Statewide Feasibility Study for a Potential New York State Biodiesel Industry

Final Report 04 -02
June 2003

New York State
Energy Research and
Development Authority

NYSERDA

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Statewide Feasibility Study for a Potential New York State Biodiesel Industry

Final Report

Prepared for the

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STATEWIDE FEASIBILITY STUDY FOR A POTENTIAL NEW YORK STATE BIODIESEL INDUSTRY

Agreement 7681

NOTICE

Preface

The New York State Energy Research and Development Authority (NYSERDA) is pleased to publish "A Statewide Feasibility Study for a Potential New York State Biodiesel Industry." The report was prepared by LECG, LLC, with technical assistance from MARC-IV, IBFG, and Advanced Fuel Solutions, and cofunding support from the New York State Department of Agriculture and Markets. This report primarily considers the cost implications associated with various statewide policy options, and is not intended to recommend specific policies, address environmental impacts or provide site-specific or detailed feedstock assessments. Available information regarding one important feedstock, yellow grease, is quite sparse. We recognize that the federal energy bill currently pending could have a significant impact on the conclusions of this report, and that as of printing time, the likelihood of the bill's passing is uncertain, as are specific details regarding any potential national biodiesel incentives or programs that may comprise final federal energy legislation. Nevertheless, it is our hope that the report will be useful as New York discusses and develops its own biodiesel policy.

TABLE OF CONTENTS

STATEWIDE FEASIBILITY STUDY FOR A POTENTIAL NEW YORK STATE BIODIESEL INDUSTRY

Agreement 7681

EXECUTIVE SUMMARY

The market for diesel fuel in New York is substantial. Total distillate fuel use in New York is estimated at 3.2 billion gallons in 2002 and is projected to increase at an annual rate of about 1.2 percent over the next decade. A B2 mandate covering all end uses would create a market of 64.1 million gallons that would increase to 73.7 million gallons by 2012. A more limited mandate covering on-highway diesel uses beginning in 2007 and expanding to include residential, commercial, industrial, and utility uses in 2009 would create a market of 23.3 million gallons in 2007 increasing to 70.6 million gallons by 2012.

- **New York can supply some but not all of the feedstock requirements for a statewide biodiesel industry.**

  The maximum capacity of New York to produce biodiesel is currently estimated at about 30 million gallons. This is projected to increase to 40 million gallons by 2012. This assumes that all of the soybeans grown in New York are crushed using current technology (mechanical extraction that yields 7.8 pounds of oil per bushel) and all of the oil produced along with all of the yellow fat produced in the State is used to produce biodiesel. Consequently, New York could theoretically meet all of the demand for a B2 mandate covering on-highway transportation fuel by 2007 and about half the demand created by a full B2 mandate by 2012.

- **New York agriculture would be a major beneficiary of a biodiesel industry.**

  Soybeans are the major oilseed currently produced in New York. While oilseed crops have never been grown extensively in New York State, the area devoted to soybeans has increased significantly over the past 20 years. Soybean acreage increased to 40,000 acres in the 1990-1991 growing seasons, 100,000 acres in 1997-1998, and about 150,000 acres in 2001-2002. In 2003, New York growers produced 5.3 million bushels of soybeans on about 144,000 acres.

  Commercial farmers have successfully produced other oilseeds – notably winter canola and sunflowers -- on limited acreage in New York in the 1980s and 1990s. We believe that both of these oilseed crops could be successfully produced in New York if there were lucrative markets. However, New York has limited capacity to process these crops and they would divert acreage that otherwise would be planted to soybeans.

The major field crops produced in New York are hay, corn, winter wheat, and soybeans. Taken together these crops were planted to nearly 2.9 million acres in 2003. Over the past 25 years the number of acres planted to these crops has declined nearly 27 percent. Most of this land was lost to development, however some acreage shifted to higher value crops such as fruit and vegetables, or was taken out of production.

The demand for vegetable oil to produce biodiesel is significant enough to provide an incentive for New York farmers to shift acreage from other crops to soybeans, and bring idled land back into production. In the absence of a national energy program or New York State biodiesel policy we expect that New York soybean acreage will continue to expand reaching 188,000 acres by 2007 with additional land coming from idled acreage and modest shifts from hay, corn, wheat, and vegetables.

The additional demand for soybean oil to supply a New York biodiesel industry under a combined B2 mandate and supply incentive policy is expected to increase soybean acreage by an additional 99,000 acres to a total of 287,000 acres by 2012. Approximately 26,000 acres are expected to come from hay, 20,000 from corn, 10,000 from wheat, and the remaining 43,000 from idled land and other crops. These acreage shifts can accommodate the production of an additional 11.2 million bushels of soybeans between 2007 and 2012 without jeopardizing the amount of hay or corn silage needed to supply New York's declining dairy herds.

Although acreage shifts from hay and corn will lead to a decline in cash receipts of $38.9 million for these crops between 2007 and 2012, additional soybean revenues of $85.5 million will result in a net gain of $46.2 million for New York farmers over the same period, or $6.6 million per year. Since the acreage shifts are relatively modest; little or no additional equipment or services should be required; and since both soybeans and alfalfa fit into existing crop rotations with corn, most of the increase in cash receipts should fall to the farmer's bottom line and increase net cash income.

- **A New York Biodiesel industry would require distributors to make investments in infrastructure that would create economic benefits.**

The key to implementation is using biodiesel blends in existing petroleum tanks and infrastructure. This is accomplished by blending biodiesel as far upstream as possible, i.e. petroleum terminals. Therefore, efficient implementation of a B2 incentive or policy would necessitate participation from terminal owners throughout the State, not necessarily the fuel dealers. Each of the 85 active deep-water storage terminals would need to determine which infrastructure upgrades their respective terminal would require. These include, but are not limited to; splash blending, preset rack blending, wild stream rack blending, and header supply wild stream blending. The cost associated with this investment is estimated at approximately $64 million.

❖ **A New York B2 incentive or policy should be phased in over time and should be linked to biodiesel capacity in New York.**

A mandate that would require that diesel use for one or more end use segments contain a certain percentage of biodiesel (e.g. two percent, or B2) should be phased in to allow adequate time for the necessary capital investment for production and infrastructure to be made <u>and</u> should be tied to New York biodiesel capacity. For example, a mandate would not become effective until at least 10 MGY of biodiesel capacity is in place. Consider that it takes about 18 months from decision to production for a new biodiesel plant. This means that legislation passed in 2004 that becomes effective in April 2005 would result in the first gallon of biodiesel delivered in late 2006 or early 2007. Therefore, a reasonable B2 mandate for on-highway use could take effect in 2007 and be expanded to residential home heating oil and other uses in 2009.

❖ **A B2 policy or other policy incentive will attract investment, expand the State economy, generate additional income for New Yorkers, and will create new jobs. Each policy option has different revenue impacts for the State Treasury and costs and benefits to consumers.**

A mandate, supply incentive, and demand incentive each are expected to attract direct investment to New York State. The investment will consist of capital expenditures to increase soybean crush capacity and build new crush capacity, build new biodiesel production capacity, and improve distribution infrastructure for each of the terminals in the State. These capital expenditures, along with the annual operating expenses associated with producing biodiesel, represent the purchase of output from other industries. These dollars will be spent and re-spent throughout all sectors of the New York economy thereby creating additional new demand and output, creating new jobs in all sectors of the economy, and generating additional income for New York households. The individual policy options are described below and are summarized in Tables 1 and 2.

- <u>Stand alone mandate (Policy Option 1)</u>

  A mandate that would require highway distillate to contain at least two percent biodiesel by 2007 and all other end uses by 2009 would affect 1.2 billion gallons of distillate use in 2007, increasing to 3.7 billion gallons by 2012. The mandate would result in a market for biodiesel in New York of 23.3 million gallons in 2007, increasing to 73.7 million gallons by 2012. The mandate should be linked to production capacity. That is, the mandate would not take effect until at least 10 million gallons of biodiesel capacity was built in New York State.

  A mandate is expected to stimulate investment in 30 million gallons of biodiesel capacity that would come on line in 2007 and 2008 and would provide a market-based incentive for New York farmers to increase acres planted and production of soybeans. The biodiesel would be produced from a blend of feedstocks comprising 70 percent yellow grease and 30 percent soybean oil. New York has adequate supplies of both feedstocks to meet this level of demand. In addition, a mandate would require fuel distributors to expand and improve terminal facilities to store and handle biodiesel and biodiesel blends required to meet the level of demand created by the mandate. The cost to expand and improve terminal facilities to accommodate a mandate is estimated at $64 million for New York's 85 terminals.

A mandate would increase biodiesel demand but would have relatively little net revenue impact for New York State. The primary cost would involve the increased cost associated with using a B2 blend in State fleets. This is estimated at $622,000 over the 2007-2012 period without the tax incentives provided in the Energy Bill now in Congress. If the Energy Bill and associated tax provisions is passed, the net cost of the mandate to the State Treasury would be less than $25,000.

However, a mandate shifts the costs associated with using a more expensive fuel blend from the State to individual businesses and consumers. Without an Energy Bill, the total cost to businesses and consumers is estimated at $219.2 million between 2007 and 2012. The cost to highway users would amount to $102.6 million; the cost to residential home heating oil consumers would amount to $76.1 million. The cost to business and industry is estimated at $40.5 million over this same period. If the Energy Bill passes into law, total costs would fall to $5.1 million of which highway users would pay $3.2 million; residential consumers would pay $1.3 million; and businesses would pay $656,000.

The reason for the large disparity in costs between the Energy Bill and no-Energy Bill scenarios lies in the Federal excise tax incentives provided by the Energy Bill. The Energy Bill provides an exemption from Federal Excise Taxes on diesel fuel of $1.00 per gallon for biodiesel made from soybean oil and animal fats and $0.50 per gallon for biodiesel made from yellow grease. This means that the 70/30 blend contemplated for New York would enjoy a $0.65 per gallon exemption. This would be passed directly along to consumers.

A B2 mandate would result in new investment and spending on biodiesel production and infrastructure investment. When the impacts of the capital and annual operating expenditures are considered, a mandate that results in a 30 MGY biodiesel industry would add nearly $380 million (1996 dollars) to the New York economy by 2012, generate an additional $177.5 million in real household income by 2012, and create as many as 1,145 new jobs throughout the New York economy. Failure to pass the Energy Bill would reduce the economic impacts slightly.

Increased income and spending will generate additional tax revenue for the State Treasury. The increased economic activity is expected to generate an additional $19.1 million in State sales, personal income, and business income taxes by 2012. When the costs to the State are netted out against the additional revenues, a mandate would provide a significant positive budgetary impact for the State Treasury.

- <u>Mandate combined with an incentive for infrastructure (Policy Option 2)</u>

Another option involves providing an incentive for expanding and improving terminal facilities to store and handle biodiesel and biodiesel blends combined with the mandate option. This incentive would offset some of the infrastructure costs that distributors would incur to meet mandated biodiesel demand. We expect that the cost to improve the existing 85 terminals in New York will be about $64 million. To facilitate this transformation and ease the financial burden on blenders and distributors, we considered an incentive of $0.25 per gallon for a total cost of nearly $32 million to the State Treasury between 2007 and 2012.

Since this policy option has no additional impact on attracting biodiesel production capacity and annual production, the economic costs and benefits are essentially the same as for a stand-alone mandate. The exception to this is in the cost to the State Treasury. The additional costs associated with providing the infrastructure incentive are estimated at about $32 million. When the additional revenue provided by the increased economic activity is considered, this policy option will result in an estimated net loss of revenue to New York State of about $10.0 million between 2007 and 2012.

- <u>Mandate combined with a biodiesel supply incentive. (Policy Option 3)</u>

  An alternative policy option for consideration is combining a mandate for biodiesel use with a supply incentive for the production of biodiesel. This incentive would provide a grant of $0.10 per gallon of biodiesel produced in New York State up to a maximum of 10 million gallons capped at five years.

  Since this combination creates a base of demand and provides an incentive for producers, it is expected to stimulate investment of 40 MGY of biodiesel capacity and production in New York State. Reflecting the larger investment and annual biodiesel production provided by this option, the combination of a mandate and supply incentive produces the largest economic benefits to New York State. Under a national energy policy, this policy option would add almost $410 million (1996 dollars) to the New York economy by 2012; an additional $195.9 million would be added to the income of New York households; and nearly 1,300 new jobs would be created in all sectors of the New York economy. If the Energy Bill is not passed we expect that the mandate and supply incentive will still attract investment, but the total economic impact would be slightly smaller.

  As is the case with a stand-alone mandate, this policy option shifts the costs associated with using a more expensive fuel blend from the State to individual businesses and consumers. Without an Energy Bill, the total cost to businesses and consumers is estimated at $219.2 million between 2007 and 2012. The cost to highway users would amount to $102.6 million, the cost to residential home heating oil consumers would amount to $76.1 million. The cost to business and industry is estimated at $40.5 million over this same period. If the Energy Bill passes into law, total costs would fall to $5.1 million of which highway users would pay $3.2 million; residential consumers would pay $1.3 million; and businesses would pay $656,000.

  The costs to the State Treasury of this option are larger than with a stand-alone mandate and are estimated at $9 million. However, increased income and spending will generate additional tax revenue for the State Treasury. The increased economic activity is expected to generate an additional $24.3 million in State sales, personal income, and business income taxes by 2012 if the Energy Bill passes and $21.3 million in the absence of an energy policy. When the costs to the State are netted out against the additional revenues, a mandate would provide a positive budgetary impact for the State Treasury of $12.3 million under no national energy policy and $15.3 million if the Energy Bill were passed.

- Stand alone supply incentive (Policy option 4)

  An alternative policy option for consideration is a supply incentive that provides a grant of $0.10 per gallon of biodiesel produced in New York State up to a maximum of 10 million gallons capped at five years. In the absence of a national energy policy, this type of incentive alone is not likely to attract a significant amount of investment in biodiesel production in New York State. The reason for this is that while the incentive reduces capital costs it will have no material impact on demand. Consequently, investors face the risk of creating supply for which no demand exists.

  Even with an Energy Bill, investors are likely to wait to see how major soybean producing states respond in increasing capacity and how New York is supplied with biodiesel fuel. As a result, we expect this policy option to attract a minimal 10 million gallons of biodiesel capacity between 2007 and 2009 at a cost to the State of $4.5 million.

  A small capital level of investment and annual production will provide limited benefits to the New York economy. This option would increase the New York economy by only $75 million (1996 dollars) by 2012; add $35 million to household income; and create only 200 new jobs. Despite the relatively small costs to the State Treasury, the limited economic activity generated by this option falls short of covering the costs so that a small net loss of about $240,000 is generated.

  As is the case with a mandate, this policy option shifts the costs associated with using a more expensive fuel blend from the State to individual highway users of biodiesel. Without a National Energy Bill, the total cost to the transportation sector is estimated at about $33 million between 2007 and 2012. If the Energy Bill were passed with tax incentives for biodiesel, the cost to the transportation sector would fall to less than $1 million between 2007 and 2012.

- Combined supply and demand incentive (Policy option 5)

  The final option investigated involved combining a demand incentive to the supply incentive described above. This incentive would take the form of a one-half of one cent exemption from New York State excise taxes on distillate fuel for each one percent of biodiesel used. This amounts to a one cent per gallon exemption for a B2 blend. Since this equates to $0.50 per gallon for B100, this option turns out to be expensive, amounting to a cost to the State Treasury of $77.3 million between 2007 and 2012 ($86.0 million when the supply incentive is added).

  Since this combination stimulates demand, the option is expected to attract 30 MGY of biodiesel production capacity and add between $272 and $274 million to the New York State economy by 2012, increase household income by $132 million, and create about 950 new jobs.

However, the additional revenue generated by this increased economic activity is estimated at only $16.4 million, resulting in a deficit to the Treasury of between $69.3 and $69.6 million between 2007 and 2012.

Since this policy option provides a demand incentive in the form of a reduction in the New York State excise tax on diesel fuel, the total costs to highway users, residential consumers, and businesses is considerably smaller than a mandate option, ranging from $105 million with no Energy Bill to $1.5 million if an Energy Bill passes.

Table 1

Economic Costs and Benefits of Alternative New York State Biodiesel Policy Options: No National Energy Bill (Cumulative 2007-2012)

	OPTION 1 B2 Mandate Highway fuel 2007 Other Use 2009	OPTION 2 B2 Mandate Plus Infrastructure Incentive	OPTION 3 Combined B2 Mandate Plus $0.10/gal Supply Incentive	OPTION 4 Stand Alone Supply Incentive $0.10/gal up to 10 MGY	OPTION 5 Combined Supply & Demand Incentive
Capacity created	30 MGY	30 MGY	40 MGY	10 MGY	30 MGY
Macroeconomic Impacts					
Gross Output (Mil 96$)	$766.186	$766.186	$879.543	$137.459	$605.868
GSP (Mil 96$)	$377.989	$377.989	$405.990	$59.021	$272.172
Household Income (Mil 96$)	$176.594	$176.594	$193.992	$35.269	$131.181
Max new jobs	1,135	1,135	1,274	200	941
NY Treasury Impact:					
Direct Cost (Mil $)	$0.622	$31.872	$9.019	$4.500	$85.571
Revenue (Mil $)	$19.053	$20.975	$21.269	$4.261	$16.258
NY State Sales Tax	$9.863	$11.764	$11.388	$2.531	$9.515
NY Personal Income Tax	$7.399	$7.548	$8.030	$1.514	$5.620
NY Corporate Tax	$1.791	$1.663	$1.850	$0.216	$1.124
Net Treasury Impact (Mil $)	$18.431	($10.897)	$12.250	($0.239)	($69.313)
Other Costs:					
Highway users	($102.639)	($102.639)	($102.639)	($33.370)	($96.521)
Residential consumers	($76.118)	($76.118)	($76.118)	NA	NA
Business & Industry	($40.484)	($40.484)	($40.484)	NA	($8.931)
Total Other Costs	($219.241)	($219.241)	($219.241)	($33.370)	($105.451)

Note: Each Policy Option includes infrastructure investment of $64 million.

Table 2

Economic Costs and Benefits of Alternative New York State Biodiesel Policy Options: National Energy Bill (Cumulative 2007-2012)

	OPTION 1 Stand Alone B2 Mandate Highway fuel 2007 Other Use 2009	**OPTION 2** B2 Mandate Plus Infrastructure Incentive	**OPTION 3** Combined B2 Mandate Plus $0.10/gal Supply Incentive	**OPTION 4** Stand Alone Supply Incentive $0.10/gal up to 10 MGY	**OPTION 5** Combined Supply & Demand Incentive
Capacity created	30 MGY	30 MGY	40 MGY	10 MGY	30 MGY
Macroeconomic Impacts					
Gross Output (Mil 96$)	$770.998	$770.998	$889.924	$160.889	$610.680
GSP (Mil 96$)	$379.497	$379.497	$409.426	$74.051	$273.680
Household Income (Mil 96$)	$177.460	$177.460	$195.896	$35.269	$132.047
Max new jobs	1,145	1,145	1,292	200	950
NY Treasury Impact:					
Direct Cost (Mil $)	$0.019	$31.269	$9.019	$4.500	$85.970
Revenue (Mil $)	$21.470	$21.470	$24.320	$4.261	$16.382
NY State Sales Tax	$12.084	$12.084	$14.021	$2.531	$9.590
NY Personal Income Tax	$7.585	$7.585	$8.419	$1.514	$5.657
NY Corporate Tax	$1.801	$1.801	$1.880	$0.216	$1.136
Net Treasury Impact (Mil $)	$21.451	($9.799)	$15.301	($0.239)	($69.588)
Other Costs:					
Highway users	($3.171)	($3.171)	($3.171)	($0.870)	($1.379)
Residential consumers	($1.256)	($1.256)	($1.256)	NA	NA
Business & Industry	($0.656)	($0.656)	($0.656)	NA	($0.073)
Total Other Costs	($5.084)	($5.084)	($5.084)	($0.870)	($1.451)

Note: Each Policy Option includes infrastructure investment of $64 million.

INTRODUCTION

The purpose of this report is to present the findings of a comprehensive analysis of the economic feasibility of creating a biodiesel industry in New York State. An integral part of the study is a review of possible policy options and an assessment of their costs and benefits to New York State and New York consumers.

The market for diesel fuel in New York is substantial. Total distillate fuel use in New York is estimated at 3.2 billion gallons in 2002 and is projected to increase at an annual rate of about 1.2 percent over the next decade. A B2 mandate covering all end uses would create a market of 64.1 million gallons that would increase to 73.7 million gallons by 2012. A more limited mandate covering on-highway diesel uses beginning in 2007 and expanding to include residential, commercial, industrial, and utility uses in 2009 would create a market of 23.3 million gallons in 2007 increasing to 70.6 million gallons by 2012.

The maximum capacity of New York to produce biodiesel is currently estimated at about 30 million gallons. This is projected to increase to 40 million gallons by 2012. This assumes that all of the soybeans grown in New York are crushed using current technology (mechanical extraction that yields 7.8 pounds of oil per bushel) and all of the oil produced along with all of the yellow fat produced in the state is used to produce biodiesel. Consequently, New York could theoretically meet all of the demand for a B2 mandate covering on-highway transportation fuel by 2007 and about half the demand created by a full B2 mandate by 2012.

This report addresses the major issues and tasks outlined in the NYSERDA Statement of Work (SOW) for this project. The section numbers correspond to the Tasks outlined in the SOW.

TASK 2: CURRENT AND FORECAST SUPPLY AND DEMAND OVERVIEW

Subtask 2.1: Distillate Fuel Demand – Current and Forecast Growth

Total U.S. demand for diesel fuel was approximately 58 billion gallons in 2002. According to the U.S. Energy Information Administration, diesel demand is expected to increase by 2.4 percent annually over the next decade, with on-highway demand accounting for over half of the nation's diesel consumption. As illustrated in Table 2.1, diesel demand within the on-highway end-use sector will increase at 3.4 percent annually and is expected to account for over sixty-three percent of nationwide distillate fuel consumption by 2015.

Table 2.1
United States Distillate Fuel Demand by End Use Segment (Million Gallons)

	2002	2005	2010	2015	CAGR*
Residential	6,492.54	7,014.93	6,791.04	6,492.54	0.0%
On-Highway	33,370.84	37,436.64	45,140.38	51,508.51	3.4%
Freight Trucks	30,078.13	33,323.34	39,469.52	44,456.23	3.1%
Intercity Bus	280.46	285.32	299.11	305.56	0.7%
Transit Bus	725.69	738.27	773.94	790.64	0.7%
Light-Duty Vehicle	1,437.97	2,226.40	3,692.79	5,031.52	10.1%
School Bus	848.60	863.31	905.03	924.55	0.7%
Commercial	3,358.21	10,895.52	3,582.09	3,656.72	0.7%
Industrial	8,059.70	8,283.58	9,029.85	9,626.87	1.4%
Freight Rail	3,674.00	3,745.23	4,030.54	4,207.96	1.0%
Intercity Rail	125.96	132.75	146.10	159.79	1.8%
Commuter Rail	199.70	210.47	231.63	253.34	1.8%
Utilities	447.76	597.01	820.90	820.90	4.8%
Domestic Shipping	1,818.71	1,872.35	2,019.28	2,143.12	1.3%
International Shipping	372.84	387.78	390.62	393.56	0.4%
Military	826.01	885.99	895.13	938.24	1.0%
Total Diesel	58,746.27	71,462.25	73,077.56	80,201.53	2.4%

* Compound annual growth rate
Source: Energy Information Administration. Annual Energy Outlook 2003 with Projections to 2025. Report #: DOE/EIA-0383(2003). January 9, 2003

The market for diesel fuel in New York is substantial. Total distillate fuel use in New York is estimated at 3.2 billion gallons in 2002 and is projected to increase at an annual rate of about 1.2 percent over the next decade. As shown in Table 2.2, residential demand for home heating is the largest end-use segment of distillate demand. On-highway transportation and commercial use are the next largest end uses. Together, these three categories account for more than 95 percent of diesel use in New York.

Table 2.2
New York Distillate Fuel Demand by End Use Segment (Million Gallons)

	2002	2005	2010	2015	CAGR
Residential	1,413.1	1,519.3	1,449.7	1,354.5	-0.3%
On-Highway	963.4	1,082.1	1,308.9	1,497.4	3.5%
Freight Trucks	667.2	739.1	875.5	986.1	3.1%
Inter-City Busses	85.9	87.3	91.6	93.5	0.7%
Transit Busses	74.7	76.0	79.7	81.4	0.7%
Light Duty Trucks	78.3	121.2	201.0	273.8	10.1%
School Busses	57.4	58.4	61.2	62.5	0.7%
Commercial	661.7	671.7	671.7	656.8	-0.1%
Industrial	41.0	40.3	43.7	45.7	0.8%
Farm	38.0	42.1	49.9	56.2	3.1%
Off-highway	37.8	41.9	49.6	55.9	3.1%
Rail	24.9	25.4	27.3	28.5	1.0%
Utilities	7.8	6.7	10.0	11.1	2.8%
Vessel Bunkering	14.6	15.1	16.1	16.9	1.1%
Military	1.9	2.1	2.1	2.2	1.0%
Other	0.1	0.1	0.1	0.1	3.1%
Total Diesel	3,204.4	3,446.7	3,629.2	3,725.4	1.2%

The composition of distillate demand in New York is projected to change considerably over the next decade as growth in light and heavy trucks accelerates. By 2015 on-highway use of diesel fuel will eclipse residential demand. Most other end-use segments are projected to grow at a two percent annual rate between 2002 and 2015.

Subtask 2.2: Feedstock Supply Analysis

The most important input in the biodiesel production is the fat or oil used as a feedstock. The focus of this section is to identify and quantify current and potential biodiesel feedstocks as well as to summarize factors that may impact their use for biodiesel fuel. The New York region, defined here as New York, New Jersey and Pennsylvania, produces or generates feedstocks that can be used to produce biodiesel: yellow grease, animal fat and soybean oil. Fats and oils imported from Canada or other foreign sources were not factored into this analysis for three reasons.

- Biodiesel made from these products does not qualify for payment under the Commodity Credit Corporation's (CCC) Bioenergy Program. This program received funding in the Farm Bill through FY 2006. It is not yet determined whether this program will be extended or not. If so, it is unlikely that imported fats and oils would qualify.

- One of the benefits of biodiesel is the contribution it makes to reduce this country's dependence upon foreign oil. Using imported animal fats and vegetable oils may help diversify our sources of energy but it does not help reduce our dependence upon foreign countries for our energy needs.

- The amount of animal fats and vegetable oils imported into New York ports of entry that is suitable for use in the production of biodiesel is relatively small. Imports of all animal fats and vegetable oils through ports of entry in New York and Vermont average 6.1 million pounds annually in 2000-2002. Only a fraction of this would potentially be used for biodiesel production.

Subtask 2.2.1: Supply of Oilseed Crops and potential for conversion of other crops to oilseeds

Soybeans are the predominant oilseed produced in New York State and the Northeast region of the United States. Small quantities of other oilseeds, notably sunflower and canola, also are grown. As shown in Figure 2.1 and Table 2.3, between 2000 and 2002 New York farmers harvested an average of nearly 4.6 million bushels of soybeans annually on 142,400 acres. According to the National Agricultural Statistics Service, New York farmers expect to harvest nearly 5.3 million bushels of soybeans in 2003. Ten New York counties concentrated in the northwest part of the State account for more than 85 percent of total New York soybean production.

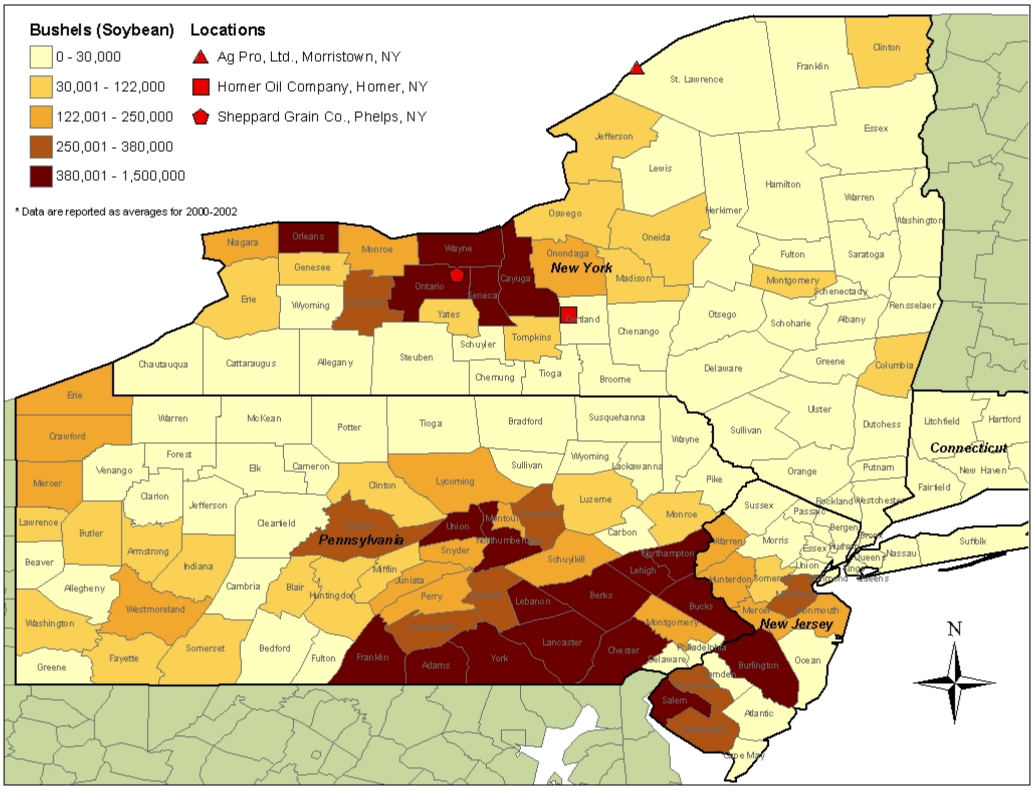
A biodiesel industry in New York would also provide a ready market for soybeans grown in nearby states. Over this same period, Pennsylvania farmers produced an average of 13.2 million bushels of soybeans while New Jersey harvested an additional 3.1 million bushels. In 2003, Pennsylvania soybean farmers will harvest 14.6 million bushels while New Jersey will produce 2.9 million bushels. Consequently, a New York biodiesel industry could call on an annual regional soybean production of about 22.8 million bushels in 2003, or the equivalent of 246 million pounds of soybean oil.

Table 2.3
New York Soybean Acreage and Production by County, 2000-2002

	Harvested Area (Acres)				Production (bu)			
	2000	**2001**	**2002**	**Average**	**2000**	**2001**	**2002**	**Average**
Cayuga	20,500	21,500	22,400	21,467	711,400	814,400	655,900	727,233
Seneca	24,000	22,600	18,700	21,767	707,800	773,400	537,000	672,733
Orleans	12,300	18,300	18,100	16,233	421,000	510,900	627,600	519,833
Wayne	13,700	15,900	14,100	14,567	505,800	566,700	484,500	519,000
Ontario	11,100	16,000	10,600	12,567	332,000	494,800	321,700	382,833
Livingston	9,700	10,600	5,800	8,700	289,900	330,100	179,000	266,333
Monroe	6,300	9,100	6,500	7,300	220,200	300,700	213,600	244,833
Onondaga	6,900	7,600	7,200	7,233	164,600	278,300	224,900	222,600
Niagara	4,100	9,800	8,700	7,533	148,600	220,800	283,200	217,533
Genesee	3,300	4,400	4,100	3,933	103,300	126,200	117,500	115,667
Oswego	2,000	2,300	1,900	2,067	80,400	86,400	63,200	76,667
Oneida	1,900	1,600	1,900	1,800	74,000	76,800	76,900	75,900
Columbia	1,700	2,000	1,700	1,800	46,600	81,000	62,200	63,267
Tompkins	2,100	1,600	2,000	1,900	62,100	49,800	64,700	58,867
Clinton	1,500	1,500	1,400	1,467	60,700	69,000	45,200	58,300
Erie	1,900	2,100	2,000	2,000	58,700	50,100	65,500	58,100
Madison	2,000	1,200	1,800	1,667	75,700	34,800	52,100	54,200
Yates	1,700	2,500	1,700	1,967	56,900	60,200	43,100	53,400
Jefferson	1,800	1,900	1,500	1,733	55,000	57,100	40,000	50,700
Montgomery	700	1,400	1,500	1,200	22,600	49,600	66,100	46,100
Cattaraugus	-	800	700	500	-	26,300	34,000	20,100
Wyoming	700	400	400	500	24,500	12,300	12,700	16,500
Chautauqua	-	500	500	333	-	21,000	18,000	13,000
Franklin	1,300	900	900	1,033	20,600	7,600	6,500	11,567
Herkimer	-	300	300	200	-	8,800	13,200	7,333
Washington	-	400	300	233	-	15,300	-	5,100
Cortland	-	-	500	167	-	-	15,200	5,067
Saratoga	-	300	-	100	-	13,000	-	4,333
St. Lawrence	-	400	-	133	-	11,000	-	3,667
Dutchess	-	-	300	100	-	-	9,300	3,100
Schuyler	-	300	-	100	-	9,300	-	3,100
Chemung	-	-	300	100	-	-	8,600	2,867
Total	**131,200**	**158,200**	**137,800**	**142,400**	**4,242,400**	**5,155,700**	**4,341,400**	**4,579,833**

Source: USDA National Agricultural Statistics Service.

Figure 2.1
Soybean Production in New York and Surrounding States
(Average 2000-2002)



A limiting factor for a potential biodiesel industry in New York is soybean-processing capacity. Reflecting the relatively small quantity of soybeans grown, few soybean processors operate in New York. We have identified three major processors in New York that crush soybeans to produce soybean meal (used for animal feed) and soybean oil. Their locations are also shown on Figure 2.1

- **Sheppard Grain Company** operates a soybean crushing and soybean oil expelling plant in Phelps, Ontario County with capacity to process 7,300 bushels per day. They are currently processing half that amount. According to Steve Sheppard, the market for meal rather than the market for soybean oil currently drives their production level.

- **Homer Oil Company** operates a soybean crushing plant in Homer, Cortland County. They have the capacity to crush about 6,000 bushels of soybeans per day but currently are processing 3,500 bushels. According to Tom Kohne, the soybean meal market also drives Homer Oil's operations.

- **Ag Pro, Ltd.** processes 1,850 bushels of soybeans per day in Morristown, St. Lawrence County and has the capacity to process 5,500 bushels per day. According to Ag Pro, crush is limited by the current high price of soybeans and low milk prices, which have led to decreased demand for high-quality feed.

Each of the three New York soybean crushing operations utilizes mechanical extraction rather than solvent extraction to produce soybean oil. This method is less efficient and yields a lower quantity of soybean oil (7.8 pounds per bushel compared to 10.5 to 11.0 pounds from the solvent extraction process used in larger plants).

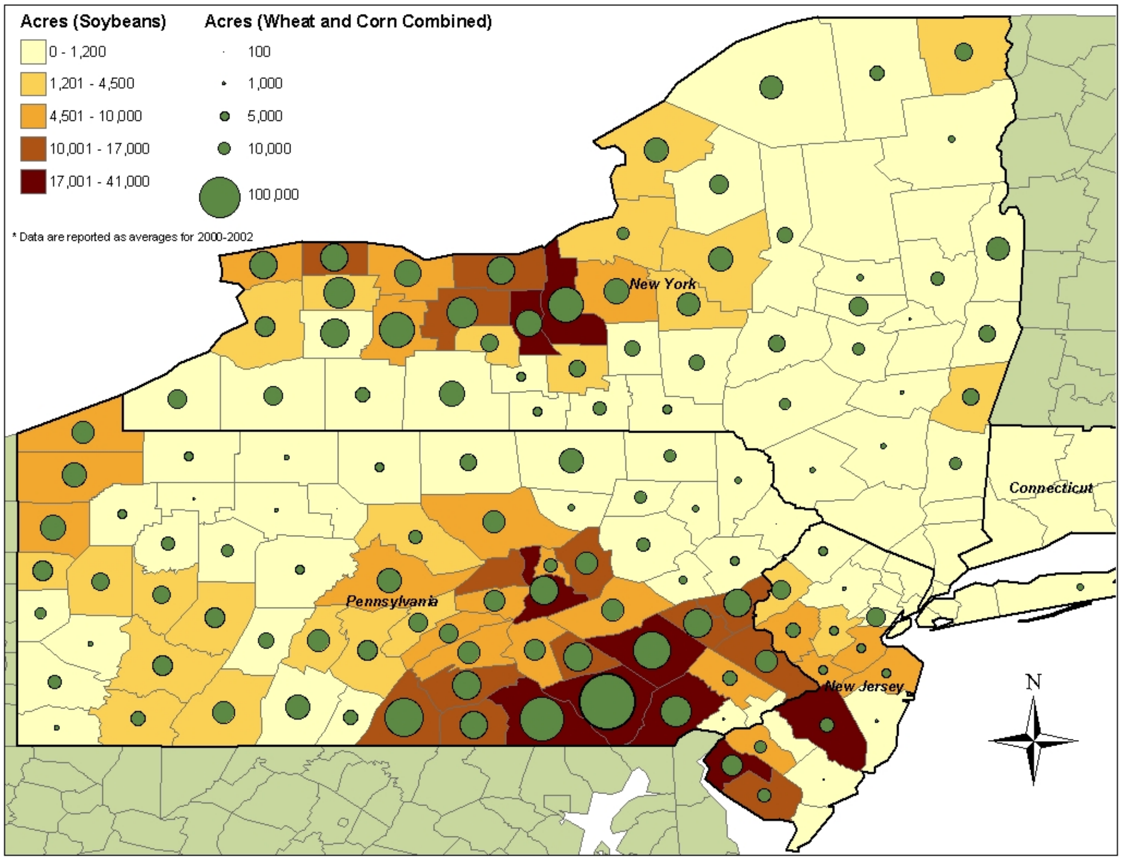
All three operations are currently operating at about one-half capacity due to weak market conditions for soybean meal. At maximum capacity, these operations could process approximately 17,270 bushels of soybeans per day yielding approximately 135,000 pounds of soybean oil. On an annual basis this amounts to about 45 million pounds of soybean oil or 5.9 million gallons of biodiesel.

Other crop acreage suitable for soybean production

The most widely planted field or forage crop in New York State is hay followed by corn. Over the past several years, New York farmers planted an average of 1.7 million acres to hay, 1.03 million acres to corn, 127,000 acres to winter wheat, 85,000 acres to oats, and 13,000 acres to barley. According to the Census of Agriculture an estimated 244,400 acres of New York cropland is idle and an additional 85,000 acres are enrolled in the Conservation Reserve or Wetlands Reserve Program.

Soybeans are grown on the same area as corn and winter wheat and play a major role as a rotational crop to restore and enhance nitrogen in soils. New York already is a corn deficient state; that is, less corn is produced than is required to feed the livestock, dairy herds and poultry flocks in the state. An increase in soybean prices resulting from new demand for soybean oil to make biodiesel is likely to pull some land from both corn and winter wheat in New York as well as provide an incentive for farmers to bring idled land back into production. Although hay is an important crop for New York's large dairy industry, declining dairy cow numbers reduce the annual requirement for this forage and are expected to free up acreage that could be planted to soybeans. Figure 2.2 displays the acreages of soybeans, corn, and wheat by county in New York.

Figure 2.2
Soybean, Corn, and Wheat Acres in New York and Surrounding States
(Average 2000-2003)



Other oilseed crops suitable for production in New York State that are not currently planted are winter canola and sunflowers. Winter canola, or winter rapeseed, is suitable to growing conditions in central and western New York State, and could produce yields as high as 3,500 lbs/acre.[1] Winter canola would most likely compete with acreage currently planted to winter wheat, soybeans, dry beans and vegetables. Based on strong demand, between 100,000 and 200,000 acres could be converted to winter canola, yielding 150,000 to 300,000 tons of canola annually. However, high levels of winter canola production would result in reduced soybean production as soybean acreage shifted to winter canola production.

Sunflowers are another oilseed crop suitable to New York State growing conditions. In Cornell Research trials conducted in the late 1970s, New York State yields averaged as high as 3,000 lbs/acre.[2] However, like winter canola, sunflowers would compete directly with soybean acreage as well as acreage in dry beans. Strong demand could result in potential sunflower acreage of 100,000 to 200,000 acres, yielding 100,000 to 250,000 tons annually, but would result in reduced soybean acreage and production.

[1] Wright and Ellis, Cornell Research Trials, 1990.
[2] Knapp, Cornell Research Trials, 1979.

As with soybeans, a limiting factor for canola or sunflower is processing capacity. If these crops were to be grown, new crushing capacity would have to be built and markets for the meal would need to be developed. Further, the economics of crush demand for these alternate crops would have to be borne primarily from the oil component since the demand base for the meal from these crops is small.

Subtask: 2.2.2: Supply of Animal Fats and Waste Greases

Animal Fats

These sources of biodiesel feedstocks are derived from the rendering process using animal tissues as the raw material. The raw material is ancillary to the slaughter and processing of food producing animals for edible meat. The amount of animal fats produced correlates to the species of animal slaughtered or processed and the degree of further processing that is associated with the marketing and distribution of the meat. The major supplies of animal fats and greases in this region are cattle (tallow), poultry (poultry fat) and hogs (choice white grease).

The annual slaughter of food animals establishes the production of fats and greases. In a given geography such as New York State, the production will be correlated to the slaughter and processing of animal tissues in the region. According to information by the U.S. Department of Agriculture in December of 2001, there were 1,615 federally inspected meat and poultry establishments in New York, New Jersey and Pennsylvania. These facilities may slaughter, process or bone the meat. Of these facilities, 25 process their own edible and inedible fats while the other facilities send their fats to rendering companies.

Livestock slaughter numbers for all species are significantly higher in Pennsylvania than in either New York or New Jersey. As a result, Pennsylvania slaughter and processing facilities generate the most animal fats of the three states analyzed, supplying up to 89 percent of the total animal fat in the region. Animal fat supplies are based upon inedible yields at slaughter and the amount of fat comprising the inedible portion of the animal. The average slaughter weights of animals in each state during 2000-2002 were multiplied by the inedible yield and percentage of fat comprising the inedible yield to provide animal fat per head by species. This figure was then multiplied by the average annual slaughter during the same time period.

Table 2.4
Estimated Quantities of Animal Fats Produced in New York, New Jersey and Pennsylvania[3]

Species	New York	New Jersey	Pennsylvania	Total
		Pounds		
Cattle	6,051,172	2,988,978	126,516,044	**135,556,194**
Hog	657,797	871,926	51,401,295	**52,931,018**
Sheep	260,856	982,433	577,464	**1,820,753**
Poultry	7,142,468	4,998,698	15,611,785	**27,752,951**
Turkey	N.A.	N.A	4,447,759	**4,447,759**
Total	**14,112,293**	**9,842,035**	**198,554,347**	**222,508,675**

If all of the animal fat generated in New York, New Jersey and Pennsylvania were processed into biodiesel it would produce approximately 30 million gallons of biodiesel. However, only 1.9 million of those gallons would be produced by feedstocks originating in New York. Therefore, any considerable reliance upon animal fats as a biodiesel feedstock would require animal fats produced in other states, particularly Pennsylvania.

The following table contains a list of meatpacking and processing locations in New York and Pennsylvania with animal fat rendering capabilities.

Table 2.5
Animal Fat Rendering Locations

Company Name	Location		
Red Meat/Poultry Processing			
Alle Processing Corp	Maspeth	NY	11378
B. Rosen & Sons	Bronx	NY	10474
Bilinski Sausage Mfg., Co.	Cohoes	NY	12047
Boars Head Provision Co	Brooklyn	NY	11201
David Mosner	Bronx	NY	10451
David Mosner	Nanuet	NY	10954
DeAn's Pork Products	Brooklyn	NY	11201
Fairbanks Reconstruction Corp	Ashville	NY	14710
Hofmann Sausage	Syracuse	NY	13202
Int'l Glatt Kosher Meat Proc	Brooklyn	NY	11220
Kane-Miller Corp	Tarryton	NY	10591
Kansas Packing Co	Kenilworth	NY	11024
Kerr's Custom Butchering	South Dayton	NY	14138
London Meat Corporation	New York	NY	10014
National Foods	Bronx	NY	10451
Newburg Packing Corp	Newburgh	NY	12550
PACE Management	Painted Post	NY	14870

[3] Data for this table has been compiled from U.S. Department of Agriculture Livestock and Poultry Slaughter Reports as well as Goldstrand, R. E. 1992. An Overview of Inedible Meat, Poultry and Fishery By-Products. In: Inedible Meat By-Products (A.M. Peirson and T.M. Dutson,) Editor Elsevier, N.Y. and from a survey of representative renderers.

Company Name	Location		
Red Meat/Poultry Processing			
Plymouth Beef Company	New York	NY	10001
Rudolph Frey Inc.	Buffalo	NY	14201
Russner Foods	Buffalo	NY	14201
Schaller and Weber Inc.	Long Island City	NY	11101
St. James Alpert Brands	Farmington	NY	14425
Alfery's Sausage Co	Mt Pleasant	PA	15666
Andrews Dried Beef Co	Nazareth	PA	18064
Conagra Grocery Products Co	Milton	PA	17847
Dietz & Watson Inc	Philadelphia	PA	19135
Emerick's Meat & Pkg Co Inc	Hyndman	PA	15545
Great Valley Meat Co	Berwyn	PA	19312
Green Valley Packing Co Inc	Claysville	PA	15323
H J Heinz LP	Pittsburgh	PA	15212
Hatfield Quality Meats Inc.	Hatfield	PA	19440
J L Miller Sons Meats Inc	York	PA	17103
John F Martin & Sons Inc	Stevens	PA	17578
John F Martin & Sons Inc	Stevens	PA	17578
Juniata Packing Co Inc/CCK Inc	Tyrone	PA	16686
Kessler's Inc	Lemoyne	PA	17043
Kunzler and Co	Lancaster	PA	17601
Moyer Packing Company	Souderton	PA	18964
North Side Foods Corp	Arnold	PA	15068
Passanante Bros Inc	Bristol	PA	19007
Peters Bros Meat Market Inc	Lenhartsvile	PA	19534
Pilgrim's Pride Corporation	Franconia	PA	18924
Standard Beef Inc.	Dunmore	PA	18512
Stoltzfus Meats	Intercourse	PA	17534
Taylor Packing Co Inc	Wyalusing	PA	18853
Wedco Inc	Pittsburgh	PA	15222
Youndt Bros	Denver	PA	17517
814 Americas Inc	Elizabeth	NJ	07202
Beef International Inc	Pennsauken	NJ	08109
Bringhurst Bros Inc	Berlin	NJ	08009
Buona Vita	Bridgeton	NJ	08302
Burger Maker	Carlstadt	NJ	07072
Cameco, Inc.	Verona	NJ	07044
Case Pork Roll Co	Trenton	NJ	08608
Davidson Meat Prod	New Bedford	NJ	07719
Kohler Delicatessen Mtg.	Newark	NJ	07102
Topps Meat Co Inc	Elizabeth	NJ	07207

Company Name	Location		
Red Meat/Poultry Processing			
Renderers			
B.A. Tofte Co.	Center Moriches	NY	11934
Baker Commodities	Rochester	NY	14603
By-Products Group, Inc	Wyalusing	PA	18853
Moyer Packing Company	Souderton	PA	18964
Valley Proteins	East Earl	PA	17519
Valley Proteins	Pittsburgh	PA	15122
American By-Products	Morristown	NJ	07960
Darling International	Newark	NJ	07102
Harry Berkowitz Industries, Inc.	Newark	NJ	07102
J&R Rendering	West New York	NJ	07093
M&E Soap Co. Inc.	Morris Plains	NJ	07950
Wagman Company	Leonia	NJ	07605

Waste Greases: Yellow and Brown[4]

Yellow grease: Yellow grease is manufactured from spent cooking oil. Spent cooking oil can be vegetable oil or animal fat that was heated and used for cooking. Renderers "manufacture" yellow grease from spent cooking oil by filtering out the solids and heating the spent cooking oil to drive out moisture until the oil meets industry specifications for yellow grease.[5]

Yellow grease is best defined as a fat product that does not meet the definitions for animal fat, vegetable fat or oil, hydrolyzed fat or fat ester. There are no published statistics on the production and consumption of yellow grease. Nor has the volume of used cooking oils and restaurant greases generated by the foodservice industry been well documented either. A very influential factor in establishing accurate volumes is the actual yield from the material obtained from the food service site. The raw material is diluted with water and contains solid material such as French fry and breading particles. These fractions must be removed by processing. The most commonly experienced yield is 65 percent, though this is highly variable and considered to be proprietary by most renderers. Another factor in accurately determining yellow grease supply is identifying non-renderer grease collectors of which resale or disposal is often not recorded. Pilfering of grease containers is also a problem in certain locations, especially when market prices for yellow grease are up.

[4] The information for this section was collected through a thorough research of available market and technical literature on yellow and brown grease supply and use. Personal conversations were held with Ralph Groschen of the Minnesota Department of Agriculture regarding his work and conclusions, and with the New York City Department of Environmental Protection. The NYC DEP has regulations requiring grease-generating establishments to install and operated grease interceptors. Compliance is difficult to monitor and reliable estimates of the amount of grease collected versus the amount disposed are difficult to obtain. We did, however, obtain quantitative data for waste grease collected at the 14 NYC wastewater treatment plants in 2003, which provided an estimate of how much waste grease was going into the sewers on a per capita basis. Dr. Gary Pearl, President of the Fats and Proteins Research Foundation, provided the analysis of the quality issues regarding yellow and brown grease as well as other technical information.

[5] Groschen, Ralph, Minnesota Department of Agriculture, "Overview of: The Feasibility of Biodiesel from Waste/Recycled Greases and Animal Fats," October 2002, p. 2.

The supply and availability of waste grease is more difficult to quantify than for vegetable oils. Most yellow grease is produced by restaurant and food operations as they recycle cooking oils. Consequently, yellow grease output is directly tied to the number and type of restaurants in a locale (consider that the typical McDonald's changes their cooking oils about once every two weeks), and output is generally expressed in terms of pounds per capita. As shown in Table 2.6, per capita and per restaurant estimates of yellow grease production vary widely ranging from a low of 5.78 pounds per person to a high of 11.3 pounds per person.[6] The mid-point of this range suggests that New York State produces somewhere in the area of 180 million pounds of yellow grease annually. If all of this were directed to biodiesel production, this would provide for 24 million gallons of biodiesel production.

It is estimated that a very high percentage (estimated at more than 90 percent) of used cooking/restaurant grease is capable of being collected from restaurant and food operations. This number would not, however, include fats and greases generated in households but only from commercial and institutional food service establishments. The percentage of available yellow grease collected from restaurants today is almost certainly lower than 90 percent.

[6] In 2003, the Census Bureau started separating out estimates of production and consumption of yellow grease in their M311K Current Industrial Reports, "Fats and Oils: Production, Consumption and Stocks," available at http://www.census.gov/cir/www/311/m311k.html

Table 2.6
Estimates of Yellow Grease Production, New York State

Source	Pounds/ Person	Estimated NY State 2002 Population (Millions)	Estimated NY State Yellow Grease Production (Million pounds)
Applewhite (1993)[1]	5.78	19.2	110.7
Render Magazine (April 2002)[2]	11.32	19.2	216.9
USDA Avg yellow grease production (1995-2000)[3]	9.40	19.2	180.1
Wiltsee (1998)	8.74	19.2	167.4
Wiltsee (1998) - weighted average	8.87	19.2	169.9

Source	Pounds/ Restaurant	Estimated NY State 2002 # of Restaurants[4]	Estimated NY State Yellow Grease Production (million pounds)
Wiltsee (1998)	6,256	29,202	182.7
Wiltsee (1998) - weighted average	6,268	29,202	183.0
# of restaurants per 1,000 people[4]		0.66	

Notes:

1) Groschen (2002) derived this estimate by dividing Hunter and Applewhites' estimate of 1.5 billion pounds of yellow grease production in the U.S. in 1993 by the estimated U.S. population in 1993 (260 million).

2) Groschen (2002) reports that this estimate is based on U.S. Census Bureau's estimate of U.S. production of 3.17 billion pounds of "grease" in 2001, divided by the 2000 U.S. Census population of 280 million. Groschen points out that it is unclear how much yellow grease is included in the total amount of "grease." Thus, this estimate may overestimate yellow grease production.

3) Groschen (2002) derived this estimate by dividing the USDA estimates of average yellow grease production between 1995-2000 of 2.633 billion pounds by the 2000 U.S. Census population of 280 million.

4) Total number of full-service restaurants and limited-service eating places (including limited-service restaurants, cafeterias, and snack and nonalcoholic beverage bars). Wiltsee reports that there is not much variability in the number of restaurants per 1,000. Estimates ranged between 1 and 2 for all 30 cities he studied. Thus, 0.66 for NY state may seem low, but the use of state figures, rather than a specific metropolitan statistical area may explain this. New York: 2001, County Business Patterns, April 2003.

A list of companies in the Region that process yellow grease as well as other rendered products is presented in Table 2.7.

Table 2.7
Yellow Grease Rendering Locations

Rendering Companies	Location	
Darling International, INC	Newark	NJ
Harry Berkowitz Industries, INC	Newark	NJ
American By-Products	Morristown	NJ
J&R Rendering	West New York	NJ
M&E Soap Co., Inc.	Morris Plains	NJ
Wagman Company	Leonia	NJ
Baker Commodities, INC	Rochester	NY
BA Tofte Co., Inc.	Center Moriches	NY
By-Products Group, INC	Wyalusing	PA
Moyer Packing Company	Souderton	PA
Valley Proteins, INC	East Earl	PA
Valley Proteins, INC	Pittsburgh	PA

Brown, or Trap, grease: Brown grease is collected from grease traps installed in commercial, industrial or municipal sewage facilities to separate grease and oil from wastewater.[7] Regulations in some states are moving toward requiring disposal of trap grease by rendering companies rather than wastewater treatment plants.[8] The water content in trap grease is high, resulting in low yield per pound collected.[9]

A major determinant in the usability of waste greases is their free fatty acid content (FFA). This is "the amount of fatty acids (in weight percent) in an oil that is not connected to triglyceride molecules."[10] Oils that are heated during food processing and preparation have relatively high FFA contents, since heating can cause fatty acids to disconnect from triglyceride molecules.[11] Summer temperatures can also increase the FFA content of oils. C.T. Donovan Associates reported that the FFA content of rendered products processed from restaurant grease or spent cooking oil is between 10 and 20 percent, as compared with anecdotal evidence that suggests the FFA content of tallow processed from animal or slaughter oils and grease is three percent or less.[12] High FFA content may increase production costs for biodiesel.[13]

According to Wiltsee, annual production of brown grease averages an estimated 13.37 pounds per person. However, this type of grease typically is considered very low quality because it contains a significant amount of water and other materials. When this is

[7] Groschen, p. 2.
[8] Wiltsee, G., Appel Consultants, Inc. "Urban Waste Grease Resource Assessment." Report for National Renewable Energy Laboratory (NREL), NREL/SR-570-26141, November 1998, p. 5.
[9] Groschen, p. 2.
[10] C.T. Donovan Associates, Inc. "The Availability of No- to Low-Cost Feedstocks for Biodiesel and Ethanol in Philadelphia," Report submitted to Northeast Regional Biomass Program, July 1998, p. 2-6.
[11] *Ibid.* p. 2-7.
[12] *Ibid.* p. 2-12.
[13] *Ibid.* p. 2-12.

accounted for, the usable grease content can be as low as five to 10 percent.[14] In other words, the supply of brown grease in New York suitable for processing into biodiesel ranges from 13 to 25.7 million pounds annually. Currently, all work on converting brown grease to biodiesel is experimental.

The relationship between fat quality and biodiesel yield

Even though soybean oil is the most abundant feedstock available on a nation-wide basis, inedible tallow and yellow grease represent a more plentiful biodiesel feedstock in the New York state region. However as discussed above, the physical and fatty acid properties of these oil supplies relative to virgin oils and their corresponding impacts on the biodiesel production process and the biodiesel fuel may limit their uses in some areas.

To assist in the definitions of specific animal fat and grease feedstock resources the following specifications are provided for the basic categories of fat/grease used as feeding fats. It must be sold on its specifications, just like any other grade of fat, which include: the minimum percentage of total fatty acids, the maximum percentage of unsaponifiable matter, the maximum percentage of insoluble impurities, the maximum percentage of free fatty acids and the amount of moisture. Most importantly, it must meet the Food and Drug Administration (FDA) established criteria for pesticides *or* other toxic chemicals. Definitions of some of the quality characteristics of fats and oils are included below.

- **Titer**, is the solidification point of the fat in degrees Centigrade, and is a rough measure of the saturation level of the fat. The higher the titer the more saturated the fat.

- **FFA** is the amount of free fatty acids contained in the product. Fats and oils are compounds containing three fatty acids each chemically connected to an oxygen on a glycerine molecule. Consequently, compounds with this structure are called triglycerides. Free fatty acids are those structures that are no longer connected to the glycerine. They are a degradation product and a measure of the quality of the fat. A high quality fat has a low FFA level.

- **MIU** (moisture, insolubles, and unsaponifiables) is a measure of the remaining compounds in the fat that are not fatty acids or triglycerides. It is also a measure of quality, as is the color. The lower the MIU level the higher the quality of the fat.

- **Iodine** value is a measure of the hardness or softness of fat and is defined as the grams of iodine absorbed by 100 grams of fat. Unsaturated fats have a higher iodine value than saturated fats. Consequently, the higher the iodine value the softer the fat.

- **AOM Stability** is a measure of the peroxide value after 20 hours of bubbling air through the sample. This test is intended to determine the ability of the fat to resist oxidative rancidity in storage.

[14] Wiltsee, p. 6.

Table 2.8
Common Values for Soybean Oil and Yellow Grease

Measurement	Crude Soybean Oil	Yellow Grease	Tallow	Choice White Grease
Titer	20 – 22	36 – 42	40.5	36
Free Fatty Acids	0.25 - 0.50	5 – 15	6	4
MIU	1.0 - 1.8	2 – 4	2	2
Iodine Value	120 – 140	58 – 79	48-58	58-68
AOM stability, hrs	40 – 45	20	20	20

The quality of yellow grease is different than soybean oil, as evidenced in the table above by the high level of free fatty acids and MIU and the low AOM stability. Soybean oil also has a higher degree of unsaturation compared to yellow grease. This explains the difference in iodine value (a measure of the amount of unsaturation) and the resulting titer (solidification point of the oil). A higher degree of unsaturation (double or triple bonds) gives a higher iodine value and a lower titer. The differences in quality characteristics between the fats and oils could produce some slight differences in the finished product of biodiesel. Saturated fats tend to produce biodiesel with cold flow properties that are slightly higher than unsaturated fats. Meanwhile, some tests have shown animal fats and vegetable oils to produce biodiesel with a slightly better emissions profile.

End-Use

The previous sections outlined the potential supply of animal fats and vegetable oils produced in the tri-state region. These fats and oils currently are utilized in the production of both edible and inedible products. Overall, edible uses consume most of the fats and oils produced. Of the edible uses, 92 percent of the fats and oils are used in baking and frying and salad and cooking oil applications. On the inedible side, 80 percent of the fats and oils are used in the production of feed products and fatty acids that are used in the oleochemical market. In 2002, 74 percent of the inedible tallow and grease in the U.S. was used in animal feed.[15] The remainder was used in fatty acids, lubricants, soap, and other inedible products.[16]

Developing a biodiesel industry in New York State could create a shift in the current distribution paths for fats and oils away from some of the lower value uses of these products, such as feed, to biodiesel production.

[15] U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau, Fats and Oils: Production, Consumption, and Stocks: 2002, Table 3b.
[16] *Ibid.*

Table 2.9 summarizes the current availability of feedstocks in New York that could be used to produce biodiesel.

Table 2.9
New York Biodiesel Feedstock Availability Summary

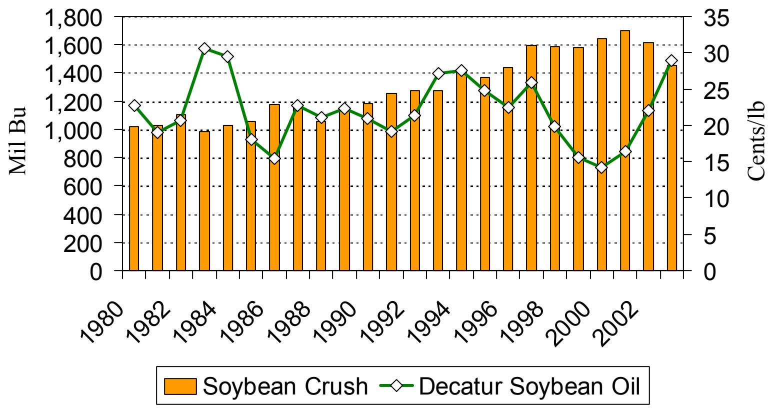
Feedstock	Potential Supply	Potential Biodiesel Produced
	Mil Pounds	*Mil Gallons*
Soybean Oil (max capacity)	48.3	6.5
Yellow Grease	180.5	24.1
Animal Fats	14.1	2.0
Total	**242.9**	**32.6**

Feedstock Prices

The market prices of various fats and oils are highly correlated. The price of soybean oil reflects the supply of soybeans and the demand for crushing which depends on the demand for soybean oil for food and industrial uses and the demand for soybean meal. As shown in Figure 2.3 the price of crude soybean oil at Decatur averaged 21.84 cents per pound over the past 25 years. Most recently, soybean oil prices fell to a post-WWII record season low of 14.15 cents per pound in 2000 reflecting record production. Subsequent lower soybean crops have drawn down stocks and pushed prices back up. The current USDA projection for soybean prices for the 2003 crop year is 28 to 30 cents per pound.[17] The soybean oil and yellow grease prices used to estimate the agricultural and economic impacts in Sections 3.4 and 4.3 are 10-year averages of forecasts prepared by LECG using an annual model of the U.S. agricultural sector. This forecast was updated in December 2003 based on agricultural and policy conditions in effect at that time.

[17] USDA. World Agriculture Supply and Demand Estimates. WASDE-407. February 10, 2004.

Figure 2.3
U.S. Soybean Crush and Decatur Crude Soybean Oil Prices

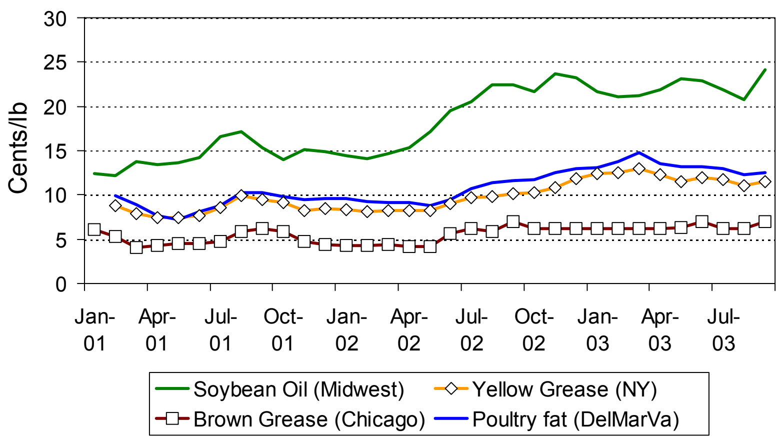


The prices of other fats closely track soybean oil prices. Groschen reports that yellow grease prices vary from eight cents to 15 cents per pound.[18] C.T. Donovan Associates found in 1998 that prices paid for rendered oils and greases in the Philadelphia area ranges from 13 cents to 22 cent per pound, averaging about 17 cents per pound.19 The authors also stated that several renderers who were surveyed believed biodiesel producers would have to pay a premium to divert waste oils and greases from renderers and current end use markets.[20]

Figure 2.4 compares monthly average cash market prices for selected fats and oils that can be used to make biodiesel. Since January 2001, Midwest soybean oil prices averaged 18.20 cents per pound. Over this same period the price of yellow grease at New York was about half that of soybean oil, averaging 9.82 cents per pound; brown grease at Chicago averaged 5.55 cents per pound, and Delmarva poultry fat averaged 10.81 cents per pound. Importantly, the price pattern of each waste grease and fat tracked soybean oil, although the increases have not been as large.

[18] Groschen, p. 9.
[19] The authors noted that one reason prices did not appear to decrease as the FFA content increased may be that the largest market for rendered oils and greases in Philadelphia area are animal feed markets on the Delmarva Peninsula and specifications for animal feed allow the use of rendered oils and greases that have a relatively high FFA content. C.T. Donovan Associates, p. 2-12.
[20] C.T. Donovan Associates, p. 2-13.

Figure 2.4
Cash Market Prices of Various Fats and Oils



Subtask 2.3: Co-Product Demand/Disposal Analysis

<u>Glycerin</u>

"Glycerin is a byproduct of producing soaps, fatty acids, and fatty esters from the triglycerides in vegetable oils and animal fats. Primary sources of glycerin include tallow, palm kernel oil, and coconut oil. Dow Chemical is presently the only U.S. manufacturer producing synthetic glycerin from petrochemicals."[21] Synthetic glycerin is obtained from petrochemical building blocks via several processing steps.[22]

"Although the terms glycerin, glycerine, and glycerol often are used interchangeably, subtle differences in their definitions do exist. Glycerin is the commonly used commercial name in the United States for products whose principal component is glycerol. Glycerine refers to purified commercial products containing 95 percent or more glycerol. Glycerol is the chemical compound 1,2,3-propanetriol."[23]

Most of the glycerin marketed today meets the requirements of the United States Pharmacopeia ("USP") and the Food Chemicals Codex ("FCC"). However, technical grades that are not USP or FCC certified ("technical grades") are also available. According to the Soap and Detergent Association there is currently a collaborative international program to harmonize the glycerin monographs in the USP and the European Pharmacopeia, which may later be expanded to include other nations.[24] Glycerin USP is regulated by the FDA, which requires all domestic owners or operators of establishments that manufacture or process glycerin USP to register and list with the

[21] USDA/ERS. *Industrial Uses Of Agricultural Materials*, August 28, 1996.
[22] "Why Glycerin USP?" The Soap and Detergent Association, 2000. Available at http://www.sdahq.org/oleo/USPGlycerin.pdf
[23] USDA/ERS. *Industrial Uses Of Agricultural Materials*, August 28, 1996.
[24] *Ibid.*

FDA. Manufacturers are defined as the original producer, as well as re-packagers and/or distributors. Glycerin FCC and USP are also subject to Good Manufacturing Practices prescribed by the FDA, while technical grade glycerin is not regulated. Substitute raw materials for glycerin include sorbitol and propylene glycol.

According to the most recently available Economic Census for New York State, the total value of shipments of soap and other detergents (including glycerin) in NY was $187.3 million, roughly one percent of total U.S. shipments of soap and other detergents.[25] The total number of establishments engaged in manufacturing soaps and other detergents in New York State in 1997 was 36, (six of which had 20 or more employees). More recent data from the 2001 County Business Patterns report for New York indicates that there were 29 establishments in this industry, seven of which had 20 or more employees, however this report does not provide the value of shipments.[26]

However, total shipments of glycerin in the U.S. totaled $265.9 million, accounting for less than two percent of the total value of product shipments of soap and other detergents.[27] Given glycerin's small share of total soap and other detergent shipments, statistics such as the number of establishments operating in this industry group in NY may not be very informative about the number of glycerin producers in New York State.

Glycerin Supply

As a general rule, production of approximately 10 pounds of oleochemical product yields about one pound of glycerin material.[28] Approximately 0.7 pounds of crude glycerin are produced for every gallon of biodiesel. Refining reduced the glycerine yield by half again.

The USDA estimates that U.S. glycerin production capacity totaled 522.5 million pounds per year in 1995, 25 percent (or 130.6 million pounds) of which is synthetic glycerin.[29] A private research firm, The Innovation Group, estimated production of 557 million pounds refined glycerin in December 2001.[30]

USDA reported that eight natural glycerin producers had 15 production plants in operation in the U.S. in 1996 and that Dow had one synthetic glycerin plant in the U.S.[31] According to The Innovation Group ("TIG"), domestic capacity for refined glycerin was 557 million pounds as of December 2001. Estimates of the distribution of production capacity by major producer are provided in Table 2.10 below. As Table 2.10 illustrates,

[25] U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau, "Soap and Other Detergent Manufacturing, 1997 Economic Census, Manufacturing Industry Series," Issued November 1999, available at http://www.census.gov/prod/ec97/97m3256a.pdf. Data represent the total value of shipments in the NAICS 325611, "Soap and Other Detergent Manufacturing." which is comprised of "establishments primarily engaged in manufacturing and packaging soaps and other detergents, such as laundry detergents, dishwashing detergent; toothpaste gels, and tooth powders; and natural glycerin."
[26] U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau, "New York: 2001, County Business Patterns," April 2003.
[27] *Ibid.*
[28] "Producers won't be paying more to keep foods moist," Purchasing Magazine, June 7, 2001. Available at http://www.manufacturing.net/pur/index.asp?layout=article&articleid=CA84442
[29] USDA/ERS. *Industrial Uses Of Agricultural Materials*, August 28, 1996.
[30] The Innovation Group, *Chemical Profile - Glycerin*. Revised 12/3/01. Available at http://www.the-innovation-group.com/ChemProfiles/Glycerin.htm. The Innovation Group ("TIG") is a consulting company serving the manufacturing industry. TIG's chemical profiles are reportedly published in the *Chemical Market Reporter,* a publication of the Schnell Publishing Company, a member of the Reed Elsevier group.
[31] USDA/ERS. *Industrial Uses Of Agricultural Materials,* August 28, 1996.

the majority of glycerin production takes place in the Midwest, with no major producers located in New York State.

Table 2.10
Leading Glycerin Producers in the U.S. by Capacity, 2001
(Million pounds per year)

PRODUCER	CAPACITY
Cognis, Cincinnati, Ohio	65
Colgate-Palmolive, Jeffersonville, Ind.	20
Crompton, Mapleton, Ill.	20
Crompton, Memphis, Tenn.	30
Dial, Montgomery, Ill.	30
Dow, Freeport, Tex.	140
Lever Brothers, Hammond, Ind. (part of Unilever)	25
Lonza, Painesville, Ohio	20
Marietta American, Olive Branch, Miss.	2
Procter & Gamble, Ivorydale, Ohio	150
Starchem, Fostoria, Tex.	20
Uniqema, Chicago, Ill. (part of ICI)	35
Total	557

Source: The Innovation Group, Chemical Profile - Glycerin. Available at http://www.the-innovation-group.com/ChemProfiles/Glycerin.htm

- Dow Chemical and Procter & Gamble are the two largest U.S. producers. Dow Chemical is the only producer of synthetic glycerin. Others obtain glycerin as a byproduct in soap and oleochemicals production using natural fats and oils as raw materials.

- Crompton upgrades crude glycerin to refined glycerin at its plant in Illinois (acquired through the merger of Crompton & Knowles and Witco, eventually named Crompton Corp. in 2000).

- Colgate refines glycerin at Jeffersonville using purchased crude.

  TIG reported that the following projects, which would have expanded domestic capacity, have been put on hold:

- Plans by Archer Daniels Midland Company to build a 50-million-pound-per-yer glycerin plant at Cedar Rapids, Iowa was put on hold in 1999;[32] and a plan by High Plains Corp., an ethanol from corn producer, to install a 10-million-pound-per-year glycerin recovery unit at its ethanol plant in Colwich, Kansas was put on hold in 2001.

- In October 2001, Proctor and Gamble Chemicals announced its plans for an additional 30,000 metric tons of glycerin capacity to be realized through a new

[32] The Innovation Group, *Chemical Profile - Glycerin*. Revised 12/3/01. Available at http://www.the-innovation-group.com/ChemProfiles/Glycerin.htm

grassroots refinery.[33] Sites in North America, Europe, and Malaysia were reportedly under consideration.

- Crompton Corp. was reportedly looking to divest its refined products operations.[34]

While no reasons were cited for the cancellation plans, it is reasonable to assume that these producers were responding to a slowing U.S. economy as well as concerns over the potential impact of increased glycerin supply on prices and profitability from a emerging national biodiesel industry.

Historically, the U.S. and Western Europe have accounted for the majority of glycerin production worldwide.[35] Over the last 15 years, Southeast Asia has become a major supplier. Within Southeast Asia, Malaysia, Indonesia and the Philippines are major exporters. The U.S. currently produces about 15 percent of the world's glycerin, approximately on par with Malaysia and Germany. By comparison, the U.S. and Europe each account for about one-third of worldwide glycerin consumption. Asia-Pacific countries account for another 16 percent, while Japan accounts for 9 percent of total global glycerin consumption. Several glycerin producers in Europe are members of the European Oleochemicals and Allied Products Group ("APAG").[36] A list of major global glycerin producers is also provided in the table of contents of a report by Global Industry Analysts.[37]

<u>Glycerin Demand</u>

Total demand for glycerin in the U.S. is estimated at 453 million pounds in 2002. TIG estimates represent average annual growth of 1.9 percent between 1996 and 2000. A Chemical Economics Handbook ("CEH") Report estimated that U.S. consumption grew at an average annual rate of 2.4 percent between 1998 and 2001, with strong gains in demand for personal care products offsetting declines in demand for polyether polyols and alkyd resins.[38]

Several different estimates of U.S. glycerin consumption were available for 2000 through 2002. The estimates differ somewhat, both in levels and in direction of growth. For example, Oleoline.com estimates that U.S. demand declined from 537.3 million pounds in 2000 to 490.5 million pounds in 2002. Conversely, Global Industry Analysts estimate that U.S. demand increased from 467.6 in 2000 to 490.1 million pounds in 2002 (Interestingly, both sources provide the same estimate of demand for 2002).

While projections of glycerin demand for the next five years also vary, the general consensus is that U.S. demand for glycerin is expected to grow between 2 and 3 percent per year through 2006. This projection is in line with historical growth in glycerin

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[33] "Proctor and Gamble Chemicals Expands Glycerin Refining Capacity to Meet Increasing Market Needs," October 1, 2001. Available at http://www.pgchemicals.com. Note, TIG appears to have mistakenly reported this increase as an additional 50,000 metric tons expansion.
[34] The Innovation Group, *Chemical Profile - Glycerin*. Revised 12/3/01. Available at http://www.the-innovation-group.com/ChemProfiles/Glycerin.htm
[35] Chemical Economics Handbook Report, Abstract, February 2003.
[36] For a list of APAG members see Tab [7]. APAG Website. Available at http://www.apag.org/
[37] Global Industry Analysts, *Glycerin*, *July* 2002.
http://www.the-infoshop.com/study/go9769_glycerin.toc.html
[38] Chemical Economics Handbook Report, Abstract, February 2003.

demand. Over the last 100 years, demand for glycerin grew at an annual average rate of 2.75 percent in the U.S., and at 2.70 percent worldwide.[39]

<u>Glycerin End Use Segments</u>

Food and beverage, personal care, and oral care products account for 60 percent or more of total glycerin usage in the U.S. TIG estimates that these three segments represent 64 percent of total usage in 2001, while Global Industry Analysts ("GIA") estimates usage by these product groups at 60 percent of total usage in 2000.[40]

Table 2.11
U.S. Glycerin Market: Percentage Share Breakdown by End Use Segment

<table>
<tr><td></td><td colspan="4">Year</td></tr>
<tr><td>End Use</td><td>Projected 2006[1]</td><td>Estimated 2001[2]</td><td>Estimated 2000[1]</td><td>Estimated 1995[3]</td></tr>
<tr><td>Food (and beverage)</td><td>19%</td><td>24%</td><td>18%</td><td>17%</td></tr>
<tr><td>Personal care (incl. skin, hair, and soap products)</td><td rowspan="3">41%</td><td>23%</td><td rowspan="3">42%</td><td>19%</td></tr>
<tr><td>Oral care (incl. toothpaste and mouthwash)</td><td>17%</td><td rowspan="2">24%</td></tr>
<tr><td>Pharmaceuticals</td><td>7%</td></tr>
<tr><td>Tobacco</td><td>13%</td><td>11%</td><td>13%</td><td>14%</td></tr>
<tr><td>Polyether polyols</td><td>11%</td><td>8%</td><td>11%</td><td>10%</td></tr>
<tr><td>Alkyd resins</td><td>6%</td><td>3%</td><td>6%</td><td>6%</td></tr>
<tr><td>Cellophane and explosives</td><td>n.r.</td><td>n.r.</td><td>n.r.</td><td>2%</td></tr>
<tr><td>Miscellaneous</td><td>10%</td><td>7%</td><td>10%</td><td>8%</td></tr>
</table>

n.r. = not reported.
<u>Sources:</u>
1. Global Industry Analysts, Inc. ("GIA") Glycerin - Regional Markets, Rpt. #5506655, May 1, 2002, p. 12.
The Innovation Group, Chemical Profile - Glycerin. Revised 12/3/01. Available at http://www.the-innovation-group.com/ChemProfiles/Glycerin.htm

Forecasts of growth in domestic demand by end use sector were available from two sources: TIG[41] and Global Industry Analysts, Inc. ("GIA").[42] GIA estimates compound annual growth in domestic use of glycerin of 3.1 percent from 2000 through 2006. The highest rates of growth are expected in food and beverage (four percent per year) and polyether polyols (3.4 percent per year). Use by pharmaceuticals and personal care products are expected to grow at 2.9 percent per year. Tobacco and alkyd resins are expected to grow at 2.7 and 2.6 percent per year, respectively.

[39] Oleoline.com, Ltd. *Glycerin Market Report*, September 2003, Issue No. 2, p. 9.
[40] The Innovation Group, *Chemical Profile - Glycerin*. Revised 12/3/01. Available at http://www.the-innovation-group.com/ChemProfiles/Glycerin.htm
[41] OpCit.
[42] Global Industry Analysts, Inc. ("GIA") Glycerin - Regional Markets, Rpt. #5506655, May 1, 2002, p. 12.

TIG estimates that the personal care sector is growing 3.5 percent per year, driven, in part, by increasing demand for skin creams from the aging baby boomer segment of the population.[43] Growth in the oral care sector is estimated at 1.5 percent annually.

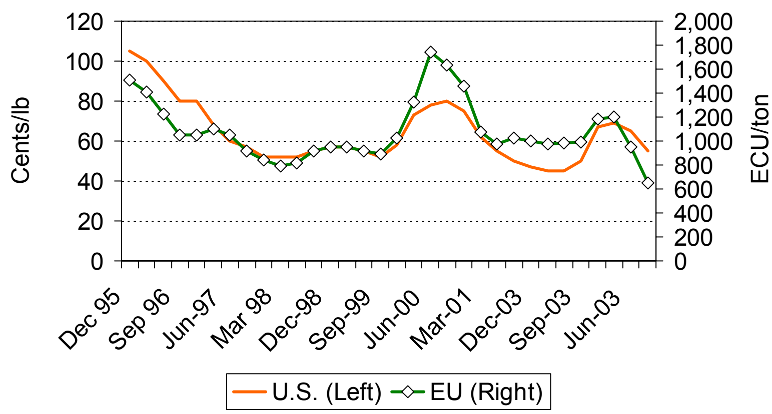
Glycerin Imports and Exports

Glycerin imports into the U.S. have increased over the last five years and now account for over 40 percent of total U.S. consumption in 2002.[44] The U.S. imports the majority of its glycerin from Malaysia. U.S. exports are primarily to Canada.

Glycerin Prices

Glycerin prices vary widely depending on supply and demand conditions. According to TIG annual average kosher grade refined glycerine prices have declined steadily from $1.08 per pound in 1996 to $0.80 per pound in 2000. A comparison of monthly spot prices of Kosher refined glycerin in the U.S. and the EU is shown in Figure 2.5.

Figure 2.5
U.S. and European Spot Glycerin Prices
(Kosher Grade 99.7%, delivered customer in bulk)



High prices in 1996 were reportedly due to a worldwide shortage of glycerin, estimated at roughly 100 million pounds.[45] Strong economic conditions in the U.S. in 1999 and 2000 reportedly spurred growth in glycerin consumption between 1998 and 2000.[46] Supplies were reportedly tight in 2000, but recessionary economic conditions in 2001and increased supply from biodiesel-related generation in Europe[47] led to a softening in the market, with prices reportedly falling to 25-year lows by the beginning of 2002.[48] CEH

[43] The Innovation Group, *Chemical Profile - Glycerin*. Revised 12/3/01. Available at http://www.the-innovation-group.com/ChemProfiles/Glycerin.htm
[44] Oleoline.com, Ltd. *Glycerin Market Report*, September 2003, Issue No. 62, p. 9.
[45] USDA/ERS. Industrial Uses of Agricultural Materials, August 28, 1996.
[46] Chemical Economics Handbook Report, Abstract, February 2003.
[47] The Innovation Group, *Chemical Profile - Glycerin*. Revised 12/3/01. Available at http://www.the-innovation-group.com/ChemProfiles/Glycerin.htm
[48] Chemical Economics Handbook Report, Abstract, February 2003.

reported that the market was stabilizing in 2002, as supplies decreased due to low biodiesel capacity utilization (reportedly at only 30-40 percent of nameplate capacity).[49]

Prices picked up slightly entering 2003, but have recently started to decline again. Oleoline.com Ltd. reports that between May and September 2003, the price of kosher quality refined glycerin declined in the U.S. 20 percent, from 69 cents/lb to 55 cents/lb.[50] The decline was more dramatic in Europe, where the high price of mineral oil is increasing the profitability of biodiesel. Oleoline.com Ltd. estimates that kosher quality refined glycerin in Europe fell 45 percent over the same period (from EUR 1200 pmt to EUR 650 pmt). The situation in Europe is expected to put downward pressure on prices in the U.S. Biodiesel production will certainly determine the future market for glycerin. Recent discussions with European refined glycerin producers further emphasize the potential impact of biodiesel on the crude glycerin supply situation. At present there is an ample supply of "conventional" crude glycerin materials and as the biodiesel industry continues to develop in Europe, the negative affect on pricing may well continue. Obviously, refined glycerin producers have several alternatives to consider including expanded applications for glycerin, substitution markets, i.e. displacing other materials such as sorbitol, and use of the glycerin as an intermediate for the production of other chemicals.

It is important to note that the conventional glycerin markets are well established and the supply of crude materials have, until recently, involved the so-called "fat splitter" and "salt-lye" crudes. Fat splitter (or "splitter") crude is derived from the processing of vegetable oils (or animal fats) to produce fatty acids and other oleochemicals, such as fatty alcohols. This industry is well established and fundamental to the production of numerous consumed products, such as cosmetics and the like.

In the production of soaps from animal fats or vegetables oils, there is also a by-product glycerol material produced. This co-product, referred to as "salt-lye crude" contains a higher level of impurities (and inorganic salts) than the crude produced in the fat-splitting process. Thus its inherent value in the marketplace is less.

Biodiesel crude, as indicated, results from the conversion of the triglycerides contained in vegetable oils or animal fats, to a methyl ester (biodiesel). The glycerin produced in the biodiesel process will typically contain a higher level of impurities than that produced in the soap making process. Thus, from an overall standpoint, the crude glycerin from biodiesel processing is the least desirable of the "conventional" crude materials. For this reason, disposition of the crude produced in the biodiesel process must be a major consideration in the overall project evaluation.

A New York 32.6 MGY biodiesel industry would produces 22 million pounds of crude glycerin or about 11 million pounds of refined glycerin annually. This would increase total U.S. glycerin supply by less than four percent and should have a negligible impact on glycerin prices. It is unclear whether this increased supply would be sufficient to attract a major glycerin user to build a new production facility in New York. Passage and enactment of a national Energy Bill is expected to increase biodiesel production significantly. Consequently, aggregate U.S. glycerin supply also will increase resulting in

[49] Chemical Economics Handbook Report, Abstract, February 2003.
[50] Oleoline.com, Ltd. *Glycerin Market Report*, September 2003, Issue No.62, p. 5.

a decline in prices. It is unclear how large the glycerin price response to increased supply may be.

Soybean Meal

Soybean meal is a co-product of soybean processing. Every bushel of soybeans crushed typically produces 23.5 pounds of soybean meal. Soybean meal is the solid matter that remains after the oil is extracted from the soybean. Soybean meal is a concentrated source of protein and energy and is lower in crude fiber than most other oilseed meals. The higher protein, energy and lower fiber content of soybean meal makes it ideal for high-energy rations such as broiler, turkey, and pig starter feeds. Soybean meal typically has a 48 – 50 percent protein level and is rich in amino acids.

Approximately 85 percent of soybean meal is fed to non-ruminants such as swine and poultry. The available amino acid levels in soybean meal complements those of corn and other coarse grains in meeting the nutrient requirements of poultry and swine.[51] Soybean meal is the standard to which all other protein sources are compared.

Soybean meal also is an important component of dairy and fed cattle rations. Soybean meal is highly palatable and digestible for dairy animals, and it assists the dairyman in obtaining the highest milk yield possible from his herd. Soybean protein products also may be used in dairy calf milk replacers with acceptable results.

Large quantities of soybean meal are used in the formulation of pet foods. Simple corn and soybean meal diets formulated for dogs perform equally to the complex diets using high levels of animal protein. In recent years, there has been a rapid expansion of soybean meal use in aquaculture. Soy protein has one of the best amino acid profiles of all of the oilseed proteins in meeting the essential amino acid requirement of fish.

The dairy industry is vitally important to New York agriculture. New York has the nation's third largest dairy herd (678,000 head) and produced 12.2 billion pounds of milk in 2002. Dairy products accounted for half of total New York farm cash receipts in 2002.

New York also is a grain and protein deficient state. That is, New York farmers use more corn and soybean meal than is produced in the state. Currently, the three soybean processors in New York have the capacity of producing 73,000 tons of soybean meal annually but produce only half that amount. A biodiesel industry that would create the demand for oil to be processed into biodiesel would raise the price of soybean oil by an estimated 7.3 percent and will provide a market incentive for these processors to produce at capacity and is expected to attract investment in another crush facility resulting in additional local soybean meal supply. The amount of soybean meal that would be produced as a result of a biodiesel industry is small relative to the total U.S. supply and is unlikely to have a noticeable impact on market prices. However, increased local supply will benefit New York dairymen and other livestock and poultry producers by reducing transportation costs and lowering the basis for soybean meal.

[51] Keith Smith and Associates. "Advances in Feeding Soybean Meal". http://www.soymeal.org/ksmith.html

TASK 3: PRODUCTION ANALYSIS – BIODIESEL AND BYPRODUCTS

Subtask 3.1: New York State Production Options

The Biodiesel Plant Development Handbook© (The Handbook) published by the Independent Biodiesel Feasibility Group (IBFG) is an excellent resource to help determine the factors to be considered before investing in the biodiesel business and installing a production plant. While The Handbook was written with the individual in mind, it provides a useful starting place to make recommendations on the most appropriate plant size and biodiesel technology for New York.

According to The Handbook, the items to be considered first when selecting a technology and building a plant are:

- Demand for Biodiesel
- Feedstock Availability
- Existing Production Capacity/Competition

The analysis performed for this section of the report assumes that sufficient demand for biodiesel already exists. The analysis focuses on which technologies would serve New York the best, given likely feedstock sources and feedstock quality available in New York from either indigenous feedstock production or through imports from other states.

We have evaluated a number of biodiesel production technologies that are commercially offered and have been demonstrated in the marketplace via the installation of at least one commercial facility. The project team has an excellent and confidential relationship with most of the technology companies, and is able to utilize this knowledge to provide an independent assessment of these technologies based upon the factors most important to the company installing or evaluating the technology. There are a variety of factors that must be taken into account when evaluating a technology. These factors can vary substantially between the technologies and even more substantially between the companies offering the technologies. This is especially true when considering the capability to handle feedstocks of varying quality. A brief summary of these factors is found below.

<u>Factors In Technology Selection</u>:

- Production Capacity – what sizes are offered?
- Capacity Expansion – is the technology easily expanded if volumes go up?
- Feedstock Flexibility (percent FFA) – Can the technology handle various FFA levels?
- Co-product Streams – Quantity and quality of glycerin and other process streams
- Equipment and Operating Complexity – How complex is the plant and its controls?
- Waste Streams – What is the quantity and quality of waste streams.
- Process Safety Design – What is the safety record for plants using this technology?
- Services Offered – Can you buy a turnkey plant, or just the engineering design?
- Previous Experience – How many plants are in operation or coming on line soon?

- Performance Warranty – Does the company offer performance warranties?
- After Sale Support – Does the company offer technical support and for how long?
- Project Delivery Time – How long will it take once the contract is signed?

To complete the evaluation, the project team contacted the leading technology companies and requested information on their technology for the following scenarios:

Soybean oil	0.5 % FFA	0.2 % MIU	Titer average of 22 °C
Yellow grease	10.0 % FFA	3.0 % MIU	Titer average of 38 °C
Animal fat	3.0 % FFA	1.5 % MIU	Titer average of 45 °C

These scenarios are based on the average quality of feedstocks available in New York. Due to the competitive nature of the business, many of the technology companies were reluctant to provide detailed information that could be included in this report. We were, however, able to obtain information with which to provide the recommendation and analysis provided below. The review is not intended to provide confidential information or go into extreme detail relative to the individual processes. Some of the technology companies were also much more willing to provide information in a timely manner.

This section recommends technology options that appear to be the best at meeting the biodiesel needs of New York State. The evaluation is based largely upon confidential information provided by the technology companies and our evaluation of this information as it relates to the factors important for New York.

It cannot be overemphasized that any one of these factors may lead an individual company or investor to select other technologies than those recommended by this report. That is why it is critical for each company to conduct a thorough investigation of the top several technologies in order to make a determination of the most appropriate technology for them.

General Biodiesel Technology Overview:

In order to provide a basis for the individual process technologies review, a general overview of the "generic" biodiesel production technique is appropriate. The discussion below overviews the basic approach to biodiesel production from refined vegetable oils, e.g. soybean oil, and identifies the basic stages involved in the manufacture of this product.

There are three basic avenues of commercial significance to the production of biodiesel (mono-alkyl esters) from naturally occurring vegetable oils and fats (also known as triglycerides (TG)).[52] Mono-alkyl esters are also made for purposes other than biodiesel such as intermediates for industrial chemicals, consumer products and the like. Thus, there is a significant amount of know-how relative to these materials. Much of the current biodiesel technology is based on the "simplification" of the conventional ester production techniques so as to allow for the manufacture of a more "commodity-like" material. The primary approaches to the manufacture of these materials include:

- Reaction of the TG with an alcohol, using a base catalyst

[52] For the remainder of this section we will use the term TG as a generic term to represent any naturally occurring vegetable oil or animal fat.

- Reaction of the TG with an alcohol, using a strong acid catalyst
- Conversion of the TG to its fatty acids, and a subsequent reaction of the fatty acids with an alcohol using a strong acid catalyst

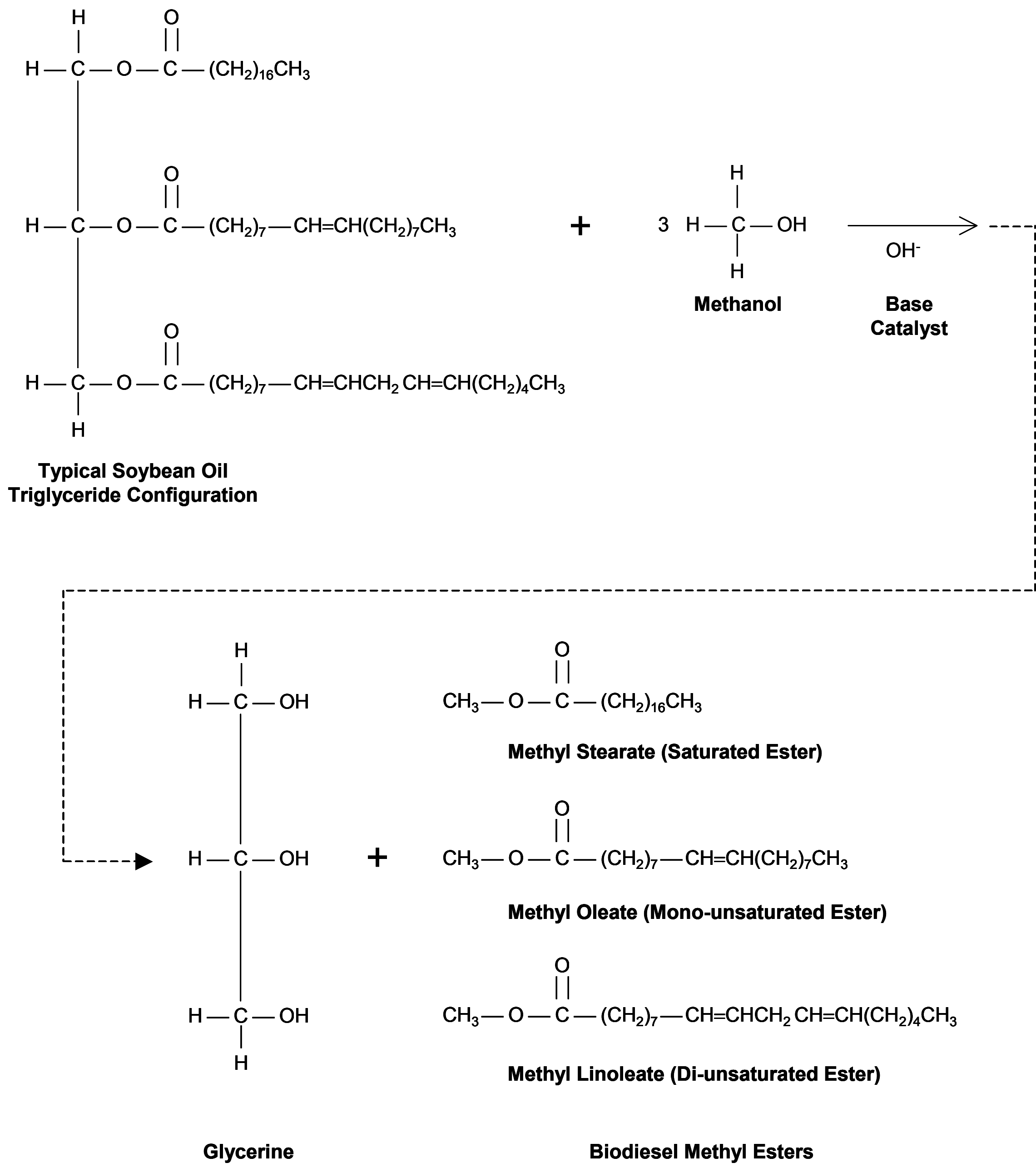
Almost all of the mono-alkyl esters of commercial significance (especially biodiesel) are produced using the base catalyzed reaction of the TG with methanol. Use of acid catalysis is typically limited to the conversion of the fatty acid fraction in high free fatty acid (FFA) feeds, or to treat intermediate high fatty acid/ester streams that can form in the acidification of the crude glycerin bottoms produced as a co-product of the transesterification reaction. Further discussion relative to the esterification concept will be presented later.

For soybean oil feedstocks, or other virgin seed oils or animal fats low in FFA, the most cost effective avenue is the base catalyzed reaction of the TG for the following reasons:

- It is a low temperature (150° F or less), low pressure chemical process
- It yields high conversion (98 percent) with minimal side reactions
- No exotic materials of construction are needed

The chemical reaction is illustrated below. Stoichiometrically, 100 pounds of TG are reacted with 10 pounds of alcohol in the presence of a base catalyst to produce 10 pounds of glycerin and 100 pounds of mono-alkyl esters or biodiesel. In practice, an excess of alcohol is used in the reaction to assist in quick and complete conversion of the TG to the esters, and the excess alcohol is later recovered for reuse. All reactants must be essentially free from water. The catalyst is usually sodium methoxide, sodium hydroxide, or potassium hydroxide that has already been mixed with the alcohol.

Figure 3.1
Illustration of the Transesterification Chemical Reaction



While the ASTM specification for biodiesel permits the use of a variety of alcohols for the production of biodiesel, methanol is currently the main alcohol used commercially for the production of biodiesel. There have been discussions regarding the use of ethanol, but to date the use of this alcohol for biodiesel is insignificant. Major reasons why methanol is the current alcohol of choice include:

- Methanol is less expensive than ethanol
- Ethanol is a larger molecule than methanol and it is incrementally more difficult to get the reaction to go to completion, requiring longer reaction times or higher temperatures
- It is more difficult to recycle the excess ethanol due to its azeotrope with water at the 95 percent concentration

For these reasons, this general overview will focus primarily on the base catalyzed reaction of the TG with methanol. As indicated, there will be a brief review of the esterification application since this step would be required if higher fatty acid materials are to be treated.

A simplified process concept for the production of biodiesel from soy oil and methanol, using transesterification only, is shown in Figure 3.2.

The general process discussion that follows is not related to any particular supplier's package, but rather outlines the various functions that must be accomplished in the overall production sequence. The overall approach to biodiesel production, for the general transesterification process concept, consists of several steps or process units.

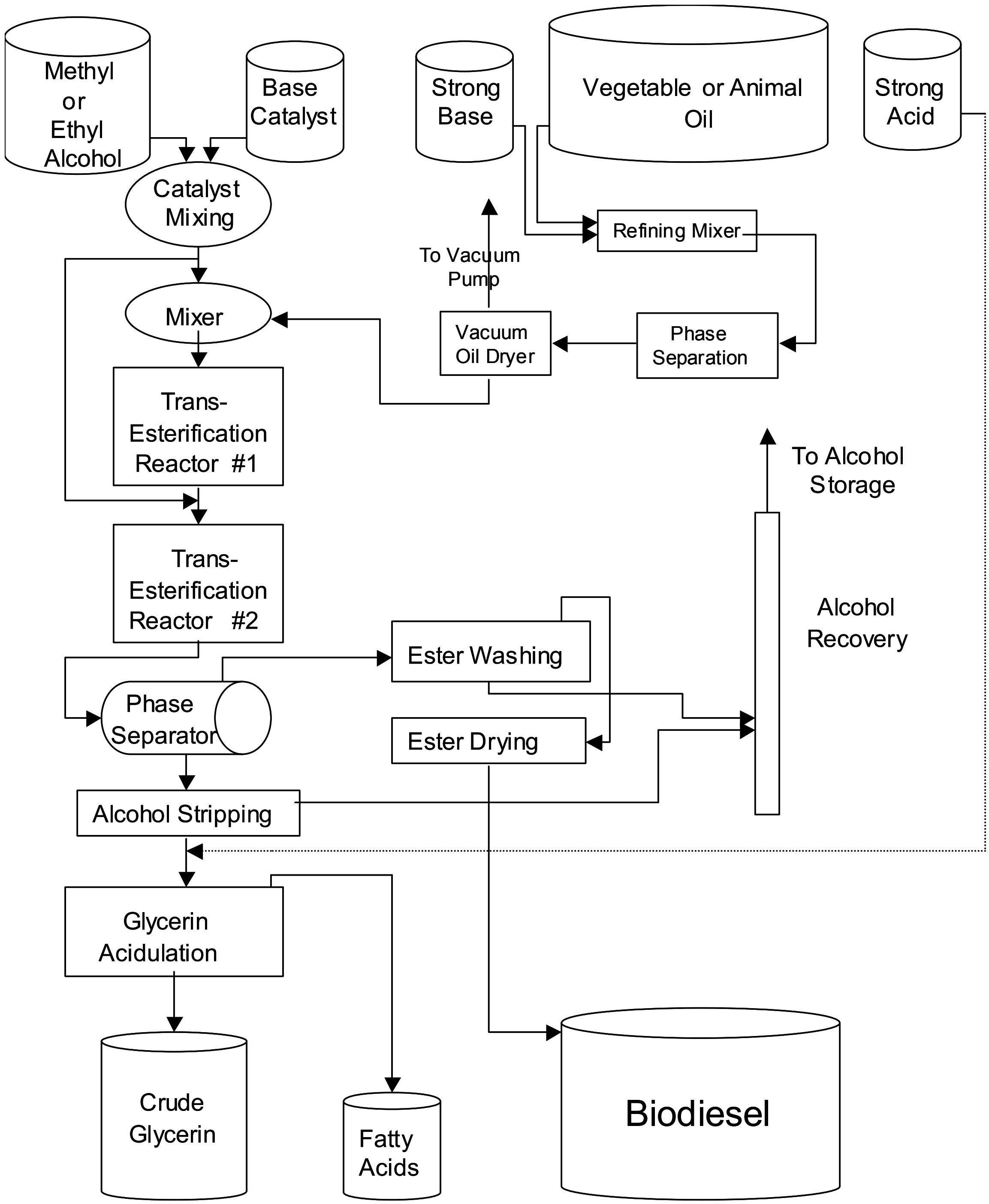
Mixing of Methanol and Catalyst:

The catalysts typically used include sodium methoxide, sodium hydroxide or potassium hydroxide. The catalyst is dissolved in the methanol with a simple mixing process. With sodium or potassium hydroxide, care must be taken to ensure that the material does not absorb water in storage. This could cause the formation of large clumps, which are hard to dissolve, and water has an adverse impact on downstream processing.

This mixing system must also be closed to the atmosphere to avoid release of methanol vapors, an important parameter for obtaining the proper permits for plant operation. In the case of sodium methoxide, the material is typically received as a concentrated solution (in methanol) and is low in water content due to the production process for the manufacture of this material.

As a side note, the use of sodium methoxide as the catalyst is common in Europe, and is gradually gaining interest in the U.S. The primary impediment to more widespread use has been the cost of the material. Most of the methoxide is manufactured in Europe resulting in an inherent freight advantage in Europe verses the United States. The advantage of using sodium methoxide is that due to its inherent anhydrous nature various side reactions in the transesterification process related to the presence of water in the reactants are minimized. As biodiesel production increases, and the potential for larger volumes of methoxide consumption materialize, the price for the material may decrease. Thus, it is important for the biodiesel producer to maintain up-to-date knowledge of the catalyst-pricing situation.

Figure 3.2
Illustration of Base Catalyzed Reaction of Triglycerides with Methanol



Transesterification Reaction:

The TG is then charged into a reactor, either continuously or in batches, and the methanol/catalyst mix is added. The reaction mix is kept at approximately 150 °F for between one and eight hours. Excess methanol is utilized to ensure that a high percentage (98.5 percent minimum for biodiesel) of conversion of the TG to methyl esters takes place. The catalyst will first react with any free fatty acids present in the oil to form sodium (or potassium) soaps. This reaction of a fatty acid with sodium or potassium hydroxide is called saponification. There must be enough additional catalyst in the reaction mixture to catalyze the reaction after the free fatty acids have been saponified. If the free fatty acid level is too high, (maximum FFA allowed varies between the process suppliers), or if any water is present, any soap formed can begin to form emulsions with the methanol and TG, slowing or preventing the reaction from occurring. Not only does this reduce the yield of the process, it has the adverse effect of creating a more dispersed mixture, which may be difficult to handle in later processing.

In some cases, the emulsion can be so stable that it forms a cottage cheese looking product. In this case, the product must be physically removed from the system and disposed of in an environmentally safe manner. Short of this, since the biodiesel must eventually be water-washed, the presence of excessive emulsions can result in the loss of biodiesel to the wash water, thus creating a yield problem or, if the water is recycled, a higher biodiesel recycle rate which can be detrimental to the overall process economics.

For these reasons, it is recommended that the incoming oil be pre-treated to minimize fatty acids, so as to maintain a level below the maximum allowable, as specified by the process provider, and that the water content in any of the feed streams also be kept to a minimum.

Methanol Removal:

In some system designs, the excess methanol is removed at this stage via a simple flash process or vacuum distillation. In other systems, the methanol is removed after the glycerin and esters have been separated. In either case, the methanol is recovered, dried and reused using conventional distillation equipment. Care must be taken to ensure no water accumulates in the recovered methanol stream. In addition, the design and control of this system must also allow for the recovery of the water stream, from the distillation system, that is essentially free of methanol.

Separation:

Once the reaction is complete, two major products exist; namely methyl esters (biodiesel) and glycerin. Due to the density difference between methyl esters, and glycerin, the two phases can be separated by gravity in conventional settling equipment and the glycerin drawn off the bottom of the settler. In some cases, a centrifuge is used to separate the two phases, depending on the specific process supplier.

Depending on the particular process approach, any “rag” (i.e. soapy emulsions layer) between the two phases can be removed and reacted with a strong acid (e.g. hydrochloric, sulfuric, or phosphoric) to recover the fatty acids. The acid water resulting from this treatment step is recycled or neutralized and sent to sewage treatment. Control of this material varies between process providers.

Glycerin Neutralization:

The glycerin phase contains the excess catalyst, fatty acid soaps, and some level of dissolved ester. In order to recover the contained fatty acids and esters the material can be acidulated with an acid, typically hydrochloric, sulfuric, or phosphoric, and sent to a settling tank where the mixture is allowed to separate by gravity. The fatty acids, along with any dissolved ester, will float to the top of the settler and can be pumped to a storage tank to be sold or used in another process. Alternatively the mixture can be returned to the biodiesel process for treatment in an acid catalyzed esterification system to convert the fatty acid fraction to esters or reintroduced into the transesterification system to maximize overall recovery. The choice as to the extent of glycerin processing is, to some extent, related to the overall plant size or specific plant site criteria and capabilities.

The acidulated glycerin is then neutralized with a weak base to a pH of 7.0 to 7.5 and sent to storage as crude glycerin. In some cases the salt formed, e.g. potassium phosphate, sulfate, or chloride, (if using a potassium hydroxide catalyst) may be recovered for fertilizer, depending on local disposal regulations and salt volumes involved. If sodium hydroxide is used as the catalyst and hydrochloric acid as the acidulation source this results in the formation of sodium chloride as the end salt. This is usually left in the glycerin or, if removed, disposed of as a non-hazardous waste. The glycerin produced in the biodiesel process can range from 50 percent to 88 percent pure glycerin, depending on the extent of treatment after acidulation.

It should be noted that the typical co-product glycerin contains sufficient catalyst (alkaline) material such that the addition of acid to neutralize the base can result in the precipitation of salts. Thus, the handling of the glycerin fraction is an important consideration in the overall process design approach.

Allowing for the production of a low concentration glycerin (e.g. 50 percent) does enable the producer to keep the salts in solution and increase the water load in the final glycerin material exiting the plant. This, of course, lowers the inherent value of the glycerin to the potential refiner.

Increasing the concentration of glycerin in the final crude will (in most cases) result in the crystallization of salts and the need for equipment to remove this solid material. The obvious advantage is that the inherent quality of the crude glycerin is improved, thus making it more attractive to potential refiners.

Methyl Ester Wash:

Once separated from the glycerin, the methyl esters are gently washed with warm, deionized water to remove any residual catalyst and soaps. The material is then dried and sent to storage. At this point the methyl esters (biodiesel) are typically 98.5 percent pure and ready to be sold as fuel. In some limited cases the esters are distilled under vacuum to achieve even higher purity. However, in the production of esters for biodiesel there is usually little need for distillation since this adds costs to the product with little (or no) additional marketing benefits as a fuel for diesel engines.

As indicated earlier, the washing step can be greatly affected by the free fatty acid level of the feed, since all the free fatty acids form soaps in the reaction. If the soap content in the washing step is too high the water wash will entrain the esters and yields will be diminished, sometimes significantly.

Fatty Acid Esterification:

As indicated, in some cases an esterification step, using an acid catalyst, is incorporated into the biodiesel processing sequence in order to treat high fatty acid feedstocks or allow for the recycle of the fatty acid/methyl ester fraction recovered in the glycerin acidulation step. This stage involves mixing the high fatty acid material with a solution of methanol that contains an acid catalyst, typically sulfuric acid. The contained fatty acids are then converted to methyl ester via the following reaction:

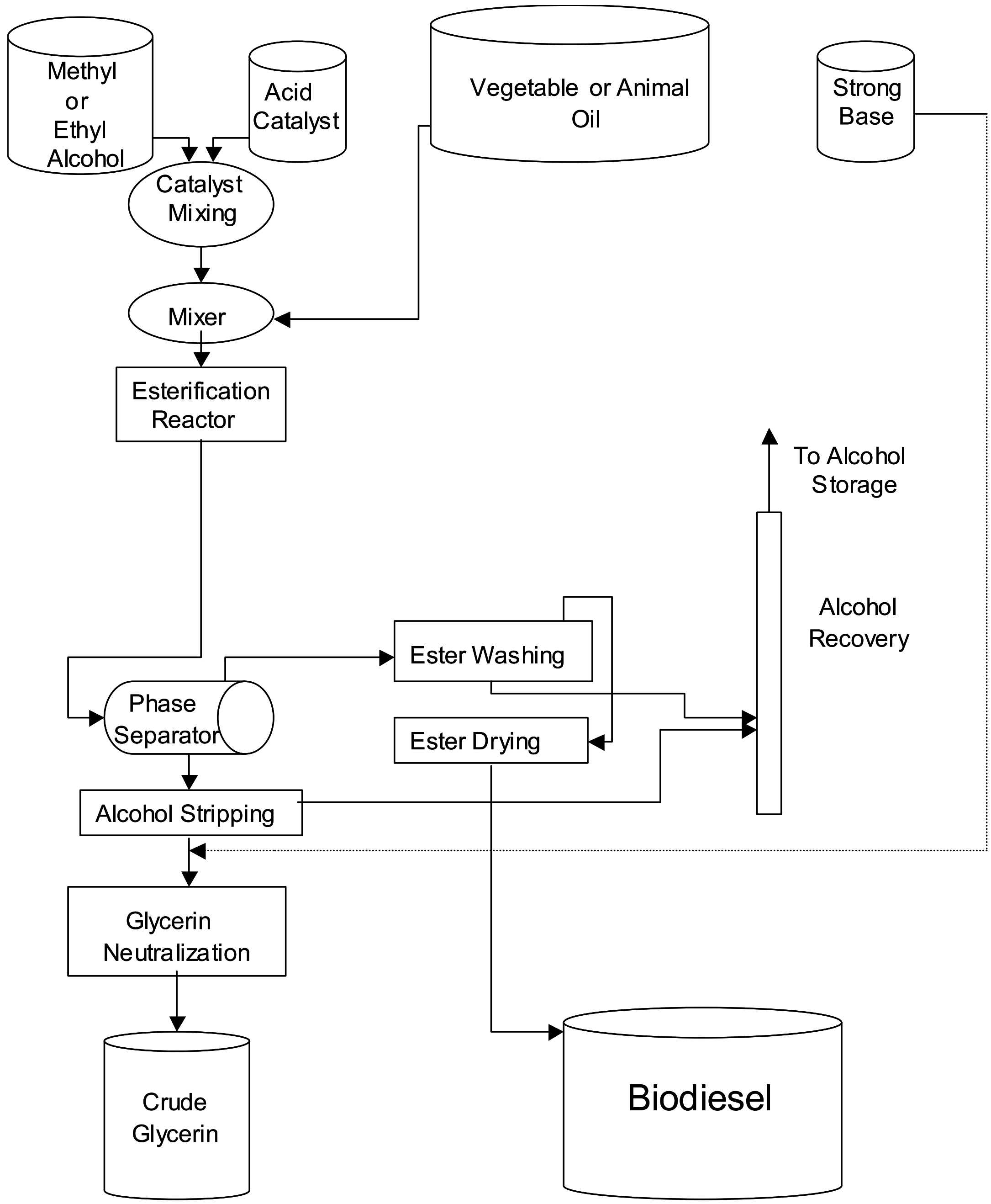
Figure 3.3
Illustration of the Esterification Chemical Reaction

$$\underset{\text{Fatty Acid}}{R\text{-}\overset{\overset{\displaystyle O}{||}}{C}\text{-}O\text{-}H} \quad + \quad \underset{\text{Methanol}}{CH_3OH} \quad \underset{\substack{H_2SO_4 \\ \text{Catalyst}}}{\text{------>}} \quad \underset{\text{Methyl Ester}}{R\text{-}\overset{\overset{\displaystyle O}{||}}{C}\text{-}O\text{-}CH_3} \quad + \quad \underset{\text{Water}}{H_2O}$$

An excess of methanol/H_2SO_4 is employed to ensure conversion and after reaction completion this excess is separated from the ester phase.

The conversion of the fatty acid to ester results in the formation of water, thus after the reaction there is water in the methanol/sulfuric acid mixture. Since this is an equilibrium reaction, the presence of excessive amounts of water will adversely affect the conversion of the fatty acid to ester. Thus, a portion (or all) of the methanol/sulfuric acid mix is purged from the system and treated to recover the methanol and reject the water. A typical approach involves using this purge material as the acidifying agent for treating the glycerin material, followed by recovery of the methanol. In this case, the water fraction will end up in the glycerin phase.

Figure 3.4
Illustration of Acid Catalyzed Reaction of Triglycerides with Methanol



<u>Individual Technology Overview:</u>

Project team member IBFG has developed extensive information relative to various process companies that offer biodiesel production technology for processing virgin oils as well as used cooking oils and animal fats. This data consists of information prepared for marketing or general distribution by the technology company, as well as that obtained as a result of personal experience and confidential business interactions. Where information has been supplied directly by the process provider, it is used as-is. In some cases IBFG estimates may have been made for certain factors.

For purposes of evaluation, the technologies were separated into those commercially available and those that are experimental. Commercially available technologies are defined as those offered for sale by a viable company and for which at least one commercial operation has been built. To preserve individual company confidentiality, the confidential information obtained from each company was combined to create an average technology for each of the three cases. This protects the confidential nature of the information supplied by the technology companies while still providing NYSERDA with reasonable cost estimates for each scenario. Only companies who chose to respond to the request for information were evaluated in this study.

The complete list of companies queried in this study, and their responsiveness to the request for information to NYSERDA, can be found below:

Companies who responded
- Axens
- Ballestra
- BDI
- Biodiesel Industries
- CD Process Conneman
- Cimbria Sket/Bratney
- Ekoil
- Energia
- Lurgi PSI
- Renewable Energy Group (Crown Iron Works/West Central Coop)

A brief summary of the technology and some background information on each company that responded can be found in Appendix 1. Also included is a brief assessment of the quality and level of detail in the information provided, which varied substantially between the companies. In previous dealings with biodiesel technology companies, IBFG has found that the responsiveness of the technology company to the request for information and the quality and level of detail provided is an important barometer in selecting a technology company. In addition, the relative experience of each provider is discussed based primarily on the number and type of facilities constructed. Note that when making estimates IBFG has attempted to take a conservative view of each factor, such as cost, schedules, etc. It is quite possible that when dealing with the provider on the basis of a real project, factors such as cost and schedule can be different once the actual scope of the project has been defined and specific details known.

Technology for soybean oil based biodiesel

There are many readily available technologies for biodiesel produced from soybean oil with free fatty acid levels of 0.5 percent and lower. In all cases, the technology of choice for soybean oil low in free fatty acids is the typical transesterification technology with methanol. The companies offering technology and who responded to the request for information for this NYSERDA project are below. Since the basic technology involved is the same for all of these technologies, the estimated costs, both installed costs and operating costs, were fairly similar with any differences being primarily due to the confidence level of the estimate. At this level of detail, all estimates are approximately

+/- 30 percent and all costs were well within that range. All companies stated their process would produce ASTM grade biodiesel.

Commercially available technologies (at least one plant in operation):

Ballestra
Biodiesel Industries
Cimbra Sket/Bratney
CD Process Conneman (low FFA oil version)
Renewable Energy Group (Crown Iron Works/West Central Coop)
Ekoil
Energia
Lurgi PSI
BDI

With similar costs and technology, the factors which set one technology apart from another are more related to the experience and responsiveness of the company, as well as the level of detail provided on the process so that a more informed decision can be made. Three companies were clearly superior to the others when taking these factors into account, especially in terms of responsiveness: Lurgi, Cimbia Sket/Bratney, and Renewable Energy Group. These companies represent the state of the art in vegetable oil based biodiesel technology, quality and service and are the recommended technologies resulting from the responses provided for this study.

Recommended State of the Art Technologies for Soybean Oil Based Biodiesel:

Lurgi
Renewable Energy Group
Cimbra Sket/Bratney

Biodiesel production costs were estimated using the Biomass Cost Estimation Guide, developed by Oak Ridge National Laboratory specifically for comparing and contrasting technologies. A detailed analysis of the production economics for each feedstock combination is presented in Appendix 2.

A summary of the economics of the small (three million gallons per year) and large (12 million gallons per year) biodiesel plants using soybean oil are found in Table 3.1. This estimation guide creates generic factors for plant financing and the sales and administration functions so that true differences in size and technology can be better separated and analyzed. Compared to actual plant operations data available to IBFG, the resulting product costs using this approach tend to be slightly higher (five to 10 percent) than real operations.

Table 3.1
Biodiesel Production Analysis for Soybean Oil
(0.5 percent) Free Fatty Acid

Plant Size	Capital Cost	Biodiesel Cost
(million gal/yr)	*(million)*	*($/gallon)*
3	$3.3	$2.38
12	$12.0	$2.12

Note: Soybean Oil Price of $.21/lb

Technology for Yellow Grease Based Biodiesel

The technology for production of yellow grease based biodiesel, while readily available, is much less plentiful than that of soybean oil. As discussed earlier, the presence of free fatty acids at too high a level causes problems with the traditional transesterification reaction. In general, the technologies available for handling higher levels of free fatty acids utilize an acid catalyzed esterification process, or a combination of a free fatty acid removal with acid catalyzed process followed by a traditional base catalyzed transesterification of the FFA free oil. The methods are much more varied than with low free fatty acid materials, and are considered highly proprietary by the technology producers. While there are commercially available technologies, there are very few operational plants with which to base solid cost estimates on.

Commercially available technologies for Yellow Grease Biodiesel:

Biodiesel Industries
Energia
BDI
Lurgi PSI

With such few plants in operation, and the proprietary nature of the technology, it is much more difficult to make a fact based recommendation on the best technology for yellow grease based biodiesel for New York. The data provided by Lurgi was by far the most complete. That, in combination with the many years of experience in the oleochemical field, perhaps puts Lurgi at the top of the list. However, Biodiesel Industries has constructed two plants and while the data provided by Biodiesel Industries was not as thorough as that of Lurgi they have just as much experience as Lurgi, if not more, in producing biodiesel from yellow grease. While BDI responded quickly to the NYSERDA request, they provided no useful information with which to evaluate their technology. Based on this data and other factors, the recommended yellow grease technologies are Lurgi PSI and Biodiesel Industries.

The economics of a small and large-scale facility can be found in Table 3.2. All yellow grease technologies claimed to convert all the free fatty acids in the incoming feed to biodiesel and this was used as the basis for the economic calculations.

Recommended State of the Art Technologies for Yellow Grease Biodiesel:
- Lurgi
- Biodiesel Industries

Table 3.2
Biodiesel Production Analysis for Yellow Grease
(10 percent) Free Fatty Acid

Plant Size	Capital Cost	Biodiesel Cost
(million gal/yr)	*(million)*	*($/gallon)*
3	$4.0	$1.53
12	$14.5	$1.36

Note: Yellow Grease Price of $.11/lb

Technology for Animal Fat Based Biodiesel

The technology for production of animal fat based biodiesel, with FFA levels at three percent, is the same as that for yellow grease. The maximum free fatty acid level of all the soybean oil based technologies was one percent. If the FFA level got higher than one percent the same technology options as that for yellow grease are employed for animal fat (i.e. acid esterification, or FFA removal with a combination of acid esterification and base transesterification). The main difference is whether the removed FFA rich stream is actually processed via acid esterification to make biodiesel, or just sold as a by-product. For the purposes of this analysis, the option of selling the high FFA stream as a by-product was chosen rather than continuing with the esterification step. This presents a good mid range between the yellow grease and soy technologies in terms of both operating and capital costs.

While only four companies responding to the survey claimed to be able to process animal fats, it should be noted that it is possible to purchase the FFA removal technology separately. Therefore, if someone wanted to use one of the low FFA biodiesel technologies applicable to soybean oil for the higher FFA animal fats, they may be able to do so if they choose to purchase the FFA removal technology from another vendor. It is more difficult to manage the transition between the two processes if two separate vendors are chosen, however, so for the purposes of this analysis only companies who claimed to do both are listed below.

Commercially Available Technologies For Animal Fat Biodiesel:
- Biodiesel Industries
- Energia
- BDI
- Lurgi PSI

For technology recommendations between these companies, the considerations are similar to those discussed in the yellow grease section. The recommended technology here, however, is Lurgi because Biodiesel Industries employs an acid esterification step with no FFA removal and therefore does not offer an option to remove and sell a high FFA stream. The economics of the animal fat based biodiesel production can be found in Table 3.3.

Recommended State of the Art Technologies for Animal Fat Based Biodiesel:

Lurgi

Table 3.3
Biodiesel Production Analysis for Animal Fat
(3 percent) Free Fatty Acid

Plant Size	Capital Cost	Biodiesel Cost
(million gal/yr)	*(million)*	*($/gallon)*
3	$3.5	$1.92
12	$13.0	$1.76

Note: Animal Fat Price of $.16/lb

It has been the experience of IBFG that most companies who wish to process animal fats are also interested in yellow grease. While animal fats are called out separately in this report, in most cases commercial entities will either choose a technology capable of processing yellow grease, which can also process animal fats and soybean oils, or they will choose one that will only handle low FFA soybean oil type feedstocks.

Technology for Mixed Feedstock Biodiesel Production in New York

Based on the available feedstocks in New York, as well as likely imports of feedstocks from surrounding states, the most likely feedstock mix for a plant in New York is 70 percent yellow grease and 30 percent soybean oil and the most likely size is 10 to 15 MM gallons per year. Even though a biodiesel plant using a 70/30 blend of yellow grease and soybean oil may not be practical in all areas of New York due to feedstock cost, availability and quality issues, it is meant to serve as an illustration of the macro feedstock situation in New York State. Economics and average price for this feedstock mix for a 12 mm gallon per year plant can be found in Table 3.4. In this case, the capital costs were assumed to be that for the full size yellow grease plant, since 70 percent of the time the plant would be operating on yellow grease. The operating costs and yields vary whether using yellow grease or soybean oil.

Table 3.4
Biodiesel Production Analysis for 70 percent Yellow Grease/30 percent Soybean Oil

Plant Size	Capital Cost	Biodiesel Cost
(million gal/yr)	*(million)*	*($/gallon)*
12	$14.5	$1.59

Note: Yellow Grease Price of $.11/lb and Soybean Oil Price of $.21/lb

Subtask 3.2: Feedstock Supply Channels

Virgin Vegetable Oils (Soybean Oil)

When soybeans are processed, two primary products result: soybean meal and soybean oil. The crude oil produced has most of the gums or sediment removed, but must be further processed or refined to prepare it for edible uses. Refining, bleaching and deodorizing the oil to remove the impurities present in the oil are the steps used by the oilseed processing industry to make the oil available for edible uses. This oil is often referred to as RBD oil. Not all oilseed processing locations have RBD processing equipment available. According to the *2002 Soyatech Bluebook*, approximately 50 percent of oilseed processors in the country have refining capabilities. Only one of the three-oilseed processors in the state of New York has refining capacity on site.

Limited local demand for crude soybean oil may exist for some processors; however, most processors either transport their crude oil to a company owned location for refining, bleaching and deodorizing or they sell it to oilseed refining operations. For New York processors, this means either selling their oil to AgPro Limited or loading it onto rail cars for destinations in the Midwest.

Crude soybean oil may have levels of fatty acids and phosphorus that are higher than desired for biodiesel applications. There is now an ASTM specification limit on the amount of phosphorus (P) contained in the biodiesel product (10 ppm max). A conventional treatment method, used in oil processing for fatty acid reduction, is caustic refining, wherein the oil is contacted with an alkaline solution and the FFA is neutralized then removed from the oil as "soap water". This method also has the effect of removing P-containing compounds and values of less than 10 ppm P are routinely achieved. An alternative method, referred to as "super-degumming" has also demonstrated the capability of reducing P levels, and has little effect on the FFA content. There have been some questions as to the consistency of P reduction with the super-degumming approach, so for purposes of this analysis it is recommended that caustic refining be considered as the treatment technique for P removal. Consequently, the FFA level of the treated oil will be low, and all of the processes considered will be able to handle the feed without further FFA considerations. If further investigation reveals that consistent P reductions can be obtained with super-degumming, then the processes that can handle higher FFA feeds will obviously have some level of increased attractiveness.

Rendered Fats and Oil (Animal Fats and Yellow Grease)

Animal Fats

Animal fats are derived from the rendering process using animal tissues as the raw material. The raw material is a byproduct of the slaughter and processing of meat animals and poultry. The amount of fat produced is directly related to the species of animal slaughtered and processed and the degree of further processing that is associated with the marketing/distribution of the meat product.

Though there are several specific systems for rendering, the process is a time/temperature treatment of sterilization, moisture removal and fat/grease extraction. As a general rule animal byproduct raw material is comprised of approximately 50 percent moisture, which upon removal results in approximately 25 percent for fat extraction and 25 percent for protein meal. The yields of both the fat/grease and protein portions are highly dependent upon species and tissues comprising the byproduct material. This is illustrated in the following table.

Table 3.5
Live Animal Yield[53]

Species	Edible	Inedible	Gastro-Intestinal Contents
Cattle	34%	50%	16%
Swine	52%	42%	6%
Chicken	70%	28%	2%
Turkey	73%	24%	3%
Lamb	37%	51%	12%
Cod Fish	36%	64%	N/A

Many of the larger packinghouses and processing plants have rendering equipment at those facilities. In other cases the raw material is transported to an independent renderer that collects and assembles raw material from a number of such accounts as well as other meat processing establishments that may not slaughter but further process/package such as supermarkets, custom slaughter/locker plants and table ready provision companies. The trend for further processing of "table ready" meat products is increasing. This has the effect of recovering more of the non-consumable tissue for rendering in contrast to having the consumer remove fat, bone etc., during kitchen preparation and disposed of as kitchen waste.

Most independent renderers have developed proprietary contracts for raw material sources. Most contracts contain formulas for determining the price of the raw material based on the yield of lipid and protein and the transportation distances involved.

The number of animals slaughtered in a given year establishes the production of fats and greases in a given location since animal lipids are not traded with defined state boundaries, the potential source of fats and greases could also be derived from surrounding states. List of processing and rendering facilities in New York State and surrounding states are presented in Tables 2.5 and 2.7.

Yellow Grease

Recycled cooking and restaurant greases are collected and processed primarily by the independent rendering sector since it is generally not a practice for packer or processing facilities to process yellow grease. It has been the independent rendering industries investment for storage containers, transportation, specialized processing and analytical equipment that has made them primary to this recyclable resource.

There are several sources and processing steps associated with yellow grease. The primary sources of the raw material lipids are any food preparation site. These can be restaurants with any number of star ratings, major food preparation facilities such as military bases, hospitals, nursing home facilities, college dormitories and numerous other

[53] Derived from: Goldstrand, R.E. 1992. An overview of inedible meat, poultry and fishery by-products. In: Inedible Meat By-Products. (A.M. Peirson and T.R. Dutson, Ed.) Elsevier, NY.

sources. Thus the primary resource is derived from frying oil exchanges but the grease derived from cooking of meat (griddle grease) becomes a component of recycled cooking and restaurant grease that when processed is most commonly traded as yellow grease and to a minor extent animal/vegetable blends.

As with the contracting by renderers for raw material sources, the acquisition of yellow grease raw material is very similar. Contracts are written to provide the service of collecting the raw material on a scheduled basis depending on the volume generated. Contracts are varied and again proprietary but often include multiple services such as providing and cleaning the storage containers. In some cases, the storage provisions have been incorporated into the original facility's building plans and located inside the facility with pump out provisions. In other facilities it may be a 55-gallon barrel that is protected in the back corner of the property. In any situation storage and collection becomes the first step. Material is collected and transported to a processing facility. It can be a temporary collection facility in which the primary process would be partial water removal. Decanting or centrifugation can accomplish this. The water content varies considerably from each facility collection point. A general 65 percent yield is commonly referenced. In most situations the raw material is transported direct to a central processing facility with water removing capability, filtration, analytical laboratories, storage and shipping capabilities.

The primary markets have been the use of yellow grease as feed ingredients for livestock, poultry, companion animals and aquaculture. This usage dictates strict quality control procedures that include a menu of analytical testing.

Subtask 3.3: Existing Biodiesel Production Facilities, Capacities and Trends

Biodiesel is not a new fuel to North America. Production can be traced back to the late 1970s and early 1980s. As a result of the OPEC crises in the 1970s, various universities and government agencies conducted significant research aimed at adapting lipids as a source of fuel. The general conclusion at that time was that biodiesel was a technically acceptable substitute, replacement, or blending stock for conventional petroleum diesel, but that costs were prohibitive compared to petroleum based diesel fuel.

It was not until 1992 and 1993 that the interest in biodiesel was renewed. Desires by both the vegetable oil and yellow grease industries to find additional uses for their respective products led both groups to fund biodiesel development projects and market evaluation studies. While both of these efforts occurred simultaneously, they were unknown to each other. Eventually, these two groups came together and the industry organization's name was changed from the National SoyDiesel Development Board to the National Biodiesel Board.

Over the last 10 years, there have been several other significant events that have helped shape the industry or will have a significant impact in the future.

- The Energy Conservation Reauthorization Act of 1998 is passed in 1998. This act allows fleets to use biodiesel in their medium- and heavy-duty vehicles as a compliance tool for Energy Policy Act of 1992 requirements.

- During Fall 2000, the Commodity Credit Corporation (CCC) creates the Bioenergy Program to stimulate and increase the production of biodiesel and ethanol.
- In December 2000, the U.S. EPA issued a final rulemaking on heavy-duty engine and vehicle standards and highway diesel fuel sulfur control requirements. The rule reduces the sulfur level in on-highway diesel fuel to less than 15 ppm. Biodiesel's lubricity enhancing characteristics could make it an important lubricity-enhancing component to Ultra Low Sulfur Diesel fuel when the sulfur levels change in 2006.
- In 2002, Minnesota passed a law that will require all diesel fuel sold in the state to contain a two percent blend of biodiesel beginning on July 1, 2005.
- On May 7, 2003, the Commodity Credit Corporation issued a final rulemaking on the structure of the Bioenergy Program. The restructuring allowed additional fats and oils to become eligible feedstocks under the program. The CCC also attempted to create parity in the subsidy payment calculations among feedstocks.
- The State of Illinois enacted a sales tax exemption for biodiesel blends greater than 10 percent and a partial sales tax exemption for biodiesel blends between one percent and 10 percent through the passage of HB46 in July 2003.

Industry Participants and Capacity

In 1993, there was only one commercial biodiesel company, Interchem in Overland Park, Kansas. By 1998, only a limited number of commercial entities were involved in significant commercial production of biodiesel. These companies included Ag Environmental Products, Griffin Industries, West Central Soy (d.b.a. Interwest L.C.), Pacific Biodiesel and Columbus Foods. Over the last four years, additional companies have installed production capacity and public announcements have been made for several more. The following tables and figures identify current biodiesel production plants and production facilities that have recently been proposed.

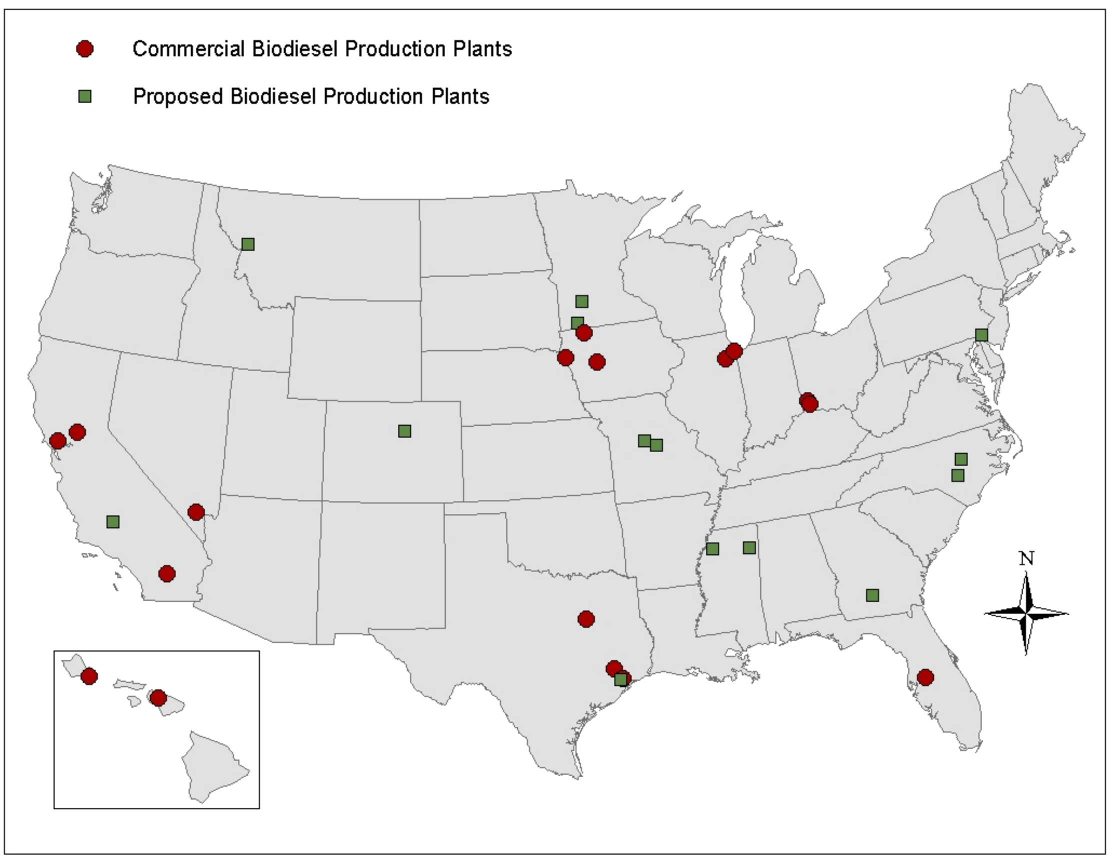
It is estimated that the current dedicated production capacity is estimated to be approximately 75-85 million gallons per year. This capacity ranges in plant sizes from less than one million gallons per year to over 12 million gallons per year. Moreover, a number of companies have reported plans to construct dedicated biodiesel plants to become operational during calendar year 2004 and 2005. These intentions are dependent upon regional demand prospects and, if fully implemented, could create an additional 115 million gallons of biodiesel capacity.

Construction of production plants in the biodiesel industry has been sporadic. The first small-scale commercial biodiesel plant was built by Interchem in 1993 and had a capacity of less than 300,000 gallons per year. Since that time, 17 other plants have come on-line with a wide range of production capabilities. Current plant capacities range from 100,000 gallons per year to 12 million gallons per year with the average plant size being approximately six million gallons per year. As the demand for biodiesel continues to grow, it is estimated that the size of dedicated biodiesel production facilities will continue to expand as firms strive to lower production costs and increase market share.

Several other companies, such as Cognis and ICI/Unichem, produce esters for internal needs, but are not actively involved in the production or marketing of biodiesel in the U.S. These companies are primarily involved in the manufacturing of oleochemicals, but have been involved in ester production for many years utilizing technology that has been developed internally. Although few estimates are available to document this surplus capacity, it has been reported that up to 200 million gallons of production capacity are available through existing long-term production agreements with biodiesel marketing firms. Even though they may be able to produce methyl esters for the biodiesel market, fuel production does not fit well with the production and marketing strategies of most of these companies, therefore this capacity cannot be guaranteed in the event that dedicated biodiesel producers do not have sufficient capacity to meet market demand for biodiesel.

The oleochemical industry also has a significant investment in methyl ester production assets; however, the primary distribution channel of the ester production from these facilities at this time continues to be to the chemical manufacturing market, rather than the fuel market.

Figure 3.5
Current and Proposed Biodiesel Production Plants[54]



[54] Source: National Biodiesel Board website, www.biodiesel.org

Table 3.6
Current and Proposed Biodiesel Production Plants

Company	Location		Status
Ag Environmental Products	Sergeant Bluff	IA	Active
Biodiesel Industries	Las Vegas	NV	Active
Bio-Energy Systems, LLC	Vallejo	CA	Active
Columbus Foods	Chicago	IL	Active
Corsicana Technologies, Inc.	Corsicana	TX	Active
Griffin Industries	Cold Spring	KY	Active
Huish Detergents	Pasadena	TX	Active
Imperial Western Products	Coachella	CA	Active
Ocean Air Environmental	Lakeland	FL	Active
Pacific Biodiesel	Honolulu	HI	Active
Pacific Biodiesel	Kahului	HI	Active
Peter Cremer (TRI-NI)	Cincinnati	OH	Active
Procter and Gamble	Sacramento	CA	Active
Soy Solutions	Milford	IA	Active
Stepan Company	Millsdale	IL	Active
Texoga Technologies	Spring	TX	Active
West Central Soy	Ralston	IA	Active
American Bio-Fuels LLC	Bakersfield	CA	Proposed
Biodiesel of Mississippi, Inc.	Marks	MS	Proposed
Biodiesel of Mississippi, Inc.	Nettleton	MS	Proposed
Biomass Energy Services	Tifton	GA	Proposed
Blue Sun Biodiesel	Commerce City	CO	Proposed
Farmers Union Marketing & Processing Assn	Redwood Falls	MN	Proposed
Filter Specialty Bioenergy LLC	Autryville	NC	Proposed
Grain Growers Cooperative	Selma	NC	Proposed
Mid America Biofuels	Jefferson City	MO	Proposed
Mid-Atlantic Biodiesel	Delaware City	DE	Proposed
Minnesota Soybean Processors	Brewster	MN	Proposed
Montana Biodiesel	Missoula	MT	Proposed
Otto Feeds	Bunceton	MO	Proposed
Texoga Technologies	Pasadena	TX	Proposed

Biodiesel Demand

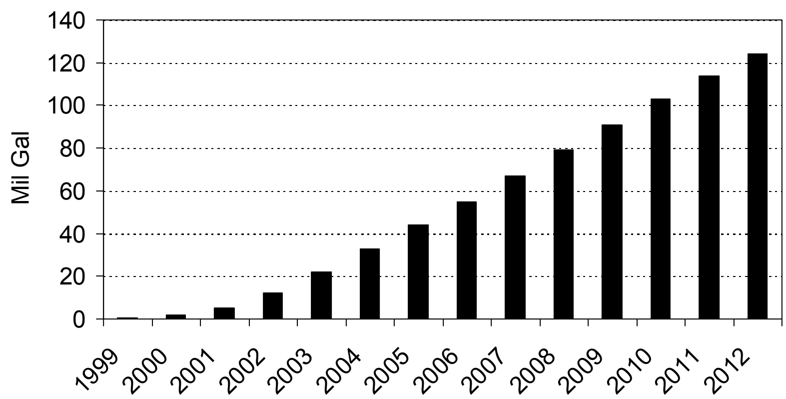
While the biodiesel industry was initially started to take excess oils and fats off the market, growth in the industry has been sustained by this country's desire to become less dependent upon foreign sources of oil and to clean up the environment. There are currently hundreds of major fleets that have implemented biodiesel programs across the country including federal fleets such as the Postal Service, U.S. Marine Corps, Department of Interior, and state fleets such as Ohio, Iowa, Virginia, Delaware, North Carolina and New Jersey Departments of Transportation. Major public utility fleets such as Commonwealth Edison, Duke Energy, Alabama Power and others use biodiesel as well.

The biodiesel industry is an expanding industry that has experienced tremendous growth since 1999. The National Biodiesel Board reports that sales have increased from about

500,000 gallons in 1999 to more than 12 million gallons in 2002. It is estimated that the biodiesel demand grew to over 20 million gallons in 2003. In a study conducted by the USDA's Office of the Chief Economist evaluating the effects of the Renewable Fuels Standard (RFS) as proposed in the Energy Policy Act of 2002 (H.R. 4) on commodity markets, farm income and employment, biodiesel demand was projected through 2012. Biodiesel demand was projected to grow from 22 million gallons in 2003 to 124 million gallons in 2012.

Figure 3.6

Current and Projected Biodiesel Sales



This study only considered demand impacts associated with the passage of the RFS and did not consider the legislative impacts of a partial excise tax exemption on biodiesel demand. Industry experts believe that if an RFS were combined with a partial excise tax exemption (such as provided in the Energy Bill currently before Congress) biodiesel demand could grow at a rate two to three times greater than the demand projections associated with the passage of an RFS only.

Several important points should be taken into consideration when interpreting this growth. The most important is the impact of the USDA's Bioenergy Program on biodiesel companies that had already installed facilities before the initiation of the program. While the Bioenergy Program is intended generally to act as a source of capital to encourage new plant construction, many biodiesel companies have used it as a subsidy for biodiesel. There have been several instances over the past year where these companies have used their USDA funds to artificially lower the price of biodiesel — sometimes to the same level as conventional diesel fuel.

A comparison of anticipated growth in biodiesel demand and the number of biodiesel producers indicates that current biodiesel production capacity exceeds biodiesel demand. However, a number of events could quickly utilize the available production in the market. As discussed previously, passage of the partial excise tax exemption and renewable fuel standard would rapidly generate significant demand for biodiesel-blended fuel.

Feedstock Selection

Soybean oil is the primary feedstock used in the production of biodiesel in the U.S. with approximately 90-95 percent of the commercially produced biodiesel made from soybean oil. The remaining percentage of biodiesel is made from yellow grease and used cooking oils. According to the Commodity Credit Corporation, the USDA agency that administers the Bioenergy Program, of the 8,861,232 million gallons of new biodiesel production in FY2002, 8,768,555 gallons were made soybean oil, 91,636 gallons were made from yellow grease and only 1,041 gallons were made from mustard seed oil.

Soybean oil's place as the feedstock of choice has come into being for several reasons.

- Soybean oil is the most abundant feedstock in the U.S.
- Due to excess production capacity, soybean oil surpluses, and declining prices, the soy industry has been a major driving force behind biodiesel commercialization.
- Federal and some state biodiesel purchasing programs favor vegetable oil based biodiesel.
- The USDA's Bioenergy Program, which provides a production incentive for new biodiesel production, initially excluded yellow grease as an eligible feedstock under the program.

It is anticipated that a growing percentage of biodiesel will be made from yellow grease and used cooking oils as: a) additional rendering companies invest in biodiesel production assets, b) the USDA's Bioenergy Program has been restructured to provide equality between biodiesel feedstocks by linking production payments from other feedstocks to soybean oil price, and c) as biodiesel users become feedstock neutral in their purchasing decisions.

New York Biodiesel Availability

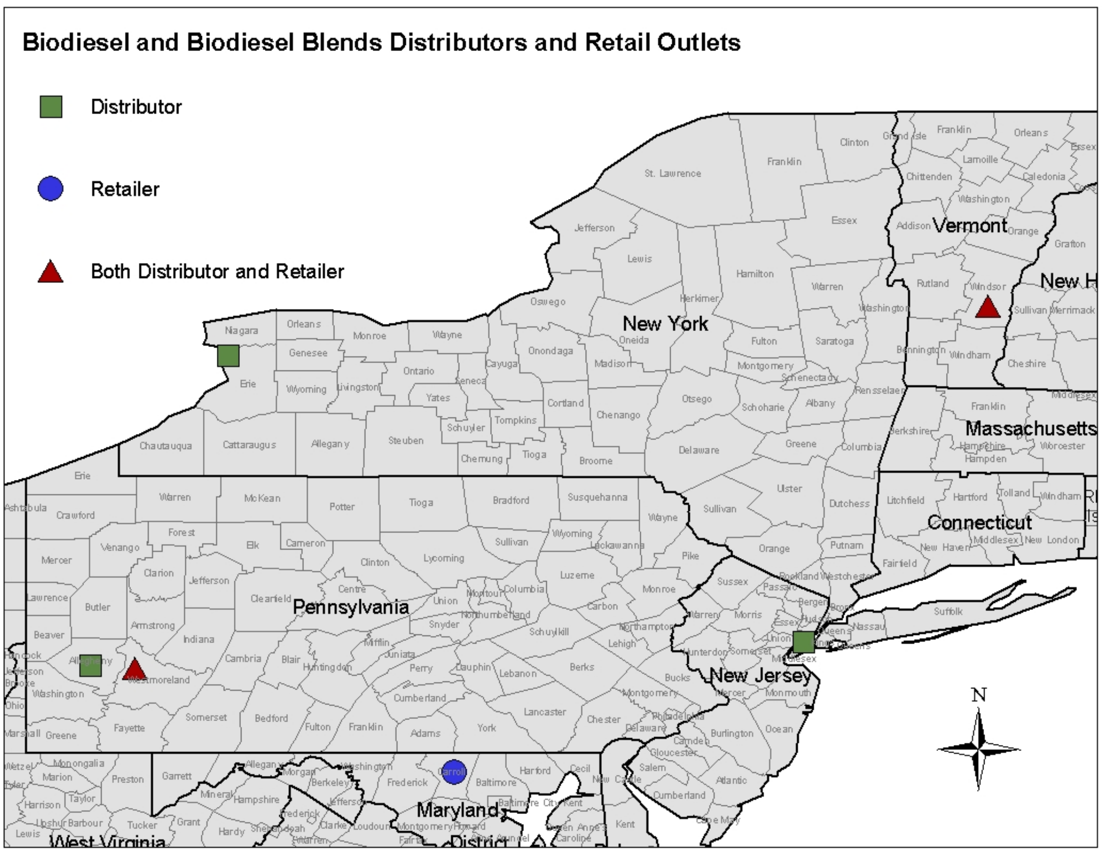
The biodiesel industry in New York is relatively small but growing. At the time of this report, no commercial scale biodiesel plants are operating in New York or the surrounding states. There are, however, a handful of biodiesel distributors and retail locations for biodiesel blended fuels. They are included in the table and figure below.

Table 3.7
Biodiesel and Biodiesel Blends Distributors and Retail Outlets Located in New York and the Surrounding States.[55]

Company	Location		Type
Burke Oil	Chelsea	MA	R
Allegheny Bio-Solutions, LP	Pittsburg	PA	D
Export Fuel Company, Inc	Export	PA	B
Schildwachter & Sons Oil	Bronx	NY	R,D
Tech Transfer	Mattituck	NY	R,D
NOCO Energy Corp	Tonawanda	NY	D
UMR Energy Systems	Staten Island	NY	D
Global E Industries, Ltd	Cavendish	VT	B

Note: R=Retailer, D=Distributor, B=Both Distributor and Retailer

Figure 3.7
Location of Biodiesel and Biodiesel Blends Distributors and Retail



[55] Source: National Biodiesel Board website, www.biodiesel.org

Subtask 3.4: Agricultural Impacts

Currently the major oilseed produced in New York is soybeans. Oilseed crops have never been grown extensively in New York State. Growers in Seneca County began producing soybeans in the early 1970s and by the early 1980s New York growers planted about 20,000 acres of soybeans annually. Soybean acreage did not expand greatly in the 1980s because of limited markets and processing facilities in New York. In the late 1980s and 1990s, however, oil processing plants were built in Oneonta (Oneida Co.), Homer (Cortland Co.), Phelps, (Ontario Co.), and Ogdensburg (St. Lawrence Co.), and some dairy farmers purchased soybean roasters for on-farm roasting and feeding to dairy cows. Soybean acreage increased to 40,000 acres in the 1990-1991 growing seasons, 100,000 acres in 1997-1998, and about 150,000 acres in 2001-2002. In 2003, New York growers produced soybeans on about 144,000 acres at a projected yield of 35 bu/acre for a total production of 5.3 million bushels.

Commercial farmers have successfully produced winter canola and sunflowers on limited acreage in New York in the 1980s and 1990s. We believe that both of these oilseed crops could be successfully produced in New York if there were lucrative markets. Winter canola would be produced in limited regions of northern New York (close to the lakes) because of over wintering problems and in eastern New York because of the limited number of cash crop producers in that region. Winter canola could expect to average about 3,000 lbs/acre in central and western New York because of its excellent adaptation to the wheat-growing regions of New York. Consequently, winter canola would compete mostly with winter wheat, soybean, dry bean, and some vegetable acreage in central and western New York if the price were attractive enough. Conceivably, winter canola could compete with some dry-shelled corn acreage, which could expand the growing region, but growers may be more reluctant to give up the steady and reliable corn market. If there were a strong demand, New York growers could probably produce winter canola on 100,000 to 200,000 acres for a total annual production of 150,000 to 300,000 tons. Winter canola production in New York, however, would reduce soybean acreage and production, especially at the higher estimate.

Sunflower is another oilseed crop that is agronomically well adapted to New York growing conditions. Sunflower has better drought tolerance compared with soybean so sunflower can tolerate the frequently dry August growing conditions, which routinely reduce soybean yields in New York. Sunflowers, however, are susceptible to numerous diseases that are prevalent in New York, including sclerototinia, verticilium, and rust. Furthermore, sunflowers are very vulnerable to severe bird damage just before harvest, which would necessitate timely harvest in New York. Sunflowers, however, must be dried down to about 10 percent before harvest, which could result in an extended-dry down period under NY environmental conditions and severe bird damage.

Sunflower yields averaged as high as 3,000 lbs/acre in Cornell Research trials in the late 1970s (Knapp, 1979) so average yields of 2,000-2,500 lbs/acre could be expected under NY growing conditions (compared with about 1,400 lbs/acre in South Dakota, the leading sunflower producing state in the U.S.). Sunflower would compete directly with soybean and dry bean acreage and indirectly with winter wheat acreage. Sunflowers could also be grown on oat acreage, which could expand the sunflower growing region to northern and eastern NY and the Southern Tier. Also, if the price were high enough, sunflowers could be produced on dry-shelled corn acreage but as mentioned previously that is unlikely. Consequently, potential sunflower acreage in New York is also about 100,000-

200,000. Total annual production of sunflower could thus potentially average 100,000 to 250,000 tons.

Clearly, if there is a demand for oilseeds in New York, New York growers will respond to the demand and adjust their acreage accordingly.

The major field crops produced in New York are hay (mainly alfalfa), corn, winter wheat, and soybeans. Taken together these crops were planted to nearly 2.9 million acres in 2003. Over the past twenty-five years the number of acres planted to these crops has declined nearly 27 percent. As is the case in other Northeastern states most of this land was lost to development, however some acreage shifted to higher value crops such as fruit and vegetables, or was taken out of production. According to the Census of Agriculture, an estimated 244,000 acres of cropland have been idled in New York.

The demand for vegetable oil to produce biodiesel is significant enough to provide an incentive for New York farmers to shift acreage from hay and to a limited extent, corn to soybeans, and bring idled land back into production. As indicated earlier, winter wheat acreage could be shifted to other oilseeds such as winter canola and sunflower.

We expect that between 2003 and 2012 New York soybean acreage will continue to expand reaching 165,000 acres by 2007 with additional land coming from idled acreage and other crops. The additional demand for soybean oil to supply a New York biodiesel industry is expected to increase soybean acreage by an additional 100,000 acres by 2012. The largest amount of this acreage (26,000) is expected to come from hay, 20,000 from corn, 10,000 from wheat, and the remaining 44,000 from idled land and other crops including vegetables.

Other oilseed crops such as winter canola and sunflower are potentially feasible alternative feedstocks for biodiesel production. However, the absence of processing facilities for these crops and the requirement for farmers to invest in new equipment is expected to prevent a significant shift of acres to these crops.

The majority of these acre shifts are likely to occur in the major soybean producing counties of north-central New York (Ontario, Livingston, Monroe, Onondaga, Niagara, Genesee, Oswego, and Oneida).

These acreage shifts can accommodate the production of an additional 11 million bushels of soybeans by 2012 without jeopardizing the amount of hay or corn silage needed to supply New York's declining dairy herds.

The increase in soybean production is expected to add an additional $85.5 million of cash receipts to New York farmer's income statement between 2007 and 2012. To the extent that land is shifted from hay and corn, cash receipts from hay are expected to decline by $18.1 million and corn receipts by $20.8 million resulting in a net gain for New York farmers of $46.6 million in higher cash receipts over the 2007 to 2012 period, or $6.7 million per year.

Since the acreage shifts are relatively modest; little or no additional equipment or services should be required; and both soybeans and alfalfa fit into existing crop rotations with corn, most of the increase in cash receipts should fall to farmer's bottom line and increase net cash income.

Task 4: Market Assessment

Subtask 4.1: Current New York Market Segmentation

While the market segments outlined in this report cover a broad based group of applications, there is, however, a common thread that holds each together, that is that they can and do currently use generic fungible ASTM D 975 or ASTM D 396 petroleum products for both mobile and stationary engines. Engine size, horsepower, filter sizes and applications vary but the fuel used is “generic” in nature. Because one product fits such a variety of market applications and the buyers of that generic product have been conditioned to procure their motor fuels based on economics it becomes challenging to introduce clean burning fuels like biodiesel even with all its positive attributes. Buyers’ purchasing attitudes and core business philosophies all play a pivotal role in consumers’ fuel purchasing habits relating to diesel fuel and related energy products.

Knowing that some diesel fuel users will pay the added costs of buying premium diesel fuel (diesel fuel enriched with a multi-functional fuel additive) retailers will use a “historical marketing practice” to add a little profit for their business to attain a return on investment (ROI) for upgraded infrastructure costs (injection systems to inject the additive). There appears to be differences in a consumer’s perception of buying a fuel based on quality characteristics versus price. Gasoline buyers appear willing to pay premium gasoline’s higher cost, rather than regular unleaded gasoline’s lower costs, in order to obtain maximum performance for their automobile. In contrast diesel fuel buyers that manage large centrally fueled fleets often view premium diesel as a waste of money.

This attitude is changing, however, with the advent of EPA regulations on sulfur reduction, emission reduction demands, lubricity issues and the continued quest to modify diesel for optimum cold weather operability. The oil industry is conditioned to sell all their products based on a price per gallon basis and this conditioning has driven petroleum products in general to be bought and sold as a commodity. The past decade has seen the emergence of more premium based fuels where the marketer is taking time to differentiate fuel quality while attempting to overcome the incremental costs associated with upgrading the fuel which ranges anywhere from $.0045 per gallon in the summer and $.0135 per gallon per treated gallon in the winter.

Operational Demands of Various Market Segments

Each of these six transportation segments and one space-heating segment are linked together relating to fuel use. Each depends on a diesel fuel or heating oil based on ASTM D 975 or ASTM D 396 standards. Both the transportation and heating oil sectors are deprived of quality parameters much needed to ensure optimum operability levels. Users are subjected to a fungible No. 2 diesel fuel with only one broad guaranteed specification, sulfur. That sulfur level in on-road diesel fuel is federally mandated today at 500 ppm but will soon decrease to less than 15 ppm based on the U.S. EPA’s ruling for 2006[56]. It is clear that once the 15 ppm diesel fuel becomes the standard, diesel

[56] “Diesel Fuel Sulfur Control Requirements; Final Rule” that, “beginning June 1, 2006, refiners must begin producing highway diesel fuel that meets a maximum sulfur standard of 15 parts per million (ppm).” Federal Register. Vol. 66 No 12 Thursday, January 18, 2001, Rules and Regulations records on P5006.

powered trucks, buses and cars will emit less SO_x as well other unhealthy emissions. The diesel oxidation catalysts (DOC) that will become standard fare will also enjoy longer life as the ultra low sulfur fuel makes it way downstream.[57] Tier 4 off road emission reduction implementation is proposed to follow the on road reductions later this decade.

However, the transition to ultra low sulfur diesel will do absolutely nothing for the other critical diesel fuel quality parameters such as cetane improvement, lubricity, and solvency impact on keeping injectors and nozzles clean. Table 4.1 depicts key diesel powered market segments versus the benefits that multi-functional additives or a blend of biodiesel would offer. The columns of this table represent different fuel quality parameters broken down by biodiesel blend. A check indicates that a biodiesel blend at the specified level would positively impact the quality parameter for a particular market segment. For example, all market segments would benefit from a 20 percent blend if emission reductions were the core benefit being sought.

Table 4.1
Market Segmentation and Possible Benefits Derived with B2, B5 and B20

Market Segment	Emissions Reduction			Cetane			Lubricity			Solvency		
	B2	B5	B20	B2	B5	B20	B2	B5	B20	B2	B5	B20
LD Truck			✓			✓	✓	✓	✓			✓
LD Vehicles			✓			✓	✓	✓	✓			✓
HD/MD Truck			✓			✓	✓	✓	✓			✓
Off-Road			✓			✓	✓	✓	✓			✓
Marine			✓			✓	✓	✓	✓			✓
Rail			✓			✓	✓	✓	✓			✓
Heating Oil			✓				✓	✓	✓		✓	✓

<u>Diesel Emissions</u>

Technology, innovation, investment, regulation, and legislation are turning the diesel world upside down. While some parts of the world still suffer with dirty diesel smoke and noise caused by obsolete engine technology, poor maintenance, and high sulfur fuels, the future remains clear that ultra low or near zero sulfur distillate fuels like biodiesel will be in demand.

Diesel engine and vehicle makers are accelerating their technology development, aiming to slash particulate matter (PM) and nitrogen oxide (NOx) emissions. Their solution: pair up sulfur sensitive exhaust catalysts and advanced engine controls with ULSD fuel for ultra clean emissions. The result: engines and vehicles that can match or beat any alternative technology at costs lower than alternative fuels while using the existing petroleum distribution infrastructure.

Worldwide demand to slash greenhouse gas emissions might open doors for future CO_2 emissions credit trading which potentially provides a future source of funds for clean

[57] Diesel Oxidation Catalyst (DOC) promoting oxidation processes in diesel exhaust. Usually designed to reduce emissions of the organic fraction of diesel particulates, gas-phase hydrocarbons, and carbon monoxide.

diesel refining and clean diesel vehicles. As regulatory demands for cleaner burning engines continue to evolve, industry decision makers are now taking the initiative to install diesel particulate traps on equipment to further cut back regulated emissions. Refiners, engine manufacturers and hardware manufacturers are beginning to use alternative emission reduction strategies, so fuels like biodiesel may become an advanced option to achieve these emission reductions.

Unlike Europe, U.S. federal environmental regulators are not pushing for new limits on cetane, aromatics, density, or distillation. The difference in thinking is due to the relatively huge growth of the light duty diesel market in Europe and the relative absence of light duty diesel vehicles in North America. Any specification reducing density likewise could have a power and fuel economy penalty, which is a larger issue in North America where the average engine horsepower range is higher than Europe. On-road trucking (the major diesel market in the U.S.) is less sensitive to cetane and much more sensitive to price. Centrally fueled fleets are more likely to accept biodiesel blends than owner operated fleets due to the limited availability of biodiesel distribution infrastructure throughout the nation at this time. Petroleum terminals and diesel distribution sites are continuing to expand nationwide as they learn about biodiesel. It is the acceptance of those that own and operate those assets that will determine if capital equipment investments are warranted based on the market demand for biodiesel and related blends. Pending the passage of the energy bill, along with proposed independent state initiatives, petroleum asset owners will begin seriously considering infrastructure upgrades to accommodate biodiesel distribution.

Lubricity

A fuel with adequate lubricity is critical to satisfactory operation of diesel engines, which rely on the fuel to lubricate the moving parts within injection equipment. The use of fuels with poor lubricity can increase fuel pump and injector wear and, at the extreme, cause catastrophic failure. Thus, ULSD will lack satisfactory lubricity and require the use of biodiesel blends or a petro-based lubricity additive. A two percent or five percent blend of biodiesel would deliver enhanced fuel lubricity. It has been documented that a two percent blend of biodiesel could impart up to a 65 percent improvement in a fuel's lubricity values. Like a diesel engine, heating oil systems all depend on a fuel pump to deliver the fuel from the storage tank to combustion. These pumps would certainly benefit from a fuel possessing a high lubricity value.

Inadequate lubricity is not the only cause of wear in diesel engine fuel systems. Diesel fuel can cause abrasive wear of the fuel system and the piston rings if it is contaminated with abrasive inorganic particles. Fuel injectors and rotary distributor fuel pumps are particularly susceptible to wear because the high liquid pressures they generate require extremely close tolerances between parts moving relative to each other. Since New York receives inbound diesel fuel and heating oil via waterborne vessels, it is dependent on a fungible storage and distribution system that impacts fuel quality to a greater degree than pipeline shipments in other parts of the country. As sulfur is reduced in diesel fuel, coupled with New York's predictable fungible distribution system challenges, fuel quality concerns will become elevated. Biodiesel offers generic distillates the clear advantage of lubricity enhancement, which is one area that will need to be addressed with the anticipated 2006 reduction in sulfur levels.

Although biodiesel at blends of two percent add $.03-$.05 per blended gallon compared to the $.0005 per gallon (500 ppm fuel) and $.0050-$.0075 per blended gallon (<15 ppm sulfur) associated with petroleum based lubricity additives, the results are well documented that low levels of biodiesel can significantly enhance the lubricity of diesel fuel. One of the main advantages of using biodiesel as a fuel lubricity agent is that the blender will not encounter any negative side effects of over blending which has been an issue for several years with users of acidic-based lubricity additives worldwide. The industry has begun to transition to a safer more reliable lubricity additive based on non-acidic formulas which have been documented to cause soapy emulsions in crank case oil when diesel fuel comes in contact with it. With the emergence of <15 ppm diesel fuel it has been stated that additive suppliers will be increasing the dosage of existing technologies to successfully replenish the much needed lubricity and at a higher cost. Although this may not meet the biodiesel blend number at one and two percent, it is certainly deemed to be higher than current values associated with non-acidic lubricity additives. Reasons blenders may view biodiesel as an attractive alternative to additives include:

- No concern of overdosing or negative repercussions that a petroleum based additive can cause if misused. Some of the existing technologies in many multi-functional diesel fuel additives have components within them that cause negative interactions with the detergents found in motor oil detergent packages. When the chemical compound in the diesel fuel lubricity additive encounters the lube oil detergent a soapy emulsion can develop causing premature filter plugging. Additive suppliers, however, are responding and began introducing non-acidic lubricity agents requiring increased treatment dosage as well as higher costs but not valued near the $.04 up charge that biodiesel blends currently generate at today's economics.

- Foreign oil displacement. Although two percent appears to be a low displacement value it reduces petroleum dependency in relationship to the blend. EIA documents a distillate fuel consumption of 8.8 million gallons per day in New York, which places New York in the number three position nationally. A two percent displacement of 8.8 million gallons per day reduces petroleum consumption by 160,000 gallons per day, a level not to be understated.

- Biodiesel blends of two percent can be blended into bulk storage tanks of diesel fuel and heating oil upon entry into a respective tank farm, potentially eliminating or reducing the costs associated with terminal storage and distribution associated with conventional fuel additives.

<u>Cold Flow Improvers</u>

Although biodiesel offers no cold flow technology improvements with the generic fuels it is mixed with, it is important to understand that once blended with generic fuels in blends up to 20 percent minimal cold flow impact would be recognized. The introduction of low sulfur diesel in 1993 was a major shock to low temperature operations in cold weather markets throughout the United States. Normal paraffins can comprise up to 30 percent of a typical diesel fuel and range from 10 to 36 carbon numbers, depending on the distillation range of the finished fuel. When sulfur is removed from a diesel fuel by hydrodesulphurization, the unsaturated hydrocarbons become saturated and the fuel becomes even more paraffinic. This increase in wax content produces a loss of low temperature handling criteria guaranteeing downstream downtime for the diesel user. The inclusion of five percent to 20 percent biodiesel blends will impact the finished fuel temperature of all areas of concern, pour point, cloud point and cold filter plugging point by two to five degrees Fahrenheit based upon lab round robins evaluations and field testing conducted nationwide over the past decade. It is the storage prior to blending the fuels that present the most challenging scenario. However, nationwide terminals have already begun investigating and in some cases preparing their infrastructure for biodiesel and the variable blends demanded by the various market segments seeking specific benefits from each blend ratio.

Low temperature operability was an industry issue even before biodiesel was introduced to generic diesel fuel. Middle distillate fuels can be equally challenging to store and blend because they contain straight and branched chain hydrocarbons (paraffin waxes) that become solid at ambient wintertime temperatures in colder geographic areas. When this happens, the wax may plug the fuel filter or it may completely gel the fuel, making it impossible for the fuel system to deliver fuel to the engine. Moisture in fuel remains a diesel fuel's number one contaminant. A combination of a moisture displacer additive and tank management housekeeping standards will help contain the negative consequences that develop when left unattended.

Engine design changes to address this problem include locating the fuel pump and filter where they will receive the most heat from the engine. The practice of pumping more fuel to the injectors than the engine requires is also beneficial, since the warmed excess fuel is circulated back to the tank. While the primary purpose of this recycle loop is to cool the injectors, it also heats the fuel in the fuel tank, which can cause diesel fuel to rapidly degrade thermally. Heating fuel is good if it prevents gelling, but bad if it degrades the fuel. As you can see many diesel fuels quality characteristics are co-dependent on one another. Fuels that have too high a cetane could have poor thermal stability. Fuels that are light gravity and better in cold weather routinely possess poor lubricity qualities. It is important when controlling cold weather aspects of fuel to remember that other critical qualities may be impacted in other ways that may be equally harmful to engine performance.

In a refinery, there are a number of approaches to improve a fuel's low temperature operability. After the fuel is in the distribution system, dilution with kerosene is the most practical way to lower cloud point. Additives and pour point depressants are used to improve the cold filter plugging point (CFPP)[58] and to lower pour point.[59] When they work, additives have several advantages over dilution: they are available in all areas of the country, the treatment cost is less, and treatment does not lower fuel density and, thus, heating value and fuel economy. The cold filter plugging point is another issue during winter operation. Currently, the cold filter plugging point can be controlled with a combination of wax crystal modifiers and kerosene. In addition, there are a few organizations that market biodiesel cold flow chemistry that claim to reduce the cold filter

[58] One dynamic test that has been widely accepted in Europe is the Cold Filter Plugging Point of Distillate Fuels (CFPP). In this test, the sample is cooled by immersion in a constant temperature bath. Thus the cooling rate is non-linear, but fairly rapid – about 40°C/hour. The CFPP is the temperature of the sample when 20 ml of the fuel first fails to pass through a wire mesh in less than 60 seconds. CFPP appears to over estimate the benefit obtained from the use of certain additives, especially for North American vehicles.

[59] ASTM D97 – Pour Point of Petroleum Products. A clean sample is first warmed and then cooled at a specified rate and observed at intervals of 5°F (3°C). The lowest temperature at which sample movement is observed when the sample container is tilted is the pour point.

plugging point to a safe level of winter operation, but, unfortunately, at an unreasonable cost.

A national chemical manufacturer has developed a pour point depressant that reduces the pour point of middle distillates up to 30 degrees Fahrenheit. However, the pricing to achieve this reduction may outweigh the additive option. Prevailing values for this technology would increase the cost of a biodiesel treated gallon between 15 - 27 cents. Although a heavy cost penalty is associated with this additive it still must be considered an additive because of its function to control cold weather performance values of the fuel.

More technological development is required on behalf of the additive industry to strike a balance between performance and costs. This leaves the hardware option as the only true method to control biodiesel's cold weather parameters which includes dilution with kerosene or adding heat to both the storage vessel and piping which carries the biodiesel into the generic fuel stream heading to the rack where trucks load for immediate distribution.

Stability

The hydro treatment process required to reduce sulfur levels in diesel fuels also acts to reduce the level of olefins present in the fuel. This results in diesel which appears to have excellent stability characteristics as measured by the current techniques such as F-21 or ASTM D6864, F-31, ASTM D4625, etc. However, the refinery desulphurization process also removes the naturally occurring antioxidants. The removal of these radical traps allows the formation of organic peroxides, which, in addition to aiding free radical polymerization, have a significant effect upon the elastomers present in vehicle fuel systems.

Another area of concern to new users of biodiesel is its shelf life, termed stability. It is true that all fuels, including middle distillate currently in use throughout New York, have storage limits. While stability is a reported concern with biodiesel, in-use results with B20 have not indicated any stability related performance problems in the field. These positive results are due, in part, to the generally accepted industry practice of using the fuel with in six months.

If longer storage life is desired, as with conventional diesel fuel a fuel stabilizer should be used or the fuel monitored to insure it stays within specification. A fuel stabilizer known to be very effective for biodiesel is TBHQ/Citric Acid combination, trade name Tenox 21, manufactured by Eastman Chemical Company. Developed as a food grade antioxidant, TBHQ at 200 ppm will make biodiesel virtually inert. It can be obtained by contacting Chempoint.com who is currently the only distributor of this product. Other companies are preparing to release biodiesel-specific type stabilizers that carry a treatment cost close to $.05 per gallon of B100.

Cetane Number

A diesel fuel's cetane number is a measure of its ignition quality. It is widely recognized that high cetane number diesel fuels offer a number of benefits important both for engine performance and the environment.

When sulfur is removed from the diesel fuel through hydrodesulphurization, the unsaturated hydrocarbons become saturated, making the fuel more paraffinic. This increase in paraffin content and the associated decrease in olefin content are beneficial to the natural cetane number of the stream but create a fuel more challenging to treat for cold weather operability. As discussed above, higher paraffin is detrimental to cold flow.

In practice, this increase is limited to, at most, a few cetane numbers and the potential benefits are reduced as the natural cetane of the feedstock increases. Although advantageous, this refining trend will not provide sufficient natural cetane to meet ASTM's progressively increasing minimum cetane specifications demanded by industry leadership groups like the Engine Manufacturers Association and The Motor Council. Using biodiesel blends in the 20 percent range could help maintain the type of cetane values this group of diesel powered vehicles desires. A less expensive alternative to using a biodiesel blend to enhance cetane is the use of a well-known cetane improver available through national chemical manufacturers and distributors.

2-Ethylhexyl nitrate (EHN) is the most widely used cetane number improver. It is sometimes also called octyl nitrate. EHN is thermally unstable and decomposes rapidly at the high temperatures in the combustion chamber. The products of decomposition help initiate fuel combustion and, thus, shorten the ignition delay period from that of the fuel without the additive. EHN is one additive that is not easily handled by the novice. Attention to safety and handling is a prerequisite for successful and safe use.

The increase in cetane number from a given concentration of EHN varies from one fuel to another. It is greater for a fuel whose natural cetane number is already relatively high. The incremental increase gets smaller as more EHN is added, so there is little benefit to exceeding a certain concentration. EHN typically is used in the concentration range of 0.05 percent mass to 0.4 percent mass and may yield a 3 to 8 cetane number benefit.

A disadvantage of EHN is that it decreases the thermal stability of some fuels. The effect of the other cetane number improvers on thermal stability is unknown, but it seems likely that they will be similarly disadvantaged. Several laboratories are investigating this issue.

Although biodiesel is a higher cost option than cetane improvers ($.0025-$.0050), it is considered a much safer and more reliable way to enhance cetane.

Performance

Neat biodiesel has slightly less energy (seven to nine percent) and a higher cetane number than the average New York fungible diesel fuel. However, in over 30 million miles of field demonstrations, biodiesel blends showed similar fuel consumption, horsepower, torque and haulage rates as conventional diesel. When biodiesel is blended with conventional diesel in proportions of 20 percent or less, a difference in engine performance is nearly imperceptible.

Biodiesel Economics

The main challenge to the increase use of biodiesel is its cost. At the time this report was being prepared, neat biodiesel FOB, Allston, Massachusetts was approximately $2.00 per gallon while distillate fuels were to be found at $.9385 for generic and $.9420 for premium, FOB Revere, Massachusetts. Until the cost of biodiesel blends comes down, its use will probably be limited to situations where it is subsidized or where the potential environmental benefits offset the additional cost. For example, biodiesel is more widely used in Europe where environmental regulations and tax subsidies make it practical. Also, amendments to the Energy Policy Act (EPAct) allow federal and state fleets to capitalize on this liquid fuel technology by earning vehicle credits for its use.

Opportunities and Barriers by Specific Market Segments

The market barriers and opportunities below were prepared assuming the current state of legislation and market dynamics as a mechanism to help understand how any proposed policy change or other legislation might impact the various market segments.

Light Duty (LD) Vehicles <8500 Gross Vehicle Weight (GVW)

- This sector may not be a large market opportunity for the biodiesel industry short term but may provide substantial opportunity in out years. Lack of product availability at commercial fueling stations and cost are the largest barriers to biodiesel use in light duty vehicles. In addition, there are relatively few light duty vehicles in the US with diesel engines at present but there is an increasing effort to move to light duty diesels in the US due to fuel economy constraints upon the automakers.

- Some light duty vehicle owners using biodiesel such as Volkswagen TDI owners tend to purchase biodiesel for its intrinsic benefits, mainly environmental friendliness and energy security and appear to be willing to pay higher prices for these perceived benefits.

Light Duty Truck >8500 GVW Commercial Light Trucks

- This sector could be a prime candidate for biodiesel use because it falls under fleet GVWs that are normally owned and operated by larger fleets, which depend on centrally fueled sites. These vehicles are normally fueled at a privately owned fuel depot, where quality and inventory are managed internally, or arrange to have their vehicles refueled by a supplier at a central location each day. Centrally fuel fleets also normally procure fuel and can control accessing it.

- From a public relations standpoint, most of these vehicles could benefit from clean burn campaigns in communities where they operate such as waste haulers and roadwork teams like DPW's.

Heavy Duty/Medium Duty (HD/MD) Trucks >8500 GVW

- Unless this market segment group falls under EPAct or other government regulations, owner/operators or private fleets under no government regulations are an unlikely market for the biodiesel industry. This sector scrutinizes price first, quality second. Until blender credits or user credits encompass this sector, the HD/MD vehicle market will rely on conventional diesel technologies.

- Particulate matter emissions are of concern. Fleets are coming under environmental pressures, so companies must start looking at technologies like biodiesel to offset this attack.

Off-Road (e.g. construction and agricultural)

- Because off-road markets are normally supplied with higher sulfur fuels with even less quality assurance than on-road fuels, the construction sector will likely be the last market to transfer to a biodiesel blend. However, emission regulations currently being discussed for Tier 4 may prompt this sector to take a closer look at biodiesel or at the very least encourage them to purchase lower sulfur fuel such as 500 ppm. Depending on the availability of 500 ppm fuel, this sector may resort to the on-road value of <15 ppm in 2006.

- This market is normally one where fuel sits for longer periods of time and requires higher cetane. Power is critical for this market, but because of the nature of the heating oil pool, acceptable cetane values between 40 and 45 are typical. Biodiesel blends at least two percent may be a good start with the emphasis placed on fuel lubricity.

- The agricultural subset of this market has demonstrated a willingness to buy biodiesel blends of B2 to B10, and in some cases higher blends. Farmers are motivated to use biodiesel blends because of its lubricity benefits and as a way to increase returns to their operations through increased demand for soybean oil.

Marine (Commercial or Pleasure Boats)

- Biodiesel is an obvious candidate for use in marine applications. Independent tests have found that pure biodiesel is non-toxic, readily biodegradable and essentially free of sulfur and aromatics.

- Biodiesel offers more environmental benefits. For research vessels and consumers using commercial vessels, biodiesel offers a more environmentally friendly alternative to regular diesel. Because it is non-toxic and biodegradable, consumers and researchers may pressure owners for biodiesel, especially in sensitive or protected waterway areas although biodiesel spills are still responded to like a conventional distillate spill.

- Biodiesel can work in several marine factions. Because biodiesel can replace or be blended with petroleum diesel with little or no engine modifications, it is a viable alternative to several categories of the marine industry, including: recreational boats, inland commercial and ocean-going commercial ships, research vessels, and the U.S. Coast Guard Fleet. Today, much of the emphasis is on recreational boats, which consume about 95 million gallons of diesel fuel annually.

- Biodiesel has a higher flash point - a minimum of 260 degrees versus about 125 degrees Fahrenheit for regular No. 2 diesels. Biodiesel also offers low-pressure storage at ambient temperatures and is safer to transport.

- The marine industry is moving towards dual fuel tanks (CA) and towards requiring low particulate fuel for cruise, commercial and pleasure crafts.

- The marine market is historically a price driven market but also one of "proud" owners. This could be categorized as an emotional purchase marketplace where those possessing diesel powered vessels may like to tell others they burn a specialty/boutique type fuel like biodiesel or biodiesel blends.

Rail

- The industry currently pays large premiums for ember fire protection insurance, which is insurance against damages causes by carbon spark right-of-way fires. A reduction in rail diesel fuel use could allow the rail industry to approach the insurance industry to reduce insurance values.

- Final rule establishing emission standards were on promulgated April 17, 1998, (63FR18977).[60] These standards are geared primarily toward NOx reductions, which may reduce biodiesel's role in meeting these emissions standards.

Heating Oil

- Heating oil industry is in need of clean burning technology to compete with natural gas. The National Oil Heat Research Alliance (NORA) program that seeks clean burning technologies inclusive of hardware innovations has begun to consider the addition of a biodiesel blend to further advance the positive net results of competition with the natural gas industry.

- Biodiesel has demonstrated through laboratory and field testing that it exceeds emission reducing expectations as well as enhances many operational categories important to upgrading fuel quality and oil heating systems overall performance.

- NORA, NYSERDA, Brookhaven, Warwick Public School Project, Abbott & Mills, NOCO and many more studies have motivated industry leadership to begin seriously thinking about low-percentage blends of biodiesel with 500-ppm sulfur fuels. Low-percentage blends soften the overall cost to the homeowner. The industry must strike the price increase balance not to exceed $0.05 per gallon. This includes the cost of moving from 3,000-ppm sulfur heating oil to 500-ppm. A two percent blend of biodiesel depending on procurement values, would add $.0350 to $.0400 per gallon while the lower sulfur diesel fuel could add between $.01 and $.0150 per gallon.

[60] www.epa.gov/oms/locomotv.htm

Subtask 4.2: Distribution Channels

The State has no petroleum refineries but relies partly on nearby refineries in New Jersey for its petroleum supply needs. Several pipelines carry petroleum products from refineries and ports located along the Delaware River near Philadelphia, Pennsylvania, to population centers in the northern portion of the State near Syracuse, New York. In addition, a major liquefied petroleum gas pipeline traverses the State and terminates at Selkirk, New York. The Energy Information Administration indicates that natural gas is the dominant home heating fuel with a market share of nearly 52 percent, followed by fuel oil with a 33 percent share.

<u>Upstream</u>

Although New York primarily receives supply from waterborne vessels, ships and barges, much of the petroleum is moved by pipeline throughout the United States. Pipelines are considered the most cost-effective means of transferring crude oil from the port facilities to the tankers. Although cheaper, pipeline operators still incur operating and labor costs, as well as various maintenance fees. If a pipeline should break, the cost of gasoline and diesel can be significantly affected.

Transportation costs can vary depending on the distance from place to place. Obviously, it costs more to ship oil from the Middle East to the U.S. than it does from other locations in the Western Hemisphere. There are also added costs if a tanker is too large to dock and must be unloaded at an offshore facility.

Another factor that can affect the cost of transporting fuel is war. For example, fighting in the Middle East or even the threat of war can cause insurance rates to dramatically increase due to the higher likelihood that oil shipments could be interrupted. Higher rates equate to higher oil prices. War can also affect gasoline and diesel prices in situations where a large-scale military operation is underway, and there is a high demand for jet fuel. A high demand for fuel relative to its availability causes prices to increase.

Once the petroleum has been transported, it is ready to be produced into gasoline, diesel and heating oil as well numerous other products drawn off the basic refinery process. There are many hydrocarbons in petroleum, but only the ones that can evaporate under engine conditions can be used in gasoline and diesel. Because crude petroleum consists of hydrocarbons that are both more and less volatile than gasoline, gasoline must be separated from petroleum through a process called distillation. Distillation, however, provides an amount and quality of gasoline that is considered insufficient. Therefore, gasoline production must be supplemented with more sophisticated refinery processes.

These processes take the less volatile and more volatile petroleum hydrocarbons and turn them into hydrocarbons that have the correct volatility. The refinery process also adds specialty chemicals to the blend to enhance the performance of the hydrocarbons. Through this, gasoline can be created to have the desirable characteristics necessary for good engine performance. The downside of this process causes the middle distillate fuel, which becomes diesel fuel, kerosene and home heating oil, to be of lower quality.

Historically, refiners have focused their attention on gasoline production while ignoring the middle distillate cut of the barrel which has caused diesel fuel users and home heating users to be subjected to fuels that are much more unstable and poorer performing in their respective combustion process. For the heating oil dealer, the net result has been increased activity in replacing nozzles, strainers and filters while the diesel user suffers poor fuel economy, more pollutants, less power and challenging cold flow characteristics as well low lubricity values. These are all deficiencies that cost fleets hundreds of thousands of dollars a year in increased operational costs.

Basic refining costs can run anywhere from 50 cents to $3.00 per barrel. The EPA has mandated that by 2005 the nation's largest oil refineries must reduce the sulfur content of gasoline by 90 percent, and calls for an equally large reduction in diesel fuel's sulfur levels by mid-2006 to <15 ppm from the current level of 500 ppm. The estimated cost of the process to remove sulfur from motor fuel is estimated to be anywhere from one to five cents per gallon.

Regulatory changes may spell the beginning of a new trend in refinery changes to meet the rising demand for lower sulfur fuels. Biodiesel creates an opportunity for petroleum organizations to utilize biodiesel as a blend stock to help reduce sulfur with out-of-specification fuels as well as to help meet the regional demand for low sulfur fuels that refineries may not be able to keep pace with. As biodiesel is being considered as a method to reduce sulfur levels, it would simultaneously address the rising lubricity concerns associated with low sulfur fuels.

<u>Downstream</u>

After the diesel fuel or gasoline is produced, it is ready to be distributed to retailers. Again, transportation is needed for this to be accomplished. Ironically, the cost of transporting these liquids through fuel trucks depends a lot on the cost of the diesel and gasoline itself. If gasoline and diesel prices increase, the cost of transporting the respective fuels to fuel depots and gasoline stations rises commensurate with the cost of fuel itself. Again, the cheapest way to transport distillates in the United Sates is through dozens of pipelines that cross the country. The 5,359-mile Colonial pipeline system between New York and Houston carries approximately 80 million gallons of petroleum products a day. Because of biodiesel's low national and regional demand, pipeline movements are currently not a consideration as a transportation mode.

Once at the retailer or private fleet fuel site, even more costs are added to the price of fuel. There are several factors that contribute to these added costs. The first is for the general upkeep of running a fuel distribution terminal, and end-user fueling site. This would include costs for maintenance, employee salaries, insurance, property taxes, as well as profit margins. The amount of this added cost varies from retailer to retailer as well as from fuel wholesale marketer/terminal operator to fuel wholesale marketer/terminal operator.

Another factor that contributes to the differences in the cost of diesel and gasoline products is the grade of fuel being offered and sold. With respect to diesel, there is generic diesel and premium diesel fuel. According to the recent changes agreed upon by the National Conference on Weights and Measures Premium Diesel Fuel Task Force, a diesel fuel merchant must adhere to meeting or exceeding basic criteria beyond generic diesel which includes documented lubricity value, thermal stability, cetane number and low temperature operability. This ruling was modified at a NCWM meeting on July 16, 2003. These changes can be found in the 2004 NIST Handbook 130. It is clear that the inclusion of biodiesel can help meet the criteria outlined in the rule.

Infrastructure Considerations

For the most economical and operationally sound distribution of biodiesel in the State of New York, existing petroleum infrastructure must be utilized. Fuel wholesalers and terminal operations currently active in the receipt, storage, blending and distribution of all types of petroleum and gas liquid products are supplying all the markets listed earlier in this outline.

ASI Engineering of Tulsa, OK and AFS has undertaken a study of the infrastructure requirements that would be necessary to enable a petroleum distributor to handle neat biodiesel cost effectively. These include splash blending, preset rack blending; wild stream rack blending and header supply wild stream blending. Additional infrastructure options beyond terminal upgrades included truck stops and small bulk plants that are re-supplied from pipeline and deep water storage terminals.

Figure 4.1
Terminals Distributing Low Sulfur Diesel Fuel in New York

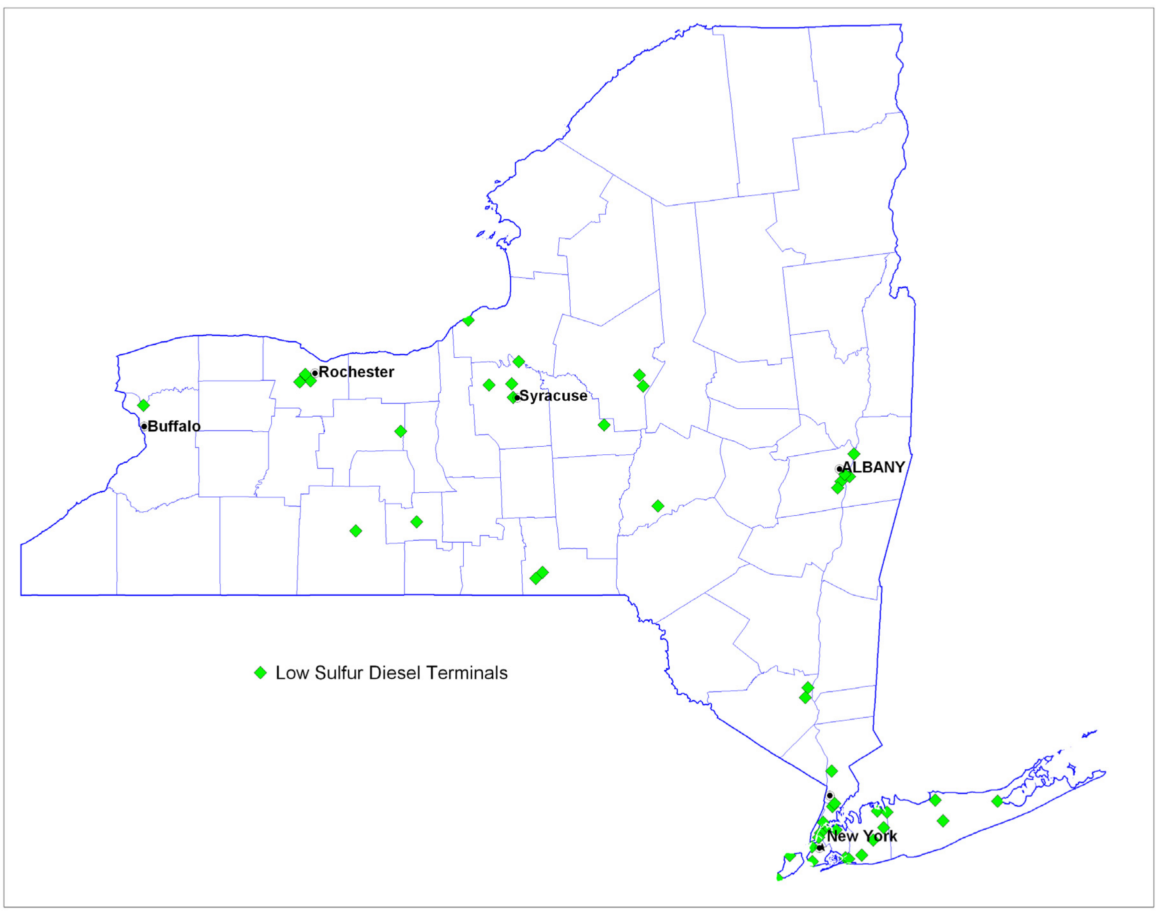


Figure 4.1 depicts the existing fuel distribution terminals strategically positioned throughout the State of New York. Not shown are the hundreds of small inland bulk terminals owned and operated by numerous private companies. Once distillate fuels are brought into the New York Harbor they are stored in deep water storage facilities and then transported throughout the vast New York region to more localized storage facilities. With mounting regulatory demands on spill containment and insurance increases, many of these smaller bulk terminal operators are reconsidering the value of keeping these assets active. For example, a Long Island terminal proprietor has decided to cease operations after this year and sell his property to a large national discount store chain for the value of the real estate.

To accommodate biodiesel blends it will be necessary for each terminal operator to determine the level of distribution that they will encounter with biodiesel. Blends of two percent to five percent or 20 percent may be accommodated through implementation of many strategies. All terminals, unless willing to take another product out of service to utilize existing storage tanks, will need to invest in storage tanks, normally above ground (due to liability issues), to accommodate the B100 which will be delivered into each location by rail (if accessible) or transport (45,000 lbs, or 6,000 gallons). Once supplied it will be necessary for the storage proprietor to keep the biodiesel safe from cold weather gelling. This challenge is easily handled by heating the storage vessel containing the biodiesel as well as the lines that carry the biodiesel into the distillate fuel (diesel or heating oil) being blended. The costs associated with the tank and heating will vary on the actual size of storage capacity being considered.

The costs associated with the array of infrastructure options is estimated at $250,000 to $2 million depending on the size of the terminal and the utilization of heat and how far the heat is carried throughout the system. For purposes of this study, an average value of $750,000 per terminal was assumed. The real costs for each terminal could vary dramatically from this number. Once the biodiesel blend is finished, conventional transports can then carry the B2, B5 or B20 directly to the truck fleet, bus fleet, rail application or homeowner with no operational headaches.

The number one market obstacle for successful biodiesel integration in any state is the economics of biodiesel fuel. A second obstacle is the infrastructure costs to transition each and every bulk plant to take receipt, store, blend and distribute a finished biodiesel blended fuel to the consumer market (any market sector being addressed above). The cost of product may be resolved by the successful passage of the blender's tax credit currently under review with in the Comprehensive Energy Bill. A blender's tax credit helps petroleum industry parties interested in biodiesel cover the costs associated with infrastructure modifications as well begin building a market demand for biodiesel. Fuel wholesalers or terminal operators need to pay back the equipment investment by moving gallons through their respective terminals. Any current petroleum product being purchased at any level has included in it a line item dedicated to throughput costs, normally .0075 points per treated gallon.

While all these strategies are developing, it will be very important to establish a comprehensive educational program to advise the petroleum industry of this unique liquid alternative fuel that may improve the quality of the existing distillate base stocks with the simultaneous benefit of impacting foreign oil displacement on an environmentally friendly note.

Subtask 4.3: Economic Sensitivity Analysis of Regional versus National Scenarios

New York can create a significant market for biodiesel by enacting a mandate. The market for diesel fuel in New York is substantial. Total distillate fuel use in New York is estimated at 3.2 billion gallons in 2002 and is projected to increase at an annual rate of about 1.2 percent over the next decade. A B2 mandate covering all end uses would create a market of 64.1 million gallons that would increase to 73.7 million gallons by 2012.

A B2 mandate covering on-highway diesel uses beginning in 2007 and expanding to include residential, commercial, industrial, and utility uses would create a market of 23.3 million gallons in 2007 increasing to 70.6 million gallons by 2012.

The maximum capacity of New York to produce biodiesel is currently estimated at about 30 million gallons. This is projected to increase to 40 million gallons by 2012. This assumes that all of the soybeans grown in New York are crushed using current technology (mechanical extraction that yields 7.8 pounds of oil per bushel) and all of the oil produced along with all of the yellow fat produced in the state is used to produce biodiesel. Consequently, New York could theoretically meet all of the demand for a B2 mandate covering on-highway transportation fuel by 2007 and about 48 percent of the demand created by a full B2 mandate by 2012.

The challenge for New York is to design policy options that require or hold the highest probability that the largest possible amount of biodiesel used in New York is produced in manufacturing facilities build and operated in New York, ideally using locally produced feedstocks. This would maximize the economic development impact for New York. Otherwise, biodiesel produced in other states would be shipped into New York to be blended for distribution, or soybean oil and other feedstocks produced in other states would be shipped it to be converted to biodiesel in state.

Successful passage of the Energy Bill now in the Senate is an obvious key to the future development of the biodiesel industry. However, development of biodiesel capacity can be expected in the major soybean producing states where the majority of the oilseed processing capacity exists (notably Illinois and Iowa). Within the Region, Pennsylvania is actively investigating the feasibility of building a biodiesel industry. This would limit the availability of a New York industry to attract feedstocks from this major Mid-Atlantic soybean producer.

Consequently, the relative (to other states) financial attractiveness of investment in biodiesel capacity in New York can be significantly affected by State-provided incentives. The most obvious -- and perhaps most cost effective --way to ensure that economic development and the benefits arising from a viable biodiesel industry accrue to New York is to link the incentive (or mandate) to New York biodiesel capacity or to biodiesel produced in New York.

TASK 5: PUBLIC POLICY OPTIONS

Subtask 5.1: Existing Federal Energy and Environmental Programs

The National Energy Policy Act of 1992 (EPAct)—Phase I

Eleven years ago, Congress enacted the Comprehensive Energy Policy Act of 1992. The intent of this statute was to strengthen the nation's energy security by displacing imported petroleum through the promotion of alternative fuels and alternative fueled vehicles. EPACT requires state fleet authorities, certain federal fleets and the fleets of alternative energy providers such as utilities, to purchase vehicles capable of running on alternative fuels. The U.S. Department of Energy (DOE) implemented these regulations with the strategy that, once purchased, the alternative fueled vehicles (AFV) would then use alternative fuels. The resulting alternative fuel usage would then meet the EPAct goals of replacing 10 percent of U.S. petroleum usage with alternative fuels by the year 2000 and 30 percent by the year 2010.

EPAct requirements affect fleets located in large metropolitan statistical areas (MSA). State fleets, federal fleets, and alternative fuel providers (primarily utilities) that operate within these metropolitan areas are required to purchase alternative fuel vehicles if they operate, lease or control 50 or more light duty vehicles within the United States. In the fall of 1998, Congress passed a provision that allows fleet managers to utilize biodiesel as a means to comply with their EPAct requirements. Under this biodiesel fuel use credits provision, fleets may choose to operate existing diesel vehicles that weigh more than 8,500 lbs. on blends of biodiesel in lieu of purchasing a new alternative fuel vehicle. The fleet may only count the biodiesel portion of that blend towards their annual vehicle purchase requirement. For each 450 gallons of pure biodiesel purchased and consumed, an alternative fuel vehicle credit is awarded. No credit is given for the non-biodiesel (petroleum) portion of the fuel blend. No credit is given for the actual vehicles operating on the biodiesel-blended fuel. Only the actual purchase of biodiesel may be substituted for a fleet vehicle purchase requirement.

New York’s state fleets and federal fleets operating in New York may find that utilizing B20 blends is the most economical method to comply with Phase I EPAct requirements.

EPAct Phase II

EPAct authorizes DOE to pursue a rulemaking concerning AFV acquisition requirements for private and local government fleets if replacement goals are not being met. The transportation sector currently accounts for approximately two-thirds of all U.S. petroleum use and roughly one-fourth of total U.S. energy consumption.

On March 4, 2003, the Department of Energy proposed to determine that a regulatory requirement for private and local government fleets to acquire alternative fueled vehicles was not “necessary”, and thus should not be promulgated. The Department felt that such a program would result in no appreciable increase in the percentage of alternative fuel and replacement fuel used by motor vehicles in the U.S. Two primary reasons were cited. First, the number of fleets that would be covered by a private and local government fleet mandate and the number of AFV acquisitions that would occur are too small to cause an appreciable increase in the percentage of replacement fuel that is used as motor fuel.

Second, even if a private and local government fleet acquisition mandate were adopted and substantial numbers of AFVs were acquired as a result, there is no assurance that the AFVs acquired by covered fleets would actually use replacement fuel. EPAct gives DOE no authority to require that vehicles acquired by private and local government fleets use any particular fuel. Therefore, Phase II of EPAct will not be a market driver for biodiesel demand.

Proposed Amendments to the Energy Policy Act

Current law allows fleets to meet up to 50 percent of their AFV acquisition requirements through the use of biodiesel in vehicles weighing in excess of 8,500 lbs. gross vehicle weight. Current law does not allow credits to be banked or traded. Biodiesel users that must comply with EPAct initiated an effort to remove the limitation on biodiesel usage to generate EPAct credits. Section 514 of the proposed Energy Bill which is being discussed by conferees would allow any covered person subject to section 501 and any State subject to section 507(o) of the Energy Policy Act of 1992 to petition the Secretary of Energy for a waiver upon demonstrating a reduction in annual petroleum fuel consumption equal to the reduction in consumption that would result from compliance with section 501 or 507(o). Fleets must also be in compliance with all applicable vehicle emissions standards established under the Clean Air Act.

This section of the Energy Bill, if passed, could provide a demand boost for immediate biodiesel sales if it is determined that fleets can meet 100 percent of their petroleum reduction requirements using biodiesel. However, the provisions will also alter the competitive position of biodiesel versus other alternative fuel technologies. Fleets would then be able to utilize any alternative fuel and receive credit for actual fuel usage. Fleets would also have the opportunity to utilize other measures such as fleet reduction or improved vehicle fuel efficiency. Therefore fleets would have several new options to consider for EPAct compliance.

Executive Order 13149

The executive order entitled Greening the Government Through Federal Fleet and Transportation Efficiency was signed on April 21, 2000. This executive order was signed to ensure that the Federal Government exercises leadership in the reduction of petroleum consumption through improvements in fleet fuel efficiency and the use of alternative fuel vehicles and alternative fuels.

Each agency operating 20 or more vehicles within the United States is required to reduce its entire fleet's annual petroleum consumption by at least 20 percent by the end of FY2005 (compared to their FY1999 consumption levels). In addition, each agency shall use alternative fuels to meet a majority of the fuel requirements of those motor vehicles by the end of FY2005. Executive Order 13149 applies to all on-road vehicles including light, medium and heavy duty.

Agencies covered under this Executive Order include the:

- Department of Agriculture
- Department of Commerce
- Department of Defense
- Department of Energy
- Department of Health and Human Services
- Department of Housing and Urban Development
- Department of Interior
- Department of Justice
- Department of Labor
- Department of State
- Department of Transportation
- Department of Treasury
- Department of Veterans Affairs
- Environmental Protection Agency
- National Aeronautics and Space Administration
- General Services Administration
- United States Postal Service

This executive order may prove to be a nice complement to requirements of the Energy Policy Act. Federal fleet managers will now be required to use alternative fuels in addition to purchasing alternative fuel vehicles. In a recent Department of Defense Alternative Fuels Workshop all branches of the military indicated that biodiesel use would become a key element in their Executive Order 13149 compliance strategy.

Ultra Low Sulfur Diesel Fuel In The U.S.

In December 2000, the EPA finalized regulations to reduce the sulfur content of highway diesel fuel by 97 percent from its current level of 500 ppm to 15 ppm. Previous research mentioned above has documented the lubricity benefits of biodiesel at very low percentages. Biodiesel could be included as a low level blending component in diesel fuel as a means to improve fuel lubricity while providing environmental, economic, and energy security benefits to diesel users and the U.S. public at the same time.

Additional Points:

- The proposed sulfur reduction rule is designed to help engine manufacturers install exhaust after treatment devices to meet the proposed 2007 emissions standards.
- A reduction of sulfur levels in diesel fuel to 15 ppm using conventional methods to remove the sulfur would require refiners to include lubricity additives to maintain fuel quality and engine performance.
- Biodiesel in blends of two percent can solve the lubricity problems of future diesel fuel
- Biodiesel itself has less than 15 ppm sulfur.
- Biodiesel blends can be used with existing petroleum infrastructure.
- Diesel fuel injection equipment companies such as Stanadyne prefer the biodiesel solution above other additives.

On May 23, 2003, the EPA proposed new emission standards for non-road diesel engines and sulfur reductions in non-road diesel fuel that will dramatically reduce emissions attributed to non-road diesel engines. This comprehensive national program will regulate non-road diesel engines and diesel fuel as a system. New engine standards will begin to take effect in the 2008 model year. This proposal represents the first time non-road diesel fuel will be regulated.

EPA proposed to reduce sulfur levels in non-road diesel fuel by more than 99 percent to 15 parts per million (ppm). Taken together, controls included in this proposed regulation would result in large public health and welfare benefits. Diesel fuel used in non-road, locomotive, and marine applications would meet a 500 ppm cap starting in June 2007, a reduction of approximately 90 percent. In 2010, sulfur levels in non-road diesel fuel (though not locomotive or marine diesel fuel) would meet a 15 ppm cap, for a total reduction of over 99 percent.

This provides an even stronger case for inclusion of biodiesel at the two percent level in all diesel fuel sold in the U.S. in 2006.

<u>Volumetric Biodiesel Excise Tax Credit Provisions</u>

Senator Grassley (R-IA) introduced Senate Bill 1548 (S1548) which repeals the reduced tax rate on sales of fuel for blending with alcohol and gasohol and imposes the full rate of excise tax on alcohol blended fuels (18.3 cents per gallon on gasoline blends and 24.3 cents per gallon of diesel blended fuel). In place of the reduced rates, the proposal provides per-gallon excise tax credits for alcohol and biodiesel fuel mixtures and provides for outlay payments (as an alternative to tax credits) to producers of alcohol and biodiesel fuel mixtures and users of 100 percent alcohol and biodiesel fuel mixtures and users of 100 percent alcohol and 100 percent biodiesel fuels. These provisions are being considered as part of the 2003 Energy Bill.

According to the Joint Committee on Taxation, *Description of the Chairman's Mark Regarding the Extension of Highway Trust Fund Provisions and the "Volumetric Ethanol Excise Tax Credit Act of 2003"* (JCX-75-03), dated September 15, 2003, the Highway Trust Fund is funded with amounts equivalent to revenues from certain excise taxes on motor fuels and on heavy trucks and tires. Under present law, six separate excise taxes are imposed to finance the Federal Highway Trust Fund program. Three of these taxes are imposed on highway motor fuels. The remaining three are a retail sales tax on heavy highway vehicles, a manufacturers' excise tax on heavy vehicle tires, and an annual use tax on heavy vehicles.

The Highway Trust Fund motor fuels tax rates are as follows:

Gasoline	18.3 cents per gallon
Diesel fuel and kerosene	24.3 cents per gallon
Special motor fuels	18.3 cents per gallon (generally)

Many exemptions are realized through refunds. Exempt uses and fuels include:

1) Use in State and local government and nonprofit educational organization highway vehicles
2) Use in buses engaged in transporting students and employees of schools
3) Use in local mass transit buses having a seating capacity of at least 20 adults (not including the driver) when the buses operate under contract with (or are subsidized by) a State or local governmental unit to furnish the transportation; and

4) Use in intercity buses serving the general public along scheduled routes. (Such use is totally exempt from the gasoline excise tax and is exempt from 17 cents per gallon of the diesel fuel tax.)

Fuels used in off-highway business use or on a farm for farming purposes generally are exempt from these motor fuels taxes as well.

The proposed policy creates two new excise tax credits: the alcohol fuel mixture credit and the biodiesel mixture credit. The sum of these credits may be taken against the tax imposed on taxable fuels (by section 4081). A person must first apply the excise tax credit against excise tax liability, if any, before making any claim for payment.

The proposal provides an excise tax credit for biodiesel mixtures of 50 cents for each gallon of biodiesel used by the taxpayer in producing a qualified biodiesel mixture. A qualified biodiesel mixture is a mixture of biodiesel and diesel fuel that is (1) sold for use or used by the taxpayer producing such mixture as a fuel, or (2) removed from the refinery by a person producing the mixture. In the case of agri-biodiesel, the amount of the credit is $1.00 per gallon and applies only if the taxpayer obtains a certification from the registered producer of the agri-biodiesel that identifies the product produced. Agri-biodiesel is biodiesel derived solely from virgin oils, including esters derived from corn, soybeans, sunflower seeds, cottonseeds, canola, crambe, rapeseeds, safflowers, flaxseeds, rice bran, mustard seeds or animal fats. Recycled biodiesel, on the other hand, is biodiesel derived from non-virgin vegetable oils or non-virgin animal fats.

This excise tax credit is coordinated with income tax credit for biodiesel such that credit for the same biodiesel cannot be claimed for both income and excise tax purposes. Under the proposal, the Secretary may require registration of every person that produces biodiesel or alcohol.

If 100 percent biodiesel is used by any person as a fuel in a trade or business or sold by any person at retail to another person and placed in the fuel tank of such person's vehicle, the Secretary is to pay such person an amount equal to the alcohol credit or the biodiesel credit with respect to such fuel.

The provision also provides a new income tax credit for qualified biodiesel and biodiesel mixtures, the biodiesel fuels credit. The biodiesel fuels credit is the sum of the biodiesel mixture credit plus the biodiesel credit and is treated as a general business credit. The amount of the biodiesel fuels credit is includable in gross income. The biodiesel fuels credit is coordinated to take into account benefits from the biodiesel excise tax credit and payment provisions. The biodiesel income tax proposal is effective for fuel sold after December 31, 2003. Provisions expire on December 31, 2005.

This bill represents the MOST significant piece of legislation that could positively impact biodiesel demand. Given the lubricity characteristics of biodiesel, passage of this bill would create a significant incentive for refiners and blenders to incorporate low levels of biodiesel as a lubricity additive into the diesel fuel supply.

Renewable Fuels Standard

Provisions of House Resolution 6 (HR6), currently under consideration by House and Senate Energy Bill conferees, would create a renewable fuel program. Known as the renewable fuel standard (RFS), this program would ensure that gasoline sold or dispensed to consumers in the United States, on an annual average basis, contains an applicable volume of renewable fuel as specified in Table 5.1. The program would apply to refiners, blenders, and importers. For the purposes of this program, the term 'renewable fuel' means motor vehicle fuel that is produced from grain, starch, oilseeds, or other biomass including cellulosic biomass ethanol and biodiesel as defined in section 312 (f) of the Energy Policy Act of 1992.

Table 5.1
Applicable Volume of Renewable Fuel.

Calendar Year	Fuel *(in billions of gallons)*
2005	2.7
2006	2.7
2007	2.9
2008	2.9
2009	3.4
2010	3.4
2011	3.4
2012	4.2
2013	4.2
2014	4.2
2015	5.0

After 2015, applicable volumes for each calendar year shall be equal to the product obtained by multiplying the number of gallons of gasoline that the EPA Administrator estimates will be sold or introduced into commerce in the calendar year and the ratio that 5.0 billion gallons of renewable fuels bears to the number of gallons of gasoline sold or introduced into commerce in calendar year 2015.

Cellulosic biomass ethanol shall be considered to be the equivalent of 1.5 gallon of renewable fuel for the program and the Administrator shall provide for the generation of an appropriate amount of credits for biodiesel fuel.

Entities that refine, blend, or import gasoline that contains a quantity of renewable fuel that is greater than the quantity required shall generate credits. Entities may use the credits or transfer all or a portion of the credits to another person. Credits may be carried forward two consecutive calendar years.

This section of the Energy Bill, if it becomes law in conjunction with biodiesel tax provisions, could result in dramatically increased usage and completely change the structure of the biodiesel industry; paving the way for large scale plants.

Amendments to the Congestion, Mitigation, and Air Quality Bill

The Biofuels Air Quality Act (HR318), introduced by Congressman Shimkus (R-IL), would allow the cost of biodiesel and other renewable fuels to be eligible for Congestion Mitigation Air Quality Program (CMAQ) funding. Currently, the CMAQ program funds transportation projects that will reduce congestion and improve air quality. However, in general, the cost of purchasing fuel does not qualify for funding. Since the only expenditure to using some renewable fuels is the cost of purchasing the fuel, cities wishing to use fuels like biodiesel in their bus fleets can be turned down for CMAQ funding. The legislation would also allow the use of CMAQ funds for the installation of capital equipment necessary for the conversion of storage and distribution facilities to carry renewable fuels or renewable fuel blends. Senator Bond has introduced a similar bill in the Senate.

This legislation would provide cities, specifically urban transits, school buses, and Clean Cities Programs, with the opportunity to receive federal grants to offset the incremental costs of B20.

IRS Reporting and Dyeing Requirements

The Internal Revenue Service of the U.S. Government requires that all companies selling fuel commercially in the U.S. report the amount of fuel sold and pay the appropriate Federal Excise Tax (commonly referred to as Road Tax) to the U.S. Treasury. The amount of this tax, and associated state tax varies depending on whether the fuel is to be used for non-exempt purposes or exempt purposes. IRS regulations require that all off-road fuel be dyed red and substantial penalties have been levied for those who use red dyed fuel for on-road use. The IRS issued a revenue ruling on November 18, 2002 that clarifies the scope of taxation for biodiesel. The IRS declared that biodiesel is an excluded liquid under section 48.4081-1(c)(2) because it contains less than four percent paraffins. Therefore, biodiesel is not taxable under section 4081(a)(1). Tax is imposed, however, under section 4081(b)(1) if biodiesel is used in the production of blended taxable fuel. The tax is imposed on the removal or sale of the blended taxable fuel. Furthermore, subject to the exemptions in section 4041, if biodiesel is sold for use or used as a fuel in a diesel-powered highway vehicle or a diesel-powered train, tax is imposed by section 4041(a)(1). Most of the biodiesel companies are selling their biodiesel to a petroleum distributor who then takes care of collecting the appropriate taxes as well as dyeing requirements. In this case, the biodiesel company does not have to collect taxes and report to the IRS.

Federal Agricultural Programs

CCC Bioenergy Programs

Background

The Bioenergy Program was conceptualized to expand industrial consumption of agricultural commodities by promoting their use in production of biodiesel and ethanol. CCC makes incentive cash payments to bioenergy producers who increase their purchase of eligible agricultural commodities, as compared to the corresponding period in the prior fiscal year, and convert that commodity into increased bioenergy production.

New program provisions also allow incentive payments to be made for existing biodiesel production.

Legislative Authority

Section 9010 of the Farm Security and Rural Investment Act of 2002 (Section 9010) is the authority for making payments on increased bioenergy production. The Commodity Credit Corporation (CCC) is using its authority under Section 5(e) of CCC's Charter Act to make program payments on biodiesel production that is not eligible under provisions of the 2002 Act. The program is funded using CCC's borrowing authority.

Program Summary

Biodiesel is defined as a mono alkyl ester manufactured in the United States and its territories that meets the requirements of an appropriate ASTM standard. Eligible commodities include barley, corn, grain sorghum, oats, rice, wheat, soybeans, cotton seed, sunflower seed, canola, crambe, rapeseed, safflower, sesame seed, flaxseed, mustard seed, cellulosic crops such as switchgrass and hybrid poplars, fats, oils, and greases (including recycled fats, oils and greases) derived from an agricultural product, and any animal byproduct (in addition to oils, fats, and greases) that may be used to produce bioenergy, as CCC determines, that is produced in the U.S. and its territories.

Biodiesel producers apply to the CCC during a sign-up period, which begins August 1st of the Fiscal Year before the Fiscal Year of applicable enrollment and ends 30 days later, and are assigned an agreement number. Those firms that are eligible producers must provide CCC with evidence of biodiesel production and purchases and utilization of agricultural commodities for the Fiscal Year quarter and Fiscal Year to date compared to the same time period in the prior Fiscal Year.

Production incentives are made on the base levels of production for FY03 – FY05, and then on increased production only in FY06 and beyond. The payment structure works as follows: Payments for increased production are paid out as before with the revised rate. Additionally, base production will receive staggered subsidies until 2006 at the following levels:

FY03 = full payment on incremental gallons and 50 percent payment on remaining gallons
FY04 = full payment on incremental gallons and 30 percent payment on remaining gallons
FY05 = full payment on incremental gallons and 15 percent payment on remaining gallons
FY06 = full payment on incremental gallons only

Annual payments to each entity are capped at five percent of the available funds for the program. The annual allocation for the program is $150 million (if appropriated), which equates to $7.5 million for a producer in a year.

The CCC bases biodiesel payments on a soybean conversion and price, adjusted further by comparing the applicable oil or grease (animal fats and oils) price to the soy oil price. An example of how CCC incentive payments are calculated is found in Appendix 2.

Implications for a New York Biodiesel Industry:

The Bioenergy Program, as implemented, has several implications for a biodiesel industry in New York State. First, there are a number of eligible feedstocks including recycled fats, oils, and greases that would be important to a New York industry. However, the incentive payments are significantly less for recycled oils compared to vegetable oils. Second, the legislative authority for the program will sunset with the overall Farm Bill in 2007. In addition, payments are dependent upon both the number of applicants and appropriations. Therefore, strong participation by other firms in either the biodiesel or ethanol industry and/or budget pressures could reduce the level of program incentives. Finally, although the program was designed to help offset the cost of capital for increasing production capacity, many firms have utilized CCC payments to help offset the premium price of the biodiesel they are currently producing.

Federal Sources

Several opportunities also exist for assistance from non-traditional funding sources on the federal level. The USDA is a primary source for grants and loans because of its desire to promote a dynamic business environment in rural America. Several of these programs are outlined in Appendix 2.

Subtask 5.2: State Biodiesel Initiatives

The previous three state legislative sessions have yielded a plethora of proposed bills specific to the biodiesel industry as well as numerous policies that have been signed into law. New laws have ranged from state policy to adequately define biodiesel to reductions in state excise or sales tax for biodiesel blends to a mandate for the use of B2 blends in all diesel fuel consumed in the state. State policy has also helped to encourage the production of biodiesel through legislation that creates incentive funds for manufacturing facilities or income tax credits on plants and equipment. Figure 5.1 demonstrates the breadth of state policy across the nation. Table 5.2, developed in conjunction with the National Biodiesel Board, provides a list of known biodiesel state policies that are depicted in the figure below. Every attempt has been made to ensure that the information presented is comprehensive in nature, however, biodiesel related policy may exist which is not included in this table.

Figure 5.1
States That Have Enacted Biodiesel Policies

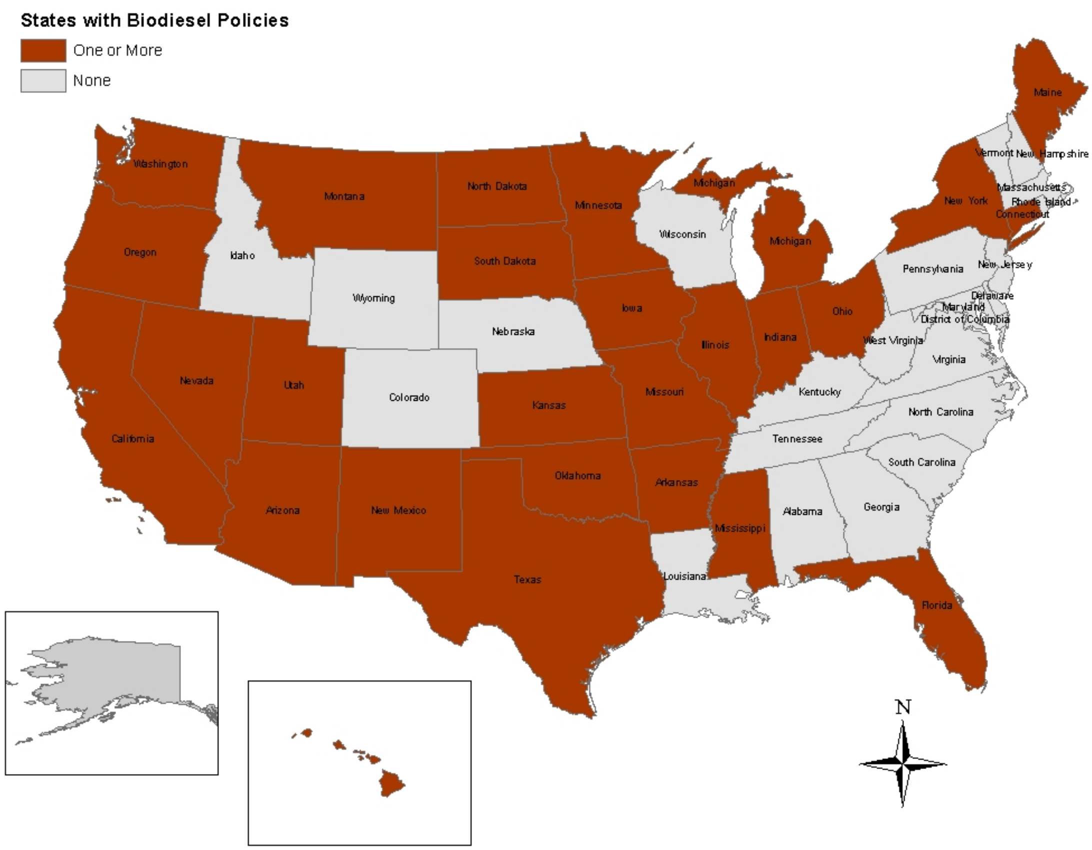


Table 5.2
Biodiesel Policies by State

StateID	Bill Number	Subtitle
Arizona	HB 2123	Restriction removal on use of biodiesel for public vehicle fleets
	AFV Grant Program	Commerce provides grants to alternative fuel implementations
Arkansas	SB 363	Biodiesel distributor tax credit
	HB 1287	Income tax credits for biodiesel facilities and equipment
California	Health Risk Red. Plan	Inclusion of biodiesel as an option for Health Risk Reduction Plan
Connecticut	HB 6402	CARB implementation
	SB 733	RPS and netmetering
Florida	SB 1176	Biodiesel manufacturers must be licensed by Revenue Dept
Hawaii	HB 1345	Alternative Fuel tax
Illinois	HB 46	Adds biodiesel to ethanol use tax exemption
	SB 1075	Economic development bill providing bonds/loans for certain businesses
	SB 46	Adds biodiesel to ethanol use tax exemption
Indiana	HB 1001	Biodiesel tax credits for producer/blender/retailer (starting at $1 pg)
	HR 88	Interim study committee for renewables
Iowa	HB 677	See HB 620
	HB 681	Tax credits for cooperatives producing value-added agricultural products
	HB 683	Modifying the value-added agricultural products and processes financial assistance program
Kansas	HB 2018	Creates the Renewable Energy Generation Cooperative
	HB 2036	Improper biodiesel marketing.
	SCR 1604	Biodiesel and ethanol support resolution
Maine	SB 160	Biodiesel definition
Michigan	HB 4010	Tax Abatements
Minnesota	HB 1597	Omnibus tax bill - includes agricultural processing facility zones
	HB 775	Biomass projects; status review
	SF 1495	Low Blend Mandate
	SF 2675	Requirement Mandate on state agencies
Mississippi	HB 928	Adds biodiesel to cash payment law for ethanol, wet alcohol and others.
Missouri	HB 257	Investment Tax Credits; Growers' Districts
	HB 289	Tax increment financing for renewable fuel plants.
	HB 868	Reimbursement to school districts for incremental cost
	SB 244	Self-Sustaining Biodiesel Revolving Fund
Montana	SB 644	Biodiesel Tax incentives
Nevada	AB 237	Provides economic incentives for the development and noncommercial use of alternative energy.
	Law	AFV Fleet Requirements
New Mexico	SB 193	Incentives for Alt. Fuel Vehicles
New York	AB 237	Provisions for diesel fueled school bus retrofit equipment projects
North Dakota	HB 1309	B2 mandate, biodiesel related income tax credit
Ohio	HB 87	Creates the Biofuel and Renewable Energy Task Force
Oklahoma	HB 1705	Requires alt fuel usage
Oregon	Law	Business Energy Tax Credit
South Dakota	HB 1279	Biodiesel definition
Texas	HB 2458	Moves excise tax collection to terminal rack level.
	SB 273	Grant program for biodiesel production
Utah	HB 1005	Income tax credit for biomass system
Washington	HB 1241	Biodiesel Distribution/Retail Sales Tax Incentive
	HB 1242	State Fleet use of biodiesel
	HB 1243	Biodiesel Pilot Project

Several state laws that are significant to the biodiesel industry and represent examples of biodiesel policy that could be initiated in other states are summarized below.

Arkansas

SB 363 provides a five percent income tax credit for plant and equipment for biodiesel fuel suppliers. In addition, the legislation provides a 10-cent per gallon grant to qualified producers. The grants are limited to the first five million gallons of biodiesel produced annually, not to exceed five years. This legislation is specifically designed to encourage plant development and infrastructure development.

This legislation was passed in the 2003 session and its ability to attract investment cannot be effectively evaluated.

Illinois

The State of Illinois enacted a sales tax exemption for biodiesel blends greater than 10 percent and a partial sales tax exemption for biodiesel blends between one percent and 10 percent through the passage of HB46 in July 2003. Diesel fuel users typically pay federal excise tax, state sales tax (at a rate of 6.25 percent), and state excise tax. State sales tax is calculated after federal excise tax has been added and prior to state excise tax. This legislation would reduce the levels of sales tax paid on biodiesel blends greater than one percent. Specifically, sales tax on blends between B1 and B10 are reduced by 20 percent and the sales tax is eliminated on blends greater than B10.

Biodiesel is defined as a renewable diesel fuel derived from biomass that is intended for use in diesel engines. Biodiesel blends are blends of biodiesel with petroleum-based diesel fuel that the resultant product contains no less than one percent and no more than 99 percent biodiesel.

The legislation went into effect in July of 2003 and has already demonstrated market acceptance. Distributors report increased sales of both B1 and B11 blends to diesel consumers.

Indiana

HB1001 (2003), effective January 1, 2004, creates incentives for biodiesel producers, blenders, and retailers. An Indiana biodiesel producer is entitled to a state tax liability credit equal to one dollar for every gallon of biodiesel produced during the taxable year. The total amount of credits for the program is capped at $1 million. In addition, a producer must reduce the amount of tax credit they are eligible for by any credit or subsidy that the group receives from the federal government for the production of biodiesel. Indiana fuel blenders are entitled to a tax credit equal to two cents per gallon for every gallon of blended biodiesel. This credit is also capped at $1 million and an eligible entity must reduce the amount of tax credit they are eligible for by any credit or subsidy that the group receives from the federal government. Finally, retailers are also eligible for state tax credits. Service station operators are entitled to a one cent per gallon credit for the total number of gallons of blended biodiesel sold and dispensed through all of their metered pumps. Biodiesel blends are defined as B2 or greater (but not B100). Biodiesel is defined as fuel meeting the ASTM D 6751 specification.

This legislation was passed in the 2003 session and its ability to attract investment cannot be effectively evaluated. Biodiesel demand in Indiana has increased and may be, in part, due to the incentives offered to blenders and retailers.

Iowa

SB 465 Established a “Biodiesel Revolving Fund,” which pays the cost of the biodiesel fuel used by the Iowa Department of Transportation. The Biodiesel Revolving Fund is self-sustaining and is funded through the sale of banked EPAct credits. Firms that have not purchased sufficient AFVs to comply with EPAct are able to purchase credits on the open market.

EPAct credits have been sold and the proceeds utilized to purchase biodiesel for the Iowa Department of Transportation. The program worked as envisioned.

Kansas

The State of Kansas enacted legislation in 2003 that would make it a violation of the Act to represent that diesel fuel is or contains biodiesel fuel or otherwise to represent that diesel fuel is made from renewable resources, unless not less than two percent of the diesel fuel mixture is mono-alkyl esters derived from vegetable oil, recycled cooking oil, or animal fats (according to the supplemental note on substitute for House Bill No. 2036). In addition, biodiesel is defined as biodiesel meeting ASTM D 6751. Finally, state-owned diesel powered vehicles and equipment are required to utilize B2 blends or higher as long as the biodiesel blend is not greater than 10 cents more per gallon than the price of diesel fuel.

Minnesota

SF 1495 (2002) requires that two percent biodiesel must be blended in all diesel sold in Minnesota. The mandate is effective on and after the date that the conditions in clauses (1) and (2), or in clauses (1) and (3), have been met:

(1) Thirty or more days have been passed since the commissioner of agriculture publishes notice in the State Register that annual capacity in Minnesota for the production of biodiesel fuel oil exceed 8,000,000 gallons;
(2) Eighteen months have passed since the commissioner of agriculture publishes notice in the State Register that a federal action on taxes imposed, tax credits, or otherwise, creates a reduction in the price of two cents or more per gallon on taxable fuel that contains at least two percent biodiesel fuel oil and is sold in this state;
(3) The date June 30, 2005, has passed.

Language requiring biodiesel production capacity within the state boundaries was added to this legislation to help ensure that economic benefits would accrue to the state. The policy has been successful at attracting investment in a biodiesel plant even though biodiesel manufacturing facilities are currently in production in Iowa. Therefore, the policy will be successful at both stimulating demand and creating economic development opportunities.

Missouri

Missouri state agencies currently follow guidelines established by the *Fuel Conservation for State Vehicles Program*, which was passed into law by the Missouri Legislature in 1991 and amended in 1998. This law, RSMo 414.400 - 414.417, charges the Department of Natural Resources with development and implementation of a program to reduce fuel consumption, improve fleet management, and promote the use of alternative fuels. Similar to EPAct, this legislation requires the acquisition of alternative fueled vehicles. The statute also requires that at least 30 percent of all motor fuel purchased annually for use in AFVs, calculated in gasoline gallon equivalents, be an alternative fuel by July 1, 2001 provided that suppliers or state agencies have or can reasonably be expected to have established alternative fuel refueling stations as needed.

The impact of this statute was enhanced in 2002, when the Missouri legislature passed RSMo 414.365. This law requires the Missouri Department of Transportation (MoDOT) to develop a program that provides for the opportunity to use fuel with at least the biodiesel content of B20 in its vehicle fleet and heavy equipment that use diesel fuel. The following MoDOT AFV requirements were summarized in Missouri legislation and will be implemented:

- On or before July 1, 2004, at least 50 percent of the department's vehicle fleet and heavy equipment that use diesel fuel shall use fuel with at least the content of B20, if such fuel is commercially available;
- On or before July 1, 2005, at least 75 percent of the department's vehicle fleet and heavy equipment that use diesel fuel shall use fuel with at least the content of B20, if such fuel is commercially available.

The Missouri Department of Transportation began incorporating biodiesel into their districts prior to passage of legislation in 2002 requiring its use. The legislation, has however, prompted an evaluation statewide of fueling infrastructure and the possibility of using biodiesel in all MoDOT districts.

In addition, SB 244 established a Self-Sustaining Biodiesel Revolving Fund in 2001. The fund is administered by the Department of Natural Resources (DNR) and is available to all state fleets. The fund pays the incremental cost of biodiesel.

Two additional pieces of legislation have been passed in Missouri that impact the biodiesel industry. HB 868, passed in the 2001 session, authorizes the incremental costs of B20 to be a reimbursable expense for Missouri school districts.

Funds would need to be appropriated in a subsequent session for this program to be initiated.

HB1348 creates the Missouri Qualified Biodiesel Producers Incentive Fund, which provides an incentive to producers of biodiesel of 30 cents per gallon for up to 15 million gallons of biodiesel produced per year for five years. The incentive is to be received on an estimated monthly production basis paid by the Department of Agriculture. Additionally, HB 1348 defines biodiesel in statute as the ASTM D 6751 specification.

Funds would need to be appropriated in a subsequent session for this program to be initiated.

North Dakota

SB 2454 mandates that the state excise tax of 21 cents per gallon is reduced by one and five hundredths cents per gallon on the sale or delivery of diesel fuel that contains at least two percent biodiesel. It imposes a "special excise tax" of two percent on all sales of diesel fuel containing B2 by weight. The effective date is conditional upon the construction and operation of a biodiesel refining facility in the state with a production capacity of at least 10 million gallons per year. This legislation was extended in the 2003 session through HB1309. HB1309 created a 10 percent tax credit for producers/blenders on equipment. The legislation also includes a $1.05 excise reduction on B2 after at least an eight million gallon capacity plant is built in the state.

This policy has been unsuccessful at attracting biodiesel investment most likely due to the incentive level compared to fuel pricing.

Washington State

HB1240 provides tax incentives for biodiesel and alcohol fuel production—sales/use/property tax “deferral” (wiped clean after seven years). HB1241 provides a tax incentive for investments associated with distribution and retail sale of biodiesel. No taxes on equipment and ingredients until 2009 (if equipment is used for at least 75 percent biodiesel distribution). Finally, HB1242 encourages state agencies to use B20. In addition, state agencies are required to use B2 as a lubricity agent beginning in 2006. HB1243 creates a biodiesel-ultra low sulfur diesel pilot project for school transportation.

These pieces of legislation were passed in the 2003 session and their effectiveness in stimulating demand or attracting investment cannot be evaluated.

Subtask 5.3: New York Policy

Current Policy Supporting Alternative Fuels

The State of New York has implemented aggressive alternative fuel vehicle programs to support environmental and energy security goals. However these programs were not designed specifically to support biodiesel and generally speaking do not support the development of the market for biodiesel compared to other alternative fuel technologies. Major existing New York initiatives include:

- Alternative fuel vehicle tax credits
- The Clean Water/Clean Air Bond Act
- Executive Order No. 111

Alternative Fuel Vehicle Tax Credits

Alternative fuel vehicle tax credits have been available for clean-fueled AFVs (60 percent of the incremental cost up to $5,000 for light-duty vehicles and up to $10,000 for heavy duty vehicles), electric vehicles (50 percent of incremental cost up to $5,000), and alternative fuel infrastructure (50 percent of installed cost).

The Clean Water/Clean Air Bond Act

Governor George Pataki signed the $1.75 billion Clean Water/Clean Air Bond Act in 1996. The Act, which includes $230 million for air quality improvement projects, provides incentives to reduce the incremental cost of AFV purchases. More than $55 million was made available through this Act for the clean-fueled bus program and the state fleet program.

The Clean-Fueled Bus Program is designed to provide grants for 100 percent of the incremental cost of new natural gas, electric, or hybrid-electric buses. The State Fleet Program helps to pay for the incremental costs of AFVs and alternative fuel infrastructure.

Executive Order No. 111

In June 2001, New York furthered its commitment to alternative fuels by signing Executive Order 111, which directs every state agency, regardless of fleet size or location, to increase its annual light-duty AFV acquisitions to 100 percent by 2010. This executive order goes beyond the requirements of the Federal EPAct program discussed in the previous section of this report. In addition to requirements for light-duty vehicle fleets, the executive order also requires vehicle fleets that operate medium- and heavy-duty vehicles to take steps to reduce petroleum consumption and emissions.

City initiatives exist, such as Local Law 6 in New York City that mandates that 80 percent of the new light-duty vehicles and 20 percent of new bus purchases must be powered by alternative fuels. Other city agencies such as the New York City Department of Transportation, the Metropolitan Transportation Authority (MTA), and the New York City taxicab fleet have begun programs to convert to AFVs.

Statewide, appropriations have been made available for diesel fueled school bus retrofit equipment projects. Retrofit equipment includes: particulate traps or filters and catalytic converters that reduce emissions of particulate matter, hydrocarbons, and oxides of nitrogen, carbon monoxide, or toxic air pollutants. Biodiesel is included as a power source for buses defined as a “clean-fueled bus” under this program.

Implications for the Biodiesel Industry

Biodiesel blends can be used in existing diesel powered vehicles and existing petroleum fueling infrastructure. Therefore, more of the current New York programs, designed to promote alternative fueled vehicles and fueling infrastructure, do not significantly aid the market development of biodiesel. Executive Order No. 111 does require steps to be taken to reduce the emissions and petroleum consumption of medium- and heavy-duty vehicles. Thus, vehicle fleets may look toward biodiesel blends to help comply with the Executive Order.

Proposed Policy Supporting Alternative Fuels

State bills have been proposed that could support the development of the biodiesel industry. S.4069, and its companion bill A.1538, require alternative fuels to be available for public use along the New York state thruway after November 1, 2004 and to provide each recommended alternative fuel at least one refueling site every one hundred twenty miles on both sides of the thruway. The definition of alternative fuel does not specifically name biodiesel and it would need to be incorporated into the bill to ensure that the proposed legislation could be advantageous to biodiesel.

Another bill, A.909, was proposed to determine the process and time frame by which the Metropolitan Transportation Authority (MTA) plans to convert their existing diesel bus fleet to an alternative fuel vehicle fleet by requiring the development of a long-range strategic plan for such purposes. Again, biodiesel is not specifically mentioned and therefore it is unclear whether biodiesel would be included as an alternative fuel in this legislation.

Other proposed legislation, such as S.4523 and A.1350 would create tax credits or exemptions on sales tax for alternative fueled vehicles. As proposed, these bills would not encourage the use of biodiesel fuel since they specifically address the incremental costs of AFVs.

Greenhouse Gas Task Force and Northeastern Governors Carbon Dioxide Trading Working Group

Governor Pataki announced in June 2001 the formation of a Greenhouse Gas (GHG) Task Force comprised of representatives from industry, environmental organizations, community leaders and state government.

Some of the major GHG Task Force recommendations include:

- Establishment of a State GHG emissions target at five percent below 1990 levels by 2010, and ten percent below 1990 levels by 2020—more aggressive than the New England Governor's/Eastern Canadian Premieres Agreement.
- Creation of a program to limit emissions from the electricity generation sector to levels 25 percent below 1990 by 2010.
- Adoption of GHG emissions standards for passenger vehicles, upon implementation in California for model year 2009, and creation of a New York biofuel program that would create new markets for farmers through: a two percent biodiesel requirement for all diesel sold, a 20 percent biodiesel goal for all State diesel vehicles, and incentives for growers and producers of biofuels.
- A comprehensive statewide inventory of GHG emissions, along with a mandatory reporting system for major industries and sectors, and a voluntary emissions registry to support companies and institutions that reduce emissions.

To date, New York has announced plans to implement a number of the recommendations including:

- On June 11, 2002 the New York State Energy Planning Board adopted the recommendation that the State establish a target to reduce GHG emissions to five percent below 1990 levels by 2010, and ten percent below 1990 levels by 2020.
- In his State of the State address in January 2003, Governor Pataki called for the creation of a renewable portfolio standard (RPS) for electric power generation that will guarantee that within the next ten years at least 25 percent of the electricity bought in New York will come from renewable energy sources like solar power, wind power, or fuel cells; and adoption of greenhouse gas emissions standards for passenger vehicles, upon implementation in California, for model year 2009.
- On April 25, Governor Pataki sent a letter to ten northeastern governors offering to create a regional power sector carbon dioxide emissions trading program. On July 24, 2003, Governor Pataki announced that he has received commitments from the Governors of nine northeast states to join New York State in a regional

strategy to reduce carbon dioxide emissions from power plants. The initiative proposed by the Governor would involve developing a flexible market-based emissions trading system to require power generators to reduce emissions.

Since life-cycle studies of biodiesel show a 78 percent reduction in CO_2 relative to petroleum diesel, biodiesel blends could play a significant role in a market-based cap and trade program.

TASK 6: ANALYSIS OF NEW YORK STATE PUBLIC POLICY OPTIONS AND ASSOCIATED COSTS AND BENEFITS

The impact of a biodiesel policy on the economy of New York will depend on the particular parameters of the policy option implemented. Further, whether a biodiesel incentive or policy should be phased in depends on the form of incentive. In any event, any policy should be linked to New York capacity in order to ensure that economic development takes place in New York. Typically, policy options (e.g. incentives) fall under one of two categories: fuel based and production oriented. Each has unique impacts on economic activity, job creation, agricultural output, fuel use, and tax and revenue implications.

The analysis of policy impacts in this report does not include environmental impacts. For a comprehensive review of impacts from biodiesel exhaust emissions, see the EPA report, "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions," EPA420-P-02-001, October, 2002.

Each policy option designed to promote the use and production of biodiesel is expected to attract direct investment to New York State. The investment will consist of capital expenditures to increase soybean crush capacity and build new crush capacity, build new biodiesel production capacity, and improve distribution infrastructure for each of the terminals in the State. These capital expenditures, along with the annual operating expenses associated with producing biodiesel represent the purchase of output from other industries. These dollars will be spent and re-spent throughout all sectors of the New York economy thereby creating additional new demand and output, creating new jobs in all sectors of the economy, and generating additional income for New York households.

The basic assumption underlying this analysis is that each policy option would be introduced and signed into law in 2004 to take effect on April 1, 2005.

The spending associated with increasing investment in biodiesel production and higher agricultural output from increased soybean production will stimulate aggregate demand, create new jobs, and generate additional household income. The gross output, household income, and job impacts were estimated by applying the most appropriate final demand multipliers calculated by the U.S. Bureau of Economic Analysis (BEA) for output, earnings, and employment to the estimates of new capital spending and additional agricultural final demand.[61] The multipliers for the agriculture sector were used to estimate the impact from increased real agricultural final demand resulting from biodiesel production. The production of biodiesel from agricultural commodities

[61] The multipliers used in this analysis are the current two-digit industry RIMS II multipliers estimated by the Bureau of Economic Analysis, U.S. Department of Commerce.

represents output of the industrial inorganic and organic compounds industry; while the most appropriate multipliers for new plant construction are those for the construction sector.

The estimates summarized below result from a static analysis of the impact of increasing biodiesel production and demand on the New York economy. That is, they reflect the combination of a series of snapshots of the economy rather than a dynamic flow analysis. The macroeconomic and budgetary impacts and cost implications for highway users, residential consumers, and business and industry for each specific policy option are presented in Table 6.1 for the absence of an Energy Bill and Table 6.2 which assumes the passage of the Energy Bill now in Congress.

Subtask 6.1: Fuel-based Incentives, Policies and Impacts

Fuel-based policy incentives are those that mandate or provide some economic incentive to replace petroleum-based diesel fuel with biodiesel or incorporate biodiesel with traditional diesel fuel in alternative blend combinations for the transportation, residential, commercial, and industrial sectors.

<u>B2 Mandate (Policy Option 1)</u>

The first option analyzed is a statewide mandate that would require any highway distillate to contain at least two percent biodiesel by 2007. The mandate would be expanded to all other distillate end uses in 2009. The mandate would be linked to production capacity. That is, the mandate would not take effect until at least 10 million gallons of biodiesel capacity was built in New York State. The mandate would affect 1.2 billion gallons of distillate use in 2007, increasing to 3.7 billion gallons by 2012. The mandate would result in a market for biodiesel in New York of 23.3 million gallons in 2007, increasing to 73.7 million gallons by 2012.

In our opinion the market created by a B2 mandate would create a market of significant size to provide an incentive for producers to invest in biodiesel production capacity in New York and for distributors to invest in infrastructure. A B20 policy for a narrow end-use segment such as State vehicle fleets would create a demand base of nearly one million gallons per year, but should not be needed to stimulate investment.

We expect that a mandate would stimulate investment in 30 million gallons of biodiesel capacity that would come on line in 2007 and 2008 and would provide a market based incentive for New York farmers to increase acres planted and production of soybeans. The biodiesel would be produced from blend of feedstocks comprising 70 percent yellow grease and 30 percent soybean oil. New York has adequate supplies of both feedstocks to meet this level of demand.

In addition, a mandate would require fuel distributors to expand and improve terminal facilities to store and handle biodiesel and biodiesel blends required to meet the level of demand created by the mandate. As indicated in Section 4.2 above, these costs are expected to range from $250,000 to $2 million per terminal. In an attempt to be conservative for purposes of this analysis we applied the low-end estimate to each of the existing 85 terminals in New York to arrive at an aggregate cost of $64 million for infrastructure improvement. Further, we assumed that this investment would take place over a five year period.

As can be seen in Tables 6.1 and 6.2, a mandate would increase biodiesel demand but would have relatively little net revenue impact for the New York State Treasury. The primary cost would involve the increased cost associated with using a B2 blend in State fleets. This is estimated at $622,000 over the 2007-2012 period without the tax incentives provided in the Energy Bill now in Congress. It should be noted that this estimate does not reflect any savings of avoided purchase of alternative fuel vehicles and infrastructure under EPACT. If the Energy Bill and associated tax provisions are passed, the net cost of the mandate to the State Treasury is less than $100,000.

However, a mandate will result in increased fuel costs to individual businesses and consumers. Without an Energy Bill, highway users of biodiesel blended fuel would face increased costs of nearly $103 million between 2007 and 2012. Businesses would face additional costs for non-highway fuel use of $40 million while the costs to residential consumers for home heating oil would amount to $76.1 million and would likely fall hardest on low-income families. If the Energy Bill passes into law, these costs would fall to $5.2 million ($3.2 million for highway fuel, $1.3 million for residential consumers and $656,000 for businesses). The reason for the large disparity in costs caused by the Energy Bill lies in the Federal excise tax incentives provided by the Energy Bill. The Energy Bill provides an exemption from Federal Excise Taxes on diesel fuel (for both transportation and home heating) of $1.00 per gallon for biodiesel made from soybean oil and $0.50 per gallon for biodiesel made from yellow grease. This means that the 70/30 blend contemplated for New York would enjoy a $0.65 per gallon exemption. We assume that most of this would be passed directly along to consumers.

A B2 mandate would result in new investment and spending on biodiesel production and infrastructure investment. When the impacts of the capital and annual operating expenditures are considered, a mandate that results in a 30 MGY biodiesel industry would add $402.6 million (1996$) to the New York economy by 2012, generate an additional $189.3 million in real household income by 2012, and create as many as 1,171 new jobs throughout the New York economy. Failure to pass the Energy Bill would reduce the economic impacts slightly.

Increased income and spending will generate additional tax revenue for the State Treasury. The increased economic activity is expected to generate an additional $22.5 million in State sales, personal income, and business income taxes by 2012. When the costs to the State are netted out against the additional revenues, a mandate would provide a significant net positive budgetary impact.

A mandate that would require that diesel use for one or more end use segments contain a certain percentage of biodiesel (e.g. two percent, or B2) should be phased in to allow adequate time for the necessary capital investment for production and infrastructure to be made <u>and</u> should be tied to New York biodiesel capacity. For example, a mandate would not become effective until at least 10 MGY of biodiesel capacity is in place. Consider that it take about 18 months from decision to production for a new biodiesel plant. This means that legislation passed in 2004 that becomes effective in April 2005 would result in the first gallon of biodiesel delivered in late 2006 or early 2007. Therefore, a reasonable B2 mandate for on-highway use could take effect in 2007 and be expanded to residential and other uses in 2009.

Table 6.1

Economic Costs and Benefits of Alternative New York State Biodiesel Policy Options: No National Energy Bill (Cumulative 2007-2012)

	OPTION 1 B2 Mandate Highway fuel 2007 Other Use 2009	OPTION 2 B2 Mandate Plus Infrastructure Incentive	OPTION 3 Combined B2 Mandate Plus $0.10/gal Supply Incentive	OPTION 4 Stand Alone Supply Incentive $0.10/gal up to 10 MGY	OPTION 5 Combined Supply & Demand Incentive
Capacity created	30 MGY	30 MGY	40 MGY	10 MGY	30 MGY
Macroeconomic Impacts					
Gross Output (Mil 96$)	$766.186	$766.186	$879.543	$137.459	$605.868
GSP (Mil 96$)	$377.989	$377.989	$405.990	$59.021	$272.172
Household Income (Mil 96$)	$176.594	$176.594	$193.992	$35.269	$131.181
Max new jobs	1,135	1,135	1,274	200	941
NY Treasury Impact:					
Direct Cost (Mil $)	$0.622	$31.872	$9.019	$4.500	$85.571
Revenue (Mil $)	$19.053	$20.975	$21.269	$4.261	$16.258
NY State Sales Tax	$9.863	$11.764	$11.388	$2.531	$9.515
NY Personal Income Tax	$7.399	$7.548	$8.030	$1.514	$5.620
NY Corporate Tax	$1.791	$1.663	$1.850	$0.216	$1.124
Net Treasury Impact (Mil $)	$18.431	($10.897)	$12.250	($0.239)	($69.313)
Other Costs:					
Highway users	($102.639)	($102.639)	($102.639)	($33.370)	($96.521)
Residential consumers	($76.118)	($76.118)	($76.118)	NA	NA
Business & Industry	($40.484)	($40.484)	($40.484)	NA	($8.931)
Total Other Costs	($219.241)	($219.241)	($219.241)	($33.370)	($105.451)

Note: Each Policy Option includes infrastructure investment of $64 million.

Table 6.2

Economic Costs and Benefits of Alternative New York State Biodiesel Policy Options: National Energy Bill (Cumulative 2007-2012)

	OPTION 1 Stand Alone B2 Mandate Highway fuel 2007 Other Use 2009	**OPTION 2** B2 Mandate Plus Infrastructure Incentive	**OPTION 3** Combined B2 Mandate Plus $0.10/gal Supply Incentive	**OPTION 4** Stand Alone Supply Incentive $0.10/gal up to 10 MGY	**OPTION 5** Combined Supply & Demand Incentive
Capacity created	30 MGY	30 MGY	40 MGY	10 MGY	30 MGY
Macroeconomic Impacts					
Gross Output (Mil 96$)	$770.998	$770.998	$889.924	$160.889	$610.680
GSP (Mil 96$)	$379.497	$379.497	$409.426	$74.051	$273.680
Household Income (Mil 96$)	$177.460	$177.460	$195.896	$35.269	$132.047
Max new jobs	1,145	1,145	1,292	200	950
NY Treasury Impact:					
Direct Cost (Mil $)	$0.019	$31.269	$9.019	$4.500	$85.970
Revenue (Mil $)	$21.470	$21.470	$24.320	$4.261	$16.382
NY State Sales Tax	$12.084	$12.084	$14.021	$2.531	$9.590
NY Personal Income Tax	$7.585	$7.585	$8.419	$1.514	$5.657
NY Corporate Tax	$1.801	$1.801	$1.880	$0.216	$1.136
Net Treasury Impact (Mil $)	$21.451	($9.799)	$15.301	($0.239)	($69.588)
Other Costs:					
Highway users	($3.171)	($3.171)	($3.171)	($0.870)	($1.379)
Residential consumers	($1.256)	($1.256)	($1.256)	NA	NA
Business & Industry	($0.656)	($0.656)	($0.656)	NA	($0.073)
Total Other Costs	($5.084)	($5.084)	($5.084)	($0.870)	($1.451)

Note: Each Policy Option includes infrastructure investment of $64 million.

- Mandate combined with an incentive for infrastructure (Policy Option 2)

  Another fuel-based policy option involves combining an incentive for expanding and improving terminal facilities to store and handle biodiesel and biodiesel blends to the mandate option. This incentive would offset some of the infrastructure costs that distributors would have to incur to meet mandated biodiesel demand. We expect that the cost to improve the existing 85 terminals in New York will cost about $64 million. To facilitate this transformation and ease the financial burden on blenders and distributors, we considered an incentive of $0.25 per gallon for a total cost of nearly $32 million to the State Treasury between 2007 and 2012.

Since this policy option has no additional impact on attracting biodiesel production capacity and annual production, the economic costs and benefits are essentially the same as for a stand-alone mandate. The exception to this is in the cost to the State Treasury. The additional costs associated with providing the infrastructure incentive are estimated at about $31 million. When the additional revenue provided by the increased economic activity is considered, this policy option will result in an estimated net loss of revenue to New York State of about $10.0 million between 2007 and 2012.

Subtask 6.2: Production-based Incentives, Policies and Impacts

Production based incentives are those that encourage development of an industry through policies that subsidize activities. A wide range of production-based incentives can be designed to stimulate a biodiesel industry. We evaluated three potential policy scenarios: A supply incentive combined with a mandate; a stand-alone supply incentive; and a combined supply and demand incentive.

It is important to point out that production-based incentives are cost-effective from a Treasury perspective only when combined with a mandate, or when the incentives provided by the Energy Bill improve the price competitiveness of biodiesel blended fuels.

- <u>Biodiesel supply incentive combined with a B2 mandate (Policy Option 3)</u>

  An alternative policy option for consideration involves combining a mandate for biodiesel use with a supply incentive for the production of biodiesel. This incentive would provide a grant of $0.10 per gallon of biodiesel produced in New York State up to a maximum of 10 million gallons capped at five years.

  Since this combination creates a base of demand through the mandate and provides an incentive for producers, it is expected to stimulate investment of 40 MGY of biodiesel capacity and production in New York State. Reflecting the larger investment and annual biodiesel production provided by this option, the combination of a mandate and supply incentive produces the largest economic benefits to New York State. Under a national energy policy, this policy option would add almost $410 million to the New York economy 2012; an additional $195.9 million would be added to the income of New York households; and nearly 1,300 new jobs would be created in all sectors of the New York economy. If the Energy Bill is not passed we expect that the mandate and supply incentive will still attract investment, but the total economic impact would be slightly smaller.

  As is the case with a stand-alone mandate, this policy option shifts the costs associated with using a more expensive fuel blend from the State to individual businesses and consumers. As can be seen in Tables 6.1 and 6.2, without a National Energy Bill, the total cost to businesses and consumers is estimated at $220 million between 2007 and 2012. The cost to residential home heating oil consumers would amount to $76.1 million. The cost to business and industry is estimated at $40 5 million over this same period. If the Energy Bill passes into law, these costs would fall to $5.1 million, $1.3 million, and $656,000, respectively.

The costs to the State Treasury of this option are larger than with a stand-alone mandate and are estimated at $9 million. However, increased income and spending will generate additional tax revenue for the State Treasury. The increased economic activity is expected to generate an additional $24.3 million in State sales, personal income, and business income taxes by 2012 if the Energy Bill passes and $21.3 million in the absence of an energy policy. When the costs to the State are netted out against the additional revenues, a mandate would provide a net positive budgetary impact on the State Treasury of $12.3 million under no national energy policy and $15.3 million if the Energy Bill were passed.

- <u>Stand alone supply incentive (Policy option 4)</u>

  Another policy option for consideration is a stand alone supply incentive for biodiesel producers. For this option we assumed a policy that provides a grant of $0.10 per gallon of biodiesel produced in New York State up to a maximum of 10 million gallons capped at five years. In the absence of a national energy policy this type of incentive employed alone is not likely to attract a significant amount of investment in biodiesel production in New York State. The reason for this is that while the incentive reduces capital costs it will have no material impact on demand. Consequently, Investors face the risk of creating supply for which no demand exists.

  Even with an Energy Bill, investors are likely to wait to see how major soybean producing states respond in increasing capacity and how New York is supplied with biodiesel fuel. As a result, we expect this policy option to attract a minimal 10 million gallons of biodiesel capacity between 2007 and 2009 at a cost to the State of $4.5 million.

  A small capital level of investment and annual production will provide limited benefits to the New York economy. This option would increase the New York economy by only $75 million by 2012; add $35 million to household income; and create only 200 new jobs. Despite the relatively small costs to the State Treasury, the limited economic activity generated by this option fall short of covering the costs so that a small net loss of about $240,000 is generated.

  As is the case with a mandate, this policy option shifts the costs associated with using a more expensive fuel blend from the State to individual highway users of biodiesel. Without a National Energy Bill, the total cost to the transportation sector is estimated at about $33 million between 2007 and 2012. If the Energy Bill is passed with tax incentives for biodiesel, the cost to the transportation sector would fall to less than $1 million between 2007 and 2012.

- Combined supply and demand incentive (Policy option 5)

  The final option investigated involved combining a demand incentive with the supply incentive described above. This incentive would take the form of a one-half of one cent exemption from New York State excise taxes on distillate fuel for each one percent of biodiesel used. This amounts to a one cent per gallon exemption for a B2 blend. Since this equates to $0.50 per gallon for B100, this option turns out to be expensive, amounting to a cost to the State Treasury of $77.3 million between 2007 and 2012 ($86.0 million when the supply incentive is added).

  Since this combination stimulates demand, the option is expected to attract 30 MGY of biodiesel production capacity and add between $272 and $274 million to the New York State economy by 2012; increase household income by $132 million, and create about 950 new jobs.

  However, the additional revenue generated by this increased economic activity is estimated at only $16.4 million, resulting in a deficit to the Treasury of between $69.6 and $69.3 million between 2007 and 2012.

  Since this policy option provides a demand incentive in the form of a reduction in the New York State excise tax on diesel fuel, the costs to highway users are considerably smaller than a mandate option, ranging from $105 million with no Energy Bill to $1.5 million if an Energy Bill passes.

TASK 7: TECHNOLOGY TRENDS, RESEARCH, DEVELOPMENT AND DEMONSTRATION NEEDS

The National Biodiesel Board (NBB) has been spearheading the research and development of biodiesel in the United States for over 10 years, primarily through funding provided by the Soybean Check off program. Government agencies—primarily United States Department of Agriculture (USDA) and United States Department of Department of Energy (USDOE)—academia and other trade groups like the Fats and Proteins Research Foundation have also funded or executed biodiesel research. More recently state energy offices like NYSERDA and other state groups have begun to fund biodiesel research and development (R&D) activities.

To assist these entities in determining priority research and development needs, the National Biodiesel Board has joined with the USDA and the USDOE to hold an annual research brainstorming and prioritization meeting. In this meeting, the best and brightest of the biodiesel research community from industry, academia, and government are brought together to share the latest technical research and data. NBB regulatory experts also review the latest in legislative activity and industry participants provide their perspective on new markets and technical activities that could help them sell more biodiesel. This group then votes on the technical activities most helpful in eliminating barriers or quantifying benefits that will result in increased customer acceptance and biodiesel sales.

The research priority list resulting from this meeting becomes the industry accepted list of technical priorities and is used by the National Biodiesel Board, USDA, USDOE and other funding entities to help prioritize their efforts. These groups coordinate their activities to help ensure high priority technical needs are addressed and to minimize duplication of effort. As the interest in biodiesel increases and the sheer number of biodiesel researchers and projects grow, it is even more important to coordinate these activities so that taxpayer and industry dollars are spent wisely.

The biodiesel research brainstorming and prioritization meeting is held each year in late January or early February. The most recent meeting was held in New Orleans January 29 and 30, 2003 and over 200 attended the 2003 session.

Each participant was allowed several votes for their opinion on the top priority. The votes could all be cast in one category, or be spread throughout several categories. The results of the rankings are instructive. The top priority areas address the range of technical and market barriers to increased use of biodiesel that can be addressed by research or other technical work. The list also pinpoints new potential markets for biodiesel where research or other technical work may be needed in order for biodiesel to penetrate them. It was interesting that stability ranked as the number one priority in 2003, since very few problems regarding stability have been reported by biodiesel users. Stability is a universal concern among the engine companies, who were more heavily represented in 2003 than at any of the previous meetings and this undoubtedly had an influence on the ranking. Perhaps the high ranking for stability is also the reason for the lower ranking of OEM warranty in 2003 compared to the 2002 rankings below.

Figure 7.1
Most Desirable Technical Activities in 2003

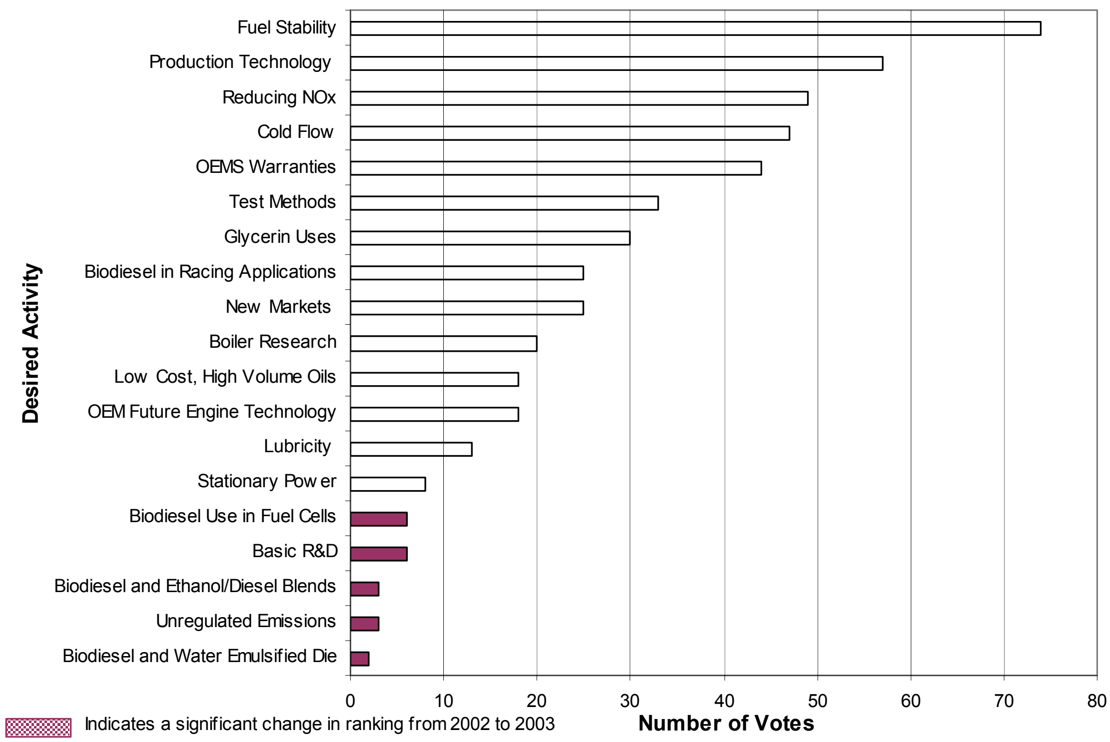
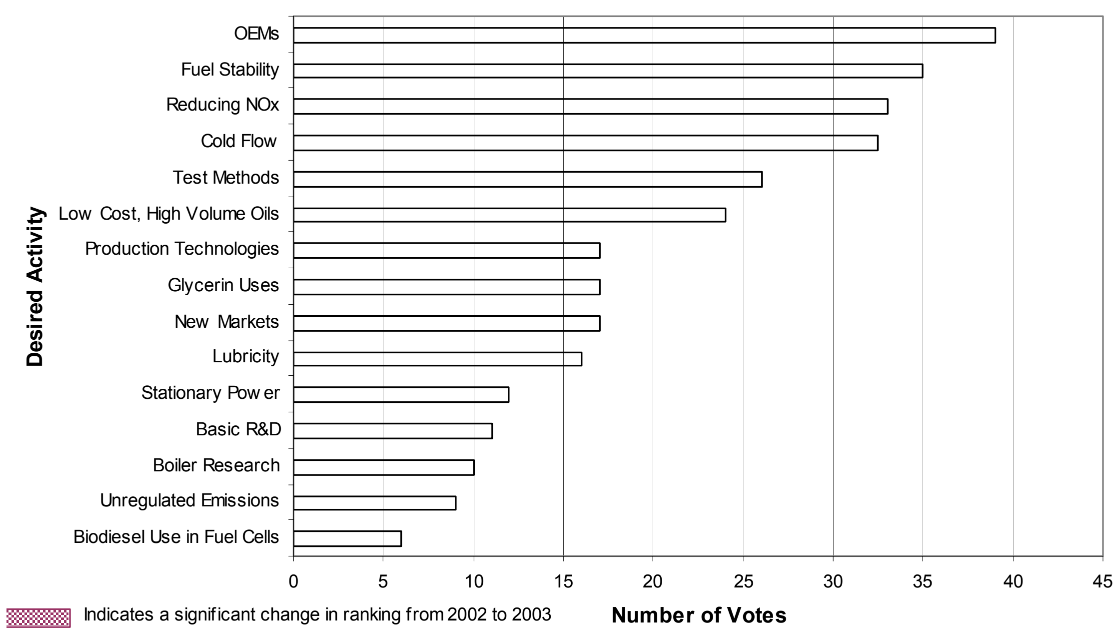


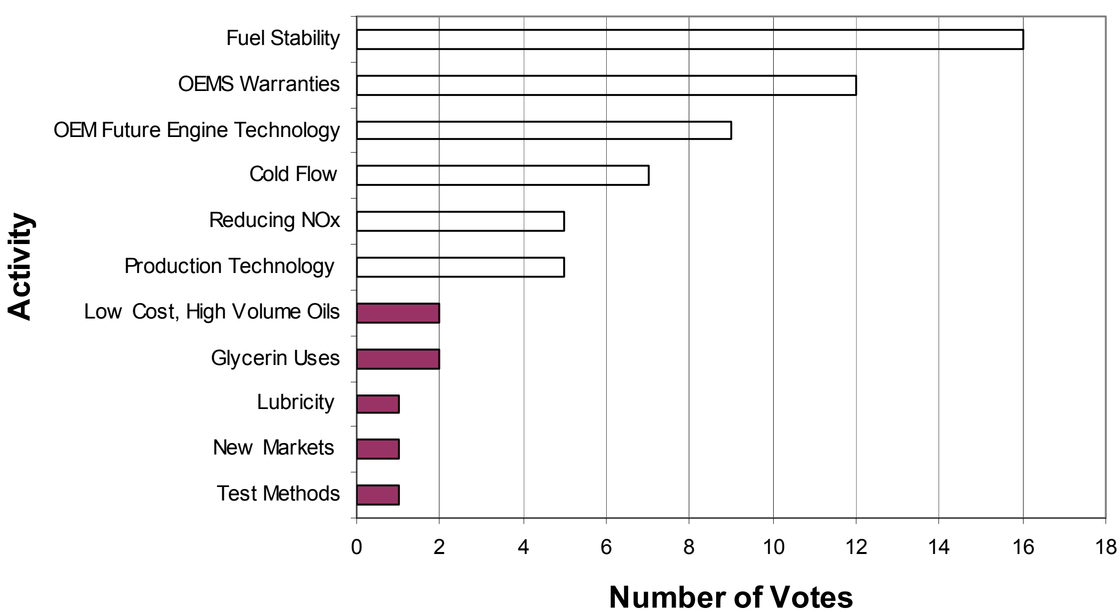
Figure 7.2
Most Desirable Technical Activities in 2002



A much higher level of new technology companies and support industry personnel attended in 2003 than in previous years. This is a sign of a blossoming industry. It is also most likely the reason new production technology was ranked higher than it has been in the past. As has been shown in the technology section of this report, better production technology may allow one company to out compete another, but the cost of technology and/or 'better' technology compared to that already available in the market will have only a small impact on biodiesel costs. This biodiesel research brainstorming and prioritization list provides a starting place for the priorities for each funding entity to consider as they prioritize their own activities and allocate resources.

In order to determine the technical priorities for the FY04 activities of the National Biodiesel Board, which begin in October 2003, a smaller group of selected industry members and researchers evaluated and re-prioritized the larger brainstorming priority list so it coincided with the specific goals and objectives of the members of the National Biodiesel Board. A similar voting scenario was employed as was used for the overall brainstorming session (i.e. each person got multiple votes which they could allocate toward one category or split among several) but the total number of people was much smaller, around 20. The list coming out of that effort was approved by the NBB as its priority list for the FY04 funding year.

Figure 7.3
National Biodiesel Board FY04 Technical Funding Efforts

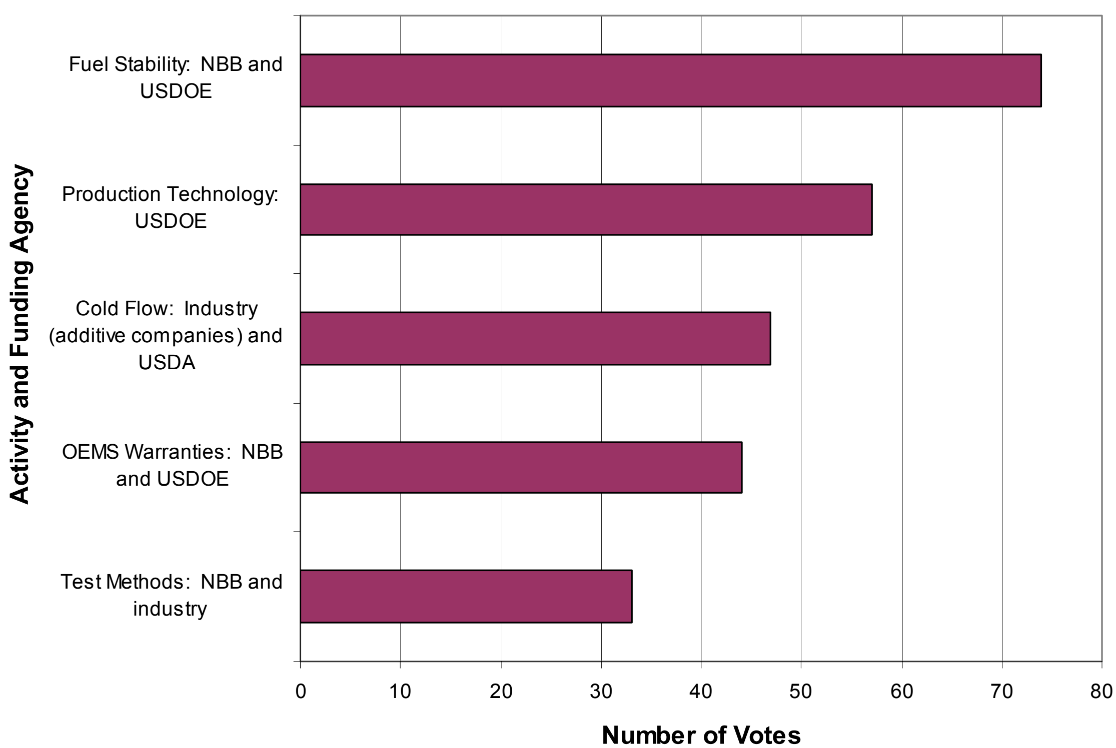


It is interesting that the NBB, comprised mostly of biodiesel companies and feedstock organizations, ranked several of the areas differently than the overall group that attended the 2003 brainstorming session. This is due in part because the NBB does not support R&D activities for production technologies which the NBB members believe is largely a private industry or government function. Additionally, the NBB members believe cold flow and NO_x issues are either largely researched already or new OEM technologies will be the solution—especially in the case of NO_x reductions. It should be emphasized that the low NBB rankings for some of these areas (i.e. new markets) does not mean that these areas are not important, it is simply the way in which NBB believes its funding can best benefit its members. Other funding agencies that may focus on different areas may come up with very different priority ranking.

The key implication for NYSERDA consideration is that the group attending the February brainstorming session is sufficiently large and has sufficient expertise that almost all worthwhile funding activities would appear on the overall brainstorming list. The overall list, therefore, serves as an excellent basis for recommendations for future NYSERDA funding.

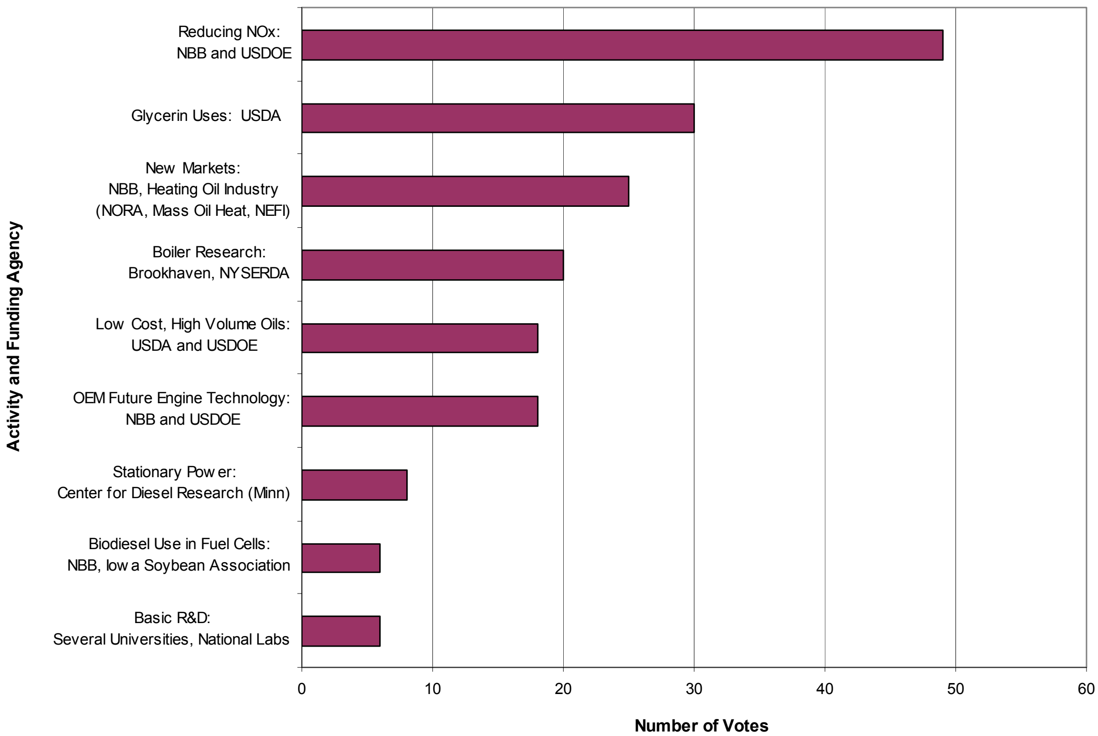
Using the research identified at the brainstorming meeting along with other organizational interests and constraints the NBB, USDOE and USDA have determined their FY04 funding priorities and almost all of the high priority items are already being fully addressed. No further funding of these areas by NYSERDA is recommended.

Figure 7.4
Most Desirable Technical Activities in 2003 Funding Currently Being Met



The technical activities that currently have some funding but would most benefit with additional funding are illustrated in Figure 7.5 below.

Figure 7.5
Most Desirable Technical Activities in 2003 Requiring Additional Funding



There is growing interest in biodiesel among the traditional entities who sponsor R&D in the alternative fuels areas (USDA, USDOE, State Agencies, Academia) so while some of the research needs identified above may not yet be funded, much of it likely will be in the not too distant future. NBB serves as the clearinghouse for this information. Therefore, is it critical that NYSERDA keep in close contact with the NBB and other leading government agencies (USDOE, USDA) as biodiesel R&D funds are allocated and prioritized by NYSERDA.

It also follows that NYSERDA would be best served through funding the areas of biodiesel research that would have the most impact on the increased use of biodiesel in applications in New York, especially those which other entities may not fund or may place on a lower priority. In addition, there are several leading edge concepts of projects which have been discussed that NYSERDA may be in a unique position to take a leadership role in. Some of these may provide increased fuel usage in the short term (one to two years) while others may set the stage for longer-term usage (three to seven years).

The specific topics recommended for additional NYSERDA funding and/or staff activity and suggested cooperating entities are below.

<u>Biodiesel use in Distributed Electrical Generation</u>:

Optimization for NO_x emissions, performance, and blend level. Biodiesel can be used as a fuel in conventional diesel generator sets, micro-turbines, or gas turbines to generate electricity in the pure form or as a blend with petrodiesel.

This project area would be separated into four main task areas, which could all be incorporated into one larger project, or could potentially be separated into four separate projects. If they are separated, the research should be closely coordinated:

1. Development and Prove-out of a biodiesel fuel sensor.

Partners: Iowa State University, Iowa Energy Center, NBB, Engine Companies, National Science Foundation. This task is to develop a robust sensor that can be placed in the fuel tank or in the fuel line that will detect the blend concentration of biodiesel in real time. The sensor would need an electrical output that can be used as an input to a control module or computer. The computer could then adjust various engine parameters (in the case of a diesel generator set) or other fuel or air intake parameters (in the case of a turbine) to optimize emissions and performance based on the actual concentration of biodiesel in the blend. This sensor technology would be targeted for first use in electrical generation applications that are less complicated in operational controls than on-road engines. Generator sets tend to run at constant speed and torque and do not need to adjust fuel and engine parameters based on varying speeds and loads that occur in on-road engines. Once developed, this technology could potentially be used in ANY biodiesel application for optimization of emissions for any blend of biodiesel, or if the blend of biodiesel being used changes from time to time.

2. NOx optimization: Diesel Generator Sets.

Partners: Universities, SwRI, Engine Companies, USDOE, NBB. The profile of biodiesel emissions is well known when used in unmodified conventional diesel engines: PM, HC, CO, SO_x and air toxics are decreased while NO_x tends to be the same or increases slightly. The fact that biodiesel can be used in these engines without modification is a major advantage. However, in certain areas of the country—particularly those in non-attainment status for ozone—any increase in NO_x is unacceptable. Many of these areas want NO_x reductions while still taking advantage of the benefits of biodiesel in terms of global warming (life cycle CO_2 reduction), reduced dependence on foreign oil, and local economic development. Since biodiesel reduces PM and other emissions, it is possible to adjust the engine to reduce NO_x while still maintaining or even decreasing other regulated pollutants. This work would investigate various engine parameters, focusing on the timing map, which could be modified when using biodiesel that will provide the following for all blend concentrations from zero to 100 percent biodiesel:

- Maximum NO_x reduction while maintaining PM neutrality
- NO_x reduction of 10 percent with as much PM reduction as possible
- Maximum PM reduction with NO_x neutrality

3. NO_x optimization: Micro turbines.

Partners: Universities, Micro-turbine companies, testing labs, Electric Power Research Institute (EPRI). This project will be the same as the NO_x optimization with generator sets, only using micro-turbines. This project will most likely involve a different set of universities, test labs, micro-turbine companies, and other collaborators than would be involved with generator sets.

4. NO_x optimization: Gas Turbines.

Partners: Universities, Gas turbine companies testing labs, EPRI. This project will be the same as the NO_x optimization with generator sets and micro turbines, only using larger turbines. This project will most likely involve a different set of universities, test labs, turbine companies, and other collaborators than would be involved with generator sets.

Biodiesel Education:

Partners: NBB, USDA. While not a specific research project, it is clear the more people know about biodiesel the more likely they are to use the fuel. NYSERDA has conducted educational meetings and conferences regarding biodiesel in the past, and this project would be to conduct several educational workshops within New York to further educate diesel users, engine and equipment dealers, as well as government agencies and policy makers on the benefits of using biodiesel. The USDA recently announced a large educational grant to the National Biodiesel Board and the University of Idaho for educational efforts around the country and would be willing to provide support and cooperative efforts toward such a project.

Home Heating Oil

Based on the distribution of the distillate fuel market in New York, and its heavy concentration in the home heating oil sector, added emphasis was placed on the existing and needed activities related to biodiesel for use as a home heating oil blending stock or as a substitute for conventional petroleum based home heating oil.

The National Biodiesel Board, U.S. Department of Energy (National Renewable Energy Laboratory, Brookhaven National Laboratory), and the heating oil industry (NORA, NEFI, Massachusetts Oil Heat Council) began investigating biodiesel as a home heating fuel several years ago. This began with a project in the school district of Warwick, Rhode Island where blends of biodiesel at the B20 and lower levels were used successfully over several winters. Fuel samples were taken, and equipment impacts (tanks, filters, burners, etc.) were monitored. The biodiesel blends worked well, with no negative impacts on the equipment or fueling infrastructure. Particular attention was give to the fuel filter area, since it is well known that biodiesel is a good solvent and may ‘clean out’ fuel systems upon initial use. Heating oil systems can contain more sediment and tank bottoms than on-road diesel applications. With the blends in this test, B20 and lower, this phenomenon was not observed and there were no differences in filter clogging with the biodiesel blends than with the conventional heating oil.

With this success, a home heating oil market assessment and emissions work was undertaken. The emissions work, conducted by Brookhaven National Laboratory with cooperative funding from NYSERDA showed significant NO_x reductions with B20 blends, as well as reductions in other pollutants. The NO_x impact is directly opposite that found in most heavy duty on-road diesel testing, and has been confirmed in two separate studies by the two most well respected heating oil labs in the country (BNL, NEFI), so the NO_x benefits of using biodiesel in home heating oil applications is real. It appears this difference is related to the different method of combustion in a heating oil furnace (open flame) and a heavy duty diesel engine (enclosed cylinder compression ignition), as well as the fact biodiesel contains 11 percent by weight oxygen. Oxygen is a key variable in home heating applications, but is usually adjusted through the intake air levels rather than through varying fuel oxygen content.

The market assessment study, conducted by Lew Derosa on behalf of the NBB, showed the benefits of biodiesel are desirable to home heat customers, and found there to be an excellent fit between the attributes of biodiesel and customer desires. This study was in line with previous feedback from heating oil customers conducted by NORA regarding the negative aspects of the image of heating oil.

In order to provide NYSERDA with recommendations regarding home heating oil research and development, all this information was reviewed in a meeting with representatives of the leadership of the home heating oil industry. MOHC, NEFI, and NORA were all represented. The Oil Heat industry believes they must reposition heating oil with their customers, and they believe lower sulfur heating oil combined with biodiesel in what is now being referred to as ‘Bio Heat’, along with improved burner technology to increase efficiency and reduce emissions, is the answer. This is very encouraging for both the biodiesel and heating oil industry and serves as a platform for future R&D efforts. Specifics of the activities needed to commercialize ‘Bio Heat’ were discussed and agreed upon:

- Testing biodiesel blends, confirming blend level vs. emissions
- Cold flow confirmation testing and additive improvements
- Fouling rates confirmation testing
- Stability confirmation testing
- Material compatibility confirmation testing
- Communication messaging
- Infrastructure requirements quantification
- Further field studies and confirmation
- S15 with biodiesel differences vs. S500 with biodiesel

Based on these prioritized activities, MOHC, NORA, NEFI, NBB, and USDOE are all evaluating their respective roles in funding these efforts along with NYSERDA. A recommendation from these groups is forthcoming. Preliminary discussions indicate a willingness for the industry groups to fund the market development and communications activities, with the government agencies funding the research and testing activities with the entire effort closely coordinated between all parties.

<u>Biodiesel use in Fuel Cells</u>:

Partners: Iowa Soybean Association, Iowa Energy Center, NBB, Fuel Cell Companies, USDOE. This project will provide baseline data with various fuel cell technologies using B100 as the hydrogen source to determine optimum reformer conditions, hydrogen purity, and overall conversion efficiency. In order to be effective, the biodiesel must be essentially free from contaminants and other minor constituents that might cause re-former degradation, so this is most likely an application for biodiesel made from a first use oil like soybean oil. Once determined, then B100 would be used in a small commercial unit for one year to determine field durability and any other impacts that need to be considered if used commercially.

APPENDIX 1

TECHNOLOGY COMPANY OVERVIEWS AND DETAILED COST ANALYSIS

Axens:

The Axens process is primarily designed for use with refined oils containing less than one percent FFA and less than 0.1 percent water. A design was developed for higher FFA feeds, but withdrawn from the market. The information provided by Axens was not as complete as that of some of the other companies.

Axens, a French company formed from the former IFP, has constructed at least 1 facility in France rated at 70,000 mt/year, (about 21 MM gallons/year (GPY)). The facility processes refined oils.

Axens has designs for facilities ranging from 3 MM to about 36 MM gallons per year. IBFG has taken the indicated capital cost for the process and used internal factors to estimate the cost for a complete facility including periphery systems and typical support systems. The order of magnitude unit capital cost for a larger facility (in the range of 15 MM to 20 MM gallons/year) is estimated to be in the $0.75 to $0.80 per annual gallon. Thus the estimated cost for a 20 MM GPY plant would be on the order of $15 MM to $16 MM. The estimated construction time is about 15 months.

Ballestra:

The Ballestra process has primarily been applied to seed oils with typical feed specification of less than 0.5 percent FFA and less than 0.05 percent water. Ballestra, an Italian company with representatives in the US, claims that they can process other materials, but each feed would have to be individually checked in their pilot to confirm process applicability. This is a sound move on Ballestra's part.

Ballestra has constructed at least two facilities that process refined oils. The company is large and does have an extensive design and support capability.

The company offers plant designs ranging from about 3 MM to 30 MM gallons per year, with larger facilities possible. The estimated unit cost for a facility in the 15 MM to 20 MM GPY range, based on IBFG estimates, is in the range of $0.75 to $0.85 per annual gallon. The estimated construction time is on the order of 15 to 18 months, depending on the extent of peripheries, etc.

BDI:

BDI, a German company of some standing, has been reluctant to share information in a generalized fashion due to their workload and previous negative experiences with the disposition of the information. However, IBFG has been able to make order-of-magnitude estimates for various factors based on information it has collected over the years.

The BDI process is capable of handling a range of materials including higher fatty acid feeds. They have commercial experience with the higher fatty acid feeds and have two plants currently under design that will process used oils. They have constructed at least

10 plants for biodiesel production worldwide. From a conservative standpoint, IBFG estimates that the process should be capable of handling materials such as yellow grease, which has an FFA up to 10 percent.

BDI offers plants ranging in size from a 0.3 MM GPY mobile facility to a 30 MM GPY grass roots (i.e. no existing facilities or infrastructure) operation. The estimated cost (IBFG factors) for a facility in the 15 MM to 20 MM would be on the order of $0.95 to $1.10 per annual gallon, and would depend to a large extent on the FFA content of the feed and the extent of process systems required for the specific feed. Obviously, higher fatty acid feeds require more extensive processing thus the expected capital would be higher than that associated with refined oil feedstocks. The estimated construction time is on the order of nine to 14 months depending on the extent of peripheries.

<u>Biodiesel Industries, Inc.</u>

Biodiesel Industries, a US company based in Nevada, indicates that their process can handle feeds with any level of fatty acid content. They currently have constructed two facilities that are processing used cooking oils (with indications that commercial yellow grease has also been treated). The facilities are rated at 3 MM and 10 MM GPY.

The company has an established design for a 3 MM gallon per year module and for plants in the 6 MM to 9 MM gallon per year range they would supply multiple modules. Large facilities would be based on a scale-up of the base module design.

The basic process module cost (3 MM GPY) ranges from $0.5 MM to $1.5 MM depending on various factors. Periphery support systems, e.g. tankage and the like, are extra. From a conservative estimating standpoint, a facility in the 15 MM GPY rate range, is estimated to cost on the order of $0.85 to $1.10 per annual gallon depending on the actual feed material and extent of plant peripheries. About three to four months is required for module preparation and shipment to site. From an overall standpoint, IBFG estimates that the total construction time with this approach would be on the order of eight to 10 months.

<u>Cimbria-Sket/Bratney:</u>

The Cimbria-Sket process is based on the same technology as the CD Process from Conneman, thus the two are obviously quite similar. Bratney companies represent Cimbria Sket, a Scandinavian company, exclusively in the US. The process is based on a refined oil feedstock and the plants constructed to date have used these as feeds. Typical feeds are less than 0.1 percent FFA and less than 0.05 percent water. The company has constructed at least 6 plants ranging in size from 1.5 MM to 36 MM gallons per year. The information provided by Cimbria Sket for the NYSERDA project was more complete and detailed than most other companies.

The estimated cost for a facility in the 15 MM GPY range (IBFG estimate) is on the order of $1.00 to $1.20 per annual gallon. The company offers facilities in the range of 1 MM (skid mounted) to 60 MM gallons per year production rate. The estimated construction time for a larger facility (IBFG estimate) is in the range of 12 to 18 months, depending on project scope.

Connemann:

The Connemann CD process, developed in Germany with affiliations from ADM and Westfalia Separator, has primarily been applied to treating refined oils, although the company claims that it can process higher fatty acid oils with the addition of an esterification step. They have not used this step in any of their commercial facilities to date, thus for assessment purposes, the process should be considered as primarily for refined oils. Their process design has been used in four facilities ranging in rate from 12 MM to 42 MM gallons per year. The company offers standard size plants in the 12 MM to 40 MM GPY range. The information provided for the NYSERDA request was lacking compared to other technology companies.

The estimated cost for a facility in the 15 MM GPY range is on the order of $1.00 to $1.20 per annual gallon. The time to construct a facility is in the range of 12 to 15 months.

Renewable Energy Group:

The Renewable Energy Group is a joint venture between Crown Iron works and West Central Cooperative in the US. They offer process design as well as startup training. Through a relationship with Todd and Sargent, they also offer turn key constructed plants. The process is based primarily on the use of refined oil feeds. The typical feed would have less than 0.3 percent FFA and less than 0.007 percent water. The company has constructed at least one facility rated at about 12 MM GPY. The information provided by the Renewable Energy Group is more comprehensive than that provided by most of the other technology companies.

The estimated unit cost for a plant in the range of 15 MM GPY would be about $1.00 to $1.10, based on IBFG estimates. The estimated time for construction would range from 12 to 18 months.

EKOIL:

Ekoil, a Slovakian company, supplies a process that has mainly been applied to refined oils. Typical feedstock would contain less than 0.1 percent FFA and less than 0.2 percent water. The company has supplied process modules for several facilities in the 1.5 MM to 4.5 MM GPY production rate range, and offers standard design for this range.

The estimated cost for a complete facility in the range of plants provided by the company (i.e. 4.5 MM GPY) is on the order of $0.85 to $0.90 per annual gallon. The estimated construction time is in the range of nine to 10 months.

Energea:

Energea, an Austrian company, claims that their process can be adapted to handle feeds with any level of fatty acid content. They currently have at least one large (12 MM GPY) facility based on their process technology (and modules) in operation. This plant processes a range of materials including yellow grease. From a “typical” standpoint, the feed would contain four percent to 12 percent FFA. Water should be less than 0.5 percent. The company has standard plant module designs ranging from 6 MM to 75 MM gallons per year production rates.

The estimated capital cost for a facility in the range of 15 MM GPY, based on a combination of Energea estimates (for process modules) and IBFG factors (for a complete facility) would be on the order of $0.80 to $1.00 per annual gallon. The estimated construction time would be on the order of nine to 10 months, (using Energea's estimate for module delivery and IBFG factors for field work).

Lurgi-PSI:

Lurgi-PSI, located in Memphis with a home office in Germany, has constructed at least seven facilities to produce methyl esters and biodiesel ranging in size from 10 MM to 30 MM gallons per year. The majority of the plants were designed for refined oil feeds, although Lurgi now claims that it can process feeds with virtually any level of FFA. For oils containing in excess of 20 percent FFA, modifications to the esterification portion of the process are required. Lurgi provided the most comprehensive package in response to the NYSERDA request of all the companies and it was quite impressive. The information provided alone is almost enough to convince a potential customer to choose Lurgi.

The estimated unit capital cost for a facility in the 12 MM to 15 MM GPY production rate range using a high i.e. >10 percent FFA feed, would be on the order of $1.00 to $1.15 per annual gallon. For low fatty acid feeds, the unit cost would be on the order of $0.95 per annual gallon (due to the decreased process needs associated with high FFA feeds). The estimated construction time would range from 12 to 15 months.

APPENDIX 2

BIODIESEL PRODUCTION ECONOMICS FOR ALTERNATIVE FEEDSTOCK COMBINATIONS

Biodiesel Production Analysis for Mixed Feedstocks

Production of Biodiesel, gal/yr	**11,972,789**
Capital Cost Estimate	**$14,500,000**

	Yearly Amount	Price Per Unit	Annual Dollars
Costs			
Real Annual Cost of Capital			$3,146,500
Sales and Admin			$1,557,653
Annualized Cost of Working Capital			$178,481
Fat/Oil, pounds, Soybean Oil	26,664,000	$0.21	$5,599,440
Fat/Oil, pounds, Yellow Grease	61,544,554	$0.11	$6,769,901
Alcohol			$793,939
Catalyst			$387,200
Plant Labor, incl. Benefits			$480,000
Utilities, Maintenance, Insurance			$1,047,175
Total Costs			**$19,960,289**
By Products Credits			
Glycerin, pound			$982,147
Fatty Acid, pound			$0
Total By-Product Credits			**$982,147**
Net Annual Costs			**$18,978,142**
Biodiesel Cost, $/gallon		**$1.59**	

Biodiesel Production Analysis for Soybean Oil, 0.5 % Free Fatty Acid

Production of Biodiesel, gal/yr	**2,993,197**
Capital Cost Estimate	**$3,250,000**

	Yearly Amount	Price Per Unit	Annual Dollars
Costs			
Real Annual Cost of Capital			$705,250
Sales and Admin			$636,786
Annualized Cost of Working Capital			$72,965
Fat/Oil Feedstock, pounds	22,220,000	$0.21	$4,666,200
Alcohol, gallon	403,333	$0.50	$199,870
Catalyst, pound	33,000	$2.00	$66,000
Plant Labor, incl. Benefits			$480,000
Utilities, Maintenance, Insurance			$250,544
Total Costs			**$7,077,615**
By Products Credits			
Glycerin, pound	2,640,000	$0.10	$264,000
Fatty Acid, pound	0	$0.10	$0
Total By-Product Credits			**$264,000**
Net Annual Costs			**$6,813,615**
Biodiesel Cost, $/gallon		**$2.28**	

Biodiesel Production Analysis for Soybean Oil, 0.5 % Free Fatty Acid

Production of Biodiesel, gal/yr	**11,972,789**
Capital Cost Estimate	**$12,000,000**

	Yearly Amount	Price Per Unit	Annual Dollars
Costs			
Real Annual Cost of Capital			$2,604,000
Sales and Admin			$2,378,446
Annualized Cost of Working Capital			$272,530
Fat/Oil Feedstock, pounds	88,880,000	$0.21	$18,664,800
Alcohol, gallon	1,613,333	$0.50	$799,480
Catalyst, pound	132,000	$2.00	$264,000
Plant Labor, incl. Benefits			$480,000
Utilities, Maintenance, Insurance			$972,175
Total Costs			**$26,435,431**
By Products Credits			
Glycerin, pound	10,560,000	$0.10	$1,056,000
Fatty Acid, pound	0	$0.10	$0
Total By-Product Credits			**$1,056,000**
Net Annual Costs			**$25,379,431**
Biodiesel Cost, $/gallon		**$2.12**	

Biodiesel Production Analysis for Animal Fat, 3% Free Fatty Acid

Production of Biodiesel, gal/yr	**2,993,197**		
Capital Cost Estimate	**$3,500,000**		
	Yearly Amount	**Price Per Unit**	**Annual Dollars**
Costs			
Real Annual Cost of Capital			$759,500
Sales and Admin			$553,041
Annualized Cost of Working Capital			$63,369
Fat/Oil Feedstock, pounds	23,540,000	$0.16	$3,745,000
Alcohol, gallon	403,333	$0.50	$199,870
Catalyst, pound	44,000	$2.00	$88,000
Plant Labor, incl. Benefits			$480,000
Utilities, Maintenance, Insurance			$258,044
Total Costs			**$6,146,824**
By Products Credits			
Glycerin, pound	2,640,000	$0.10	$264,000
Fatty Acid, pound	1,320,000	$0.10	$132,000
Total By-Product Credits			**$396,000**
Net Annual Costs			**$5,750,824**
Biodiesel Cost, $/gallon		**$1.92**	

Biodiesel Production Analysis for Animal Fat, 3% Free Fatty Acid

Production of Biodiesel, gal/yr	**11,972,789**		
Capital Cost Estimate	**$13,000,000**		
	Yearly Amount	**Price Per Unit**	**Annual Dollars**
Costs			
Real Annual Cost of Capital			$2,821,000
Sales and Admin			$2,043,466
Annualized Cost of Working Capital			$234,147
Fat/Oil Feedstock, pounds	94,160,000	$0.16	$14,980,000
Alcohol, gallon	1,613,333	$0.50	$799,480
Catalyst, pound	176,000	$2.00	$352,000
Plant Labor, incl. Benefits			$480,000
Utilities, Maintenance, Insurance			$1,002,175
Total Costs			**$22,712,268**
By Products Credits			
Glycerin, pound	10,560,000	$0.10	$1,056,000
Fatty Acid, pound	5,280,000	$0.10	$528,000
Total By-Product Credits			**$1,584,000**
Net Annual Costs			**$21,128,268**
Biodiesel Cost, $/gallon		**$1.76**	

Biodiesel Production Analysis for Yellow Grease, 10% Free Fatty Acid

Production of Biodiesel, gal/yr	**2,993,197**		
Capital Cost Estimate	**$4,000,000**		
	Yearly Amount	**Price Per Unit**	**Annual Dollars**
Costs			
Real Annual Cost of Capital			$868,000
Sales and Admin			$432,677
Annualized Cost of Working Capital			$49,578
Fat/Oil Feedstock, pounds	21,980,198	$0.11	$2,397,840
Alcohol, gallon	399,340	$0.50	$197,891
Catalyst, pound	55,000	$2.00	$110,000
Plant Labor, incl. Benefits			$480,000
Utilities, Maintenance, Insurance			$273,044
Total Costs			**$4,809,030**
By Products Credits			
Glycerin, pound	2,376,238	$0.10	$237,624
Fatty Acid, pound	0	$0.10	$0
Total By-Product Credits			**$237,624**
Net Annual Costs			**$4,571,406**
Biodiesel Cost, $/gallon		**$1.53**	

Biodiesel Production Analysis for Yellow Grease, 10% Free Fatty Acid

Production of Biodiesel, gal/yr	**11,972,789**
Capital Cost Estimate	**$14,500,000**

	Yearly Amount	Price Per Unit	Annual Dollars
Costs			
Real Annual Cost of Capital			$3,146,500
Sales and Admin			$1,549,660
Annualized Cost of Working Capital			$177,565
Fat/Oil Feedstock, pounds	87,920,792	$0.11	$9,591,359
Alcohol, gallon	1,597,360	$0.50	$791,564
Catalyst, pound	220,000	$2.00	$440,000
Plant Labor, incl. Benefits			$480,000
Utilities, Maintenance, Insurance			$1,047,175
Total Costs			**$17,223,824**
By Products Credits			
Glycerin, pound	9,504,950	$0.10	$950,495
Fatty Acid, pound	0	$0.10	$0
Total By-Product Credits			**$950,495**
Net Annual Costs			**$16,273,329**
Biodiesel Cost, $/gallon		**$1.36**	

APPENDIX 3

CALCULATION OF INCENTIVE PAYMENTS

The following information is utilized to calculate the level of payment to eligible producers of biodiesel:

Conversion Factor for soybeans:	1.4
Payment Factor:	1.0
Payment Rate:	
Less than 65 million gallons/yr	2.5
More than 65 million gallons/yr	3.5

Formulas: Incremental Gallon Payment for Soybean Oil = ((((Increased Biodiesel Production in Gallons ÷ Conversion Factor) ÷ Payment Rate) x Posted County Price) x Payment Factor)

Incremental Gallon Payment for Other Oils = (((((Increased Biodiesel Production in Gallons ÷ Conversion Factor) ÷ Payment Rate) x Posted County Price) x Payment Factor) x (Other Oils Price/Soybean Oil Price))

Base Production Payment = (((Incremental Gallon Payment ÷ Incremental Biodiesel Production) x Base Production Prorate Factor) x Base Production in Gallons)

Total Payment = Incremental Gallon Payment + Base Production Payment

Example 1: In FY03, a biodiesel producer using soybean oil generated a 1,000 gallon increase in biodiesel production (conversion rate = 1.4) with a base production capacity of 1,000 gallons (payment rate = 2.5) when the relevant Soybean Posted County Price is $5.59 per bushel and the payment factor is 100 percent for FY03

Incremental Gallon Payment: ((((1,000 ÷ 1.4) ÷ 2.5) x $5.59) x1.0) = $1,597.00

Base Production Payment: ($1,597 ÷ 1,000) x 50%) x 1,000) = $798.50

Total Payment: $1,597.00 + $798.50 = $2,395.50

Example 2: In FY03, a biodiesel producer using yellow grease generated a 1,000 gallon increase in biodiesel production (conversion rate = 1.4) with a base production capacity of 1,000 gallons (payment rate = 2.5) when the relevant Soybean Posted County Price is $5.59 per bushel and the payment factor is 100 percent for FY03. Soybean oil price was $.2259 per pound while the yellow grease price was $.1000 per pound of oil.

Incremental Gallon Payment: (((((1,000 ÷ 1.4) ÷ 2.5) x $5.59) x1.0) x (.1000 ÷ .2259))= $707.01

Base Production Payment: ($707.01 ÷ 1,000) x 50%) x 1,000) = $353.51

Total Payment: $707.01 + $353.51 = $1,060.52

USDA Grants and Loan Programs

Value-Added Agricultural Produce Market Development Grant Program (VADG)

In September 2003, the Rural Business-Cooperative Service announced the availability of approximately $27.7 million in competitive grant funds for FY03 to help independent agricultural producers enter into value-added activities. These funds were to be used for one of two types of activity (1) developing feasibility studies or business plans and (2) acquiring working capital to operate a value-added business venture or an alliance that will allow the producers to better compete in domestic and international markets.

VADG was authorized by the Agriculture Risk Protection Act of 2000 and was amended by the Farm Security and Rural Investment Act of 2002, better known as the Farm Bill. The Farm Bill establishes four related, but different programs from the $40 million of funds per year. The programs are (1) VADG producer grants, (2) a resource center, (3) a series of innovation centers, and (4) university research on the impact of value-added activities. Title VI of the Farm Bill authorizes up to $40 million per year for six years, beginning in FY02.

Application forms can typically be obtained by contacting your State USDA Rural Development office or through the website at www.rurdev.usda.gov/rbs/coops/vadg.htm. This is a highly competitive grants program. FY01 applicants had about a 9 percent success rate. Applicants should also note you can apply for funds for "Planning" or "Working Capital" but not both. These two types of grants have different scoring criteria under the FY03 program. Other important points include:

- You must pursue an emerging market
- The grant requires a one-for-one match for all grant funds requested.
- You must be able to show how producers are committed to the project.

Biodiesel operations would qualify under the criteria of this program.

Rural Business Opportunity Grants (RBOG)

The purpose of the RBOG program is to promote sustainable economic development in rural communities with exceptional needs. This is accomplished by making grants to pay the costs of providing economic planning for rural communities, technical assistance for rural businesses, or training for rural entrepreneurs or economic development officials.

To be eligible for a Rural Business Opportunity Grant (RBOG) applicants must be a public body, nonprofit corporation, Indian tribe, or cooperative with members that are primarily rural residents. You must have significant expertise in the activities you propose to carry out with the grant funds and financial strength to ensure you can accomplish the objectives of the proposed grant. You must be able to show that the funding will result in economic development of a rural area (any area of a State that is not within the boundaries of a city with a population in excess of 10,000 inhabitants.) Your project must include a basis for determining the success or failure of the project and assessing its impact.

Grant funds may not be used for:

- Duplication of current services or replace or substitute support previous provided.
- Pay costs of preparation of application.
- Costs incurred prior to effective date of the grant.
- Fund political activities.
- Acquisition of real estate, building construction or development.

Most RBOG grants are $50,000 or less. Applications must go through the Rural Development State Office in the State where the grant will be conducted.

Renewable Energy Systems and Energy

In April 2003, the Rural Business Cooperative Service announced the availability of approximately $23 million in competitive grant funds for FY03 to make direction loans, loan guarantees, and grants to agricultural producers and rural small businesses to purchase renewable energy systems and make energy efficiency improvements. Biodiesel projects would be eligible under the program guidelines, however RBS has indicated they currently plan to only initiate the program in FY03.

Business and Industry Direct Loans

The Business and Industry (B&I) Direct Loan Program provides loans to public entities and private parties who cannot obtain credit from other sources. Loans to private parties can be made for improving, developing, or financing business and industry, creating jobs, and improving the economic and environmental climate in rural communities (including pollution abatement). This type of assistance is available in rural areas (this includes all areas other than cities or unincorporated areas of more than 50,000 people and their immediately adjacent urban or urbanizing areas).

Eligible applicants include any legally organized entity, including cooperatives, corporations, partnerships, trusts or other profit or nonprofit entities, Indian tribes or Federally recognized tribal groups, municipalities, counties, any other political subdivision of a State, or individuals. Loans are available to those who cannot obtain credit elsewhere and for public bodies.

The maximum aggregate B&I Direct Loan amount to any one borrower is $10 million.

Business and Industry Guaranteed Loans

This program provides guarantees up to 90 percent of a loan made by a commercial lender. Loan proceeds may be used for working capital, machinery and equipment, buildings and real estate, and certain types of debt refinancing. The primary purpose is to create and maintain employment and improve the economic climate in rural communities.

Business and Industry loan guarantees can be extended to loans made by recognized commercial lenders or other authorized lenders in rural areas (this includes all areas other than cities or unincorporated areas of more than 50,000 people and their immediately adjacent urban or urbanizing areas). Generally, recognized lenders include Federal or State chartered banks, credit unions, insurance companies, savings and loan associations, Farm Credit Banks or other Farm Credit System institutions with direct lending authority, a mortgage company that is part of a bank holding company, and the National Rural Utilities Finance Corporation. Other loan sources include eligible Rural Utilities Service electric and telecommunications borrowers and other lenders approved by RBS who have met the designated criteria.

Assistance under the B&I Guaranteed Loan Program is available to virtually any legally organized entity, including a cooperative, corporation, partnership, trust or other profit or nonprofit entity, Indian tribe or Federally recognized tribal group, municipality, county, or other political subdivision of a State.

The maximum aggregate B&I Guaranteed Loan(s) amount that can be offered to any one borrower under this program is $25 million.

APPENDIX 4

METHODOLOGY FOR ECONOMIC ANALYSIS

1. Macroeconomic Impacts

The U.S. biodiesel industry is in its infancy compared to the much larger ethanol industry but has the potential to grow and develop in much the same way. Biodiesel (mono-alkyl esters) are manufactured from naturally occurring vegetable oils and fats (also known as triglycerides). Mono-alkyl esters are also made for purposes other than biodiesel such as intermediates for industrial chemicals and consumer products. Much of current biodiesel technology is based on a "simplification" of well-known and well understood conventional ester production techniques.

Biodiesel is a product of the industrial inorganic and organic chemicals industry and uses inputs supplied primarily by the agriculture and food processing industry (oilseed refining), other sectors of the chemicals industry (alcohol and catalysts) as well as utilities and water, and maintenance services. Spending on these goods and services represents the purchase of output of other industries. In addition, the construction of new biodiesel plants results in spending for a wide range of goods and services. At an estimated construction cost of $1.25/gallon for a new biodiesel plant, 40 MGY of new biodiesel capacity would represent the expenditure of $50 million.

The spending associated with biodiesel production and investment spending on new plant capacity will circulate throughout the entire economy several fold. Consequently this spending will stimulate aggregate demand, support the creation of new jobs, generate additional household income, and provide tax revenue for government at all levels. The impact from the creation of a biodiesel industry on the New York economy was estimated by applying the most appropriate final demand multipliers for output, earnings, and employment for the relevant supplying industry calculated by the U.S. Bureau of Economic Analysis (BEA) to the estimates of spending consistent with the size and scale of the industry outlined by each Policy Scenario.

The Regional Input-Output Modeling System (RIMS II)[62]

The effective estimation of the full implications of a public- or private-sector project or programs at the State and local levels requires a systematic analysis of the economic impacts of these projects and programs on affected regions. In turn, systematic analysis of economic impacts must account for the interindustry relationships within regions because these relationships largely determine how regional economies are likely to respond to project and program changes. Thus, regional input-output (Input-Output) multipliers, which account for interindustry relationships, are useful tools for conducting regional economic impact analysis.

In the 1970's, the U.S. Department of Commerce's Bureau of Economic Analysis (BEA) developed a method for estimating regional Input-Output multipliers known as RIMS (Regional Industrial Multiplier System). An enhancement to RIMS, known as RIMS II

[62] This section is based on material from the U.S. Department of Commerce, Bureau of Economic Analysis.

(Regional Input-Output Modeling System) was introduced in the 1980's, and has been continuously updated and enhanced.

RIMS II is based on an accounting framework called an Input-Output table. For each industry, an Input-Output table shows the industrial distribution of inputs purchased and outputs sold. A typical Input-Output table in RIMS II is derived mainly from two data sources: BEA's national Input-Output table, which shows the input and output structure of nearly 500 U.S. industries, and BEA's regional economic accounts, which are used to adjust the national Input-Output table to show a region's industrial structure and trading patterns.[63]

Using RIMS II for impact analysis has several advantages. RIMS II multipliers can be estimated for any region composed of one or more counties and for any industry, or group of industries, in the national Input-Output table. The accessibility of the main data sources for RIMS II keeps the cost of estimating regional multipliers relatively low. Empirical tests show that estimates based on relatively expensive surveys and RIMS II-based estimates are similar in magnitude.[64]

To effectively use the multipliers for impact analysis, users must provide geographically and industrially detailed information on the initial changes in output, earnings, or employment that are associated with the project or program under study. The multipliers can then be used to estimate the total impact of the project or program on regional output, earnings, and employment.

The Use of RIMS II to Calculate the Economic Impact for New York of a Biodiesel Industry

RIMS II uses BEA's 1999 national Input-Output table, which shows the input and output structure for approximately 500 industries. Since a particular region may not contain all the industries found at the national level, some direct input requirements cannot be supplied by that region's industries. Input requirements that are not produced in a study region are identified using BEA's regional economic accounts. Currently, data for 2000 are used.

Measuring impacts of a new industry on a state economy such as New York has two facets: measuring the size of the industry and then determining its impact, based on its size. The direct contribution of the biodiesel industry to the New York economy is related to the value added by the industry. Value added measures the contribution of the industry's employees and owners above the value of the goods and services purchased by the industry required to produce biodiesel fuel.

The biodiesel industry's value added is its direct contribution to the State economy. Industry operations also have indirect effects through the purchases of goods by its

[63] See U.S. Department of Commerce, Bureau of Economic Analysis, The Detailed Input-Output Structure of the U.S. Economy, Volume II (Washington, DC: U.S. Government Printing Office, November 1994); and U.S. Department of Commerce, Bureau of Economic Analysis, State Personal Income, 1929-93 (Washington, DC: U.S. Government Printing Office, June 1995).

[64] See U.S. Department of Commerce, Regional Input-Output Modeling System (RIMS II), chapter 5. Also see Sharon M. Brucker, Steven E. Hastings, and William R. Latham III, "The Variation of Estimated Impacts from Five Regional Input-Output Models," International Regional Science Review 13 (1990): 119-39.

employees and through the employment and value added generated in its supplying industries. The biodiesel industry's indirect contribution to the New York economy and hence its total direct and indirect effect on the State economy is measured using final demand multipliers. Final demand multipliers measure how industry purchases generate value added and employment in its supplying industries. Table A4.1 displays the final demand multipliers for output, earnings and employment for the industries relevant to this analysis.

Table A4.1

RIMS II Final demand Multipliers for New York

	Final DD Output ($)	Final DD Earnings ($)	Final DD Employment (Jobs)
Industrial inorganic and organic chemicals	1.6878	0.3402	6.6000
New industrial Construction	1.8744	0.5198	13.2000
Oilseed production	1.8170	0.3451	14.4000
Edible fats & oils/animal fats	1.6915	0.2820	8.3000

- The final demand output multiplier for the New York industrial inorganic and organic chemicals industry is approximately 1.7 and the output multiplier for new industrial construction is approximately 1.9. This means that every dollar of value added created by the biodiesel industry generates approximately an additional seventy cents of output in the economy for a total contribution of approximately $1.70 while the construction activity to build capacity generates a total contribution of nearly $1.90.

- The earnings multiplier for the industrial inorganic and organic chemicals industry in New York is 0.32 while the new construction multiplier is 0.52 meaning that every dollar of value added created by the biodiesel industry generates approximately an additional $0.32 of additional household income for New Yorkers while every dollar of construction activity to build biodiesel capacity generates $0.52 of income.

- Increased economic activity creates jobs. Every million dollars of value added created by the biodiesel industry supports the creation of 6.6 new jobs throughout the entire New York while 13.2 jobs are created by the construction activity to build biodiesel capacity.

2. Agricultural Impacts

The impacts of a biodiesel industry on New York's agricultural sector were analyzed through the use of a long-term model of U.S. agriculture that includes detailed soybean and soybean product supply, demand, and prices and the livestock and poultry sector. This model was used to develop a baseline forecast for soybean, soybean oil, and soybean meal supply and prices that is consistent with the December 2003 USDA World Agricultural Supply and Demand Estimates and agricultural and energy policy in effect at that time. An alternative scenario for the Energy Bill was developed that incorporated the renewable fuel standard provisions and tax incentives for ethanol and biodiesel under consideration by the U.S. Senate.

The model produces forecasts at the national level. LECG economists linked New York agriculture performance to this to determine both a baseline and Energy Bill Scenario specific to New York. This effort relied on State specific data for area planted, harvested, average yield and production data for soybeans, corn, wheat, and hay, and farm-level process provided by the New York Department of Agriculture and Markets and New York Agricultural Statistics Service. Cash receipts and farm income specific to New York were determined by calculating the change in the value of production and marketings required for each policy scenario under both Baseline and Energy Bill price paths. This analysis was linked to Subtasks 2.2 and 2.3 and specifically considered impacts associated with New York State biodiesel production levels consistent with each policy option.

The main assumptions underlying the agricultural analysis for soybeans, corn, and hay are summarized in the following supply and utilization tables A4.2 through A4.4.

Table A4.2
New York Soybean Supply and Utilization
Baseline and Energy Bill Scenario

BASELINE

	NY Soybeans Planted Thou ac	NY Soybeans Harvested Thou ac	NY Soybeans Yield bu/ac	NY Soybeans Production Thou bu	NY Soybean Farm Price $/bu	U.S. Soybean Farm Price $/bu	U.S. Soybean Oil Price $/lb (1)	U.S. Soybean Meal Price $/Ton (2)
1998				3,977	$5.10	$4.93	$0.1990	$138.50
1999				4,736	$4.20	$4.63	$0.1560	$167.70
2000				4,356	$4.55	$4.54	$0.1415	$173.60
2001				5,214	$4.55	$4.34	$0.1646	$167.73
2002				4,608	$5.85	$5.31	$0.2204	$181.75
2003		142	37	5,254	$6.94	$6.81	$0.2749	$217.94
2004	152	149	35	5,221	$5.75	$5.65	$0.2258	$180.68
2005	156	153	35	5,400	$5.52	$5.42	$0.2167	$162.56
2006	161	157	36	5,585	$5.73	$5.63	$0.2250	$168.79
2007	165	162	36	5,776	$5.72	$5.62	$0.2246	$168.45
2008	169	166	36	5,974	$5.73	$5.62	$0.2247	$168.56
2009	174	170	36	6,178	$5.75	$5.65	$0.2259	$169.42
2010	179	175	37	6,388	$5.72	$5.61	$0.2244	$168.28
2011	183	180	37	6,606	$5.82	$5.71	$0.2283	$171.25
2012	188	185	37	6,830	$5.99	$5.88	$0.2350	$176.28

ENERGY BILL SCENARIO

	NY Soybeans Planted Thou ac	NY Soybeans Harvested Thou ac	NY Soybeans Yield bu/ac	NY Soybeans Production Thou bu	NY Soybean Farm Price $/bu	U.S. Soybean Farm Price $/bu	U.S. Soybean Oil Price $/LB	U.S. Soybean Meal Price $/Ton
1998				3,977	$5.10	$4.93	$0.1990	$138.50
1999				4,736	$4.20	$4.63	$0.1560	$167.70
2000				4,356	$4.55	$4.54	$0.1415	$173.60
2001				5,214	$4.55	$4.34	$0.1646	$167.73
2002				4,608	$5.85	$5.31	$0.2204	$181.75
2003		142	37	5,254	$6.94	$6.81	$0.2751	$218.06
2004	152	149	35	5,221	$5.88	$5.77	$0.2309	$184.69
2005	156	153	35	5,400	$6.08	$5.97	$0.2388	$179.11
2006	161	157	36	5,585	$6.17	$6.05	$0.2421	$181.54
2007	177	174	36	6,215	$6.28	$6.16	$0.2465	$175.62
2008	195	191	36	6,891	$6.26	$6.15	$0.2459	$175.20
2009	215	211	36	7,639	$6.17	$6.06	$0.2423	$172.66
2010	237	232	37	8,469	$6.25	$6.14	$0.2455	$174.89
2011	261	255	37	9,388	$6.14	$6.03	$0.2411	$171.79
2012	287	281	37	10,407	$6.16	$6.05	$0.2419	$172.34

(1). Soybean oil price, Crude, Tanks, Decatur
(2) Soybean meal price, 48% Protein, Decatur

Table A4.3
New York Corn Supply and Utilization
Baseline and Energy Bill Scenario

BASELINE

	NY Corn Planted Thou ac	NY Corn Harvested Thou ac	NY Corn Yield bu/ac	NY Corn Production Thou bu	NY Corn Farm Price $/bu	U.S. Corn Farm Price $/bu
1998	1,130	580	114	66,120	$2.21	$1.84
1999	1,150	590	101	59,590	$2.24	$1.71
2000	980	450	98	44,100	$2.35	$1.85
2001	1,030	540	105	56,700	$2.51	$1.96
2002	1,040	450	97	43,650	$2.85	$2.30
2003	1,020	460	112	54,280	$2.54	$2.16
2004	1,050	536	100	53,550	$2.49	$2.11
2005	1,055	538	101	54,343	$2.23	$1.89
2006	1,060	541	102	55,141	$2.18	$1.86
2007	1,065	543	103	55,944	$2.44	$2.07
2008	1,070	546	104	56,753	$2.59	$2.20
2009	1,075	548	105	57,566	$2.71	$2.30
2010	1,080	551	106	58,385	$2.88	$2.45
2011	1,085	553	107	59,208	$3.12	$2.65
2012	1,090	556	108	60,037	$3.16	$2.68

ENERGY BILL SCENARIO

	NY Corn Planted Thou ac	NY Corn Harvested Thou ac	NY Corn Yield bu/ac	NY Corn Production Thou bu	NY Corn Farm Price $/bu	U.S. Corn Farm Price $/bu
1998	1,130	580	114	66,120	$2.21	$1.84
1999	1,150	590	101	59,590	$2.24	$1.71
2000	980	450	98	44,100	$2.35	$1.85
2001	1,030	540	105	56,700	$2.51	$1.96
2002	1,040	450	97	43,650	$2.85	$2.30
2003	1,020	460	112	54,280	$2.54	$2.16
2004	1,050	536	100	53,550	$2.77	$2.36
2005	1,055	538	101	54,343	$2.83	$2.40
2006	1,060	541	102	55,141	$2.94	$2.49
2007	1,045	533	103	54,894	$2.97	$2.52
2008	1,050	536	104	55,692	$3.20	$2.72
2009	1,055	538	105	56,495	$3.22	$2.74
2010	1,060	541	106	57,304	$3.24	$2.75
2011	1,065	543	107	58,117	$3.27	$2.78
2012	1,070	546	108	58,936	$3.39	$2.88

Table A4.4
New York All Hay Supply and Utilization
Baseline and Energy Bill Scenario

BASELINE

	NY Hay Harvest thou ac	NY Hay Yield tons/ac	NY Hay Production thou tons	NY Hay Farm Price $/ton	U.S. Hay Farm Price $/ton
1998	1,400	2.22	3,110	$93.00	$84.60
1999	1,500	1.98	2,975	$108.00	$76.90
2000	1,520	2.04	3,098	$103.00	$84.60
2001	1,660	2.14	3,548	$104.00	$96.50
2002	1,720	2.17	3,726	$106.00	$92.40
2003	1,600	2.20	3,596	$102.75	$92.57
2004	1,627	2.17	3,530	$98.77	$88.98
2005	1,597	2.17	3,465	$98.31	$88.57
2006	1,567	2.17	3,400	$99.15	$89.32
2007	1,536	2.17	3,334	$100.17	$90.24
2008	1,506	2.17	3,269	$101.05	$91.04
2009	1,476	2.17	3,203	$101.68	$91.60
2010	1,446	2.17	3,138	$102.45	$92.30
2011	1,416	2.17	3,072	$103.21	$92.98
2012	1,386	2.17	3,007	$103.55	$93.29

ENERGY BILL SCENARIO

	NY Hay Harvest thou ac	NY Hay Yield tons/ac	NY Hay Production thou tons	NY Hay Farm Price $/ton	U.S. Hay Farm Price $/ton
1998	1,400	2.22	3,110	$93.00	$84.60
1999	1,500	1.98	2,975	$108.00	$76.90
2000	1,520	2.04	3,098	$103.00	$84.60
2001	1,660	2.14	3,548	$104.00	$96.50
2002	1,720	2.17	3,726	$106.00	$92.40
2003	1,600	2.20	3,596	$102.75	$92.57
2004	1,627	2.17	3,530	$98.77	$88.98
2005	1,597	2.17	3,465	$98.31	$88.57
2006	1,567	2.17	3,400	$99.15	$89.32
2007	1,536	2.17	3,334	$100.17	$90.24
2008	1,478	2.17	3,208	$101.80	$91.04
2009	1,449	2.17	3,144	$102.43	$91.60
2010	1,419	2.17	3,080	$103.21	$92.30
2011	1,390	2.17	3,016	$103.97	$92.98
2012	1,360	2.17	2,951	$104.32	$93.29

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