Gasohol is a mixture of one part ethanol (commonly known as grain alcohol" or beverage alcohol) and nine parts unleaded gasoline. The ethanol can be produced from several types of plant material using technology that is currently available, and in most cases gasohol can be substituted for gasoline with only minor changes in mileage and performance. Another type of gasohol can be produced with one part methanol ("wood alcohol" or methyl alcohol) and nineteen parts gasoline. Although a consideration of this fuel is not included here, methanol fuel will be included in the later report on Energy from Biological Processes.

This memorandum addresses the major technical, economic, environmental and social factors related to gasohol production and use. It also contains a summary of the current federal gasohol programs and policies but does not include an analysis of policy options. The most important points developed in this report are summarized below as brief discussions of crucial questions.

- WILL USING GASOHOL SAVE GASOLINE?

The amount of premium fuels (oil and natural gas) displaced by ethanol depends critically on the boiler fuel used at the ethanol distillery and the way the ethanol is used in gasohol. The distillery producing most of the fuel ethanol today uses natural gas as a boiler fuel and the ethanol is used to produce a high octane gasohol. Because local conditions enable this distillery to be particularly energy efficient, the use of gasohol made this way currently saves 1/3 gallon of gasoline and natural gas energy

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equivalent for every gallon of ethanol (i.e., for every ten gallons of gasohol). Less energy efficient distilleries fueled with premium fuels, however, could result in a net increase in premium fuel usage with gasohol production.

If distilleries are fueled with coal and solar energy (including biomass), and the ethanol is used to produce a “regular’’-grade gasohol, however, the energy balance is far more attractive. Under these more optimum conditions, gasohol use may save nearly one gallon of gasoline and natural gas equivalent for every gallon of ethanol used.

- HOW MUCH GASOHOL CAN BE PRODUCED?

In the 1980's there is the physical - though not necessarily economic - possibility of producing at least 5-10 billion gallons of ethanol per year, mostly from increased crops devoted to ethanol production. (This corresponds to 325,000-650,000 bbl./day or 4.5-9% of the current gasoline consumption of 110 billion gallons per year.) In the 1990’s, however, the available land for energy crops could drop to a point where only about one third this amount could be produced. In addition, using conversion technologies currently under development, there is the physical possibility of producing 5 billion gallons of ethanol per year from crop residues, 10-20 billion gallons per year from increased forage grass production, and considerably more from wood. Due to a variety of factors, however, gasohol’s practical potential will undoubtedly be considerably less than that which is physically possible.

Gasohol's practical potential depends on the time frame. In the next 3-5 years, domestic gasohol production will be limited primarily by the rate that new distilleries are built and idle capacitv converted. Conversion should bring the fuel ethanol capacity to an estimated 40-90 million gallons per year by the end of 1980. This would yield 400-900 million gallons of gasohol per year compared to the current levels of 150-200 million gallons.

If gasohol is produced using coal or other non-premium fuels to supply energy for the distillation plant and marketed as a "regular''-grade transportation fuel, currently planned ethanol capacity could save 35-80 million gallons of gasoline and natural gas energy equivalent per year by the end of 1980 (2,300-5,200 bbl./day or 0.03-0.07% of current gasoline consumption.>

In addition to domestic production, there are plans to import 120 million gallons of ethanol per year from Brazil which would displace about 95 million gallons per year (6,000 bbl./day or 0.09% of current consumption) of gasoline. These imports would also increase the annual U.S. trade deficit by at least $50 million.

Because there is a 2 year lead time for distillery construction and start-up, the capacity that will come on line in 1981 depends on the current rate of investment in new distilleries. Although the available information is incomplete, there are at least 50-70 million gallons per year of new capacity which are under study or have been ordered.

Within the next decade, gasohol production could be limited by

feedstock supply.

The longer term future of gasohol is still less assured. Future production costs are highly uncertain, due to uncertainties in future farm commodity prices, feedstock availability, and the cost of conversion processes using alternative feedstocks such as crop residues, grasses, wood and municipal solid waste. In addition, the development of less expensive octane boosters, or engine improvements which reduce the need for high octane fuels, could jeopardize the utility of ethanol as an octane booster. This would alter the economics of fuel ethanol use and could reduce the demand.

These and other uncertainties may limit investment in ethanol distilleries to a total production level below that which is physically possible and can be sold profitably in the 1980's. It is equally possible that federal and state incentives may encourage the development of a large scale ethanol industry whose output may be difficult to market in the 1990's0

For these reasons, both the level of fuel ethanol production that will be achieved and the long term stability of price and demand are highly uncertain.

o WILL GASOHOL PRODUCTION COMPETE WITH FOOD AND FEED PRODUCTION?

There are numerous sources of ethanol feedstocks, including food processing wastes, spoiled grain, and various substitutions among agricultural products which can free land for energy crop production. 1-2 billion gallons of ethanol per year (l-2% of current gasoline consumption)

can probably be produced without a significant impact on food and feed , prices. Beyond this ethanol production level, new cropland would have to be brought into production, and the farm commodity prices necessary to induce this land conversion are highly uncertain. Consequently, ethanol production levels significantly larger than 1-2 billion gallons per year if derived from food cropland, could lead to strong inflationary trends in food and feed markets, which would be a substantial indirect cost of ethanol Production.

In the 1990's however. ethanol may be able to be Produced competitively from cellulosic feedstocks (e.g., crop residues and wood), which would have little impact on food prices.

- WHAT ARE THE COSTS?

Depending on the method of financing, distilleries should be able to sell ethanol (from $2.50/bu. corn) at between $0.91 and $1-11 per gallon plus delivery (currently $.10 to $.30 per gallon for stations outside the distillery's immediate locale). Due to the strong demand created by federal and state subsidies (totalling $0.40-$1.10 per gallon or $16.80-$46.20 per bbl. of ethanol) and intangible factors, ethanol was being sold for as much as $1.70 per gallon (F.O.B. the distillery) in June and July, 1979.

Gasohol wodd be competitive with gasoline costing the service station owner $070/gallon (i.e., retail gasoline at about $0.99/gallon) if the ethanol costs $0.90-$1.00/gallon. With only the federal subsidy ($.04/gallon of gasohol or $16.80/bbl. of ethanol), gasohol can now compete

$1.30-$1.40 per gallon.

The current federal subsidy is adequate (although marginally so in some cases) to allow gasohol to compete with gasoline at today's ethanol production costs and gasoline prices.

It should be noted that current gasohol subsidies apply to imported as well as domestic ethanol, and the state plus federal subsidies on the planned imports of ethanol (120 million gallons per year) would amount to $50-$130 million per year.

- CAN FARMERS PRODUCE THEIR OWN FUEL ON-FARM?

It is technically quite simple to produce ethanol containing 5% or more water on-farm. This alcohol could be used as a supplement to diesel fuel in retrofitted diesel engines, but even under favorable conditions the cost of the ethanol is about twice the current cost of the diesel fuel it would displace. Cost estimates significantly below this have been popular, but are based on questionable assumptions.

With slightly more sophisticated equipment, dry ethanol suitable for use in gasohol could be produced. On-farm production of dry ethanol could become competitive with commercially distilled ethanol if relatively automatic and inexpensive mass produced distilleries were available and if farmers charge little for their labor. As an economically profitable venture, however, on-farm ethanol production is, at best, marginal under present conditions.

For some farmers the cost and/or labor required to produce dry or

wet ethanol may be of secondary importance. The value of some degree of energy self-sufficiency and the ability to divert limited quantities of corn and other grains when the price is low may outweigh the inconvenience and cost. As evidence, the Bureau of Alcohol, Tobacco, and Firearms expects to receive over 5000 applications for on-farm distillation permits this year.

- WHAT ARE THE ENVIRONMENTAL IMPACTS?

All components of a gasohol "fuel-cycle" - growing and harvesting the biomass feedstock, converting it to alcohol, and using the gasoline/alcohol blend in automobiles - have significant environmental effects.

The choice of ethanol feedstock is the most critical factor determining the environmental impact of gasohol. As ethanol production grows beyond the feedstock capacity of surplus and waste materials, new land may be placed into intensive cultivation to provide additional feedstocks. If corn is the primary gasohol feedstock, the result will be a substantial increase in soil loss as well as fertilizer and pesticide use as millions of additional acres are put into production. The choice of other feedstocks will drastically alter these impacts; for example, using perennial grasses would considerably decrease erosion damages.

The major impact of alcohol distilleries -- potential degradation of water quality from the waste stillage" -- can be prevented by byproduct recovery or waste treatment.

Despite claims of strong air quality benefits, gasohol use in automobiles appears to have a very mixed effect on automotive pollution. It

is difficult to categorize the overall effect as either positive or negative, although carefully programmed use in selected locations (e.g., areas with high carbon monoxide concentration but no smog) or in selected segments of the automobile fleet (e.g., very richly tuned fleets in areas where hydrocarbons are more of a problem than oxides of nitrogen) may have unambiguously positive results.

- WHAT ARE THE SOCIAL IMPACTS?

The predominant social and economic impacts of gasohol production are the potential for new on-farm and other rural employment opportunities and the possibilities of conflicts between food and energy uses of cropland. The pace of development and the quantity of ethanol produced will be critical determinants of the social impacts. If the demand for fuel ethanol increases beyond the supply of feedstocks, competition between energy and food uses of land could result in more rapidly rising food prices and, eventually, more rapidly rising land prices. This would benefit landowners, but would hurt farmers who rent their land or who want to expand their holdings. Low and middle income groups would bear the greatest share of these costs. Although farming groups have supported gasohol initiatives in the hope that increased demand for corn would raise prices, historic experience indicates that rising land prices would absorb much of the profit.

If the demand for gasohol rises gradually and market imbalances are avoided, the overall social and economic impacts of fuel ethanol production could be strongly positive. On-farm and distillery employment could stabilize those rural communities which are currently experiencing unemployment problems.