SMALL AND LARGE BUSINESS PARTICIPATION IN THE ETHANOL EQUIPMENT MANUFACTURING INDUSTRY AND THE EFFECT OF GOVERNMENT PROGRAMS

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EXECUTIVE SUMMARY

This report documents findings of a SBA-sponsored study on small and large business participation in the ethanol equipment manufacturing industry. The study addresses the effect of government programs on this participation and evaluates the role of small business in meeting national ethanol production goals—and the barriers to meeting these goals. Finally, the study discusses the implications of and provides recommendations for small business participation in the ethanol equipment manufacturing industry as well as other fledgling alternative energy industries.

Ethanol is an alcohol product derived from biomass feedstocks, of which corn is the most widely used. Ethanol production involves several steps in the conversion of grain to liquid fuel, including feedstock preparation, cooking, saccharification, fermentation, distillation, and condensation. Ethanol can be used as a fuel either as an additive to unleaded gasoline, which results in what is called "gasohol", or it can be burned directly.

Two general categories of ethanol are derived from this process -- anhydrous (dry) ethanol, and hydrous (wet) ethanol. Most of the ethanol produced is anhydrous, which is used to produce gasohol. Hydrous ethanol, on the other hand, cannot be mixed with unleaded gas, but can be burned in modified gas engines.

In the last three to four years, the government has strongly supported ethanol production in order to lower oil imports, to reduce our dependence on unstable oil supplies, and to improve the U.S. balance of payments. This support has included tax incentives, fuel excise tax exemptions, loan programs for plants, gasohol purchases and the establishment of national ethanol production goals. Currently, the Administration is reviewing many of these programs, and future support may change significantly from that provided in the past.

While still in its early development, the ethanol equipment manufacturing industry consists of a large number of firms in the initial stages of product commercialization. The study identifies about 100 manufacturers, of whom 47 were contacted by the authors. The large number of entries in the field at this early stage is due to extensive public interest, primarily on the part of farmers concerned with obtaining small scale ethanol production units. This interest was supported by the government through the establishment of major loan programs which enable the farmers to purchase these units, or "stills".
In general, equipment manufacturers have had little previous experience in fuel alcohol production or technology. The consensus in the industry has been that only simple modifications to existing beverage alcohol production and technology would be required to develop marketable products that can produce fuel alcohol on a small scale.

On the whole, the industry and its participants exhibit the following characteristics:

- they are primarily small business (over 90%).
- they are young; about 40% started business in 1978 or later.
- their sales have been limited to about 200 stills, and most sales occurred in 1980.
- their prices are highly variable, depending on size, type, and features of the system offered.
- they use unique marketing strategies to expand sales. Some examples are the design of mobile units, the use of low-value feedstocks such as garbage and sludge, sales tie-ins, and high by-product utilization.
- no equipment certification or standards for the industry exist.

While initial industry activity was strong, product characteristics and market conditions have greatly limited development of the ethanol equipment industry. Manufacturers have not been able to develop a product that is easy to operate, that is cost effective, and that is able to produce dry ethanol for the gasohol market. Also, initial products sold displayed significant design flaws which have greatly reduced product acceptance by potential customers.

Since mid-1980, market conditions also deteriorated primarily because of two factors. One was the increase of gasoline supplies at more or less stable prices. The second factor was that farm commodity prices, particularly corn prices, rose significantly between 1978 and 1981, thereby reducing interest by farmers in developing alternative markets for crops.

The effects of government programs and policies on small business participation in the ethanol equipment industry were mixed. Initial government actions seemed to favor large business, as loan programs, tax incentives and fuel excise tax exemptions were directed at large-scale ethanol production plants controlled by large firms. However, loan programs established through USDA and, to some extent, SBA were seen to increase the sales potential for ethanol equipment production of small scale, pre-packaged stills. Thus, small business entry into the industry was encouraged. The long-term cumulative effect of this support could, however, prove to be negative, as the market for ethanol equipment was not then firmly established, and has, in fact, declined in recent months. If this decline continues, many of the small businesses in the industry will probably fail. Had the government not implied a significant ethanol market, either in response to political pressure or by misinterpreting
market signals, or both, the number of entrants in the field would have been smaller, thus reducing the number of businesses that are now likely to fail.

The ethanol equipment manufacturers will apparently make only minor contributions to meeting U.S. ethanol production goals. Because of this, and a general slowdown in gasohol demand, it is estimated that ethanol production capacity will be about 35% below the 1981 U.S. production goal.

Findings of this study prompt the following recommendations for both government and the ethanol equipment manufacturing industry. For the government, it is recommended that:

- In lieu of loan programs for the purchase of stills, eligibility requirements for research grants should be modified to make it easier to obtain research support for refinement of small-scale technology in the areas of cooking, fermentation, material separation, and distillation.

- Aid to manufacturers be given to establish operator training courses and to broaden understanding of small-scale alcohol production.

- Support to be continued for development of industry standards, certification, and warranties.

- Support and promotion of the development of pure-alcohol vehicles be increased.

- Program officials broaden their knowledge of the technology, economics and issues of small-scale ethanol production.

- Additional support should not be given for new entrance by small or large business until the market improves and current participants have exhibited viability.

For the ethanol equipment manufacturing industry, it is recommended that:

- Manufacturers concentrate on the economic and financial justification of plants versus energy independence for farmers and other emotional issues.

- Standards and certifications be established for equipment.

- Industry promote and support conversion of gasoline engines, as well as import and development of alcohol vehicles to expand the market for low-proof ethanol.

- A general but accurate educational program on ethanol production and use be established.
• Greater assessment of the market be completed in terms of market segments, potential market size and customer needs.

• The balance between product development and market development be improved by expanding market development and marketing activities. For example, marketing should be expanded, or redirected, toward livestock producers who have a viable use for high value by-products.
I. INTRODUCTION

This report documents results of economic research conducted under the Small Business Administration's (SBA's) Small Business Research Program, administered by the Office of Economic Research of the Chief Counsel for Advocacy in the SBA. The program provides grants to promote extramural economic research on topics dealing with:

- the effect of Government programs, policies and regulations on small business
- the contribution of small business to the economic and social welfare of the United States
- The development of theories or methodologies useful in studying small business problems

This particular study was performed under Grant No. SB-IA-00003-01-0.

The purpose of this study is to assess the role and effect of government programs and policies on small and large business participation in the ethanol equipment manufacturing industry. Also, the study assessed the overall role of small business in developing the ethanol equipment manufacturing industry and in meeting government ethanol policy goals. Finally, the study addresses implications for government programs and policies on (1) long run participation by small ethanol equipment manufacturers, and (2) small manufacturers' contributions to alternative energy development.

A. Background

1. Ethanol Production

Ethanol, also known as ethyl alcohol or grain alcohol, is an alcohol product derived from fermentation of primarily agricultural feedstocks, which converts starch and/or sugar to alcohol. Although ethanol can also be produced from fermentation of cellulose feedstocks, such as wood, grass and paper, commercial production is not currently feasible, as technical problems exist. The most common feedstock for production of ethanol is corn.

Fuel ethanol production can be divided into two categories. The first is anhydrous (dry) ethanol, which is 100%, or 200 proof, alcohol and is free of water. The second category - hydrous (wet) ethanol - has an alcohol content of between 80 and 95% (160 to 190 proof), with some water existing in the final product.
Most of the ethanol produced in the U.S. is anhydrous alcohol, as it is required to make gasohol, currently the major market for ethanol. Gasohol is usually a blend of 10 percent anhydrous ethanol and 90 percent unleaded gasoline. Gasohol can be used in most automobiles with little or no engine adjustment.

Wet alcohol, while much easier to produce, makes up a small share of U.S. production, as markets are limited. While it can be used as a straight fuel at 160 to 190 proof, its use requires significant modification of conventional engines or the availability of alcohol burning vehicles. Wet alcohol can also be purchased by re-refiners or "topping" plants that can upgrade hydrous alcohol to anhydrous. However, very few topping plants are currently in existence and those operating have experienced significant problems. The problems include a generally soft market for ethanol, unreliable and dispersed supplies of farm produced ethanol, high transportation costs for collection of low proof ethanol and, because of the prior problems, limited private and public financial support for construction of plants [1]. These problems have put topping plants in a financial squeeze, as they must compete against large ethanol producers, such as Archer-Daniels-Midland (ADM) or Midwest Solvents, in the soft ethanol market, and at the same time, they must offer farmers attractive prices for wet alcohol in order to obtain raw material and maintain operating levels. This combination of unreliable and high cost raw material supplies and strong competition, has recently caused the bankruptcy of a large 10 million gallon per year topping plant. Add to this the limited financial support for topping plants and the potential for expansion in the near term is limited.

As suggested above, anhydrous (dry) ethanol is relatively difficult to produce. The problem is that water and alcohol form an azeotrope at 194.4 proof (97.2%), which causes alcohol and water to boil and thus vaporize concurrently under normal distillation practices. Procedures are available for additional water separation; however, they are relatively expensive, energy intensive and technologically advanced, and have proved feasible only in large scale ethanol production.

2. General Government Ehtanol Policy

Use of ethanol has been actively supported by the government as a means of reducing oil consumption and, thus, our dependence on imported oil. The first major governmental action included the enactment of the Energy Tax Act of 1978, which provides a Federal motor fuel excise tax exemption for gasohol. Subsequently,

Congress passed the Energy Security Act and the Crude Oil Windfall Profit Tax Act. These acts, combined with executive orders, have resulted in:

- establishment of national ethanol production goals
- government assistance in building production plants
- promotion of gasohol use
- extended exemption of gasohol from fuel excise tax
- research and development assistance

3. Overview of the Ethanol Equipment Manufacturing Industry

The "ethanol equipment manufacturing industry" investigated in this study is an extremely young industry and is without conventional industry definitions, such as the Standard Industrial Code. Furthermore, there is no historical or current information on the industry, such as Census of Manufacturers data on sales, employment and investment. To the author's knowledge, this report represents the first extensive analysis of the industry and its firms.

For this study, the industry is defined to include establishments primarily engaged in the manufacturing of equipment, or "stills", which can produce fuel alcohol generally on a small scale. Most of the equipment is pre-designed and compatible with assembly line processes. While some components for the equipment can be purchased from existing manufacturers, component manufacturers are excluded from this study as the primary market for their products would not be ethanol equipment.

The industry originated in response primarily to an interest or desire on the part of farmers to produce alcohol for their own use and, more importantly, for sale as a profitable energy product. This interest arose from three inter-related factors:

1. alternative (more profitable) market for grains, particularly corn
2. inexpensive supply of fuel for on farm use
3. energy independence or the need for a dependable supply of fuel.

This situation appeared to create a demand by farmers for equipment that could produce alcohol on a small scale, with limited technical expertise and requirements, and at a price competitive with unleaded gas which would allow a fair return to farmers for grain inputs.

Government also supported this farmer interest by initiating farmer loan programs to purchase ethanol equipment, or "stills". This action seemed to provide the seed capital necessary for purchasing equipment, although the programs did not provide capital to develop, manufacture and commercialize equipment as these activities were left to the private sector.
In response to this, many firms, predominately small manufacturers, started to produce ethanol equipment. Some manufacturers independently built prototypes with which to assess and refine operating characteristics, while others marketed equipment on a "cut and try" basis with little pre-market research on equipment capabilities or operating results. Both the operational design and the manufacturing capacities were limited, and as some units have been marketed, major product quality and performance issues have arisen. This has restricted development and growth of the equipment market, and thus small business participation and success.

The basic product of the industry is the small, pre-packaged, mass or semi-mass-produced "still" which will produce ethanol for direct fuel use or for sale as a fuel product. The technology incorporated is a modification of that employed by beverage alcohol distillers which involves:

- grain or feedstock preparation and formulation
- cooking
- saccharification (add enzymes and yeast to convert starch to sugar)
- fermentation (convert sugar to alcohol)
- distillation (separate ethanol from water and solids)
- condensation
- denaturing

Unfortunately, the beverage alcohol product and the fuel alcohol product are significantly different, and problems in applying beverage distillation technology to fuel distillation have emerged. The major stumbling block is that beverage alcohol is a much higher valued product than fuel alcohol, approximately $20 per gallon vs. $2, and the production process for beverage alcohol requires a much lower efficiency than for fuel alcohol. For a fuel alcohol plant to be feasible, it must produce at near optimum yields; that is, 2.5 gallons of 180 to 195 proof ethanol per bushel of corn. Manufacturers have not been able to develop a product using conventional and affordable technology that will consistently produce at near optimum yields under field conditions. Normal field results run from 1.5 to 2.3 gallons of 160 to 180 proof alcohol per bushel of corn. With corn costs of $3 to $3.50 per bushel and yields of 2 gallons per bushel, raw material costs alone are $1.50 to $1.75 per gallon for low proof ethanol. Add to this labor, energy and equipment amortization costs, and ethanol becomes very expensive. Independent research by Farmland Industries and GROWMARK, an affiliate of the Indiana Farm Bureau, indicated that total annual costs of ethanol from farm-size stills would run between $3 and $7 per gallon, depending on income tax credits and the value assigned to feed by-products 1/. This compares to current gasoline prices of $1.25 to $1.50 per gallon.

Technology restraints are not the only causes of low yields. Production of fuel grade alcohol is a very complex process requiring substantial chemistry, biology, engineering and management expertise. Operators must understand relationships between temperature and fermentation processes; they must be knowledgeable of steam engineering; they must adhere to numerous technical government requirements and regulations; and they must perform accurate and sophisticated operating procedures to assure that optimum yields and efficiencies are obtained. Many potential customers do not possess this technical background and have not purchased stills.

As mentioned earlier, many of the stills are intended for on-farm use, which has presented another market problem. Because ethanol production is a complex, labor intensive process under the present state-of-the-technology, many farmers have had difficulty integrating ethanol production with other farming activities.

Finally, ethanol equipment manufacturing has been limited due, in large part, to the fact that the initial promotion suggested that product technology was well established and ethanol is simple and inexpensive to produce. In a sense, this early promotion was a "bill-of-goods" and as the industry has developed, it has become more important to refine the technology and educate customers on the complexity of alcohol production. Overcoming these obstacles will be difficult, but many of the producers recognize the problems and are directing the limited resources available to improving and standardizing technology and educating and training potential fuel ethanol producers.

B. Identification of Issues

When this study was initiated, an immediate goal of the government alcohol program was to increase annual alcohol production capacity to 500 million gallons in 1981, as opposed to the production capacity of between 155 and 195 million gallons for 1980. While it is true that a few large scale plants of 50 to 100 million gallons annual capacity would meet these goals, design and construction time for these plants would be two to three years, and their potential in meeting the 1981 goal appears to be limited. Thus, by inference and explicit statement, heavy reliance will be placed on small-scale plants which can be installed quickly. To this end, significant packages of loans and loan guarantees for purchase of small ethanol plants have been established. These include a part of $525 million administered by the Department of Energy, $525 million available from USDA, and $10 million from the Department of Commerce. The Department of Energy also has a program aimed at planning studies and loans for large-scale ethanol production facilities, and the DOE Crude Oil Program offers a gallonage subsidy for ethanol used for fuels.

Portions of the USDA programs were aimed at farmers, who will purchase ethanol production equipment (stills). These prospective investors needed packaged plants if they indeed expected to add production quickly, and thus help meet government policy goals.
Another issue arises from communications with equipment manufacturers, who have indicated apparent problems in the scope of the loan programs. While extensive funds were allocated for equipment purchase, little support was available for equipment manufacturers for research, development, start-up, and operating capital. Many are trying to operate on extremely tight budgets which restrict their abilities to commercialize products for a market created, in large part, by recent government policy. This would appear to present the potential for a severe supply constraint of small-scale ethanol equipment, and thus ethanol for fuel.

A second major goal of U.S. government policy is to promote the role of small business in the U.S. economy. To simultaneously meet this goal, as well as ethanol production goals, it is critical that two events occur: the development of an ethanol equipment manufacturing industry to provide the practical technology for ethanol fuel production, and government action to stimulate activity and/or eliminate barriers to small business entry into this industry and other alternative energy-related industries. An issue exists as to whether these events have occurred, and this study provides the opportunity to assess various programs, policies and other factors in determining effects on small business involvement in ethanol equipment manufacturing. Thus, a specific issue that this study was intended to assess was the effect of government regulations, programs and policies on (1) small and large business entry into the young and incompletely developed ethanol equipment manufacturing industry, and (2) the ethanol equipment manufacturing industries' ability to respond to demand for ethanol and to meet governmental policy and program goals for ethanol production.

C. Study Objectives

The general objectives of this study were three-fold. First, the study evaluated the role and effect of government programs, regulations and policies, as well as other factors, on participation by small and large businesses in the ethanol equipment manufacturing industry. Closely related to this was the assessment of small and large businesses' role in the development of and participation in the infant industry of ethanol equipment manufacturing. Finally, the study assessed the role of small and large ethanol equipment manufacturers in meeting the government ethanol policy goals.

The study also provided insights into the entry of small and large businesses into alternative energy-related industries and other developing industries. It addressed the implications of government programs, regulations and policies in promoting entry and contributions by small businesses to infant and alternative energy-related industry development, and provided recommendations on government policies, programs and regulations to improve small business participation in the ethanol equipment manufacturing industry and other infant industries.
D. Scope of Study

There are four major classes of equipment supplied to ethanol fuel producers. These include:

- pre-packaged small-scale stills
- general materials and fluid control equipment and components
- equipment for large-scale commercial plants
- equipment for do-it-yourself builders and inventors

Of these classes of equipment, only one is conducive to the development of a commercial product that is manufactured in the traditional assembly line fashion and for which a unique yet infant industry has evolved. That class of equipment is the pre-packaged small-scale ethanol still, and the scope of the study will concentrate on the manufacturers of such equipment. Only limited analysis will be given to the producers of the other three major classes of equipment. Reasons for limiting analysis of these equipment classes will follow.

The general materials and fluid control equipment is produced by a wide range of equipment manufacturers who are highly diversified and who produce equipment for many uses, one of which is ethanol production. Their products include tanks, pipe, boilers, pumps, grain augers, controls and gauges. These manufacturers were considered too numerous and diverse for consideration by this study. Also, their equipment sales for ethanol production would likely be a small share of their total sales and would be very difficult to document.

Equipment for large-scale commercial plants would be generally custom-designed and fabricated. This equipment would be provided by a joint effort on the part of engineering and metal fabricating firms. The singularity of the design and the limited number of large commercial plants being built suggests that little or no continuous equipment production or manufacturing for this segment exists.

Equipment for do-it-yourself builders and inventors includes primarily two types of equipment: general off-the-shelf equipment and scrap material. Equipment manufacturing for this particular segment of alcohol producers would be small and difficult to identify, and thus was not assessed in this study.

Regarding the manufacturers of pre-packaged small-scale ethanol stills, the study and this report addressed the following specific topics:

- an analysis of government programs and their general effect on the ethanol equipment manufacturing industry.
- an analysis of the pre-packaged ethanol equipment manufacturing industry, including who they are, their general characteristics and a general review of the industry.
- an assessment of small and large business participation in the industry and the effect of government programs on small and large business participation.

- an examination of industry problems and constraints and related barriers to achieving ethanol production goals.

- conclusions and implications of the study.

- recommendations regarding government's role in small and large business participation in ethanol equipment manufacturing.
II. GOVERNMENT PROGRAMS

Motivated by strong economic and political concerns, both federal and state governments established numerous programs, policies and regulations in the period of 1977 through 1980 to promote the use of ethanol. This chapter will discuss why these programs were established and their general intent. Material also will be provided on specific ethanol production goals and objectives and key programs developed to meet goals and objectives. Finally, the general effect of the programs on the ethanol equipment manufacturing industry will be reviewed.

A. Justification and Intent of Government Support

Several factors motivated government support of fuel ethanol production by state and federal governments. The basic incentives were to reduce dependence on unstable oil/fuel imports and to ease balance-of-trade problems that stem from large oil imports. Resulting from this and ethanol production characteristics were several other attractions for a significant shift to ethanol production:

- It would help the economic well-being of U.S. farmers and agricultural-related industries, as demand for agricultural products would rise and reduce price depressing surpluses 1/.

- Farmers can produce fuel to be marketed directly as another farm product or to be used on the farm to reduce dependence on imports and domestic supplies, thereby insuring a supply of fuel for critical planting and harvesting periods.

- A new fuel ethanol industry would require a large number of plants employing thousands of people 2/.

- Gasohol, a major market for ethanol, is reported to burn cleaner and provide better mileage and engine performance than unleaded gasoline.


These attractions were widely publicized and actively supported, especially in rural areas and farm states. Thus, the economic justification brought with it much political pressure and support for the government to aid in establishing programs to stimulate supplies of ethanol feedstock and to subsidize both ethanol production and market development/consumption.

Opposition to these programs did exist, however. In fact, there was extensive concern about the energy balance or the efficiency of the ethanol production process, with numerous claims that the energy used to produce ethanol was greater than the energy produced. Another major issue was the concern regarding the increased use of grain for fuel decreasing food supplies and thereby increasing food prices. This increased use could also lower grain exports, negating any balance-of-trade improvements from reduced oil imports. These issues have been analyzed extensively, however, and concern in these areas seems to have diminished.

Proponents of government support prevailed, and extensive programs were established setting production goals and objectives, providing tax incentives and exemptions, providing loan programs for large and small-scale (on-farm) production, supporting research and development on biomass conversion, and demonstrating uses and potential for alcohol. Most important among these were establishing government goals and objectives for alcohol production and consumption.

B. Government Goals and Objectives

The overall goals for federal and state support of fuel alcohol are to lessen critical economic and national security problems tied to our dependence on unstable foreign oil supplies and the subsequent outflow of dollars to import oil. In fact, the Energy Security Act of 1980 (P.L. 96-294) mandates the achievement of energy security for the United States.

To achieve the prior overall goals, specific alcohol production goals were established by P.L. 96-294 and by Presidential programs. Specifically, the Alcohol Fuel Program established on June 30, 1980, a fuel alcohol production capacity goal of 500 million gallons per year during 1981. The Energy Security Act (P.L. 96-294) supplemented this goal with the following 1/:

- to achieve a total level of alcohol production and use of at least 60,000 barrels per day (920 million gallons per year) by December 31, 1982.
- to achieve domestic production capacity of 2 billion gallons per year by mid-1989.
- to displace ten percent of gasoline consumption with alcohol by 1990 (at 1980 consumption level, about 100 billion gallons; this requires annual production and import of 10 billion gallons of alcohol).

Meeting these goals will require substantial development of the alcohol refining industry, which currently has an annual capacity of between 150 and 200 million gallons.

States have endorsed alcohol production for the general goals of energy independence, as well as providing markets for agriculture products and increasing economic development in the states. No specific state goals or objectives have been set, however.

It should be noted that all the goals and objectives, as well as the programs to support them, were developed prior to the election of a new Administration which is committed to reduced government spending. The Administration already has proposed extensive reduction in programs to support alcohol and thus may amend the government's goals and objectives in this area. As such, an assessment of the future of alcohol production goals, objectives and programs is very tentative. (See Appendix A for an article on current budget reduction and a rescission proposal for alcohol programs.)

C. General Description of Government Policy and Programs

I. Federal Fuel Alcohol Programs

Many programs have been established that affect ethanol equipment manufacturers. Some act as barriers to industry participation, while others are intended to provide incentives to meet those federal production goals mentioned above. To follow is a discussion of key federal programs that have affected ethanol equipment manufacturers. These will be discussed from an agency or department perspective, with reference to specific legislative mandate where applicable.

In general, four types of government involvement have evolved for ethanol production. These are:

- direct and indirect funding of projects,
- tax exemptions and credits,
- procurement by federal agencies,
- license permits and regulations

Generally, the loan support is administered through the Department of Agriculture (USDA), the Department of Energy (DOE), the Department of Commerce-Economic Development Administration (DOC-EDA) and the Small Business Administration (SBA); these have the most direct impact on equipment manufacturers. Tax exemptions and credits are supervised by the Internal Revenue Service - Department of Treasury (IRS). Procurement programs have been initiated by legislation and executive mandate and are implemented by various agencies that purchase significant volumes of gasoline. Regulatory effects originate primarily from the Bureau of Alcohol, Tobacco, and Firearms (BATF), the DOE and the Environmental Protection Agency. Specific agency and department programs, policies and regulations follow.
Department of Energy

Project Funding -- Public Law 96-126 provides funds and other support allocated by DOE for construction of commercial-size ethanol plants. The funding includes $100 million in direct loans for feasibility studies, $100 million in direct loans for cooperative agreements to fund construction of plants, $1.5 billion in loan guarantees for construction of plants, and $1.5 billion for purchase commitments and price guarantees for ethanol produced by approved plants. Alcohol fuel projects funded under this program must have an annual capacity of at least one million gallons per year.

Under the Energy and Water Development Appropriations Act (P.L. 95-482), the DOE, through the Solar Energy Research Institute, can fund research and development for projects in advanced alcohol conversion processes. However, the program is in its second year, and there had been no funding of conventional alcohol conversion processes as of June 1980.

The DOE can also support R&D under its Appropriate Technology Small Grants Program. A review of awards, though, indicates that alcohol R&D has not received significant attention, as it competes with solar, wind and other energy forms and, based on conversations with program administrators, it appears that R&D support for improvement of conventional ethanol conversion processes is given a low priority.

Other Types of Programs -- The DOE administers several energy pricing and allocation programs; however, these have generally had little impact on ethanol equipment manufacturers.

U.S. Department of Agriculture (USDA)

The USDA is primarily involved in providing funds for alcohol production. These include direct loans, loan guarantees and insured loans for small and large-scale producers to evaluate, construct and purchase facilities. The USDA is authorized to make the bulk of its funding by The Energy Security Act of 1980 (P.L. 96-294) (Synfuels Bill), and the Supplemental Appropriations and Recision Act of 1980 (P.L. 96-304). Currently, USDA is authorized under P.L. 96-304 to provide $525 million in financial assistance for facilities that produce less than 15 million gallons of alcohol per year. These funds are administered by the Farmers Home Administration and any of the $525 million used to guarantee loans can be "leveraged" on a three-to-one basis, which means that $3 in loan guarantees can be made for every dollar the USDA has available in reserve for the guarantee program.


2/ Ibid.

The Farmers Home Administration (FmHA) can also provide loans for alcohol production under its Business and Industrial (B&I) Loan Program, which is a general program to create and maintain employment and improve the economic and environmental climate in rural communities. For FY 1980, the B&I program was awarded $1.5 billion for all types of B&I loans (alcohol and non-alcohol). The alcohol projects funded will most likely be medium to large in size, as applicants requesting $350,000 or less are requested to apply at SBA. These loans would be for non-farm stills and would require strict guidelines for pre-engineered plants which must be met by an operating prototype.

For on-farm stills, the FmHA provides funding under the Rural Development Act of 1972 1/ and the Agricultural and Credit Act of 1978 2/. These include operating and ownership loans for production of fuel alcohol by farmers who operate as individuals, corporations, or cooperatives but are not larger than family-size farm or ranch operations.

The USDA has no major regulatory requirements pertaining to alcohol production. Other support includes limited use of gasohol in department vehicles, a Commodity Credit Corporation program to promote use of biomass to produce industrial hydrocarbons and alcohol, and research grants to colleges and universities on alcohol production and use.

**Economic Development Administration (EDA)**

While future support from the EDA is doubtful, it has been eligible, in the past, to provide funding for alcohol projects in depressed economic areas. However, alcohol projects were considered on their comparative merits with other energy and non-energy projects.

**Small Business Administration (SBA)**

Regarding alcohol production equipment, the SBA's primary support is from direct energy loans or energy loan guarantees as established under Section 7(1) of the Small Business Act. These can be used to begin, continue or expand small businesses that are developing, manufacturing, selling, installing, or servicing specific energy conservation measures. In addition, small business can apply for other general small business loans. These are available from Section 7(a) of the Small Business Act and other programs.

**Department of the Treasury**

The Treasury administers alcohol-related programs under the Internal Revenue Service (IRS) and the Bureau of Alcohol, Tobacco and Firearms (ATF).

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Major programs originating in the IRS include:

- 4¢ per gallon federal excise tax exemption for gasohol,
- alcohol blender and user tax credit of 40¢ per gallon of alcohol of at least 190 proof, and 30¢ per gallon of alcohol of at least 150 proof,
- additional 10 percent business investment tax credits

The ATF is primarily responsible for Treasury-related regulations on production permits, licensing, bonding, denaturing and reporting and record keeping requirements. While these are rather extensive regulations, they have been modified significantly to ease development of alcohol fuel production -- especially for small producers (less than or equal to 10,000 proof gallons per year and medium producers (10,000 - 500,000 proof gallons per year).)

(For additional information, see the National Alcohol Fuel Commission's report, Federal Agency and Department Alcohol Fuel Programs (June 1980).)

Environmental Protection Agency (EPA)

The EPA enforces statutes and regulations on air quality, water quality and solid waste. In each of these areas, actual and potential impacts on alcohol use and production occur. Under the Clean Air Act, the EPA sets air emission standards for both motor vehicles and ethanol plants.

Up until December 16, 1978, alcohol was not approved as a gasoline additive to produce gasohol, and the EPA still has the authority to ban gasohol in the future. Also, the Clean Air Act currently does not allow for extensive use of pure alcohol for fuel, as emission standards for fuel alcohol have not been established.

A plant producing alcohol may also be directly affected by EPA regulations, if emission, effluent and solid wastes produced by the plant are covered under the Clean Air Act, Clean Water Act or the Resource Conservation and Recovery Act.

Other Agency Programs, Policies and Regulations

There are several other agency programs, policies and regulations pertaining to alcohol fuel; however, they generally have had little effect on ethanol equipment manufacturers. These include Housing and Urban Development's Urban Development Action Grants, gasohol octane posting and gasohol specifications, shipping rates for gasohol and alcohol import requirements, and will not receive additional attention in this report.
2. State Fuel Alcohol Programs

Many states have enacted alcohol fuels legislation, which has primarily been in the form of tax exemptions or incentives. Most of these pertain to gasohol, which is commonly exempted from state gasoline excise taxes. Where the exemptions are in effect, they range from one cent per gallon of gasohol (Connecticut) to ten cents per gallon (Iowa), with a typical exemption being four to five cents per gallon. A summary of state tax exemptions is provided in Appendix Table B.

D. General Effect of Programs on Ethanol Equipment Manufacturing Industry

1. Direct Effect

A review of the government's programs, substantiated by contacts with manufacturers, reveal limited direct effects on ethanol equipment manufacturers. No loan programs have been established directly for ethanol manufacturers for research and development to refine or improve conventional alcohol distillation technology for small-scale production -- a serious need of the industry. No energy-related programs have been established to provide start-up capital, market research funds, operating and investment capital, or investment tax credits specifically for ethanol equipment manufacturers.

The direct effects have been restricted to limited support for R&D on innovative technologies and conventional SBA business loans or loan guarantees. There have also been direct effects (costs) due to numerous regulations, including application for BATF permits and compliance with EPA, OSHA and fire safety standards, to operate both manufacturing plants and prototype ethanol stills.

2. Indirect Effects

The indirect effect of the government's alcohol policies and programs on ethanol equipment manufacturers has been substantial. Unfortunately, in the long run the results may prove to be damaging to the industry. The harm may occur in that the government, supported by some grassroots interest and extensive but misrepresentative publicity, signaled or suggested a large on-farm market for ethanol production equipment or stills. Many firms interpreted this signal as being an accurate reflection of a large and strong market and subsequently entered into production. However, little publicized government research and manufacturer market assessment were performed to assess the extent to the new market and its characteristics, which may have shown a weak, highly segmented market, dependent on short-term economic and international conditions of low corn prices and an Iranian oil embargo.
While the market signal, primarily through establishing a loan program for small-scale/on-farm ethanol program, was probably the most significant indirect effect of the government's programs, others also existed. These evolved from ethanol production goals and general ethanol promotion, which implied that ethanol would become an important fuel in America and would provide an extensive market for the products of both large and small ethanol manufacturers. In reality, the market for ethanol, even anhydrous, has been soft due to price differentials between gasohol and unleaded gasoline, which has also made marketing of ethanol equipment difficult. This compounds the problems for small-scale still manufacturers, as their equipment produces primarily wet alcohol. If this cannot be used on-the-farm or by the producer, it is very difficult to market, as it does not meet specifications for use in gasohol, the major open market for ethanol.
III. CHARACTERISTICS OF ETHANOL EQUIPMENT MANUFACTURERS

To follow is information on characteristics of ethanol equipment manufacturers. Most of the information was developed from informal personal and telephone contacts with 47 manufacturers from a master list of 100 manufacturers developed during this study. This information was supplemented with material from recent reports and trade journals, input from ethanol and gasohol distributors and findings from research on other ethanol related projects. It should be noted that findings and results cannot be subjected to standard statistical tests or analyses, as no formal survey of manufacturers was completed. The information is developed from both general and specific comments provided by manufacturers in unstructured, open-ended discussions. To follow is specific information on manufacturer identification, manufacturer contacts, and finally characteristics of manufacturers and their industry.

A. Manufacturer Identification

To complete the identification of manufacturers from the numerous sources listing them and the variety of types of names listed in each source, it was first necessary to define the term "ethanol equipment manufacturers." For this study, it was determined that manufacturers would be restricted to those firms that:

(a) offer for sale a complete process system, both large and small, the major parts of which are fabricated by the firm or on contract to the firm, and that the firm is essentially responsible for the performance of the whole system - a packaged plant manufacturer,

(b) are also designers or engineering firms which operate or control fabrication of complete plants and which are custom designers and manufacturers of "turn-key" installations. While these are not prepackaged plants, it was found that the stills are highly uniform and contain limited variances from a prepackaged design.

Not included are component manufacturers or suppliers whose components or services may be only a small part of the complete plant.

Based on these criteria, a manufacturers list was compiled from three major sources. The first source was a computer printout of names entitled "U.S. Alcohol Fuel Equipment Manufacturers," provided by the Solar Energy Research Institute of Boulder, Colorado (SERI). The second source was obtained from the "Alcohol Fuel Directory", compiled by the Institute of Human Engineering Sciences of Canoga Park, California. The third source of manufacturers' names was drawn from the contractor's in-house files that have been built.
over the past three years from industry contacts stemming from project research in this area. This list, which contains approximately 100 names, has been checked for name changes and duplication, but the contractor has not directly contacted, and therefore cannot vouch for the correctness of every name that appears. The list of 100 manufacturers is included in Appendix C.

B. Industry Contacts

From the list of manufacturers described above, the study team established some form of direct informal contact with 47 of the manufacturers. The contacts were performed as follows:

- Personal and plant visits: 15
- Telephone conversations: 27
- Trade show exhibit contacts: 4
- Receipt of sales literature only: 1
- **TOTAL CONTACTS:** 47

The 53 manufacturers not contacted are simply listed as manufacturers fitting the definition previously given, but because there was no direct contact by the contractor, the characteristics of these 53 manufacturers could not be included in the analysis that follows. However, it is the study team's opinion that those firms contacted are representative and provide substantial insight on the entire industry.

C. Analysis of Characteristics

In this new fuel alcohol industry spawned by gasoline and diesel fuel shortages and abruptly rising fuel prices, who are the ethanol plant equipment suppliers? Where have they come from? How did they develop? Where are they headed? What have they accomplished?

Before dealing with those questions, it is important to identify where manufacturers as a whole are in the market life cycle of this product -- ethanol plant equipment. In a competitive market, products go through definite and identifiable stages in their life cycle. These stages are defined by Wasson 1/ as:

1. Conception
2. Product development
3. Introduction of product and market development
4. Period of rapid growth
5. Maturation - competitive turbulence
6. Stability and saturation
7. Declines
8. Death and replacement

---

As indicated by the data that follows, the ethanol equipment manufacturing industry and its firms are still in the development phase of each of the first three stages listed above. It is still a very young industry.

1. Reasons for Market Entrance

Before discussing normal industry characteristics such as types of products, types of organizations, age of firms, prices and size of firms, it is useful to review the reasons that the firms entered the ethanol equipment manufacturing industry, as it directly relates to the industries' status and characteristics. Obviously, expected profits were a major reason for entrance; however, entrance normally requires more detailed and market oriented justification than profit alone. This can include technology or expertise transfer from existing manufacturing activities or established markets, such as modification of a product or innovative use of an established process.

Immediate profit potential was more important than usual for entrance in this market, however, as the manufacturers perceived technology and expertise experience and transfer as being minimal. This reflects the condition that manufacturers would simply be producing and selling an old and established technology and process, alcohol distillation, for a new use and for new alcohol producers. The technology and expertise was transferred from limited experience from beverage alcohol production and from general public information obtained from reports, seminars and conferences. The manufacturing experience was obtained from basic machine or metal millwork experience. Very few of the firms or key individuals had significant direct experience with fuel alcohol production on either large or small scales, and little experience in manufacturing.

Furthermore, both farmers and government were indicating strong support for small-scale ethanol production. This was further justification, as manufacturers expected the market development requirements would be minimal, which coincided with the limited market development experience possessed by most firms.

2. Type of Products

The product type can best be characterized by size as measured by annual gallons of ethanol production capacity per year. Using size of plants as a product criteria, manufacturers generally fall into four product categories.

(a) Small plants (complete) - less than 1 million gal/yr,
(b) Large plants (complete) - more than 1 million gal/yr,
(c) Both large and small plants, and
(d) Custom built plants (usually large).
In addition to size, plants can vary by other characteristics. These are:

(a) Ethanol proof--Most of the firms manufacture plants that produce a lower proof ethanol of 160 to 190 proof; however, some of the plants have dehydration facilities and can produce 200-proof ethanol.

(b) Distillation by-product--When grains are used as a feedstock, by-products can be spent grain or brewer's spent grain if separation of grain is made prior to fermentation or prior to distillation. However, if the entire mash is fermented and goes into the distillation column, the residual by-product will be distiller gains. All of these residual by-products are high protein feeds and may be available for local feeding in a wet form (30-70 percent moisture) or a dry form (10-13 percent moisture) for distant markets.

(c) Feedstock--Most of the 47 firms contacted produced stills designed to use corn or milo as the basic feedstock; classification by feedstock was therefore not a significant differential.

(d) Equipment--There are many minor equipment differences in cooking, distillation, separation and in continuous or batch-type operations.

In the consideration of these possible types of classifications, it appeared that size was most significant. Small plants usually produce low proof ethanol, wet by-products, and operate by batch or continuous methods. Large plants usually produce 200-proof ethanol, dry distiller's grains, and they distill continuously. The custom plants resemble the large plants in both product and operation.

For manufacturers contacted during this study, the following distribution by product type existed:

<table>
<thead>
<tr>
<th>Type of plants</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>58</td>
</tr>
<tr>
<td>Large</td>
<td>2</td>
</tr>
<tr>
<td>Both small &amp; large</td>
<td>21</td>
</tr>
<tr>
<td>Custom</td>
<td>19</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
</tr>
</tbody>
</table>

3. Type of Companies

From the discussions with the manufacturers, there appears to be only two types of companies that have made a determined effort to enter the ethanol plant equipment industry by developing, copying or adapting equipment. Those two major types are:

(a) Small businesses formed for the specific purpose of developing and marketing ethanol producing equipment, although a few have other products, and
Large companies with a division formed to develop and promote fuel ethanol, or companies in the beverage ethanol equipment business now adding or converting to fuel ethanol operations.

Of the companies contacted, 95 percent employed less than 500 persons and were identified as small business, while 5 percent were divisions of large businesses or affiliates of large businesses.

Most all companies of both sizes are incorporated, and there is no significant difference noted in general business organization. Of course, the level of business sophistication and basic operations does vary from company to company, but no major findings or trends were observed.

4. Age of Companies

In looking at the dates that companies started in business, three time frames appear to be significant. These include company start-up since 1978, between 1975 and 1978, and before 1975.

Companies started since 1978 are classified as newcomers. They were quickly formed to take advantage of the widespread publicity about ethanol and gasohol and the potential loan programs for financing plant construction. About 40 percent of those contacted had started since 1978.

Companies that began operation between 1975 through 1978 are the middle group. These firms have spent considerable time and money to establish themselves as competent equipment manufacturers. They represent about one-quarter of the contacts.

At the other end of the spectrum are companies operating before 1975 who had some significant product or ethanol production experience in the beverage industry. These are the "old timers", and represented about one-third of those contacted.

While the companies' ages have varied, age by entrance into the ethanol equipment market is more constant and very recent. Most sales originated in 1980; however, sixteen companies contacted had yet to make their first commercial sale.

5. Location of Manufacturers

Of the 100 ethanol equipment manufacturers identified, half of them (51) are located in just six states -- Colorado, Iowa, Minnesota, Texas, Illinois, and Georgia, with Colorado the leading state, listing 14 manufacturers. The other states with numbers of manufacturers located in each state are shown on the following page:
These 100 manufacturers divide into SBA Regions in the following manner:

<table>
<thead>
<tr>
<th>Region</th>
<th>States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region I</td>
<td>AL, IL, NY, SD</td>
</tr>
<tr>
<td>Region II</td>
<td>CA, IN, MN, OH, TX</td>
</tr>
<tr>
<td>Region III</td>
<td>CO, IA, MO, OK, UT</td>
</tr>
<tr>
<td>Region IV</td>
<td>KS, MT, OR, VA</td>
</tr>
<tr>
<td>Region V</td>
<td>FL, IA, NE, PA, WA</td>
</tr>
<tr>
<td>Region VI</td>
<td>ID, KS, NE, SC, WI</td>
</tr>
<tr>
<td>Region VII</td>
<td>CA, CO, GA, KY, NE, NY, SD</td>
</tr>
<tr>
<td>Region VIII</td>
<td>IN, KS, MO, OK, OR, UT</td>
</tr>
</tbody>
</table>

6. Price Ranges for Ethanol Equipment Plants

In October of 1979, prices for packaged ethanol plants were projected by manufacturers to range from $.27 to $.84 per annual gallon for plants producing 190 proof ethanol. One producer who perceived his plant to be of especially high quality estimated that his price would be $1.00 per annual gallon.

These same manufacturers, when contacted in February 1981, revised their price schedules to $.38 to $1.15 per annual gallon for 190 proof plants. For the large 200 proof plant, the new price quoted was $1.80 per annual gallon. Table III-1 shows the details of the quoted prices for some of the manufacturers contacted. These price ranges are believed to be indicative of most of the manufacturers contacted.

The price differentials between plants in most cases is due to quality of the product and in some cases the degree of completeness of the plants. The lower cost plants, for example, used mild carbon steel in the distillation tower, while the high priced plants used stainless steel in the columns. Some included a boiler or dryer and some did not.

The later prices quoted in February of 1981, however, reflected other changes. First, inflation and the high production costs in the intervening 16 months accounted for part of the increase. However, the major difference, according to the comments, was due to incorporation of high actual costs into their products in contrast to projected costs used in the 1979 estimates. This also reflects manufacturers' experience that their designs were inadequate and that the products needed to be improved in order for them to operate properly and to achieve longer life and less maintenance.

Again, these price changes reflect some maturation of an infant industry that occurs in all industries at this stage of development. And of course, inflation must be taken into account as a factor. Generally, in an infancy period, designers underestimate their design requirements, which leads to underestimated costs and requires substantial price increases to maintain acceptable margins.
<table>
<thead>
<tr>
<th>Plant size (gallons/year)</th>
<th>Ethanol (proof)</th>
<th>October 1979 price</th>
<th>February 1981 price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total gallon</td>
<td>Per annual gallon</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>144,000</td>
<td>190</td>
<td>60,000</td>
<td>.42</td>
</tr>
<tr>
<td>180,000</td>
<td>190</td>
<td>49,000</td>
<td>.27</td>
</tr>
<tr>
<td>237,000</td>
<td>190</td>
<td>200,000</td>
<td>.84</td>
</tr>
<tr>
<td>2,300,000</td>
<td>200</td>
<td>2,300,000</td>
<td>1.00</td>
</tr>
</tbody>
</table>

1/ Based on 24-hours per day - 300 days per year.

Source: DPRA estimates based on industry contacts.
7. Sales and Income

A normal measure of performance of an industry is sales income, or the number of units sold over time. In this emerging industry, no published figures are available either in dollar value or in units sold. Therefore, the responses received from contacted manufacturers were used as an approximation of sales figures for the industry. These sales figures are only approximations, however, as the 47 companies that did respond were not always specific on units that were in fact sold versus units that were under test of development work and not actually sold and paid for.

Of the 47 companies contacted, 36 volunteered information regarding sales or lack thereof. Of these, 16 had no sales whatever. Of the 20 companies that reported sales a total of 210 units of the various sized plants had been sold. These plants ranged in cost from $25,000 to $5,000,000. Under general assumptions that these plants sell for $.40 per annual gallon for the very small plant, $1.00 for the larger plants and $1.80 for the custom plants based on annual gallons per year, an order of magnitude for total industry sales is estimated at about $136 million. These are not annual sales, but represent essentially the sum total of sales since the fuel alcohol production equipment market began in 1977.

This benchmark estimate excludes some of the very large industrial plants that have been built and sold as well as the do-it-yourself plants that have been built by farmers throughout the country. Another segment of alcohol plants that may be large and significant as far as numbers are concerned, but are very small in the amount of total ethanol produced, are the small 100-300 gallon per batch pot stills. As such, the prior estimate is simply the contractor's best approximation of total sales of factory-built packaged ethanol plants.

8. Equipment Certification

At this stage of the ethanol equipment industry, there are widely varying claims of capacity, yield, energy efficiency and equipment life being made by each manufacturer. The variation stems not only from differences in the equipment performance, but also from performance measurement procedures. To alleviate this confusing situation, standards of performance and standard methods of reporting performances are necessary to make comparisons of competing products. Unfortunately, during the development phase of the equipment, while designs and performances are changing along the learning curve, it is extremely difficult for a group of manufacturers to establish and agree on performance standards or for any outside association or agency to impose standards or certified performance.

From the point of view of the prospective buyer and that of the financial institutions considering advancing, purchasing or leasing funds on such equipment, certified performance or reliable standards are essential. Lending institutions are well qualified to evaluate business risks and assign a risk factor or interest rate for such risk, but are not qualified nor interested in accepting any performance or technology risk associated with indi-
vidual lending decisions. Without the development of standards or certified performance backed by the resources of the manufacturers and understood by all parties, loan evaluations based on business risk alone cannot proceed and, thus, many loans will not be approved. It is unknown how many loans are rejected due to a lack of certification which lenders perceive as a performance risk, but equipment manufacturers admit that lenders are skeptical of performance characteristics, and verification or certification equipment performance would increase the potential for loan approvals and thus sales.

A reaction to this need was sponsored by the National Alcohol Fuel Producers Association, when a group of interested manufacturers and government lending officials met in Fairfax, VA on February 26, 1981, to discuss this issue and to set into motion events that may lead to the development of necessary standards and the acceptance of the need for those standards on the part of manufacturers. Thus, these manufacturers, looking at their own best interests, would cooperate on the establishment and adoption of basic minimal standards.

The following items are some of the factors that could be uniformly measured and reported by each manufacturer. This preliminary list could be used to lead to certified performance expected and thus, in the future, offer a basis for direct comparisons of products based on that performance:

<table>
<thead>
<tr>
<th>Certified Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Yield</td>
</tr>
</tbody>
</table>
| 2. Capacity           | - Specify batch or continuous operation  
  a. gallons - proof/hour  
  b. gallons - proof/day  
  c. gallons - proof/year (300 days) |
| 3. Controls           | - Specify manual or the degree of automated control |
| 4. By-product         | - Specify the material by:  
  a. percent solids or moisture  
  b. percent protein  
  c. quantify per gallons of ethanol output |
| 5. Energy Use         | - Specify boiler fuel  
  Input Btu/gallon of ethanol output |
| 6. Water Consumption  | - Minimum and maximum gallons of water/gallon of output |
7. Process type  - Identify key features
   a. cooking
      - batch
      - extrusion
      - other
   b. separation
      - starch-grain
      - sugar-grain
      - alcohol-stillage
   c. distillation
      - plates
      - packed
      - vacuum
   d. dehydration
      - none
      - benzene extraction
      - other extraction
      - molecular sieve
      - energy used-Btu/gallon

8. Manufacturers certification and warranty--include the degree of
   UL approval, degree of OSHA compliance, specify material used
   in cooking tank
   - fermentation tank
   - distillation columns
   - rectification column.

9. Innovative Ideas in Product Development and Marketing

During the period of this study, a number of innovative designs and marketing ideas were noted. These innovations came essentially from the small business concerns. The larger businesses tended to develop their products with known technology or technology transferred from the beverage alcohol industry.

As the examples show, small businesses, on the other hand, have tried to develop unique ideas or variations of known technology with their products. This innovative development is not yet proven, and it remains to be seen whether or not these small businesses will achieve economic success. It does, however, reinforce the fact that small businesses are responsible for more of the innovative development than are the large companies.

Following are some of the innovative products and market development ideas the study team noted during contacts with the small businesses.
a. Unusual feedstock

Most developers of ethanol-producing equipment stress that their equipment will handle a variety of feedstocks. However, when their testing and prototype equipment are examined, corn is invariably the feedstock that is used, and most data that are discussed in advertising brochures are in fact based on corn. One equipment developer, however, is attempting to develop equipment using two readily available feedstocks that not only are low in value, but may, in some cases be negative in value. The two feedstocks are municipal sewage sludge and old newspapers. Both of these materials contain cellulose with the lignin removed and do represent a potential for conversion of cellulose to fermentable sugars, and thus alcohol. The interesting innovation in this case, however, is the fact that both materials are a costly waste that require additional costs for disposal. However, if they could be converted into useful products, that is ethanol, these wastes could be disposed of at a profit. This is a promising development, but has yet to prove its economic feasibility.

b. Innovative marketing

One manufacturer is selling his equipment based on the fact that if a hog farmer feeds 100 bushels of shelled corn per day, he can divert 35 of those bushels into alcohol production and have available the distiller's grains left over from the alcohol process which, when put back with the original 65 bushels of shelled corn, produces an equivalent feed for hogs. Similar practices can be incorporated with beef and dairy operations, which in essence utilize excess energy in the ration while maintaining protein requirements and producing a balanced equivalent ration. This analysis thus takes away the cost of the feedstock, and alcohol can therefore be produced for only the operating costs by farmers that have sufficient operations to integrate an alcohol producing unit with a livestock raising operation.

c. Additional by-product revenue

Another manufacturer is developing an ethanol producing process that incorporates a hydroponic greenhouse in conjunction with the alcohol production. The hydroponic greenhouse will, in fact, use some of the liquid solubles from the distillers' grain as a fertilizer and will also use the growth stimulating carbon dioxide from the fermentation process which is normally vented and lost. Again, this is still in the development stage, but if successful, the added investment of the hydroponic greenhouse may, in fact, provide a substantial improvement in the economic feasibility of a project.

d. Built-in transportation

One of the problems in building packaged alcohol stills is making a plant that is technically complete, universally flexible for most sites, and mobil. One developer has solved this problem by actually manufacturing the package plant on two or three flatbed trailers which eventually become the basic platform for the equipment. To install the plant, truck type rear axle and wheels are added to these bases, which are then towed to their ultimate destination and set on their foundations. The wheels are then removed and...
back for credit. Such a plan minimizes transportation costs and allows the complete preassembly of the plant to an extent apparently not possible with other manufactured units. It also allows better plant mobility, which can stimulate purchase by cooperatives or multiple users. Though a less important feature, the mobility may also improve resale value of the plants.

e. Tie-in sales

Two companies that were originally building conversion kits for cars or converting cars to alcohol fuels have expanded to ethanol equipment manufacturing. They have entered the alcohol production business as a means of providing fuel for the converted automobiles. This tie-in is still in the early stages, but provides a way of adding a new division as well as helping to expand the original product sales.
IV. SMALL AND LARGE BUSINESS PARTICIPATION

This chapter provides information and findings on small and large business participation in the ethanol equipment manufacturing industry and the effect of government programs on participation. The types of information presented are classification of manufacturers in small and large business categories, small and large manufacturers product characteristics, small and large business equipment sales characteristics, manufacturers' awareness of government programs and the effect of programs on participation.

Based on the extensive number of contacts made and the favorable cooperation of the manufacturers, it is estimated that over 90 percent of the current manufacturers employ less than 500 persons and would be classified as small businesses according to proposed SBA size standards. While this estimate arose from informal general response, some incomplete and unverified operations data and limited assumptions by the analysts, it is believed to provide a good benchmark on participation until the industry matures and more comprehensive secondary data are available.

A. Size of Manufacturers

Based on the conversations with equipment manufacturers, it was estimated that 45, or 96 percent, of the manufacturers contacted could be classified as small businesses. This was based on a small business standard of less than 500 employees. A more detailed breakdown of manufacturers by employment size is shown in Table IV-I, and it indicates that most manufacturers (75 percent) are in fact very small, with less than 50 employees. The authors believe the distribution for all ethanol equipment manufacturers would be closely represented by the sample of 47 firms contacted, as it is a large share of industry, and no competitors were identified which would be classified as a large manufacturer.

While there are large manufacturers producing ethanol equipment, their volume of ethanol equipment manufacturing and the number of employees directly involved in manufacturing ethanol equipment is a small share of the company total. Thus, for practical purposes, there are no large equipment manufacturers, only small manufacturing divisions within large companies that manufacture other types of products.

While some information was obtained on sales units, little was ascertained about sales dollars. However, even if sales dollars could be obtained, the results, in all probability, would indicate an even greater number of small businesses. Sales for the most part are concentrated with certain firms and numerous manufacturers had yet to make significant sales of stills.
Table IV-1. Size of ethanol equipment manufacturers based on employment, 1980

<table>
<thead>
<tr>
<th>Number of employees</th>
<th>Number of manufacturers</th>
<th>Percent of manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-49</td>
<td>35</td>
<td>75</td>
</tr>
<tr>
<td>50-99</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>100-499</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>500+</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>100</td>
</tr>
</tbody>
</table>
B. Product Characteristics of Small and Large Businesses

As was discussed in Chapter III, equipment manufacturers' product lines can be classified into four primary groups. These include manufacturers who produce:

1. small stills (prepackaged) - capacity to produce 50 gallons or less per hour, or 360,000 gallons annually (300 days, 24 hours per day), with an average annual capacity of about 144,000 gallons,

2. large stills (prepackaged) - capacity of over 50 gallons per hour, with an average annual production of about 1 million gallons,

3. both small and large stills,

4. custom stills - manufacture major components for large commercial, custom design alcohol plants averaging 5 million gallons of production per year. Again, while these have been classified as custom stills, the design and many components are standardized and manufactured by the designing firm.

With regard to the size of firms, it was found that small manufacturers of less than 50 employees tend to produce only small prepackaged stills. Of 47 firms contacted 27 employed less than 50 persons and produced only small stills; these represented 77 percent of the firms with less than 50 employees, and 93 percent of the plants producing only small prepackaged stills. As shown in Table IV-2, the larger firms tended to diversify more, producing both small and large stills or manufacturing major components for custom designed alcohol plants. The latter of the two appears to be the most active market as far as fuel alcohol production and plant construction is concerned.

Small and large firms also differ in regard to their general product development. The small manufacturers tend to have a more extensive effort in product development, as they generally design their product from scratch. The larger firms have tended to merely downsize already proven large scale technology.

C. Small and Large Business Sales Characteristics

Another measure of small and large business participation in the ethanol equipment manufacturing industry is sales. The study team developed estimates of sales based on general manufacturer sales information and certain assumptions on product characteristics. The estimates are on a unit of production basis, however, as manufacturers were hesitant to provide sales dollar information.

Prior to discussing these estimates, however, it should be stressed that accuracy of them is limited. This reflects three conditions. First, manufacturers' sales were not verified, as obtaining customer lists and contacting them was beyond the scope of this study, and most manufacturers consider customer lists to be confidential. Second, the manufacturers generally provide sales in terms of number of units sold by general size category; thus the analysts had to estimate average sizes for various types of plants.
<table>
<thead>
<tr>
<th>Size of manufacturer (number of employees)</th>
<th>Products</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small</td>
<td>Large</td>
<td>Both small</td>
<td>Custom turn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>stills</td>
<td>stills</td>
<td>large</td>
<td>key stills</td>
<td>Total</td>
</tr>
<tr>
<td>1-49</td>
<td>27</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>35</td>
</tr>
<tr>
<td>50-499</td>
<td>2</td>
<td>--</td>
<td>3</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>500+</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>1</td>
<td>10</td>
<td>7</td>
<td>47</td>
</tr>
</tbody>
</table>

1/ Stills that include manufacture of key components but for which some variance in design occur.
Table IV-3. Estimated ethanol production capacity from ethanol plants sold by small (<500 employees) and large (500+ employees) manufacturers and expected to be operational in 1981

<table>
<thead>
<tr>
<th>Manufacturer size</th>
<th>No. of plants</th>
<th>190 proof</th>
<th>200 proof</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Average plant</td>
<td>Total</td>
</tr>
<tr>
<td>Small manufacturers</td>
<td>196</td>
<td>27.4</td>
<td>6.0</td>
</tr>
<tr>
<td>Small</td>
<td>190</td>
<td>.144</td>
<td>27.4</td>
</tr>
<tr>
<td>Large</td>
<td>6</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Custom</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>27.4</td>
<td></td>
</tr>
<tr>
<td>Large manufacturers</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>13</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Large</td>
<td>2</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Custom</td>
<td></td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All manufacturers</td>
<td>211</td>
<td>27.4</td>
<td>73.0</td>
</tr>
<tr>
<td>Small</td>
<td>190</td>
<td>.144</td>
<td>27.4</td>
</tr>
<tr>
<td>Large</td>
<td>8</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Custom</td>
<td>13</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>27.4</td>
<td></td>
</tr>
</tbody>
</table>
Finally, the study team did not contact all manufacturers. However, because it is believed that most if not all the major manufacturers were contacted, the estimates were not adjusted to reflect any significant production from the manufacturers not contacted. Another reason for not making adjustments is that manufacturers tend to be optimistic, reflecting soft sales, prototypes, and sales to universities and other research-oriented clients.

Given these conditions, benchmark estimates were developed which indicate that equipment manufacturers have delivered or plan to deliver ethanol plants accounting for about 100 million gallons of ethanol production capacity. The capacity includes just over 200 plants with capacity for 27 million gallons of wet alcohol (190 proof or less) and 73 million gallons of anhydrous alcohol (200 proof) (See Table IV-3).

Small manufacturers were estimated to account for all the wet alcohol capacity (27 million gallons), and 6 million gallons of the 200 proof capacity. Their sales, while representing over 90 percent of the plants sold, account for only one-third of the capacity sold and to be delivered through 1981. Small manufacturers will account for essentially all the small ethanol plants sold, 190 plants, and six of the eight large prepackage plants in operation or to be delivered. Unfortunately, small businesses have not been able to participate in component manufacturing for combination custom/standard designed large plants which are usually manufactured by large engineering firms which operate component fabricating/manufacturing facilities.

While large manufacturers' involvement with large custom plants account for only 7% of the plants sold, they are responsible for fully 2/3 of the capacity sold. Thus, while small manufacturers have sold over 10 times more plants, the total capacity, and thus sales value, is approximately one-half that of large businesses.

**D. Effect of Government Programs on Participation**

**1. Manufacturers' Awareness and Evaluation of Program**

Most of the manufacturers contacted were appraised of government programs, policies and regulations pertaining to ethanol production and ethanol equipment manufacturing. This reflects substantial interest on the part of manufacturers and an effective media and educational program supported by the fuel alcohol movement.

The manufacturers were also generally informed on program characteristics and often cited requirements and criteria as reasons for not utilizing certain programs. For example, concern over required waiving of patent rights discouraged some from seeking SBA loans. They also perceived DOE support to be primarily for large scale ethanol production.
Generally, participation both directly and indirectly in government programs was quite limited. Of the 47 manufacturers contacted, only 2 claimed to have received any direct assistance. One had received a DOE grant for development of innovative technology, while the other had received an SBA loan/loan guarantee. In addition to program characteristics, other reasons for program avoidance were paperwork, bureaucratic red tape and, most frequently, availability of private support and financial arrangements. It should be noted the sources of private support usually include friends, families, and private investors but not banks.

Indirect participation in financial assistance programs has been more frequent than direct participation, but is still limited. The participation primarily has been in the form of assistance to potential alcohol producers (equipment customers) on applications to the FmHA for loans to purchase stills. Similarly, some manufacturers have assisted producers in SBA applications. Of the 47 manufacturers interviewed, eight had indirect experience with FmHA programs and four with SBA.

When asked to evaluate government programs, the manufacturers contacted generally were critical. Their prevalent criticism included:

- too much emphasis on large, commercial stills and production versus small, on-farm stills,
- limited support of use of straight alcohol as a fuel,
- lack of technical expertise by program administrators,
- severely limited eligibility requirements or program coverage,
- excessive delays in responding to their own and customer's requests for financial assistance.

With regard to specific agencies, comments were the most unfavorable for the FmHA and DOE programs. Eight of the manufacturers singled these agencies out as being very unhelpful and primarily attributed these agencies' lack of assistance to their support of large commercial production and early support of questionable projects which have tempered recent interest.

It should be pointed out that some of the criticism of FmHA is related to its administration policy, which conflicts with industry conditions. Some equipment manufacturers have not commercially established the technical capabilities or performance of their product. This involves technical or technology risk on the part of purchases, in addition to financial risk. The FmHA will finance projects that involve only financial risk and will not support producers using equipment subject to technology risk. In contrast, technology for large, commercial production is well proven, and thus qualifies for FmHA support.

Comment by manufacturers on SBA programs were favorable for the most part. They cited SBA officials as being cooperative and more responsive to their financial assistance application. This responsiveness was primarily on action and not necessarily on approval or requests. Specific criticisms were low funding limits per project and delays in getting funds after requests were approved.
2. Effect on Small and Large Business Entrance and Participation

As the ethanol equipment manufacturing is in such an early stage of development, participation is, in essence, restricted to industry entrance. The lack of historical sales or operations precludes any broader assessment of small and large business participation and the effect of government programs.

The effect of government programs on small and large business participation vis-a-vis entrance in the ethanol equipment industry should be considered to be substantial, and did in fact aid and encourage significant small business participation. However, as discussed below, the long run effects may not be beneficial.

The immediate effect on small business was to encourage and legitimize entrance into the ethanol equipment industry. This occurred as government implied through the development of large loan programs, that not only did a market for small scale prepackaged stills exist, but there would also be substantial public funds available to supplement private funds for purchase of these stills. While this encouraged large business entrance, such did not materialize for two major reasons. First, in a new industry small businesses traditionally make the initial entry and dominate early product and market development. Larger businesses, which are more risk adverse, meanwhile expand conventional product lines and markets while evaluating new markets, such as ethanol equipment. This evaluation would indicate, as small businesses have experienced, a soft, highly fragmented market. While interest is high, most of it is in the form of "curiosity seekers" which is not easily converted into product sales.

Furthermore, of the three major economic factors promoting ethanol production on farms--low corn prices, low stocks of gasoline, and high gasoline prices--only one remains significant, that is high gasoline prices. This alone cannot support the ethanol equipment industry because even at high prices, prepackaged equipment has not been able to yield a cost competitive product, and additional incentive for production is required.

Over the long run, the potential for small prepackaged stills for farm use appears limited under present costs, technologies and operating requirements. It is believed that these conditions will cause numerous small business failures that, in fact, have already started to materialize. While government is not responsible for the ultimate causes of the bankruptcy, it may be responsible in part for the volume of business failures that appear imminent, as programs and policies supported or reinforced small businesses' reasons for entrance. The authors believe that had government not enacted such programs, which were well publicized by industry and government although not necessarily well funded or utilized, the eventual number of business failures or, at least, financial hardship would not be as large. In this sense, the long-run effects do not appear to be beneficial to either small business or the ethanol equipment manufacturing industry.
V. BARRIERS TO INDUSTRY MARKET DEVELOPMENT AND ACHIEVEMENT OF ETHANOL PRODUCTION GOALS

The ethanol equipment industry, as already mentioned, has experienced major barriers and problems in developing a product market and in realizing significant sales. The conversations with manufacturers revealed a pervasive concern about this situation and this subject provides some of the major findings of this study. Also, the industry development concerns, and causes for them, will affect the potential for achieving U.S. ethanol production goals and could alter the effectiveness of U.S. policy on ethanol production. This chapter will discuss these barriers and the reasons they developed.

In summary, the problems are extensive. In the first place, product interest waned due to changes in economic factors. Product technological and operational characteristics were often unacceptable and not matched with market needs. Finally, the manufacturers possess limited marketing skills, have not adequately assessed their market and thus do not understand the market situation and trends and marketing requirements.

A. Product Demand

The ethanol equipment manufacturing industry can identify the early emergence of demand or, at least strong interest, in the latter part of 1977. The interest came primarily from farmers for small prepackaged stills which were relatively inexpensive, easy to operate, and which operated at high energy and production efficiency. Their interest was aroused by two concurrent events. One was a critical level of gasoline stocks, which threatened to cause both shortages and allocations of this major farm input. Also, farmers were receiving low commodity prices, with corn at a five year low of $1.60 per bushel in 1977. These conditions were supplemented by concern for ever increasing energy costs. The result of these conditions was a belief by some farmers that by producing alcohol on the farm they could

- insure adequate supplies of liquid fuel for critical farm operations
- increase the return to farm crops
- produce a marketable energy product to compete with gasoline

Some interest also arose from nationalistic pride in lessening dependence on Middle East, particularly Iranian oil, and to reduce purchases from major petroleum companies.

1. Changes in Demand

The basic factors generating interest in ethanol equipment changed dramatically from 1977 to early 1981. The changes included corn prices rising 100 percent between September of 1977 and November of 1980 (Table V-1). In ...
<table>
<thead>
<tr>
<th>Corn Price ($/bu)</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Annual Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>2.34</td>
<td>2.34</td>
<td>2.35</td>
<td>2.31</td>
<td>2.25</td>
<td>2.12</td>
<td>1.88</td>
<td>1.63</td>
<td>1.60</td>
<td>1.67</td>
<td>1.88</td>
<td>1.97</td>
<td>2.02</td>
</tr>
<tr>
<td>1978</td>
<td>2.00</td>
<td>2.03</td>
<td>2.15</td>
<td>2.24</td>
<td>2.29</td>
<td>2.28</td>
<td>2.16</td>
<td>2.01</td>
<td>1.98</td>
<td>1.97</td>
<td>2.02</td>
<td>2.09</td>
<td>2.25</td>
</tr>
<tr>
<td>1979</td>
<td>2.11</td>
<td>2.18</td>
<td>2.22</td>
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<td>2.49</td>
<td>2.64</td>
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<td>2.40</td>
<td>2.36</td>
<td>2.42</td>
<td>2.49</td>
<td>2.73</td>
<td>2.92</td>
<td>3.01</td>
<td>2.99</td>
<td>3.20</td>
<td>3.19</td>
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<tr>
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<td>3.19</td>
<td>3.22</td>
<td>3.16</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Stock of gasoline (mil. bbl.)</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Annual Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>252.6</td>
<td>255.5</td>
<td>262.1</td>
<td>258.8</td>
<td>262.5</td>
<td>256.4</td>
<td>258.2</td>
<td>256.9</td>
<td>255.8</td>
<td>254.9</td>
<td>258.0</td>
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<tr>
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<td>248.9</td>
<td>233.5</td>
<td>219.4</td>
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<td>220.5</td>
<td>238.0</td>
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<td>1979</td>
<td>255.7</td>
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<td>239.2</td>
<td>235.2</td>
<td>227.2</td>
<td>229.3</td>
<td>241.5</td>
<td>232.7</td>
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<td>236.7</td>
<td>234.7</td>
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<tr>
<td>1980</td>
<td>262.1</td>
<td>274.4</td>
<td>282.7</td>
<td>271.7</td>
<td>262.9</td>
<td>264.6</td>
<td>260.7</td>
<td>259.0</td>
<td>257.9</td>
<td>247.2</td>
<td>256.5</td>
<td>260.1</td>
<td>263.3</td>
</tr>
<tr>
<td>1981</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</table>

<table>
<thead>
<tr>
<th>Unleaded gasoline price ($/gal)</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Annual Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>64.0</td>
<td>65.0</td>
<td>65.4</td>
<td>66.1</td>
<td>66.7</td>
<td>67.2</td>
<td>67.3</td>
<td>67.0</td>
<td>67.0</td>
<td>67.0</td>
<td>67.0</td>
<td>67.2</td>
<td>66.4</td>
</tr>
<tr>
<td>1978</td>
<td>65.8</td>
<td>65.7</td>
<td>65.0</td>
<td>66.1</td>
<td>66.9</td>
<td>67.8</td>
<td>66.6</td>
<td>68.8</td>
<td>69.8</td>
<td>70.2</td>
<td>70.2</td>
<td>71.1</td>
<td>71.7</td>
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<tr>
<td>1979</td>
<td>72.9</td>
<td>74.5</td>
<td>77.4</td>
<td>81.6</td>
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<td>105.4</td>
<td>108.2</td>
<td>93.8</td>
</tr>
<tr>
<td>1980</td>
<td>114.6</td>
<td>120.7</td>
<td>125.2</td>
<td>126.4</td>
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<td>126.9</td>
<td>127.1</td>
<td>126.7</td>
<td>125.7</td>
<td>125.0</td>
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<tr>
<td>1981</td>
<td>130.0</td>
<td>138.0</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>

Source: U.S. Department of Agriculture and U.S. Department of Energy
comparison, unleaded gasoline prices during the same period rose slightly less at 87 percent. Gasoline stocks bottomed at 209 million barrels in August 1978, and had increased 24 percent by late 1980 to 260 million barrels. Furthermore, due to price differences, product quality concerns and ample supplies of gasoline, general gasohol demand stagnated, which lowered demand and marketability of ethanol produced by farmers. The prior changes occurred over a relatively short time period with regard to the commercial development of products for a new market. Thus, manufacturers committed extensive time and resources to development and refinement of technology for the market, only to see market conditions worsen, thereby making recovery of R&D and start-up costs very difficult.

2. Size of Demand

No known estimates are available on aggregate demand for ethanol equipment. However, the magnitude of government support and public interest, combined with the entrance of about 100 manufacturers, suggest it is a very large market. Government support alone implies that it is a multi-million dollar market. Closer market scrutiny would likely contradict these implications though, and would indicate a relatively small but highly visible segment of the farm market.

Reviewing briefly, farmers can be grouped into five general categories, including:

- innovators
- early adaptors
- early majority
- late majority
- skeptics

Their relative distribution in the farm community is shown below and suggests that market viability is not likely until product acceptance by the early majority.
However, before acceptance by the early majority it is critical that early adaptors accept the product, as they are the key to product success 1/. The early adapter plays the role of being influential in society and prioritizes product values higher but more nearly in line with the early majority. The early adaptor, as opposed to the innovators, is relied upon to validate the claimed benefits of the new product. Based on the low level of sales, it appears that only innovators have been purchasing or constructing ethanol equipment to date. With innovators experiencing low acceptance and low product benefits in cases of acceptance, the overall market potential at this time is limited.

B. Barriers to Industry Market Development

Compounding the problem of an ethanol equipment market that is currently bearish, the manufacturers are experiencing problems even in satisfying the limited demand that exists. These problems fall into three general categories:

- technological
- market development
- financial

Each problem, in itself, would require substantial work and innovation to overcome but must be corrected if the industry is to survive infancy.

1. Technological problems and constraints

A significant problem facing equipment manufacturers relates to the requirements of producing alcohol. Contrary to early publicity, it is not a simple case of "buy or build a still, plug it in, pour in some corn and watch the alcohol come out" 2/. Ethanol production is very complex and involves chemistry, steam engineering, microbiology, plumbing, meticulous housekeeping and, of course, good management. All of these inputs are used in the basic steps of production, which are:

- feedstock preparation - grinding, crushing biomass
- batch formulation - preparing slurry, adding enzymes
- cooking - gelatinizing starches
- saccharification - adding second enzyme and yeast
- fermentation - converting sugars to alcohol
- distillation - separating ethanol from "beer"
- condensation - condensing ethanol vapors to liquid
- denaturing - rendering ethanol unfit for human consumption 3/

1/ Chester R. Wasson, Dynamic Competitive Strategy and Product Life Cycle, Challenge Books, St. Charles, Illinois, 1974, p. 120.

2/ Hughes, H.A. and J.W. Gird, "On-Farm Production of Ethanol from Grain". Dept. of Ag Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA, 1980.

While it is true that the technology to produce ethanol is well established, the operation of ethanol plants and the production of ethanol is still difficult.

The prior conditions have caused many potential buyers of prepackaged stills to reconsider purchase of a still, as they realize they do not possess the technical or management skills to properly run a plant. Also, the still operation does not conform with the limited labor and management resources or labor patterns many purchasers can allocate to operating a still which is often considered as a secondary part of an overall farm operation.

There also are more plant-specific technological problems which manufacturers must deal with. These include the type of construction material—mild steel, stainless steel or aluminum alloy. Material selection involves a trade-off between initial costs and operating characteristics and product life. Also, manufacturers must assess the level of automated controls to install, whether to use a packed distillation tower or sieve type, and whether to distill by use of a single tower or twin towers.

One general problem manufacturers have not overcome is a way to economically produce anhydrous ethanol on a small scale basis (less than 500,000 gallons per year). To date, anhydrous capabilities on small plants both increase front-end costs beyond acceptable levels and increase energy requirements to produce alcohol. Thus, the alcohol from most manufactured stills cannot be used to make gasohol.

2. Market Development Problems

There has existed a noticeable dearth of market development by ethanol equipment manufacturers primarily due to a concentration of limited resources on technological problems and R&D requirements. To eventually develop the ethanol equipment market, the following activities will be required:

- make more comprehensive efforts to understand market potential, user needs and learning requirements.
- perform adequate production runs/product testing and formulate company specific marketing plans before offering product.
- gain trial by early adaptors.
- better educate user on potential benefits and costs of equipment.
- stimulate and develop market potential for low proof alcohol.

3. Financial Problems and Constraints

Generally high interest rates have also had a negative effect on the ethanol equipment manufacturing industry, especially since ethanol is considered high risk and competes with lower risk alternatives for very limited capital supplies. Some manufacturers have solved this problem by developing leasing arrangements. Government loans and loan guarantees have been used occasionally. For their own operating requirements, manufacturers have relied on private non-bank sources, as banks tend to view them as very high risk businesses.
4. Specific Problems of Manufacturers

Most of the manufacturers contacted expressed disappointment in sales and market development that had been made so far. The disappointments were expressed by those who had been developing and marketing equipment for as many as three years, as well as those who had only been operating for only one or two years.

When asked what kinds of problems had been encountered, the following responses were given:

1. Technical problems with components
2. Technical problems experienced by customers
3. Still doing R & D work--no production or sales yet
4. Lack of finances for R & D work
5. Lack of finances for customers to buy equipment
6. Lack of market for low proof ethanol
7. High interest rates
8. Improved gasoline supplies and stable prices.

For purposes of discussion, these eight reasons cited above have been collapsed into four specific kinds of problems so that some quantitative analysis could be done on the problems the companies face. These closely correspond with the general problems discussed earlier. As shown below, the two major problem areas are product market development and customer finance.

<table>
<thead>
<tr>
<th>Problem Reasons</th>
<th>Percent of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Technical</td>
<td>23</td>
</tr>
<tr>
<td>2. Company finance</td>
<td>18</td>
</tr>
<tr>
<td>3. Customer finance</td>
<td>28</td>
</tr>
<tr>
<td>4. Product market</td>
<td>31</td>
</tr>
</tbody>
</table>

Examples of the specific problems cited by manufacturers for the various problem categories are given below.

1. Technical--Problems that were classified as technical related to equipment problems and operator problems. Some respondents had problems with separation of the spent grains and the alcohol and had tried other separations. Some separated starch and others tried separating sugar so as to reduce the bulk of solids in the distillation columns. Other problems related to cooking and the conversion of grain to starch and starch to sugar, which resulted in low yields of alcohol per bushel of grain.

The companies that reported these technical problems tended to be small companies producing small sized plants, and had been in business less than three years.
Another issue concerning technology, is that while manufacturers recognized that there were substantial technology and operational problems associated with equipment in the industry, the problems were exclusive to other manufacturers. Furthermore, the other manufacturers' "bad apples" were often cited as a problem for general market development and a particular company's low sales.

2. Company Finance--Companies that reported problems of financing their development work and initial production and sales were undercapitalized or had underestimated their capital needs. For these companies, equity capital was required but it appeared that they hoped to find guaranteed loans or grants to fund their R & D growth.

The characteristic profile of these manufacturers was that they were new, small companies with very few sales.

3. Customer Finance--A frequently named problem holding back the anticipated growth of ethanol equipment manufacturers was financing for their potential customers. It was claimed that many more sales of ethanol plants would have resulted had farmers and other individual and buyer groups been able to get loans for equipment purchases. This lack of customer finance resulted from several factors:

   a. Attempts to obtain loans on unproven or undeveloped products,
   b. Unwillingness of lenders to loan on new types of ventures without guarantees or performance bonds,
   c. Underestimation of customers and manufacturers alike on the delays and procedural red tape necessary to pursue government loans with resulting frustration and bitterness,
   d. General shortage of loanable funds and the high interest costs that made the economic feasibility of some ethanol plant operations questionable.

Companies that expressed these reactions were on the whole the same kinds of companies that were characteristic of the previous problems except these companies on the average had more sales and were more aggressively marketing their products.

4. Product Market--An infrequently named deterrent to growth of the ethanol equipment industry was the lack of market for ethanol, especially 190 proof. The difficulty of funding dehydration to upgrade 190 to 200 proof marketable ethanol, coupled with the lack of direct uses for 190 proof ethanol, was a serious problem to four respondents. This group of respondents on the average had sold more plants and had more plants in operation.

More frequently cited "market problems" were stabilized gasoline prices and higher corn prices in the latter half of 1980. Most were optimistic that these conditions were only temporary, as either corn prices will come down or gasoline prices will climb.
C. Potential For Achieving U.S. Alcohol Production Goals

One of the objectives of this study was to assess the potential for achieving U.S. alcohol production goals and the role alcohol equipment manufacturers would have in meeting the goals. During the course of the study, it became apparent that short term goals would be very difficult to achieve because of market barriers, industry and technology barriers and some government barriers. Long-term goals are much more difficult to assess but meeting them also appears to be unlikely.

1. Apparent Capacity Shortfall

The apparent low potential for achieving production goals is verified by comparing actual and planned production capacity with mandated production goals. The specific goals were as follows:

<table>
<thead>
<tr>
<th>Date</th>
<th>Alcohol Production Goal</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>500 million gallon of annual capacity (Equivalent to 2.52 million gallon per day)</td>
<td>Executive Order</td>
</tr>
<tr>
<td>Dec. 31, 1982</td>
<td>Produce and use 60,000 barrels per day (920 million gallon per year)</td>
<td>Energy Security Act</td>
</tr>
<tr>
<td>Mid-1989</td>
<td>Domestic production capacity = 2 billion gallon per year</td>
<td>Energy Security Act</td>
</tr>
<tr>
<td>By 1990</td>
<td>Displace 10% of gasoline consumption with alcohol (equivalent of about 10 billion gallon of ethanol and methanol per year)</td>
<td>Energy Security Act</td>
</tr>
</tbody>
</table>

Industry contacts, literature reviews and information from other industry analysts indicate that annual production capacity as of January 1981 was about 155 million gallons (Table V-1), and additions for the year should be about 160 to 175 million gallons. This is estimated to bring the total annual capacity up to about 315 to 330 million gallons by the end of 1981. Based on these levels, a capacity shortfall of 34 to 37 percent is expected to occur in 1981. Primarily because of market barriers, it appears that the actual capacity will be at least as far behind the goals for 1982. Detailed descriptions of market and other barriers to meeting these goals are discussed below.

2. Small and Large Equipment Manufacturers Contribution to U.S. Alcohol Production Goals

A national goal for 1981 of 500 million gallons of fuel alcohol capacity (ethanol and methanol) was set in conjunction with a program designed to encourage consumption and production of alcohol as part of a national energy strategy. This program relied heavily on ethanol and, as mentioned earlier, ethanol equipment manufacturers were anticipated to play a large role in meeting the 1981 goal by rapidly producing small prepackaged stills that could quickly be put into operation. While a few very large ethanol refineries could easily meet this goal, planning and construction of these could not be completed over the short term.
Table V-1. Fuel ethanol production capacity from grain fermentation, 1981

<table>
<thead>
<tr>
<th>Producers</th>
<th>Annual capacity (mil gal)</th>
<th>Source of estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PRODUCTION CAPACITY (January 1981)</td>
</tr>
<tr>
<td>LARGE COMMERCIAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Archer Daniels Midland</td>
<td>100</td>
<td>SERI, production guide</td>
</tr>
<tr>
<td>Midwest Solvents</td>
<td>15</td>
<td>SERI, production guide</td>
</tr>
<tr>
<td>Publicker</td>
<td>20</td>
<td>SERI, installation data</td>
</tr>
<tr>
<td>Georgia Pacific</td>
<td>4.6</td>
<td>SERI, production guide</td>
</tr>
<tr>
<td>White Flame</td>
<td>3</td>
<td>SERI, installation data</td>
</tr>
<tr>
<td>Sub-total</td>
<td>142.6</td>
<td></td>
</tr>
<tr>
<td>SMALL AND MEDIUM</td>
<td>13</td>
<td>SERI, installation data</td>
</tr>
<tr>
<td>TOTAL</td>
<td>155</td>
<td></td>
</tr>
</tbody>
</table>

ESTIMATED PRODUCTION CAPACITY ADDITIONS FOR 1981

| LARGE COMMERCIAL        |                          | Industry reports                 |
| Other                  | 40-50                    | DPRA estimate                    |
| SMALL AND MEDIUM        | 20-25                    | DPRA estimate                    |
| TOTAL 1981 ESTIMATED CAPACITY | 315-330                |                                 |
| 1981 CAPACITY GOAL      | 500                      |                                 |
| 1981 CAPACITY DEFICIT   | 170-185 (34-37%)         |                                 |
Small business advocates also saw this program as an opportunity for entrance of new small business in the manufacture of this equipment, and as shown earlier several small businesses have participated. Unfortunately, the small ethanol equipment manufacturers have made only a minor contribution to the alcohol capacity. The ethanol plants operational, or to be delivered by about 50 small manufacturers in 1981, are estimated to represent approximately 33 million gallons of capacity, which is 7 percent of the national production goal. In contrast, one firm, Archer-Daniels-Midland, the nation's largest producer of alcohol, is expected to have two 100 million gallon plants in operation by the end of 1981, which will represent 40 percent of the national production goal.

Large equipment manufacturers will play a much bigger role in reaching production goals primarily on the strength of major equipment components in custom designed plants. It is estimated that large manufacturers have or will deliver plants that account for 13 percent of the 500 million gallon alcohol capacity goal.

3. Barriers to Achieving Ethanol Production Goals

The improbable achievement of ethanol production goals is the result of many barriers and problems, most of which are similar to those faced by ethanol equipment manufacturers in developing their market. Some of the problems are more extensive, however, and are related to more pervasive market barriers and government program and policy limitations.

a. Market Barriers

Currently, the market for ethanol and the incentive to produce it are linked for the most part to the sales of gasohol. Direct consumption of fuel alcohol has been limited due to the lack of converted or pre-designed engines to burn pure alcohol.

Gasohol sales, like ethanol equipment sales, are primarily a function of three major variables: gasoline prices, gasoline stocks and ethanol feedstock prices. As already discussed, conditions in these three areas are presently unfavorable, with no immediate indication of improvement.

Another market barrier appears to be consumer uncertainty about gasohol. This evolves from conflicting publicity on performance characteristics of gasohol versus unleaded gasoline. The buying public should be better informed on the advantages and disadvantages of gasohol.

Over the long-term, the market for ethanol would be greatly expanded by the availability and use of alcohol fuel vehicles. Currently, a limited commercial ethanol supply and distribution system and a small number of alcohol vehicles restrict pure ethanol sales as a vehicle fuel. This market can be developed, however, by promoting shifts to alcohol vehicles in fleets. Conversion of fleets to alcohol either by engine modification or by replacement of gasoline vehicles greatly reduces fueling station requirements, a severe restraint to commercial conversion to alcohol vehicles.
b. Government Barriers

While both federal and state governments have been generally supportive of ethanol production, certain events have restrained potential alcohol production and capacity. The most significant event has been a recent shift away from federal support and intervention in the energy market. The impact on alcohol production is that it has caused extensive review, re-evaluation and delay in ethanol production. But time may expose this merely as an aberration allowing for a shift from government support to more private support. This of course assumes that the project evaluation on either the private or government level would support similar levels of profitability and risk.

Another government barrier to achieving alcohol production goals is the limited support of federal policies for the use of gasohol in federal vehicles. Also, the federal government has not provided significant support for pure-alcohol vehicles and has not provided adequate follow-up to promote consumer acceptance of gasohol.

Various gasohol tax exemption programs on the state level have also hampered widespread use of ethanol. This has resulted in most of the promotion and consumption of gasohol in certain states. These states have tended to be small in population and are agriculturally oriented. Currently, midwestern states provide the largest incentives for gasohol, with Iowa, Kansas, and Nebraska being the leaders.
VI. CONCLUSIONS AND IMPLICATIONS

The ethanol industry is a dynamic, complex industry characterized by substantial debate and controversy; food versus fuel, energy efficiency versus inefficiency, improved mileage and performance versus lower mileage and performance, and positive versus negative balance of trade. In such an infant industry development of definitive conclusions or implications are difficult, but from this study it was possible to reach some general conclusions and present broad implications regarding certain facets of the ethanol industry. Specifically, these include conclusions and implications regarding (1) the relationship between government and the ethanol equipment manufacturing industry, (2) the characteristics of the ethanol equipment manufacturing industry, (3) the role of small business in this and other energy related industries and (4) ethanol production and its relationship to ethanol equipment manufacturing and small business.

A. Government

The U.S. government has actively participated in the development of fuel ethanol use and production. It has also supported development of an ethanol equipment manufacturing industry to produce "stills" for on-farm alcohol production. Unfortunately, these activities are somewhat in conflict. For example, an effective and efficient program to promote alcohol use and production should support low cost production primarily from large commercial stills, probably in excess of 10 million gallons per year [1]. In contrast, a program to support on-farm ethanol production and the ethanol equipment manufacturing industry will generate a lower level of alcohol production, and thus use, at a higher unit cost to society. Concern during fuel shortages about adequate supplies for critical agriculture operations, another incentive for on-farm production, can probably be more effectively handled through an allocation program. Moreover, as energy dependence is lessened, the potential for farm fuel shortages and the resultant need for on-farm ethanol production should be reduced.

Nonetheless, the small on-farm production program, as maintained by the U.S. government, appears to have lacked a proper balance between support of market development and product development. In an exception to the rule, there appears to have been much more support for product sales than product development, and manufacturers were not provided sufficient R&D and product development support to provide acceptable products for the limited market or the strong interest that initially emerged. This lack of product development and government support of it, along with major economic/market factors, contributed to an early decline in the market for ethanol equipment, as products did not meet clients' needs.

The ethanol equipment manufacturing industry is responsible for much of the government neglect in product development, as manufacturers publicized the availability of technology and knowledge for product development which could be rapidly commercialized, given some initial market support. This simply did not occur, as actual market needs were not compatible with initial commercial stills which were not only highly complex and labor intensive, but also inefficient in producing even wet alcohol as well as being cost ineffective.

The implication for government is that its actions can be misinterpreted by small business as to the market potential, in this case for on-farm stills. Government and manufacturers both should have more carefully examined the market to avoid the hardships that will occur as businesses fail. The failures, are in part, attributable to the entrance in a market based on interpreted government signals of strength which, in fact, were an aberration.

Furthermore, small firms may not be suitable for participation in all industries, and government assistance should be directed accordingly. For example, in the production of ethanol, large-scale plants have considerable economic advantages over small-scale prepackaged stills and the authors believe large ethanol plants will dominate alcohol production. Both construction and operation of the larger plants will likely be concentrated, with only a limited number being built. Also, for large-scale, the technology is a simpler modification of large-scale beverage ethanol production. All of these conditions generally favor participation by large business, while small business searches out new markets and makes the major innovations in both new and established markets.

B. Ethanol Equipment Industry

The ethanol equipment industry provides a vivid example of the difficulty in developing a new product for a new unestablished market. This is in contrast to developing a new product for an established market or an old product for a new market. True, early perceptions were that the technology was established and transferable, but it became apparent that modifications in technology from large-scale to small-scale for inexperienced users were massive, and essentially a new product was required. The modifications included improvement of energy efficiency of small stills; increasing cooking, fermentation and distillation product efficiency; lowering operational requirements, and, at the same time, reducing operating and investment costs.

Thus, the industry became highly involved with product development and inadequately addressed the market in terms of need, size and characteristics. Because of publicity, interest and government support, the manufacturers perceived a strong extensive market.

Also, individual manufacturers may have seriously damaged market potential by marketing inferior products or making exaggerated claims about product potential. For example, an equipment manufacturer recently advertised that his still would produce alcohol for $.40 per gallon. This compares to university or research farm results which indicate small-scale production costs between $2 and $7 per gallon.
Another implication for the industry, if it prevails, is that it must accept a greater responsibility in product and market development as it adjusts to less government support from the present administration.

Finally, when this study was initiated, there was concern about the industries manufacturing and distribution capabilities. Could the equipment be supplied in adequate quantities? While this has not been critical to date because of actual demand being limited, it could become a serious problem if demand greatly strengthened. Manufacturing capabilities are limited to mill work operations, and only minor distribution and service organization exists.

C. Small Business Participation

Small business has played the leading role in the birth and growth, however limited, of the ethanol equipment manufacturing industry. While the industry may not grow and reach maturity, a review of its development substantiates the role of small business in general industry development and provides implications for small business participation in alternative energy and similar infant industries. In particular, the following conclusions and implications are reached:

- Small business will provide the bulk of the product and market development for an innovative market, be it a market of either real or perceived potential.
- Small businesses participate by concentrating more on developing products than on developing markets, which reduces any actual commercialization potential that may exist.
- Both small and large firms find marketing of ethanol equipment to be an overly complex task, as the clientele is diverse and the market is highly fragmented and not well established.
- Small business participation will respond to government support and general market interest, whereas large business will respond only after extensive market research and establishment of a market.
- Small business' participation and role it plays in the ethanol industry may be more substantial in operating medium-sized (10-50 million gallons per year) commercial ethanol plants than building and marketing either small-scale prepackaged stills (limited market) or custom-built or commercial stills (designed and constructed by larger established firms).

D. Ethanol Use and Production

Ethanol use and production, while better established than the ethanol equipment manufacturing industry, is still in its early stages of development. Some commercial success has been experienced, but extensive market development must be initiated to maintain and improve market acceptance. This market development should come in two general areas.
First, the market for ethanol used in gasohol should be solidified. Currently, gasohol is positioned for two markets. One is as a gasoline substitute; the second is as a gasoline additive or octane supplement. This dual marketing approach is creating confusion in the marketplace, as the marketing strategies and consumer demand are different and often conflicting for the two approaches. Specifically, as a gasoline substitute, the pricing of gasohol must be nearly equal to gasoline prices as cross elasticities should be high and product differences should be minimized. As a gasoline additive or octane supplement, gasohol price differentials can and will be initiated, cross elasticities should be low, and product differences or advantages should be maximized. Either market approach alone may prove more successful than the dual approach, and the industry should assess and develop a long-term consistent approach to the market development of gasohol.

In concurrence with recent reports, the ethanol industry would benefit from expanded use of pure alcohol as a fuel. This requires the development and promotion of engine conversion kits, importation or production of ethanol burning motor vehicles and the establishment of a fuel alcohol distribution network. This, however, must be viewed as a long-term and complex market development project with limited potential for increasing ethanol consumption in the immediate future.
VII. RECOMMENDATIONS FOR IMPROVING AND MAINTAINING SMALL BUSINESS PARTICIPATION IN THE ETHANOL EQUIPMENT MANUFACTURING INDUSTRY

During the course of this study, the research team was provided numerous comments and recommendations for aiding small business participation in the ethanol equipment manufacturing industry. Based on these and additional findings, the study team formulated the following specific recommendations to improve and maintain small business participation in this and related infant industries. The recommendations are divided into two categories, those that pertain to government activities, and those that pertain to industry activities.

Government-related recommendations and their justification follow:

1. The Department of Energy should broaden its eligibility criteria for the Appropriate Technology Small Grants Program to allow research grants for technology refinement in conventional small-scale prepackaged stills in such areas as cooking, distillation and materials separation. Currently, the Department will consider only innovative technologies (solar distillation) or unique applications. Such action would assist the industry in overcoming some of the technological problems that were not initially anticipated, but have proved to be major obstacles to market development. These include aid in developing a low cost process for small-scale dehydration, improving equipment automation and increasing energy efficiency of stills.

2. The U.S. Department of Agriculture, either through the Extension Service or Farmers Home Administration, should aid manufacturers in providing intense operator training courses or seminars using different manufacturers' equipment to help customers understand the complexity of ethanol production and variances between different types of equipment.

3. Government should continue to support the industry's current development of equipment and operating standards, certifications and warranties. Development of standards and certification of equipment would reduce inconsistencies and complications in comparing and evaluating equipment. This will aid customers in understanding equipment characteristics and will improve potential for financing, as lenders would be exposed to less performance and technology risks.

4. The Department of Energy, Department of Agriculture (FmHA) and Small Business Administration should support and promote research and market development of gasoline-to-alcohol engine conversion kits and commercialization of pure-alcohol vehicles, which will expand the market for the low proof alcohol produced from pre-packaged stills.
5. Program administrators and officials should be better informed and more knowledgeable on the technology and economics of alcohol production and, must remain objective concerning issues related to alcohol production. While all administrators and officials would like to be better informed, the need seems to be paramount in this case, as equipment manufacturers were especially critical of public officials' lack of expertise on alcohol production and the issues that surround it. Furthermore, the industry and the economics and technology are changing rapidly at this stage of maturation and program officials must keep abreast of major developments that affect the industry and its participants.

6. Under current conditions in which major equipment improvements are needed and the market for ethanol equipment has softened, the Small Business Administration should not actively support new small business entrance into the ethanol equipment manufacturing industry. Current participants, primarily small businesses, are experiencing significant financial hardships, and additional entrances will, in general, only increase financial losses and potential business failures. This should not preclude R&D or production assistance to some current participants who have superior and potentially marketable products and can verify marketing success and customer satisfaction.

Industry-specific recommendations are as follows:

1. Industry participants must concentrate on the economic and financial feasibility of plants to produce ethanol at a price competitive with other fuels. While the promotion of energy independence for farmers and other purchasers of stills can continue, it should be secondary to financial parameters.

2. Industry should establish its own equipment and operating standards, certification and warranties to promote consumer confidence and improve ability to raise private financing of equipment sales.

3. Industry should promote and assist in converting gasoline engines to ethanol, and supporting development or import of alcohol vehicles to expand the market for low-proof ethanol, the basic product of most equipment manufactured to date.

4. Industry should solicit the support of manufacturers and other fuel alcohol groups to develop general education programs and seminars for basic ethanol production. Now that many potential buyers are aware of the complexity of production, they should be realistically informed that despite such complexity, production is still manageable.
5. Equipment manufacturers should expand or possibly redirect their small-scale still sales to include livestock producers who have a much more viable use for the important ethanol by-products (spent grain or distillers dried grains) as opposed to grain farmers with limited direct access to a by-product market or use.

6. Manufacturers should attempt to establish the extent of their market and the segments of the market in terms of number and characteristics of their particular innovators, early adaptors, early majority, late majority and skeptics. This will aid them in developing more acceptable products and in improving the utilization of limited marketing resources the manufacturers possess.

7. Having established market characteristics, the industry entrants must expand marketing activities to provide a more equal balance between product development and market development this can include:

- developing a marketing plan
- identifying potential customers
- assessing learning requirements of customers
- soliciting recommendations from customers
APPENDIX A

Proposed Energy (Alcohol) Budget

Reductions and Recissions
Details of Stockman’s energy budget proposals

The proposed Reagan/Stockman budget proposals, designed to substantially reduce federal spending, will clobber the alcohol fuels programs if Congress passes the cuts. The purpose of the cuts is to “refocus” the government’s role in energy research and development. According to Energy Secretary James B. Edwards, the government should only be involved with “long-term high risk activities” which promise high gains as well.

The budget proposals, written by OMB Director David Stockman, indicates that the Administration will no longer consider alcohol projects as high risk. Stockman says the technology has been demonstrated, and the price decontrol of oil has made alcohol fuels more competitive. He is therefore proposing the “termination of feasibility studies, cooperative agreements and loan guarantees for alcohol fuels and biomass energy development . . .”

Tax credits which can amount to $18/barrel will continue under Stockman’s plan, giving alcohol the competitive edge to match decontrolled oil.

The revised budget calls for the “rescission” of $745 million already appropriated. The figures are:

Alcohol Fuel Subsidies
(millions of dollars)

<table>
<thead>
<tr>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Budget authority</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Outlays</td>
<td>114</td>
<td>29</td>
<td>15</td>
<td>15</td>
<td>15</td>
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<tr>
<td>Policy reduction:</td>
<td>-745</td>
<td>0</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>Outlays</td>
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<td>-29</td>
<td>-13</td>
<td>-15</td>
<td>-15</td>
</tr>
<tr>
<td>Proposed budget:</td>
<td>-745</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tax credits &amp; excise tax exemptions for gasohol</td>
<td>292</td>
<td>431</td>
<td>628</td>
<td>900</td>
<td>1,065</td>
</tr>
</tbody>
</table>

The FmHA’s small-scale alcohol plant loan program will also feel the knife. The proposed budget calls for the elimination of the alcohol fuels and biomass loan program (see Steve Kopperud’s Washington Report in the last issue). This means the rescission of an unobligated $500 million. The figures are:

FmHA Loan Budget
(millions of dollars)

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>Budget authority</td>
<td>525</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Outlays</td>
<td>56</td>
<td>104</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Policy reduction:</td>
<td>-505</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Outlays</td>
<td>-46</td>
<td>-94</td>
<td>-3</td>
<td>-4</td>
<td>-3</td>
</tr>
<tr>
<td>Proposed budget:</td>
<td>20</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Outlays</td>
<td>10</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

A program that will not even see the light of day due to the cuts is the Solar Energy and Energy Conservation Bank. This program was designed to promote residential energy conservation and solar technology investments. The budget proposals say rising energy costs have already done this. “Therefore, implementing regulations have been withdrawn and will not be published, and no loan subsidies will be disbursed.” The appropriations were $121 for FY 1981, and set to rise to $166 million by 1986. Outlays were set at $47 million this year, rising to $162 million in 1986. But under the proposed budget, no money will be released.

The budget proposals call for the synfuels program to be put entirely under control of the Synfuels Corp. instead of being split between the corporation and the DOE. This will avoid the duplication of efforts. Stockman’s budget proposal said, which will save the taxpayer “a minimum of $2.7 billion over the next 5 years — and possibly twice that amount if project overruns follow historical patterns.” Shifting commercialization and demonstration activities to the new corporation will also avoid “pork barrel” politics, the report said.

Government financing of coal liquefaction and gasification projects will be terminated and interim funding will be rescinded, if the proposals are carried out. However, the Synfuels Corp. can start up the programs again if it believes they are worthy.

The figures for this proposal are:

DOE Synfuel Budget
(millions of dollars)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Budget authority</td>
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<td>858</td>
<td>1,064</td>
<td>362</td>
<td>140</td>
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<tr>
<td>Outlays</td>
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<td>864</td>
<td>859</td>
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<td>-1,064</td>
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<td>-864</td>
<td>-859</td>
<td>-676</td>
<td>-224</td>
</tr>
<tr>
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<td>-130</td>
<td>-170</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Outlays</td>
<td>-</td>
<td>-</td>
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</tr>
</tbody>
</table>

Another area to be curtailed is the Energy Information Agency’s (EIA) data and analytic services. The budget proposals explain that the service has tended to become more detailed and less meaningful. A cut in funding will force the agency to concentrate on basic oil, gas, coal and electrical data systems. The publications the agency will put out will be limited to only those of “proven value, such as the Monthly Energy Review . . .”

In the area of solar research, the Administration feels that increased oil prices have made this alternative more price competitive so, again, less financing will be required. The government assistance should be focused on long term research in high technology projects which may be “too risky for private firms to undertake.”

As part of the solar budget reduction, the Solar Energy Research Institute (SERI) has been put on a sort of notice. Funding for a permanent facility for the agency has been deferred “until the mission of the organization is better defined and an appropriate staffing level agreed upon.” What happens next to SERI is anybody’s guess. But it’s a sure bet it won’t be expanded.

Source: AG Energy, March 9, 1981
Vol 2, No. 9
APPENDIX B

Summary of State Tax Exemptions
## Summary of State Tax Exemptions

<table>
<thead>
<tr>
<th>State</th>
<th>Excise Tax</th>
<th>Sales, use or gross receipts</th>
<th>Property tax reduction**</th>
<th>Income tax reduction***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exemption for gasohol/gal.</td>
<td>Total tax/ gal. motor fuel</td>
<td>for exemptions for gasohol*</td>
<td></td>
</tr>
<tr>
<td>Alabama</td>
<td>3¢</td>
<td>11¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Alaska</td>
<td>8¢</td>
<td>8¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Arizona</td>
<td>0¢</td>
<td>8¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Arkansas</td>
<td>9.5¢</td>
<td>9.5¢</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>California</td>
<td>0¢</td>
<td>7¢</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Colorado</td>
<td>5¢</td>
<td>7¢</td>
<td>no</td>
<td>yes (98%)</td>
</tr>
<tr>
<td>Connecticut</td>
<td>1¢</td>
<td>11¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Delaware</td>
<td>0¢</td>
<td>9¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Florida</td>
<td>5¢</td>
<td>8¢</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Georgia</td>
<td>0¢</td>
<td>7.5¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Hawaii</td>
<td>0¢</td>
<td>11.5-15.0¢</td>
<td>yes (sales) (4%)</td>
<td>no</td>
</tr>
<tr>
<td>Idaho</td>
<td>4¢</td>
<td>9.5¢</td>
<td>no</td>
<td>yes (0.8%)</td>
</tr>
<tr>
<td>Illinois</td>
<td>0¢</td>
<td>7.5¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Indiana</td>
<td>0¢</td>
<td>8.5¢</td>
<td>yes (sales) (4%)</td>
<td>no</td>
</tr>
<tr>
<td>Iowa</td>
<td>10¢</td>
<td>10¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Kansas</td>
<td>4¢</td>
<td>8¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Kentucky</td>
<td>0%</td>
<td>9% of the avg. wholesale price</td>
<td>yes (sales) (5%)</td>
<td>yes (99%)</td>
</tr>
<tr>
<td>Louisiana</td>
<td>8¢</td>
<td>8¢</td>
<td>yes (sales)</td>
<td>no</td>
</tr>
<tr>
<td>Maryland</td>
<td>0¢</td>
<td>9¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>4¢</td>
<td>9.8¢</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Michigan</td>
<td>0¢</td>
<td>11¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Minnesota</td>
<td>4¢</td>
<td>11¢</td>
<td>no</td>
<td>yes (20%)</td>
</tr>
<tr>
<td>Mississippi</td>
<td>0¢</td>
<td>9¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Missouri</td>
<td>0¢</td>
<td>7¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Montana</td>
<td>7¢</td>
<td>9¢</td>
<td>no</td>
<td>yes (97%)</td>
</tr>
<tr>
<td>Nebraska</td>
<td>5¢</td>
<td>10.4¢ and 2% of the average state wide cost of fuel.</td>
<td>no</td>
<td>no</td>
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<tr>
<td>Nevada</td>
<td>0¢</td>
<td>6¢</td>
<td>no</td>
<td>no</td>
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<tr>
<td>New Hampshire</td>
<td>5¢</td>
<td>11¢</td>
<td>no</td>
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<tr>
<td>New Jersey</td>
<td>0¢</td>
<td>8¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>New Mexico</td>
<td>8¢</td>
<td>8¢</td>
<td>yes (3%) (gross receipts)</td>
<td>no</td>
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<tr>
<td>New York</td>
<td>0¢</td>
<td>8¢</td>
<td>no</td>
<td>no</td>
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<tr>
<td>North Carolina</td>
<td>4¢</td>
<td>9¢</td>
<td>no</td>
<td>yes (20%)</td>
</tr>
<tr>
<td>North Dakota</td>
<td>4¢</td>
<td>8¢</td>
<td>yes (sales)</td>
<td>no</td>
</tr>
<tr>
<td>Ohio</td>
<td>0¢</td>
<td>7¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>6.5¢</td>
<td>6.58¢</td>
<td>no</td>
<td>yes (100%)</td>
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<tr>
<td>Oregon</td>
<td>0¢</td>
<td>7¢</td>
<td>no</td>
<td>yes (100%)</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>0¢</td>
<td>11¢</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>South Carolina</td>
<td>5¢</td>
<td>11¢</td>
<td>no</td>
<td>no</td>
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### Summary of State Tax Exemptions - Continued

<table>
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<tr>
<th>State</th>
<th>Excise Tax Exemption for gasohol/gal.</th>
<th>Total tax/gal. motor fuel</th>
<th>Sales, use or gross receipts for exemptions for gasohol*</th>
<th>Property tax reduction**</th>
<th>Income tax reduction***</th>
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</thead>
<tbody>
<tr>
<td>South Dakota</td>
<td>4-5¢</td>
<td>12-13¢</td>
<td>yes (use) (4%)†</td>
<td>yes (100%)†</td>
<td>no</td>
</tr>
<tr>
<td>Tennessee</td>
<td>7¢</td>
<td>7¢</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Texas</td>
<td>0¢</td>
<td>5¢</td>
<td>yes (4%)†</td>
<td>yes, (100%)†</td>
<td>no</td>
</tr>
<tr>
<td>Utah</td>
<td>5¢</td>
<td>9¢</td>
<td>no</td>
<td>no</td>
<td>yes†</td>
</tr>
<tr>
<td>Vermont</td>
<td>0¢</td>
<td>9¢</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Virginia</td>
<td>0¢</td>
<td>11¢</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Washington</td>
<td>1.8¢</td>
<td>12¢</td>
<td>yes (sales &amp; use) (4, 5%)†</td>
<td>yes†</td>
<td>no</td>
</tr>
<tr>
<td>West Virginia</td>
<td>0¢</td>
<td>10.5¢</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>0¢</td>
<td>9¢</td>
<td>no</td>
<td>no</td>
<td>yes†</td>
</tr>
<tr>
<td>Wyoming</td>
<td>4¢†</td>
<td>8¢</td>
<td>yes (sales) (3%)</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

* Sales, use and gross receipts tax exemptions—Percent listed is the sales tax rate in that state. In all cases, the entire amount of the tax is exempted.

** Property tax reduction—The percent listed equals the percent of the state property tax applicable to qualifying fuel alcohol production facilities which is exempted.

*** Income tax exemptions, credits and deductions—The percent listed equals the percent of the exemption, deduction, or credit with respect to taxable income attributable to qualifying fuel alcohol production.

1. The enabling legislation contains a decreasing scale, sunset provision, an expiration date and/or a maximum ceiling provision which limits the total amount of excise tax refunds which the state can lose as a result of the gasohol excise tax exemption.

2. Gasohol’s exemption is restricted in some manner to alcohol produced from state crops, produced within the state or blended within the state.

3. Applies to agricultural use only.

4. Includes only unmixed ethyl and methyl alcohol.

5. If production does not exceed 1000 gallons annually.


7. The corporate income tax reduction is based on the amount of property taxes paid by producers of fuel alcohol for production costs incurred in the manufacture of fuel alcohol.

8. An additional 10% income tax reduction is credited to those producers of fuel alcohol whose distilleries are powered primarily by the use of an alternative fuel source.

9. A 1/8 cent sales tax charge is levied on gasohol exempted from the 3% state sales tax.

10. No standard amount of reduction is stated in the law. Certain business expenses incurred in the production of fuel alcohol qualify as deductions in the calculation of the producer’s next corporate income tax.

11. A gross income tax deduction for a coal conversion system to process coal into liquid fuel applies only to those who receive the federal depreciation deductions for a coal conversion system.

12. The law provides for both corporate and personal income tax reductions.

13. A 9 cent excise tax exemption is provided for nonanhydrous alcohol which is not used for sale or distribution.

14. The exemption only applies when the gasohol is used for agricultural or industrial purposes.

15. 100% income tax exemption—applies only to alcohol fuels production.

16. 50% investment tax credit—applies to all alternative energy development projects.

17. The exemption only applies to the purchase of equipment used in the production of ethyl alcohol.

18. This exemption includes leasehold tax exemptions.

19. A 2 cent increase in the gasoline excise tax is imposed in Northern Virginia.

APPENDIX C

List of Manufacturers
## APPENDIX C

**List of Manufacturer's**

<table>
<thead>
<tr>
<th></th>
<th>Manufacturer</th>
<th>Address</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ACR Process Corp.</td>
<td>602 E. Green St. Champaign, IL 61820</td>
<td>Rob Chambers/John Chambers</td>
</tr>
<tr>
<td>2</td>
<td>Acme International Equip. &amp; Supply Co. Inc.</td>
<td>Box 6097 Spartanburg, SC 29304</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Agri-Fuel Corp.</td>
<td>200 Market Bldg., Suite 961 Portland, OR 97201</td>
<td>(503) 223-6660 Tim Casey</td>
</tr>
<tr>
<td>4</td>
<td>Agri-Fuel</td>
<td>P.O. Box 26581 Denver, CO 80226 (303) 989-3343</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Agri-Fuel Equipment Co.</td>
<td>R # 2, Box 132 Marshfield, MO 65706</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Agrihol Inc.</td>
<td>Box 18 Rosholt, SD 57260 (605) 537-4252</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Agri Stills of America</td>
<td>3550 Great Northern Ave. RR #4 Springfield, IL 62707</td>
<td>(217) 787-4233 Dole Deverman</td>
</tr>
<tr>
<td>8</td>
<td>Agri-Systems International</td>
<td>2301 Independence Blvd. Kansas City, MO 64124</td>
<td>(816) 231-6990 Jim Dunham</td>
</tr>
<tr>
<td>10</td>
<td>Alcodynamics Corp.</td>
<td>Box A, 30 School St. Carlisle, IA 50047</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Agrodyne, Inc.</td>
<td>P.O. Box 934 Idaho, Falls, ID 83401 (208) 524-1000 Don Curet/Steve Winston</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Alcohol Technology, Inc.</td>
<td>Box 1489 Rockdale, TX 76567 (512) 446-6777 G. Jones</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Alcogas</td>
<td>5200 S. Quebec, Suite 201 Englewood, CO 80111 (303) 770-9667 Evan Goulding, Pres.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Alcohol Fuels</td>
<td>Franklin, NE 68939 (308) 425-6575 Bryan Hayes</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Alcohol Fuel Works</td>
<td>8549 Sunset Ave. Fun Oaks, CA 95628 (916) 961-2896 Dean Hock</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Alcohol Plant Supply Co.</td>
<td>P.O. Box 248 Sherwood, OR 97140 (530) 244-3230 Carl Santesson</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Alcohol Power Consultants</td>
<td>Rural Route Linden, IA 50146 (515) 744-2086 Tim Woodvine</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Alcohol Production Engineering Co.</td>
<td>7201 West Vickery St. Ft. Worth, TX 76116 (817) 731-4121</td>
<td></td>
</tr>
</tbody>
</table>
Exhibit 1 (Con'd)

19. Alcohol Technology Inc.  
Box 1489  
Rockdale, TX 76567  
(512) 446-67-7

20. Alternative Energy Systems  
423 Smith Dr.  
Colby, KS 67701  
(913) 462-7171  
Don Smith

21. Amber Laboratories  
6101 N. Tentonia Ave.  
Milwaukee, WI 53209  
(414) 462-3700

22. American Alcohol Equipment  
Div. of American Agri-Fuels Corp.  
1006 Grand Ave.  
Kansas City, MO 64106  
(816) 221-0070

23. American Alloy Steel Inc.  
Dept. TR  
2070 Steel Dr.  
Tucker, GA 30084  
(404) 934-1681

604 E. Eisenhower  
Loveland, CO 80537

25. APV Company Inc.  
395 Filmore Ave.  
Tonawanda, NY 14150  
(716) 692-3000  
Leonard Stiel

26. Arlon Industries Inc.  
P.O. Box 347  
Sheldon, IA 51201  
David Vandergreen

27. Berreau Industries Inc.  
Box 5  
Round Lake, MN 56167

28. Biosyntheties Inc.  
6811 Maryland Ave.  
Braddock Heights, MD 21714  
(301) 371-9153  
Anthony E. Clifford

29. Bahler Bros. of America Inc.  
1625 W. Belt N.  
Houston, TX 77043  
(713) 465-8376  
Alexander Allen

30. Brannom, Champ & Wimbash Inc.  
6755 Peachtree Industrial Blvd #108  
Atlanta, GA 30360  
(404) 449-3333  
Ralph Sorota

31. Bryant-Poff Inc.  
Coatesville, IN 46121

32. E. G. Carlson  
Omaha, NE  
(402) 345-3090  
Elmer Carlson

33. CCI Industries  
27 West 990 Industrial Rd.  
Barrington, IL 60010  
(312) 381-7441  
Larry Hogan

34. Chemape Inc.  
230 Crossways Park Dr.  
Woodbury, NY 11797  
(516) 364-2100  
Rene Loser, Mgr.

35. Chem-Pro Equip. Corp.  
27 Daniel Rd.  
Fairfield, NJ 07006  
(201) 575-1924

36. Clary Corp.  
917 Parkway Dr.  
Grand Prairie, TX 75051  
(214) 647-4156
37. Conklin Co. Inc.
Valley Industrial Park
Shakopee, MN  55379
(612) 831-4044
Jim Leonard

38. Conrad Industries
Box 130
Bonapart, IA  52620
(319) 592-3131
Cliff Briworth, Consultant

39. Double A Products Co.
P.O. Box 1107
Highway 65 South
Albert Lea, MN  56007
(507) 373-1458
Dale Drommer Hausen

40. Double L Mg. Inc.
P.O. Box 533
American Falls, ID  83211
(208) 226-5592

41. Easy Engineering Inc.
3353 Larimer St.
Denver, CO  80205
(303) 893-8936
Richard Stewart, Pres.

42. Ecothermia Inc.
550 12th St., Suite 1801
Denver, CO  80203
Lloyd Lore Wartes, VP

43. Elwood Energy Inc.
P.O. Box 321
Plainfield, IL  60544
(815) 436-7463

44. Endless Energy
P.O. Box 1508
Palson, MT  59860
(406) 883-4314
Gordon Harding, Mgr.

45. Energy Independence Corp.
Box 389
Montrose, MN  55349
(612) 543-3277
Jack Harmon

46. Energy Restoration Inc.
1201 J. St., Suite 101
Lincoln, NE  68508
(402) 475-9237
Richard Goos, Pres.

47. Energy Stills Corp.
4200 S. Louise, Suite 303
Sioux Falls, SD  57106
(605) 331-2555
Robert Hoff, Pres.

48. Ethanol International Inc.
1372 S. Filmore
Denver, Co.  80210
(303) 744-8355
Stephen Munson

49. Farm Fuels Inc.
621 17th St., Suite 811
Denver, Co  80202
(303) 892-6624
Thomas E. Voss

50. Gletsch Inc.
Box 226227
Dallas, TX  75266
(214) 631-8341
Bird Claymer

51. Harrison & Ellis Corp.
P.O. Box 528
Cairo, GA  31728
(912) 377-4482
J. A. (Jack) Funderburk, Mgr.

52. Hot Energy Shoppe
490 West 300 South
Provo, Utah  84601
(801) 377-8130
Joe Andrews
<table>
<thead>
<tr>
<th>No.</th>
<th>Company Name</th>
<th>Address</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td>International Fuel Systems</td>
<td>P.O. Box 7232, Overland Park, KS 66207</td>
<td>(913) 341-8211</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Larry Merlott</td>
</tr>
<tr>
<td>55</td>
<td>Industrial Denver</td>
<td>5717 6th Ave. W., Denver, CO 80214</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>Industrial Innovators</td>
<td>P.O. Box 387, Ashford Plaza Shopping Center, Ashford, AL 36312</td>
<td>(205) 899-3314</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vernon Haines</td>
</tr>
<tr>
<td>57</td>
<td>Inprotec</td>
<td>Tyler, TX</td>
<td>(214) 597-0596</td>
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<tr>
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<td>Tony Cheavens</td>
</tr>
<tr>
<td>58</td>
<td>International Fuel Systems</td>
<td>Box 7232, Overland Park, KS 66207</td>
<td>(913) 341-8211</td>
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<tr>
<td>59</td>
<td>KSI Assoc. Energy Conserving</td>
<td>RRI Box 19, Minong, WI 54859</td>
<td>(715) 466-4468</td>
</tr>
<tr>
<td></td>
<td>Products International</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>L &amp; A Engineering Inc.</td>
<td>4124 S. Soderquist Rd., Turlock, CA 95380</td>
<td>(209) 632-3191</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Doug Barth</td>
</tr>
<tr>
<td>61</td>
<td>Lane Fuel Systems</td>
<td>Box 952, Adrian, MI 49221</td>
<td>(517) 263-8474</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wm. J. Check, VP</td>
</tr>
<tr>
<td>62</td>
<td>Lucas Engineering Inc.</td>
<td>4205 Fox St., Denver, CO 80216</td>
<td>(303) 458-7460</td>
</tr>
<tr>
<td>63</td>
<td>Mandrl Corp.</td>
<td>Colorado Technical Center, 12687 W. Cedar Dr., Lakewood, CO 80228</td>
<td>(303) 989-7155</td>
</tr>
<tr>
<td>64</td>
<td>Malsbary Mfg. Co.</td>
<td>RR 119, P.O. Box 546, Uniontown, PA 15401</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>Middle States Mfg. Co.</td>
<td>16th Ave., Box 788, Columbus, NE 68601</td>
<td>(402) 546-1411</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Jerry Joseph</td>
</tr>
<tr>
<td>66</td>
<td>MRC Energy Systems</td>
<td>R#2, Box 399, Plymouth, IN 46563</td>
<td>(219) 784-8500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mike Kelley, Mgr.</td>
</tr>
<tr>
<td>67</td>
<td>Marlin Can Care Inc.</td>
<td>Highway 6 N, Box 1009, Marlin, TX 76661</td>
<td>(817) 883-3491</td>
</tr>
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<td></td>
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<td>Del Spreckles, Mgr.</td>
</tr>
<tr>
<td>68</td>
<td>McCrabb Mfg. Inc.</td>
<td>109 N. Miller St., P.O. Box 318, West Liberty, IA 52777</td>
<td>(319) 627-2158</td>
</tr>
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<td></td>
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<td></td>
<td>Jim McCrabb, Pres.</td>
</tr>
<tr>
<td>69</td>
<td>Metalcrafts Inc.</td>
<td>P.O. Box 1665, Savannah, GA 31402</td>
<td>(912) 236-0615</td>
</tr>
<tr>
<td>70</td>
<td>Nabal Ltd.</td>
<td>Box 82842, Lincoln, NE 68501</td>
<td>(402) 475-7671</td>
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<td>Don Dunn, Mgr.</td>
</tr>
<tr>
<td>71</td>
<td>N &amp; M Sales</td>
<td>12483 So. Hwy. 285, Alamosa, CO 81101</td>
<td></td>
</tr>
</tbody>
</table>
P.O. Box 282  
Mountain Home, OR 72653  
(501) 492-6494

73. Osage Plains Inc.  
P.O. Box 287  
Butler, MO 64730  
(816) 679-3842  
Rob Leslie

74. RB Industries  
Riverdale, MI 48877  
(513) 833-7584  
Bill Kanitz

75. Reversible Energy System  
Kleinfeltersville, PA 17039  
(717) 949-3077  
Floyd Horst

76. Rochelle Energy Development  
Box 356  
Rochelle, IL 61068  
(815) 562-7372  
John Askvig

77. Revenoor Inc., The  
Box 185  
LaCenter, WA 98629  
(206) 263-2200  
Jerry Walstead

78. SEI Corporation  
54-45 44th St.  
Maspeth, NY 11378

79. Seven Energy Corp.  
11901 W. Cedar Ave.  
Lakewood, CO 80226  
(303) 989-7777  
Ernest Barcell

80. Shur Steello  
1607 SW Spokane St.  
Portland, OR 97202  
(503) 231-1130  
Nick Shur

81. Silver Engineering Wks Inc.  
3309 Blake St.  
Denver, CO  (303) 623-0211  
Richard Smith

82. Solar Fuel Co.  
Box 423  
Dubuque, IA 52001

83. Solargizer International Inc.  
Box 20142  
Bloomington, MN 55420  
(612) 888-0018  
Bob Thornberg

84. Tailor, John Co.  
Bettendorf, Iowa  
John Tailor

85. Tallgrass Research Center  
Formoso, KS 66942  
(913) 794-2236

86. Tri-Star Corp. (Freedom Still)  
Route 3, Illinois Ave.  
Vandolia, IL 62471  
(681) 283-1666

87. 3T Engineering Inc.  
P.O. Box 80  
Arentzville, IL 62611  
(217) 997-2188

88. Union Development Co.  
4608 S. Garnett Rd. # 409  
Tulsa, OK 74145

89. United International Inc.  
P.O. Box 11  
Buena Vista, GA  
(912) 649-7444

90. United States Alcohol Corp.  
6410 Rockledge Dr., Suite 201  
Bethesda, MD 20034  
(301) 897-8900
Exhibit 1 (Con'd)

91. U.S. Alcohol Corp.  
   6565 Carperter St.  
   Marlette, MI 48453  
   (517) 635-3484

92. U.S. Fuels  
   Barnesville, FA 30204

93. U.S. Soil Inc.  
   P.O. Drawer 926  
   Salida, CO 81201  
   (303) 539-3535

94. Vendome Copper & Brass Wks Inc.  
   N. Shelby St.  
   Louisville, KY 40202  
   (502) 587-1930  
   Tom Sherman

95. Vera International Inc.  
   Gulf & Western Plaza  
   1201 19th Place  
   Vero Beach, FL 32960  
   (305) 567-1320

96. Victory Still Inc.  
   3317 Tait Terrace  
   Norfolk, VA 23513  
   (804) 855-7110

97. Vulcan Cincinnati Inc.  
   2900 Vernon Place  
   Cincinnati, OH 45219  
   (513) 281-2800

98. Wenger Alko-Vap Systems  
   904 Oakdale Court  
   Holland, MI 49423  
   (616) 399-2436  
   Harvey Wenger

99. Wessels, Inc.  
   305 E. Main St.  
   Cedar Falls, IA 50613  
   (319) 277-4315  
   Duane Wessels

100. Alcohol Equipment Corporation of America  
    Ephrata, WS 98823