RESOURCE SYSTEMS GROUP
INCORPORATED

ECONOMIC IMPACT OF FUEL ETHANOL FACILITIES IN THE NORTHEAST STATES

Prepared for:

Northeast Regional Biomass Program

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EXECUTIVE SUMMARY

Resource Systems Group, Inc. under contract to the Northeast Regional Biomass Program, has prepared a study of the economic impacts of the fuel ethanol production in the Northeast States. This report provides an estimate of the expected economic impact of ethanol and evaluates the possible future economic impacts of ethanol production under three scenarios for development of the industry. The study is generally applicable to the northeastern states but specific quantitative analysis of impacts are provided for those states which are considered to be most likely candidates for near term development of ethanol facilities. These are the states of Maine, New Hampshire, New York, New Jersey, and Pennsylvania.

The results of the study of the economic impact of fuel ethanol plants in these states are based on a hybrid input/output model of the ethanol industry and the state economies. The input for the model is the estimated expenditures of ethanol plants on construction and operation. The results are given as estimated changes in income, jobs, and state taxes in each state as a result of specified levels of ethanol production.

The results show that in all cases construction of ethanol plants results in large short term increases in employment and income. The construction of a 50 million gallon per year wood to ethanol plant would generate between $170 million to over $200 million in income and create from 4000 to 6000 jobs depending on the state and the type of plant. The construction cost of corn-based ethanol plants will be lower and corn plants if constructed are expected to be smaller in size. Therefore the jobs and income generated during construction will also be lower.

The economic impact of the operation of the plants are more important because they provide permanent jobs and income over the lifetime of the plant and therefore have greater impact on the communities where they are located and on the state economy.

The results of the study of operational economic impacts lead to several conclusions as follows:

- Ethanol plants using purchased wood, cellulose materials, and corn all have substantial net positive impacts on the state economy in terms of income, jobs, and state tax revenues. A 50 million gallon per year wood ethanol plant would generate from $41 to $48 million per year in income, 540 to 830 jobs, and $1 to $ 3 million in state taxes depending on the state and other factors. Most of the impacts are related to the purchase of the wood feedstock. Lower cost wood or other lower-cost cellulose residues produce comparable but proportionally lower impacts when compared to higher-cost wood.

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- Under the highest production scenario evaluated, at 100 million gallons per year for each state, wood-based ethanol plants are estimated to generate from $65 to 95 million in income, 950 to 1650 jobs and $2 to $6 million in state taxes annually.

- Ethanol plants using corn as a feedstock would also generate net positive impacts on the state economies at income and tax revenue levels comparable to wood, but corn plants are estimated to generate more jobs. It is not clear if corn-based ethanol plants can compete with very large plants in the mid-western states where the corn prices are lower than in the northeastern states
- Ethanol plants using municipal solid waste and sewage that charge a disposal fee generate much lower levels of income, jobs, and state taxes. When displacements of income and jobs from other solid waste processing facilities are considered, waste to ethanol plants may under some circumstances bring about a net reduction in state income, jobs, and taxes.
- The effect of a state-level ethanol production subsidy from state revenues is to lower the net economic impacts of the plant. The break even point at which net state tax revenues are eliminated by the cost of the production subsidy ranges from 2.2 cents per gallon for New Hampshire to 5.7 cents per gallon for New York. This variation is primarily due to differences in state tax rates and structures.

Initial development of ethanol facilities in the region are likely to be smaller niche plants that take advantage of the availability of low cost feed stocks or existing plant infrastructure. These plants may not therefore generate such high levels of income, employment and taxes as facilities that purchase feed stocks at market prices. Individual projects should be evaluated with site specific and technology specific cost data in order to determine the economic impacts at the state and local level.

1 INTRODUCTION AND PURPOSE OF THE STUDY

Resource Systems Group, Inc. under contract to the Northeast Regional Biomass Program, has prepared a study of the economic impacts of the fuel ethanol production in the Northeast States. This report provides a description of the current situation with respect to the development and economic impact of ethanol and evaluates the possible future economic impacts of ethanol production under three scenarios for future development of the industry. The study is generally applicable to the northeastern states but specific quantitative analysis of impacts are provided for those states which are considered to be most likely candidates for near term development of ethanol facilities. These are the states of Maine, New Hampshire, New York, New Jersey, and Pennsylvania.

The purpose of the study is to provide a credible estimate of the direct and indirect economic impacts of the production of fuel ethanol at the state and local level. Economic impacts are quantified in terms of jobs, income, and state taxes. The study also considers, as far as possible, the economic impacts of displacements of other economic activities, the possible effects of potential ethanol subsidies, and the short-term construction phase impacts. Second order economic consequences such as those arising from competition between ethanol facilities and other businesses for raw materials, land and labor are identified. As a supplement to this analysis, a project specific model has been developed which will make it possible to estimate the state wide impacts of specific projects in the five states when project plans have advanced to the stage that project expenditures are known in more detail.

1.1 BACKGROUND

Fuel ethanol production capacity in the United States has grown to 1.9 billion gallons in 2000. Approximately 12 % of all gasoline sold in the US now blended with ethanol. There are 56 fuel ethanol plants with the greatest concentration of plants found in the corn-belt states of the Mid-west. Most of the production capacity is dependent on corn as the feedstock although other grains, and food and brewery wastes are used. There is one plant using waste paper. The production of ethanol continues to grow and the prospect of a phase out of the use of MTBE in reformulated gasoline and current high oil prices are creating the expectation of substantial further increases in demand for ethanol both as an oxygenate and as a gasoline substitute. Ethanol blended gasoline is available in the Northeast and the demand for additional ethanol in the Northeast is expected to increase substantially in the near future.

There are no commercial fuel ethanol plants in the northeastern states, although there is active interest in developing plants in Maine, New Hampshire, New York, New Jersey, and Pennsylvania. The proposals range from a small conventional dry mill corn-based facility to advanced technology wood and cellulose-based systems employing enzymatic hydrolysis. There is also a proposal for converting a brewery and a plan for a new technology ethanol plant using municipal solid waste. Most of the proposed facilities for the northeastern states can be described as niche facilities which will capitalize on the existence of a previously unused or underused raw material base or may use existing capital equipment to

lower plant costs. The niche characteristics of most of the existing plans make it difficult to generalize about the potential economic impact of ethanol in the northeastern states.

Within the Northeast the most advanced plans at this time are for a solid waste and sewage sludge treatment facility that will produce 9.5 million gallon per year of fuel ethanol from the cellulose material in the waste. This facility is proposed by Masada Corporation for Middletown, New York. At the present time only limited economic information is available for this plant and therefore it is not possible to determine what spending may be attributable to the ethanol production component of this proposed multiple material waste processing system.

1.2 TECHNOLOGIES AND IMPLICATIONS FOR ECONOMIC IMPACT

There are two basic types of technology that have been proposed for ethanol production from biomass in the northeastern states. These are the more conventional corn or starch based systems and cellulose based systems. The main difference between the two processes is that cellulose based systems involve a hydrolysis step prior to fermentation.

Conventional fuel ethanol technology that currently provides most of the commercial fuel ethanol in the United States uses corn as a feedstock. Both wet mill and dry mill corn processes are used for fuel ethanol production and both produce approximately 2.5 gallons of ethanol per bushel of corn. The wet mill process soaks the corn kernels so that the components can be separated. The starch is used for fermentation to produce ethanol and other components are used to produce corn oil, protein gluten meal, protein gluten feeds and other products. The ethanol is then distilled and purified to fuel grade. Wet mills are typically larger in size and produce a wider range of products than dry mills. In consequence they are potentially more flexible and more profitable although they require greater capital and more marketing of the wider range of products. Because wet mills are usually operated as integrated multi-product businesses, it is more difficult to calculate how much of the economic impact of a plant is due to ethanol when compared to other products.

In the dry mill process the corn is ground to a flour that includes the starch which is fermented to produce ethanol. The ethanol is distilled and the residual material is dried to produce a protein rich product sold as distillers dry grains (DDGs) used as a food supplement or for animal feeds. Dry mills are simpler, less capital intensive and can be much smaller in size than wet mills. The dry mill however has a smaller range of products and less flexibility in its revenue. Its operations are thus more dependent on ethanol sales.

Cellulose-based ethanol production can use many types of cellulose raw materials including wood, wood waste, straw, grass, corn stover, crop residues, paper, paper and pulp waste, and parts of municipal solid waste. The process involves dilute acid prehydrolysis of the cellulose raw material and detoxification of the hydrolysate, followed by enzymatic saccarification to convert the cellulose and hemicellulose to sugars, fermentation of the sugars to ethanol, and distillation and purification of the ethanol to fuel grade. The residuals include waste water, which is treated with aerobic and anaerobic digestion to produce biogas. The biogas along with other residuals is burned in a boiler to produce steam for the process and electric power for the plant and for sale. This process description assumes that proposed plants will be similar to the model facility described in the NREL report “Lignocellulosic Biomass to Ethanol Process

Design and Economics Utilizing Co-Current Acid Prehydrolysis and Enzymatic Hydrolysis Current and Futuristic Scenarios" [1]. Some alternative designs have been discussed including a solid waste to ethanol facility using a proprietary process in New York and a potato waste-based plant in Maine. Never-the-less it seems most probable that any significant volume of production of ethanol in the northeastern states will likely depend ultimately on using wood or paper waste for which this process is a reasonable model.

Initial cellulose-based ethanol plants are likely to be smaller in size than the 50 million gallons per year size that the NREL has suggested may be most cost effective[2]. This is because they are likely to be niche facilities using existing infrastructure or an available low cost waste. Additionally because cellulose-based ethanol facilities are commercially unproven, ethanol plant developers may want to start with smaller plants.

1.3 SCOPE OF THE STUDY

The scope of this study is to provide an economic impact analysis of fuel ethanol production at the state level under three possible scenarios. The three scenarios, which are described in detail in section 4, represent three potential levels of ethanol development that could occur in the future. The focus of the study is on the states of Maine, New Hampshire, New York, New Jersey, and Pennsylvania where there is an active interest in the development of ethanol production. Economic impacts may be greater at the regional level due to interstate transactions but they are not evaluated in this study as there is in sufficient information at this point on how the regional ethanol industry will develop. In addition the economic impacts of alternative technologies based on corn and cellulose material are evaluated.

2 METHODOLOGY USED

2.1 APPROACH

The approach taken in this report is to provide an economic impact assessment of ethanol and wood energy facilities at the state level, in terms of employment and income generated and taxes paid. The method includes a computer-based spreadsheet model that uses a hybrid approach to economic impact assessment. It combines direct input of technology and state specific data on costs, salaries and labor requirements with input/output model-derived multipliers, that are used to assess the indirect and induced employment and income. In the tax revenue analysis state tax revenues are calculated using statewide formulae. In all cases, the analytical method covers all parts of the system, including plant design, construction, operation, maintenance, and feedstock/fuel procurement and transportation. Economic impacts are summarized for both the construction and operation phases.

[1] Robert Woolley et al., 1999, Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Acid Prehydrolysis and Enzymatic Hydrolysis Current and Futuristic Scenarios, NREL, Golden ,Colorado.
[2] Robert Woolley et al., op cit

2.2 ECONOMIC IMPACT ANALYSIS METHOD

Economic impact analysis is a collection of quantitative techniques used to determine how a specific economic activity, or class of economic activities will affect the economy of a community, state, region, or nation in which the activity takes place. The usual measures that are used for this analysis are income, employment, and taxes paid. Because all economic activities involve the expenditure of money, which in turn becomes the income of other community members, there is a multiplier effect that creates additional jobs and income and further tax payments. These indirect or multiplier effects are very important and are a key part of a complete economic impact analysis. Not all the expenditures of a specific project will remain in the community however, as purchases of equipment, fuel, and specialized services may transfer expenditures out of the state or abroad. Therefore, determining which expenditures directly benefit the community, the magnitude of the multiplier effect, and the income and taxes generated by jobs is a principle task of a quantitative economic impact analysis. An economic impact analysis has two essential components. First, it should provide a clear objective method for tabulating the direct expenditures and employment of a specific activity and second, it should provide an objective method for determining the indirect effects of these expenditures on the community.

2.3 THE LIMITATIONS OF ECONOMIC IMPACT ANALYSIS

Some of the more important limitations of economic impact analysis are as follows:

- Economic impact analysis cannot determine if an ethanol plant or any other facility is economically feasible or profitable because revenue estimates are generally not part of the analysis. It is possible that projects with very large favorable economic impacts may be quite unprofitable.
- Economic impact analysis can only deal with impacts that are easily quantifiable in dollars or employment. Environmental, health, or social impacts are not normally assessed, even though they may have economic implications.
- Economic impact analysis does not assess all the long-term side effects of economic activities, such as the magnet effect that an industry may have in attracting other industries to locate in the same area. Similarly the analysis will not itself estimate impacts on local prices of goods or services purchased for the facility.
- Economic impact analysis assumes linear relationships between changes in demand for products and services and the resulting changes in income and employment. It therefore does not take into account how specific businesses may increase their productivity over time, or with changing local circumstances. The analysis also assumes that the response to any incremental change in demand for goods or services is at the average rather than the marginal rate. This may slightly overestimate the impacts of personal consumption expenditures on basic sectors, such as food, and underestimate the impacts on discretionary purchase sectors, such as recreation.

- Economic impact analysis cannot identify the specific individuals or the location of individuals or businesses impacted. For example, the analysis may show that a specific number of jobs may be generated in trucking, but it cannot determine if those jobs will be filled from a specific town or what will be the effect on unemployment rolls or welfare payments in specific towns.

The limitations of the analysis are greater under a scenario in which a state has only a single ethanol facility. This is because the multipliers provided are based on statewide data for each state, whereas individual communities and industries may differ from those averages. Furthermore, facilities that are closely integrated with other industries may also differ markedly from statewide averages. Ultimately, the quality of an economic impact analysis is only as good as the data used and this model must therefore rely on the industry for detailed financial information. Unfortunately, some of the information that is essential to a good economic impact analysis, such as the prices paid for fuel, or payroll and profit margins, is precisely the type of information that companies wish to keep confidential. Therefore, the estimates are limited by the data that are available.

2.4 THE MEASURES OF ECONOMIC IMPACT

Every economic activity, including ethanol production, involves expenditure, income, employment and the payment of taxes. The expenditure of any business becomes the income of other businesses and individuals, which in turn is re-spent in the economy to provide more income for others. Thus any initial economic activity has a multiplier effect that ripples through the economy. Economic impact analysis is a set of techniques that provide measures of these economic effects in the area where the activity takes place.

The assessment of economic impact must be made for a specific geographic area that is defined in advance. The method described here calculates the economic impact based on the state in which the activities are located, because the method is dependent upon statewide multipliers derived from IMPLAN, a national economic input/output model used in this method[1]. Not all the impacts of a facility are confined to the home state. Purchases of equipment, services, fuel, and ethanol feedstock may occur out of the state. Some purchases, such as fuel oil, may be imported, which means that there would be an economic impact abroad. These out-of-state and foreign impacts are not assessed in this model and therefore the economic impact assessment is always an underestimate of the total economic impact of the activity. Even within the state, the economic impact is not evenly distributed and certain activities, such as plant operations, grain growing, and wood harvesting, will mainly impact the local area. Major equipment purchases and specialized engineering services will often entail expenditures and economic impacts further away, even if they occur within the state.

[1]Minnesota IMPLAN Group Inc., IMPLAN Professional, Users Guide, Analysis Guide and Data Guide, Minnesota IMPLAN Group Inc, Stillwater MN , 1997.

The method used here provides specific measures of economic impact that can be summarized in the following categories.

2.4.1 Total Expenditure

The total expenditure is the sum of all the direct spending made by the facilities in a specific state. This includes salaries and wages paid to direct employees of the plant, profits or compensation to owners and managers, purchases of feedstock and other supplies, and contracted services. These data come from the plant owners or are estimated based on industry averages or in the case of some of the proposed ethanol plants, on NREL studies.[1]

2.4.2 Direct Income

Direct income in the state is the sum of the money paid directly by the facility to its direct employees in the state and also profits or dividends paid to owners in the state. It does not include payments made to contractors.

2.4.3 Direct Employment

The direct employment is the number of persons employed directly by the plants in the state, including owners and managers. This information is either provided by the plant owners or estimated from industry sources.

2.4.4 Indirect Income

The term indirect income, as used in this analysis, is actually the sum of the indirect and induced income. It is composed of the sum of the expenditures made by the companies that act as suppliers to the energy facility (indirect income), plus the expenditures made by the employees of the facility and the expenditures made by the employees of suppliers (induced income). These expenditures include such items as spare parts, supplies, fuel, utilities, trucking, financial services, and the retail and other personal expenditures of employees. The estimates of indirect income are obtained by taking the plant's expenditure on supplies, equipment and services and applying IMPLAN multipliers to determine the amount of indirect and induced income from each class of expenditure. For example, in the case of the indirect effects of spending by employees, IMPLAN provides the average fraction of personal income spent in each sector (retail, automotive, food, etc.), from which the indirect income can be calculated.

[1] Robert Woolley et al, op cit.

2.4.5 Indirect Employment

Indirect employment is the number of persons employed as a result of the indirect income generated by the facility. The number is derived by using the IMPLAN indirect employment multiplier expressed as the number of jobs per $1 million of indirect income. The jobs estimates are provided for the same categories as indirect income.

2.4.6 Local Property Taxes

Most biomass energy plants pay local property or other local taxes dependent on the value of the plant, land and/or inventory. These vary with municipality, and publicly owned or non-profit organizations may be exempted. At present, specific ethanol plant proposals have not reached the point where local property taxes are known, therefore individual plant property taxes have not been estimated.

2.4.7 State Taxes

The actual amount of state taxes paid by ethanol plants and by their suppliers and employees is very hard to estimate and is usually considered to be confidential information. The amount of corporate tax will depend not only on the profitability of a plant but also on its parent company. Because it is usually impossible to estimate the plant-specific state tax payments, the method used here assumes the taxes paid as a percentage of income by the facility, and all directly and indirectly related activities are the same as the state average.[1] If a specific tax subsidy had been granted, the value of the tax subsidy would be calculated and entered in the model. At present there are not any state level ethanol subsidies in the states under study. A further discussion of subsidies is provided in the results section of this report.

2.4.8 Cost Savings

Some of the proposed ethanol plants currently under discussion in the northeastern states expect to use waste materials such as paper, potato, or wood waste or involve the processing of municipal solid waste, which may provide savings when compared to existing waste disposal methods. Where such savings occur they can be evaluated and considered as part of the economic impact of the plant. The theory about how to include these savings in the cost is complicated by our imperfect knowledge of what happens to the savings. There are four possibilities. First, savings may contribute to higher profits, in which case they can be included as company or proprietors' income. Second, they may be passed on to workers in the form of higher wages, in which case they will be accounted for in the analysis as employee income. Third, they may be passed to customers in the form of lower prices for the product. This is unlikely in the case of fuel ethanol. Fourth, the savings may result in making the plant economically

[1]The tax rate is the total state tax revenues of each state (excluding property and other local taxes) divided by the gross state product. Source: U.S. Dept. of Commerce, Statistical Abstract of the United States 1999, U.S. Govt. Printing Office Washington D.C. 1999.

feasible whereas it would not have been without the savings, in which case the savings are integral to plant economics and the economic impact analysis fully captures the impacts of the plant. In this analysis, any savings are assumed to be integral to plant economics and therefore are not evaluated separately.

2.4.9 Displacement

In this analysis it is assumed that ethanol is blended with gasoline as a gasoline fuel substitute or as a re-placement for MTBE in reformulated gasoline. In either case ethanol in the blended product can be considered primarily as displacing gasoline. Therefore it is displacing gasoline and related petroleum-based economic activities. In this analysis the displacement of gasoline production is limited because all five states are net importers of gasoline and therefore displacement of gasoline production will be an out-of-state impact.

2.5 ECONOMIC IMPACT ANALYSIS AND COST BENEFIT ANALYSIS COMPARED

The economic impact analysis method used in this report provides a basis for estimating the more important economic consequences for a state, which can be a useful tool in planning and decision making. Economic impact analysis has some similarities with another planning tool known as cost benefit analysis, but it also differs from it in several important respects.

The first major difference between economic impact analysis and cost benefit analysis is that cost benefit analysis attempts to quantify all the benefits and costs associated with the project, including social and environmental parameters, which are not usually quantified in terms of dollars. Consequently, there is more controversy associated with the values that are given to the parameters in a cost benefit analysis.

A second important difference is that an economic impact analysis makes no judgments about whether economic effects are beneficial or not. Jobs and income are simply quantified and the users of the analysis can decide if they consider such changes to be beneficial.

Finally, cost benefit analysis is frequently used as a decision-making tool where typically a benefit cost ratio over one (or some number greater than one) becomes the basis for deciding in favor of the project. There are no such thresholds in economic impact analysis. The employment, income, and tax estimates of economic impact analysis should be used along with many other factors in making decisions about biomass energy projects.

2.6 DIRECT IMPACTS: COLLECTION OF DATA

Economic impact analysis is only as good as the basic data that form the input to the analysis. The data on direct expenditures (income) and direct employment are best obtained from the facilities owner or operator. However, in this study ethanol plant planning was at an early stage or facility owners were not willing to provide information and therefore it was necessary for us to estimate plant expenditures based on industry averages or published sources.

The direct impacts are divided into two parts corresponding to the construction phase and the operations phase. This distinction is important because the construction phase activity, although it involves large expenditures, lasts for a relatively short period of time ranging from a few months to two years. The impacts for the construction phase are best considered as occurring during a discrete period, while the operations phase, which will normally last many years, is best characterized by expressing the impacts on an annual basis. Making this distinction is also important because the impacts are usually very different in character as well as magnitude. Construction usually brings temporary workers who commute to the site, or take up temporary residence near the site, and therefore have a different type of impact than the permanent workers and contractors of the operations phase.

Direct expenditure includes all payments that are made directly by the plant owners. That includes payments that must be made for local taxes and fees, such as water or sewer fees, and the state or federal income and sales tax expenditures included in invoices and salaries. When an ethanol energy operation is part of a larger business, that proportion of the costs that are attributable to the ethanol plant have been separated. In the case of ethanol plants, other products such as high fructose corn syrup and by-products such as distillers dry grains (DDGs) are also produced. As far as possible expenditures on materials and labor for co-products such as corn syrup have not been included. Expenditures on by-products such as DDGs are integral and generally cannot be separated from the ethanol plant. The analysis method then uses IMPLAN multipliers to calculate how much remains in the state, and in the case of personal income, how that income is spent among the different sectors of the economy. The same principle applies to determining direct employment and a consistent set of assumptions was used with respect to employment and income. If a job position is part of the direct employment, then the salary of that position was included in the direct expenditure under payroll.

The estimates of direct expenditure must be made for a specific year (the input reference year), which for this study was 1999. The IMPLAN base year from which the multipliers are derived is 1997. The computer model adjusts from 1997 to 1999 dollars using the appropriate producer or consumer price index[1].

The sources of data for direct expenditures and impacts are as follows:

- Construction expenditures for corn based ethanol plants are from industry averages collected from several plants constructed in the 1980's and 1990's and adjusted to 1999 prices.

[1]U.S. Bureau of Labor Statistics, Producer Price Indexes (Monthly and Annual), Monthly Labor Review and CPI Detailed Report, (January issue each year).

- Construction expenditures for wood-based cellulose to ethanol plants are based on the NREL cost analysis for a 52 million gallon per year plant.[1] This plant may be larger than some contemplated in the five states studied but it is the best available estimate and its general validity was confirmed by industry sources.
- Construction expenditures for waste-based cellulose to ethanol plants are also based on the NREL cost analysis for a 52 million gallon per year plant. Almost certainly waste-based plants will have different construction costs because they are likely to be smaller and will incorporate other waste processing components. However, in the absence of specific costs estimates for waste-based plants, the NREL estimate is a reasonable approximation of the ethanol component of a cellulose waste processing facility.
- The non-feedstock operational costs of corn-based ethanol plants are from industry averages collected from several plants constructed in the 1980's and 1990's and adjusted to 1999 prices.
- The non-feedstock operational costs for wood- and waste-based cellulose to ethanol plants are based on the NREL cost analysis for a 52 million gallon per year plant.[2]
- The feedstock prices for corn are based on current regional corn prices. Current corn prices in the mid-western states are lower, which raises the question of the competitiveness of ethanol production in the northeastern states. However, if a corn plant is built in the northeastern states it must be assumed to pay regional corn prices. Additional demand for corn is likely to increase prices but that has not been considered in this analysis.
- The feedstock prices for wood are based on current regional wood prices. A range of prices from high to low is considered. The low wood price plants that may utilize waste wood or other cellulose waste may have fuel costs which come closer to waste-based plants. Waste based plants may charge a tipping fee to users that is part of the revenue for the plant. The tipping fee offsets the additional cost in processing wastes. In some cases there may be no raw material cost and therefore no economic impact on waste-based raw material suppliers.

2.7 INDIRECT IMPACTS: USE OF INPUT/OUTPUT MODELS

The indirect impact (including induced impacts) of ethanol facilities could in theory be obtained by conducting surveys and field investigations of how the expenditures of the plant actually flow through the economy. Such surveys would be very time consuming and costly and would involve intruding into the

[1] Robert Woolley et al, op cit
[2] Robert Woolley et al, op cit

financial affairs of numerous individuals and companies that have business relationships with the plant. Because this approach is impractical, most economic impact analyses make use of input/output models of the economy, which trace the linkages between various business sectors and can estimate the indirect income and employment associated with specific direct expenditures.

This study uses the results of the IMPLAN input/output model in the form of a set of multipliers and expenditure fractions that have been calculated for each state. The IMPLAN model uses basic data on business that have been collected by the Department of Commerce for businesses categorized by SIC codes. IMPLAN is an input/output model originally developed by the U.S. Forest Service for economic impact analysis of forest and natural resource-based activities, although it has been used for many applications throughout the country. This report uses the IMPLAN 1997 data set for each state and runs version 1.1 of the IMPLAN Professional model[1]. These IMPLAN results are incorporated into the computer spreadsheet model that is used to calculate the economic impacts.

Several of the limitations of economic impact analysis, previously discussed, stem from the characteristics of input/output models. Nevertheless input/output models are the only practical way of assessing the indirect effects of this type of economic activity. In this methodology, the input/output approach is combined with direct income and employment in a hybrid assessment. This is necessary because ethanol production is not classified as a separate industry by the Department of Commerce and has no SIC code of its own. For larger industries, such as electric utilities or the oil industry, the impacts can be estimated by direct reference to IMPLAN. The appropriate IMPLAN multipliers have also been used for assessing the impacts of displaced economic activities such as gasoline sales.

2.8 TAX IMPACTS

The tax impacts at the state level are calculated by using average state tax payment rates. The economic impacts associated with these taxes, expressed as indirect income and employment, are calculated using multipliers for state and local government expenditure. No special tax treatment for ethanol is assumed at the state level. Subsidies that originate from the federal treasury are ignored in the state level analysis.

The federal excise tax of $0.54 on gasoline is remitted on gasohol mixtures. None of the states studied have ethanol tax subsidies. The federal tax subsidies go to ethanol producers. They are a reduction in federal tax revenues and result in a reduction in economic impacts in those sectors where federal tax revenues would have been spent. However, it is assumed here that federal revenue reductions in gasoline taxes results in no differential reduction of federal expenditure in the state.

[1]Minnesota IMPLAN Group Inc., IMPLAN Profesional, Users Guide, Analysis Guide and Data Guide, Minnesota IMPLAN Group Inc, Stillwater MN , 1997..

2.9 USE OF INDIRECT IMPACT MULTIPLIERS

The computer model automatically selects the appropriate multipliers from a set of tables included within the program. These multipliers are derived from the IMPLAN input/output model for each state. Impacts are calculated and reported separately for the construction and operation phases. The selection of the multipliers has been made as follows:

- Direct expenditures by the plant, including payments of salaries, are partitioned into appropriate sectors based on statewide averages of personal consumption expenditures (PCE) in different sectors and in the case of wood-based plants, data specific to the wood industry.
- Expenditure by sector is multiplied by the statewide total income multiplier to calculate the total indirect income within the state for that expenditure.
- Expenditure by sector is in turn multiplied by the total employment multiplier, which is expressed in full-time equivalent jobs per $1,000,000 of expenditure, to calculate the indirect and induced jobs by sector.
- All expenditure, direct and indirect, is summed and multiplied by the state tax multipliers to obtain the estimated state taxes paid by the economic activity resulting from the facility.

3 SCENARIOS FOR FUTURE ETHANOL DEVELOPMENT

This study is future oriented as there are no commercial fuel ethanol production plants in the northeastern states at present. Although several developers and state and local agencies have expressed interest in, and in some cases made proposals for, ethanol production there is at present no consensus on how ethanol production will develop in these states. Therefore we have put forward some scenarios for ethanol production in the future that are possible and are illustrative of the level of economic impact that may result from potential ethanol production activities.

In developing the scenarios three separate groups of factors have been considered as follows:

- Choice of feedstock and technology: Three feed stocks; corn, cellulose wastes such as paper and municipal solid waste, and natural wood have been proposed for ethanol plants in the northeastern states. They each use somewhat different technologies and have different capital and operating costs. Each of these three feed stocks are considered as options in the analysis although it is unlikely that under the scenario with the highest production level the whole production could be sustained with either cellulose waste or corn alone.

- Competitive costs of raw materials and the transportation of ethanol from other areas: At present corn prices are higher in the northeastern states than in the Midwest and in consequence the cost of producing ethanol is likely to be higher. It appears likely that corn-based plants will only be able to compete in the northeastern ethanol market if their prices do not exceed the corn-belt ethanol plus transportation costs. The development of an ethanol pipeline from the corn-belt to the northeast may undercut the location cost advantage of northeastern plants that rely on corn.

- Present and future uncertainties with respect to reformulated gasoline policy, carbon dioxide control policy and the price of petroleum: A demonstrated public policy commitment to the use of ethanol in reformulated gasoline at the national or regional level, a carbon tax or equivalent and maintenance of the present high price of oil would all contribute to increasing the use of ethanol fuel in the northeastern states. It has taken over 20 years and federal and state subsidies to develop a corn based ethanol industry in the Midwest to the point where in the key ethanol producing states ethanol use is approximately 6% of on road gasoline consumption.[1]

Three scenarios have been developed which characterize three possible levels of ethanol production in the northeastern states.

3.1 SCENARIO A: NICHE PLANTS OF 10 MILLION GALLONS CAPACITY

This scenario envisions the development of one or two small niche plants totaling 10 million gallons annual capacity in each of the five states. This is the most likely scenario in the short term and reflects the existing expressions of interest among developers and state agencies. Any of the three possible technologies could be used. Existing developer interests range from waste-based plants using municipal solid waste or agricultural wastes, wood-based plants and dry mill corn-based plants. Plans for a waste based plant using the Masada Oxynol process in Middletown New York with a capacity of 9.5 million tons fits in this category. Expressions of interest in a wood based plant in either New Hampshire or Maine could involve a plant larger than 10 million gallons but would probably not be as large as the 50 million gallons considered optimal by the NREL study. The New Jersey Farm Bureau is currently studying a small dry mill corn plant that fits this category. Plants of this size could be developed and on line in two years. The time scale for this scenario is 2 to 5 years. For comparison purposes the scenario compares three options for 10 million gallon capacity plants in each state. The three options are plants based on harvested wood, lower cost wood waste or cellulose waste and corn.

[1] Energy Information Agency: State Energy Reports Washington DC 1999.

3.2 SCENARIO B: 50 MILLION GALLONS CAPACITY BASED ON LARGER PLANTS

In this scenario the state level production in each of the five states rises to 50 million gallons per year based on the construction of one or more plants. This capacity could optimally be realized by the construction of a single 50 million gallon plant, which for wood and or wood waste based plants is the optimal size. It could also be achieved by the construction of a single wet mill integrated plant using corn. However, given corn costs and other considerations this is less likely in the northeastern states. For New Hampshire and Maine at least a 50 million gallon plant would need to serve a multi-state market initially. This scenario has a 5 to 10 year time frame.

3.3 SCENARIO C: 100 MILLION GALLONS CAPACITY BASED ON LARGER PLANTS

This scenario of 500 million gallons in the five states assumes a considerable increase in demand for ethanol in the northeastern states. It would require an increase in ethanol use in gasoline from its present average level of about 0.7% to about 4.0%. This would provide for use of ethanol in gasoline at levels comparable to the present levels in the six largest ethanol producing corn belt states. This scenario could be achieved with the equivalent of two 50 million gallon state-of-the-art wood, or possibly corn-based plants in each of the five states. It could also be supplemented with significant amounts of cellulose waste although these would probably be in smaller plants. Neither corn nor waste-based plants are likely to be the primary source for ethanol production at this level. This level of production will probably require a significant change in the public policy and economics of wood-based ethanol production. This level of demand would probably create secondary effects in raw materials markets. The time frame for this scenario is greater than 10 years.

4 THE RESULTS OF THE ANALYSIS

The analysis using the model described has been undertaken for the three scenarios and in each case showing the optional use of a harvested wood plant and a lower cost wood or waste cellulose plant. Options using corn are also provided, although it is unlikely that corn would be the primary source at higher production scenarios.

4.1 RESULTS FOR STATES AND TECHNOLOGY OPTIONS

First the results are presented for the economic impacts for each state for each of three plant options in Table 1a through 1e. This is based on standard plants of 50 million gallons capacity evaluated for each of the five states and allows comparisons to be made between plant options and states. Actual plants constructed would almost certainly differ form this, as explained in the discussion of scenarios.

There are three primary measures of economic impact, which although related, should be considered separately. These are income, employment and taxes. Income and employment are both divided into direct and indirect components. Taxes are for the state level. The results are separated into construction phase and operation phase impacts. In the operation phase results, the annual impact of operation (gross impacts) are given first, followed by the annual displacement impacts and the net impacts. The net impacts are the gross impacts minus the displacement impacts.

Total construction and operation expenditures are gross expenditures and include payments made outside the state. Construction phase and operations phase impacts should be considered separately and not added together. Although the impacts are expressed in the same categories they are not directly comparable. The impact summary is self-explanatory. In the case of construction phase impacts, only total impacts are given because direct impacts, defined as impacts resulting from direct expenditures by the facilities, are generally small. This is because most of the construction impacts are through contracted services. Generally it is recommended that more emphasis be placed on the total jobs and total income, rather than on the distinction between direct and indirect impacts. Both direct and indirect jobs and income have the same effect in the state, although direct jobs may be located closer to the facility. To some extent, the distinction between direct and indirect jobs and income may be arbitrary, depending for example, on whether the work is done by company employees or by independent contractors, or whether plant repairs are made by plant employees or outside contractors.

Table 1a: Economic Impact of Ethanol Production in Maine (50 Million Gallons Facility)

	Wood Harvest Based		Cellulose Waste Based		Corn Based	
	Income	**Jobs**	**Income**	**Jobs**	**Income**	**Jobs**
Construction Phase Impacts						
Total Construction Expenditure	$233,800,000		$233,800,000		$87,500,000	
Total Income	$169,814,523		$169,814,523		$63,553,339	
Total Jobs		6,021		6,021		2,253
Total State Taxes	$12,437,766		$12,437,766		$4,654,853	
Operations Phase Impacts (Annual)						
Total Operation Expenditure	$43,691,588		$35,603,353		$75,425,315	
Direct Income	$11,196,036		$8,117,647		$1,121,309	
Indirect Income	$31,328,475		$25,495,443		$33,930,360	
Total Income	$42,524,511		$33,613,091		$35,051,669	
Direct Jobs		53		53		53
Indirect Jobs		802		694		2,683
Total Jobs		855		747		2,736
Total State Taxes	$3,114,633		$2,461,932		$2,567,298	
Displacement Impacts (Annual Income, Jobs and Taxes Lost)						
Total Income	$1,199,551		$1,199,551		$0	
Total Jobs		28		28		0
Total State Taxes	$87,859		$87,859		$0	
Net Impacts						
Total Income	$41,324,961		$32,413,540		$35,051,669	
Total Jobs		827		719		2,736
Total State Taxes	$3,026,774		$2,374,073		$2,567,298	

In this and the following sections of Table 1 the wood harvest-based system is assumed to be using harvested wood at relatively high cost of $36 per dry ton delivered. The cellulose waste-based system is assumed to use lower cost waste wood or paper waste, or agricultural residues, or a mix of wood and cellulose material. The average delivered price of material under this category is assumed to be $25 per dry ton. This option does not include municipal solid waste or sewage sludge based systems in which a disposal fee is charged by the plant. That option is discussed in section 4.3.

Table 1b: Economic Impact of Ethanol Production in New Hampshire (50 Million Gallons Facility)

	Wood Harvest Based		Cellulose Waste Based		Corn Based	
	Income	**Jobs**	**Income**	**Jobs**	**Income**	**Jobs**
Construction Phase Impacts						
Total Construction Expenditure	$233,800,000		$233,800,000		$87,500,000	
Total Income	$179,362,159		$179,362,159		$67,126,556	
Total Jobs		5,402		5,402		2,022
Total State Taxes	$4,874,225		$4,874,225		$1,824,186	
Operations Phase Impacts (Annual)						
Total Operation Expenditure	$43,691,588		$35,603,353		$75,425,315	
Direct Income	$11,752,577		$8,521,165		$1,177,047	
Indirect Income	$30,919,795		$25,423,464		$35,998,046	
Total Income	$42,672,373		$33,944,630		$37,175,094	
Direct Jobs		53		53		53
Indirect Jobs		645		561		2,102
Total Jobs		698		614		2,155
Total State Taxes	$1,159,636		$922,456		$1,010,245	
Displacement Impacts (Annual Income, Jobs and Taxes Lost)						
Total Income	$1,187,672		$1,187,672		$0	
Total Jobs		20		20		0
Total State Taxes	$32,275		$32,275		$0	
Net Impacts						
Total Income	$41,484,700		$32,756,958		$37,175,094	
Total Jobs		678		594		2,155
Total State Taxes	$1,127,360		$890,181		$1,010,245	

Table 1c: Economic Impact of Ethanol Production in New Jersey (50 Million Gallons Facility)

	Wood Harvest Based		Cellulose Waste Based		Corn Based	
	Income	**Jobs**	**Income**	**Jobs**	**Income**	**Jobs**
Construction Phase Impacts						
Total Construction Expenditure	$233,800,000		$233,800,000		$87,500,000	
Total Income	$205,332,372		$205,332,372		$76,845,948	
Total Jobs		4,511		4,511		1,688
Total State Taxes	$11,888,744		$11,888,744		$4,449,380	
Operations Phase Impacts (Annual)						
Total Operation Expenditure	$43,691,588		$35,603,353		$75,425,315	
Direct Income	$11,381,396		$8,252,042		$1,139,873	
Indirect Income	$35,060,102		$28,755,535		$46,734,428	
Total Income	$46,441,498		$37,007,577		$47,874,301	
Direct Jobs		53		53		53
Indirect Jobs		524		456		1,735
Total Jobs		577		509		1,788
Total State Taxes	$2,688,963		$2,142,739		$2,771,922	
Displacement Impacts (Annual Income, Jobs and Taxes Lost)						
Total Income	$2,511,499		$2,511,499		$0	
Total Jobs		34		34		0
Total State Taxes	$145,416		$145,416		$0	
Net Impacts						
Total Income	$43,929,999		$34,496,078		$47,874,301	
Total Jobs		543		474		1,788
Total State Taxes	$2,543,547		$1,997,323		$2,771,922	

***Table 1d**: Economic Impact of Ethanol Production in New York (50 Million Gallons Facility)*

	Wood Harvest		Cellulose Low Cost		Corn	
	Income	**Jobs**	**Income**	**Jobs**	**Income**	**Jobs**
Construction Phase Impacts						
Total Construction Expenditure	$233,800,000		$233,800,000		$87,500,000	
Total Income	$207,712,232		$207,712,232		$77,736,614	
Total Jobs		4,757		4,757		1,780
Total State Taxes	$13,552,489		$13,552,489		$5,072,039	
Operations Phase Impacts (Annual)						
Total Operation Expenditure	$43,691,588		$35,603,353		$75,425,315	
Direct Income	$11,292,644		$8,187,693		$1,130,984	
Indirect Income	$37,569,541		$30,764,996		$46,537,070	
Total Income	$48,862,186		$38,952,689		$47,668,054	
Direct Jobs		53		53		53
Indirect Jobs		586		511		1,700
Total Jobs		639		564		1,753
Total State Taxes	$3,188,085		$2,541,525		$3,110,172	
Displacement Impacts (Annual Income, Jobs and Taxes Lost)						
Total Income	$1,251,598		$1,251,598		$0	
Total Jobs		20		20		0
Total State Taxes	$81,662		$81,662		$0	
Net Impacts						
Total Income	$47,610,587		$37,701,091		$47,668,054	
Total Jobs		620		544		1,753
Total State Taxes	$3,106,423		$2,459,863		$3,110,172	

Table 1e: Economic Impact of Ethanol Production in Pennsylvania (50 Million Gallons Facility)

	Wood Harvest Based		Cellulose Waste Based		Corn Based	
	Income	**Jobs**	**Income**	**Jobs**	**Income**	**Jobs**
Construction Phase Impacts						
Total Construction Expenditure	$233,800,000		$233,800,000		$87,500,000	
Total Income	$216,752,196		$216,752,196		$81,119,834	
Total Jobs		5,722		5,722		2,142
Total State Taxes	$13,330,260		$13,438,636		$5,029,430	
Operations Phase Impacts (Annual)						
Total Operation Expenditure	$43,691,588		$35,603,353		$75,425,315	
Direct Income	$11,337,905		$8,216,129		$1,134,912	
Indirect Income	$38,010,009		$31,239,712		$50,456,209	
Total Income	$49,347,914		$39,455,841		$51,591,121	
Direct Jobs		53		53		53
Indirect Jobs		705		613		2,067
Total Jobs		758		666		2,120
Total State Taxes	$3,034,897		$2,446,262		$3,198,650	
Displacement Impacts (Annual Income, Jobs and Taxes Lost)						
Total Income	$1,386,459		$1,386,459		$0	
Total Jobs		26		26		0
Total State Taxes	$85,267		$85,960		$0	
Net Impacts						
Total Income	$47,961,455		$38,069,382		$51,591,121	
Total Jobs		732		640		2,120
Total State Taxes	$2,949,630		$2,360,302		$3,198,650	

All figures are in 1999 dollars. They can be adjusted to any other year using the consumer price index[1]. Jobs should not be adjusted. The estimates of tax payments for the operations phase allow for the tax effects of changes in state expenditures, and employment of state workers. This analysis does not take into consideration any potential reductions in federal agricultural support payments that would affect federal revenue but not state revenue.

[1]U.S. Bureau of Labor Statistics, CPI Detailed Report,

Table 2 provides a summary of the average operational gross and net impacts of ethanol production for the five states studied, for each of three feedstock technology options on the basis of income, jobs, and state taxes per million gallons of ethanol. This shows that on average there is only a small variation in gross income between alternative raw material sources with a range from about $769,000 to $882,000 per million gallons. For wood and cellulose systems the net income is between 84% and 96 % of gross income. The reduction of income is mainly attributable to the displaced electric power production resulting from electric power sales by the plants. The corn plants do not sell electric power and therefore there are no displacements. Gasoline production is also displaced by ethanol and should be accounted for if the production of ethanol would result in a reduction in gasoline production in the state. In Maine and New Hampshire there is no gasoline production to displace. New Jersey, New York, and Pennsylvania are net importers of gasoline and therefore any reduction in demand for gasoline as the result of ethanol use would be reflected in reduced imports from other states or overseas. Because ethanol blended gasoline is distributed through the same channels as pure gasoline there is no change in the distribution impacts.

The greatest differences are found in the number of jobs predicted by the model. Corn-based systems appear to create greater employment than wood and cellulose based systems. This is because of the influence of the relatively high price of corn and the relatively lower wages in the agricultural sector. This result should be interpreted with care. It assumes that ethanol production in the Northeast is competitive, even with higher corn prices than the mid-west.

Table 2. Summary of Average Income, Jobs, and State Taxes Per Million Gallons of Ethanol Produced

	Wood Harvest Based		Low Cost Cellulose Based		Corn Based	
	$	Jobs	$	Jobs	$	Jobs
Five State Average						
Gross						
Income	$919,000		$732,000		$877,000	
Jobs		14		12		42
State taxes	$53,000		$42,000		$51,000	
Net						
Income	$889,000		$702,000		$877,000	
Jobs		14		12		42
State taxes	$51,000		$40,000		$51,000	

Table 3 gives a summary of the operational gross and net impacts of ethanol production for each of the five states studied, for each of three feedstock technology options on the basis of income, jobs, and state taxes per million gallons of ethanol.

Table 3: Summary of State Income, Jobs, and Taxes Per Million Gallons Of Ethanol Produced

	Wood Harvest Based		Low Cost Cellulose Based		Corn Based	
	$	**Jobs**	**$**	**Jobs**	**$**	**Jobs**
Maine						
Gross						
Income	$850,000		$672,000		$701,000	
Jobs		17		15		55
State taxes	$62,000		$49,000		$51,000	
Net						
Income	$826,000		$648,000		$701,000	
Jobs		17		14		55
State taxes	$61,000		$47,000		$51,000	
New Hampshire						
Gross						
Income	$853,000		$679,000		$744,000	
Jobs		14		12		43
State taxes	$23,000		$18,000		$20,000	
Net						
Income	$830,000		$655,000		$744,000	
Jobs		14		12		43
State taxes	$23,000		$18,000		$20,000	
New Jersey						
Gross						
Income	$929,000		$740,000		$957,000	
Jobs		12		10		36
State taxes	$54,000		$43,000		$55,000	
Net						
Income	$879,000		$690,000		$957,000	
Jobs		11		9		36
State taxes	$51,000		$40,000		$55,000	
New York						
Gross						
Income	$977,000		$779,000		$953,000	
Jobs		13		11		35
State taxes	$64,000		$51,000		$62,000	
Net						
Income	$952,000		$754,000		$953,000	
Jobs		12		11		35
State taxes	$62,000		$49,000		$62,000	
Pennsylvania						
Gross						
Income	$987,000		$789,000		$1,032,000	
Jobs		15		13		42
State taxes	$61,000		$49,000		$64,000	
Net						
Income	$959,000		$761,000		$1,032,000	
Jobs		15		13		42
State taxes	$59,000		$47,000		$64,000	

The model outputs in Table 3 shows that there are variations among the five states especially with respect to net jobs and net taxes. Net jobs are lowest for the wood- and cellulose-based systems because the wood/cellulose raw material costs are lower per gallon of ethanol produced. These results are model based and although they indicate the general magnitude and direction that can be expected, it must be recognized that specific new facilities could differ from the general pattern.

State taxes also vary considerably from state to state mainly due to differences in state tax rates and tax structures. State taxes are estimated based on average, not marginal tax rates and only state-level taxes are considered. There will be local property taxes paid but they are quite site-specific. It is notable that New Hampshire, which has no general income tax or broad-based transactions taxes, would collect much less in taxes on a new ethanol industry than other states. This also means that it would have less tax revenue to use for state-wide incentives for ethanol production.

There are a number of variations which are not captured in this model because the model is based on hypothetical plants rather than real regional examples. Ultimately the actual impacts from plants may be expected to show variations attributable to a number of factors including:

- Variations in real profitability between facilities. The profit may become income in the state or outside the state.
- Wide variations in initial capital cost that affect profitability and direct plant costs such as local tax payments, maintenance costs and insurance costs. This may be the case especially when existing facilities such as breweries or waste processing plants are converted.
- Variation in the extent of by-product and co-product sales (e.g. distillers dry grains and corn syrup and electric power) and the effect that has on the overall accounting in the industry.
- Variation in the total income and employment multipliers from state to state. In general states with relatively large diverse economies, such as Pennsylvania, New York, and New Jersey have higher multipliers than states with smaller economies, such as Maine and New Hampshire.

4.2 RESULTS FOR THE THREE ETHANOL FUTURE PRODUCTION SCENARIOS

The economic impact analysis model was run for each of the three ethanol production scenarios for each of the five states studied. The three production scenarios were for 10 million gallons per year, 50 million gallons per year and 100 million gallons per year. Results are given in constant 1999 dollars for comparison purposes, even though the time frame for the highest level of production is 10 or more years

into the future. Averaged over the five states the highest production level corresponds to approximately the same level of ethanol blending currently found in the corn-belt states.

The net impacts in terms of income, jobs, and state taxes are given in Table 4 for each scenario for each of the five states. Two feedstock options are considered: high and low cost wood /cellulose. The corn option is not listed as it seems improbable that the higher levels of production will be achieved with corn-based systems in this region. As shown in previous tables there is considerable variation among states.

Under the 10 million gallons per year scenario for wood and cellulose systems, state income ranges from nearly $9.6 million in Pennsylvania down to a low of $6.5 million in Maine and from over 170 jobs in Maine to 90 jobs in New Jersey. At the highest production scenario of 100 million gallons per year, state income ranges from an estimated $95 million down to a low of $65 million. Comparable employment estimates range from over 1650 to 950 and state taxesat the 100 million gallon per year production level. These results confirm that ethanol production in the each of the five states studied has the potential to make positive net contributions to jobs, and income in the states. These impacts will more noticeable in the rural areas most affected by the increased demand for feed stocks.

Table 4: Economic Impact of Ethanol By State For Three Production Scenarios

		Maine		New Hampshire		New Jersey	
		Wood/Cellulose High Cost	Wood/Cellulose Low Cost	Wood/Cellulose High Cost	Wood/Cellulose Low Cost	Wood/Cellulose High Cost	Wood/Cellulose Low Cost
Scenario A	Net Income	$8,300,000	$6,500,000	$8,300,000	$6,600,000	$8,800,000	$6,900,000
Niche Plants	Net Jobs	170	140	140	120	110	90
10 mllion gal/yr	Net State Tax	600,000	500,000	200,000	200,000	500,000	400,000
Scenario B	Net Income	$41,300,000	$32,400,000	$41,500,000	$32,800,000	$43,900,000	$34,500,000
Large Plants	Net Jobs	830	720	680	590	540	470
50 million gal/yr	Net State Tax	$3,000,000	$2,400,000	$1,100,000	$900,000	$2,500,000	$2,000,000
Scenario C	Net Income	$82,600,000	$64,800,000	$83,000,000	$65,500,000	$87,900,000	$69,000,000
Large Plants	Net Jobs	1,650	1,440	1,360	1,190	1,090	950
100 million gal/yr	Net State Tax	$6,100,000	$4,700,000	$2,300,000	$1,800,000	$5,100,000	$4,000,000

		New York		Pennsylvania	
		Wood/Cellulose High Cost	Wood/Cellulose Low Cost	Wood/Cellulose High Cost	Wood/Cellulose Low Cost
Scenario A	Net Income	$9,500,000	$7,500,000	$9,600,000	$7,600,000
Niche Plants	Net Jobs	120	110	150	130
10 mllion gal/yr	Net State Tax	600,000	500,000	600,000	500,000
Scenario B	Net Income	$47,600,000	$37,700,000	$48,000,000	$38,100,000
Large Plants	Net Jobs	620	540	730	640
50 million gal/yr	Net State Tax	$3,100,000	$2,500,000	$2,900,000	$2,400,000
Scenario C	Net Income	$95,200,000	$75,400,000	$95,900,000	$76,100,000
Large Plants	Net Jobs	1,240	1,090	1,460	1,280
100 million gal/yr	Net State Tax	$6,200,000	$4,900,000	$5,900,000	$4,700,000

4.3 IMPACTS ASSOCIATED WITH WASTE TO ETHANOL PLANTS.

The economic impacts associated with waste to ethanol plants are much more complex than for wood or corn based facilities. There are so few waste to ethanol plants that it is difficult to generalize about their economics. However, their main characteristic is that they receive a waste product such as municipal solid waste, waste paper, or agricultural residues at zero cost, or they charge a collection fee or disposal fee. The situation may be attractive to waste generators, public or private, if the ethanol plant

charges lower disposal fees than alternative services or if it provides access to disposal in a situation where existing landfills or other disposal alternatives cannot be guaranteed in the future. The reuse of waste may be beneficial from an environmental perspective and in the savings of imported gasoline.

From the perspective of the economic impact on the community however, expenditure of an ethanol plant on raw material, which is the largest single local impact, generating most of the jobs, income, and taxes at the state level, is eliminated. Therefore, waste-based ethanol plants that make no payments for their wastes create far fewer jobs and much less income than corn or wood-based plants. If there are cash savings to waste generators because they pay less for waste disposal to an ethanol plant, then these savings may be spent in the state and those expenditures generate offsetting jobs, income, and taxes. The net economic impact of these transactions depends on the disposal fee charged by the ethanol plant and the price for alternative disposal.

In order to evaluate the impact of a waste-based ethanol plant we have used the model to evaluate a hypothetical waste based plant in New York State with an annual capacity of 10 million gallons using municipal solid waste as the source of cellulose. The plant is assumed to use the same wood/cellulose-based technology previously described for ethanol processing. The parts of the operation that involve sorting, processing and disposal of the non-biomass parts of the waste stream are ignored, on the assumption that they are not integral to ethanol production and could actually be considered as a separate business. The plant is assumed to charge a tipping fee of $100 per ton of waste received which is assumed to be the prevailing tipping fee at local landfills. Therefore the operation of the ethanol plant is offset by a displacement of the expenditures on landfills. There are no payments to providers of raw material.

The results of the model run for this hypothetical facility indicates that the gross economic impacts of the operation of the plant are $3.2 million in state income, $200,000 in state taxes and 78 jobs on a continuing basis. Local property taxes, depending on the facility location and local arrangements, would be additional. This compares with an estimated $10 million in state income, $600,000 in state taxes and 128 jobs from an ethanol plant using harvested wood. When the effects of the displacement of landfill operations are considered, the net economic impact at the state level is negative. The net result of the operation of the new facility would be a loss of $9 million in state income, $600,000 in state taxes, and 150 jobs. This compares with an estimated net positive $9 million in state income, $600,000 in state taxes, and 120 jobs from an ethanol plant using harvested wood. This analysis does not consider the impacts of the operation of the waste separation component of the plant. For the purposes of this analysis these are considered to be a separate business and the labor and other expenses of the operation of that business are not added in. However, the economic impact of the separation and recycling would also be offset by the displacement of other similar waste disposal operations.

The construction costs and therefore the economic impacts of construction would be higher for a relatively smaller capacity waste to ethanol plant and the addition of separation and recycling facilities would further increase the cost. This would result in greater construction phase income and jobs impacts when compared with a wood or corn ethanol plant.

The results of this analysis of waste to ethanol plants are not surprising. This study and all other studies have shown that the dominant economic benefit from ethanol plants depends on the economic effects on the rural economy that result from the purchase of large quantities of grains or wood[1]. Without the raw material purchase the economic impacts of the plants operation are small and may be offset by displacements in other parts of the economy. In the case of the example facility the plant charges a tipping fee for waste disposal that completely offsets any savings from avoided landfill charges, so there are no savings to individual residents of businesses which are available to spend. If landfill charges increase in the future so that they exceed the ethanol plant tipping fee then savings to businesses and residents will be spent and increase the demand for other goods and service in the state. The model was run to determine what increase in landfill costs would be required to offset the loss in income, jobs and state taxes. The model run for this hypothetical New York State facility shows that landfill tipping fees would need to increase by about 45% above the ethanol plant tipping fee for the income and state tax losses to be fully offset. The landfill fee increase needed to fully offset the job losses would be approximately 60 %.

It would be wrong to interpret this analysis as implying that there are no economic or other social benefits from a waste to ethanol plant. The avoidance of landfill operations with their associated environmental and property value impacts, the resource conservation benefits from recycling materials and the public health and global climate benefits from using a less polluting fuel are all real and substantial. Furthermore, new technologies that use materials more efficiently in the long run improve the overall efficiency of the economy and improve social welfare. These improvements will ultimately be reflected in improved economic conditions at the regional or national level. However, these longer term benefits do not show up in a near term state level economic impact analysis based on income and jobs.

A more complete analysis of the economic impact of waste to ethanol plants will require more site-specific information, especially on the cost interconnections between waste processing and ethanol processing, the costs of feedstock preparation and the pricing of tipping fees in relation to landfill fees.

4.4 INCENTIVE PROGRAMS

The fuel ethanol industry in the mid-western and western states has grown considerably in part as the result of programs of federal and state incentives that include excise tax rebates, production subsidies, and capital cost subsidies. The federal excise tax rebate has clearly encouraged the development of the ethanol industry and indirectly reduced the level of agricultural price supports[2]. Not surprisingly, this

[1] Michael Evans, 1997, The Economic Impact of the Demand for Ethanol, Midwestern Governors Conference, Lombard Illinois.

[2] Michael Evans, 1997, op cit.

issue has been actively discussed in the northeastern states with a view to trying to encourage the development of an ethanol industry in the region. The federal excise tax rebate of $ 0.054 per gallon on ethanol blended gasoline is in place, but at present there are no state fuel ethanol subsidies in the region and the federal program does not directly affect state tax revenues The economic impact model can provide guidance on the effect that providing state subsidies will have on the state economy and specifically on state revenue.

Among the several methods by which government can support the ethanol industry, most attention has been focused on either capital cost subsidies or production subsidies. The existing federal program is a production subsidy and most of the other state programs have been directly or indirectly based on production, usually through the use of tax benefits. Capital cost subsidies cannot be easily evaluated through the use of the economic impact model at this time because the full costs of the application of the new technologies are still unclear. The model has been used to evaluate the effects of different amounts of state-level production subsidy on the state economy. The results show the effect of a state subsidy on state revenues for each state.

Table 5 shows the break even point for state production subsidies. This is the level of subsidy per gallon of ethanol produced at which the net state tax revenue is zero. A subsidy below the break even point would result in additional tax revenue and a subsidy above will result in a net loss of state revenues.

Table 5: State Ethanol Production Incentive Break Even Point For Net Tax Revenue

State	**Breakeven point (cents/gal)**
Maine	4.5
New Hampshire	2.2
New Jersey	3.7
New York	5.7
Pennsylvania	5.5

Not surprisingly there are considerable variations between states depending mainly on the state tax rates. The lowest is New Hampshire where any production subsidy above 2.2 cents per gallon is estimated to cause a net loss to the state tax fund. New Hampshire is lower than the other states because it does not have any broad-based taxes and has a lower than average tax rate. The highest break even point is for New York at 5.7 cents

This study is not designed to answer the question how large a subsidy is necessary to make ethanol production sufficiently attractive for private developers to take the risk of entering the business. Nor does it imply that the existence of a production subsidy will increase the volume of production.

5 CONCLUSIONS

The results of the study of the economic impact of fuel ethanol plants in the states of Maine, New Hampshire, New York, New Jersey, and Pennsylvania are based on a hybrid input/output model of ethanol industry and the state economies. The input for the model is the estimated expenditures of ethanol plants on construction and operation. The results are given as estimated changes in personal income, jobs, and state taxes in each state as a result of specified levels of ethanol production.

The results show that in all cases construction of ethanol plants results in large short term increases in employment and income. The construction of a 50 million gallon per year wood to ethanol plant would generate between $170 million to over $200 million in income and create from 4000 to 6000 jobs depending on the state and the type of plant. The construction cost of corn-based ethanol plants will be lower and corn plants if constructed are expected to be smaller in size. Therefore the jobs and income generated during construction will also be lower.

The economic impact of the operation of the plants are more important because they provide permanent jobs and income over the lifetime of the plant and therefore have greater impact on the communities where they are located and on the state economy.

The results of the study of operational economic impacts lead to several conclusions as follows:

1) Ethanol plants using purchased wood, cellulose materials, and corn all have substantial net positive impacts on the state economy in terms of income, jobs, and state tax revenues. A 50 million gallon per year wood ethanol plant would generate from $41 to $48 million per year in income, 540 to 830 jobs, and $1 to $ 3 million in state taxes depending on the state and other factors. Most of the impacts are related to the purchase of the wood feedstock. Lower cost wood or other lower-cost cellulose residues produce comparable but proportionally lower impacts when compared to higher-cost wood.
2) Ethanol plants using corn as a feedstock would also generate net positive impacts on the state economies at income and tax revenue levels comparable to wood but are estimated to generate more jobs. It is not clear if corn-based ethanol plants can compete with very large plants in the mid-western states where the corn prices are lower than in the northeastern states.
3) Ethanol plants using municipal solid waste and sewage that charge a disposal fee generate far lower levels of income, jobs, and state taxes. When displacements of income and jobs from other solid waste processing facilities are considered, waste to ethanol plants may under some circumstances bring about a net reduction in state income, jobs, and taxes.

4) The effect of a state-level ethanol production subsidy from state revenues is to lower the net economic impacts of the plant. The break even point at which net state tax revenues are eliminated by the cost of the production subsidy ranges from 2.2 cents per gallon for New Hampshire to 5.7 cents per gallon for New York. This variation is primarily due to differences in state tax rates and structures.