RENEWABLE FUELS AND THE BIOECONOMY IN MICHIGAN:

The Current Situation—Ethanol and Biodiesel

The interest and enthusiasm for ethanol production and utilization in Michigan is at a fever pitch. From farmers that want to grow corn for ethanol production, to investors that see the potential for a quick return on their investment in ethanol production facilities, to consumers who view ethanol as a substitute for foreign oil, ethanol is front and center!

The first ethanol plant was constructed in Michigan nearly 30 years ago in Alma. That plant only operated a short time, and never really achieved commercial operation. It was soon abandoned, and ethanol production in Michigan didn't hit the news again until the year 2000, when a group initiated the process of trying to find a site for a plant in Michigan's Thumb region.

Two years ago, Michigan Ethanol began production in Caro, with a 36 million gallon per year (MGPY) production facility. This year has seen two more plants come on line: the Anderson's in Albion and U.S. BioEnergy in Woodbury, each with a 50 MGPY production facility.

In addition, Great Lakes Ethanol in Riga/Blissfield is well along with another 50 MGPY facility, which should come on line in January 2007; and construction at Marysville Ethanol is under way for their 50 MGPY facility, which should be producing within the next 12 months. Even while currently being built to an original capacity of 50 MGPY, Great Lakes Ethanol is already doubling their capacity.

Other plants in various stages of development include a 100 MGPY plant in Gratiot County (called Liberty Renewable Fuels) where ground has been broken. Liberty also has established supply agreements to help make sure they have corn supplies. Two or three additional 50 MGPY ethanol plants have been proposed for Watervleit, Manistee, and McBain or another northern Michigan location. Reportedly the permit process has been initiated for the Watervleit location.

Following is a summary, at this writing, of ethanol production, corn utilization, and plant status:

Plant	Production (million gallons}	Corn demand (million bushels)	Status
Caro	36	16	Producing
Albion	50	20	Producing
Woodbury	50	20	Producing
Riga (1)	50	20	January 2007
Marysville	50	20	September 2007
RIGA (2)	50	20	July 2007
Gratiot	100	40	February 2008
Watervliet	50	20	?
McBain	50	20	?
Manistee	50	20	?
Total	536	216	

In addition to corn demand for Michigan facilities, there is also demand for corn across the border in Ontario for the Sarnia (Suncor), Hensell (ground broken), and Chatham facilities. It is estimated by some that those plants may use as much as 20 million additional bushels of Michigan-grown corn, though historically there has been as much as 60 million bushels of Michigan corn shipped to Ontario annually for feed and processing use. For the sake of this analysis, we will peg Ontario demand at 60 million bushels of Michigan corn annually.

Current feed demand for corn in Michigan amounts to an estimated 74 million bushels. As distillers grain becomes more available from ethanol plants, as much as 20 percent of that corn may be displaced by dried distiller grain (DDG, the material remaining after ethanol is extracted from corn), still leaving a feed demand of 60 million bushels of corn. By adding the potential in-state ethanol demand for corn (216 million bushels), with Canadian demand (60 million bushels) with feed demand (60 million bushels), that suggests an annual demand for 336 million bushels of corn. Most believe that 60 million bushels of that demand is uncertain (Watervleit, McBain and Manistee facilities). Even so, without that 60 million bushels of demand, the total is still 276 million bushels of corn.

In 2005, Michigan farmers produced 289 million bushels of corn, and the Michigan industry shipped more than 150 million bushels of the grain to feeders and other users across the country. While it should be noted again that a percentage of this corn shipped for feed can be replaced with DDG- (up to 20 percent in some cases), there is still strong demand for corn for feed purposes. Additional corn production in Michigan will be driven by prices (as a result of demand). Farmers seem willing to change their cropping rotations and grow more corn.

Some have suggested that in 2007, corn acreage may increase as much as 15–20 percent (330,000–440,000 acres) from the 2006 level of 2.2 million corn acres. It should also be noted that many forecast continuing corn yield increases per acre, but in 2006 Michigan yields did not increase as fast as they have in most recent years. With this additional acreage, and even a 10 percent yield increase, Michigan corn production in future years could approach just over 400 million bushels.

It must be noted that acreage shift as identified above may involve some acreage that is not as productive as some currently used for corn, and that may not move the yield curve as high as some suggest, nor as quickly as some have projected. Therefore, even with an increase in acreage and additional yield, Michigan producers will barely be able to meet new and some traditional demand for corn, and those traditional users will still need corn to feed livestock and poultry. That corn will continue to come from some source.

Some may not view this as a problem and believe any shortfall of corn supplies can be found elsewhere in the U.S., but the battle for corn supplies to fuel the burgeoning ethanol industry is roaring all across the country. With 42 new ethanol plants and seven expansions under construction, U.S. production capacity will increase by three billion gallons in the next few months. With 300 additional proposals pending to build additional ethanol plants, the total capacity would hit 20 billion gallons.

Iowa State Agricultural Economist Robert Wisner says that "the latest crop estimate and USDA utilization projections indicate the 2006 crop estimate is a billion bushels below potential use. (Our) latest balance sheets show a 1.1 billion bushel production-use gap, even this year."

In Iowa, the current plant capacity, plants under construction, and planned plants would take their total annual corn processing demand to nearly 2.6 billion bushels, about 25 percent more than their current total production. Those numbers do not even include in-state feed use. With the Iowa state average corn yields per acre at just over 190 bushels per acre, the acreage in Iowa needed to supply all currently planned and existing plants at their rated capacity, along with feed needs and current shipments out of state, would need to be increased about 67 percent.

About 2.2 billion bushels of the 2006 corn crop will be used nationally for ethanol production at 106 ethanol plants, but by the end of 2007, an additional 1.4 billion bushels could be needed to supply new or expanded plants. To meet this demand, corn acreage will have to jump nationally to between 88 million and 89 million acres, a 10-million-acre increase from 2006.

Total United States	
Year	**Corn necessary to meet ethanol demand (billion bushels)**
2006–2007	2.2
2007–2008	2.9
2008–2009	4.5
2009–2010	5.4–8.7

The U.S. Department of Agriculture (USDA) is forecasting that farmers will produce 10.91 billion bushels this year, the third-highest total on record but down from last year's 11.11 billion bushels. Keith Collins, USDA's chief economist, says that by 2010, 90 million acres of corn will be needed to meet feed, ethanol, and export demand, and prices will have to drive enough acres to corn production to meet that demand. Even though overall demand for corn will skyrocket over the next 12–24 months, ethanol demand will not displace the traditional demand for corn for feed, just increase the price of that grain.

A factor that seems to have been ignored by many corn production/supply analyses is the fact that agricultural production is subject to weather, including drought, untimely frost, or other calamities. Any significant weather-induced impact on production could dramatically influence overall production totals in any given year. In addition, contrary to historical practice in Michigan and many other states, the volume of corn traditionally shipped to other locations for feed and storage will not happen to the extent is has in the past. Considerable additional storage will be necessary in the state to hold the crop to meet the needs right here.

As farmers increase their corn acreage, it will come at the expense of other crops. While cotton acreage in the southeast and spring wheat acreage in the Northern United States may suffer, in Michigan many project that wheat acres that didn't get planted this fall will move to corn next spring, and soybeans could take a hit of 10–20 percent, with those

acres all moving to corn. Dry beans and other specialty crops will not be immune as growers base their cropping decisions on what crops will yield them the most profit! Some projections have already suggested Michigan dry bean acreage may fall in 2007 by as much as 50,000 acres.

CURRENT SITUATION—BIODIESEL

While there are several biodiesel plants either under construction in Michigan, or about to start production, the simple fact is that the supply of "blendable" oil will soon be outpaced by demand. Whether used cooking oil, animal fats (from rendering operations) or soybean, canola, or other commercially produced oils, the demand will exceed supply.

Plants are currently about to start up in Bangor and Escanaba, with other facilities in various stages of development in Milan, Reading, and elsewhere. The challenges to this industry, aside from the availability of blendable oils are the comparatively low technology requirement and low investment required to locate, build, and commercialize a production facility.

While there are proposals to build additional soybean crushing facilities, with the goal of creating additional oil for blending, the byproduct from this process is soybean meal, again most of which is currently fed to livestock. While there is some competition between DDG and soybean meal, the issue is the overall challenge to the meal and DDG pricing complex. Demand for both of these products is somewhat limited, at least with present feed technology, and with an increased supply and little additional demand, prices will fall in the future.

Many suggest that increasing local livestock production, especially beef and dairy production, could not only consume DDG and soybean meal locally, but handle DDG in a "wet" form, rather than requiring ethanol plants to dry that product as they currently must. This could help improve the profitability of ethanol plants (because the need to dry DDG would be eliminated), as well as serve as an inexpensive source of feed for livestock.

With this as a consideration, some environmental groups have recently opposed new renewable fuels plants to avoid this pressure for more livestock production. Also, while "virgin" soybean oil is often mentioned as the most likely source of oil for blending, there are alternatives in terms of crops that produce a higher oil content, etc.

In simple agronomic terms, canola may be better suited for this opportunity than other crops that either produce a lower yield of oil, or simply cannot be grown in northern climates. Canola can be produced here, and the industry is in the midst of rapid expansion in many western states.

UNINTENDED CONSEQUENCES

This is a difficult situation to contemplate, but with 300,000–400,000 acres shifting to corn from other crops next spring, and likely more acres in subsequent years to meet corn demand for traditional uses and the new ethanol demand, other crop acreage will continue to suffer.

It is believed that most new corn acres will come from soybean acres, but wheat and dry beans will also be hit. In addition, if soybean acres are reduced, land available for fall wheat planting will also be reduced, which could put pressure on acres available for soft white winter wheat, a specialty wheat type produced mainly in Michigan and the surrounding region for the cereal industry.

A reduction in dry bean acres will push more of that demand toward foreign producers (primarily China and possibly Ethiopia), reduce crop rotation options, and possibly set aside one of the traditional specialty crops produced in Michigan.

Recently there has been discussion among sugar beet growers in Michigan that they may be inclined to look away from sugar beets, a very expensive crop to produce and manage. This is on the heels of a very difficult harvest of the crop this past fall, however, which may account for this attitude.

The reduction in soybean acres will happen across the Midwest, and put additional pressure on supplies of soybeans for crushing to produce soybean meal and oil. This is a direct threat to the biodiesel industry, just in its infancy, and starting to gear up to use more soybean oil.

In any case, if acreage is to be retained for dry bean, wheat, soybean, and other specialty crop production, the profit per acre for those crops that farmers receive will have to equal or exceed that available for corn. In addition, with the production risk being greater for some of those specialty crops, increases in prices for those particular crops will have to be sufficient to offset that greater risk.

Another significant issue regarding this dramatic shift from being primarily a grain export state to using most of the crop here, at least in the case of corn, is that rail traffic could fall dramatically in the rural areas of the state. That would mean less revenue for rail operators and may mean lower maintenance expenditures and eventual degradation and possible abandonment of rural railroad lines. The impact of this on the economics of other crops and the movement of crop production inputs to rural areas, especially fertilizer, could be profound.

It is already projected that there will be a major increase in truck traffic in the state as corn moves to ethanol plants and trucks haul ethanol and DDG to customers. The impact of more trucks on highways could be an issue, but even more difficult will be the task of simply finding people to drive trucks in the numbers that will be required.

FUTURE DEVELOPMENT

Perhaps the greatest challenge (assuming the above scenarios play out in production agriculture in the next few years) is whether grain-based ethanol production will continue to be state-of-the-art technology, or whether the baton will pass to another source of raw material for renewable fuel production.

In addition, technology for corn-based ethanol and biodiesel production is changing at a rapid pace. From fractunating, the use of new or advanced enzymes, crushing DDG for oil to be used in biodiesel production, and other technology to improve ethanol and biodiesel production, new plants are different from older facilities. As this new

technology comes on line, in order for existing or older plants to be sustainable they will be forced to add these new technologies to their plants, usually at considerable expense.

There are currently two competing technologies for bio-based fuel production, fermentation and gasification. While many are focusing on fermentation, and that is the process embraced by ethanol producers today, there is gasification technology ready for commercialization. Cellulosic ethanol production appears to be next on the horizon and several companies including Broin, DuPont, Honda, Abengoa, and Iogen have recently made announcements about their biomass technologies, and Broin has even finalized plans to build their first plant using their cellulosic technology near Des Moines, Iowa.

These announcements raise several questions, including what biomass source can be used, how much biomass there is (of each type), and how much will it cost to convert biomass to ethanol. The U.S. Department of Energy (DOE) has developed a document that characterizes those biomass sources that are capable of producing one billion tons per year (feedstockreview.ornl.gov). A billion tons of biomass, they project, will produce enough ethanol to displace at least 30 percent of the petroleum-based fuel that the United States currently consumes. This study also indicates that the largest single source of biomass in the United States is wood fiber. Forestlands in the 48 states can produce 368 million dry tons of biomass annually.

The DOE study also suggests that agricultural lands could contribute 194 million tons of dry biomass, assuming that 40 percent of crop residue such as corn stover (stalks, husks, etc.) was collected. Corn stover alone could account for as much as 75 million tons of biomass. Additional sources of biomass include wheat straw (11 million tons), other crop residues (21 million tons), manures (35 million tons), and other residues (62 million tons), and combined account for another 119 million tons. Even at a relatively low conversion rate of 60 gallons per dry ton, this material could provide an additional 11.6 billion gallons of ethanol.

The DOE report also considers the implications of increased levels of crop production (25–50 percent higher yields) and increased residue yield and harvest rate. In this scenario, they estimate that 423–597 million tons of biomass could be produced.

One of the greatest challenges involving biomass is the ability to handle the sheer volume of material that will need to be harvested, handled, and processed. Some contend that there will need to be several, smaller scale production plants located in rural communities to facilitate this challenge. Others believe that a form of baling or even bulk chopping could work, with local receiving points to gather the harvest, and then using trucks or rail to haul the material to larger, centrally located plants. This would be a similar system to that used today for sugar beets in Michigan's Thumb and Saginaw Valley.

The longer term impact of harvesting cellulosic material from fields on soil structure and nutrient levels (agronomic matters) is a major area where considerable research is necessary, if this scenario becomes reality.

The DOE study also addresses the cost of producing ethanol from biomass. Their conclusions are as follows:

Estimated Biomass Quantities and Costs				
Cost per ton	<$20	<$30	<$40	<$50
Amount available (million tons)	21.6	95.8	285.9	464.4
Feedstock cost per gallon ethanol*	$0.33	$0.50	$0.66	$0.83

*Assuming yield of 60 gallons per ton

Clearly there is a great deal of biomass available that can be converted to ethanol at a competitive cost. As new technologies and enzymes become available to convert biomass to a fermentable form at even lower costs than currently projected, significant opportunities will open for agriculture and the renewable fuels industries. Again, the major challenges facing these developments involve determining the best technology to use, which biomaterial to source, and how to handle the volume of material that will be necessary to fuel any such plant.

BEYOND ETHANOL AND BIODIESEL

While there is tremendous interest in renewable fuels, and rightly so, there is also a growing interest in what is referred to as the bio-economy, the technology that makes more from biomass or grain than just fuel. The production of fine chemicals, polymers, and other materials for virtually every segment of industry holds tremendous potential.

Manufacturing companies are expressing the need for consistent, reliable, and price stable raw materials for their manufacturing processes, especially those that traditionally use petroleum-based products. They view renewable, bio-based materials as an exciting stable and predictable option for their business. From automotive applications to fibers for carpet, clothing, and other uses including furniture and building materials, the bio-economy and biomaterials are part of the focus of every manufacturer. While mostly in the research and development phase, the bio-economy holds tremendous potential for economic activity, but the challenges again include questions about the feedstock, process, and products with the greatest potential.

While there are commercial ventures already launched, including the Sonora ® project and production facility for fiber spearheaded by DuPont, various plastic material producers, and others, there are still questions about technology, which biomass materials to use as a raw material, etc. It seems that the bio-economy is at about the same stage of development as cellulosic ethanol production.

What is clear is that there will be a second generation of ethanol production that will likely involve biomass; the future of biodiesel probably lies with other, new sources of oil being exploited; and that the bio-based economy will thrive. This will all happen; it is just unclear at this point how and in what form it will occur.

POLICY

With all this on the horizon, especially with the euphoria surrounding the bio-based economy, there is an exciting window of opportunity and at the same time a tremendous void of leadership and drive to encourage this new economy. The opportunity is at hand for policymakers interested in the bio-economy, the next generation of renewable fuels, and economic growth to fill that leadership vacuum. There are several obvious benefits

for the State of Michigan to take the lead in this exciting industry. Jobs, economic growth, creating development tied to the bioeconomy, and becoming a center of research in the renewable fuel sector are but the most basic benefits. The use of the skilled workforce in Michigan, commercializing discoveries from major universities, and partnering with the solid manufacturing base in this state to harness the bio-economy are a few additional benefits. Policies at the state and local level should launch Michigan forward in the bio-economy, with work centered in five primary areas, outlined below:

POLICY

- Define renewable energy resources (wind, solar, ethanol, biodiesel, hydro, etc.).
- Create a system so that when research discoveries developed at Michigan universities and other institutions of higher education are released to the private sector, companies commercializing those discoveries receive tax credits or other incentives for doing so in Michigan, over and above what may be offered other companies doing business here.
- Create a "bio-corridor" along U.S. 127 with a bio-stock (bio-mass) nursery, bio refinery, and incubators for startup companies.
- Create a cabinet-level office on the bio-based economy to coordinate state policy and development efforts for both the bio-economy and renewable fuels.
- Create educational and degree opportunities for various disciplines within the bio-economy, including bio-processing and renewable fuel plant operation, etc.

RESEARCH AND TECHNOLOGY

- Create a nursery of likely biomass crops to evaluate their potential in Michigan, agronomic issues associated with these crops, and also enhance those plants to better adapt them to Michigan conditions, production practices, and bio-mass opportunities.
- Construct a "laboratory style" biorefinery for researchers, the private sector, and others to use as a test facility for various projects related to renewable fuel and bioeconomy research.
- Create a tax credit for bio-based research and development.
- Determine the feasibility of encouraging the development of a canola production and processing business in northern Michigan to produce oil for biodiesel blending.

COMMERCIALIZATION

- Targeted exemption from personal property tax for a set period of time for companies that invest in bio-based industries.
- Allow startup/entrepreneurial companies to sell their loss/carry forward tax credits to help fund their enterprises
- Allow 15-year carry forward provision for Net Operating Losses (NOLs) for bio-based companies or startups.
- Allow the transfer or sale of tax credits from the receiving company to other companies to generate revenue for startups.

- Defer sales tax for a set period of time on the sales of bio-based materials, or even direct revenue if sales tax is collected (or at least a portion of those funds) to a special biodevelopment fund to support research and development.
- Target state pension funds for investments in the bio-economy, and new, entrepreneurial, bio-based companies.
- Create incentives to construct biomass gathering and handling facilities to support cellulosic based opportunities.
- Create a state-based Investment Tax Credit for companies entering the bio-economy on equipment they buy to participate in the industry.

LEADERSHIP

- New public construction must access x percent of their energy from renewable sources when constructed.
- Universities and state government must access x percent of their energy from renewable resources, on an increasing sliding scale, starting very low and accelerating as time passes.
- Create a program mandating that under public procurement processes that x percent of all products purchased by government units be produced from renewable resources.
- Develop a flow chart and an infrastructure plan for handling biomass crops.

SUSTAINABILITY

- Create a special tax incentive for existing ethanol plants (that are operating by a certain date to encourage the addition of new technologies to help maintain their economic viability.
- Develop tax incentives to locate biomass/cellulosic ethanol plants in Michigan.
- Create a comprehensive database of information about biomass, renewable fuels, the bio-economy, and other similar opportunities as a resource for Michigan companies and industries.
- Create a "bio-bond" to help finance startup and expanding businesses that are becoming active in the bio-economy.

CONCLUSIONS

Renewable fuel production will continue to expand.

Ethanol and biodiesel production will continue to expand in Michigan and across the country. There will be challenges to provide enough corn and oil to operate these plants, but the resourcefulness of the agricultural industry will rise to the challenge.

Credit and profitability may limit new production.

Plant feasibility and credit availability (not necessarily seed investment money) will tend to drive future ethanol and biodiesel production plant construction. As indicated in many quarters, the construction of an ethanol plant with less than 100 MGPY capacity may no

longer be economically viable because of the rapidly escalating cost of construction and materials (tanks, piping, valves, etc.) for the plant.

Corn prices, plant construction costs, and lengthy delays in being able to start construction will limit new plant construction.

As corn prices increase (as they have recently), ethanol plants become far less profitable. In addition, because of the demand for tanks, piping, etc., and metal overall, the cost to build a plant has virtually doubled in the past two to three years. There is increasing concern that the profitability of plants coming on line in the future will likely diminish (compared to plants that have been on line for a period of time) as time passes, and corn and oil potentially become more expensive as the cost to build the plants increases.

Oil will limit biodiesel blending.

The supply of blendable oil will also limit biodiesel development. Additional soybean crush capacity may help fill some of that void, but a crushing plant is far more expensive than a biodiesel blend plant, and that will ultimately limit that option.

There will be considerable competition between crops for acreage.

There will be increasing competition between crops for acreage. A "bidding" war based on crop prices will help farmers decide to plant.

Crop acreage for certain crops will decrease, and the price of those crops will increase.

Acres for such crops as dry beans, pickles, wheat, soybeans, etc. will be in jeopardy as corn prices increase. The following example shows the challenges as corn prices have increased.

November 2006					
Crop	Production cost/acre[1]	Yield	Grower price	Total revenue	Profit/acre
Soybeans	$190	55	$6.20	$341	$151
Corn	300	150	3.30	495	195
Wheat	180	80	5.00	400	220
Dry beans	225	18[2]	20.00[3]	360	135

[1] Land value is included at $125 per acre.

[2] Hundredweight

[3] Price per hundredweight

For farmers to plant dry beans—,especially navy beans which tend to be a relatively illiquid crop (in terms of markets available)—prices will have to increase at least three to four dollars per hundredweight to compete with corn in terms of profitability. It is likely that farmers will demand an extra incentive to produce crops that have less marketability and are more difficult to produce. There may need to be as much as a 25 percent increase in dry bean prices received by growers to even maintain acreage. This is only one example of a particular crop, and the impact of higher corn prices on that crop.

All crops will see an increase in values in the fight for acres.

Competition for acres, whether it is between corn and soybeans, corn and wheat, or corn and dry beans, will cause the pricing "complex" for all these crops and others to increase to encourage farmers to plant these other crops.

Crop rotation will continue, but flexibility in rotation plans will allow acreage to move between crops.

Farmers of course rotate crops from year to year, but they do have some flexibility. That discretion will be tested as crop prices dictate profit potential differentials.

Grain storage capacity will increase.

Producers will also be challenged in how they handle the crop, whether they construct storage on their farm or commercial elevators continue to expand their storage capacity. It is anticipated that both entities will increase storage capacity.

Holding corn rather than shipping at harvest will become important.

Simply holding corn in Michigan during harvest, rather than shipping considerable quantities to feed users, will present a considerable challenge to Michigan agriculture and a fundamental change in how the crop is currently handled at harvest. There will, however, still be some quantities of corn shipped to users during harvest, even if it means other corn will have to move back to Michigan as the season progresses after harvest.

Smaller grain handlers will face enormous challenges as the grain handling channel adapts to these new demands.

With the need to hold grain rather than ship, and the volume of demand in particular for corn from ethanol producers, it will be increasingly difficult for smaller grain handlers to compete with larger rail shippers, or those with considerable storage.

Bringing CRP land to production and growing more corn in northern Michigan will not happen in any significant regard.

There are those that suggest that Conservation Reserve Program (CRP) land should be brought back into production to help meet the demand for corn and other crops, and that the overall production area for corn should be expanded further north in Michigan. Neither of those suggestions is very realistic, and certainly not in the short term. The support for CRP extends far beyond agriculture. Environmental organizations and those who have purchased property for outdoor activities and have enrolled the land in the CRP or Conservation Reserve Enhancement Program (CREP) will not easily allow that property to return to crop production.

In regard to increasing corn production in northern Michigan, genetic (seed) options are not currently available to allow producers to successfully produce corn for grain in most parts of Michigan north of Clare. Most of the corn that is produced in those areas currently is harvested as silage or high-moisture corn, which is not acceptable for ethanol production.

New technologies will require that older plants be updated and new technology added to ensure their sustainability.

As ethanol production and biodiesel blending technology improve, and perhaps source raw materials change (perhaps from corn to cellulosic for ethanol), older production plants will need to be updated to take advantage of these advances. Higher yields of fuel per unit of raw material, etc., are all examples of technological adaptations that will need to be added to older plants to ensure their sustainability. This is a critical issue as ethanol and biodiesel plants proliferate across the country. Providing incentives to encourage the addition of new technology will help make sure that the plants in Michigan extend their profitable operation.

Michigan has the opportunity to capture advanced technology development and lead the bio-economy.

The renewable fuel industry will change in the future, and the bio-economy will become more important as discoveries are refined and commercialized. Michigan can be in the position to capture the industries that lead these exciting developments with research, innovative policies, and strong inducements for companies to locate their production facilities in this state. A strong partnership between Michigan's research institutions, state government, and the private sector could help move this effort forward.

SUMMARY

The opportunities for renewable fuels and the bioeconomy in Michigan are boundless. Aggressive leadership can enhance those opportunities and boost Michigan's economy. Research, technology, and commercial development are the keys to the future of the bio-economy. Michigan can be the leader in these developments.