities, boilers, and desalinization unit, are already in place to support this operation. The firm has already refurbished two 7-million-gallon storage tanks and reactivated an oil-fired boiler and a desalinization unit.

At the present time, the firm has not decided when to begin the final phase of construction. Approximately 3 to 4 workers are employed at the site during this time. According to a company spokesman, efforts have been made to secure contracts for wet ethanol, mainly from European sources, at reasonable prices, without any success. In addition, the material available at lower prices is of such low quality and ethanol content that it must be run through a rectifier to remove impurities before it can be run through the dehydration unit. Since this facility does not have a rectifier, a decision must be made to either add a new column or modify one of the existing columns. This decision could add about 14 cents per gallon to their production costs, which would further increase the price of their anhydrous ethanol.

Because of these reasons, the future of this project remains unclear. According to the firm's spokesman, the dehydration facility was to begin operating as soon as it was completed and thus generate sufficient capital to build the full fermentation unit, which would use raw material (e.g., sugarcane juice or molasses) from CBI countries. This would result in increased employment at the plant.

Bahamas.[1]—The fuel ethanol plant currently under construction on Grand Bahama Island by Allied Ethanol was designed and is being built under the supervision of Butler Research International. The principals involved in this plant to be owned and operated by Allied Ethanol include Burton Josephs of Minneapolis, Minnesota and Burt Turner of Baton Rouge, Louisiana. In addition, there are Jamaican-origin interests in Allied Ethanol who have not as yet made their identities known. These Jamaicans had originally planned to construct this fuel ethanol facility in Jamaica; however, other interests were able to amass the necessary capital to build the second Jamaican fuel ethanol facility in Jamaica before the financing for the Allied Ethanol plant was completed.

The facility with a daily capacity of 134,000 gallons is located on the south end of Grand Bahama Island and consisted in 1988 of a complete azeotropic distillation unit and three incomplete storage tanks. In their condition at that time, it would take approximately 16 weeks for those tanks to be completed once the construction work was restarted.

The facility itself sits on land leased fro South Riding Point Holding Limited (SRPHL), a holding company that operates a small, deep-water harbor facility at the south end of Grand Bahama Island. Allied Ethanol has arranged for the SRPHL facility to obtain and provide potable water, electricity, and all other necessities of operation, as there is no infrastructure available at that location on Grand Bahama Island. SPRHL has also arranged to provide Allied Ethanol with the necessary port facilities to handle exports of fuel ethanol, as well as any imports of wet ethanol to be used as feedstock for the distillation facility. The port currently handles operations of the Burma Oil Co., also now owned by a holding company, BURMPAC.

The Allied Ethanol facility was supposed to have been completed and brought onstream January 1, 1988. However, a disagreement with the subcontractor engaged to construct the three storage tanks for the ethanol has remained unresolved. Several industry sources have stated that they believe there will be no resolution of this problem until the question of domestic content is resolved in the U.S. Congress and Allied Ethanol is assured that the plant will be able to function profitably. At least initially facility would be strictly an azeotr dehydration plant.

Other countries.—In addition to the Caribbean Basin fuel ethanol plants grandfathered under the existing congressional legislation, there are facilities capable of producing anhydrous ethanol in El Salvador and Guatemala. El Salvador is reported to have progressed the most in developing a fuel ethanol industry.[2] The first fuel ethanol facility built in El Salvador was completed in 1983 at the El Carmen Sugar Mill, with a capacity of approximately 16,000 gallons per day. The capacity at this facility has recently been increased to approximately 32,000 gallons per day. In addition, the construction of three other facilities culminating with the recent initiation of a new facility at La Cabana Sugar Mill with a capacity of approximately 32,000 gallons per day, would bring the Salvadoran fuel ethanol capacity up to 96,000 gallons per day.[3] Despite this continuous increase in capacity, problems with U.S. quotas for sugar, reduced availability of molasses, aprolonged drought during 1987, and construction work being done at various facilities all contributed to declining fuel ethanol output

[1] Information presented here was obtained by the Commission on an official trip to this country.

[1] Memorandum from Fransico Arechega, industry expert, to Eric Vaughn, President of the Renewable Fuels Association, dated Nov. 11, 1988; submitted a an appendix to the post-hearing brief of the Renewabl Fuels Association.
[2] Ibid.

during 1987.[1] It is expected that El Salvador will pass legislation pertaining to a national alcohol fuel policy by the end of 1989. Once this legislation is approved, it is expected that most of their fuel ethanol production will be consumed domestically.

Guatemala is the largest producer of cane sugar in Central America, with 19 functioning sugar mills, but has thus far not actively embraced a policy of encouraging the development of a fuel ethanol industry. Of the 19 sugar mills, only one has the ability to produce ethanol. The El Palo Gordo Sugar Mill has a full fermentation facility that came onstream during 1987 with a capacity of about 46,000 gallons per day. This plant has available the longest number of days of operation of any plant located in Central America, approximately 180 days per year. At full capacity, which rarely occurs in the fuel ethanol industry, this plant can produce about 8 million gallons of fuel ethanol per year.[2] According to industry sources, the El Palo Gordo facility is privately owned and, as a result, ethanol is produced to maintain the owner's options and maximize profits. This country has the possibility of greatly increasing its fuel ethanol capacity if given sufficient incentive and clear policies from the Guatemalan and U.S. Governments.

There have been sales of hydrous ethanol from Guatemala to the Costa Rican firm LAICA (within the requirements of the CBERA domestic content requirement that the fuel ethanol be produced from Caribbean sources),[3] reportedly so that Costa Rican sugarcane could be used to produce sugar instead of being diverted from sugar production to be processed in the fermentation plant for fuel ethanol. These sales were made despite the reportedly high price paid by the Costa Rican fuel ethanol producers for the hydrous ethanol because of the increase in the market price obtained by the Costa Ricans for their sugar.

Honduras currently does not have any fuel ethanol plants, although there are eight operating sugar mills. Although the Government of Honduras does not have a policy regarding fuel ethanol as in Guatemala, there is ample sugar production to support a fuel ethanol industry.[4]

In Haiti, a privately-owned sugar processor is planning to restart its ethanol production in early 1989. The Haitian American Sugar Company (HASCO) has a three-year old fermentation plant with a daily capacity of 36,000 gallons and an additional dehydration unit with a daily capacity of 36,000 gallons to upgrade hydrous ethanol. It is doubtful, however, that fuel ethanol will be exported to the United States soon because of the current requirements. Efforts are underway to use gasohol in the Haitian market.[5]

[1] Ibid.
[2] Ibid.
[3] Written response from Mr. Hogan, Hogan & Company, Inc.
[4] Ibid.

Alternative Sources of Wet Ethanol

European wine alcohol.—The primary feedstock used by the Caribbean ethanol industry to produce the nonindigenous portion of their fuel ethanol for export to the United States has been surplus European wine alcohol, the European "wine lake." This resource, consisting of distilled wine and wine "must,"[6] originated as a consequence of the European Community's efforts to "stabilize (wine) markets and ensure a fair standard of living for the agricultural community."[7] In an effort to bring together the French and Italian wine industries within a single, free market and form the basis for the EC wine industry, certain instruments were set up by the European Commission to regulate grape production and fermentation.[8] However, these measures did not effect the desired result. A succession of surplus production years in France and Italy, along with the development of major wine production centers in Spain and Portugal, created a significant amount of surplus table wine in the Community.[9] In response to this table wine surplus, the Council of European Communities amended Regulation No. 337/79 (containing the regulations that were controlling the European wine industry) in 1982 and has since adopted a series of new regulations. The current regulation that is the basis for the EC's intervention in the European wine market is EC regulation 822/87. The principals governing these regulations have been summarized as follows:[10]

1. Community intervention must guarantee a price for table wine of not less than 82 percent of the guide price.[11]
2. There may be automatic opening of optional "preventive distillation" from September 1 each year, with producers paid 65 percent of the guide price.

[5] Alcohol Update, Jan. 16, 1989, p. 6.
[6] Grape must is the liquid product obtained naturally, or by physical processes, from fresh grapes.
[7] *Official Journal of the European Communities*, "Regulation No. 816/70 of the Council of 28 April 1970 laying down additional provisions for the common organisation of the market in wine."
[8] Ibid.
[9] *Wine in the European Community*, Office of Official Publications of the European Communities, January 1988, p. 67.
[10] Ibid., p. 67.
[11] The guide price indicates the average wholesale price that has been adopted by the Community as its policy objective in the sector. The price is set each year for each type of wine.

3. All producers may be required to distill a portion of theirwine production in the event of "crisis conditions" in the market, at a price ranging from 40 to 60 percent of the guide price depending on the producer's yield per hectare.

4. Producers may choose the option of "voluntary distillation" at a price of 82 percent of the guide price at any time when the Council deems it necessary to resort to compulsory distillation.

The development of these regulations "established distillation no longer as intervention of an exceptional nature, as was originally intended when the common market in wine was launched, but as the basic, if not the only, instrument for regulating the market and eliminating surpluses"[1] of table wines.

Regulations were concurrently passed by the Council to prevent the volume of table wines produced in the EC from increasing any further than had occurred during the previous 5 years. However, although the production volume of wine stabilized somewhat, the level of domestic consumption in the EC nations steadily declined. In essence, this regulation resulted in a continuation of the table wine surplus along with the development of a concurrent alcohol surplus.

In addition to the EC wine support program, certain individual nations also provided support programs for their own table wine industries that operated in a manner similar to programs imposed by the EC Council. These additional supports created a second-tier surplus of alcohol at the national level.

Individual distillers in the EC nations are also reported to have significant stocks of wet ethanol available. These stocks are free from the EC Council regulations and any other EC restrictions.[2]

The levels of wine distilled under the EC program are shown in the following tabulation:[3,4]

Production Year	*Volume in hectoliters (1,000)*	*Volume in gallons (millions)*
1981-82	13,903	367.04
1982-83	22,913	604.90
1983-84	37,153	980.84
1984-85	29,929	790.13
1985-86	24,288	641.20
1986-87	36,000	950.40

[1] *Wine in the European community*, op.cit., p. 67.
[2] Kirby Moulton, "Wine Policy in Europe and its Implications for California," May 2, 1988.
[3] *Wine in the European Community*, op. cit., pp. 61-62.
[4] There are no comparable data available concerning the amount of wine alcohol distilled under the programs of the individual nations or by the individual distillers.

The European Community recently announced further steps involving revisions of the rules for ethanol production from excess wine production. These rules seek to make it unprofitable for a wine producer to produce wine purely for the purpose of receiving payment from the EC for "intervention stocks."[5] The goal of these steps is to reduce the EC's wine production capacity by 1.1 billion gallons.[6]

A comparison of total exports of all EC-produced fermentation alcohol (table F-14) to those exports specifically going to the Caribbean (table F-15) shows that the Caribbean Basin markets have had a relatively insignificant effect in helping reduce the surplus wine alcohol inventory in Europe.[7] Caribbean Basin producers of fuel ethanol and other informed sources have stated that the EC wine alcohol is not an appropriate feedstock for the fuel ethanol producers to use in their azeotropic distillation columns.[8] According to industry sources, the material imported from Italy, France, and Spain required more intense, and therefore, more expensive processing (several passes through a single distillation column or the use of a preliminary rectifying column before the azeotropic distillation) in order to remove the water, impurities, and other contaminants from the ethanol. A number of the Caribbean Basin fuel ethanol producers could add a rectifier as a preliminary step to the azeotropic distillation, but have thus far not done so because of the additional costs. Also, these nations view such a step as a commitment to using wine alcohol from the EC as a permanent feedstock. The use of several passes through the distillation column reportedly made the fuel ethanol product significantly more expensive than if cleaner hydrous ethanol with far fewer impurities had been used as a feedstock.[9] This increased expense relates both to the time that the column is used for each volume of fuel ethanol produced (twice the production expense for two passes through the column) and also to the physical disruption to the catalysts and other materials used within the column when exposed to unusually high levels of impurities and contaminants.

[5] Kirby Moulton, "Wine Policy in Europe and its Implications for California," May 2, 1988.
[6] Ibid.
[7] Includes ethanol produced from all agricultural sources, as well as a minimum amount of synthetic ethanol.
[8] *Post-hearing brief of* Tropicana Energy Company, *attachment to post-hearing brief of* Petrojam Limited *(letter written by Lars A. Garrison, President of* International Alcohols Limited, the sole U.S. marketing representative of Petrojam), and conversations with Mr. Robert Butler of Butler Research International, a chemical engineering consultant who designed much of the equipment being used by the Caribbean Basin fuel ethanol industry.
[9] Ibid.

According to EC statistics, Jamaica was the only Caribbean Basin nation to import wine alcohol during 1986-87 (table F-15). This shipment was to Tropicana under a long-term contract and used as feedstock, which reportedly came from the second category of wine alcohol currently being stored in the individual EC nations (table F-14). The U.S. marketing firm with which Tropicana has contracted to market its U.S. sales of fuel ethanol has reported the following approximate cost structure for European wine alcohol used as feedstock to produce fuel ethanol for the U.S. market, in cents per gallon of fuel ethanol:[1]

Cost component	*Estimated cost of fuel ethanol*
Purchase of wine ethanol f.o.b	55.5
Freight (EC to Jamaica)	10.0
Processing cost (double pass)	25.0
Freight (Jamaica to New Orleans) ..	5.0
Marketing	5.0
Total	100.5

According to responses from the Commission questionnaire, Costa Rica has also imported surplus wine alcohol from Spain and Italy during 1986-88. Total imports of surplus wine alcohol from the EC to CBI countries during 1985-88 amounted to approximately 90 million gallons.[2] The major importing countries were Costa Rica and Jamaica, which yielded approximately 63 million gallons of anhydrous ethanol. The remainder was water, impurities, and inventories.

It has been estimated that the combined stocks of the EC and the member nations may range from 400 to more than 600 million gallons[3] of wine alcohol with the EC controlling approximately 200-250 million gallons. It is reported that all the stocks have an alcohol content greater than 92 percent, but the quality of these stocks varies significantly. In addition, the price levels for the various different stocks of European wine alcohol have been estimated to range from a low of approximately 20 cents per gallon[4] to as much as 65 to 70 cents per gallon depending upon the stated quality and proof (more than $1.00 per gallon when transportation and processing are included).[5] As a result, Caribbean Basin producers have thus far avoided much of this potential fuel ethanol feedstock and some have indicated that they will continue to avoid the use of this material as long as their production is maintained at current levels and there are other sources of feedstock available.

With regard to other potential markets for the European fuel ethanol, the Council of European Communities requires that wine alcohol be sold outside the EC only for nonbeverage purposes, thereby limiting the market to fuel and industrial uses.

Official EC statistics show that the United States was a major export market for the agricultural alcohol, as shown in table F-16.[6] In each year during 1983-87, the United States has accounted on a value basis for the largest share of EC exports of agricultural alcohol of any nation outside the Community as shown in table F-17.[7] However, on a quantity basis, the EC exported more of such alcohol to Jamaica than to the United States in 1987. There are no indications from any sources as to the intended purpose of these exports.

On December 12, 1988, the EC published regulation 3877/99, which announced its intention to dispose of its wine alcohol obtained from distillation. Sales are expected to begin in the spring or summer of 1989 and are all by auction. So far, the only restriction governing these sales is that they not disrupt European industrial and beverage markets.

Brazil.—In addition to the large European wine alcohol (hydrous) reserve that has already been tapped by some Caribbean producers of fuel ethanol, the large ethanol industry in Brazil has been regarded by industry sources as a potential source of excess hydrous ethanol for the Caribbean producers' distillation facilities.

Brazil is the only Western Hemisphere nation, other than the United States, with a well-developed plan to substitute alternative fuels, such as ethanol, for part of its motor gasoline supply. There are currently two types of passenger vehicles marketed in Brazil—ones similar to those sold in the United States that accept as a fuel a mixture of gasoline and ethanol, and in addition, a fleet of vehicles that use "neat" ethanol as a fuel.

As a result, the Brazilian Government has fostered the development of a strong fuel ethanol industry that can help defray the expense and economic disruption associated with a dependence on imported motor fuels and other petroleum products.[8] There are a number of different programs sponsored by the Brazilian

[1] Information furnished by Lars A. Garrison, International Alcohols Limited, U.S. marketing representative of Tropicana Energy Company, on Oct. 28, 1988.
[2] Responses to Commission questionnaire.
[3] Agra Europe, Aug. 5, 1988.
[4] Agra Europe, Aug. 5, 1988
[5] Report from marketing representatives of a Carribbean fuel ethanol producer.

[6] Compiled from official statistics (Eurostat) of the Council of European Communities. There are no equivalent statistics compiled by the U.S. Department of Commerce.
[7] Ibid.
[8] U.S. International Trade Commission, *Certain Ethyl Alcohol from Brazil*, USITC Publication 1818, March 1986.

Government that were designed to provide enough fuel ethanol for use domestically in Brazil,[1] as well as to provide a buffer for years in which there would be a shortfall in production. In order to maintain such a buffer, the Brazilian Government set up programs to develop a significant export production of fuel ethanol that could also be redirected to its domestic market if the situation warranted.

Additionally, the Brazilian Government regulates the amount of sugarcane used to produce sugar or ethanol through acreage allotments and also establishes sugarcane production quotas to allow for the domestic and export markets for both sugar and ethanol. As stated by Eric Vaughn[2] during the public Commission hearing, Brazilian ethanol is an agricultural product "produced from sugarcane, that enjoys a tremendous amount of government support in country, but it's (an equivalent) product (to U.S.-produced fuel ethanol, and is accorded the same treatment) as (the product of) Mr. Shepard's[3] corn milling facility, which produces ethanol from a raw agricultural material."

Brazilian law also requires the maintenance of inventories of both hydrous and anhydrous ethanol to help prevent a shortfall in domestic supplies.[4] This hydrous ethanol reserve is the pool of wet ethanol from which the Caribbean nations could seek to secure additional material that may be distilled to produce fuel ethanol for export to the U.S. domestic market. Mr. Vaughn also stated that hydrous ethanol is, and would be, available from Brazil.[5]

[1] *Federal Register*, Vol. 50. No. 218, Nov. 12, 1985, (C-351-501), pp. 46681-46686; and *Federal Register*, Vol. 51. No. 13, Jan. 21, 1986, (A-351-502), pp. 2746-2747.
[2] President, Renewable Fuels Association.
[3] President, A.E. Staley Manufacturing Company, a U.S. producer of fuel ethanol from grain sources.
[4] Ibid.
[5] Ibid.

Table 3-2 contains data reported to the Commission in the course of its Investigation No. 701-TA-239 and 731-TA-248 by the respondents to the Commission questionnaire and published in a public Commission report.[6]

The report of the investigation went on to state[7]:

> ...The significance of all this is that Brazil has more than sufficient physical plant capacity to produce ethanol, both hydrous and anhydrous, to supply its domestic and export markets until 1990.
>
> ...(However,) in any given year, physical plant capacity is not...the limiting factor in Brazil's ability to produce ethanol. The determining factor is the sugarcane crop...

The ethanol supply situation in Brazil as of December 1988, despite the various legislative and government incentives concerning the production of fuel ethanol, was reported by U.S. industry sources to be deficient in both hydrous ethanol for use as a "neat" fuel and anhydrous ethanol for fuel blending and extending purposes. Additional reports from such industry sources indicate that the fuel ethanol shortfall in Brazil has prompted the Brazilian Government and industry to attempt to purchase surplus wine alcohol from Europe, regardless of its reported poor quality. As a result, the price of European wine alcohol has effectively increased by 40 to 60 percent, or by approximately 20 cents per gallon. This increase in price, if maintained, could effectively eliminate the Caribbean fuel ethanol producers as potential buyers of the European wine alcohol, as this action would render the close-to-cost operations of the Caribbean Basin producers noncompetitive with producers of fuel ethanol in the domestic U.S. market.

[6] U.S. International Trade Commission, *Certain Ethyl Alcohol from Brazil*, Investigation Nos. 701-TA-239(Final) and 731-TA-248(Final), USITC Publication 1818, March 1986.
[7] Ibid.

Table 3-2

Anhydrous fuel ethanol: Brazil's capacity, production, inventories, domestic shipments, and exports, 1982-85, with projections for 1986 and 1987

(In millions of gallons)

Item	*1982*	*1983*	*1984*	*1985*[1]	*Projections 1986*	*1987*
Capacity[2]	2,245	2,695	3,076	3,302	3,525	3,727
Production	902	674	566	723	578	550
Inventories[3]	53	369	416	243	327	308
Domestic shipments	533	574	550	564	518	516
Exports[4]	53	53	189	75	79	79

[1] Actual through November 1985 with estimates for December 1985.
[2] Effective total capacity to produce hydrous ethanol, crop-year basis.
[3] As of January 1, each following year.
[4] Exports of anhydrous fuel ethanol and anhydrous industrial grade ethanol to all markets with the assumption that there will be no exports of fuel ethanol to the United States in 1986 or 1987.

Chapter 4

U.S. Fuel Ethanol Industry and Market

Introduction

Ethanol has been used as a fuel for internal combustion engines for decades. During World War II, the United States operated an ethanol plant in Nebraska to produce fuel for the Army. However, because of the availability and low price of gasoline after the War, the potential for ethanol's use as a motor fuel waned. By the early 1970's, there were virtually no commercial fuel ethanol plants in operation in the United States. However, spurred by the first crude petroleum embargo in 1973, which resulted in tight supplies of motor fuel for domestic consumption, the State of Nebraska implemented an incentive program to encourage the production and use of fuel alcohol within the State. Other Midwestern States soon followed this program, which resulted in the emergence of the present U.S. ethanol industry. This chapter will review the domestic ethanol industry and its market. It will also identify factors that determine the potential size of the domestic market.

The Fuel Ethanol Industry and Market in the United States

In 1973–74, the Archer Daniels Midland Co. (ADM) built two wet-milling plants to produce high-fructose corn syrup; however, when sugar prices later declined, ADM began producing fuel ethanol from these plants.[1] When the second crude petroleum embargo began in 1979, the need for alternative fuels and a lessened dependence on imported crude petroleum was apparent to the United States. In late 1979, there were 10 plants in the United States producing fuel ethanol.[2] By mid-1982, there were more than 85 plants producing ethanol-blended gasoline, which accounted for about 1 percent of total motor fuel consumption. The number of plants in operation soon increased to 163, but by the end of 1985, all but 74 of these plants had shut-down.[3] By the end of 1987, only 61 plants were producing fuel ethanol. This decline was due to a number of reasons, such as lower than expected prices and profits, smaller plants being below minimum economic size, decline in the price of crude petroleum, and inexperienced management in this field. Despite this situation, ethanol blended with gasoline is purchased for reasons other than lessening dependence on foreign crude petroleum, as discussed below.

The use of ethanol-blended gasoline.— Ethanol was originally marketed as an extender for gasoline, which was in tight supply as a result of the OPEC embargoes. The typical blend consists of 10 percent (by volume) ethanol and 90 percent (by volume) gasoline. Gasohol is currently marketed as "unleaded gasoline with ethanol," and many States require service station pumps to be labeled to indicate the ethanol content.

Ethanol can also be used as an octane enhancer because it has a research octane number (RON) or rating[4] of about 112 compared with 87 for regular unleaded gasoline. However, due to additional transportation and storage costs that affect the final price, fuel ethanol is not competitive with other octane enhancers. Recently, its use as an oxygenator is being promoted to enhance sales. When ethanol-blended gasoline is burned it emits lower levels of carbon monoxide than gasoline without an oxygenator. It is thus more environmentally acceptable and can be used to reduce pollutant levels in areas that exceed the mandated standards. However, ethanol has about 67 percent the Btu (British thermal units) content of gasoline, which results in reduced fuel economy. As a gasoline extender, ethanol would have a negative impact on mileage ratings.

Ethanol's cost in the United States depends primarily on the level of Federal assistance and the price of corn. Without existing Federal assistance to the ethanol industry, and assuming the price of corn at $2 per bushel, crude petroleum prices must be at least $40 per barrel for ethanol to be competitive with petroleum-based octane enhancers. Petroleum prices have been well below $15 per barrel and are not expected to reach the $40 per barrel level in the near future.[5] Without the Federal subsidy, there is no corn price that would make ethanol competitive with crude petroleum prices below $25 per barrel (if the fuel byproduct credit does not exceed the price of corn).

[1] National Advisory Panel on Cost-Effectiveness of Fuel Ethanol Production, "Fuel Ethanol Cost-Effectiveness Study," November 1987, p. 1-1.

[2] U.S. Department of Agriculture, Office of Energy, "Fuel Ethanol and Agriculture: An Economic Assessment," Agricultural Economic Report No. 562, August 1986, pp. 3 and 4.

[3] Ibid. p. 4.

[4] The octane number is a numerical rating of the antiknock properties of motor fuel, based on the percentage, by volume, of isoctane in a standard reference fuel.

[5] Statement on behalf of the American Petroleum Institute and the National Petroleum Refiners Association before the House Energy and Commerce Subcommittee on Energy and Power and the House Agriculture Subcommittees on Wheats, Soybeans and Feed Grains, and Forests, Family Farms, and Energy, May 11, 1988, p.2.

The key Federal subsidy is the exemption for blends containing 10 percent ethanol from the Federal gasoline excise tax. Originally this was 4 cents per gallon, but when the Federal gasoline excise tax was increased to 9 cents per gallon in 1982, the alcohol-blend fuel exemption was raised to 5 cents per gallon and, 2 years later, to 6 cents per gallon. (Six cents per gallon of blend results in 60 cents per gallon of ethanol).

In addition to cost competitiveness, there are technical difficulties associated with the use of ethanol-blended fuels. There are volatility differences in the mixtures that the more commonly used octane enhancers, such as methyl tert-butyl ether, do not experience. Alcohol blends are more volatile than alcohol-free gasolines and have reported evaporative emissions of 5 to 220 percent above emissions for straight gasoline. The increased volatility caused by alcohol can be counteracted by the removal of butanes from gasoline; however, refiners prefer to use the less expensive hydrocarbons (such as butanes) to increase octane.[1] The octane level of ethanol is about 7 percent higher than MTBE. Also, ethanol is water soluble and therefore must be stored in water-free vessels. Transportation of ethanol is more difficult and costly than gasoline with MTBE (usually transported via pipelines) because of water contamination problems in the pipelines.

U.S. production and sales of fuel ethanol.—During the early 1980's, the fuel ethanol industry grew at a steady pace as a result of Federal and State legislation encouraging development and production of alcohol-blended fuels. U.S. production of fuel ethanol increased from 40 million gallons in 1980 to 750 million gallons in 1986. By 1986, sales of ethanol-blended gasoline represented 7 percent of total U.S. gasoline demand.[2]

The following tabulation lists U.S. sales and production of fuel ethanol during 1979–87 (both in millions of gallons):[3]

Year	Sales	Production
1978	–	10
1979	40	20
1980	80	40
1981	85	75
1982	234	210
1983	443	375
1984	567	430
1985	792	650
1986	798	750
1987	825	810

Note.—"Sales" include both sales of domestic production and imports.

[1] U.S. Department of Agriculture, Office of Energy, "Fuel Ethanol and Agriculture: An Economic Assessment,"p p. 3 and 4.
[2] National Advisory Panel, "Fuel Ethanol Cost-Effectiveness Study," November 1987, p. 1-1.
[3] Congressional Research Service, "Alcohol Fuels," May 1988, p. CRS-8..

In 1986, there were approximately 55 facilities, operating in more than 20 States. Of these plants, less than 50 percent used corn as feedstock; however, corn is the feedstock used to produce 85 to 90 percent of domestic ethanol.[4] Table 4-1 lists most of the fuel ethanol facilities operating in 1986, by State.

Total motor gasoline sales in the United States in 1987 were 116.5 billion gallons, of which about 7 percent was an ethanol-gasoline blend. In 1988, U.S. ethanol fuels output is expected to rise above 900 million gallons, with ethanol blends accounting for about 8 percent of total gasoline sales. Most of the domestic production, nearly 80 percent, is accounted for by five producers; one producer accounts for a large portion of that percentage. These firms have been very successful in selling fuel ethanol because they are more cost effective than the smaller producers.

Overall, ethanol fuel sales tend to be concentrated in the grain-producing States of the Midwest or States that have granted exemptions from gasoline excise or sales tax. In 1987, Illinois was the leading State in terms of gallons of ethanol-blended gasoline sold. The following tabulation, derived from official statistics of the U.S. Department of Agriculture (USDA), shows the ten leading States in terms of ethanol-blended gasoline sales, (in millions of gallons):

State	Sales of ethanol-blended gasoline
Illinois	1,436
Ohio	898
Kentucky	775
Indiana	714
Michigan	494
Texas	459
Alabama	452
Iowa	372
Tennessee	332
Virginia	320

All of these States except Michigan exempt ethanol-blended gasoline from the State gasoline excise tax. As of October 1988, there were 25 States granting subsidies.

In 1987, there 23 States with almost no sales of fuel ethanol (i.e., zero or less than 2 percent market penetration). Sales of fuel ethanol-gasoline blends in 23 coastal States were 24.6 percent of total sales of blends in 1987, whereas total sales of gasoline in coastal States were 58 percent of the gallonage of gasoline sold in all 50 States (and District of Columbia).

According to responses to the Commission questionnaire, shipments of domestically

[4] National Advisory Panel, "Fuel Ethanol Cost-Effectiveness," p. 1-1.

Table 4-1
U.S. fuel ethanol plants in operation in 1986, by company and location

Company	Location	Capacity (Million gallons per year)
Archer Daniels Midland	Decatur, IL	255
Archer Daniels Midland	Peoria, IL	95
Archer Daniels Midland	Cedar Rapids, IA	80
Archer Daniels Midland	Clinton, IA	70
Pekin Energy	Pekin, IL	70
South Point Ethanol	South Point, OH	60
New Energy Company of Indiana	South Bend, IN	60
A.E. Staley Manufacturing Company	Loudon, TN	40
Shepherd Oil Co.[1]	Jennings, LA	25
Tennol Energy Company	Jasper, TN	25
Kentucky Agricultural Energy Products	Franklin, KY	20
Midwest Grain Products	Pekin, IL	12
American Diversified Corp. (ADC I)	Hastings, NE	11
Cenex Agri-Fuels Co	Walhalla, ND	11
Grain Processing Corp	Muscatine, IA	10
High Plains Corp	Colwich, KS	10
New Church Energy Association	New Church, VA	9
Pinedell, Inc	Charles City, VA	8
Floyd Agri-Energy Coop	Floyd, VA	8
Chemical Ethanol Producers	Chesapeake, VA	7
American Fuel Trading Co	Chesapeake, VA	6
Virginia Solid Fuels, Inc	Bealton, VA	6
American Diversified Corp. (ADC II)	Hamburg, IA	5
A. Smith Bowman Distillery	Reston, VA	5
Grain Power-Tucumcari Ltd	Tucumcari, NM	5
Alchem Ltd	Grafton, ND	5
Butterwood Farms	Wilson, VA	4
Virginia Feed & Fuel, Inc	Madison, VA	4
Bio-Regional Energy Associates	Floyd, VA	4
Georgia Pacific Corporation	Bellingham, WA	3
J.R. Simplot	Caldwell, ID	3
Others	([2])	14
Total U.S. operational capacity		953

[1] Closed in 1987.
[2] Various areas of the United States.

Note.—Due to rounding, figures may not add to total.

Source: U.S. Department of Agriculture, Office of Energy, "Fuel Ethanol and Agriculture: An Economic Assessment," Agricultural Economic Report No. 562, August 1986, p. 3 and 4.

produced fuel ethanol tended to follow overall sales obtained by the USDA. The five States accounting for almost 60 percent of reported shipments were Illinois, Ohio, Indiana, Michigan, and Iowa. In all, shipments of fuel ethanol were reported in 26 States by the respondents and accounted for approximately 80 percent of ethanol sales in 1987. Some of these States with small sales were Texas, California, Louisiana, Virginia, and Maryland. In 1987, imports of CBERA fuel ethanol were mainly shipped to Louisiana, Virginia, and Maryland. It should also be noted that the prices of CBERA and U.S.-produced fuel ethanol during 1985–88 have varied from each other and, have frequently moved in opposite directions (see app. G, table G-4). This would seem to indicate that the two products are imperfect substitutes.

One area that may contribute to the overall differences in these products is transportation costs. According to responses to the Commission questionnaire, transportation costs from a Midwestern plant to a Coastal States ranged from 9 to 14 percent of the delivered price, or 8 to 14 cents per gallon.

Imports.—When the Federal gasoline excise tax exemption for ethanol blends began with the Energy Tax Act of 1978, it applied to both domestic and imported ethanol. Objections to the exemption for imported ethanol were expressed on the basis that without an offsetting tariff, ethanol imports would receive the benefit of the excise tax exemption, resulting in Federal subsidization of foreign ethanol production. Beginning in 1981, a tariff on imported fuel ethanol was imposed in the amount of 10 cents per gallon for that year followed by increasing tariffs in subsequent years to keep pace with the excise tax exemption for alcohol fuel. The tariff has been 60 cents per gallon since 1984, in addition to the 3-percent ad valorem tariff on ethyl alcohol for nonbeverage purposes. U.S. imports of fuel ethanol produced by fermentation increased from 1981, the first year of substantial imports, to a peak of 137.3 million gallons in 1984, followed by a decline to 41.1 million gallons in 1987, caused mainly by the withdrawal of Brazil from the U.S. market, as shown in the following tabulation:[1]

Year	Quantity (million gallons)	Unit value (per gallon)
1981	4.4	$1.31
1982	13.5	.98
1983	30.2	.97
1984	137.3	.81
1985	81.7	1.49
1986	41.6	.95
1987	41.1	.94

Gasoline and Fuel Ethanol Distribution and Marketing

The motor fuel distribution system begins with large regional storage facilities such as terminals or bulk plants. Regional terminals receive gasoline from refiners via pipeline, tanker, and barge. The product is then transferred by truck or rail to wholesale distributors, fuel oil dealers, and gasoline retailers. Bulk plants are smaller terminals that receive gasoline by truck or rail and distribute it to chemical companies and gasoline retailers. Bulk plant operators tend to be independent gasoline marketers and wholesalers.

As noted above, a major limitation on the incorporation of fuel ethanol into the distribution system is its inability to be transported by pipelines. Since anhydrous ethanol, even when blended with gasoline, will tend to pick up water whenever it is exposed to water, the transportation and storage facilities used with ethanol and gasohol must be totally dry. As this would be an impossible task, ethanol is not blended at the refinery, and no anhydrous ethanol or ethanol product is transported through the major pipelines.

Ethanol-blended gasoline is sold both by large integrated petroleum companies and independent marketers. However, the majority of ethanol is purchased and resold (as gasohol) by the relatively smaller independent marketers. In 1987, independent marketers accounted for more than 77 percent (6.4 billion gallons) of total ethanol-blended gasoline sales.[2] Ethanol is mixed with gasoline by the independent wholesalers and blenders, usually in a process called "splash blending,"[3] at either the wholesale or retail level. Ethanol purchased by the major petroleum companies is often sold through subsidiaries using different brand names.

[1] Official statistics of the U.S. Department of Commerce and Commission estimates.
[2] "1988 Statistical Report," Society of Independent Gasoline Marketers of America (SGMA), Washington, D.C.
[3] Gasoline and ethanol are both added to the tank truck and are splash blended during the trip to the gasoline retailer.

Other Octane Enhancers Used in Gasoline

Background.—Internal combustion engines work by the ignition of a compressed air/fuel mixture. Rapid increases in the pressure and temperature of the mixture in the combustion chamber during normal engine operation may lead to uneven combustion throughout the chamber. Side reactions can also develop, resulting in carbonaceous deposits inside the piston chamber, which cause premature detonation of fuel. This premature detonation of fuel can occur to varying degrees and is sometimes heard as a "knock" or "ping" in the engine. An increase in fuel octane rating tends to result in a lower amount of engine knock.

The overall purpose of octane enhancers in gasoline is twofold. The first is to raise octane rating of motor fuels so that the fuel will prevent engine knock. The second is so that petroleum refiners and gasoline blenders can provide motor fuels with consistent octane ratings to consumers and conform to pump labeling requirements.

Enhancing octane ratings in gasoline originally involved blending operations. One gasoline blend with a lower octane rating than desired could be blended with another gasoline blend with a higher octane rating to achieve an overall slightly higher octane rating. Gasoline with higher octane ratings generally contains more aromatic compounds such as benzene, toluene, and xylene, or a mixture of all three compounds, known as "BTX." Butane can be blended with gasoline to increase octane ratings as well as enhance engine starting and warmup capabilities. All of these chemicals are used most frequently in gasoline blending, because they form part of the basic gasoline blending stock, or clear octane pool, to which other octane enhancers may be added.

The first widely used antiknock additive and octane enhancer, tetraethyl lead, was introduced in 1925. Although tetraethyl lead was the first antiknock additive, it was soon followed by tetramethyl lead and reacted mixtures of tetraethyl- and tetramethyl lead. Since then, other products, including cerium, manganese, cobalt, and iron compounds have been used in antiknock preparations. Some of the more prominent antiknock compounds used outside the United States include methyl cyclopentadienyl-manganese tricarbonyl (MMT) and ferrocene.

Fuel blending agents that have been used to increase octane include ethanol, methanol, methyl tert-butyl ether, other alcohols, and blends of alcohols and ethers. These fuel blending agents are also called fuel oxygenators because they increase the amount of oxygen available in the combustion chamber and result in higher octane, less engine knock, and lower hydrocarbon and nitrogen oxide emissions.

Since the Arab oil embargo in 1973, the design of the internal combustion engine has been adjusted to accommodate fuels with lower octane ratings, as well as to conform to the Clean Air Act. Petroleum refiners have had to rely on lower grades of crude oil from which to produce gasoline, resulting in the use of modern refining techniques, such as severe catalytic reforming of certain petroleum fractions, to maintain a high quality clear octane pool with a high octane rating. Reductions in the use of lead have resulted in increased demand for octane enhancers, notably fuel oxygenators for unleaded gasoline.

The legislative history of the programs to phase out lead use in gasoline is quite complex. On October 1, 1979, the Environmental Protection Agency instituted regulations mandating a content of 0.8 grams per gallon of leaded gasoline for large refineries (50,000 barrels or more per day capacity). Small refineries, defined as having a certifiable capacity of up to 5,000 barrels per day, could produce gasoline with a pooled standard of 2.65 grams per leaded gallon, with lead content gradually reduced for larger refineries up to a certified capacity of 20,000 barrels per day. Until November 1, 1982, there were no regulations for importers.

The banking of lead credits began in November 1983. At this time, refiners producing both unleaded and leaded gasoline usually met the total allowable limits of lead in gasoline. Refiners could use less lead additives, and buy or sell lead "credits" to be used by other refiners. Widespread use of fuel oxygenators such as methanol, MTBE, and ethanol began at this time to meet the increasing production demands of unleaded gasoline.

As of July 1983, small refineries were subjected to the same requirements as large refineries. Refiners were allowed to "bank" or set aside lead credits as of January 1985 in addition to buying or selling lead credits. Beginning in January 1986, refiners could no longer generate any additional lead credits, although lead credits could be purchased.

The lead phasedown program as mandated by the EPA gave rise to projections for an increased demand for a fuel blending agent or fuel oxygenator that would satisfy additional octane requirements between the clear octane pool and finished gasoline. The supply of sources for additional octane requirements was expected from the increased use of benzene or BTX, fuel oxygenators, and the process of severe reforming techniques in the production of gasoline feedstocks, which would result in a higher overall octane rating in the clear octane pool.

The projections for lead phasedown and ethanol replacement equivalents are summarized in table 4-2.

Because of rules finalized in 1985 by the EPA, domestic annual lead consumption was projected to be reduced from an estimated 25.8 billion grams per year, corresponding to 0.38 grams per leaded gallon in 1985, to 1.1 billion grams of lead per year, corresponding to 0.01 grams per leaded gallon, by 1994. Ethanol is generally estimated to replace lead additives at the rate of 1 gallon of ethanol for every 5 grams of lead.[1] In 1985, a total of 3.7 billion gallons of ethanol would have been required to replace the lead additives lost from the imposition of the new EPA ruling. By 1994, a total of 4.9 billion gallons of ethanol would be required to replace lead in gasoline.

[1] Assuming ethanol alone is used to make up the loss in octane rating associated with the removal of lead.

Table 4-2

U.S. gasoline demand: Total and leaded, with reduction in lead usage and alcohol equivalent, 1985-94

Year	Gasoline demand: Total	Gasoline demand: Leaded	Reduction in lead usage	Alcohol equivalent
	Billion gallons		*Million grams*	*Billion gallons*
1985	100.6	32.2	18.5	3.70
1986	100.3	28.8	38.4	7.68
1987	100.0	25.6	35.8	7.16
1988	99.6	22.4	33.4	6.68
1989	99.3	19.2	30.9	6.18
1990	99.0	16.4	28.8	5.76
1991	99.0	14.9	26.3	5.26
1992	99.0	13.4	25.9	5.18
1993	99.0	12.4	25.2	5.04
1994	99.0	11.5	24.6	4.92

Source: *Chemical & Engineering News*, April 8, 1985, p.17, USEPA, and Herman and associates.

A historical summary of leaded and unleaded gasoline production and actual ethanol consumption by year is presented in table 4-3.

Total gasoline usage increased by 8.9 percent in terms of quantity during 1983-87, or from 102 billion gallons to 111 billion gallons. Leaded gasoline usage decreased, from 47 billion gallons in 1983 to 25 billion gallons in 1987, or by about 47 percent. Unleaded gasoline usage increased by 56 percent in terms of quantity, from 55 billion gallons in 1983 to 86 billion gallons in 1987. The volume of ethanol used in fuel was about 443 million gallons in 1983, and increased by 86 percent, to about 825 million gallons in 1987. Although the use of ethanol as a replacement for lead in motor gasoline led to projections of a potential demand for ethanol to be as much as 7.7 billion gallons in 1987, historical use of ethanol has never exceeded 1 percent of total gasoline usage.

The projections for ethanol as a replacement for leaded additives were not realized principally because of the use of other blending agents that are better octane enhancers, such as MTBE and methanol. In addition, refiners could incorporate additional butane or BTX into gasoline feedstocks in order to form a clear octane pool with a higher starting octane value, reducing the need for octane enhancers.

Butane is a desirable component in gasoline because it acts as an aid to quickly starting and idling. However, a drawback to the use of butane in gasoline is its inherent volatility even during winter months, and in regions of the United States that are seasonally cool. In warmer climates, butane tends to vaporize from the tank, often increasing pressure within the tank to dangerous levels. Butane slowly escapes to the atmosphere, acting as a pollutant. For this reason, the EPA has begun investigations to determine appropriate butane levels in gasoline.

Large refiners have been concerned with potential EPA restrictions on the volatility of gasoline. Butane is a common component of gasoline, constituting about 7 percent by volume. The availability of low-cost butane makes it preferred to higher cost ethanol. Any restrictions on the volatility of gasoline would probably result in the reduction of butane and other low-cost components that increase the volatility of gasoline.

Currently, proposed EPA limitations on butane content of gasoline are not expected to present any barriers to refiners or blenders in maintaining gasoline at current quality and octane levels. The amount of butane in gasoline in late 1988 needed to afford ease of starting and idling capabilities in modern engines averages about 7 percent. An industry source has projected that by 1993, pending potential limits on butane by the EPA and increased use of MTBE, butane content will likely be reduced to about 6 percent, as shown in the following tabulation of actual and projected gasoline pools, 1987 and 1993 as reported in the *Oil & Gas Journal*, April 4, 1988, pg. 35-40:

Component	Percent composition 1987	Percent composition 1993
Blending butanes	7.0	6.0
Light run	4.5	-
Isomerate	3.5	10.0
Cat. cracked	35.5	35.0
Coker	1.0	-
Hydrocracked	2.5	2.5
Alkylate	11.0	12.0
Reformate	34.0	33.0
MTBE	1.0	1.5

Although the EPA is concerned with improving the quality of the air in the United States, stricter rules on air quality have been imposed by State and local authorities. On January 1, 1988, the Colorado Air Quality Commission required all gasoline sold in the eight counties of the Rocky Mountain Front Range (including the city of Denver) to contain 1.5 percent by weight of oxygen. The required oxygen level increased to 2 percent by weight, the EPA maximum allowable limit for oxygen content

Table 4-3
U.S. gasoline and ethanol consumption: Leaded and unleaded gasoline, lead, and ethanol used, 1983-87

Year	Leaded	Unleaded	Total	Lead: Total	Lead: Concentration	Ethanol used for fuel
	Billion gallons	Billion gallons	Billion gallons	Billion grams	Percent	Million gallons
1983	47.33	54.70	102.03	51.59	1.09	443
1984	43.77	61.90	105.67	46.17	1.05	567
1985	38.86	65.62	104.48	22.06	0.52	792
1986	32.83	75.36	108.19	10.27	0.31	798
1987	25.46	85.60	111.06	5.66	0.22	825

Source: U.S. Environmental Protection Agency in gasoline, in 1989. The plan, known as the "Denver Plan," is expected to reduce carbon monoxide levels in the region by about 8 to 10 percent. Based on a previous waiver of the maximum allowable limit for oxygen content established by the EPA, incorporation of ethanol in gasoline in Denver and other possible areas could amount to about 10 percent by volume, or about 3.7 percent by weight.

There are a number of octane enhancers/extenders on the market that compete with ethanol. A comparison of the major gasoline blending components is shown in table 4-4.

A more detailed analysis of these major enhancers/extenders follows.

Methanol and methanol blends.—Methanol is a low-boiling alcohol usually produced from natural gas. Methanol can also be produced from coal, from destructive distillation of wood or cellulose, and from biomass.

In 1987, there were seven companies in the United States producing methanol with a combined annual capacity of 1.4 billion gallons. U.S. production of methanol reached its lowest level of the 1983-87 period in 1985, 759 million gallons, valued at $350 million (table F-18), primarily as a result of industry restructuring and closing of facilities to cope with world oversupply. Production in 1987 amounted to 1.1 billion gallons, valued at about $377 million. U.S. apparent consumption has steadily increased since 1985, from 1.1 billion gallons to 1.5 billion gallons in 1987, an increase of 38 percent.

As shown in table F-18, the annual average unit value of U.S. production of this product gradually decreased during 1983-87, from 46 cents per gallon in 1983 to 33 cents per gallon in 1987. The expectations of increased methanol fuel demand led to overcapacity in the world during the past five years. The expected decreasing demand through 1985, coupled with overcapacity, led to decreasing unit values. Demand has since started to increase because of methanol used in producing MTBE, but average unit values continued to fall in 1987.

Currently, the use of methanol and methanol blended with other alcohols or oxygenates in gasoline is allowed by the EPA under certain circumstances, although its use directly as a fuel has not met expectations. The EPA, under Section 211(f) of the Clean Air Act, allows 0.3 percent by volume methanol in gasoline with no other oxygenates present, or 2.75 percent by volume methanol with 2.75 percent by volume butanol or higher molecular weight alcohols. Methanol and gasoline-grade tert-butyl alcohol may be blended in a 1:1 ratio such that the total oxygen content does not exceed 3.5 percent by weight. Methanol may also be blended 5 percent by volume with 2.5 percent cosolvent alcohols under certain conditions.

Most of the current growth in demand for methanol is directly related to demand for a downstream product, MTBE. Several world-scale plants are, or are expected to come on stream by the end of 1988. Although operating rates at methanol plants worldwide are currently about 85 percent, some industry sources have forecast demand growth rates for methanol at 7 percent per year through 1990.

Table 4-4
Major gasoline blending components, advantages and disadvantages

Product	*Advantages*	*Disadvantages*
Ethanol[1]	Produced from renewable resources; economic incentives exist; clean burning; easily handled.	Economic incentives can be removed; comparatively high cost of starting material.
Methanol and methanol blends	Higher oxygen content by weight than ethanol; very economically produced from natural gas.	Absorbs water; corrosive to engine parts, fuel line and tank; EPA requires anti-corrosive additives in some instances.
MTBE	Higher octane rating than ethanol or methanol; economical starting materials.	Cost of starting materials can fluctuate.
ETBE	Similar to MTBE in nearly all respects; easily produced using technology applicable to MTBE.	Ethanol is used as a starting material, but ETBE receives no incentives as ethanol.
Other alcohols and blends	Provide alternate method for boosting octane.	High cost and more complex technology required to produce.

[1] Only the product obtained by fermentation.

However, pricing forecasts for methanol as a fuel have projected the cost of methanol to replace an equivalent amount of gasoline at about $1.42 per gallon in 1991. Another similar study expects equivalent costs to be about $1.24 per gallon in 1991. A forecast for the equivalent cost of gasoline projects only $1.09, making methanol as a neat fuel less economical than gasoline.

California recently installed stations to provide methanol as a neat fuel for the General Motors Corsica, a vehicle capable of using different fuels, as a part of a joint project between the California Energy Commission and Chevron. The Corsica is the first of what is hoped to be many variable-fueled or multifuel vehicles in the United States, capable of running on ethanol, methanol, methanol/alcohol blends, or methanol blended with gasoline. The California Energy Commission hopes to have 5,000 such vehicles by 1990.

Methyl tert-butyl ether.—Methyl tert-butyl ether, or MTBE, is a low-boiling ether. Chemically, it is a mixed ether of methanol and tert-butyl ether. Because MTBE is produced from methanol, which is also used as a fuel, its production may be limited by the availability of methanol. This has not occurred because of availability of natural gas feedstocks to produce ample supplies of methanol.

Isobutylene is also used in the production of MTBE. Isobutylene is an olefin typically derived from catalytic cracking of petroleum. Because of this process technology, isobutylene has been subject to constraints in production and supply to downstream users. Technology recently introduced on a large scale will allow production of isobutylene by catalytic dehydrogenation from isobutane, which can be obtained from petroleum reforming. Currently, two such large-scale plants to produce isobutane, isobutylene, and subsequent production of MTBE were constructed, one in Saudi Arabia and the other in Venezuela.

Production volumes of MTBE typically follow unleaded gasoline. In 1987 there were a total of 15 producers of MTBE, with a combined capacity of about 7.6 billion pounds (table F-19). In 1983, production amounted to 839 million pounds, valued at $151 million. Production gradually increased to a level of 6.4 billion pounds, valued at $763 million, in 1987, an eightfold increase from that of 1983. Apparent U.S. consumption of MTBE is essentially the same as production, because nearly all of MTBE is used domestically as a fuel blending agent.

The average unit value of sales of MTBE gradually decreased because of scale production economies associated with the large-scale MTBE plants that came on stream after 1983. In 1983, the estimated average unit value was 18 cents per pound; during 1983-87, the average unit value declined by 33 percent to an estimated 12 cents per pound in 1987.

Currently, the use of MTBE blended in gasoline is allowed by the EPA under certain circumstances, although it may not be used as a neat fuel. The EPA, under Section 211(f) of the Clean Air Act, allows MTBE as a single component additive for fuel use at a concentration of 0 to 7 percent by volume. Conditionally, up to 15 percent MTBE in gasoline has been granted.

Forecasts for growth of MTBE are at the rate of about 6 percent per year until about 1989 and leveling to a slightly lower growth rate of 4 to 5 percent per year during 1989-93. Also, the increased expectations of use of methanol directly as a fuel in multifuel-capable or variable-fueled vehicles is not expected to result in any drastic shortages of methanol feedstocks for production of MTBE.[1]

Ethyl tert-butyl ether.—Ethyl tert-butyl ether, also called ETBE, is an ether of two monohydric alcohols, ethanol and isobutyl alcohol. It is nearly identical to MTBE with the exception that it has a slightly higher molecular weight and a higher boiling point. A higher boiling point is an advantage in fuel blending, as fuel blends made with ETBE (as opposed to MTBE) would result in a lower vapor pressure or RVP. A higher molecular weight means that, since there is only one oxygen atom per molecule (as in MTBE), the overall oxygen content by weight is lower, and its value as a fuel oxygenator is somewhat less than that of MTBE.

ETBE is produced much in the same manner as MTBE; ETBE may be produced in the same columns used to produce MTBE. More care must be exercised, however, to ensure that the ethanol feedstock is anhydrous, in order to avoid undesirable side reactions and byproducts.

Production of ETBE to the present time has been limited to that produced on a laboratory scale. ETBE has been produced since the early 1970's for use as an experimental octane improver, and for comparison with MTBE. Most industry sources agree, however, that MTBE and ETBE are so similar that the cost of methanol or ethanol starting materials, respectively, will determine which product is used; thus far, methanol is by far the cheaper, more abundant feedstock. Fermentation ethanol would be used only if there would be a fuel tax credit for ethanol used in the production of ETBE similar to the current credit available for fuel ethanol production.

According to the EPA, ETBE, like any other aliphatic alcohol or ether, may be used as a fuel oxygenator to the point that total oxygen content does not exceed 2.0 percent by weight in the

[1] *Automotive News*, December 7, 1987, p. 41.

final gasoline blend. This allows for blending of ETBE at about 12.7 percent by volume. The amount of ETBE used in gasoline to make a blend comparable to that with MTBE is about 15 percent greater than the amount of MTBE. Thus, in order to compete with MTBE in the maximum allowable concentration of 15 percent, about 17 percent by volume ETBE would be needed.

The outlook for ETBE is promising. According to industry sources, if the fuel tax credits were available for the ethanol used in production of ETBE, production of ETBE could compete with production of MTBE, and in instances where the price of methanol would rise to levels making MTBE uneconomical to produce, ethanol could be directly substituted for methanol in the production process.

Other fuel additives.—Many other different types of chemical compounds have been proposed or used as octane enhancers, antiknock compounds, and fuel blending agents as an alternative to the use of ethanol. These include the use of tert-amyl methyl ether, tert-butyl alcohol, other butyl and propyl alcohols, crude product mixtures of methanol, higher molecular weight alcohols, and organometallics such as MMT and ferrocene.

Tert-amyl methyl ether, or TAME, is an ether similar to MTBE and ETBE. Although it has similar or greater octane enhancing ability than MTBE or ETBE, TAME has an even higher molecular weight, translating to a lower oxygen content than either of the other two. Tert-butyl alcohol is produced as a byproduct from the process for MTBE, and its use in gasoline blended with methanol has been approved. Mixtures of higher weight alcohols, including other butyl, propyl, octyl, and decyl alcohols, have been proposed and approved for use as cosolvents with methanol or ethanol. MMT is currently approved for use in leaded gasoline only.

The future of these miscellaneous chemicals used as fuel additives is uncertain. The majority of higher molecular weight alcohols is expected to follow trends commensurate with their use in blends with either methanol or ethanol as cosolvents. Other products used as single-component fuel blending agents are subject to the factors of production economics, including cost and availability of starting materials. MMT could conceivably be approved for use in the United States in the near future; MMT has been used as an antiknock additive in Canada for many years with no undesirable vehicle emissions or effects on catalytic converters. Ferrocene is used to some extent in Europe as an alternative to MMT or lead alkyls, and its use as an alternative antiknock additive will probably continue.

Sources of Future Uncertainty

There is a variety of various pending and current legislation that could substantially increase the demand for fuel ethanol and other oxygenated enhancers. Some of these bills, mostly because of the importance of fuel alcohol to the farm States, have been introduced in Congress to speed up and magnify the growth of fuel alcohol in the United States by mandating that gasoline must be blended with a given high percentage of ethanol. Such a mandate would eliminate the necessity to subsidize the high-cost ethanol, but at the same time would result in an increase in the retail cost of gasoline.

According to an analysis by the CRS,[1] enactment of such legislation would cause net farm income to increase by about $1 billion per year, but consumer food expenditures would rise by about $6.1 billion per year. The future average pump price of motor fuel blended with ethanol is estimated by CRS to range from about the same price as straight gasoline to approximately 12 cents per gallon higher, depending on the assumption of ethanol costs and other factors.

In addition to these legislative sources, there are also other factors that could significantly affect the fuel ethanol industry, such as changes in the sugar quotas, farm program changes affecting corn prices, and the volatility of crude petroleum prices. These factors are discussed in more detail in the other sections of this report.

Demand for fuel ethanol because of environmental concerns is another factor that could result in the growth of fuel ethanol consumption. The use of ethanol-blended gasoline reduces carbon monoxide emissions from automobiles. Disadvantages are the propensity of alcohol blends to pick up water and separate into two layers, the increased volatility of alcohol blends, which may increase ozone formation,[2] and the major one—the fact that ethanol thus far costs so much more to produce than gasoline that its consumption must be supported mainly by an exemption from Federal excise taxes on gasohol.

The major environmental legislation pertaining to automobile emissions is the Clean Air Act. In general, it requires that concentrations of specified pollutants not exceed certain levels set by the EPA. Two of the most known pollutants are carbon monoxide (CO) and ozone. In areas where the concentrations of these pollutants exceed the standards, plans

[1] "Analysis of Possible Effects of H.R. 2052, Legislation Mandating Use of Ethanol in Gasoline", Congressional Research Service (CRS) 1987, p. 1, and CRS presentation at 1988 National Conference on Fuel Ethanol, October 1988.

[2] A report from Systems Application, Inc., though preliminary, holds that ozone formation is not increased by the more volatile blends.

must be developed to reduce the levels of pollutants to the standard. One strategy to reduce pollutants from vehicle emissions is to mandate a minimum oxygen weight in gasoline, which can be accomplished by using fuel ethanol. For a more detailed discussion of the Act and the strategies being employed to reduce the levels of two pollutants, namely CO and ozone, see app. H.

In addition to CO and ozone, other compounds either in gasoline or produced during combustion of gasoline are becoming environmental concerns. Aromatics—benzene, toluene, and the three xylenes—are high-octane hydrocarbons that have always been constituents of gasoline. With the removal of tetraethyl lead, oil refiners have increased the percentage of aromatics in gasoline to more than 30 percent. Benzene, however, is a known carcinogen and is considered a cause of blood disorders, anemia, and a proneness to infection. Though its concentration in the U.S. gasoline pool is less than 1.5 percent, benzene is a likely target for removal from gasoline.[1]

Acetaldehyde, and, to a smaller extent, formaldehyde, are emitted when ethanol blends are used as fuels. At low concentrations these aldehydes may cause eye irritations and skin rashes in some individuals, but the amounts emitted are generally considered too low to pose a significant health risk to the general population.[2]

[1] "Octane Improvement in the 1990's," George Unzelman at 1988 Conference on Octane and Oxygenated Fuels, March 1988; and BioCom International, submission to the Commission, pp. I-K, H, I.

[2] National Advisory Panel, "Fuel Ethanol Cost-Effectiveness Study," p. 4-15.

Chapter 5

The Impact of Alternative Domestic Content Requirements

Introduction

This chapter discusses the quantitative effects that various feedstock and value added requirements have on CBI exporters of fuel ethanol and on the domestic ethanol industry, as well as the important role that gasoline prices have in determining ethanol imports.[1] The first section of this chapter discusses how different feedstock requirements affect the cost of production for CBI fuel ethanol producers, and how changes in domestic feedstock prices affect domestic production costs. Requirements about the value-share of CBI feedstock are related to valued-added requirements and to requirements concerning the volume share of CBI feedstock. Given the manner in which different feedstock costs affect the cost of production, this chapter also discusses the effects of alternative requirements and changes in gasoline prices on CBI fuel ethanol exporters, and on U.S. ethanol producers and consumers.

CBERA-Feedstock Requirements and the Cost of Production

Under the original provisions of the CBERA, producers located in CBI countries were able to import hydrous ethanol, transform it into anhydrous ethanol, and export to the United States without the 3-percent ad valorem and 60 cents per gallon tariff applied to imports of fuel ethanol from other countries. The U.S. Customs Service determined, in two separate rulings, that the dehydration process qualified as a significant transformation of the hydrous product.[2] This meant that, as long as the cost of dehydration represented at least 35 percent of the final value of the product, the anhydrous ethanol entered free of duty. When the price of imported hydrous ethanol is high enough relative to the cost of dehydration, imported feedstock must be blended with CBI-originated feedstock. With the passage of the Tax Reform Act of 1986, anhydrous ethanol was required to contain 30 percent CBI feedstock, by value, to qualify under CBERA. This change effectively negated the Customs rulings, disallowing distillation as a qualified activity under CBERA.[3]

The cost of production for varying feedstock requirements and the relationship of feedstock value share requirements to volume share and value added requirements is presented in table 5-1. These represent average production costs in

[1] The methodology used to arrive at the cost estimates and the effects various feedstock requirements have on CBERA countries and on U.S. ethanol producers is discussed in app. G.

[2] The National Corn Growers Association, Staley, and ADM challenged the original determination in the U.S. Court of International Trade. See *Certain Hydrous Ethanol From Brazil*, USITC publication 1818, March 1986, pages A-7 through A-10.

[3] "Ethyl alcohol (or a mixture) must have been dehydrated within that insular possession or beneficiary country from hydrous ethyl alcohol that includes hydrous ethyl alcohol which is wholly the product or manufacture of any insular possession or beneficiary country and which has a value of not less than (1) 30 percent of the value of the ethyl alcohol or mixture, if entered during calendar 1987, (2) 60 percent of the value of the ethyl alcohol or mixture, if entered during calendar year 1988, and (3) 75 percent of the value of the ethyl alcohol or mixture, if entered after December 31, 1988." Senate Report 100-71, page 215, Section 898.

Table 5-1
The effect of indigenous feedstock requirements on the cost of production assuming landed cost of imported feedstock of $0.63[1]

A	*B*	*C*	*D*	*E*
Indigenous feed-stock value share requirement (s)	*Share of CBI ethanol by volume (g)*	*Cost of production*	*Effective value added*	*Value added cost*
Percent	*Percent*		*Percent*	
10.0	8.1	$0.97	12.0	$0.93
15.0	12.4	.99	18.0	.93
20.0	16.8	1.01	23.0	.93
25.0	21.5	1.03	29.0	.93
30.0	26.3	1.05	35.0	.94
35.0	31.4	1.08	41.0	.97
40.0	36.8	1.10	47.0	1.00
45.0	42.3	1.13	52.0	1.03
50.0	48.2	1.16	58.0	1.07
55.0	54.3	1.19	64.0	1.10
60.0	60.8	1.22	70.0	1.14
65.0	67.6	1.25	76.0	1.19
70.0	74.7	1.28	82.0	1.23
75.0	82.3	1.32	88.0	1.28

[1] This table assumes indigenous hydrous feedstock cost of $1.20 per gallon, dehydration cost for indigenous feedstock of $0.20 per gallon, landed cost of imported hydrous feedstock of $0.63 per gallon, and dehydration cost of imported feedstock of $0.30 per gallon.

Source: USITC estimates based on questionnaire data and information from other industry sources.

1988 for CBI producers, and are based on questionnaire data and information from other industry sources. While these costs are considered as generally "representative" of plants in the Caribbean Basin, they do not reflect specific costs for any specific plant. The cost of production will of course vary from plant to plant and country to country. The figures are meant to illustrate the effects of changing feedstock costs.

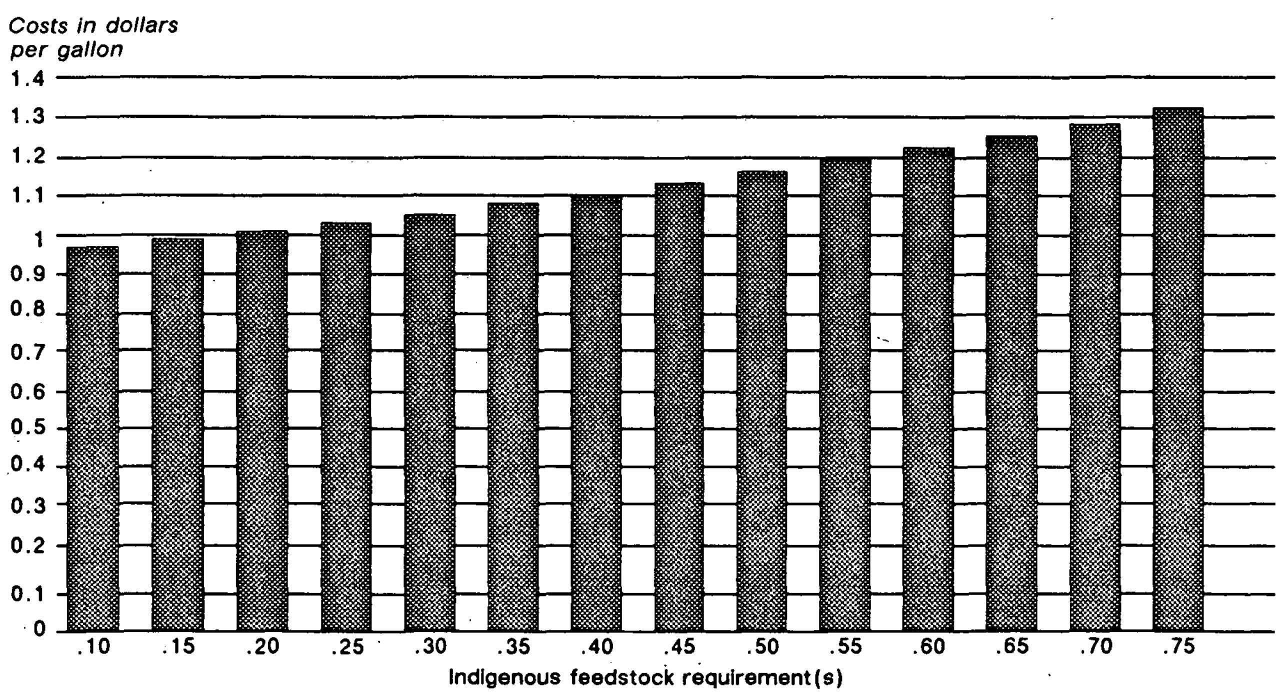
According to industry sources, hydrous feedstock imported from the EC tends to be of a lower quality than CBI feedstock. It is often contaminated with residue and is substantially less than 190 proof. Distillation and dehydration costs are thus higher for hydrous feedstock imported from EC countries than for either U.S. or CBI hydrous feedstock.

Based on the numbers in table 5-1, Figure 5-1 is a graphic representation of the relationship between different feedstock requirements and the cost of production. It can be seen that a 30-percent feedstock requirement results in a per-gallon cost of approximately $1.05 (excluding shipping). CBI feedstock represents 26 percent of the final product, by volume. If we define value added as including the costs of both CBI feedstock and dehydration, then the 30-percent feedstock requirement results in a 35-percent value added, according to column D of table 5-1.

However, this figure can be misleading. This does not mean that a 30-percent feedstock requirement and a 35-percent value added requirement are identical. The effective va added of 35 percent in table 5-1 represents percent of a higher cost than would have resulted with a straight 35-percent value added requirement. Column E of table 5-1 presents the lowest cost of production actually possible with a value added requirement identical to that in Column D and with no indigenous feedstock requirement. It can be seen that, although the 30-percent feedstock results in a 35-percent value added, it also results in a cost of production 12 percent higher than with only a 35-percent value added requirement.

The cost figures in table 5-1 are based on questionnaire data, discussion with industry sources, and information submitted by industry representatives in pre- and post-hearing briefs. (For example, see the statement of John G. Reilly prepared for BioCom, LAICA, and Tropicana.) However, the effect of feedstock requirements on production costs depends critically on the landed cost of imported hydrous feedstock. Tables 5-2 and 5-3 present alternative estimates of the cost of production with different imported feedstock costs. Tables 5-2 and 5-3 assume imported hydrous feedstock costs of $1.00 and $0.35 respectively. At a price of $0.63 per gallon of imported feedstock, going from a 10-percent to a

Figure 5-1
CBI feedstock requirements and cost



Source: USITC estimates based on questionnaire data and information from other industry sources.

Table 5-2

The effect of indigenous feedstock requirements on the cost of production assuming landed cost of imported feedstock of $1.00[1]

A	B	C	D	E
Indigenous feed-stock value share requirement (s)	*Share of CBI ethanol by volume (g)*	*Cost of production*	*Effective value added*	*Value added cost*
Percent	*Percent*		*Percent*	
10.0	10.9	$1.31	12.0	$1.30
15.0	16.5	1.32	18.0	1.30
20.0	22.0	1.32	23.0	1.30
25.0	27.7	1.33	29.0	1.31
30.0	33.3	1.33	35.0	1.31
35.0	39.1	1.34	41.0	1.32
40.0	44.8	1.34	47.0	1.33
45.0	50.6	1.35	53.0	1.34
50.0	56.5	1.36	58.0	1.34
55.0	62.4	1.36	64.0	1.35
60.0	68.4	1.37	70.0	1.36
65.0	74.4	1.37	76.0	1.37
70.0	80.5	1.38	82.0	1.37
75.0	86.7	1.39	88.0	1.37

[1] This table assumes indigenous hydrous feedstock cost of $1.20 per gallon, dehydration cost for indigenous feedstock of $0.20 per gallon, landed cost of imported hydrous feedstock of $1.00 per gallon, and dehydration cost for imported feedstock of $0.30 per gallon.

Source: USITC estimates based on questionnaire data and information from other industry sources.

Table 5-3

The effect of indigenous feedstock requirements on the cost of production assuming landed cost of imported feedstock of $0.35[1]

A	B	C	D	E
Indigenous feed-stock value share requirement (s)	*Share of CBI ethanol by volume (g)*	*Cost of production*	*Effective value added*	*Value added cost*
Percent	*Percent*		*Percent*	
10.0	5.8	$0.69	12.0	$0.65
15.0	9.0	.72	18.0	.65
20.0	12.4	.74	23.0	.65
25.0	16.0	.77	29.0	.65
30.0	20.0	.80	35.0	.65
35.0	24.3	.83	41.0	.65
40.0	28.9	.87	47.0	.65
45.0	33.9	.90	53.0	.69
50.0	39.4	.95	58.0	.74
55.0	45.4	.99	64.0	.79
60.0	52.0	1.04	70.0	.85
65.0	59.3	1.09	76.0	.92
70.0	67.4	1.16	82.0	1.01
75.0	76.5	1.22	88.0	1.10

[1] This table assumes indigenous hydrous feedstock cost of $1.20 per gallon, dehydration cost for indigenous feedstock of $0.20 per gallon, landed cost of imported hydrous feedstock of $0.35 per gallon, and dehydration cost for imported feedstock of $0.30 per gallon.

Source: USITC estimates based on questionnaire data and information from other industry sources.

75-percent feedstock requirement adds 35 cents per gallon to the cost of production. By contrast, when the landed cost of imported feedstock is $1.00 per gallon, going from a 10 percent to a 75-percent feedstock requirement adds only 8 cents per gallon of anhydrous ethanol. The effect of increasing feedstock requirements on the cost of production is much greater with lower imported feedstock costs than with higher feedstock costs.

The cost figures in tables 5-1, 5-2, and 5-3 all assume that the cost of CBI feedstock is $1.20 per gallon. This assumption does represent the current average cost per gallon, but this cost may change in the future. The effects of different feedstock requirements on production costs will vary as CBI hydrous feedstock costs vary. Tables 5-4 and 5-5 present production costs given CBI hydrous feedstock prices of $1.50 and $0.90 per gallon, respectively. With a cost of $1.50 per gallon for CBI feedstock, going from a 10-percent to a 75-percent feedstock requirement adds 53 cents per gallon to the cost of production. With a cost of $0.90 per gallon for CBI feedstock, going from a 10-percent to a 75-percent feedstock requirement adds only 13 cents per gallon.

Employment in the CBERA-Ethanol Industry

In the CBERA-ethanol industry, production of fuel ethanol from indigenous feedstock involves employing a significantly larger amount of local labor than production using imported hydrous feedstock. This is because the production of local hydrous feedstock from sugarcane or molasses through fermentation requires the employment of cane workers and of local labor. This is in addition to the labor required to dehydrate the resulting hydrous feedstock.

Table 5-6 presents the average amount of labor employed to produce 1 million gallons of fuel ethanol under different indigenous feedstock requirements. The values in the table are based on industry average levels of employment based on questionnaire data and other industry sources, and are not necessarily representative of any particular CBERA production facility. The table assumes the average production costs reported by industry sources and used to calculate the production cost figures in table 5-1. It can be seen that increasing the indigenous feedstock requirement from 30 to 60 percent increases labor employed to produce 1 million gallons from 219 to 467 workers. From table 5-1, this change increases producton costs from $1.05 to $1.22 per gallon.

Table 5-4

The effect of indigenous feedstock requirements on the cost of production assuming landed cost of indigenous hydrous feedstock of $1.50[1]

A	B	C	D	E
Indigenous feed-stock value share requirement (s)	*Share of CBI ethanol by volume (g)*	*Cost of production*	*Effective value added*	*Value added cost*
Percent	*Percent*		*Percent*	
10.0	6.5	$0.98	11.0	$0.93
15.0	10.1	1.01	17.0	.93
20.0	13.8	1.04	23.0	.93
25.0	17.8	1.07	28.0	.93
30.0	22.0	1.10	34.0	.94
35.0	26.5	1.13	40.0	.98
40.0	31.2	1.17	45.0	1.02
45.0	36.3	1.21	51.0	1.06
50.0	41.7	1.25	57.0	1.11
55.0	47.5	1.30	62.0	1.16
60.0	53.8	1.34	68.0	1.22
65.0	60.5	1.40	74.0	1.29
70.0	67.7	1.45	79.0	1.36
75.0	75.6	1.51	85.0	1.44

[1] This table assumes indigenous hydrous feedstock cost of $1.50 per gallon, dehydration cost for indigenous feedstock of $0.20 per gallon, landed cost of imported hydrous feedstock of $0.63 per gallon, and dehydration cost for imported feedstock of $0.30 per gallon.

Source: USITC estimates based on questionnaire data and information from other industry sources.

Table 5-5

The effect of indigenous feedstock requirements on the cost of production assuming landed cost of indigenous hydrous feedstock of $0.90[1]

A	B	C	D	E
Indigenous feed-stock value share requirement (s)	*Share of CBI ethanol by volume (g)*	*Cost of production*	*Effective value added*	*Value added cost*
Percent	*Percent*		*Percent*	
10.0	10.5	$0.95	12.0	$0.93
15.0	16.0	.96	18.0	.93
20.0	21.5	.97	24.0	.93
25.0	27.1	.98	31.0	.93
30.0	32.9	.99	37.0	.94
35.0	38.7	1.00	43.0	.95
40.0	44.7	1.01	49.0	.97
45.0	50.8	1.02	55.0	.98
50.0	57.1	1.03	61.0	1.00
55.0	63.4	1.04	67.0	1.01
60.0	69.9	1.05	73.0	1.03
65.0	76.6	1.06	79.0	1.04
70.0	83.4	1.07	86.0	1.06
75.0	90.3	1.08	92.0	1.08

[1] This table assumes indigenous hydrous feedstock cost of $0.90 per gallon, dehydration cost for indigenous feedstock of $0.20 per gallon, landed cost of imported hydrous feedstock of $0.63 per gallon, and dehydration cost for imported feedstock of $0.30 per gallon.

Source: USITC estimates based on questionnaire data and information from other industry sources.

Table 5-6

The effect of indigenous feedstock requirements on the amount of labor employed to produce 1 million gallons of anhydrous ethanol[1]

A	B	C	D	E
Indigenous feed-stock value share requirement (s)	*Cane workers[2]*	*Processing and fermentation*	*Dehydration*	*Total*
Percent	*Labor employed*			
10.0	43	15	29	87
15.0	66	23	29	118
20.0	90	31	29	150
25.0	115	39	29	184
30.0	141	48	29	219
35.0	169	58	29	255
40.0	197	67	29	294
45.0	227	77	29	334
50.0	259	88	29	376
55.0	222	99	29	420
60.0	326	111	29	467
65.0	362	124	29	516
70.0	401	123	29	567
75.0	442	151	29	622

[1] This table assumes indigenous hydrous feedstock cost of $1.20 per gallon, dehydration cost for indigenous feedstock of $0.20 per gallon, landed cost of imported hydrous feedstock of $0.63 per gallon, and dehydration cost for imported feedstock of $0.30 per gallon.

[2] Employment of cane workers assumes 9.59 workers per thousand short tons of cane, and 17.86 gallons of ethanol from one short ton of cane. These figures are based on employment and production data for Belize, Costa Rica, Guatemala, Honduras, and Jamaica. Cane workers include the labor required on an annual basis for planting, field maintenance, harvesting, and related activities. Since sugarcane can not be harvested in the first few years after planting, these numbers represent long-run employment levels for producing 1 million gallons under a given value-share requirement.

Source: USITC estimates based on USDA data; questionnaire data, and data from other industry sources. Numbers may not sum due to rounding.

Table 5-6 demonstrates that changing the indigenous feedstock requirement for CBI producers does increase the amount of labor used to produce ethanol. This results in a reallocation of cane workers from producing cane for sugar to producing cane for ethanol. However, because the ethanol industry represents only a residual share of total demand for cane, there is not a significant effect on total employment of cane workers. Rather, there is primarily a reallocation of cane workers.

Net Corn Costs and Domestic Production Costs

Whereas feedstock prices and CBERA feedstock requirements are very important to the cost of production for CBI producers, net corn costs are a critical determinant of the cost of production for domestic producers. Ethanol yields are approximately 2.5 gallons per bushel of corn for wet milling and 2.6 gallons per bushel of corn for dry milling. At a corn cost of $2.60 per bushel, this would mean a feedstock cost of $1.04 per gallon for wet milling and $1.00 for dry milling. However, byproduct sales can substantially reduce this cost. Byproduct yields from wet milling one bushel of corn are about 13 pounds of corn gluten feed, 3 pounds of corn gluten meal, and 1.7 pounds of corn oil. For dry milling, byproduct yields are about 17 to 18 pounds of distillers' dried grains with solubles (DDGS) per bushel. Sale of these byproducts can lead to substantial reductions in corn feedstock costs.

Table 5-7 and figure 5-2 present USITC estimates of net corn costs for wet milling and dry milling for January-March 1985 through April-June 1988. It can be seen net-corn costs fell dramatically from 1985 through 1986, though they have been increasing since January-March 1987.

The U.S. Department of Agriculture, Economic Research Service (USDA-ERS), study *Ethanol: Economic and Policy Tradeoffs*, surveyed the six largest ethanol producers (over 40 million gallons per year) as well as five small and medium sized producers. Average operating costs are reported, excluding net corn costs. Operating costs were averaged across wet-mill and dry-mill operations by ERS, and were not reported separately for each mill type. Excluding net corn costs, the industry average costs per gallon of anhydrous ethanol were $0.17 for energy, $0.24 for ingredients, personnel, and maintenance, and $0.06 for management, administration, insurance, and taxes. Capital charges per gallon ranged from $0.19 to $0.48 per gallon. Based on these figures, the increase in net corn costs since 1987 has led to an approximate increase in the average variable cost of production (excluding fixed costs) from $0.61 to $0.92 per gallon.[1]

The Effects of Alternative Content Requirements

This section presents estimates of the effects of alternative content requirements on CBI countries and on the U.S industry. Two different scenarios are presented, based on alternative assumptions about future market conditions. The importance of gasoline prices as a determinant of CBI fuel ethanol export performance is also considered.

The level of ethanol imports depends on corn costs, CBERA feedstock requirements, the cost of imported and CBI hydrous feedstocks used by CBI producers, and also, the price of gasoline. Ethanol can be used as a gasoline extender, an octane enhancer, and an oxygenator. As an octane enhancer, ethanol

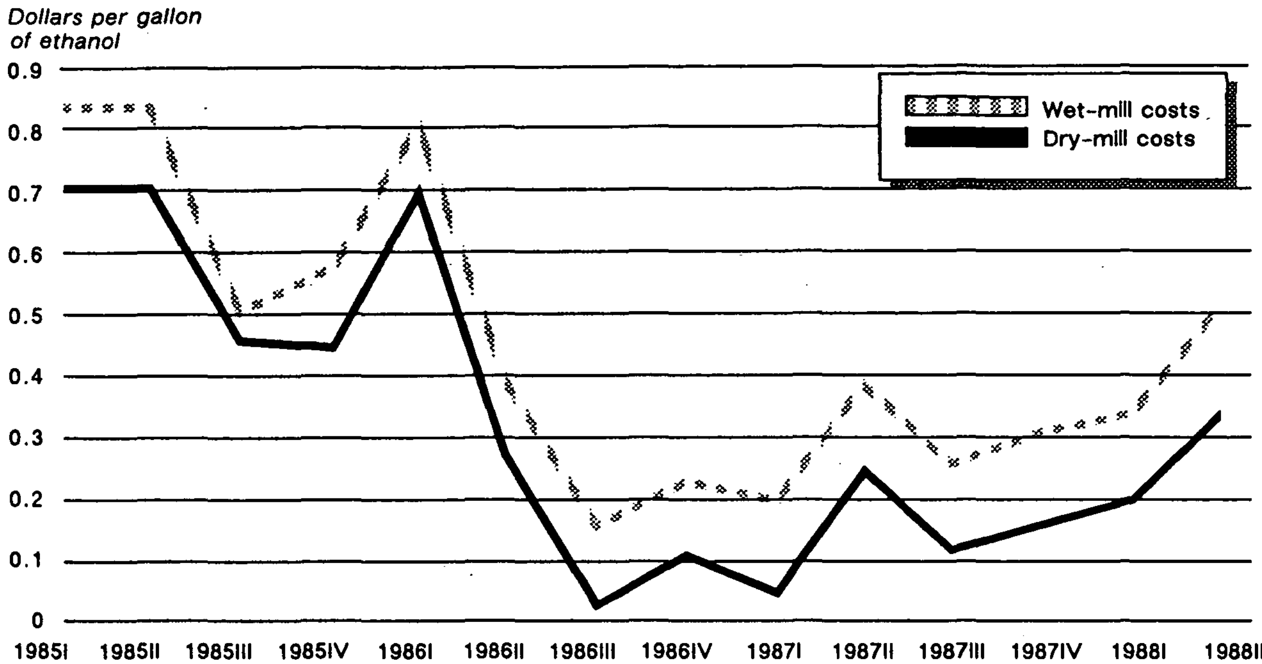
[1] These figure are, at best, approximations. Of course, the least efficient producers would be expected to drop out of the market as costs increase, possibly reducing the average value of other operating costs. The average total cost figure in the text includes an average of wet- and dry-milling net corn costs weighted by wet-milling and dry-milling corn usage in 1987/88.

Table 5-7
Net-corn costs per gallon for ethanol production

Quarter	*Dry milling*	*Wet milling*
1985 I	$0.71	$0.84
1985 II	.71	.84
1985 III	.46	.51
1985 IV	.45	.58
1986 I	.71	.82
1986 II	.27	.39
1986 III	.03	.16
1986 IV	.11	.23
1987 I	.05	.20
1987 II	.25	.39
1987 III	.12	.26
1987 IV	.16	.31
1988 I	.20	.34
1988 II	.34	.52

Source: USITC estimates based on byproduct yields reported by the National Advisory Panel on Cost-Effectiveness of Fuel Ethanol Production report (1987) and byproduct prices reported in the Economic Research Services study (1988), various issues of *Alcohol Outlook*, and in official data of the U.S. Bureau of Labor Statistics.

Figure 5-2
Net corn cost per gallon



Source: USITC estimates based on questionnaire data and information from other industry sources.

must compete with several alternatives, including methanol, MTBE, and high-octane gasoline. Through blending, high-octane gasoline can itself be used to boost the octane of low-grade gasolines as well, and low-octane gasolines can thus be boosted to higher octanes without adding additional MTBE, ethanol, or methanol. Production of higher octane gasolines at the refining and processing stage is also more cost effective than using octane enhancers as crude petroleum and gasoline prices fall relative to the prices of MTBE, ethanol, and methanol.[1] Given changes in the price of gasoline, the demand for ethanol will also shift. As the price of gasoline falls, ethanol becomes less attractive as a gasoline extender and as an octane enhancer. As a result, demand for both CBI and U.S. ethanol declines.

Table 5-8 presents the effects that feedstock changes have on CBI countries and on U.S. producers. These figures are based on the following scenario. Net corn costs for U.S. firms are assumed to be equal to their average level for the second half of 1987, which were estimated to be $0.28 per gallon for wet mills, and $0.14 per gallon for dry mills. Average unleaded gasoline prices were assumed to be equal to the average price level for the second half of 1987, when unleaded regular gasoline sold for an average retail price of $0.98 per gallon (according to official statistics of the U.S. Bureau of Labor Statistics). The changes in production costs for CBI producers are based on the figures in table 5-1, which reflect actual 1988 production costs. Columns B and C present the estimated price and quantity of imports of fuel ethanol from CBI countries under various feedstock requirements. These feedstock requirements can be related to value added requirements using table 5-1.

Table 5-8 shows, for example, that raising the indigenous feedstock level from the baseline case of 30 percent to a level of 60 percent results in a net loss to the economies of CBI countries of $483,000 per year and a loss to U.S. consumers of $6,166,000, with a gain to U.S. producers of $2,696,000. This effect is identical to increasing a volume share requirement from 26 percent to 61 percent. The change also results in an increase in the sale of ethanol by U.S. producers of 2,749,000 gallons. These gains and losses to producers represent gained or lost revenue net of income that could be earned elsewhere by labor, capital, farmers, and others that are displaced as a result of the changes. Since CBI ethanol is produced almost exclusively for the U.S. market, CBI losses also represent the decrease in the Gross Domestic Product (GDP) from the baseline case.

Table 5-8 also reports employment effects for the CBI fuel ethanol industry. While higher indigenous feedstock requirements imply higher

[1] For information on the changing role of fuel ethanol, see the proceedings of "Government and Marketplace Developments and Their Impact on the Environment, the Farm Economy, Trade and Gasoline Consumption," a conference sponsored by the Renewable Fuels Association, Washington, October 1988.

levels of local employment in the industry for a given level of output, there are several other factors that must be considered as well. Given the higher cost of production associated with indigenous CBI fuel ethanol, these higher levels of local employment within the sector will be accompanied by higher production costs. Increasing indigenous feedstock requirements forces CBI-ethanol producers to use a more expensive production process. These higher costs in turn imply lower sales volume, which offsets some of the employment increase in the sector caused by a higher feedstock requirement.

As the indigenous feedstock requirement is increased from the baseline level of 30 percent in table 5-8, the combination of higher production costs and reduced sales volume results in a net decrease in the contribution of the ethanol industry to CBI GDP levels. At the same time, the increase in the number of cane workers devoted to the CBI ethanol industry can be accounted for primarily by a reallocation of existing cane production from sugar and molasses to ethanol. The change in employment in the sector does not imply a net change in overall local employment of the same magnitude. Based on questionnaire responses, the shift from a 30-percent to a 60-percent feedstock requirement results in the shifting of approximately 4,152 additional CBI workers into planting and harvesting sugarcane for fermentation and into actually producing the hydrous feedstock for dehydration, and results in the employment of an additional 8 workers annually in the domestic industry. However, the net effect on CBI countries is a decline in national income of $483,000 per year. The employment effects on the domestic industry are not of the same magnitude as the effects on the CBI industry. This is because the analysis assumes that all existing U.S. agricultural production subsidy and price support programs remain in place. The employment effects in the United States are thus focused on ethanol production workers.[1]

[1] Given that CBI ethanol production is less than 4 percent of U.S. market, and that U.S. fuel ethanol production in turn accounts for approximately 4 percent of domestic corn consumption, going from a 30-percent to a 60-percent feedstock requirement increases total demand for corn by less than .015 percent. For an analysis of the effects of changing ethanol production subsidies for domestic corn growers, see USDA Agricultural Economic Report Number 562, *Fuel Ethanol and Agriculture: An Economic Assessment*, August 1986. Domestic employment figures are based on output per hour worked as reported in table 5 of *Certain Ethyl Alcohol from Brazil*, USITC pub. 1818, March 1986.

Table 5-8

Annual effects of alternative feedstock requirements relative to baseline case of 30-percent feedstock requirement scenario 1[1]

A	B	C	D	E	F	G	H
Feedstock value share(s)	*CBI price*	*CBI exports*	*Displaced domestic production*	*CBI gains*	*Gain to domestic producers*	*Gain to domestic consumers*	*CBI employment shift*
Percent	*c.i.f. dollars per gallon*	*—Thousand gallons—*		*Thousand of dollars*			
Baseline case:							
30.0	1.153	28,300.76	([2])	([2])	([2])	([2])	([2])
Changes from baseline case:							
10.0	1.087	32,501.55	1,441.79	286.99	-1,410.80	3,442.83	-3,481
15.0	1.103	31,364.81	1,071.17	211.60	-1,048.35	2,540.78	-2,579
20.0	1.120	30,288.55	707.50	139.12	-692.56	1,667.57	-1,701
25.0	1.136	29,268.57	350.52	67.08	-263.73	648.86	-842
35.0	1.177	26,939.48	-514.19	-96.06	503.72	-1,188.34	729
40.0	1.193	26,087.53	-849.58	-157.25	832.42	-1,953.69	1,536
45.0	1.218	24,884.00	-1,342.04	-245.28	1,315.28	-3,064.68	2,218
50.0	1.243	23,767.72	-1,822.34	-328.39	1,786.47	-4,134.73	2,878
55.0	1.267	22,725.70	-2,291.07	-407.61	2,246.54	-5,167.36	3,521
60.0	1.291	21,752.84	-2,748.77	-482.99	2,696.03	-6,165.70	4,152
65.0	1.316	20,843.09	-3,195.97	-555.05	3,135.39	-7,132.53	4,773
70.0	1.340	19,991.00	-3,633.14	-623.58	3,565.13	-8,070.30	5,390
75.0	1.371	18,936.31	-4,201.18	-710.18	4,123.84	-9,279.30	5,853

[1] Net corn costs are assumed to be $0.28 for U.S. dry mill producers, and $0.14 per gallon for U.S. wet mill producers, and unleaded regular gasoline is assumed to sell for an average retail price of $0.98. Imports were actually 18,373,000 gallons for July-December 1987, which would represent 36,747,000 gallons on an annual basis. However, production costs were also higher in 1988 than they were in July-December 1987. Since cost figures are based on the values in table 5-1, which represent the higher 1988 costs, import figures have been adjusted to account for the higher cost of production.
[2] Not applicable.

Source: USITC estimates based on questionnaire data, official data of the U.S. Bureau of Labor Statistics, U.S Department of Transportation, U.S. Department of Commerce, U.S. Department of Agriculture, and information from other industry sources, including Information Resources, Inc.

Since the beginning of 1988, net corn costs have increased dramatically for U.S. ethanol producers. For the second quarter of 1988, net corn costs for wet mill production were approximately 52.4 cents per gallon, and net corn costs for dry mills were approximately 33.7 cents per gallon, compared with 28.3 cents and 14 cents in the last half of 1987. Table 5-9 presents annual estimates of the effects of various feedstock requirements under a second scenario, with net corn costs at their second quarter 1988 levels. Gasoline prices are still assumed to remain at July-December 1987 levels. This increase in the cost of production for U.S. producers leads to a large increase in the baseline level of imports, from 28.3 million gallons to 42.8 million gallons. Given the higher level of imports, changes in feedstock requirements have a greater effect on domestic and CBI producers than under the first scenario. Under the second scenario, increasing the feedstock requirement from 30 percent to 60 percent by value leads to an annual loss of $832,000 for CBI countries, a loss of $8,712,000 for U.S. consumers, and a gain of $2,800,000 for the domestic industry. An additional 2,718,000 gallons are sold by the domestic industry. An additional 6,284 cane workers are shifted over to ethanol production, and an additional 8 U.S. workers are employed by the domestic industry.

An important determinant of the demand for fuel ethanol is the price of gasoline. From 1985 II to 1988 II, the retail price of unleaded gasoline (according to official U.S. Bureau of Labor Statistics data) has fallen from an average of $ 1.23 per gallon to $ 0.95 per gallon. Changes of this magnitude in the price of gasoline have as great an effect on CBI fuel ethanol exports as changing feedstock requirements. To illustrate this point, table 5-10 presents estimated export quantities, prices (c.i.f), and the contribution of ethanol exports to CBI Gross Domestic Product (GDP) given various gasoline prices. Apart from gasoline prices, all other parameters are the same as the scenario 1 baseline case of table 5-8, with a feedstock requirement of 30 percent by value. A decline in the price of gasoline from 97 cents to 92 cents per gallon, as happened between the last quarter of 1987 and the first quarter of 1988, leads to a decline in imports of almost 10 million gallons annually. Based on the scenario 1 estimates in table 5-10, Figure 5-3 presents CBI fuel ethanol exports and total export revenues for unleaded regular gasoline prices ranging from $1.16 to $0.84 per gallon. From 1985 II to 1988 II, the price of gasoline has fallen from an average of $ 1.23 to $0.95. Under scenario 1, this implies a decline in CBI exports from over 100 million gallons to under 24 million gallons. This decline suggests that any benefits the CBI

Table 5-9
Annual effects of alternative feedstock requirements relative to baseline case of 30 percent feedstock requirement Scenario 2[1]

A	B	C	D	E	F	G	H
Feedstock value share(s)	*CBI price*	*CBI exports*	*Displaced domestic production*	*CBI gains*	*Gain to domestic producers*	*Gain to domestic consumers*	*CBI employment shift*
Percent	*c.i.f. dollars per gallon*	*—Thousand gallons—*		*——— Thousand of dollars ———*			
Baseline case							
30.0	1.311	42,832.52	(2)	(2)	(2)	(2)	(2)
Changes from baseline case							
10.0	1.235	49,190.30	1,425.49	489.88	-1,465.53	4,962.39	-5,268
15.0	1.254	47,469.86	1,059.06	360.16	-1,089.03	3,657.29	-3,904
20.0	1.273	45,840.97	699.50	235.46	-719.44	2,397.28	-2,574
25.0	1.292	44,297.15	346.56	115.49	-273.98	1,000.09	-1,275
35.0	1.339	40,772.24	-508.38	-165.39	523.23	1,701.43	1,103
40.0	1.358	39,482.83	-839.97	-270.73	864.67	2,794.30	2,325
45.0	1.386	37,663.99	-1,326.87	-421.89	1,366.26	4,375.83	3,356
50.0	1.414	35,971.86	-1,801.74	-565.37	1,855.72	5,896.86	4,355
55.0	1.442	34,394.78	-2,265.17	-701.74	2,333.63	7,360.09	5,329
60.0	1.469	32,922.41	-2,717.70	-831.52	2,800.55	8,711.52	6,284
65.0	1.496	31,545.51	-3,159.84	-955.16	3,257.04	-10,135.50	7,224
70.0	1.523	30,255.91	-3,592.06	-1,073.10	3,703.45	-11,456.20	8,157
75.0	1.559	28,659.64	-4,153.69	-1,222.13	4,283.83	-13,155.70	8,858

[1] Net corn costs are assumed to be $0.53 for U.S. dry mill producers, and $0.34 per gallon for U.S. wet mill producers, and unleaded regular gasoline is assumed to sell for an average retail price of $0.98. Since cost figures are based on the values in table 5-1, which represent the higher 1988 costs, import figures have been adjusted to account for the higher cost of production.
[2] Not Applicable.

Source: USITC estimates based on questionnaire data, official data of the U.S. Bureau of Labor Statistics, U.S Department of Transportation, U.S. Department of Commerce, U.S. Department of Agriculture, and information from other industry sources, including Information Resources, Inc.

Table 5-10
Gasoline prices and CBI exports of ethanol

A	B	C	D	E
Gasoline price	*CBI exports*	*CBI price*	*Export revenues*	*Contribution to CBI GDP*
Dollars per gallon	*Millions of gallons*	*Dollars per gallon (c.i.f.)*	*—— Millions of dollars ——*	
1.20	125,239.4	1.38	172,358	18,369
1.18	110,696.8	1.36	150,117	15,998
1.16	97,636.7	1.34	130,438	13,901
1.14	85,929.6	1.32	113,062	12,049
1.12	75,455.5	1.30	97,754	10,418
1.10	66,103.1	1.28	84,296	8,984
1.08	57,769.4	1.25	72,494	7,726
1.06	50,359.3	1.23	62,169	6,626
1.04	43,785.1	1.21	53,159	5,665
1.02	37,965.9	1.19	45,316	4,829
1.00	32,827.2	1.17	38,509	4,104
0.98	28,300.8	1.15	32,617	3,476
0.96	24,323.9	1.13	27,532	2,934
0.94	20,839.4	1.11	23,156	2,468
0.92	17,794.7	1.09	19,404	2,068
0.90	15,142.3	1.07	16,197	1,726
0.88	12,838.5	1.05	13,465	1,435
0.86	10,844.0	1.03	11,146	1,188
0.84	9,123.1	1.01	9,186	979

Source: USITC estimates based on questionnaire data, official data of the U.S. Bureau of Labor Statistics, U.S Department of Transportation, U.S. Department of Commerce, U.S. Department of Agriculture, and information from other industry sources, including Information Resources, Inc.

countries may receive from exports of fuel ethanol to the United States depend critically on gasoline prices.[1]

Chapter Summary

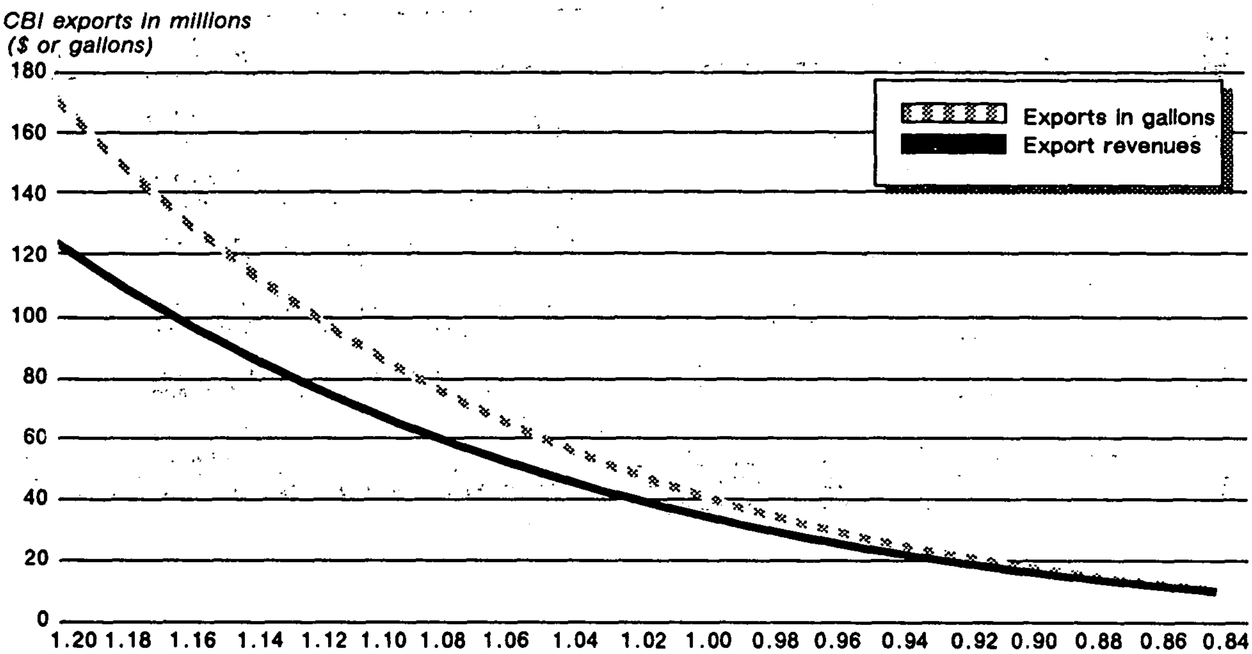
This chapter has demonstrated that there are several factors, in addition to the indigenous feedstock requirement, that have a significant influence on the level of ethanol exports from the CBI and the contribution of ethanol to the U.S. and CBI economies. These other factors include the cost of imported hydrous feedstock in CBI countries, indigenous CBI feedstock costs, net corn costs for U.S. producers, and gasoline prices. In recent years, these factors have been at least as important to CBI ethanol producers as the indigenous feedstock requirement. Because so many factors influence CBI ethanol exports, it is not possible to mandate a single feedstock requirement that will guarantee a CBI ethanol industry of any particular size that has a minimal effect on the U.S. ethanol industry.

[1] Between July-December 1987 and January-June 1988, the average retail price of unleaded gasoline fell from \$0.98 to \$0.935, the indigenous feedstock requirement was increased, and CBI production costs rose with the price of European ethanol. The model predicts that, under these conditions, CBI exports would be approximately 16 million gallons annually. CBI exports actually were running at an annual rate of approximately 16 million gallons in the first half of 1988. The more dramatic the changes in gasoline or feedstock costs relative to current levels, the more likely it is that actual future values will deviate appreciably from predicted values.

Feedstock requirements have a significant effect on the cost of production for CBI ethanol producers. However, the effects variable requirements have on the cost of production depend on several factors, including the cost of indigenous feedstock, the cost of imported feedstock, and the cost of dehydration. Feedstock requirements are a more significant aspect of production costs when imported feedstock costs are low than with higher imported feedstock costs.

It is important to note in the examples provided that a single feedstock requirement simply cannot compensate for all of the variations that occur in gasoline prices, European wet ethanol prices, and U.S. net corn costs. On the basis of recent variations in these prices, it can be expected that the health of the CBI and U.S. industries will depend greatly on these variations, whatever the feedstock requirement. For example, under the first scenario of section 5-5, which most closely resembles market conditions in 1987, a 30-percent feedstock requirement would allow the CBI ethanol industry to export approximately 28.3 million gallons of fuel ethanol to the United States annually, which is close to actual 1987 export levels. However, this assumes that the average retail price of unleaded regular gasoline remains at 98 cents per gallon, and that CBI production costs remain at current levels. Gasoline prices fell well below 1987 levels in 1988. If gasoline prices were to remain at its 1988 level of 94 cents per gallon and the indigenous requirement frozen at 30 percent, CBI fuel ethanol exports to the United States would

Figure 5-3
CBI ethanol exports and gasoline prices



Source: USITC estimates based on questionnaire data, official data of the U.S. Bureau of Labor Statistics, U.S. Department of Transportation, U.S. Department of Commerce, U.S. Department of Agriculture, and information from other industry sources, including Information Resources, Inc.

only be about 20 million gallons annually. Thus, even if a 30-percent feedstock requirement were found to make a 28.3-million-gallon industry "feasible," this would not be the case if gasoline prices remained below 98 cents.

Alternatively, under the market conditions assumed in the second scenario (which assumes mid-1988 net corn costs and a 98 cents per gallon price for gasoline), substantially higher net corn costs would make a 28.3 million gallon CBI industry possible with a 60-percent feedstock rule. However, with corn costs at the higher level and with gasoline prices at 94 cents per gallon, a level closer to actual 1988 levels, a 28.3-million-gallon CBI industry would only be possible with a feedstock requirment of 35 percent or less. This requirement is much lower than the mandated 60-percent rate actually in effect in 1988. Given mid-1988 market conditions, a 28.3-million-gallon CBI fuel ethanol industry would only be feasible with a feedstock requirement of 35 percent or less.

Within the constraints imposed by uncertainty about future market conditions, this chapter has analyzed the effects of alternative feedstock requirements under market conditions like those encountered in late-1987 and mid-1988. Under both late-1987 and mid-1988 market conditions, a CBI industry producing at approximately 1987 levels would only have been feasible with a feedstock requirement of less than 35 percent. However, future feasibility will depend on future market conditions. The alternative scenarios presented here are meant to illustrate the problems of trying to mandate a single feedstock requirement with known effects, even under relatively stable market conditions. The effectiveness of various feedstock requirements would vary even more dramatically with more significant swings in gasoline, net corn, and European wet ethanol costs. Fixing indigenous content requirements will not guarantee the feasibility of any particular level of production in CBI countries. Given changes in gasoline, net corn, and European wet ethanol prices, table 5-11 illustrates the direction of change that would be required in a mandated feedstock requirement to maintain a CBI industry of a particular size.[1]

[1] If a constant indigenous requirement can not ensure a feasible industry, industry sources suggested that other alternatives, such as an import quota, by country, similar to those on sugar, a variable import tax, or a percentage requirement that is revised annually (or more often, if needed) might also offer a solution to this problem. However, these alternatives have similar disadvantages. For example, a percentage requirement would have to be revised frequently, as would a variable tax, to take into account the impact of changing market conditions. However, this would severely impact the CBI sugarcane growers' ability to plan for future plantings. New sugarcane plants require about three years of growth before harvesting. An import quota, by country, might give the growers a more stable base, but would have to take into account complex factors affecting future U.S. demand and the opportunity for other CBI countries with facilities not yet operating or with developmental plans for facilities to enter this market. Establishment of quotas on fuel ethanol related to international treaties may also give rise to GATT and other problems.

Table 5-11

Change required in indigenous feedstock requirement necessary to maintain CBI production targets[1]

Market variable and direction of change	*Required change in feedstock requirement*
Indigenous feedstock cost:	
Increase	**Decrease**
Decrease	**Increase**
Imported feedstock cost:	
Increase	**Decrease**
Decrease	**Increase**
U.S. net corn cost:	
Increase	**Increase**
Decrease	**Decrease**
U.S. gasoline prices:	
Increase	**Increase**
Decrease	**Decrease**
U.S. ethanol consumption subsidies:	
Increase	**Increase**
Decrease	**Decrease**
U.S. ethanol production subsidies:	
Increase	**Decrease**
Decrease	**Increase**

[1] When more than one market factor changes at the same time, the necessary change in feedstock requirements would depend on the relative change in each of the factors.

APPENDIX A
EXCERPTS FROM THE TAX REFORM ACT OF 1986, THE OMNIBUS TRADE AND COMPETITIVENESS ACT OF 1988, AND THE TARIFF SCHEDULE OF THE UNITED STATES ANNOTATED (1987)

Public Law 100-418
100th Congress

An Act

To enhance the competitiveness of American industry, and for other purposes.

Aug. 23, 1988
[H.R. 4848]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Omnibus Trade and Competitiveness Act of 1988.
Exports.
Imports.
International agreements.
19 USC 2901 note.

SECTION 1. SHORT TITLE AND TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the "Omnibus Trade and Competitiveness Act of 1988".

(b) TABLE OF CONTENTS.—

SEC. 1910. ETHYL ALCOHOL AND MIXTURES FOR FUEL USE.

(a) IN GENERAL.—Subsection (b) of section 423 of the Tax Reform Act of 1986 (19 U.S.C. 2703, note) is amended—

(1) by striking out "and 1988" in paragraphs (1) and (2) and inserting in lieu thereof ", 1988, and 1989",

(2) by striking out "an insular possession of the United States or" in paragraph (1)(A),

(3) by striking out "January 1, 1986, or" in paragraph (1)(A) and inserting in lieu thereof "July 1, 1987,",

(4) by inserting "or an insular possession of the United States" after "beneficiary country" in paragraph (1)(B)(ii)(II),

(5) by striking out the period at the end of paragraph (1)(B) and inserting in lieu thereof ", or",

(6) by inserting the following new subparagraph after subparagraph (B) of paragraph (1):

"(C) a distillation facility operated by a corporation which, before the date of enactment of the Omnibus Trade Act of 1987—

"(i) has completed engineering and design of a full-scale fermentation facility in the United States Virgin Islands, and Virgin Islands.

"(ii) has obtained authorization from authorities of the United States Virgin Islands to operate a full-scale fermentation facility.", and

(7) by striking out "or (B)" in paragraph (2) and inserting in lieu thereof ", (B), or (C)".

(b) STUDIES.—

(1) The United States International Trade Commission and the Comptroller General of the United States shall each immediately undertake a study regarding whether the definition of indigenous ethyl alcohol or mixtures thereof used in applying section 423 of the Tax Reform Act of 1986 is consistent with, and will contribute to the achievement of, the stated policy of Congress to encourage the economic development of the beneficiary countries under the Caribbean Basin Economic Recovery Act and the insular possessions of the United States through the maximum utilization of the natural resources of those countries and possessions. Each study shall specifically include—

(A) an assessment regarding whether the indigenous product percentage requirements set forth in subsection (c)(2)(B) of such section 423 are economically feasible for ethyl alcohol producers; and

(B) if the assessment under subparagraph (A) is negative, recommended modifications to the indigenous product percentage requirements that—

(i) will ensure meaningful production and employment in the region,

(ii) will discourage pass-through operations, and

(iii) will not result in harm to producers of ethyl alcohol, or mixtures thereof, in the United States; and

(C) an assessment of the effects of imports of ethyl alcohol, and mixtures thereof, from such beneficiary countries and possessions on producers of ethyl alcohol, and mixtures thereof, in the United States.

(2) The United States International Trade Commission and the Comptroller General of the United States shall each submit a report containing the findings and conclusions of the study carried out under this subsection to the Committee on Ways and Means of the House of Representatives and the Committee on Finance of the Senate before the 180th day after the date of the enactment of this Act.

SEC. 1911. ENFORCEMENT OF RESTRICTIONS ON IMPORTS FROM CUBA.

The United States Trade Representative shall request that all relevant agencies prepare appropriate recommendations for improving the enforcement of restrictions on the importation of articles from Cuba. Such recommendations should include, but not be limited to, appropriate measures to prevent indirect shipments or other means of circumvention. The United States Trade Representative shall, after considering such recommendations, report to the Congress, within 90 days after the date of enactment of this Act, on any administrative measures or proposed legislation which the United States Trade Representative considers necessary and appropriate to enforce restrictions on imports from Cuba.

Reports.

SEC. 1912. CUSTOMS FORFEITURE FUND.

Section 613A of the Tariff Act of 1930 (19 U.S.C. 1613b) is amended—

(1) by striking out "beginning on the date of the enactment of this section, and ending on September 30, 1987," in subsection (c) and inserting in lieu thereof "described in subsection (a) for which the fund is available to the United States Customs Service,", and

(2) by striking out "private citizens" in subsection (a)(iii) and inserting in lieu thereof "private persons".

PART 2—MISCELLANEOUS TRADE PROVISIONS

SEC. 1931. TRADE STATISTICS.

(a) REPORTING OF IMPORT STATISTICS.—Subsection (e) of section 301 of title 13, United States Code, is amended by striking out the last sentence thereof.

13 USC 301 note.

(b) VOLUMETRIC INDEX.—

(1) The Director of the Census, in consultation with the Director of the Bureau of Economic Analysis and the Commissioner of Labor Statistics, shall conduct a study to determine the feasibility of developing, and of publishing, an index that measures the real volume of merchandise trade on a monthly basis, which would be reported simultaneously with the balance of merchandise trade for the United States.

Reports.

(2) The Director of the Census shall submit to the Committee on Finance of the Senate and the Committee on Ways and Means of the House of Representatives a report on the study conducted under paragraph (1) by no later than the date that is one year after the date of enactment of this Act.

SEC. 1932. ADJUSTMENT OF TRADE STATISTICS FOR INFLATION AND DEFLATION.

Subsection (e) of section 301 of title 13, United States Code, is amended by adding at the end thereof the following new sentence: "The information required to be reported under this subsection shall 'ace it appears and inserting in lieu thereof "Reduction in x".

(3) EFFECTIVE DATE.—The amendments made by this subsection shall take effect on January 1, 1987.

(b) EXTENSION OF REDUCTION IN TAX FOR FUEL USED BY TAXICABS.—Paragraph (3) of section 6427(e) (relating to termination) is amended by striking out "September 30, 1985" and inserting in lieu thereof "September 30, 1988".

SEC. 423. ETHYL ALCOHOL AND MIXTURES THEREOF FOR FUEL USE.

(a) IN GENERAL.—Except as provided in subsection (b), no ethyl alcohol or a mixture thereof may be considered—

(1) for purposes of general headnote 3(a) of the Tariff Schedules of the United States, to be—

(A) the growth or product of an insular possession of the United States,

(B) manufactured or produced in an insular possession from materials which are the growth, product, or manufacture of any such possession, or

(C) otherwise eligible for exemption from duty under such headnote as the growth or product of an insular possession; or

(2) for purposes of section 213 of the Caribbean Basin Economic Recovery Act, to be—

(A) an article that is wholly the growth, product, or manufacture of a beneficiary country,

(B) a new or different article of commerce which has been grown, produced, or manufactured in a beneficiary country,

(C) a material produced in a beneficiary country, or

(D) otherwise eligible for duty-free treatment under such Act as the growth, product, or manufacture of a beneficiary country;

unless the ethyl alcohol or mixture thereof is an indigenous product of that insular possession or beneficiary country.

(b) EXCEPTION.—

(1) Subject to the limitation in paragraph (2), subsection (a) shall not apply to ethyl alcohol that is imported into the United States during calendar years 1987 and 1988 and produced in—

(A) an azeotropic distillation facility located in an insular possession of the United States or a beneficiary country, if that facility was established before, and in operation on, January 1, 1986, or

(B) an azeotropic distillation facility—

(i) at least 50 percent of the total value of the equipment and components of which were—

(I) produced in the United States, and

(II) owned by a corporation at least 50 percent of the total value of the outstanding shares of stock of which were owned by a United States person (or persons) on or before January 1, 1986, and

(ii) substantially all of the equipment and components of which were, on or before January 1, 1986—

(I) located in the United States under the possession or control of such corporation,

(II) ready for shipment to, and installation in, a beneficiary country, and

(iii) which—

A-5

(I) has on the date of enactment of this Act,

(II) will have at the time such facility is placed in service (based on estimates made before the date of enactment of this Act),

a stated capacity to produce not more than 42,000,000 gallons of such product per year.

(2) The exception provided under paragraph (1) shall cease to apply during each of calendar years 1987 and 1988 to ethyl alcohol produced in a facility described in subparagraph (A) or (B) of paragraph (1) after 20,000,000 gallons of ethyl alcohol produced in that facility are entered into the United States during that year.

(c) DEFINITIONS.—For purposes of this section—

(1) The term "ethyl alcohol or a mixture thereof" means (except for purposes of subsection (e)) ethyl alcohol or any mixture thereof described in item 901.50 of the Appendix to the Tariff Schedules of the United States.

(2) Ethyl alcohol or a mixture thereof may be treated as being an indigenous product of an insular possession or beneficiary country only if the ethyl alcohol or a mixture thereof—

(A) has been both dehydrated and produced by a process of full-scale fermentation within that insular possession or beneficiary country; or

(B) has been dehydrated within that insular possession or beneficiary country from hydrous ethyl alcohol that includes hydrous ethyl alcohol which is wholly the product or manufacture of any insular possession or beneficiary country and which has a value not less than—

(i) 30 percent of the value of the ethyl alcohol or mixture, if entered during calendar year 1987, except that this clause shall not apply to any ethyl alcohol or mixture which has been dehydrated in the United States Virgin Islands by a facility with respect to which—

(I) the owner has entered into a binding contract for the engineering and design of full-scale fermentation capacity, and

(II) authorization for operation of a full-scale fermentation facility has been granted by the Island authorities before May 1, 1986,

(ii) 60 percent of the value of the ethyl alcohol or mixture, if entered during calendar year 1988, and

(iii) 75 percent of the value of the ethyl alcohol or mixture, if entered after December 31, 1988.

(3) The term "beneficiary country" has the meaning given to such term under section 212 of the Caribbean Basin Economic Recovery Act (19 U.S.C. 2702).

(4) The term "United States person" has the meaning given to such term by section 7701(a)(3) of the Internal Revenue Code of 1986.

(5) The term "entered" means entered, or withdrawn from warehouse, for consumption in the customs territory of the United States.

(d) AMENDMENT TO APPENDIX TO SCHEDULES.—The item designation for item 901.50 of the Appendix to the Tariff Schedules of the United States is amended to read as follows: "Ethyl alcohol (provided for in item 427.88, part 2D, schedule 4) or any mixture containing such ethyl alcohol (provided for in part 1, 2 or 10, schedule 4) if such ethyl alcohol or mixture is to be used as fuel or in producing a mixture of gasoline and alcohol, a mixture of a special fuel and alcohol, or any other mixture to be used as fuel (including motor fuel provided for in item 475.25), or is suitable for any such uses."

(e) DRAWBACKS.—

(1) For purposes of subsections (b) and (j)(2) of section 313 of the Tariff Act of 1930 (19 U.S.C. 1313), as amended by section 1888(2) of this Act, any ethyl alcohol (provided for in item 427.88 of the Tariff Schedules of the United States) or mixture containing such ethyl alcohol (provided for in part 1, 2, or 10 of schedule 4 of such Schedules) which is subject to the additional duty imposed by item 901.50 of the Appendix to such Schedules may be treated as being fungible with, or of being of the same kind and quality as, any other imported ethyl alcohol (provided for in item 427.88 of such Schedules) or mixture containing such ethyl alcohol (provided for in part 1, 2, or 10 of schedule 4 of such Schedules) only if such other imported ethyl alcohol or mixture thereof is also subject to such additional duty.

(2) Paragraph (1) shall not apply with respect to ethyl alcohol (provided for in item 427.88 of the Tariff Schedules of the United States) or mixture containing such ethly alcohol (provided for in part 1, 2, or 10 of schedule 4 of such Schedules) that is exempt from the additional duty imposed by item 901.50 of the Appendix to such Schedules by reason of—

(A) subsection (b), or

(B) any agreement entered into under section 102 (b) of the Trade Act of 1974.

(f) CONFORMING AMENDMENTS.—

(1) General headnote 3(a)(i) of the Tariff Schedules of the United States is amended by inserting "and except as provided in section 423 of the Tax Reform Act of 1986," after "part 7 of schedule 7,".

(2) Section 213(a)(1) of the Caribbean Basin Economic Recovery Act (19 U.S.C. 2703(a)(1)) is amended by inserting "and subject to section 423 of the Tax Reform Act of 1986," after "Unless otherwise excluded from eligibility by this title,".

(3) The headnotes to subpart A of part 1 of the Appendix to the Tariff Schedules of the United States are amended by adding at the end thereof the following:

"2. For purposes of item 901.50, the phrase 'is suitable for any such uses' does not include ethyl alcohol (provided for in item 427.88, part 2D, schedule 4) that is certified by the importer of record to the satisfaction of the Commissioner of Customs (hereinafter in this headnote referred to as the 'Commissioner') to be ethyl alcohol or a mixture containing such ethyl alcohol imported for uses other than liquid motor fuel use or use in producing liquid motor fuel related mixtures. If the importer of record certifies nonliquid motor fuel use for purposes of establishing actual use or suitability under item 901.50, the Commissioner shall not liquidate the entry of ethyl alcohol until he is satisfied that the ethyl alcohol has in fact not been used for liquid motor fuel use or use in producing liquid motor fuel related mixtures. If he is not satisfied within a reasonable period of time not less than 18 months from the date of entry, then the duties provided for in item 901.50 shall be payable retroactive to the date of entry. Such duties shall also become payable, retroactive

to the date of entry, immediately upon the diversion to liquid motor fuel use of any ethyl alcohol or ethyl alcohol mixture certified upon entry as having been imported for non-liquid motor fuel use."

(g) EFFECTIVE PERIOD.—

(1) The provisions of, and the amendments made by, this section (other than subsection (e)) shall apply to articles entered—

(A) after December 31, 1986, and

(B) before the expiration of the effective period of item 901.50 of the Appendix to the Tariff Schedules of the United States.

(2) The provisions of subsection (e) shall take effect on the date of the enactment of this Act.

TITLE V—TAX SHELTER LIMITATIONS; INTEREST LIMITATIONS

Subtitle A—Limitations On Tax Shelters

SEC. 501. LIMITATIONS ON LOSSES AND CREDITS FROM PASSIVE ACTIVITIES.

(a) GENERAL RULE.—Subpart C of part II of subchapter E of chapter 1 (relating to taxable year for which deductions taken) is amended by adding at the end thereof the following new section:

"SEC. 469. PASSIVE ACTIVITY LOSSES AND CREDITS LIMITED.

"(a) DISALLOWANCE.—

"(1) IN GENERAL.—If for any taxable year the taxpayer is described in paragraph (2), neither—

"(A) the passive activity loss, nor

"(B) the passive activity credit,

for the taxable year shall be allowed.

"(2) PERSONS DESCRIBED.—The following are described in this paragraph:

"(A) any individual, estate, or trust,

"(B) any closely held C corporation, and

"(C) any personal service corporation.

"(b) DISALLOWED LOSS OR CREDIT CARRIED TO NEXT YEAR.—Except as otherwise provided in this section, any loss or credit from an activity which is disallowed under subsection (a) shall be treated as a deduction or credit allocable to such activity in the next taxable year.

"(c) PASSIVE ACTIVITY DEFINED.—For purposes of this section—

"(1) IN GENERAL.—The term 'passive activity' means any activity—

"(A) which involves the conduct of any trade or business, and

"(B) in which the taxpayer does not materially participate.

"(2) PASSIVE ACTIVITY INCLUDES ANY RENTAL ACTIVITY.—The term 'passive activity' includes any rental activity.

"(3) WORKING INTERESTS IN OIL AND GAS PROPERTY.—

"(A) IN GENERAL.—The term 'passive activity' shall not include any working interest in any oil or gas property which the taxpayer holds directly or through an entity

Item	Stat. Suf-fix	Articles	Units of Quantity	Rates of Duty 1	Rates of Duty Special	Rates of Duty 2
		Ketones:				
427.60	00	Acetone	Lb.	Free		20% ad val.
427.62	00	Ethyl methyl ketone	Lb.	3.1% ad val.	Free (A,E,I)	20% ad val.
427.64		Other		4% ad val.	Free (A,E,I)	20% ad val.
	10	Isophorone	Lb.			
	20	Methyl isobutyl ketone	Lb.			
	30	Other	Lb.			
		Alcohols, monohydric, unsubstituted:				
427.70	00	Allyl	Lb.	7.5% ad val.	Free (A,E,I)	45% ad val.
427.72	00	Amyl	Lb.	7.2% ad val.	Free (A,E,I)	37.5% ad val.
427.74		Butyl		8.8% ad val.	Free (A,E,I)	50.5% ad val.
	10	n-Butyl	Lb.			
	20	Isobutyl	Lb.			
	30	Other	Lb.			
427.82	00	Crotonyl	Lb.	6% ad val.	Free (A,E,I)	41.5% ad val.
427.84	00	Decyl	Lb.	3.7% ad val.	Free (A*,E,I)	25% ad val.
427.88	00	Ethyl for nonbeverage purposes	Gal.	3% ad val. 1/	Free (E,I)	20% ad val.
427.92	00	Fusel oil	Lb.	1.3c per lb.	Free (A,E) 0.5c per lb.(I)	6c per lb.
427.94	00	Hexyl	Lb.	3.7% ad val.	Free (A,E,I)	20.5% ad val.
		Methyl:				
427.96	00	Imported only for use in producing synthetic natural gas (SNG) or for direct use as a fuel	Gal.	Free		18c per gal.
427.97	00	Other	Gal.	18% ad val.	Free (A,E) 7.2% ad val.(I)	46% ad val.
427.98		Octyl		3.7% ad val.	Free (A,E,I)	25% ad val.
	10	2-Ethyl-1-hexanol	Lb.			
	20	Other	Lb.			
428.04	00	Propargyl	Lb.	5.5% ad val.	Free (A,E,I)	37% ad val.
428.06		Propyl		14% ad val.	Free (A,E) 5.6% ad val.(I)	66% ad val.
	10	n-Propyl	Lb.			
	20	Isopropyl	Lb.			
428.12	00	Other	Lb.	3.7% ad val.	Free (A,E,I)	25% ad val.

1/ Certain imports of ethyl alcohol are subject to additional duties. See item 901.50 in part 1A, Appendix to the Tariff Schedules.

(1st supp. 6/10/87)

Item	Stat. Suf-fix	Articles	Units of Quantity	Rates of Duty			Effective Period
				1	Special	2	

PART 1. - TEMPORARY LEGISLATION

Subpart A. - Temporary Provisions for Additional Duties

Subpart A headnotes:

1. Except as provided in general headnote 3(e)(iii)(A)) the duties provided for in this subpart are cumulative duties which apply in addition to the duties, if any, otherwise imposed on the articles involved. The duties provided for in this subpart apply only with respect to articles entered during the period specified in the last column.

2. For purposes of item 901.50, the phrase "is suitable for any such uses" does not include ethyl alcohol (provided for in item 427.88, part 2D, schedule 4) that is certified by the importer of record to the satisfaction of the Commissioner of Customs (hereinafter in this headnote referred to as the Commissioner) to be ethyl alcohol or a mixture containing such ethyl alcohol imported for uses other than liquid motor fuel use or use in producing liquid motor fuel related mixtures. If the importer of record certifies nonliquid motor fuel use for purposes of establishing actual use or suitability under item 901.50, the Commissioner shall not liquidate the entry of ethyl alcohol until he is satisfied that the ethyl alcohol has in fact not been used for liquid motor fuel use or use in producing liquid motor fuel related mixtures. If he is not satisfied within a reasonable period of time not less than 18 months from the date of entry, then the duties provided for in item 901.50 shall be payable retroactive to the date of entry. Such duties shall also become payable, retroactive to the date of entry, immediately upon the diversion to liquid motor fuel use of any ethyl alcohol or ethyl alcohol mixture certified upon entry as having been imported for non-liquid motor fuel use.

3. [Headnote deleted]

(1st supp. 6/10/87)

Item	Stat. Suf-fix	Articles	Units of Quantity	Rates of Duty 1	Rates of Duty Special	Rates of Duty 2	Effective Period
901.50	1/	Ethyl alcohol (provided for in item 427.88, part 2D, schedule 4) or any mixture containing such ethyl alcohol (provided for in part 1, 2 or 10, schedule 4) if such ethyl alcohol or mixture is to be used as fuel or in producing a mixture of gasoline and alcohol, a mixture of a special fuel and alcohol, or any other mixture to be used as fuel (including motor fuel provided for in item 475.25), or is suitable for any such uses...	1/	60c per gal.	No change (E,I)	60c per gal.	On or before 12/31/92

Subpart B. - Temporary Provisions Amending The Tariff Schedules

Subpart B headnotes:

1. Any article described in the provisions of this subpart, if entered during the period specified in the last column, is subject to duty at the rate set forth herein in lieu of the rate provided therefor in schedules 1 to 8, inclusive, except as provided in general headnote 3(e)(iii)(A).

2. For purposes of item 903.25--
(a) the term "culled carrots" refers to those carrots which fail to meet the requirements of the United States Department of Agriculture for carrots of grades "U.S. No. 1" or "U.S. No. 2" (See 7 CFR sections 2851.4141 and 2851.4142); and
(b) the total quantity of carrots which may be entered under item 903.25 during the period specified in that item shall not exceed 20,000 tons.

1/ See Appendix statistical headnote 1 and subpart A headnote 1.

(1st supp. 6/10/87)

APPENDIX B
NOTICE OF INSTITUTION OF INVESTIGATION NO. 332-261
IN THE *FEDERAL REGISTER*

development assistance program. The proceeds of this loan will be used to finance shelter projects for low-income families in Portugal. The Government of Portugal has authorized A.I.D. to request proposals from eligible investors. The name and address of the Borrower's representative to be contacted by interested U.S. lenders or investment bankers, and the amount of the loan and project number are indicated below:

Government of Portugal

Project: 150-HG-005—$25,000,000.
Attention: Dr. J. Coutinho Pais, President, Instituto Nacional de Habitacao, Av. Columbano Bordalo Pinheiro, 5, 8th Floor, 1000 Lisboa Codex, Portugal, Telex No.: 64041 INH P, Telephone No.: 351/(1) 726-2608 or 4944

Interested investors should submit their bids to the Borrower's representative on October 12, 1988 no later than 10:00 a.m. New York Time. Bids should remain open for 48 hours. Copies of all bids should be simultaneously sent to the following addresses:

Mr. David Leibson, Housing and Urban Development Officer, Embaixada dos Estados Unidos, Av. das Forcas Armadas, 12507 Lisboa Codex, Lisbon, Portugal, Telex No.: 12528 AMEMB P, Telephone No.: 351/(1) 726-6600 or 6659, 8880, 8670, Telefax No.: 351/(1) 726-8814

Michael G. Kitay, Agency for International Development, GC/PRE, Room 3328 N. S., Washington, DC 20523, Telex No.: 892703 AID WSA, Telefax No.: 202/647-4958 (preferred communication)

Each proposal should consider the following terms:

(a) *Amount:* U.S. $25 million.
(b) *Term:* Up to 30 years.
(c) *Grace Period on Principal:* 10 years on repayment of principal.
(d) *Interest Rate:* Proposals will be made on the basis of fixed, variable rate, variable rate with interest rate cap and/or variable rate with Borrower's option to convert to fixed rate.
(e) *Draw Down:* Net proceeds from borrowing should be disbursed to Borrower upon signing.
(g) *Prepayment:* Proposals should include the possibility of partial or total prepayment of the loan by Borrower, if pricing is not materially affected.
(h) *Fees:* Payable at closing from proceeds of loan.

Selection of investment bankers and/or lenders and the terms of the loan are initially subject to the individual discretion of the Borrower and thereafter subject to approval by A.I.D. The lender and A.I.D. shall enter into a Contract of Guaranty covering the loan. Disbursements under the loan will be subject to certain conditions required of the Borrower by A.I.D. as set forth in agreements between A.I.D. and the Borrower.

The full repayment of the loans will be guaranteed by A.I.D. The A.I.D. guaranty will be backed by the full faith and credit of the United States of America and will be issued pursuant to authority in Section 222 of the Foreign Assistance Act of 1961, as amended (the "Act").

Lenders eligible to receive an A.I.D. guaranty are those specified in Section 238(c) of the Act. They are: (a) U.S. citizens; (2) domestic U.S. corporations, partnerships, or associations substantially beneficially owned by U.S. citizens; (3) foreign corporations whose share capital is at least 95 percent owned by U.S. citizens; and, (4) foreign partnerships or association wholly owned by U.S. citizens.

To be eligible for an A.I.D. quaranty, the loans must repayable in full no later than the thirtieth anniversary of the disbursement of the principal amount thereof and the interest rates may be no higher than the maximum rate established from time to time by A.I.D.

Information as to the eligibility of investors and other aspects of the A.I.D. housing guaranty program can be obtained from:

Peter M. Kimm, Director, Office of Housing and Urban Programs, Agency for International Development, Room 315, SA-18C, Washington, DC 20523, Telephone: 703/875-4808

Date: September 29, 1988.

Fredrik A. Hansen,

Deputy Director, Office of Housing and Urban Programs, Agency for International Development.

[FR Doc. 88-22825 Filed 9-30-88; 8:50 am]

BILLING CODE 6116-01-M

INTERNATIONAL TRADE COMMISSION

[332-261]

Ethyl Alcohol and Mixtures Thereof; Assessment Regarding the Indigenous Percentage Requirements for Imports

AGENCY: United States International Trade Commission.

ACTION: Institution of investigation and notice of public hearing.

FOR FURTHER INFORMATION CONTACT: Mr. Stephen Wanser (telephone 202-252-1363).

EFFECTIVE DATE: September 23, 1988.

Background and Scope of Investigation: The Commission on September 23, 1988, instituted investigation No. 332-261 following passage of the Omnibus Trade and Competitiveness Act of 1988 which directs the Commission to conduct an investigation under section 332(g) of the Tariff Act of 1930 (19 U.S.C. 1332(g)) to determine whether the definition of indigenous ethyl alcohol used in applying section 423 of the Tax Reform Act of 1986 is consistent with the objectives of the Caribbean Basin Economic Recovery Act legislation.

Public Hearings: The Commission will hold a public hearing on this investigation at the United States International Trade Commission Building, 500 E Street SW., Washington, DC, beginning at 9:30 a.m. on October 27, 1988. All persons shall have the right to appear in person or be represented by counsel, to present information, and to be heard. Persons wishing to appear at the public hearing should file requests to appear and should file prehearing briefs (original and 14 copies) with the Secretary, U.S. International Trade Commission, 500 E Street SW., Washington, DC 20436, not later than noon, October 20, 1988. Persons with mobility impairments who will need special assistance in gaining access to the Commission building should contact the Office of the Secretary at (202) 252-1000. Post-hearing briefs are due by November 15, 1988.

Written Submissions: Interested persons are invited to submit written statements concerning the investigation. Written statements should be received by the close of business on November 15, 1988. Commercial or financial information which a submitter desires the Commission to treat as confidential must be submitted on separate sheets of paper, each clearly marked "Confidential Business Information" at the top. All submissions requesting confidential treatment must conform with the requirements of § 201.6 of the Commission's *Rules of Practice and Procedure* (19 CFR 201.6). All written submissions, except for confidential business information, will be made available for inspection by interested persons. All submisssions should be addressed to the Secretary, United States International Trade Commission, 500 E Street SW., Washington, DC 20436.

Hearing-impaired individuals are advised that information on this matter can be obtained by contacting our TDD terminal on (202) 724-0002.

By order of the Commission.

Kenneth R. Mason,

Secretary.

Issued: September 27, 1988.

[FR Doc. 88-22607 Filed 9-30-88; 8:45 am]

BILLING CODE 7020-02-M

[Investigations Nos. 701-TA-297 (Preliminary) and 731-TA-422 (Preliminary)]

New Steel Rails from Canada

AGENCY: United States International Trade Commission.

ACTION: Institution of preliminary countervailing and antidumping investigations and scheduling of a conference to be held in connection with the investigations.

SUMMARY: The Commission hereby gives notice of the institution of preliminary countervailing duty investigation No. 701-TA-297 (Preliminary) under section 703(a) of the Tariff Act of 1930 (19 U.S.C. 1671b(a)) to determine whether there is a reasonable indication that an industry in the United States is materially injured, or is threatened with material injury, or the establishment of an industry in the United States is materially retarded, by reason of imports from Canada of new steel rails [1] that are alleged to be subsidized by the Government of Canada.

The Commission hereby also gives notice of the institution of preliminary antidumping investigation No. 731-TA-422 (Preliminary) under section 733(a) of the Tariff Act of 1930 (19 U.S.C. 1673b(a)) to determine whether there is a reasonable indication that an industry in the United States is materially injured, or is threatened with material injury, or the establishment of an industry in the United States is materially retarded, by reason of imports from Canada of new steel rails [1] that are alleged to be sold in the United States at less than fair value.

As provided in §§ 703(a) and 733(a), the Commission must complete preliminary countervailing and preliminary antidumping investigations in 45 days, or in these cases by November 10, 1988.

[1] For the purposes of these investigations, "new steel rails" include rails, whether or not of alloy steel, provided for in items 610.20, 610.21, and 688.42 of the Tariff Schedules of the United States (subheadings 7302.10.10, 7302.10.50, and 8548.00.00 of the Harmonized Tariff Schedule of the United States). Specifically excluded from the scope of these investigations are imports of "light rails," which are 60 pounds or less per yard, such as are used in amusement park rides. "Relay rails," which are used rails that have been taken up from a primary railroad track and are suitable to be reused as rails (such as on a secondary rail line or in a rail yard), are also excluded.

For further information concerning the conduct of these investigations and rules of general application, consult the Commission's Rules of Practice and Procedure, part 207, subparts A and B (19 CFR Part 207) (see commission interim rules (53 FR 33034, August 29, 1988)), and Part 201, subparts A through E (19 CFR part 201).

EFFECTIVE DATE: September 26, 1988.

FOR FURTHER INFORMATION CONTACT: Tedford Briggs (202-252-1181), Office of Investigations, U.S. International Trade Commission, 500 E Street SW., Washington, DC 20436. Hearing-impaired individuals are advised that information on this matter can be obtained by contacting the Commission's TDD terminal on 202-252-1810. Persons with mobility impairments who will need special assistance in gaining access to the Commission should contact the Office of the Secretary at 202-252-1000.

SUPPLEMENTARY INFORMATION:

Background. These investigations are being instituted in response to a petition filed on September 26, 1988, by Bethlehem Steel Corporation, Bethlehem, PA.

Participation in the investigations. Persons wishing to participate in these investigations as parties must file an entry of appearance with the Secretary to the Commission, as provided in § 201.11 of the Commission's rules (19 CFR 201.11), not later than seven (7) days after publication of this notice in the **Federal Register**. Any entry of appearance filed after this date will be referred to the Chairman, who will determine whether to accept the late entry for good cause shown by the person desiring to file the entry.

Service list.—Pursuant to § 201.11(d) of the Commission's rules (19 CFR 201.11(d)), the Secretary will prepare a service list containing the names and addresses of all persons, or their representatives, who are parties to these investigations upon the expiration of the period for filing entries of appearance. In accordance with §§ 201.16(c) and 207.3 of the rules (19 CFR 201.16(c) and 207.3), each document filed by a party to the investigations must be served on all other parties to the investigations (as identified by the service list), and a certificate of service must accompany the document. The Secretary will not accept a document for filing without a certificate of service.

Limited disclosure of business proprietary information under a protective order.—Pursuant to § 207.7(a) of the Commission's rules (19 CFR 207.7(a)), the Secretary will make available business proprietary information gathered in these preliminary investigations to authorized applicants under a protective order, provided that the application be mde not later than seven (7) days after the publication of this notice in the Federal Regiter. A separate service list will be maintained by the Secretary for those parties authorized to receive business proprietary information under a protective order. The Secretary will not accept any submission containing business proprietary information with a certificate of service indicating that it has been served on all the parties that are authorized to receive such information under a protective order.

Conference.—The Director of Operations of the Commission has scheduled a conference in connection with these investigations for 9:30 a.m. on October 19, 1988, at the U.S. International Trade Commission Building, 500 E Street SW., Washington, DC. Parties wishing to participate in the conference should contact Tedford Briggs (202-252-1181) not later than October 14, 1988, to arrange for their appearance. Parties in support of the imposition of countervailing and/or antidumping duties in these investigations and parties in oppposition to the imposition of such duties will each be collectively allocated one hour within which to make an oral presentation at the conference.

Written submissions.—Any person may submit to the Commission on or before October 21, 1988, a written brief containing information and arguments pertinent to the subject matter of the investigations, as provided in § 207.15 of the Commission's rules (19 CFR 207.15). A signed original and fourteen (14) copies of each submission must be filed with the Secretary to the Commission in accordance with § 201.8 of the rules (19 CFR 201.8). All written submissions except for business proprietary information will be available for public inspection during regular business hours (8:45 a.m. to 5:15 p.m.) in the Office of the Secretary to the Commission.

Any business information for which business proprietary treatment is desired must be submitted separately. The envelope and all pages of such submission must be clearly labeled "Business Proprietary Information." Business proprietary submissions and requests for business treatment must conform with the requirements of §§ 201.6 and 207.7 of the Commission's rules (19 CFR 201.6 and 207.7).

Parties which obtain disclosure of business proprietary information pursuant to § 207.7(a) of the Commission's rules (19 CFR 207.7(a))

APPENDIX C
CALENDAR OF PUBLIC HEARING

TENTATIVE CALENDAR OF PUBLIC HEARING

Those listed below are scheduled to appear as witnesses at the United States International Trade Commission's hearing:

Subject	:	Ethyl Alcohol and Mixtures Thereof: Assessment Regarding the Indigenous Percentage Requirements for Imports in Section 423 of the Tax Reform Act of 1986
Inv. No.	:	332-261
Date and Time	:	October 27, 1988 - 9:30 a.m.

Sessions will be held in connection with the investigation in the Main Hearing Room 101 of the United States International Trade Commission, 500 E Street, S.W., in Washington, D.C.

WITNESS AND ORGANIZATION	TIME CONSTRAINTS
Renewable Fuels Association Washington, D.C.	25 Minutes
Lin Shepard, Vice President A.E. Staley Manufacturing Company and Chairman of the Board, Renewable Fuels Association	
Eric Vaughn, President Renewable Fuels Association	
Francisco J. Arechaga, Independent Consultant Miami, Florida	
Minnesota Ethanol Commission St. Paul, Minnesota	10 Minutes
Kathy Graf, Chair of the Commission and Ethanol Producer in Grafton, Minnesota	

- more -

WITNESS AND ORGANIZATION	TIME CONSTRAINTS
New Energy Corporation of Indiana Washington, D.C.	10 Minutes
National Corn Growers Association Steven Wentworth, President Dr. William C. Motes, Director of International Consulting Raymond R. Casey, Vice President of Corporate Affairs, Ohio Farm Bureau Federation, Inc.	25 Minutes
Collier, Shannon, Rill & Scott Washington, D.C. on behalf of Petrojam Limited Jamaica William V. Saunders, Group Managing Director Christopher Chin Fatt, Technical Manager Patrick J. Magrath, Managing Director Georgetown Economic Services R. Timothy Columbus))—OF COUNSEL Patrick B. Fazzone)	25 Minutes

- more -

WITNESS AND ORGANIZATION	TIME CONSTRAINTS
Roger & Wells Washington, D.C. on behalf of Liga Agricola Industrial de la Cana de Azucar (LAICA) Costa Rican Sugar and Alcohol Producers' Trade Association John G. Reilly, Economics Expert Temple, Barker & Sloane, Inc. W. Anthony Hogan, President Hogan & Company Eugene T. Rossides))—OF COUNSEL Robert E. Ruggeri)	25 Minutes
James L. Moody, Attorney at Law Washington, D.C. on behalf of Tropicana Energy Company Euless, Texas Carl A. Pescosolido, Secretary/Treasurer James A. Moody)—OF COUNSEL	10 Minutes
Biochom International Limited Hamilton HM DX, Bermuda David E. Hallberg Executive Vice President	10 Minutes

- end -

APPENDIX D
THE SUGAR INDUSTRY IN THE MAJOR CBERA-BENEFICIARY COUNTRIES

THE CBI SUGAR INDUSTRIES

Barbados

Sugar is the most important commodity produced in Barbados, only recently surpassed by tourism in its contribution to foreign exchange earnings and gross domestic product.[1] The sugar industry is administered by Barbados Sugar Industries, Ltd., which runs the mills and sets production targets. Several of the smaller, older mills have been replaced during the 1980's. Sugar producers include about 130 estates of about 250 acres each and approximately 6,000 smallholdings of less than 10 acres each.[2] In all, the sugar industry employs less than 10,000 people, but only because it is highly mechanized.[3] The government plays an active role in the sugar industry, most notably by controlling prices in the domestic market.

Due largely to changes in the U.S. sugar program (discussed in Chapter 2) all the industries of the region have faced decreased demand for their sugar. In response, Barbados and many of the other countries have chosen to decrease production. The government in Barbados has encouraged diversification in the sugar sector through the production of fancy molasses rather than sugar from sugarcane,[4] and the change from sugarcane cultivation to that of onions, peanuts, cotton, and green vegetables.[5]

Belize

The sugar industry in Belize accounts for 20 percent of GDP and 50 to 60 percent of all exports; it is one of the most export-intensive sugar industries in the world. The cultivation of sugarcane represents about one-half of the current total cultivated area.[6] The Belize Sugar Industry, mostly government-owned, runs the country's sugar mills, and the combined efforts of the government, the Cane Farmers' Association, and milling companies work to meet domestic and export sugar demand.[7] The sugar industry in Belize employs about 20,000 people, or about 25 percent of the working population.[8] In the face of decreasing demand, Belize is also reducing sugar production through diversification and some mill closures; but diversification attempts are hampered by the reluctance to give up the benefits of the sugar industry.[9]

Costa Rica

Costa Rica is one of the smaller sugar producers in the region, with a largely privately run industry. However, sugar is the fourth largest export commodity for the country, after coffee, bananas, and meat.[10] The Liga Agricola Industrial de la Cana de Azucar, an autonomous nonprofit organization, controls the production and marketing of sugar in Costa Rica, as well as serving as the organization for sugarcane growers and millers in the country. There are currently 21 sugar mills; the one mill that is operated by a holding company processes about 8 percent of the total crop. The government also regulates the sugar industry and controls domestic prices.[11] Diversification of the sugar sector is Costa Rica's primary response to decreasing demand; for example, there has been some movement out of sugarcane production and into coffee production.[12] LAICA, however, has also responded by investing millions of dollars in the production of hydrous and anhydrous ethanol (see Chapter 3 for more details on the ethanol industry in Costa Rica).

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[1] Ralph Ives and John Hurley, *U.S. Sugar Policy: An Analysis*, U.S. Department of Commerce, International Trade Administration, April 1988, p. 63.
[2] Agricultural Counselor, Caracas, Venezuela, *Barbados, Annual Sugar and Molasses Report*, Foreign Agricultural Service (FAS), U.S. Department of Agriculture (USDA), 1988.
[3] Ives and Hurley, *U.S. Sugar Policy*, p. 64.
[4] Barbados, Annual Sugar and Molasses Report, *1988*.
[5] Ives and Hurley, *U.S. Sugar Policy*, p. 66.
[6] Ives and Hurley, *U.S. Sugar Policy*, p. 62.
[7] Ibid, p. 63.
[8] Ibid, p. 64.
[9] Agricultural Attache, Guatemala, *Belize-Sugar Annual Report*, FAS, USDA, 1988.
[10] Ives and Hurley, *U.S. Sugar Policy*, p. 60.
[11] Ibid, p. 58.
[12] Agricultural Attache, Costa Rica, *Costa Rica: Sugar Annual Report*, FAS, USDA, 1988.

Dominican Republic

The Dominican Republic is the largest sugar producer of the CBI-eligible countries, with sugar being its top merchandise export earner. However, the land devoted to sugarcane cultivation only represents 12 percent of the total cultivated land in the country. The sugar producers are divided into four groups; the first two are privately held companies—Central Romana, which owns about 20 percent of the sugarcane land and has the largest sugar producing unit in the world, and Casa Vicini, which is a family-run organization with only about 4 percent of the land and 3 sugar mills. The government, through the State Sugar Council (CEA), is a third group, with 12 sugar mills, which are responsible for 60 percent of the total sugar output, and about 40 percent of the sugarcane land. The last group is the nearly 8,000 smallholders (colonos) with the remainder of the land, who sell their cane to mills owned by the CEA and Central Romana.[1] The sugar industry is the country's second largest employer, with about 10 percent of the total workforce.

The government is also involved in the sugar industry through the Dominican Sugar Institute (INAZUCAR), which sets domestic production targets and export quotas for the mills, and the Price Stabilization Institute (INESPRE), which purchases all mill output for domestic distribution, reselling the sugar to wholesalers and other distributors.[2]

In the face of declining export demand for sugar, a few mills have been closed, both private and public, and attempts have been made at diversification. Mill closures have been limited by the inability to change land from sugarcane production to other crops,[3] and political pressures make most diversification attempts difficult because of the historical importance of the sugar industry in the Dominican Republic.[4] Most diversification attempts into the other crops have met with mixed success; there have been problems associated with vegetables, citrus, and palm oil, along with limited success in pineapples.[5]

El Salvador

Sugar is the third largest agricultural crop (after coffee and cotton) in El Salvador, which has a largely government-owned and operated sugar industry. Since 1980, the country's sugar mills, currently numbering ten, have been controlled (five directly and five indirectly) by the Instituto Nacional de Azucar (INAZUCAR), which sets domestic and export market quotas for each mill. In addition, INAZUCAR purchases all the sugarcane from growers.[6] Most of the current cane cultivation is by agricultural cooperatives, made up of former land tenants, which hold about one-half of the sugarcane acreage.[7] The sugar industry in El Salvador is also undergoing diversification, along with that of most of the Caribbean region.

Guatemala

Guatemala is the second largest sugar producer of the CBI-eligible countries after the Dominican Republic. Sugar is Guatemala's third most important crop after coffee and cotton. Guatemala has 18 sugar mills, and the major force in the sugar industry is a private company, Pantaleon, which is the largest sugar concern in Central America. The extent of government involvement is in conjunction with the Guatemalan Association of Sugar Producers, regulating the industry through quota allocations for mills, setting price ceilings, and distributing export licenses.[8] The sugar industry is the second largest employer, with as many as 35,000 seasonal and full-time employees. In contrast with most other countries in the region, the sugar industry in Guatemala is expanding, but this is primarily due to problems in other agricultural sectors (especially cotton).[9] There have been some diversification efforts.

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[1] Ives and Hurley, *U.S. Sugar Policy*, p. 51.
[2] Ibid., p. 51.
[3] American Embassy, Santo Domingo, *Dominican Republic-Annual Sugar Report*, FAS, USDA, 1988.
[4] Ives and Hurley, *U.S. Sugar Policy*, p. 52.
[5] Dominican Republic-Annual Sugar Report, *1988*.
[6] Agricultural Attache, Guatemala, *El Salvador-Sugar Annual Report*, FAS, USDA, 1988.
[7] Ives and Hurley, *U.S. Sugar Policy*, p. 57.
[8] Ibid., p. 54.
[9] Ibid., p. 55.

Haiti

Haiti is a country with little arable land, a primitive agricultural sector, and little monetary support for agriculture.[1] Despite this situation, the sugar industry in Haiti is an important foreign exchange earner and employer. Haiti has primarily marginal, small-scale subsistence farms. The industry had consisted of two major private sugar operations, the Haitian American Sugar Company (HASCO) and Central Dessalines, and two newer, public sugar mills. However, HASCO has recently closed, and one of the public mills was closed in 1986.[2] The sugar industry usually employs over 25,000 planters, cutters, millers, and transport workers; however, the closure of HASCO, the largest employer, will mean the loss of many of these jobs.[3] The future of the Haitian sugar industry is uncertain.

Honduras

Sugar in Honduras ranks fifth in export value, behind bananas, coffee, wood, and meat; and sugarcane occupies about one-third of the total arable land in the country.[4] Sugar is the fourth largest agricultural employer in the country, generating almost 20,000 jobs.[5] There are seven corporations that operate eight mills in the sugar industry; the government controls three of the seven corporations, through the National Industrial Development Corporation, and regulates domestic prices and production quotas for other factories. Approximately one-third of the sugarcane lands are controlled by CAHSA, a private concern, while another 20 percent are controlled by ACENSA, a government entity. The remaining sugar holdings are divided among the other four corporations and independent producers.[6] There has been some diversification from sugarcane to rice, citrus, plantains, pineapple, and melons, as the government has encouraged such diversification and exports of nontraditional products.[7]

Jamaica

Historically sugarcane has been an important part of the Jamaican economy, dating back 300 years. Although it has declined in importance relative to tourism, mining, and manufacturing, it remains an important part of the agricultural economy, accounting for some 25 percent of cultivated land and 18 percent of the agricultural labor force, or approximately 45,000 workers. Nevertheless, sugarcane output has declined in recent years for a variety of reasons, such as high production costs and irrigation problems. In 1965, there were 18 estates in Jamaica, which produced 506,000 tons of sugar. By 1987, nine estates were producing 220,000 tons of sugar. The Jamaican Government, in response to this decline, has begun to diversify and rationalize sugarcane acreage and to create government-private sector agencies that coordinate the distribution and sale of sugarcane products. In addition, the Jamaican government has negotiated with the World Bank to improve the sugar industry. One purpose of the loan will be to increase Jamaica's sugar production from the 1987 level of 210,000 tons to 245,000 tons. The target level will be sufficient to meet Jamaica's domestic requirements and to supply their preferential export markets in the United States and the European Community.[8]

The large sugarcane estates are the main production units in Jamaica. Each estate consists of a few thousand acres, a sugar mill, and, on some estates, (e.g., Appleton) a distillery for rum. Four of the nine estates are privately owned and three of these also produce rum. The remaining five are public sector estates. Two of the public estates (Bernard Lodge and Duckenfield) have been designated to eventually direct their cane into ethanol production. Jamaica has begun limited diversification out of sugar into winter vegetables.[9]

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[1] Ibid., p. 69.
[2] American Embassy, Santo Domingo, *Haiti Annual Sugar Report*, FAS, USDA, 1987.
[3] Ives and Hurley, *U.S. Sugar Policy*, p. 70.
[4] Ibid., p. 57.
[5] Agricultural Attache, Guatemala, *Honduras-Sugar Annual Report*, FAS, USDA, 1988.
[6] Ives and Hurley, *U.S. Sugar Policy*, p. 58.
[7] Honduras-Sugar Annual Report, *1988*.
[8] For a review of Jamaica's recent efforts to stabilize the sugar industry, see The World Bank, Staff Appraisal Report, Jamaica, Second Sugar Rehabilitation Report, May 20, 1987.
[9] American Embassy, Santo Domingo, *Annual Sugar Report-Jamaica*, FAS, USDA, 1988.

Panama

Agriculture in Panama accounts for about 6 percent of GDP, with the sugar industry representing about 8 to 10 percent of total agricultural production. Sugar is the third most important agricultural crop, after bananas and coffee.[1] The sugar industry consists of two sugar mills under government control and two under private ownership.[2] While no single body governs all sugar operations, in 1980 the government established La Victoria Corporation to oversee the mills and coordinate export marketing. La Victoria currently has two-thirds of the export market and one-third of the domestic market.[3]

In addition to the four main mills, there are numerous small mills producing sugar for local consumption. Sugarcane for the industry is cultivated on about 25 percent of the irrigated administration lands, and on the nonirrigated holdings of about 3,000 local growers, whose yields are less than half that of irrigated lands.[4] In previous years, the Panamanian industry had two other government-owned mills in operation that have since been closed, as demand has fallen.[5] Also, as mentioned in Chapter 2, Panama has recently lost its U.S. sugar quota allocation.

St. Christopher-Nevis (St. Kitts)

The sugar industry in St. Christopher-Nevis provides more than 10 percent of the nation's GDP and about 60 percent of its merchandise export earnings.[6] The sugar industry was reorganized in 1986, with the establishment by the government of the St. Kitts Sugar Manufacturing Association, which placed the management of sugar processing, marketing, and production under one organization. Out of a total laborforce of 17,000 people, the agricultural and industrial aspects of sugar production normally employ 6,000 people.[7] Diversification has not been very successful in St. Christopher-Nevis, as no other crop has proven as good at preventing soil erosion and providing jobs and income.[8]

Trinidad-Tobago

The sugar industry is the second largest industry in Trinidad-Tobago after petroleum refining. Sugar contributes only about 2 percent to total export earnings, though sugarcane occupies about one-third of the cultivated land in the country.[9] The sugar industry is government-owned and run through the Caroni company.[10] The industry employs about 15,000 people, including 5,000 cane farmers and 8,000 mill workers.[11] The government is supporting efforts to diversify out of sugar and into processed sugar products, but because of a lack of sugar refining capacity (only two mills), Trinidad-Tobago has to import large amounts of refined sugar to carry out such efforts.[12]

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[1] Ives and Hurley, *U.S. Sugar Policy*, p. 71.
[2] Agricultural Attache, San Jose, *Panama: Sugar Annual Report*, FAS, USDA, 1988.
[3] Ives and Hurley, *U.S. Sugar Policy*, p. 69.
[4] Ibid., p. 70.
[5] Panama: Sugar Annual Report, *1988*.
[6] Ives and Hurley, *U.S. Sugar Policy*, p. 63.
[7] Ibid., p. 64.
[8] Ives and Hurley, *U.S. Sugar Policy*, p. 66.
[9] Ibid., p. 63.
[10] Agricultural Counselor, Caracas, Venezuela, *Trinidad, Annual Sugar Report*, FAS, USDA, 1988.
[11] Ives and Hurley, *U.S. Sugar Policy*, p. 64.
[12] Ibid., p. 68.

APPENDIX E
U.S. AND CBERA PRODUCTION PROCESSES FOR FUEL-GRADE ETHANOL

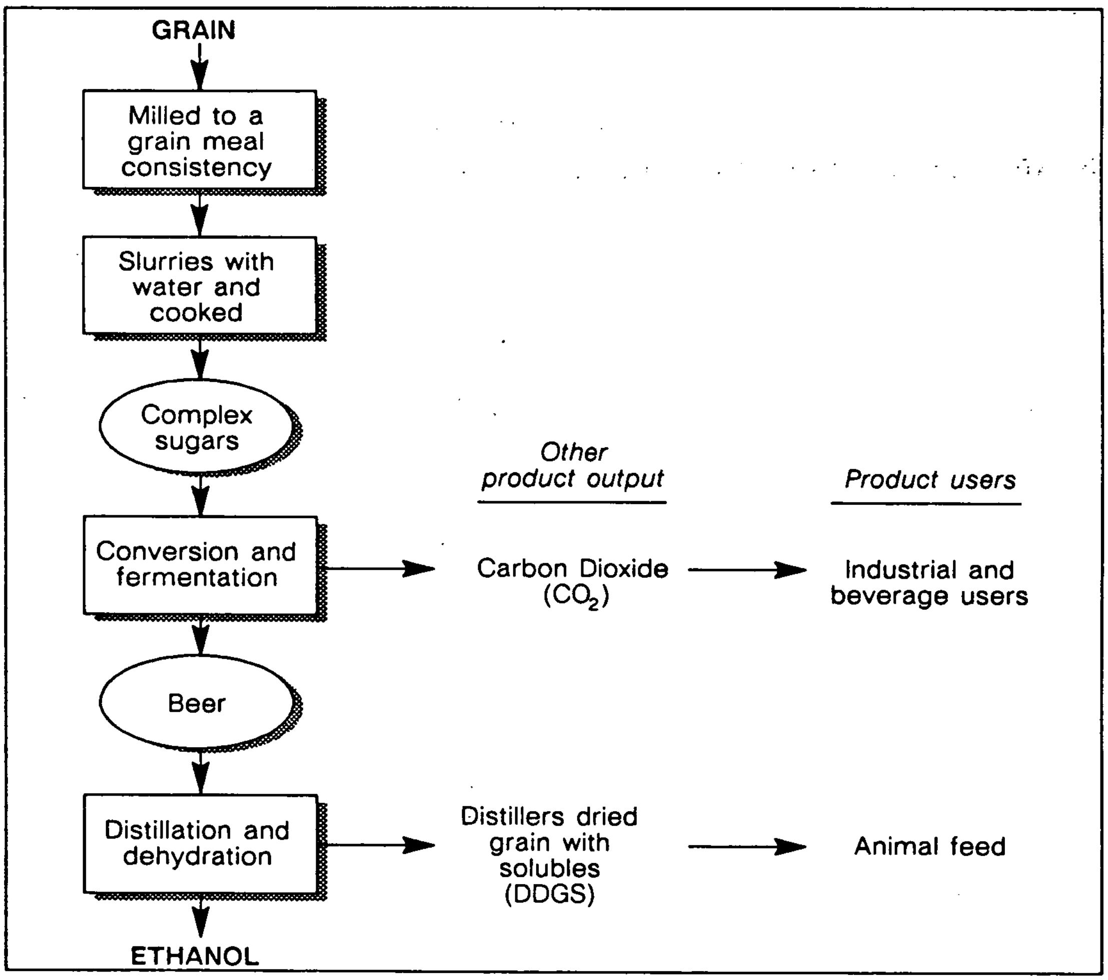
U.S. AND CBERA PRODUCTION PROCESSES FOR FUEL-GRADE ETHANOL

U.S. production process[1]

The modern production of fuel ethanol in the United States relies on two proven grain processing technologies—dry and wet milling. Dry milling is the traditional technology for the manufacture of potable alcohol; wet milling is an outgrowth of the refining of corn to starch. With the exception of the initial separation process, the technology for conversion of the starches to fuel ethanol is generally the same in both types of plants.

Dry milling.—In dry milling, corn is first milled to open the grain in preparation for the "mashing" or cooking process (figure E-1). Starch in the mash is liquefied, saccharified (converted to sugar) and fermented by the action of yeast. The resulting solution, known as "beer" is then distilled to produce hydrous ethanol. The final step in the process, dehydration, will remove the remaining water content to produce anhydrous (200 proof) fuel-grade ethanol.

Figure E-1
Dry Mill Processing



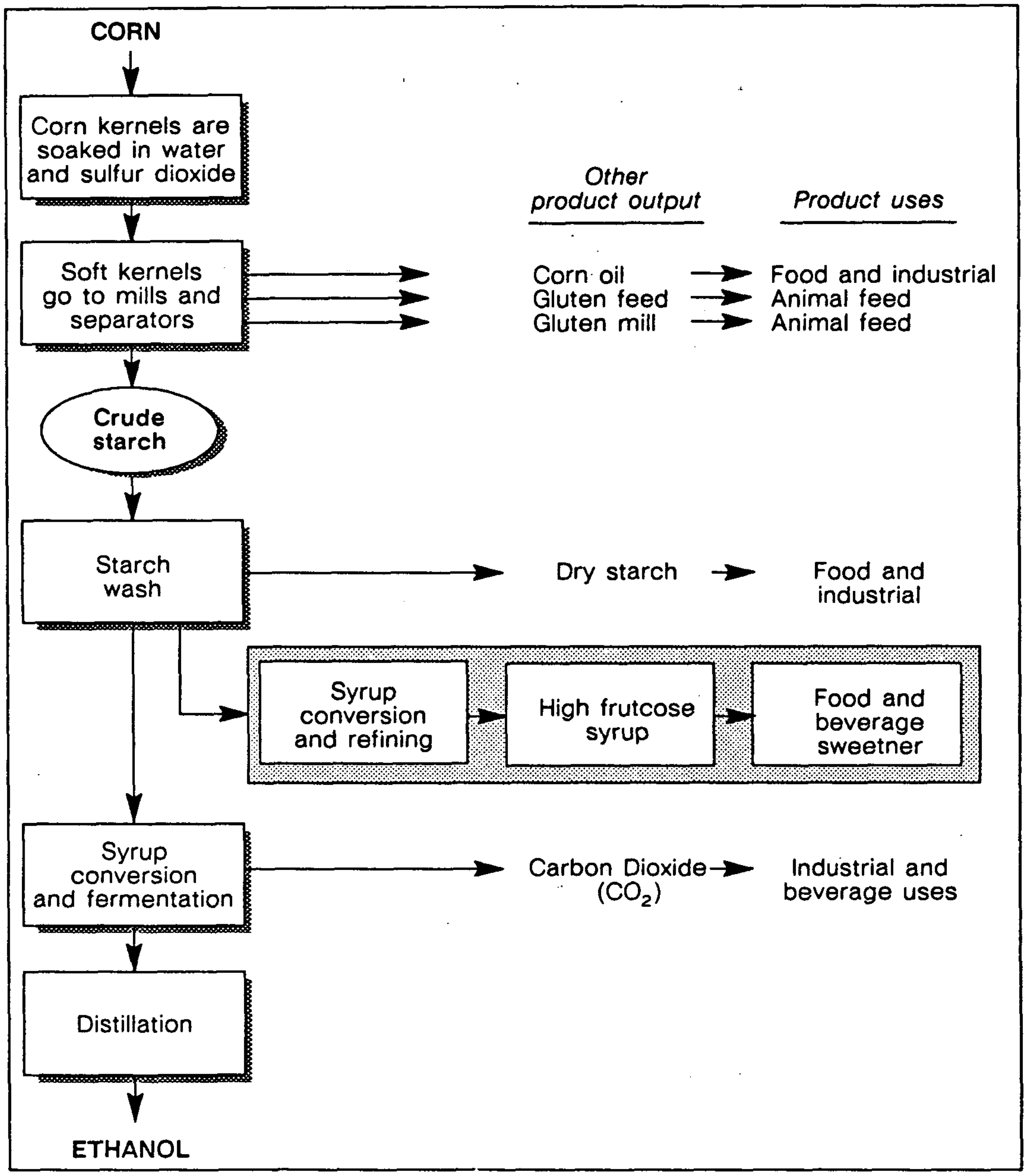
Source: General Accounting Office, *Alternative Fuels: Feasibility of Expanding the Fuel Ethanol Industry Using Surplus Grain*, June 1987, pg. 63.

[1] Renewable Fuels Association, post-hearing brief, Nov. 16, 1988, app. E.

In addition to ethanol, a dry-milling plant yields a byproduct, distillers dried grain with solubles, commonly used as a high protein animal feed. Using current technology, ethanol distillers can produce 2.5 to 2.6 gallons of undenatured fuel-grade ethanol plus 16.5 to 17.4 pounds of DDGS from one bushel of corn. Carbon dioxide may also be collected from fermentation tanks and sold.

Wet milling.—In wet milling, corn is separated into its major components: the germ, fiber, gluten, and starch components (figure E-2). The starch component can be processed to produce ethanol or high fructose corn syrup.

Figure E-2
Wet Mill Processing



Source: General Accounting Office, *Alternative Fuels: Feasibility of Expanding the Fuel Ethanol Industry Using Surplus Grain*, June 1987, pg. 63.

Ethanol yields for wet-milling plants are typically in the same range or just below those of dry-milling plants. Byproduct yields from one bushel of corn are about 1.7 pounds of corn oil, 3 pounds of corn gluten meal (60% protein), 13 pounds of corn gluten feed (21% protein) and 17 pounds of carbon dioxide.

Production of ethanol (ethyl alcohol) from grain.—The production of fuel-grade ethanol from grain requires the proper design, specification and integration of the following steps: receipt and storage of grain, preparation of grain cooking, saccharification, fermentation, alcohol recovery, rectification, distillation, dehydration, and byproduct processing.

1. **Receipt and storage of grain:**
   - Grain is received by truck or rail.
   - Tests are conducted for quality.
   - Grain received into granary (silos, bins)
   - Enzymes, yeast and other additives are received and stored under environmentally controlled conditions.
   - Dust abatement pollution control equipment must be included.
   - Foreign materials removed.
2. **Preparation of raw material and additives:**
   - Grain is transferred from storage to screening, steeping, crushing, and milling.
   - Screening assures that the correct-sized particle is reached for proper storing consistency.
   - Steeping is the addition of water to place the starch in solution.
   - Crushing/milling breaks the outer cellulose protective wall around the kernel and exposes the starch surface to the action of the cooking process.
3. **Cooking:**
   - Starch is separated and prepared for conversion to sugar by interaction with heat.
   - Interaction with heat gelatinizes the starch.
4. **Conversion of preparation grain to alcohol:**

   A. *Saccharification*:
      - Complex starch molecules are divided into dextrines, maltose, and various sugars, by the action of enzymes.
      - This conversion or saccharification is a very complex chemical/biological change.
      - Primary conversion occurs before yeast addition and usually involves 70 to 80 percent of the available starch.

   B. *Fermentation*:
      - Conversion of fermentable sugars to ethyl alcohol, carbon dioxide, and trace amounts of other organic compounds.
5. **Alcohol recovery:**
   - End product of fermentation at approximately 20 proof.
   - Fermented solution is concentrated by a series of rectification/distillation procedures to approximately 190 proof.

- Stripping column
- Extractive column
- Rectifying column
- Recovery column
- The production of 190-proof alcohol requires the use of at least three distillation procedures (stripping, rectifying, and recovery) due to the complexity of—

  (a) Separation of solids present in the fermented solution,

  (b) Accumulation of trace organic compounds in distillation system, and

  (c) Inefficiency of separation, requiring some redistribution.
- Dehydration in a multiplate column produces richer and richer mixtures of ethyl alcohol with each successive condensation and distillation that occurs on each successive plate as the vapor moves up the column.

6. **Dehydration:**

- 190-proof alcohol is then increased to 200 proof using one of a variety of methods (azeotropic distillation, molecular sieves).

A. *Azeotropic distillation*:

- The 190-proof alcohol is boiled and a chemical agent such as benzene is added. The vapor above the boiling mixture is richer in alcohol content than the liquid below because the relative volatility of ethyl alcohol, compared with water, is higher.
- The 200-proof alcohol is removed from the bottom of the column while benzene and water are removed at the top.

B. *Molecular sieves*:

- A sieve material has the ability to attract water molecules to the exclusion of the alcohol. After a period of time the sieve material becomes saturated.
- It must be noted that the dehydration step represents a processing step removing 4.4 percent (by weight) water content. The product itself and its characteristics were determined in the multiprocess steps that occurred long before the final "drying" procedure.

7. **Byproduct processing:**

- Alcohol vapor is removed from the fermentation mash.
- Excess water is removed.
- Mash is dried, tested, processed, and prepared for shipping.

CBERA production process

Feedstock preparation.—In the preparation phase, the molasses is obtained from the storage tank and mixed with hot fresh water, hot stillage (the byproduct of fermentation), or both. The water or stillage is added at high temperatures to facilitate the dilution process. But before it is passed into the fermenter, the mash is cooled to 30°C using a heat exchanger that has water as the cooling agent.

Molasses is the product left after the sugar (sucrose) is crystallized and separated from the juice. Molasses is available in three forms. It can be either the sugar refiner's cane molasses, formed when raw sugar is processed into refined sugar, or it can be blackstrap molasses, left when raw sugar is extracted from sugarcane juice. A third alternative is high test molasses, simply the concentrate of sugarcane juice. Although it is possible to distill cane juice directly, the juice is susceptible to bacterial infection and cannot be stored. Basically, molasses is a more dense substance that contains insufficient oxygen to grow bacteria.

Molasses does contain varying amounts of suspended solids, and can also be infected with micro-organisms. Therefore, before it is used, the fermentation facility clarifies and sterilizes the molasses.

Fermentation.—In the fermentation stage, the cooled, diluted mash is pumped into one of a number of fermentation tanks arranged in a parallel series. At the end of the series will be a collection tank that stores the fermented product as it waits to be distilled. The tanks are connected in parallel so that mash can go directly to the storage tank.

The fermentation process begins once a yeast culture is introduced into the mash. The mash temperature is kept constant during fermentation with external cooling apparatus. Circulation pumps move the mash through the cooler. Fermentors will have provisions for introducing ingredients to assist the fermentation (e.g., antibiotics, nutrients, steam).

As yeast feeds on sugar and multiplies, it produces the biological waste products ethanol and carbon dioxide (CO_2), both of which have commercial value. A fermentor has connected to it a CO_2 scrubber that recovers the ethanol from the gases generated during fermentation. The CO_2 is collected and sold or vented to the atmosphere.

When the fermentation is complete, the resulting solution is strained through a filter, which screens out foreign matter, and then into a centrifuge where the yeast is separated from the solution.

Distillation.—The fermented molasses mash contains approximately 9 to 12 percent alcohol by volume plus a residue containing a variety of soluble and insoluble materials including unfermented carbohydrates, insoluble fats and oils, and a high concentration of minerals. This residue, once the alcohol and water are removed, has the potential to be a useful fertilizer. However, environmental concerns may require that the mash be processed further to remove the high mineral content that can be harmful to the soil.

The alcohol is removed from the mash by passing the liquid through two distillation units (columns).[1] The first unit is a stripping column that removes the nonvolatile material plus some 90 percent of the water. The alcohol stream will then be passed to a second column, called a rectifying column, that separates ethanol from other organic volatile material.

Upon leaving the stripping column, the volatile stream stripping is transferred to the rectifying column. As the low-boiling organic material and the ethanol and water mixtures pass up through the column, the less volatile material is continuously withdrawn from the middle of the column to be discarded.

Yeast propagation and recovery

The ethanol fermentation plant will also have a yeast propagation and recovery unit in which yeast is cultured to the appropriate concentration. The "yeast cream" is recovered by centrifuging flows into a propagation unit where it is treated with water, sterilized air, sulfuric acid, and other materials if necessary.

Dehydration

A brief description of the azeotropic distillation process is as follows:

> At 190+ proof, ethanol will have formed an azeotrope with water and other impurities that must be removed before the ethanol can successfully

[1] Distillation columns are tall, vertical cylinders fitted inside with a series of trays. The trays are designed to allow water or liquid to collect on them and overflow to the plate below. At the same time the trays allow vapor from below to pass up through the liquid and either collect there or pass on to the next tray.

be blended with gasoline to make gasohol. As an azeotrope is a constant boiling point liquid, traditional distillation processes are ineffective to break the azeotropic system. Thus, to produce ethanol suitable for blending to make gasohol, the azeotrope must be "cracked" using a Ternary Azeotropic Distillation process, whereby a third chemical is added to the ethanol solution to form a new mixture. This chemical is called an entrainer and is usually benzene, although cyclohexane, di-isopropyl ether, and gasoline have also been used. The entrainer forms a ternary azeotrope, which is mainly water and benzene with a boiling temperature different from water. This temperature varies widely with the relative concentrations of ethanol, entrainer, and water. In addition, flow rates and pressure become critical control variables. Once the ternary azeotrope solution is separated from the ethanol, its vapors are condensed and sent to another distillation column to separate the benzene and trace amount of ethanol from the water.[1]

The 190-proof ethanol feedstock that is taken from the rectifier is partially heated, then passed onto the midportion of the azeotropic distillation column. As the hydrous ethanol becomes heated in the column, anhydrous ethanol migrates to the bottom of the column while the ethanol-benzene-water azeotrope migrates to the top of the column. Part of the stream from the top of the column is used to preheat the incoming feedstock before it enters the column, while the remainder of the stream is cooled and passed to a decanter. In the decanter, the liquid separates into two layers. The top layer, rich in ethanol, is returned to the top of the dehydration tower.

The lower layer is passed to the top of a stripper column. The waste material in this stream then passes to the bottom of the column, while the vapors that pass from the top of the column, primarily benzene, are cooled and returned to another storage tank for reuse.

The material passing out of the bottom of the dehydration column, the product material, is cooled, denatured and passed into a storage tank. This anhydrous ethanol passing from the dehydration tower has a concentration of 99.5 percent (or higher) ethanol, by volume.

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[1] Letter to Stephen Urbanczyk from Harvey Fox, U.S. Customs Service, Department of the Treasury, Nov. 19, 1985, (CLA-2 CO:R:CV:V, 553849 HS).

APPENDIX F
STATISTICAL TABLES

Table F-1

Sugarcane: Area harvested, sugarcane production, cane sugar production, sugar recovery rate, sugarcane yield, and sugar yield, by CBI-eligible countries, marketing years 1980-81 to 1987-88

Country and marketing year	*Area harvested*	*Sugarcane production*	*Cane sugar production*	*Sugar recovery rate*	*Sugarcane yield*	*Sugar yield*
	1,000 acres	—— *1,000 short tons* ——		*Percent*	— *Short tons/acre* —	
Barbados:						
1980/81	40	1,332	106	7.9	33.3	2.65
1981/82	40	886	97	10.9	22.2	2.42
1982/83	34	712	94	13.2	20.9	2.76
1983/84	34	946	111	11.8	27.8	3.26
1984/85	37	851	109	11.5	25.7	2.94
1985/86	37	1,020	121	11.9	27.6	3.27
1986/87	32	759	91	12.0	23.7	2.84
1987/88	30	794	88	11.1	26.5	2.93
Belize:						
1980/81	59	1,086	109	10.1	18.4	1.85
1981/82	59	1,227	119	9.7	20.8	2.02
1982/83	59	1,282	128	10.0	21.7	2.17
1983/84	59	1,138	114	10.0	19.3	1.93
1984/85	59	1,076	108	10.0	18.2	1.83
1985/86	59	786	105	11.0	13.3	1.78
1986/87	59	980	95	9.7	16.6	1.61
1987/88	59	951	94	9.8	16.1	1.59
Costa Rica:						
1980/81	91	2,423	208	8.6	26.6	2.28
1981/82	91	2,416	201	8.3	26.5	2.21
1982/83	91	2,416	222	9.2	26.5	2.44
1983/84	91	2,860	266	9.3	31.4	2.92
1984/85	91	2,860	266	9.3	31.4	2.92
1985/86	82	2,663	240	9.0	32.5	2.93
1986/87	79	2,598	252	9.7	32.9	3.19
1987/88	79	2,779	259	9.3	35.2	3.28
Dominican Republic:						
1980/81	464	11,623	1,253	10.8	25.0	2.70
1981/82	464	12,459	1,416	11.4	26.8	3.05
1982/83	464	12,456	1,344	10.8	26.8	2.90
1983/84	464	12,125	1,312	10.8	26.1	2.8[illegible]
1984/85	432	9,810	1,080	11.0	22.7	2.5[illegible]
1985/86	395	9,073	985	10.9	23.0	2.49
1986/87	445	9,397	898	9.6	21.1	2.02
1987/88	420	9,149	882	9.6	21.8	2.10
El Salvador:						
1980/81	67	1,983	198	10.0	29.6	2.96
1981/82	67	2,116	195	9.2	31.6	2.91
1982/83	76	2,712	255	9.4	35.7	3.36
1983/84	79	3,164	267	8.4	40.0	3.38
1984/85	86	3,245	291	9.0	37.7	3.38
1985/86	94	3,546	294	8.3	37.7	3.13
1986/87	101	3,262	305	9.4	32.3	3.02
1987/88	91	2,380	209	8.8	26.2	2.30
Guatemala:						
1980/81	193	6,063	525	8.7	31.4	2.72
1981/82	190	6,944	629	9.1	36.5	3.31
1982/83	148	6,092	617	10.1	41.2	4.17
1983/84	183	6,324	601	9.5	34.6	3.28
1984/85	207	6,140	640	10.4	29.7	3.09
1985/86	200	6,000	688	11.5	30.0	3.44
1986/87	217	6,971	725	10.4	32.1	3.34
1987/88	230	7,275	694	9.5	31.6	3.02
Haiti:						
1980/81	74	799	52	6.5	10.8	.70
1981/82	148	849	55	6.5	5.7	.37
1982/83	143	744	47	6.4	5.2	.33
1983/84	124	772	51	6.6	6.2	.41
1984/85	148	716	57	8.0	4.8	.38
1985/86	133	625	47	7.6	4.7	.35
1986/87	124	579	43	7.4	4.7	.35
1987/88	124	579	44	7.6	4.7	.35

Table F-1—Continued

Sugarcane: Area harvested, sugarcane production, cane sugar production, sugar recovery rate, sugarcane yield, and sugar yield, by CBI-eligible countries, marketing years 1980-81 to 1987-88

Country and marketing year	*Area harvested*	*Sugarcane production*	*Cane sugar production*	*Sugar recovery rate*	*Sugarcane yield*	*Sugar yield*
	1,000 acres	—— *1,000 short tons*	——	*Percent*	— *Short tons/acre*	—
Honduras:						
1980/81	74	2,405	234	9.7	32.5	3.16
1981/82	76	2,570	242	9.4	33.8	3.18
1982/83	76	2,450	226	9.2	32.2	2.97
1983/84	76	2,543	237	9.3	33.5	3.12
1984/85	76	2,535	242	9.6	33.4	3.18
1985/86	72	2,678	259	9.7	37.2	3.60
1986/87	64	2,646	220	8.3	41.3	3.44
1987/88	59	2,150	193	9.0	36.4	3.27
Jamaica:						
1980/81	111	2,704	226	8.4	24.4	2.04
1981/82	106	2,779	223	8.0	26.2	2.10
1982/83	109	2,838	215	7.6	26.0	1.97
1983/84	101	2,667	218	8.2	26.4	2.16
1984/85	99	2,646	204	7.7	26.7	2.06
1985/86	96	2,407	225	9.3	25.1	2.34
1986/87	89	2,199	212	9.6	24.7	2.38
1987/88	91	2,480	225	9.1	27.2	2.47
Panama:						
1980/81	118	3,081	205	6.6	26.1	1.74
1981/82	118	3,092	263	8.5	26.2	2.23
1982/83	124	2,544	207	8.1	20.5	1.67
1983/84	94	2,436	198	8.1	25.9	2.11
1984/85	94	2,594	194	7.5	27.6	2.06
1985/86	86	2,212	176	8.0	25.7	2.05
1986/87	59	1,425	136	9.5	24.2	2.30
1987/88	49	1,270	118	9.3	25.9	2.41
St. Christopher-Nevis:						
1980/81	7	369	36	9.9	52.7	5.14
1981/82	7	342	42	12.3	48.8	6.00
1982/83	7	304	31	10.1	43.4	4.43
1983/84	7	309	33	10.7	44.1	4.71
1984/85	7	328	31	9.4	46.8	4.43
1985/86	7	328	30	9.2	46.8	4.28
1986/87	7	328	28	8.5	46.8	4.00
1987/88	7	328	28	8.5	46.8	4.00
Trinidad-Tobago:						
1980/81	69	1,598	102	6.4	23.2	1.48
1981/82	62	1,330	87	6.5	21.4	1.40
1982/83	69	1,727	88	5.1	25.0	1.28
1983/84	67	969	72	7.4	14.5	1.07
1984/85	67	1,104	94	8.5	16.5	1.40
1985/86	67	1,240	88	7.1	18.5	1.31
1986/87	67	1,102	92	8.4	16.4	1.37
1987/88	67	1,102	99	9.0	16.4	1.48
Total/average:						
1980/81	1,367	35,466	3,254	8.6	27.8	2.45
1981/82	1,428	37,010	3,569	9.2	27.2	2.60
1982/83	1,400	36,277	3,474	9.1	27.1	2.54
1983/84	1,379	36,253	3,480	9.2	27.5	2.60
1984/85	1,403	33,905	3,316	9.3	26.8	2.51
1985/86	1,328	32,578	3,258	9.5	26.8	2.58
1986/87	1,343	32,246	3,097	9.4	26.4	2.49
1987/88	1,306	31,237	2,938	9.2	26.2	2.43

Source: Derived from statistics of the Foreign Agricultural Service, U.S. Department of Agriculture.

Table F-2

Centrifugal sugar: Beginning stocks, production, imports, distribution, exports, domestic consumption, and ending stocks, by CBI-eligible countries, marketing years 1980-81 to 1987-88

(In thousands of short tons, raw value)

Country and marketing year	*Beginning stocks*	*Production*	*Imports*	*Distribution*	*Exports*	*Domestic consumption*	*Ending stocks*
Barbados:							
1980/81	14	106	0	120	70	16	33
1981/82	33	97	0	130	97	16	16
1982/83	16	94	0	110	78	15	16
1983/84	16	111	0	128	106	15	7
1984/85	7	109	0	116	86	15	14
1985/86	14	121	0	136	108	15	12
1986/87	12	91	0	104	74	18	12
1987/88	12	88	0	100	72	18	11
Belize:							
1980/81	6	109	0	115	102	8	4
1981/82	4	119	0	123	109	8	7
1982/83	7	128	0	134	123	7	4
1983/84	4	114	0	118	107	7	4
1984/85	4	108	11	123	94	7	23
1985/86	23	105	4	132	109	7	16
1986/87	16	95	7	118	100	7	11
1987/88	11	94	4	109	98	7	4
Costa Rica:							
1980/81	51	208	0	259	85	141	33
1981/82	33	201	4	238	56	147	35
1982/83	35	222	4	261	79	143	38
1983/84	38	266	0	304	100	152	52
1984/85	52	266	0	317	97	152	68
1985/86	68	240	0	309	51	171	87
1986/87	87	252	0	340	87	183	69
1987/88	69	259	0	328	63	188	77
Dominican Republic:							
1980/81	112	1,253	0	1,366	952	254	160
1981/82	160	1,416	0	1,576	972	254	350
1982/83	350	1,344	0	1,694	955	254	486
1983/84	486	1,312	0	1,798	1,263	242	292
1984/85	292	1,080	16	1,389	596	325	412
1985/86	412	985	0	1,398	507	365	504
1986/87	504	898	0	1,402	625	387	368
1987/88	368	882	0	1,250	606	386	230
El Salvador:							
1980/81	16	198	0	215	48	149	18
1981/82	18	195	12	225	58	154	12
1982/83	12	255	0	267	73	160	34
1983/84	34	267	0	301	96	165	40
1984/85	40	291	0	331	133	165	32
1985/86	32	294	0	326	121	162	43
1986/87	43	305	0	348	127	178	43
1987/88	43	209	0	252	44	186	22
Guatemala:							
1980/81	14	525	0	539	226	273	40
1981/82	40	629	0	669	191	245	203
1982/83	203	617	0	820	312	222	128
1983/84	128	601	0	729	247	278	147
1984/85	147	640	0	787	208	304	208
1985/86	208	688	0	896	331	320	104
1986/87	104	725	0	829	229	349	162
1987/88	162	694	0	856	287	369	134
Haiti:							
1980/81	0	52	13	65	0	65	0
1981/82	0	55	19	74	0	74	0
1982/83	0	47	42	89	14	75	0
1983/84	0	51	42	92	6	75	12
1984/85	12	57	25	95	12	69	13
1985/86	13	47	34	95	12	72	11
1986/87	11	43	45	99	8	77	14
1987/88	14	44	38	97	9	79	9

Table F-2—Continued

Centrifugal sugar: Beginning stocks, production, imports, distribution, exports, domestic consumption, and ending stocks, by CBI-eligible countries, marketing years 1980-81 to 1987-88

(In thousands of short tons, raw value)

Country and marketing year	Beginning stocks	Production	Imports	Distribution	Exports	Domestic consumption	Ending stocks
Honduras:							
1980/81	14	234	0	248	105	131	12
1981/82	12	242	6	260	97	130	33
1982/83	33	226	0	259	127	117	15
1983/84	15	237	0	252	107	121	24
1984/85	24	242	0	267	120	128	19
1985/86	19	259	15	293	130	130	33
1986/87	33	220	19	272	105	137	31
1987/88	31	193	14	238	44	149	45
Jamaica:							
1980/81	28	226	33	287	140	105	42
1981/82	42	223	23	288	150	105	33
1982/83	33	215	43	291	170	105	16
1983/84	16	218	84	318	158	127	34
1984/85	34	204	34	272	144	117	11
1985/86	11	225	61	296	159	120	18
1986/87	18	212	57	287	150	120	16
1987/88	16	225	44	286	148	121	16
Panama:							
1980/81	22	205	0	227	122	81	23
1981/82	23	263	0	287	123	86	77
1982/83	77	207	0	284	146	72	67
1983/84	67	198	0	266	101	76	88
1984/85	88	194	0	282	110	139	33
1985/86	33	176	0	209	67	116	26
1986/87	26	136	0	162	43	89	30
1987/88	30	118	0	148	35	72	41
St. Christopher-Nevis:							
1980/81	1	36	0	37	33	3	1
1981/82	1	42	0	43	40	2	1
1982/83	1	31	0	32	29	2	2
1983/84	2	33	0	35	29	2	1
1984/85	1	31	0	32	28	2	2
1985/86	2	30	0	32	26	2	3
1986/87	3	28	0	31	25	2	3
1987/88	3	28	0	31	28	2	1
Trinidad-Tobago:							
1980/81	23	102	22	148	74	61	13
1981/82	13	87	26	127	55	65	7
1982/83	7	88	42	137	69	66	1
1983/84	1	72	83	151	72	73	11
1984/85	11	94	52	156	73	69	14
1985/86	14	88	34	137	53	69	14
1986/87	14	92	33	140	62	70	7
1987/88	7	99	33	139	56	73	9
Total:							
1980/81	301	3,254	68	3,626	1,957	1,287	379
1981/82	379	3,569	90	4,040	1,948	1,286	774
1982/83	774	3,474	131	4,378	2,175	1,238	807
1983/84	807	3,480	209	4,174	2,392	1,333	712
1984/85	712	3,316	138	4,167	1,701	1,492	849
1985/86	849	3,258	148	4,259	1,674	1,549	871
1986/87	871	3,097	161	4,132	1,635	1,617	766
1987/88	766	2,933	133	3,834	1,490	1,650	599

Source: Derived from statistics of the Foreign Agricultural Service, U.S. Department of Agriculture.

Table F-3

Sugarcane processing: Number of factories, daily cane processing capacity, and daily refined sugar capacity, by CBI-eligible countries, 1987

Country	*Number of factories*	*Daily cane processing capacity*[1]	*Daily refined sugar capacity*[2]
	Short tons		Gallons
Barbados	6	15,036	(3)
Belize	2	9,408	(3)
Costa Rica	21	34,303	961
Dominican Republic	16	[4] 71,981	(3)
El Salvador	10	30,754	606
Guatemala	18	[5] 71,209	(3)
Haiti	2	[4] 3,968	99
Honduras	8	[4] 20,613	(3)
Jamaica	9	27,514	(3)
St. Christopher-Nevis	1	3,307	(3)
Trinidad-Tobago	2	17,306	265
Total	95	305,399	1,931

[1] Rated capacity for 24 hours, aggregated over all factories.
[2] Rated capacity for 24 hours, aggregated over those factories with refineries; Costa Rica—15 refineries, El Salvador—capacity for 1 of 2 refineries, Haiti and Trinidad-Tobago—1 refinery each.
[3] Not available.
[4] Capacity for 1 factory not listed.
[5] Capacity for 3 factories not listed.

Source: Adapted from F.O. Licht, *International Sugar Economic Yearbook and Directory*, 1987, and industry sources.

Table F-4

Sugar exports: CBI-eligible countries, by country of destination, 1980-87

(In thousands of short tons, raw value)

Source and destination	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*
Barbados:								
Soviet Union	0	0	0	0	0	0	23	0
United States	66	14	29	17	8	19	13	23
All other	68	57	70	64	86	66	61	61
Total	134	71	99	81	94	85	97	84
Belize:								
Soviet Union	0	0	0	0	0	0	6	0
United States	72	57	45	31	41	14	61	19
All other	41	48	70	96	71	105	48	74
Total	113	105	115	127	112	119	115	93
Costa Rica:								
Soviet Union	0	0	0	0	0	0	0	53
United States	81	62	65	64	92	3	12	41
All other	9	0	0	0	0	([1])	0	0
Dominican Republic:								
Soviet Union	10	0	259	213	61	248	56	161
United States	579	784	400	591	677	513	394	334
All other	285	168	278	250	238	35	79	152
Total	874	952	937	1,054	976	796	529	647
El Salvador:								
United States	39	54	62	102	86	127	114	44
Guatemala:								
Soviet Union	17	0	77	0	18	45	50	41
United States	205	230	69	136	144	157	131	81
All other	9	21	94	309	174	114	231	207
Total	231	251	240	445	336	316	412	329
Haiti:								
United States	10	0	6	15	17	0	0	8
Honduras:								
Soviet Union	0	0	0	0	0	23	5	32
United States	90	83	74	34	89	40	70	9
All other	0	0	22	60	10	33	29	0
Jamaica:								
United States	48	0	9	28	33	28	19	10
All other	101	137	146	145	144	142	142	139
Panama:								
United States	160	123	108	151	91	86	75	12
All other	0	0	15	0	0	0	0	0
St. Christopher-Nevis:								
United States	22	15	12	19	14	5	9	7
All other	14	18	25	10	17	22	16	18
Trinidad-Tobago:								
United States	0	0	0	0	0	10	13	8
All other	71	74	55	69	52	58	54	53

[1] Less than 500 short tons.

Source: Derived from statistics of the International Sugar Organization, *Statistical Bulletin, various dates.*

Table F-5

Sugar imports: CBI-eligible countries, by country of origin, 1980-87

(In thousands of short tons, raw value)

Importer and origin	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*
Bahamas:								
United States	5	4	4	3	12	6	9	8
All other	4	4	5	4	1	2	2	2
Barbados:								
United States	0	0	2	0	0	0	0	0
All other	0	0	0	0	([1])	([1])	([1])	([1])
Belize:								
All other	0	0	0	0	0	0	8	1
Costa Rica:								
United States	0	5	0	0	0	0	0	0
All other	0	0	14	([1])	0	0	0	0
El Salvador:								
All other	0	0	12	0	0	0	0	0
Haiti:								
United States	([1])	8	([1])	10	12	19	23	18
All other	11	([1])	12	27	11	1	([1])	11
Honduras:								
United States	0	0	0	([1])	0	0	0	0
Jamaica:								
United States	5	14	7	22	48	25	37	24
All other	0	18	31	46	36	11	24	34
Netherlands Antilles:								
United States	6	6	6	5	11	7	7	8
All other	4	3	5	6	2	2	2	2
Trinidad-Tobago:								
United States	20	22	6	31	6	0	([1])	0
All other	2	0	21	16	89	31	30	33

[1] Less than 500 short tons.

Note.—These data and the data in table F-4 may differ from data of the U.S. Department of Agriculture.

Source: Derived from statistics of the International Sugar Organization, *Statistical Bulletin, various dates.*

Table F-6

Sugar: Net exports[1] to the free market by CBI-eligible countries, 1980-87

(In thousands of short tons, raw value)

Net exporter	1980	1981	1982	1983	1984	1985	1986	1987
Barbados	73	21	32	23	14	26	40	28
Belize	72	57	67	78	62	56	59	43
Costa Rica	90	58	50	64	92	3	73	94
Dominican Republic	874	952	937	1,054	976	795	530	647
El Salvador	39	54	50	102	86	127	114	44
Guatemala	231	251	240	445	336	316	412	330
Honduras	90	83	106	117	99	96	105	41
Panama	160	123	123	151	91	86	75	12
St. Christopher-Nevis	22	16	13	19	15	6	9	8
Total	1,651	1,615	1,618	2,053	1,771	1,511	1,417	1,247

[1] Net exports to the free market are shipments to countries outside preferential agreements.

Note.—These data may differ from data of the U.S. Department of Agriculture.

Source: Derived from statistics of the International Sugar Organization, *Statistical Bulletin, September 1988.*

Table F-7

Sugar: Net imports[1] from the free market by CBI-eligible countries, 1980-87

(In thousands of short tons, raw value)

Net importer	1980	1981	1982	1983	1984	1985	1986	1987
Bahamas	9	9	9	7	13	7	11	10
Haiti	1	8	5	22	6	20	23	21
Jamaica	[2](42)	32	29	40	51	8	41	48
Netherlands Antilles	10	4	8	10	13	9	8	10
Trinidad-Tobago	22	22	28	47	94	21	17	25
Total	[3]0	75	79	126	177	65	100	114

[1] Net imports from the free market are shipments from countries outside preferential agreements.
[2]Jamaica was a net exporter in 1980.
[3] Net imports total to zero due to Jamaica's net exports.

Note.—These data may differ from data of the U.S. Department of Agriculture.

Source: Derived from statistics of the International Sugar Organization, *Statistical Bulletin, September 1988.*

Table F-8

Molasses: Production by CBI-eligible countries, marketing years 1982-83 to 1987-88

(In thousands of short tons)

Country	Marketing year[1] 1982/83	1983/84	1984/85	1985/86	1986/87	1987/88
Barbados	28	30	29	38	31	30
Belize	42	36	31	28	28	26
Costa Rica	80	87	87	94	95	101
Dominican Republic	372	448	344	309	305	320
El Salvador	112	153	152	159	161	116
Guatemala	246	236	264	228	294	298
Haiti	42	38	38	39	39	39
Honduras	91	83	88	84	80	61
Jamaica	111	110	88	86	80	85
Panama	101	99	91	92	60	57
St. Christopher-Nevis	14	12	12	12	12	12
Trinidad-Tobago	54	42	53	57	58	61
Total	1,293	1,374	1,277	1,226	1,243	1,206

[1] The marketing year for both sugar and molasses in each of the CBI-eligible countries is as follows: September/August—Barbados, Belize, El Salvador, and Honduras; October/September—Costa Rica and Panama; November/October—Dominican Republic and Guatemala; and, January/December—Haiti, Jamaica, and Trinidad-Tobago. Marketing year information is not available for St. Christopher-Nevis.

Source: Derived from official statistics of the Foreign Agricultural Service, U.S. Department of Agriculture, *World Sugar and Molasses Situation and Outlook*, various dates.

Table F-9

Industrial molasses: Exports by CBI-eligible countries, marketing years 1982-83 to 1986-87

(In thousands of short tons)

Country	Marketing year 1982/83	1983/84	1984/85	1985/86	1986/87
Dominican Republic	227	215	139	115	108
El Salvador	23	26	44	0	0
Guatemala	139	151	180	154	154
Honduras	67	56	50	45	45
Panama	46	44	40	20	16
Trinidad-Tobago	16	14	15	33	24
Total	518	506	468	367	347

Source: Derived from official statistics of the Foreign Agricultural Service, U.S. Department of Agriculture, *World Sugar and Molasses Situation and Outlook*, various dates.

Table F-10

Raw sugar: World and U.S. prices, by months, January 1980–August 1988[1]

(In cents per pound)

Month	World price	U.S. price	Month	World price	U.S. price	Month	World price	U.S. price
1980:			1983:			1986:		
Jan	17.23	19.66	Jan	5.98	21.23	Jan	4.87	20.67
Feb	23.03	24.69	Feb	6.40	21.76	Feb	5.55	21.01
Mar	20.12	21.28	Mar	6.18	21.86	Mar	7.07	20.95
Apr	21.61	22.67	Apr	6.71	22.43	Apr	8.36	20.85
May	31.33	31.89	May	9.27	22.59	May	7.64	20.88
Jun	31.61	32.10	Jun	10.80	22.54	Jun	6.36	20.99
Jul	28.12	28.75	Jul	10.53	22.09	Jul	5.58	20.97
Aug	31.97	33.14	Aug	10.52	22.55	Aug	5.50	20.87
Sep	35.12	36.03	Sep	9.46	22.20	Sep	4.67	20.87
Oct	41.09	41.70	Oct	9.67	21.94	Oct	5.42	21.08
Nov	37.95	39.28	Nov	8.52	21.83	Nov	5.93	21.17
Dec	28.98	30.29	Dec	7.82	21.47	Dec	5.66	21.12
Avg	29.01	30.12	Avg	8.49	22.04	Avg	6.05	20.95
1981:			1984:			1987:		
Jan	28.01	29.57	Jan	6.95	21.51	Jan	6.47	21.50
Feb	24.27	26.07	Feb	6.58	21.90	Feb	7.32	21.76
Mar	21.77	23.81	Mar	6.42	22.00	Mar	7.51	21.76
Apr	17.90	19.91	Apr	5.96	22.03	Apr	6.64	21.81
May	15.08	17.43	May	5.58	22.01	May	6.71	22.01
Jun	16.35	18.95	Jun	5.48	22.06	Jun	6.40	22.06
Jul	16.32	19.10	Jul	4.51	21.89	Jul	6.03	22.07
Aug	14.76	17.42	Aug	4.01	21.72	Aug	5.57	21.88
Sep	11.66	15.49	Sep	4.11	21.70	Sep	5.79	21.88
Oct	12.13	15.66	Oct	4.66	21.56	Oct	6.60	21.69
Nov	11.96	16.28	Nov	4.41	21.40	Nov	7.28	21.75
Dec	12.96	17.07	Dec	3.51	21.10	Dec	8.25	21.76
Avg	16.93	19.73	Avg	5.18	21.74	Avg	6.71	21.83
1982:			1985:			1988:		
Jan	12.99	18.16	Jan	3.59	20.72	Jan	9.64	21.83
Feb	13.05	17.77	Feb	3.66	20.38	Feb	8.40	22.[illegible]
Mar	11.24	17.13	Mar	3.78	20.91	Mar	8.48	22.[illegible]
Apr	9.53	17.89	Apr	3.37	20.97	Apr	8.49	22.16
May	8.12	19.57	May	2.77	21.09	May	8.85	22.13
Jun	6.85	21.03	Jun	2.74	21.27	Jun	10.52	22.54
Jul	7.83	22.15	Jul	3.15	21.23	Jul	14.04	23.43
Aug	6.80	22.45	Aug	4.35	20.59	Aug	11.09	21.90
Sep	5.90	20.88	Sep	5.14	19.51	Oct	5.91	20.44
Oct	5.01	18.68	Nov	6.50	20.79	Nov	5.53	18.89
Dec	6.27	20.83	Dec	5.37	19.89			
Avg	8.42	19.92	Avg	4.04	20.34			

[1] World price: FOB Caribbean, Contract No. 11, Coffee, Sugar and Cocoa Exchange (CSCE). U.S. price: 1980–May 1985—CIF, duty/fee-paid, Contract No. 12, CSCE; June–December 1985—nearby No. 12 futures, CSCE; 1986-present—nearby No. 14 futures, CSCE.

Source: Compiled from official statistics of the U.S. Department of Agriculture.

Table F-11

Blackstrap molasses, bulk: Monthly-average wholesale price at New Orleans, Louisiana, January 1980-September 1988

(In dollars per short ton)

Month	Price	Month	Price	Month	Price
1980:		**1983:**		**1986:**	
January	89.90	January	44.40	January	65.00
February	91.50	February	45.00	February	65.60
March	92.00	March	45.00	March	68.50
April	92.00	April	45.00	April	71.00
May	92.00	May	47.50	May	73.75
June	92.00	June	49.40	June	79.00
July	92.00	July	53.75	July	79.10
August	92.00	August	61.50	August	76.60
September	94.40	September	68.75	September	72.30
October	103.50	October	72.50	October	68.10
November	111.60	November	72.50	November	60.25
December	113.00	December	72.50	December	55.50
Average	96.18	Average	56.48	Average	69.56
1981:		**1984:**		**1987:**	
January	116.75	January	72.50	January	56.25
February	118.00	February	72.50	February	59.40
March	115.00	March	72.50	March	62.00
April	103.00	April	72.50	April	59.40
May	95.50	May	70.00	May	59.10
June	88.00	June	68.75	June	53.00
July	83.00	July	59.00	July	50.60
August	71.60	August	50.00	August	48.60
September	67.50	September	50.00	September	45.30
October	58.75	October	50.00	October	45.00
November	52.00	November	50.00	November	47.00
December	50.00	December	50.10	December	53.10
Average	84.92	Average	61.49	Average	53.23
1982:		**1985:**		**1988:**	
January	50.00	January	50.00	January	60.30
February	50.00	February	50.00	February	62.00
March	50.00	March	50.00	March	60.60
April	50.00	April	50.00	April	56.90
May	50.00	May	50.00	May	55.50
June	50.00	June	47.75	June	62.50
July	49.50	July	41.00	July	72.50
August	48.00	August	41.90	August	72.50
September	48.00	September	48.00	September	70.00
October	44.25	October	53.75		
November	40.00	November	57.50		
December	41.25	December	63.50		
Average	47.58	Average	50.28		

Source: Compiled from statistics of the Market News Service, Agricultural Marketing Service, U.S. Department of Agriculture.

Table F-12

U.S. sugar quota: Allocations for CBI-eligible countries, quota years 1982-83 to 1988

(In short tons, raw value)

Country	Quota year— 10/1/82-9/30/83	9/26/83-9/30/84	10/1/84-11/30/85	12/1/85-12/31/86	1/1/87-12/31/87	1/1/88-12/31/88
Barbados	19,600	21,294	17,780	12,500	7,500	8,205
Belize	30,800	33,462	27,940	18,876	10,010	11,045
Costa Rica	42,000	62,415	52,302	34,713	17,583	19,577.5
Dominican Republic	492,800	535,392	447,040	302,016	160,160	176,710
El Salvador	72,800	89,163	74,561	49,999.8	26,019.8	28,815.5
Guatemala	134,400	146,016	121,920	82,368	43,680	48,185
Haiti	16,500	16,776	12,500	12,500	7,500	8,000
Honduras	28,000	59,514	50,017	32,713.2	15,917.2	17,877
Jamaica	30,800	33,462	27,940	18,876	10,010	11,045
Panama	81,200	88,218	73,660	49,764	26,390	[1]0
St. Christopher-Nevis	16,500	16,776	12,500	12,500	7,500	8,000
Trinidad-Tobago	19,600	21,294	17,780	12,500	7,500	8,205
Total	985,000	1,123,782	935,940	639,326	339,770	345,665

[1] The quota allocation for Panama was reallocated pro rata among all eligible countries in 1988 through legislative action.

Source: Compiled from official statistics of the U.S. Department of Agriculture.

Table F-13

EC preferential sugar quota: Allotments for CBI eligible countries, 1984

(In thousands of short tons, refined (white sugar) basis)

Country	Quota allotment
Barbados	55,154
Belize	44,195
Jamaica	130,367
St. Christopher-Nevis	16,964
Trinidad-Tobago	47,937
Total CBI eligible countries	294,617

Source: Ralph Ives and John Hurley, *U.S. Sugar Policy: An Analysis*, U.S. Department of Commerce, International Trade Administration, April 1988,p. 97.

Table F-14

Ethyl alcohol from agricultural sources: Total exports from EC nations, 1983-87

Source[1]	1983	1984	1985	1986	1987
			Quantity (million gallons)		
France	38	36	39	50	89
Italy	2	1	2	1	21
Netherlands	6	8	1	9	7
Spain	([2])	([2])	([2])	25	5
Other EC	43	62	55	52	6
Total	89	107	103	167	194
			Value (1,000 ECU)		
France	62,154	65,053	71,822	74,268	99,434
Italy	3,276	2,187	1,456	2,692	8,931
Netherlands	10,604	15,290	15,748	17,803	27,999
Spain	([2])	([2])	([2])	14,897	3,458
Other EC	76,534	118,993	106,602	87,838	86,331
Total	153,018	201,523	195,628	197,498	223,153
			Unit value (ECU per gallon)		
France	1.66	1.83	1.83	1.49	1.12
Italy	1.67	1.59	1.72	1.89	0.42
Netherlands	1.97	1.87	1.98	2.04	1.68
Spain.	([2])	([2])	([2])	0.61	.66
Other EC	1.74	1.92	1.93	1.68	1.35
Average	1.72	1.88	1.90	1.44	1.15

[1] The total figure for 1983-5 represents exports of the EC-10 and that for 1986-7 exports of the EC-12.
[2] Spain was not included in EC statistics until 1986.

Source: Compiled from official statistics (Eurostat) of the Council of European Communities.

Table F-15

Ethyl alcohol from agricultural sources: Exports from EC nations to Jamaica, 1986-87

Source	Volume	Value	Unit value
	1,000 gallons	*1,000 ECU's*	*ECU per gallons*
1986:			
Spain	69	17	0.25
France	5,855	1,722	.29
Total EC nations	5,924	1,739	.29
1987:			
Spain	265	116	.44
France	8,715	2,775	.32
Italy	13,253	2,366	.18
United Kingdom	1	6	-
Total EC nations	22,235	5,263	.24

Source: Compiled from official statistics (Eurostat) of the Council of European Communities.

Table F-16

Ethyl alcohol from agricultural sources: Exports from EC nations to the United States, 1983-87

Year and source nation	Volume	Value	Unit value
	1,000 gallons	*1,000 ECU's*	*ECU per gallons*
1983:			
France	821	1,535	1.87
Italy	3	33	(1)
Total	824	1,568	1.90
1984:			
France	1,503	2,360	1.57
1985:			
France	4,144	5,949	1.44
Netherlands	75	99	1.33
Total	4,219	6,048	1.43
1986:			
France	4,105	4,475	1.09
Italy	11	44	(1)
Netherlands	354	263	0.74
Spain	5,219	3,576	.68
Other EC-12 nations	8,274	12,644	1.53
Total	7,962	21,002	1.17
1987:			
France	4,903	3,091	.63
Italy	03	2	(1)
Netherlands	5,508	6,403	1.16
Other EC-12 nations	6,633	6,292	.95
Total	17,404	15,788	.93

[1] These unit values, based on rounded figures, are not representative of the unit values of the indicated transactions.

Source: Compiled from official statistics (Eurostat) of the Council of European Communities. There are no equivalent statistics compiled by the U.S. Department of Commerce.

Table F-17

Ethyl alcohol from agricultural sources: Exports from EC nations to the world, other EC nations, and United States, 1983-87

Year and source	Value	Share of total
	1,000 ECU's	Percent
1983:		
Exports to—		
World	153,018	100
Other EC-10 nations	76,886	50
United States	1,568	1
1984:		
Exports to—		
World	201,523	100
Other EC-10 nations	90,223	45
United States	2,360	2
1985:		
Exports to—		
World	195,628	100
Other EC-10 nations	90,402	46
United States	6,048	3
1986:		
Exports to—		
World	197,498	100
Other EC-10 nations	142,626	72
United States	21,002	11
1987:		
Exports to—		
World	223,153	100
Other EC-10 nations	161,276	72
United States	15,788	7

Source: Compiled from official statistics (Eurostat) of the Council of European Communities. There are no equivalent statistics compiled by the U.S. Department of Commerce.

Table F-18

Methanol: U.S. production, exports of domestic merchandise, imports for consumption, and apparent consumption, 1983-87

Year	U.S. production	Exports	Imports	Apparent consumption	Ratio (percent) of imports to consumption
	Quantity (million gallons)				
1983	1,211	99	104	1,216	9
1984	1,242	43	194	1,393	14
1985	759	8	355	1,105	32
1986	1,093	34	376	1,435	26
1987	1,143	29	402	1,516	27
	Value (million dollars)				
1983	559	45	41	555	7
1984	491	27	64	528	12
1985	350	6	111	244	45
1986	360	12	95	443	21
1987	377	13	80	444	18
	Unit value (cents per gallon)				
1983	46	45	39	46	-
1984	40	62	33	38	-
1985	46	57	31	22	-
1986	33	37	25	31	-
1987	33	47	20	29	-

Source: Estimated by the staff of the U.S. International Trade Commission.

Table F-19

Methyl tert-butyl ether (MTBE): U.S. production, exports of domestic merchandise, imports for consumption, and apparent consumption, 1983-87

Year	*U.S. production*	*Exports*	*Imports*	*Apparent consumption*	*Ratio (percent) of imports to consumption*
			Quantity (million pounds)		
1983	839	(1)	0	839	0
1984	1,376	(1)	(1)	1,376	(2)
1985	1,891	(1)	0	1,891	0
1986	4,725	(1)	0	4,725	0
1987	6,360	(1)	(1)	6,360	(2)
			Value (million dollars)		
1983	151	(3)	0	151	0
1984	220	(3)	(1)	220	(2)
1985	303	(3)	0	303	0
1986	520	(3)	0	520	0
1987	763	(3)	(1)	763	(2)
			Unit value (cents per gallon)		
1983	18	20	–	18	–
1984	16	20	20	16	–
1985	16	18	–	16	–
1986	11	14	–	11	–
1987	12	14	14	12	–

[1] Less than 500,000 lbs.
[2] Less than 0.5 percent.
[3] Less than $500.000.

Source: Estimated by the staff of the U.S. International Trade Commission.

Table F-20

Metropolitan statistical areas with carbon monoxide levels greater than standard (9 ppm), 1987

Name of area	*Design value*[1]	*Number of times limit was exceeded*
Los Angeles/Long Beach, CA	27.4	52
Denver, CO	24.0	59
Phoenix, AZ	20.3	85
Provo/Orem, UT	19.1	73
Fort Collins, CO	17.8	7
Fairbanks, AK	17.7	40
Albuquerque, NM	17.2	57
Medford, OR	16.3	43
Sacramento, CA	16.3	31
Las Vegas, NV	16.3	21
Reno, NV	16.2	26
Greeley, CO	16.2	12
Anchorage, AK	16.0	43
Boise, ID	15.5	15
Spokane, WA	15.4	15
San Jose, CA	14.3	19
Yakima, WA	13.9	6
El Paso, TX	13.3	8
Colorado Springs, CO	13.2	4
Oklahoma City, OK	12.8	10
Kansas City, MO	12.8	6
Anaheim/Santa Ana, CA	12.7	7
Missoula, MT	12.6	8
San Francisco, CA	12.3	4
Tacoma, WA	12.2	15
Portland, OR	12.2	10
Salt Lake City/Ogden, UT	12.0	9
Fresno, CA	12.0	9
Tucson, AZ	11.8	14
Seattle, WA	11.5	10
Grants Pass, NM	11.3	12
Santa Barbara/Santa Maria/Lompoc, CA	10.5	5
Des Moines, IA	10.4	6
Dubuque, IA	10.3	2
Dallas, TX	10.3	2
San Diego, CA	10.3	4
Boulder/Longmont, CO	9.9	2
Salem, OR	9.8	4
Vallejo/Fairfield/Napa, CA	9.7	4
Chico, CA	9.6	2

[1] Fourth highest reading in 3-year period, 1983-85 (three readings over 9 ppm allowed in 3 years).

Source: Environmental Protection Agency.

Table F-21

Air quality areas exceeding ozone standard (0.12 ppm): 1987

Name of area	*Design value*[1]	*Number of times limit was exceeded*
Los Angeles, CA	0.36	123.2
Houston/Galveston/Brazoria, TX	.25	20.2
Greater Connecticut, CT	.23	35.6
New York, NY-NJ-CT, NY	.22	31.3
San Diego, CA	.21	11.2
Chicago/Gary/Lake Co., IL	.20	8.5
Atlanta City, NJ	.19	10.3
Providence/Pawtucket/Fall River, RI	.18	10.3
Philadelphia, PA	.18	9.9
Sacramento, CA	.18	8.6
Baltimore, MD	.17	10.1
Cincinnati/Hamilton, OH	.17	7.1
Fresno, CA	.17	6.6
Milwaukee/Racine, WI	.17	6.2
San Francisco, CA	.17	3.7
Atlanta, GA	.16	7.5
Bakersfield, CA	.16	27.2
Baton Rouge, LA	.16	3.4
Beaumont/Port Arthur, TX	.16	8.3
Boston/Lawrence/Salem, MA	.16	6.6
Dallas/Ft. Worth, TX	.16	13.6
New Bedford, MA	.16	10.8
Phoenix, AZ	.16	4.8
Portland, ME	.16	6.8
Santa Barbara/San Maria/Lompoc, CA	.16	3.0
St. Louis, MO.	.16	9.4
Washington, DC-MD-VA, DC	.16	8.5
Longview/Marshall, TX	.15	2.3
Louisville, KY	.15	8.0
Memphis, TN	.15	2.9
Modesto, CA	.15	13.0
Salt Lake City/Ogden, UT	.15	4.4
Seaford, DE	.15	4.6
Stockton, CA	.15	9.0
Worcester, MA	.15	3.0
York Co., ME	.15	9.5
Allentown/Bethlehem, PA	.14	3.8
Cleveland/Akron/Lorain, OH	.14	3.3
Dover, DE	.14	3.7
Gardner, ME	.14	2.2
Huntington/Ashland, WV-KY, WV	.14	5.2
Jacksonville, FL	.14	1.7
Kansas City, MO-KS, MO.	.14	2.4
Lake Charles, LA	0.14	1.7
Muskegon, MI	.14	3.6
Nashville, TN	.14	2.8
Northampton Co., VA	.14	2.6
Acadia National Park, ME	.13	1.4
Birmingham, AL	.13	2.4
Charleston, WV	.13	1.3
Charlotte/Gastonia/Rock Hill, NC	.13	1.8
Dayton/Springfield, OH	.13	1.5
Denver/Boulder, CO	.13	1.7
Detroit/Ann Arbor, MI	.13	2.2
Erie, PA	.13	1.4
Grand Rapids, MI	.13	1.3
Hancock, Co., ME	.13	1.5
Harrisburg/Lebanon/Carlisle, PA	.13	1.7
Iberville Parish, LA	.13	2.4
Indianapolis, IN	.13	2.5
Janesville/Beloit, WI	.13	1.9
Lancaster, PA	.13	3.3
Miami/Ft. Lauderdale, FL	.13	1.3
Pittsburgh/Beaver Valley, PA	.13	2.6
Point Coupee Parish, LA	.13	3.1
Portland/Vancouver, OR-WA, OR	.13	1.4
Portsmouth/Dover/Rochester, NH-ME, NH	.13	1.3
Reading, PA	.13	2.1
Richmond/Petersburg, VA	.13	2.6

See footnote at end of table.

Table F-21—Continued

Air quality areas exceeding ozone standard (0.12 ppm), 1987

Name of area	*Design value*[1]	*Number of times limit was exceeded*
St. James Parish, LA	.13	3.9
Tampa/St. Petersburg/Clearwater, FL	.13	1.7
Tulsa, OK	.13	1.9
Visalia/Tulare/Porterville, CA	.13	8.8
York, PA	.13	2.5
Yuba City, CA	.13	3.0

[1] Fourth highest reading in 3-year period, 1983-85 (three readings over 0.12 ppm allowed in 3 years).

Source: Environmental Protection Agency.

APPENDIX G
METHODOLOGY

METHODOLOGY

This appendix explains the methods used to estimate the effects of changes in feedstock requirements on CBI ethanol producers, domestic producers, and consumers. It derives the equations used to calculate the effect of changing feedstock requirements on the cost of production. An imperfect substitutes model is also developed and used to derive measurements of producer and consumer surplus changes.

Measurement of the welfare benefits realized by changes in CBERA feedstock requirements should, in principle, include any changes in tariff or duty collections. There are currently no tariffs collected on ethanol under CBI. In addition, there is a duty rate of 3 percent and a duty of 60 cents per gallon levied against all imports of fuel ethanol from non-CBI sources. This tariff has proved to be prohibitive. Although ethanol is imported to the United States for industrial purposes subject to the 3-percent duty, the additional duty of 60 cents per gallon on fuel ethanol has precluded imports of ethanol for blending with gasoline. However, there is, in effect, a production subsidy for CBI and U.S. ethanol producers. The U.S. Government currently provides a credit of 6 cents per gallon tax for 10-percent ethanol blends. This works out to be a subsidy of 60 cents per gallon fuel ethanol. There are also various State and local subsidies.

Federal and State subsidies need to be balanced against the benefits of additional fuel ethanol use. Ethanol blended fuels can significantly reduce emissions of carbon monoxide, aromatic carcinogens, and the formation of ozone in urban areas. Whitten (1988) and Randall (1988) have both reported that use of ethanol blends significantly reduces CO emissions. Randall has reported that ethanol blends may reduce CO emissions by as much as 30 percent. These significant reductions in CO emissions more than compensate for volatile organic compound emissions associated with ethanol blends, resulting in significant reductions in ozone formation in urban areas. Ethanol is also a much more environmentally benign substance than the aromatic hydrocarbons like benzene, toluene, and xylene that have been substituted for lead since the EPA instituted the phaseout of lead in gasoline. Benzene is a known carcinogen. Both xylene and CO contribute to urban ozone formation. High levels of ozone can in turn result in lung cancer. A significant number of major metropolitan areas are currently in "nonattainment" status regarding EPA air quality standards (see tables F-20 and F-21).

Ethanol is an alternative to curbing transportation and industrial growth to meet air quality standards, and offers an opportunity to significantly reduce cancer and other illnesses related to air quality. (See the Renewable Fuels Association 1988 proceedings). The social consensus embodied in EPA enforcement of clean air standards and the fact that additional subsidies will be needed to meet these standards implies that current subsidy rates per gallon of ethanol underestimate the social benefits of ethanol use. This suggests that welfare measurements based on market prices, like those presented in chapter 6, will underestimate actual social welfare benefits.

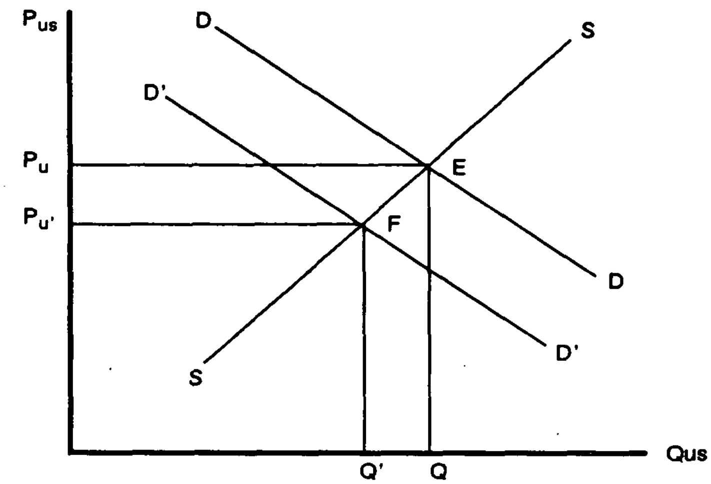
The geometry of the model

To understand the full effect of various feedstock requirements, we need to consider the interaction between changes in the cost of production with other demand and supply conditions. This allows the estimation of the full effect that alternative content requirements have on CBI countries and on the domestic industry. This section discusses these effects. It explains, geometrically, what is measured as the "effect" that changing content requirements has on the U.S. industry and on CBI exporters.

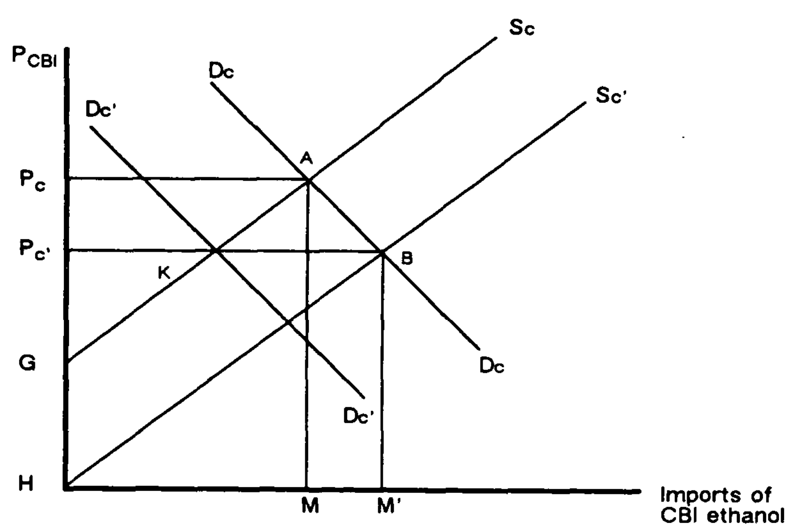
The market for domestic fuel ethanol is represented by the supply and demand curves SS and DD in panel a. of figure G-1, and the market for Caribbean fuel ethanol is

Figure G-1

Partial equilibrium analysis of the effects of changing CBERA indigenous feedstock requirements for fuel ethanol production on U.S. imports from CBERA beneficiaries, competing domestic industry, and U.S. consumers



a. U.S. market for the competing domestic industry



b. U.S. market for CBERA ethanol imports represented by the curves $S_c S_c$ and $D_c D_c$ in panel b of figure G–1.[1] With a decline in indigenous feedstock requirements, the supply curve for Caribbean ethanol shifts from S_cS_c to $S_c'S_c'$. The result is an increase in imports from M to M'. The price of imported fuel ethanol falls from P_c to P_c'. The fall in the price of imported ethanol results in a decline in the demand for domestic fuel ethanol, with DD shifting to D'D'. The quantity sold by the domestic industry declines from Q to Q', while the price falls from P_u to P_u'. The net gain to the Caribbean economies exporting ethanol is measured by the difference between areas GAP_c and HBP_c'. This represents the net increase in GNP for CBI countries, and is often referred to as producer surplus.[2] The loss to factors of production in the domestic industry (capital equipment, labor, corn farmers, etc.), is measured by the trapezoid $P_u'FEP_u$. Changes in producer surplus represent the difference between changes in revenue and the income that can be earned elsewhere by displaced factors. The gain for U.S. consumers is measured by the sum of $(P_c'-P_c)(Q_c'+Q_c)/2$ and $(P_u'-P_u)(Q_u'+Q_u)/2$.

A decline in the price of gasoline leads to a decline in the demand for U.S. and CBI ethanol. In terms of figure G–1, this shift in demand can be represented by the shift in the demand for the U.S. product from DD to D'D' and by the shift in demand for the Caribbean product from D_cD_c to $D_c'D_c'$. The loss to U.S. and CBI producers is then measured by the trapezoids $P_u'FEP_u$ and $P_c'KAP_c$.

The equations

This section develops the equations used to calculate the effects of changes in feedstock requirements. When the price of imported hydrous feedstock represents no more than 65 percent of the value of the final product, the original CBERA requirements meant that

(1) $C(E)=C(F_I)+C(D_I)$,

where C(E) is the per gallon cost of anhydrous ethanol f.o.b., $C(F_I)$ is the per gallon cost of imported feedstock, and $C(D_I)$ is the per gallon cost of distillation of imported hydrous feedstock.

[1] The model presented here assumes that Caribbean and U.S. fuel ethanol are imperfect substitutes for each other. The imperfect substitutes assumption is supported by extensive empirical evidence, such as Isard (1977), Richardson (1978), and Kravis and Lipsey (1978). In the case of fuel ethanol, the prices of Caribbean and U.S.-produced fuel ethanol have historically varied significantly from each other and have often moved in opposite directions. Price data are presented in table G-1. It can be seen that the U.S. product price (P_u) and the CBI product price (P_c) have often moved in opposite directions, supporting the imperfect substitutes approach.

[2] In principal, one needs to consider the effect on consumers as well. However, CBI fuel ethanol is produced almost exclusively for U.S. consumption.

Table G-1
U.S. ethanol prices 1985I–1988II (In U.S. dollars per gallon)

Period	*Pu* [a]	*Pc* [b]
1985I	1.45	1.19
1985II	1.50	1.31
1985III	1.50	1.10
1985IV	1.49	0.93
1986I	1.40	1.08
1986II	1.13	1.07
1986III	0.93	0.97
1986IV	0.73	1.01
1987I	0.89	0.99
1987II	1.15	1.00
1987III	1.20	1.03
1987IV	1.09	1.09
1988I	0.99	1.13
1988II	1.06	1.10

[a] ADM, f.o.b., Decatur, IL.

[b] c.i.f.

Source: Official data of the U.S. Department of Commerce, as well as data from Information Resources, Inc.

When the cost of imported feedstock represented more than 65 percent of the value of anhydrous ethanol, producers were technically required, by the original provisions of CBERA, to blend the imported feedstock with CBI-originated feedstock. In this case, the original value added requirements can be stated formally as

$$(2) \qquad .35=\frac{[g(C(FCBI)+C(DCBI))+(1-g)C(DI)]}{[g(C(F_{CBI})+C(D_{CBI}))+(1-g)\ (C(D_I)+C(F_I)]}.$$

In equation (2), g represents the per gallon share of anhydrous ethanol that is produced from CBI feedstock. $C(F_{CBI})$ is the cost of CBI feedstock, and $C(D_{CBI})$ is the cost of dehydrating hydrous CBI ethanol. From equation (2), we can derive

$$(3) \qquad C(E)=\frac{C(FI)(C(FCBI)+C(DCBI))}{.65(C(F_{CBI})+C(D_{CBI}))+.35(C(F_I)+C(D_I))-D_I}$$

$$(4) \qquad g=\frac{.35(C(FI)+C(DI))-C(DI)}{.65(C(F_{CBI})+C(D_{CBI}))+.35(C(F_I)+C(D_I))-D_I}.$$

According to equation (3), the cost of production increases with domestic value added requirements as long as the cost of producing anhydrous ethanol is lower for imported feedstock rather than CBI feedstock. For different value-added requirements R, the terms .65 and .35 in equations (3) and (4) are replaced by (1-R) and R.

With the new feedstock requirement introduced with the Tax Reform Act of 1986, duty-free treatment now requires that

$$(5) \qquad s=\frac{g(C(FCBI))}{[g(C(F_{CBI})+C(D_{CB}))+(1-g)(C(D_I)+C(F_I)]}.$$

In Equation (5), s is the share of CBI feedstock, by value, in total cost. In 1987, s was set at .30, .60 in 1988, and .75 in 1989. The difference between equations (5) and (2) is that distillation no longer counts in terms of value added. Given equation (5), we can derive the requirements

$$(6) \qquad C(E)=\frac{C(FCBI)(C(FI)+C(DI)}{(1-s)C(F_{CBI})+s(C(F_I)+C(D_I))-sC(D_{CBI})}$$

$$(7) \qquad g=\frac{s((CI)+(DI))}{(1-s)C(F_{CBI})+s(C(F_I)+C(D_I))-sC(D_{CBI})}$$

Equations (6) and (7) allow us to determine the cost of production given various feedstock requirements, as represented by the variable s.[1]

The supply and demand curves for U.S.- and CBI-produced ethanol are assumed to have constant elasticities.[2] The U.S. market for CBI ethanol is represented by the equations

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[1] Producers could use a larger share of CBI ethanol, though at a higher cost. Equations (3) and (7) represent the *minimum* cost at which firms can produce and still qualify under CBERA.

[2] Assuming constant elasticities is a common practice in estimating the effects of trade policy. See for example Arce, Boltuck and Mendez (1988), Rousslang and Lindsey (1984), and Stern, Deardorff, and Shiells (1982).

(8) $Q_c = k_d (P_c/R)^{nms}$

(9) $Q_c = k_s (P_c)^{nmd} (P_g)^{nmg} (P_u)^{nmu}$,

where Q_c is the level of imports, P_c is the price of CBI ethanol, R is an index of the CBI total cost of production relative to a base period, P_g is the price of gasoline, and P_u is the price of U.S. ethanol. Changes in R are determined by changes in CBERA feedstock requirements. These changes measure movements in the industry's marginal cost curve that result from changing feedstock requirements, and are estimated using equation (6) and cost figures reported by various industry sources as "representative" of the industry. The parameter n_{ms} is the import elasticity of supply, n_{md} is the import elasticity of demand, n_{mg} is the cross-price elasticity of demand between CBERA ethanol imports and gasoline, n_{mu} is the cross-price elasticity of demand for CBERA ethanol with respect to U.S. ethanol, and k_d and k_s are constants.

The U.S. market for domestic ethanol is represented by the equations

(10) $Q_u = k_s (P_u)^{eus} (V)^{euv}$

(11) $Q_u = k_d (P_u)^{eud} (P_g)^{eug} (P_m)^{eum}$,

where Q_u is the quantity of domestic ethanol, P_u is the price of U.S. ethanol, and V is an index of variable input costs. V is based on net corn costs and average labor and energy costs per plant as reported by LeBlanc and Reilly (1988).[1] The parameter e_{us} is the elasticity of supply for U.S. ethanol, e_{uv} is the elasticity of supply with respect to the cost parameter V, e_{ud} is the elasticity of demand for U.S. ethanol, e_{ug} is the cross-price elasticity of demand for domestic ethanol with respect to the price of gasoline, e_{um} is the cross-price elasticity of demand for U.S. ethanol with respect to the price of CBI ethanol, and K_s and K_d are constants.

The elasticities of equilibrium price and quantity in the CBI ethanol market with respect to R, $n_{mp,r}$ and $n_{mq,r}$, are determined by the equations

(12) $n_{mp,r} = [1-((n_{mu} e_{um})/((e_{us}-e_{ud})(n_{ms}-n_{md})))]^{-1} [n_{ms}/(n_{ms}-n_{md})]$

(13) $n_{mq,r} = n_{ms}(n_{mp,r}-1)$.

The elasticities of equilibrium price and quantity in the U.S. domestic product market with respect to R, $e_{up,r}$ and $e_{uq,r}$, are determined by the equations

(14) $e_{up,r} = n_{mp,r}[e_{um}/(e_{us}-e_{ud})]$

(15) $e_{uq,r} = e_{us} e_{up,r}$.

From equations (8) and (10), producer surplus for CBI and U.S. producers, PS_c and PS_u, or the areas between the price lines and the supply curves, is given by

(16) $PS_c = [1/(1+n_{ms})][Q_c P_c]$

(17) $PS_u = [1/(1+n_{us})][Q_u P_c]$.

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[1] The USDA-ERS study surveyed the six largest ethanol producers (over 40 million gallons per year) as well as five small and medium-sized producers. Average operating costs are reported, excluding net corn costs (page 10). Since operating costs were averaged across wet-mill and dry-mill operations by ERS, measures of variable costs include net corn costs weighted by wet and dry milling capacity. Net corn costs are based on byproduct yields reported by the National Advisory Panel on Cost-Effectiveness of Fuel Ethanol Production (1987, pp 2.3-2.6), and on byproduct prices reported by LeBlanc and Reilly, the U.S. Bureau of Labor Statistics, and Information Resources, Inc.

Given a change in the supply of imported ethanol because of a change in feedstock requirements, there will be a change in Q_c to Q_c', P_c to P_c', Q_u to Q_u', and P_u to P_u'. These changes are measured, in percentage terms, by equations (12)–(15). The net gain to CBI producers can be measured using equation (16). Given a change in the cost of production, the net cost or benefit to CBI producers C_{Pc} is

$$(18) \quad C_{PC} = [1/(1+n_{ms})][(Q_c' P_c')-(Q_c P_c)].$$

Since CBI ethanol is produced almost exclusively for export to the U.S., equation (18) also measures the change in CBI GDP that results from the change in production costs. The net cost or benefit to U.S. producers C_{Pu} is

$$(19) \quad C_{Pu} = [1/(1+e_{us})][(Q_u' P_u')-(P_u Q_u)].$$

The net welfare gain for the U.S. is the sum of benefits to producers and consumers.[1] The cost to consumers of a change in CBI production costs and of the resulting change in the price of CBI ethanol is measured by

$$(20) \quad CC_c = (P_c'-P_c)(Q_c+Q_c')/2,$$

and the cost to consumers of a change in the price of U.S. ethanol is measured by

$$(21) \quad CC_u = (P_u'-P_u)(Q_u+Q_u')/2.$$

The total cost to consumers is then measured by

$$(22) \quad CC_t = (1/2)[(P_c'-P_c)(Q_c+Q_c') + (P_u'-P_u)(Q_u+Q_u')].$$

Description of the data

Import data were taken from official statistics of the U.S. Department of Commerce. Data for the domestic industry were taken from official statistics of the U.S. Department of Transportation, the U.S. Department of Commerce, and from data provided by Information Resources, Inc. The dollar estimates of changes in consumer and producer surplus that were presented in the text of Chapter 6 and the average change in the cost of production that resulted from changes in indigenous feedstock requirements were calculated using the equations developed in this appendix.

The parameters e_{us}, e_{ud}, e_{ug}, and e_{uv} were estimated econometrically from quarterly data covering the period 1985I–1988I. The parameters n_{ms}, n_{mg}, and n_{md} were calculated as point estimates from 1987 and 1988 import and price data.[2] The reduced-form cross-price elasticity of CBI ethanol imports with respect to gasoline prices was also calculated as a point estimate from 1987 import and price data. Finally, the cross-price elasticities between the United States and CBI product were calculated using relationships suggested by economic theory. There were no fuel ethanol imports from

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[1] See Rousslang and Suomela (1985) and Rousslang and Lindsey (1984) for further discussion of the calculation of consumer surplus. Consumer surplus changes can be measured using information on total expenditures and elasticities. However, since quantities and prices were estimated in this report to answer other questions about displaced production, consumer surplus changes are estimated here directly from these estimates. Since we have constant elasticity demand curves, the estimates made here are biased upwards. However, given the additional social benefits not reflected in private costs, it is not clear whether social benefits are over- or under-estimated.

[2] The domestic market equations were estimated using two-stage least squares, and using the Theil and Nagar (1961) method for correcting for small-sample auto-correlation. For a more complete discussion of the identification problem and its solution using two-stage least squares, see Wonnacott and Wonnacott (1979, pp 274–285). Since much of the quarterly data used in the regression is averaged monthly data, auto-correlation is expected. Correcting for small sample auto-correlation by the Theil-Nagar method is discussed by Gujarati (1978, pp. 241–242).

third countries competing with CBI and U.S. ethanol in 1987–88.[1] The cross-price elasticity of demand between U.S. ethanol and the price of CBI ethanol was then calculated by assuming that all expenditures that shifted away from CBI ethanol as CBI prices changed were shifted toward U.S. ethanol. This assumption yields an upper-bound estimate of e_{um}, since some of the expenditures shifted away from CBI ethanol are probably spent on other octane enhancers, and even on other commodity groups. This approach also assumes that any changes in U.S. GNP are negligible as a result of CBI ethanol price changes.[2]

Given the full set of elasticity estimates, the effect of changes in feedstock requirements was estimated through equations (12)–(15), (19)–(20), and (22). The time period, July–December 1987, was taken as the baseline period for estimation purposes, with adjustments made for changes in production costs.

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[1] There were imports of ethanol from other countries for "nonbeverage" purposes. However, they were all subject to only a 3-percent rate of duty, meaning they were declared to Customs as not intended for use as fuel ethanol.

[2] Formally, we assume that $dV_j = -dV_i$, where $V_j = P_j Q_j$, or that

$$dC_j = (Q_j dP_j) + (P_j dQ_j) = -P_i dQ_i.$$

By collecting and rearranging terms and multiplying by $(1/Q_i)$ and $(1/dP_j)$, we get

$$(Q_j/Q_i)(dP_j/dP_j) = -[(P_i/dP_j)(dQ_i/Q_i) + (P_j/dP_j)(dQ_j/Q_i)]$$

which, when further rearranged, yields

$$-(Q_j/Q_i) = [(P_i/P_j)e_{ij} + (Q_j/Q_i)e_{jj}].$$

Multiplying both sides by (P_j/P_i), and making one further set of manipulations yields

$$e_{ij} = -[(Q_j P_j)/(Q_i p_i)][1 + e_{jj}] = -(V_j/V_i)[1 + e_{jj}].$$

See Rousslang and Parker (1984) for a method of estimating cross-price elasticities when there is more than one import competing with the domestic product.

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APPENDIX H
ENVIRONMENTAL AND FUTURE DEMAND ASPECTS OF THE CLEAN AIR ACT AND SPECIFIED POLLUTANTS ON FUEL ETHANOL

ENVIRONMENTAL AND FUTURE DEMAND ASPECTS OF THE CLEAN AIR ACT AND SPECIFIED POLLUTANTS ON FUEL ETHANOL

The Clean Air Act

The Clean Air Act, as amended (42 USC 7401–7626) requires that the concentrations of specified pollutants in the air not exceed specified levels—National Ambient Air Quality Standards, or NAAQS—set by the Environmental Protection Agency (EPA) to protect public health. The Act specifies six such pollutants and gives EPA the responsibility of identifying others over time.

Two of the original six are ozone and carbon monoxide (CO). CO is emitted directly as a pollutant, mostly as a product of imperfect combustion in vehicle engines and other combustion sources in industry. Ozone is not emitted directly but forms in the air by reaction in the presence of sunlight of volatile organic chemicals (VOC's) and nitrogen oxides (NO_x), both of which are emitted from vehicles, industry, and other sources.

The Act specifies that, in areas of the country where concentrations of these pollutants exceed the standards, the States are to develop plans (State Implementation Plans, or SIP's) to control emission sources so that ambient air concentrations are reduced to the point that the standards will be met, and the deadline for meeting the standards was set at December 31, 1987 for CO and ozone,[1] later extended by Congress to August 1988.

The States with nonattainment areas have taken a number of steps to reduce the offending emissions, such as inspection/maintenance systems for cars in use, improved public transit, improved traffic flow, and staggered work hours. However, in November 1987, the EPA identified 81 metropolitan areas as not meeting the CO standard and 76 as not meeting the ozone standard. For the most part, these metropolitan areas missed the deadline, or dropped below the standard in recent months. (For example, 13 cities that met Federal air quality standards in 1986 slipped out of compliance in 1987. In 198[illegible] more areas regressed.)

For most of the nonattainment areas, most of the easy steps have been taken. The next increments of emission reduction will be seen by many as imposing significant cost or inconvenience.[2] In the Los Angeles area, even a stretched-out program to meet the clean air standards includes the possibility of a ban on gasoline-fueled automobiles and the shutdown of industrial plants.

On the national level, the EPA has taken a number of steps to reduce emissions. Perhaps the best known is the emission control program for new vehicles. Other steps involve alleviation of industrial sources.

As noted above, the Clean Air Act called for attainment of the carbon monoxide and ozone NAAQS in all States by the end of 1987, later extended to August 1988. States failing to adopt plans to achieve attainment face a prospective ban on new major emission sources. Areas that fail to attain the standards are subject to a new round of planning and emission controls. States that do not prepare an adequate plan in the post-1987 period face the ban on new source construction as well as freezes in Federal grants for other purposes. A few of them, including some of the largest metropolitan areas, also face a freeze in Federal highway funds. Additionally, if a State fails to develop an adequate plan (SIP) for attaining the NAAQS, the EPA is required by law to promulgate and enforce a Federal Implementation Plan (FIP rather than SIP), which may include disruptive control actions such as downtown parking restrictions, staggered working hours, gasoline rationing, Stage II gasoline vapor recovery, and others.

In general, strategies proposed by EPA and States to establish a path to Clean Air Act attainment for ozone and CO, in addition to those discussed above, include more rigorous

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[1] Congressional Research Service, "Emissions Impact of Oxygenated Fuels," May 20, 1987.
[2] Ibid.

and frequent automobile inspections and maintenance, reducing gasoline volatility limits, and other types of fuel modification requirements, including mandating minimum oxygen weight in gasoline.[1] Officials of eight Northeastern States recently agreed on a plan to cut ozone pollution. If implemented it reportedly could cut emissions by up to 200,000 tons every summer, at a cost of 2 to 3 cents per gallon of gasoline.[2]

Although reauthorization of the Clean Air Act was not achieved by the 100th Congress, legislative proposals made in 1987 and 1988 are likely to emerge in some form in 1989. Prominent among them was the Mitchell bill, S. 1894, which would require States to submit revised implementation plans for areas not meeting standards for CO or ozone. Depending on the severity of the problem, the plans should provide for attainment of the standards by 1992, 1997, or 2002. The implementation plans should require vehicle emission control programs, recovery of hydrocarbon emissions from fueling of motor vehicles, schedules for requiring the use of alternative fuels with lower emission characteristics, and other actions.[3]

In the House, Representative Henry Waxman's proposals included new CO and hydrocarbon emissions limits for vehicles beginning with the 1992 model year and required vehicles sold after 1990 to be equipped with an onboard vapor recovery system.[4] The Group-of-Nine bill, H.R. 3054, would impose less stringent controls than those of the Waxman bill; would provide for a phased-in approach to tailpipe standards of hydrocarbons, CO, and nitrogen oxides; and proposes onboard recovery for vehicles.[5]

Carbon monoxide.—Carbon monoxide (CO) is a poisonous gas emitted directly in vehicle exhaust because of the incomplete combustion of gasoline or other fuel. CO affects cardiovascular functions. Transportation sources account for more than two-thirds of CO emissions nationwide, and as much as 90 percent in many urban areas. Additionally, cars account for approximately two-thirds to three-fourths of all vehicle emissions. Measures to reduce ambient levels of CO (and ozone) have included Federal emissions standards for new automobiles; in some areas, State-level inspection and maintenance programs; improving traffic flow; carpooling; and expanding public transportation.[6]

The National Ambient Air Quality Standard for CO is 9 parts per million (ppm) averaged over 8 hours, and 35 ppm for a 1-hour average not to be exceeded more than once a year. Altogether, 81 metropolitan areas were in nonattainment with CO standards (10 in California) in a list published by EPA on November 17, 1987.[7] Table F-20 shows the major offenders.

Pre-1981 vehicles contribute approximately 87 percent of the volatile-organic-chemical (see ozone section below) and CO exhaust emissions and are expected to be the source of about 65 percent in 1990. CO nonattainment is expected to improve as new cars with low CO displace older cars, such that by 1995 approximately 80 to 90 percent of the urban areas now in nonattainment for CO will achieve attainment. (However, recent doubts have arisen about emission levels during cold-start situations, when the three-way catalysts are not yet operative.)[8]

Blends of gasoline with alcohols or other oxygenated hydrocarbons are effective in reducing CO emissions. The additives of most interest have been ethanol, methanol, and MTBE. Preferably the oxygen content of the blend should be in the range of 2 to 3.5

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[1] BioCom International, submission to U.S. International Trade Commission, Nov. 11, 1988, pp. I-K, L.
[2] *Business Week*, Oct. 31, 1988, p. 152D.
[3] "The Impact of the Proposed Clean Air Act Amendments," *Chemical Engineering Progress*, December 1988, pp.41-49.
[4] Ibid. Also see *Alcohol Week*, May 9, 1988, p. 11.
[5] Ibid.
[6] National Advisory Panel, "Fuel Ethanol Cost Effectiveness Study." pp. 4-1 to 4-4.
[7] BioCom International, submission to U.S. International Trade Commission, Nov. 11, 1988, pp. I-N, I.
[8] Ibid.

percent. The commonly used blend of 90 percent gasoline and 10 percent ethanol has an oxygen content of 3.7 percent.[1] The reduction of CO emissions by the blends is most pronounced with pre-1981 model year cars. Late-model cars have sensors in the exhaust system controlling the air-fuel ratio in the engine as well as fuel injection and/or "adaptive learning" electronic systems for the same purpose, which minimize CO and other emissions.[2] For all model years the CO reduction is greatest at high altitudes.

The State of Colorado, after studying oxygenated fuels for several years as a control technique for its CO nonattainment problem, in June 1987 made the use of oxygenated fuels mandatory during the winter months in Denver and other "front range" cities. These areas have serious CO problems during the winter months. During January and February 1988, fuels sold in the affected areas had to contain 1.5 percent oxygen by weight. The Coloradans chose to do this by blending gasoline with MTBE rather than with ethanol. In later years the requirement will be 2.0 percent oxygen content from November through February.

In Phoenix, AZ, EPA was under Federal District Court order to promulgate a CO plan to provide for attainment by 1991.[3] Other areas considering mandates for use of oxygenated fules are New Mexico; Reno, NV; Tucson, AZ; and Salt Lake City, UT.

Ozone.—Ozone high in the stratosphere is beneficial because it screens out harmful solar rays. In recent years ozone depletion in the stratosphere, including the ozone "holes" over Antarctica, has been a subject of international concern. But close to the ground (in the troposphere) smog-causing ozone is a dangerous respiratory irritant produced by the sunlight-catalyzed chemical reactions of oxygen with hydrocarbons and nitrogen oxides, the source of which is mainly motor vehicles. Numerous health risks are associated with overexposure, such as pulmonary irritation, susceptibility to bacterial infection, worsening of asthma attacks, and premature aging symptoms. In addition, ozone is responsible for crop yield reductions and forest injury. The NAAQS for ozone is a maximum of a 1-hour level of 0.12 ppm, not to be exceeded more than three times in a 3-year period. Recent recommendations are that the standard should be set at 0.08 to 0.14 ppm.[4]

In a report published by EPA in November 1987, 76 metropolitan areas were listed for nonattainment with EPA's ozone standard, including 11 cities in California and 13 cities that had met the standards in 1986. More cities regressed in 1988. Table F-21 shows EPA's 1987 list.

For areas with the most serious ozone problems, the solution may be to completely replace gasoline with methanol or ethanol in newly designed vehicles (such as Brazil has done), or conceivably even switch to electric cars. This plan, including installation of a new fuel distribution system as well, would take years.

By far the worst problem—CO as well as ozone—exists in Los Angeles and the surrounding area (known as the South Coast Basin). Officials there proposed a 20-year plan for reduction of hydrocarbons that anticipated that 40 percent of passenger vehicles and 70 percent of trucks would be converted to clean fuel or even electricity. This plan was favored by EPA. However, a Federal court ruled in January 1988 that EPA cannot approve a plan expected to take longer than 5 years. In November 1988 EPA issued a notice seeking public comment options for controlling ozone immediately, in 5 years, or in 20 years. All these plans are based on reducing 80 to 90 percent of hydrocarbon emissions from the largest, oil-based sources—motor vehicles; airplanes and boats; the chemical, pharmaceutical, petroleum, and rubber industry's manufacturing facilities; and household cleaners and beauty products. Depending on the time allowed, EPA holds out the possibility of a ban on gasoline-fueled automobiles and shutdown of manufacturing

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[1] Emissions Impact of Oxygenated Fuels, ibid. The EPA limit was originally set at 2 percent under the "substantially similar" section of the act. The 3.7 percent content is one of the waivers permitted by EPA.

[2] "The Role of Ethanol in the 1990's," EPA testimony at House of Representatives Hearing, May 11, 1988.

[3] Ibid.

[4] BioCom International, submission to U.S. International Trade Commission, Nov. 11, 1988, p. I-I.

plants, and that any attempt to achieve Federal clean air standards within the court-ordered 5 years would "destroy the local economy and impose requirements so draconian as to remake life there."[1]

Other areas for possible mandates to reduce ozone are Louisville and Chicago suburbs, East St. Louis, Atlanta, Dallas/Fort Worth, and Sacramento.[2] There are 30 other hardcore areas that will not achieve attainment even with the full set of implementation measures under consideration. Although ozone emissions will decline as new cars come on line and take the place of older cars, the number of nonattainment areas could still equal 30 to 40 by 1990.[3]

Ozone nonattainment is expected to worsen in the late 1990's, because:

(a) the relative importance of new vehicles is less for ozone than for CO;

(b) vehicle miles driven in urban areas are expected to continue to increase in the future, thus offsetting and, at some point, overwhelming the reduction of emissions in each car; and

(c) Volatile-organic-chemical precursors to ozone (see below) from industries and other stationary sources will increase due to general economic growth.

Ozone is not directly emitted in automobile exhaust. It is formed in air when primary pollutants, namely volatile organic chemicals and nitrogen oxides react in the presence of sunlight and heat. Though ethanol itself is no more volatile than gasoline, the volatility of its blends with gasoline is 1.5 to 2 times as high as the volatility of gasoline alone. That translates into an increase in Reid Vapor Pressure, the standard measure of volatility used for fuels) of 1 to 2 pounds per square inch (psi). The blends currently sold are under waiver from EPA (and from many States), despite their higher *volatility*.[4]

Higher volatility means that more fuel evaporates during and after vehicle operation, and more fuel escapes into the air during vehicle refueling and from evaporation both from the fuel tank and the fuel metering system (carburetor or injection system). What escapes is mostly gasoline—i.e., hydrocarbons, referred to as volatile organic compounds, or VOC's—which contributes to ozone formation.

Most of the States regulate volatility in some manner and for some time EPA has considered putting a new nationwide vapor pressure regulation into effect that would put an upper limit on RVP. It might or might not grant ethanol-gasoline blends an allowance that would permit their RVP to be 1 or 2 psi higher than that of gasoline alone. However, in a recent study sponsored by the Renewable Fuels Association, it was found that—

> "despite the fact that the use of ethanol-blended fuels in automobiles can be expected to increase the ambient concentrations of VOC in urban atmospheres, these fuels are not likely to increase smog formation. . . The study reported here shows that CO reductions can reduce ozone formation in urban areas, reductions that more than compensate for the effect on ozone of increased emissions of VOC from the use of ethanol-blended fuels. . . Reductions in CO emissions resulting from automobiles using ethanol blends always mitigate and often reverse any increases in urban ozone that might result from the evaporative emissions increases identified with the use of ethanol blends."[5]

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[1] "L.A. Won't Be Fine for a Long Time, Smog Report Says," *The Washington Post*, Nov. 28, 1988.
[2] *Chemical Week*, Sept. 7, 1988, p. 15.
[3] BioCom International, submission to the Commission, pp. I-K, H, I.
[4] Congressional Research Service, "Emissions Impact of Oxygenated Fuels," May 20, 1987.
[5] Testimony of Renewable Fuels Association at Congressional Hearing, May 11, 1988.

This test was preliminary and subject to verification by subsequent work.

Regulating and lowering the RVP of gasoline, especially if no special RVP allowance is granted to blends containing ethanol, would cause problems at petroleum refineries, which would have to reformulate their fuel by removing some of the lighter components, particularly butane. Butane is cheap, high octane, clean burning, nontoxic, adds about 7 percent to the U.S. gasoline supply, and has very few other desired uses. For a conventional commercial gasoline without ethanol or other oxygenates, an RVP reduction of 2 psi for summer gasoline would require lowering the butane content from 6 to 2 percent by volume. For a blend containing 10-percent ethanol, the same RVP reduction would require eliminating the butane content entirely.[1]

[1] Ashland Petroleum Company, statement of Sept. 15, 1985.