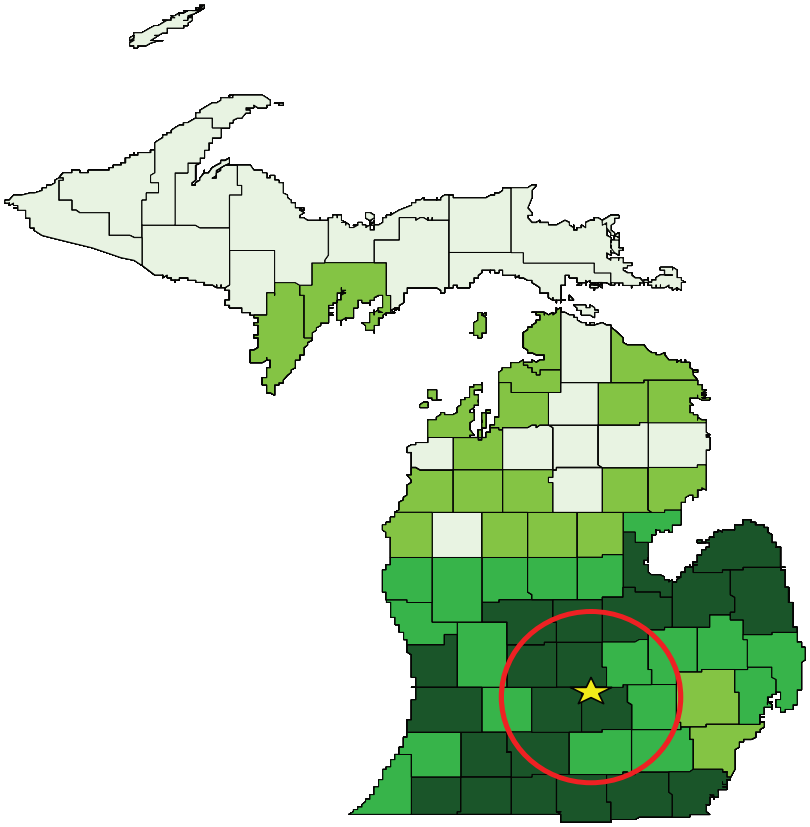
yields of the areas in those counties outside the catchment area. Clearly, more detailed analysis and due diligence must be performed to determine the technical and economic feasibility of using corn stover as bio-manufacturing feedstocks by measuring actual yields that can be captured within a supply catchment area.

Figure 4-9
Corn Stover Catchment Area
45-Mile Radius



Source: MSU Center for Community & Economic Development.

Nevertheless, this simple analysis indicates that corn stover could be used as a reliable feedstock supply in the bio-manufacture of renewable, bio-degradable bio-products that can replace petroleum-based products.

4.6 Tri-County Region Transportation Infrastructure

The Tri-County Region is well-positioned to access biofeedstocks from agricultural supply sources both within and outside the region. The regional transportation infrastructure provides an effective network through which feedstocks can be delivered to the biorefinery at all times of day and in all types of weather. By the same token, bio-products manufactured at the facility can be shipped by road or rail in all directions, including major interstate highway routes to reach end-markets in Chicago, Southeastern Michigan, Ontario, Indiana, Ohio, and points beyond.

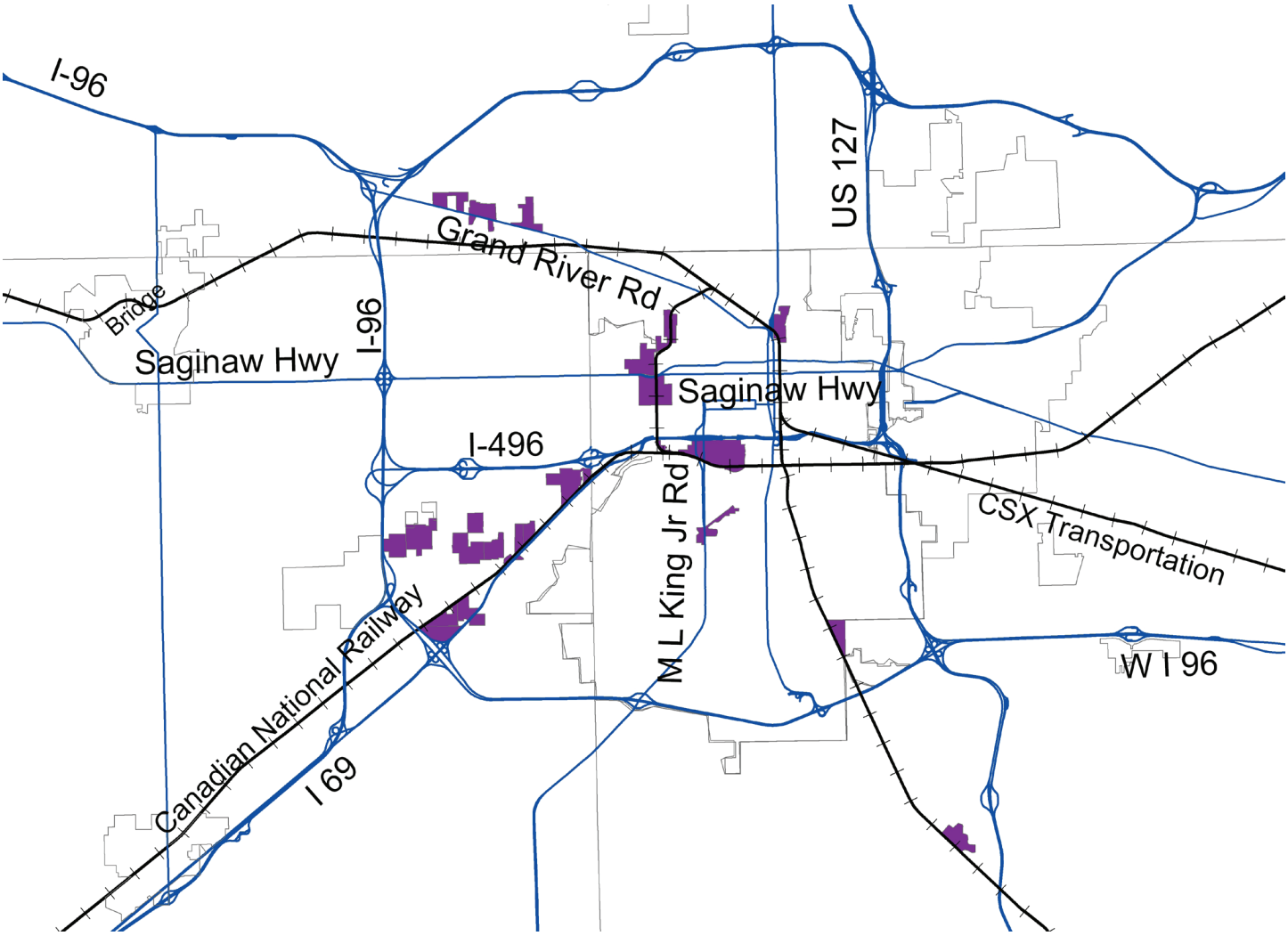
4.6.1 Logistical Sufficiency of the Tri-County Transportation Infrastructure

A biorefinery must also have access to an adequate transportation network to efficiently distribute its bio-products to its end-market customers. Figure 4-10 and Figure 4-11 show the transportation infrastructure in the region that can provide strong logistical support to biorefinery operations.

The maps below show the connectivity of road and rail transportation with industrial sites in the Tri-County Region.

Figure 4-10

Industrial and Transportation Infrastructure for Lansing and Vicinity



Source: MSU Center for Community & Economic Development and Tri-County Regional Planning Commission.

The Lansing and vicinity map above shows existing industrial parcels of 40 acres or larger in close proximity to major roads, railways or interstates. The industrial parcels are represented in the purple blocks, interstates in blue, major city streets in gray and railways in black. A 100- MGY bio-refinery is estimated to need 40 acres or more for its manufacturing production and material storage.

There are about 10 industrial parcels either vacant or in use in the Lansing region. Some of these sites may have expansion potential if needed.

Several industrial parcels are located on either major highways, such as I-496, I-96 or I-69 or the Canadian National Railway. Accessibility to these major arterials allows easy transportation access to and from the bio-refinery.

Figure 4-11

Industrial and Transportation Infrastructure for Charlotte and Vicinity

Source: MSU Center for Community & Economic Development and Tri-County Regional Planning Commission.

The map above shows five 40-acre industrial parcels located in Charlotte and vicinity, or about half of the number in the Lansing area.

The industrial sites are primarily located near the Canadian National Railway. This railway also has the capacity to connect to some of the parcels in Lansing. Few of the parcels are near smaller arterial roads such as Lawrence Road and Clinton Road. None are directly off of the closest interstate (I-69).

Commercial roads with the capacity to transport feedstock supplies to industrial sites are those roads with over 5,000 commercial annual average daily trips (CAADT) within each county. These roads have the capacity to accommodate the increase in truck traffic supplying a biorefinery. Most of the larger industrial parcels are located near I-96, I-69 and I-496.

4.7 Labor and Employment

A refinery by itself is not a large employer. It employs, on average, approximately 30 full-time employees (see Figure 4-12). However, as both an end user of agricultural products and producer of feedstocks for other industry sectors, a biorefinery supports employment in the agricultural production and bio-manufacturing sectors. In the Tri-County Area the agricultural sector employed 2,427 in 2000 and 2,645 in 2006, according to the U.S. Census.

The Tri-County Region has long been a leader in automobile and consumer product manufacturing. Severe reverses in the domestic auto industry have left many workers in the region without jobs (see section 2). Bio-manufacturing offers the Lansing area a new opportunity to tap a new well of manufacturing production. Regional economic revitalization will

depend on the ability to develop eco-friendly products in the post petroleum economy.

Figure 4-12
Estimated Costs of Labor

Labor	Cost
Plant Manager (1)	$150,000
Supervisors (4)	$320,000
Sales (1)	$80,000
Clerical (3)	$120,000
Workers (20)	$900,000
Total Labor	**$1,570,000**

Source: Holtzapple, M. (2007, September 5). *Advanced Biomass Refinery: Third-Generation Technology*. Presented at the Department of Chemical Engineering, Texas A&M University, College Station, TX.

The data in Figure 4-13 indicate hourly automotive worker wages of $13.23 per hour. However, the wages of most Lansing area automotive workers are covered by the UAW contract which provides a current hourly wage of $28.43.[46]

Figure 4-13
State and National Hourly Wages

Labor	Hourly (U.S.)	Hourly (MI)	Yearly (U.S.)	Yearly (MI)
Automotive Workers	$11.63	$13.23	$24,200	$27,500
Chemical Technicians	$23.60	$23.15	$49,100	$48,200

Source: Occupational Information Network.

Our regional workforce, including auto workers, has many of the skills and knowledge needed for bio-manufacturing. Some skill categories have more overlap than others, such as the work styles, abilities and the activities. The requirements within those areas could be learned on the job or be a general trait a person has such as cooperation, self control and attention to detail which are listed under the work styles. Some examples of work abilities would be control precision, problem sensitivity and oral expression. An example of work activities would be the ability to identify objects, actions, and events performing general physical activities.

There are more gaps under the categories where prior information is required. The chemical technicians' requirements are more focused on prior knowledge, while the automotive team assemblers' requirements could be learned on site. Chemical technicians need a background in chemicals, law and government, mathematics, computers and electronics and other things requiring a formal education. Automotive team assemblers share knowledge in production and processing, and skills such as operation monitoring, active listening and quality control analysis; however skills such as troubleshooting and speaking were not identified.

4.8 Section Summary

Based on traditional manufacturing capacity, the Tri-County Region has sufficient material collection and processing capacity, industrial infrastructure, and a skilled industrial labor force capable of producing ethanol and other bio-products from cellulosic feedstocks.

The Tri-County Region may be exceptionally well-positioned to compete in the emerging bio-manufacturing sector with the development of a cellulose-based biorefinery. The feasibility of a 100 MGY ethanol biorefinery is based in large part on access to reliable and consistent supplies of cellulosic feedstocks (corn stover, energy crops, wood waste, and others) from rural parts of the region as well as available industrial parcels where a biorefinery may be sited.

The regional transportation network provides a fully-developed road network and rail system with sufficient carrying capacity to accommodate the moderate increases in traffic resulting from feedstock delivery and outgoing shipping.

The region has, in addition, effective capacity to retrain manufacturing and other skilled workers displaced by the severe structural changes in U.S. automotive markets.

5. Regional Intellectual Infrastructure

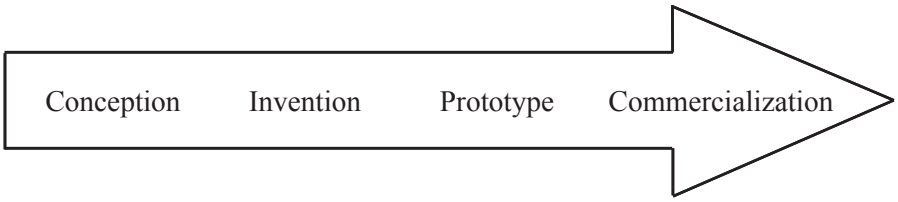
5.1 Introduction

Identifying the intellectual capabilities of the region is fundamental to determining the feasibility of developing a bio-manufacturing industry in the Tri-County Region. The capacity to develop and sustain a bio-manufacturing economy depends in large part on the intellectual abilities to invent products and develop innovative new methods of production, markets, and supply chains. Early adapter communities will face significant "start-up challenges" but they will be better positioned as bio-manufacturing economic centers with great expansion potential in the near and long-term future.

This section provides a comparative assessment of the Tri-County Region's intellectual capabilities associated with the emerging bioeconomy. The region has of course the distinct advantage of being home to a major research institution in Michigan State University. MSU has a nationally-recognized expertise in the emerging bioeconomy. MSU has committed significant faculty and related resources to grow Michigan's bioeconomy and bio-manufacturing sector. The advantage of close proximity to this institutional intellectual capacity can not be over emphasized.

Figure 5-1

The Innovation-Commercialization Continuum



The bio-manufacturing sector, like other emerging technology-driven sectors, relies on research institutions to create relevant knowledge, invent new products, and make scientific discoveries that lead to innovation in the conceptual stages. The capacity to test and evaluate new methods of production and products in the prototype stage (See Figure 5-1) is equally fundamental to the commercialization process.

University-private sector collaboration can facilitate licensing and provide critical inputs to the developing patents. Innovation is so completely critical to success in the bioeconomy but much of the necessary R&D needed for innovations is beyond the capacity of small and medium enterprises and even major corporations. The private sector simply lacks the capacity to conduct sufficient research needed for the rapidly flowing stream of innovations driving the bioeconomy. Moreover, the processes of discovery as well as the dissemination of ideas and techniques are by their very nature collaborative processes. Finally, the university needs the engagement of the private sector to take research-based ideas and inventions to their commercial applications and creation of markets. University-private sector collaboration is critical to successfully compete in the technology-driven global knowledge economy.

5.2 Performance Indicators of Regional Intellectual Capabilities

The MSU Center for Community and Economic Development conducted assessments of the capacity of Michigan counties and metro centers to compete in the global knowledge economy in 2006 and 2007, respectively. An overall ranking for each county and metro center was calculated by applying the Knowledge Economy Index and producing a set of simple unweighted averages for 17 specific indicators to determine each ranking.

The 17 indicators evaluate performance in five key areas of the knowledge economy and include the following:

Knowledge Jobs

- Information Technology Jobs
- Managerial and Professional Jobs
- Workforce Education

Digital Economy

- Internet Use
- Cable Modem Access
- Digital Government

Innovation

- High-Tech Jobs
- Venture Capital
- Patents
- Engineers
- Bioscience Jobs

Globalization

- Firms with Foreign Parents
- Exporting Firms

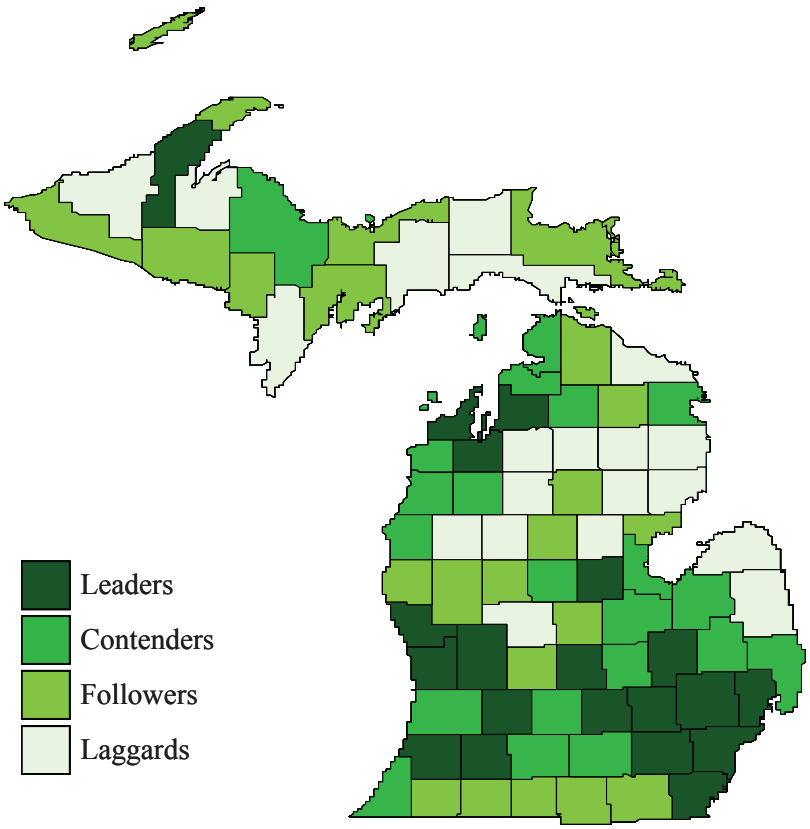
Dynamism/Creative Community Capacity

- Change in Manufacturing
- Sole Proprietorship
- Service Sector Jobs
- Assessments of community's creative capacity

Figure 5-2

Michigan Knowledge Economy Index

County Rankings



Source: Michigan Knowledge Economy Index. (2007, July). *Overall Rankings* (2nd ed.).

Ingham and Clinton Counties are clearly leaders compared to other Michigan counties as shown in Figure 5-2,. Eaton County lags slightly behind as a contender. Readers are encouraged to visit http://ced.msu.edu/techresearchreportspg1.html. for an in-depth analysis of the region's assets and performance in the global knowledge economy.

5.2.1 Patent Applications and Patents Issued

In this section, MSU capabilities are compared to those of other Big Ten Land Grant research universities, based on a 2006 Association of University Technology Manager (AUTM) survey. The survey included the University of Illinois (includes both Urbana-Champaign and Chicago campuses), Purdue University, University of Wisconsin – Madison (U-W Madison), Penn State University, Ohio State University, and the University of Minnesota in addition to Michigan State University.

Experience in the patent application process indicates both inventive capacity and the critical ability to commercialize applications of innovative ideas. Purdue was the leader with 241 patent applications and 32 issued (see figure 5-3). U-W Madison was second with 203 but had the most patents issued with 69. Michigan State University was in the middle range with 148 patent applications and 21 patents issued.

Figure 5-3

Patent Applications and Patents Issued for Big 10 Land Grant Universities

University	Patent Applications	Patents Issued
Purdue	241	32
U-W Madison	203	69
University of Illinois	157	41
Michigan State	148	21
Penn State	106	37
Ohio State	64	27
University of Minnesota	60	28

Source: Association of University Technology Managers.

5.2.2 Licenses

To commercialize discoveries and inventions, it is critical that the licensing process of such discoveries and inventions is both efficient and fairly conducted. With fair and equitable licensing processes, individual innovation is encouraged while protecting public investments in the infrastructure and supplies supporting faculty researchers.

U-W Madison shows the most cumulative active licenses with 907 in 2006 (see figure 5-4). Michigan State was in the second tier with 351 active licenses.

Figure 5-4

Cumulative Active University Licenses

2006

University	Cumulative Active Licenses
U-W Madison	907
University of Minnesota	720
Purdue	356
University of Illinois	354
Michigan State	351
Penn State	156
Ohio State	143

Source: Association of University Technology Managers.

5.2.3 Technology Transfer and University Business Start-Ups

The ability to create new products and develop new production methods must be complemented by the capacity to transfer new technology. This capacity depends on a coherent networking process to take new discoveries and innovations from research labs to new commercial applications or incorporate new methods and techniques of production, marketing, and other related areas.

A key indicator of that capacity is the number of reported university business start-ups. Start ups require a supportive infrastructure and sufficient resources to support researchers in negotiating the process of transferring knowledge generated in a learning institution to the production of goods or services and compete in the market place. Penn State and Purdue had the most businesses start ups, each with 14. Michigan State was in the second tier with four start ups in 2006.

Figure 5-5
University Business Start-Ups
2006

University	Startups
Penn State	14
Purdue	14
University of Illinois	9
U-W Madison	7
Ohio State	5
Michigan State	4
University of Minnesota	3

Source: Association of University Technology Managers.

5.2.4 Dedicated Bio-Manufacturing Research Capacity

In the development of the bio-manufacturing sector, one of the most critical "raw" materials is the number of researchers who can contribute to the development of this sector. Michigan State University has approximately 150 faculty members researching key issues and questions associated with developing the bio-manufacturing sector. These researchers are connected with the MSU Office of Bio-Based Technology that was created in 2006.

Lansing Community College has approximately 9 faculty members engaged in bio-manufacturing.

5.2.5 Targeted Bio-Manufacturing Research Expenditures

A relatively crude method to assess inventive capability is to assess the level of research investments. While this measure may suggest some level of intellectual commitment/ capacity, the aggregate data is unlikely to reflect the level of well-focused intellectual commitments and targeted research expenditures.

The University of Illinois had the highest amount of research expenditures with $817,990,000; U-W Madison followed closely behind with $798,099,000. Michigan State University was last with $333,735,000 (based on 2005 AUTM survey data).

However, MSU recently partnered with the University of Wisconsin-Madison and obtained a major U.S. Department of Energy grant to establish the Great Lakes Bioenergy Research Center. There are seven other DOE centers. MSU will receive $50 million over the next five years for basic science research. UW-Madison will receive $125 million. MSU's world renowned plant scientists will focus on using cellulosic materials to create ethanol fuel. In addition, MSU benefits from its connectivity to agriculture as well as its close proximity to the automotive industry in the Lansing area.

Figure 5-6
Research Expenditures for Big 10 Land Grant Universities
2005

University	Research Expenditures
University of Illinois	$817,990,000
U-W Madison	$798,099,000
Penn State	$637,911,000
University of Minnesota	$548,873,000
Ohio State	$511,500,000
Purdue	$407,837,000
Michigan State	$333,735,000

Source: Association of University Technology Managers.

Another method of assessing research capacity is to identify faculty clusters that focus on generating research and knowledge relevant to the needs of the region and state to compete successfully in the bioeconomy. MSU has 11 institutes and centers with bioeconomy-related research capacity.

The 11 institutes and centers at MSU with bioeconomy-related capacity are briefly described here:

- The **Office of Bio-based Technologies** (OBT) was created in 2006 to integrate innovations in the lab with advances in the market place and foster connections with public and private sector initiatives to support expansion of the state's bioeconomy.
- The **MSU-Department of Energy** (DOE) **Plant Research Lab** (PRL) conducts plant research at the molecular level to create more efficient and economical ways to produce biodiesel, including genetic modification of nonfood plants such as grasses. Up to 10 times more biodiesel feedstock per acre than soybean oil can be produced. Other research has developed technology to allow plants to accumulate extremely high levels of starch which is easier to convert into fermentable sugars (the basic component in ethanol production).
- The **Center for Bio-Based Renewable Energy** focuses on converting biomass into renewable energy.
- The **Biomass Conversion Research Lab** scientists are developing pretreatment, enzymatic, and fermentation technologies to break down cellulose and hemicellulose more economically and efficiently, an absolutely critical component in cellulosic ethanol production. Pretreating cellulose and hemicellulose uses a patented method called ammonia fiber expansion. Using cellulosic resources provides a more sustainable bioenergy system.
- The **Composite Materials and Structures Center** focuses on the production of composite materials and conducts industry outreach programs.
- The **Center for Microbial Ecology** researches the benefits of using microorganisms in the bioeconomy; for example, cleaning up toxic spills by breaking down complex sugars, microorganisms could benefit the bioeconomy.
- The **Energy and Automotive Research Laboratories** provides lab capacity for research and development of automobile engines, with a focus on reducing emissions and using alternative energy resources.
- The **Long Term Ecological Research Project** conducts research on ecosystem management and biodiversity. Researching mainly agriculture and forestry issues, this project addresses questions about the carbon cycle and green house gases when biofuel systems are introduced to the ecosystem.
- The **Center for Nanostructured Biomimetic Interfaces** integrates nanotechnology with protein science to produce devices and processes.
- The **Product Center for Agriculture and Natural Resources** helps entrepreneurs who rely on agriculture and natural resources. The center promotes production of bio-products by providing relevant guidance and information.

- The **Center for Community and Economic Development**, the author of this report, promotes and supports innovative collaborative learning to assist community/economic development and provides multidisciplinary capacity to respond to multiple, interrelated problems of distressed communities. The Center regards the development of the bioeconomy as a key element in revitalizing Michigan communities.

5.3 Section Summary

Technology-led economic development offers vast potential for the generation of individual and community wealth for those who are creative and talented, and have a modern IT infrastructure and the foresight to plan for the new economy. Many of these characteristics are typical of "university towns" like the Lansing-East Lansing area where public and private investments in the generation and application of knowledge have been a long-term priority. Communities with a research and development capacity will likely do well in the technology-led, knowledge-based global economy. However, these communities must demonstrate the intellectual leadership and boldness in the private sector to take risks to advance new bio-products and bio-based technologies.

Current practices suggest that in the early phases of conceptualizing and prototyping an innovation, it is often critical for the "inventor" to be near a university/research institute where the necessary intellectual critical mass (human capital), technological infrastructure, financial capital, and creative environment exist to support the incubation of new ideas/ methods.

The mid-Michigan area has significant intellectual capacity to support the development of the bio-manufacturing sector in the growing bioeconomy.

6. Regional Leadership Capacity

6.1 Introduction

The emergence of a bio-based economy challenges traditional economic development models and offers communities not currently benefiting from other emerging economic sectors the potential for growth. Moreover, the use of agricultural products and cellulosic materials is being developed outside of traditional industrial and high-tech business hubs. This offers regions interested in developing bio-manufacturing the opportunity to reinvent economic development and government strategies that can keep pace with the rapidly evolving paradigms of the emerging bioeconomy.

Development of the bioeconomy depends on regional leadership that values innovation, is not averse to taking risks, and provides peer support for emerging entrepreneurs. Such entrepreneurial support includes providing access to private and public financial capital that will stimulate and support development of bio-manufacturing initiatives.

Communities with significant competitive advantages in natural resources, industrial infrastructure, and intellectual capital may lack the individual and collective will to advance along a new economic frontier. The creation of an innovative economic sector requires visionary leadership at all levels of a community. A shared community vision combined with supportive public policies and creative and persistent entrepreneurs are critical to the development of a new economic sector. This section examines the demonstrated and potential leadership capacity of mid-Michigan to develop and sustain a bio-based manufacturing sector.

The ability to access sufficient capital resources to finance a bio-based manufacturing facility estimated to cost $200-250 million is critical to the development of this new industrial sector. Both short-term and long-term public and private financing need to be secured to provide capital for a bio-manufacturing initiative to develop and refine its bio-manufacturing processes and develop stable markets for its bio-products.

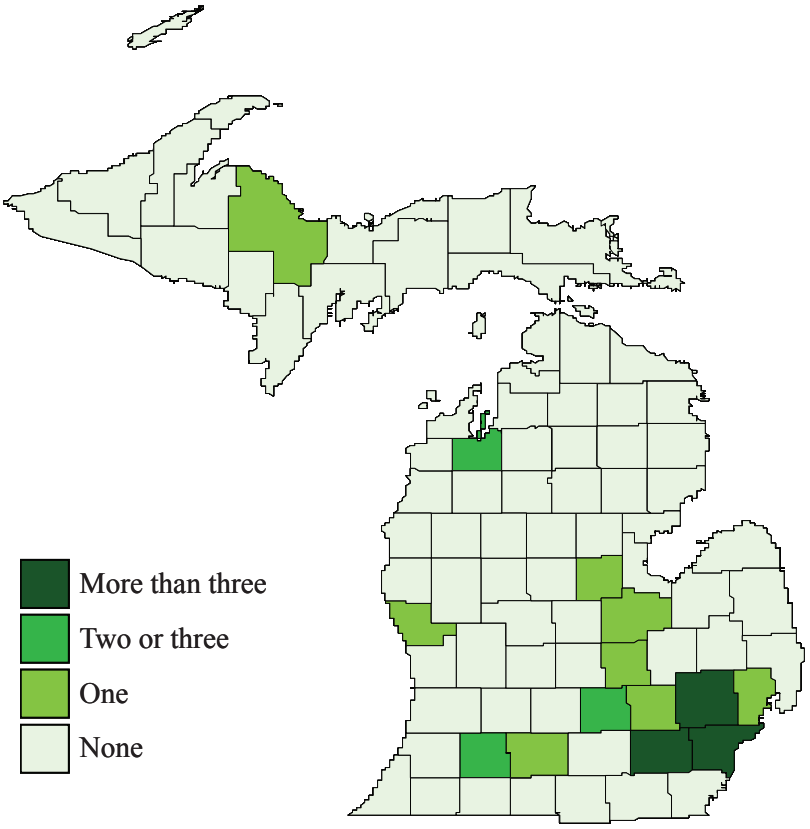
6.2 Venture Capital Firms in the Region

Access to private sector venture capital in the early start up phases is critical. Venture capital firms are less risk averse in their investment decisions than other private investors, but they expect generous rates of return on their early stage, high-risk investments. Venture capitalists also take a keen interest in emerging firms and research indicates they often prefer close proximity to their investments. Thus, one way of assessing the capacity to grow a bio-manufacturing sector is to identify the number of venture capital firms in a region. In the map below, the distribution of venture capital firms in Michigan in 2007 is presented.

Figure 6-1

Number of Michigan Venture Capital Firms

By County



Source: Michigan Business/Organization Directory.

A list of venture capital firms was obtained for this study from the Michigan Business/Organization Directory. Most venture capital firms are concentrated in Southeastern Michigan. Three venture capital firms were identified in Ingham County. None were identified in Eaton County or Clinton County; however, a few were identified in surrounding counties. Nearby venture capital firms may still benefit the Tri-County region by providing financing to develop the region's bio-based economic sector (complete list in appendix E).

Figure 6-2

Venture Capital Firms in the Tri-County and Nearby Regions

Firm	City	County	Type
Capital Area Investments	Lansing	Ingham	Venture
Michigan Homeland Security Consortium	Lansing	Ingham	Venture
Capital Community Angels	East Lansing	Ingham	Angel
Ann Arbor SPARK	Ann Arbor	Washtenaw	Angel

Source: Michigan Business/Organization Directory.

Risks are of course associated with investing in a young, not-yet-mature economic sector. Since venture capital firms are more familiar with investments in more established areas like telecommunications, oil discovery and production, real estate development, agricultural commodities, and traditional manufacturing, investing in the bio-manufacturing sector may take investors to relatively uncharted territory.

Venture capital virtually always plays a critical role in the start-up of new enterprises. However other forms of capital, longer-term debt, and equity investments are also necessary to fully capitalize bio-manufacturing development.

6.3 Community Financing and Biorefinery Cooperatives

Many communities face the realities of inadequate private financing for the construction of biorefineries and other bio-manufacturing cluster development. Biorefinery capital costs are expected in the $200-250 million range with annual operating costs in the $60-100 million range.

An attractive alternative to private financing may exist in cooperatively-owned biorefineries. Communities may want to consider this method of financing as there are the added benefits of providing a measure of local control and a mechanism to generate local wealth (returns on investments to local investors).

Cooperatives offer a sustainable profit stream for local farmers to hedge against market fluctuations. When corn and other commodity prices are high, farmers can benefit from selling their crops for bio-manufacturing feedstocks or food. However, when crop prices slump, farmers with a stake in a local biorefinery cooperative can still benefit from sales revenue from biofuels and other bio-based products. Farmer-owned cooperatives are of course not new. As early as the nineteenth century, cooperatives were formed in the U.S. and by 1930 the number had reached 30,000 locally-owned cooperatives.

Biorefinery co-ops are found across the globe from Australia to California to Mississippi. There are 42 locally owned ethanol plants out of 141 in the United States, or about 30% of the plants with many in the Midwest. Minnesota is the state most supportive of biorefinery co-ops providing state incentives for locally-owned bioeconomy facilities. Minnesota's effort – known as the Minnesota Model – has led to over a dozen smaller and medium-sized plants that generate $3 for every dollar invested.

As bio-manufacturing emerges as a new industry with the potential to reinvigorate both the agricultural and manufacturing sectors, biorefinery cooperatives can offer farmers, manufacturers and residents a direct financial stake in their economic future. Mid-Michigan leaders, farmers, manufacturing workers, local governments, and other residents may want to consider forming a community-owned bio-refinery with monetary investments made by all who participate through ownership and have a direct stake in the region's economic success.

6.4 Public Sector Funding and Resources

In addition to capital available through traditional and innovative private sector investments, entrepreneurs engaged in bio-manufacturing can seek assistance from public programs that help capitalize land acquisition, manufacturing infrastructure, and assist with labor training and development costs. In Figure 6-3 public programs are listed that offer financial assistance to bio-manufacturing facility and/or related infrastructure initiatives in mid-Michigan. Appendix H provides additional detail for these programs.

Figure 6-3

State and Federal Incentives for Bio-based Economic Development

Type	Program	Source
State	Biomass Energy Program Grants	Michigan Dept. of Labor and Economic Growth
State	21st Century Jobs Fund	Michigan 21st Century Investment Fund, LP
State	MEGA High-Tech Jobs Creation Tex Credit	Michigan Economic Development Corporation
Federal	Small Business Innovation Research (SBIR)	Small Business Administration
State	The Economic Development Job Training (EDJT)	Michigan Economic Development Corporation
State	Michigan Economic Growth Authority Tax Credit	
State	Michigan Economic Growth Authority	The Geography of Incentives, Good Jobs First
State	Transportation Economic Development Fund	The Geography of Incentives, Good Jobs First
State	Industrial Facility Property Tax Exemption	The Geography of Incentives, Good Jobs First
State	Renaissance Zones	Michigan Economic Development Corporation
State	Job Creation Tax Credit	Michigan Economic Development Corporation
State	Capital Access Program	Michigan Economic Development Corporation
State	Employee Ownership Program	Dept. of Labor and Economic Growth
State	Industrial Development Revenue Bonds (IDRB)	
State	Singles Business Tax	
State	Michigan SmartZones	Michigan Economic Development Corporation
State	Urban Land Assembly Program	Michigan Legislature
State	Michigan Life Sciences Corridor	
Federal	Economic Adjustment Assistance	http://www.eda.gov/
Federal	Indian Employment Assistance	
Federal	Economic Development Technical Assistance	http://www.eda.gov/
Federal	Grants for Public Works and Economic Development Facilities	http://www.eda.gov/
Federal	Economic Development Support for Planning Organizations	
Federal	Trade Adjustment Assistance	

Source: MSU Land Policy Institute.

6.5 Industry Support Networks and Private Sector Leadership

Communities with a strong business sector are often built, at least in part, upon strong industry support networks. These networks facilitate building coalitions, accessing resources, sharing knowledge, and advocating public and private policies and practices to improve the market performance of that sector. The close proximity of a cluster attracts more people engaged in that economic sector and thereby builds the economy of that region. Clusters also facilitate and promote faster technology advances. Jobs are created and this cluster economic activity can also result in transferring innovative ideas, information, and data which may lead to development of more efficient technology.

Currently there is no bio-manufacturing support network in the region. The formation of such a group could more effectively advance the development of a bio-manufacturing sector.

The Tri-County Region does have effective industry and other support networks that may have interests in the advancement of the region's bio-manufacturing economy. These organizations may complement and indeed support the feasibility of a bio-manufacturing sector in the region by helping to fill the gaps that are relevant to the new sector in areas like education for example. The following list includes existing peer support networks that may be of potential assistance to an emerging regional bio-manufacturing sector.

- The **Capital Area Manufacturing Council** provides a forum for which information and knowledge can be discussed on common issues. The council offers manufacturing skills training employment programs to

educate workers in areas in which they lack knowledge.

- The **Michigan Agriculture Business Association** shows natural interest in the bioeconomy by encouraging development of agriculture business. This association is well aware of the importance of educating employees and promoting informational programs to be knowledgeable for the job positions.
- The **Prima Civitas Foundation** (PCF) focuses on job growth to promote economic development in Mid-Michigan. PCF helps support the bioeconomy in Michigan by recruiting workers and providing training opportunities for the new bio-technology jobs that are brought to the Tri-County area. The foundation encourages research for alternative energy as well as developing next generation transportation.
- **Lansing Economic Area Partnership** (LEAP) is a regional economic development collaborative founded in 2007 that focuses on integrating emerging industries, talent and research with business incentives, leadership training, and other programs for a strong economic future through a collaborative regional model.

These regional networks may be positioned to promote development of a new bio-manufacturing sector that complements or even expands their own respective economic sectors. As a bio-manufacturing sector emerges, a specific industrial promotion network for the new sector could spin-off from these existing organizations (see summary and recommendation section).

The region has outstanding private-sector leadership committed to a strong bioeconomy in mid-Michigan. Leaders of these companies, some of which are "spin-offs" resulting from research at Michigan State University, are helping to define the future of the global bioeconomy while fostering an emerging economic sector in the region.

- **Michigan Brewing Company** and **Working Bugs** work together to create products that use bio-chemicals and bio-fuels in their manufacturing.
- **KTM Industries** creates Green Cell biodegradable foam cushions to protect products in shipping. The Green Cell foam is similar to Styrofoam, but biodegradable.
- **EcoSynthetix** uses products to replace petroleum-bases products with nanobiomaterials. This company's vision is to create biomaterials that would wean companies from petroleum-based materials.
- **Woodbridge Group** concentrates on producing materials for automotive manufacturing using urethane technologies.

6.6 Public Sector Leadership and Policy Support

A demonstrated commitment to bioeconomy development by the public sector – state, local and higher educational institutions – provides a key advantage to regions seeking to become leaders in emerging bio-industries. Michigan and the Lansing region have been innovators in both developing new technologies in the bioeconomy and in fostering the public-sector leadership commitment and favorable intellectual/business climate for bioeconomy, and specifically, bio-manufacturing growth.

6.6.1 State and University Leadership and Public Policies

State political leaders have demonstrated a high-profile commitment to positioning Michigan as a world leader in cutting-edge bio-based technologies that deliver alternative renewable fuels, eco-friendly consumer products, and a sustainable environment.

Governor Jennifer Granholm has made the bioeconomy a central component of her economic development strategy. She has led numerous trade missions to Europe to open international bioeconomy markets to Michigan firms and attract international investments to the state. In addition, her call for increased alternative fuel production in Michigan and incentives for other green energy production have helped create new jobs and push Michigan's leadership in alternative biofuels and energy production. The state legislature is currently working on bills to create renewable portfolio standards and reduce Michigan's dependence on foreign oil.

Moreover, Michigan State University's leadership in the bioeconomy goes well beyond that of a typical intellectual and research hub. President Dr. Lou Anna K. Simon has lead her administration in a broad commitment to not only advancing

research to benefit scholarship, but in the true land grant tradition, research to improve the quality of life for Michigan's residents and foster economic development across the state and in the Lansing region.

President Simon unveiled her Boldness by Design Initiative in her 2006 State of the University Address. This initiative is designed to harness the university's agricultural and economic development research and outreach resources to make MSU a leader in cutting-edge research in alternative fuels and bio-based products. Leveraging this research can lead to job creation in the state and Tri-County Region.

President Simon stated in her address, "(MSU's Office of Bio-based Technologies) is …a dramatic step toward an economy powered by strategic partnerships among states, research universities and industry… our preeminent scientists are dedicated to addressing problems and opportunities of today, but, more importantly, of the future partnerships among states, research universities and industry."

6.6.2 Community Support for the Development and Growth of a Bioeconomy

In addition to providing financial and other support to development of a bio-manufacturing sector, community planning and economic development organizations can provide a "pre-development readiness" for this emerging sector. This leadership is demonstrated by, for example, the Tri-County Regional Planning Commission, Michigan State University, Lansing Community College and numerous community supporters in developing this feasibility study and companion reports on workforce displacement and retraining programs.

Lansing Mayor Virg Bernero demonstrated his commitment to a stronger and sustainable mid-Michigan in his 2006 State of the City Address by announcing the city's effort to utilize more fuel-efficient and flex-fuel capable vehicles reduce its carbon footprint. The mayor also stated his committment to bio-manufacturing job growth in Lansing and the region.

However, education and information outreach are critically needed. In a 2007 survey of local and regional planners conducted by the MSU CCED with the Michigan Association of Planning, only 14% of respondents indicated that their communities have planning policies or zoning ordinances that support the development and growth of a bioeconomy; 53% do not. About 33% percent of the communities were unaware of whether they even have such plans or ordinances. The Tri-County Region is providing exemplary leadership in assessing the feasibility of bio-manufacturing development for the region.

6.7 Targeted Community Action to Develop the Local/Regional Bioeconomy

Communities have important opportunities to leverage their regional assets, provide incentives, and create catalysts to support the growth of global bioeconomy clusters. Regional leaders can connect regional businesses to emerging U.S. and global markets, and streamline services and due diligence for venture capital and bio-manufacturing firms willing to relocate to clusters developing in the region.

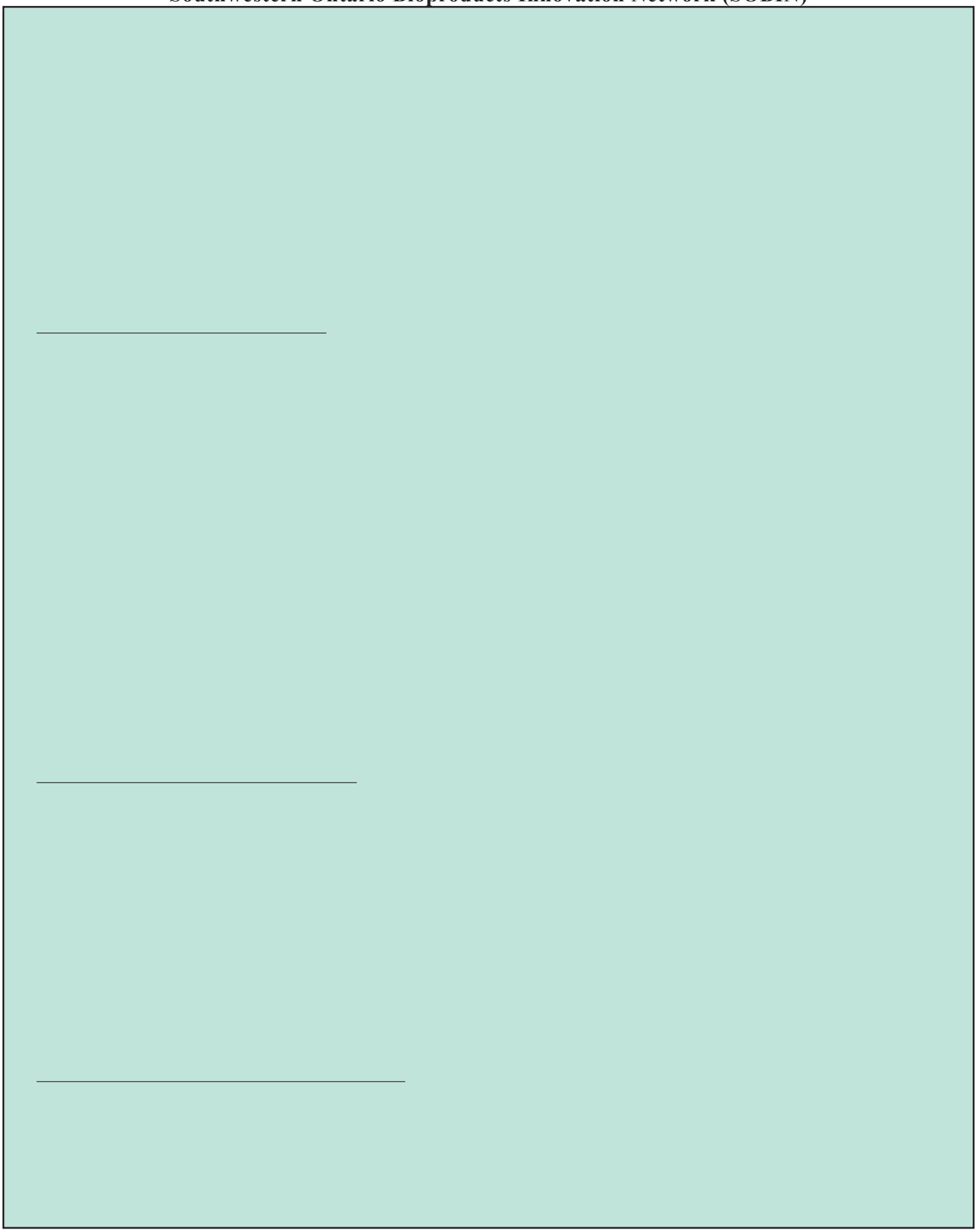
Fostering collaboration among government, business, education and other stakeholders is essential to the growth of the bioeconomy as new paradigms transform the bioeconomy and bio-manufacturing sector. Industry clusters can leverage local assets like industrial specialization and expertise, Great Lakes quality of life, and unique intellectual expertise to attract new firms and investors. Collaborative strategies to fashion a "purposeful response to change" throughout the business cycle from discovery/invention to commercial maturity are also critical to creating bioeconomy clusters.

6.7.1 Ontario Case Study of Regional Clustering: Southwestern Ontario Bioproducts Innovation Network (SOBIN)

In 2005, Southwestern Ontario, Canada formed a bio-products innovation network to leverage its manufacturing and agriculture sectors and link these sectors with cutting-edge research and other regional assets to become a world leader in automotive bio-manufacturing. The Southwestern Ontario Bioproducts Innnovation Network (SOBIN) partners with industry and government to ensure effective reuse of industrial lands, to cultivate synergies between related companies, and help companies maximize resources and minimize waste. This type of regional network may be relevant to mid-Michigan needs and is described below.

Figure 6-4

Southwestern Ontario Bioproducts Innovation Network (SOBIN)



Source: Southwestern Ontario Bioproducts Innovation Network. Retrieved September 2, 2008, from http://www.sobin.ca/

6.8 Section Summary

The Tri-County Region's leadership assets are considerable with the clear potential to support development of a regional bio-based manufacturing sector. Assets include organizational leadership, state and university commitment to bioeconomy development, and an extensive portfolio of public resources to support an emerging bio-manufacturing sector.

Challenges include accessing private capital to finance this sector. However, strong, well informed leadership could create innovative ways to structure deals and capitalize early development of a bio-manufacturing cluster.

Close proximity to agricultural feedstocks, intellectual commitment and capacity, manufacturing and agricultural expertise, and a natural resource base provide a solid platform for locating bio-manufacturing facilities in the Tri County Region.

7. Executive Summary and Project Recommendations

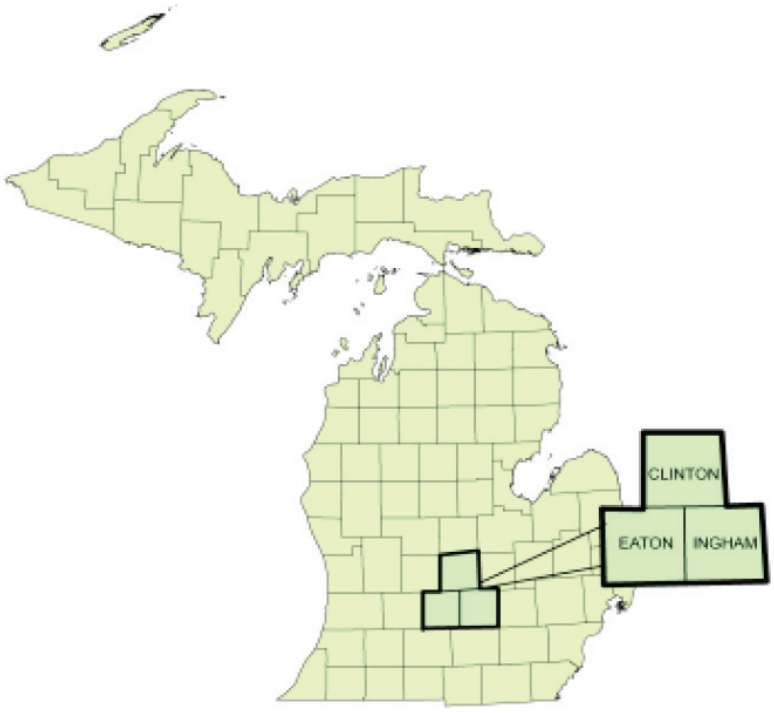
7.1 Overview

Communities and companies around the world are recognizing the economic and environmental benefits of the bioeconomy-- "going green"--and supporting and developing production processes and products that rely on renewable, bio-degradable natural resource-based and agricultural materials. Indeed it is a new global reality.

Given its historic competitive advantages in both its manufacturing and agricultural sectors, the Lansing Tri-County Region may be uniquely positioned to lead the development of the state's bioeconomy.

The MSU Center for Community & Economic Development Program (MSU CCED) examined the Tri-County Region's current and potential role in the emerging bio-manufacturing sector as part of a project with partial financial support from the U.S. Department of Commerce Economic Development Administration. Bio-based inputs, including agricultural and natural resources, and the labor base, infrastructure capacity, intellectual capabilities, leadership, and access to capital were analyzed. The project team assessed the feasibility of the development of a bio-manufacturing sector in the Tri-County Region based on this information and data.

Figure 7-1
The Lansing Tri-County Region



Source: MSU Center for Community & Economic Development.

This feasibility study provides ***an evidential base from which communities may make informed decisions about investing in an alternative community and economic development future focused on bio-manufacturing***. The predictive reliability of a feasibility study is limited in part by the appropriateness of its research methods and the accuracy of the data analyzed. It is rarely possible to accurately predict the willingness of stakeholders to take informed risks, change behaviors and blaze a new path into an uncertain future. While every reasonable effort was made to insure a realistic assessment of future development, only one certainty exists and that is the future is ever changing and largely unknown.

The research team has sought to improve the reliability of this study by utilizing a previously-developed feasibility model of a new emerging industry sector and incorporating some of the more traditional elements of business feasibility studies employed by planners and economic developers. The research team also relied on the ongoing advice and guidance of its Technical Advisory Committee. Consultation and the advice of scholars, industry managers, and community leaders were routinely sought as data and information were gathered, sorted, and interpreted. The study examined data and information

for the region in the following five areas:

- Demographic and Employment Profile
- Agriculture/Natural Resources/Environment Profile
- Industrial and Infrastructure Capacity
- Intellectual Capabilities
- Leadership Commitment

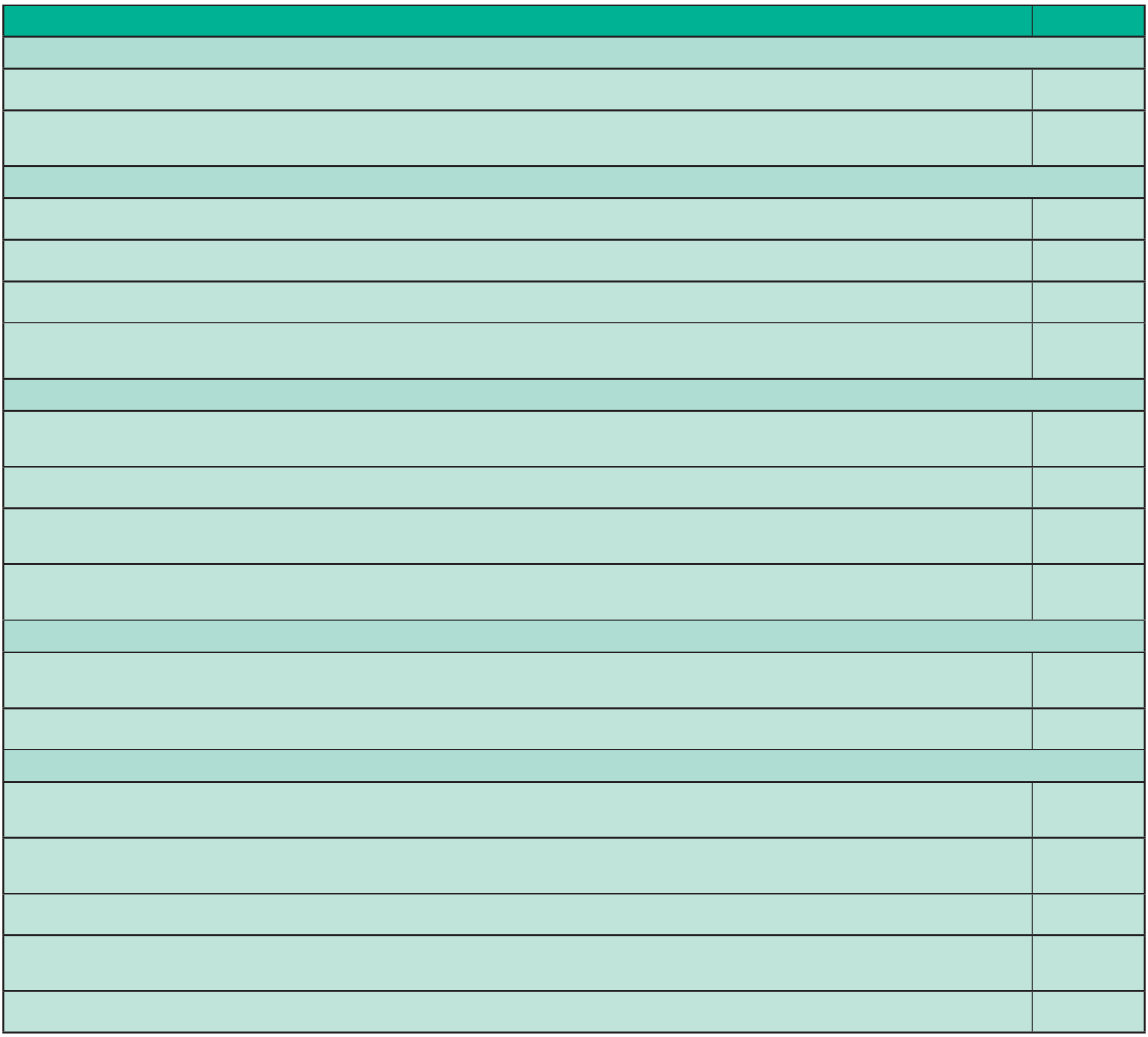
7.2 Key Performance Factors in the Emerging Bio-Manufacturing Sector of the New Global Bioeconomy

Relevant U.S. and international cases were studied, particularly those from the European Union. Bio-manufacturing research, industry definitions, principles and products for automotive, bio-manufacturing were reviewed to identify current industry standards and evaluate market potential. Global firms engaged in automotive bio-manufacturing production were studied to identify their production inputs, products, and supply chains. Key levels of inputs needed for bioproducts including agricultural and other natural resource inputs, labor skills, infrastructure, technology transfer and others, were then benchmarked and the Tri-County Region's performance for each factor was assessed to determine the feasibility of bio-manufacturing in the region (MSU Office of Bio-Based Technologies, 2006).

The region's strengths and weaknesses were determined for five key performance factors in the bio-manufacturing sector of the bioeconomy and 17 indicators based on the evaluation and analysis of information generated from an extensive literature review, over 35 key informant interviews, and periodic reviews by the technical advisory committee. The following matrix summarizes the findings for the region's capacity and performance in the emerging bio-manufacturing sector. A green up arrow indicates a strength; a down red arrow indicates a weakness, and a purple square represents an undetermined position for that particular benchmark. Preliminary findings of the study were filtered through the Technical Advisory Committee before the project findings were finalized. These findings as presented in Figure 1 were used to inform the recommendations to regional leaders and stakeholders interested in bio-based economic development.

Figure 7-2

Evaluating Regional Capacity and Performance in the Emerging Automotive Bio-Manufacturing Sector
Summary of Findings



Legend

▲ Regional Strength

▼ Regional Weakness

■ Inconclusive Data

7.3 Assessing the Tri-County Region's Position in the Emerging Bio-Manufacturing Sector

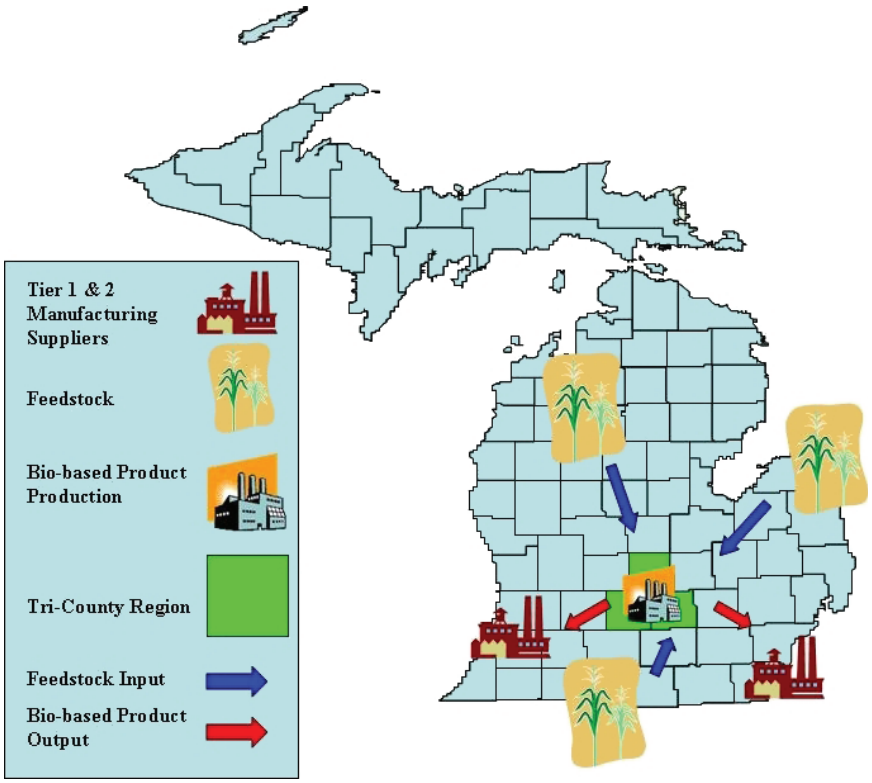
The MSU CCED analysis here indicates that the Tri-County Region ***has the potential to develop a competitive edge in bio-manufacturing given the region's manufacturing strength, accessible agricultural base, skilled labor force and unparalleled higher education research in the bioeconomy***. In addition, the well-developed network of automotive,

chemical, plastics and related manufacturing firms and suppliers in the region offers clear market potential for locally-manufactured bio-products. Stronger public and private-sector leadership willing to adopt policies and business models that utilize green products needs to emerge to capture this important new market.

The Lansing Tri-County Region's emerging bio-based economy is structured on the availability of various necessary inputs, existing and emerging markets, and required infrastructure. Readily accessible feedstock supplied by nearby agricultural producers provides the bio-material input without excessive transportation costs. Centralized location, available trained workforce, access to knowledge and innovation, and existing industrial infrastructure and facilities allow the Tri-County Region to provide an effective center to collect and process feedstocks into bio-based products. The region's commanding central location gives it the position to implement of efficient distribution of bio-based products throughout the region, state, and regional automotive manufacturing centers and tier one and two suppliers.

Figure 7-3

The Future of the Lansing Tri-County Region in the Bio-Based Economy



The Tri-County Region shows substantial strength for three of the five performance factors with mixed indicators for two of the factors. The region is strongest with its industrial infrastructure and transportation capacity and relatively strong for food and non-food feedstocks and intellectual capabilities. The region lags in terms of its immediate bio-product market potential and leadership capacity indicators although one strong indicator is Michigan State University's firm commitment to the development of a regional and state bioeconomy. The region's distinct advantage in having a world-class research institution strongly supporting development of a regional bioeconomy could clearly leverage other regional assets and improve performance for those indicators where the region lagged.

The Lansing Tri-County Region's ability to create and sustain a bio-manufacturing economy will depend in large part on the region's inventive intellectual talents in developing new methods of production, products and markets. The bio-manufacturing sector rapidly changes as an emerging component of the fast-paced expansion of the global knowledge economy. Communities that are early adapters will face significant "start-up challenges" but will have the potential to position themselves as bio-manufacturing centers with significant potential to expand in the years ahead.

The Tri-County Region also faces critical challenges including:

- Underdeveloped regional market to support production of automotive and other types of bio-products

- Lack of cellulosic biomass from forest resources for biofuels and bio-products
- Lack of available private sector and public financing in place to support bio-manufacturing production and facilities
- Weak public sector commitment at the local planning and economic development level as well as other public policy that fosters the growth of a regional bio-manufacturing sector
- Absence of a bioeconomy industry network to foster development of a bio-manufacturing sector in the Tri-County Region.

Strategic repositioning of regional resources and capacity can effectively answer these challenges.

There are three areas for which the data are inconclusive: the length of the growing season; the sufficiency of the region's technology transfer capacity; and leadership capacity to position the region to successfully compete in the rapidly-evolving bio-manufacturing sector of the global bioeconomy.

Technology-led economic development offers vast potential for generating wealth for individuals and communities who are creative and talented, and have a modern IT infrastructure and foresight to strategically plan to successfully compete in an innovation-based, post-petroleum global economy. Many of these characteristics are favored by "university towns" like the Tri-County Region where public and private investments in the generation and application of knowledge has been a long-term priority. Communities with research and development capacity will tend to do well in the emerging technology-led global knowledge economy. However, the region must demonstrate the intellectual drive and boldness in the market place to take the risks necessary to advance the region in the early development of the global bioeconomy.

7.4 Recommendations

Based on the analysis of the feasibility study and the summary matrix presented above, the research team recommends the following actions to the leadership of the Lansing Tri-County Region:

- Establish a Lansing Tri-County Region bio-manufacturing industry network that includes private sector leaders from the manufacturing and agricultural crop production sectors with the participation of the region's higher education institutions and regional economic development organizations. The Tri-County Region Bio-manufacturing Network would:
    - Work with companies in the automotive, agricultural, energy and chemical sectors to identify opportunities that advance the development of bio-products and bio-manufacturing in the region.
    - Partner with the research community to identify research needs associated with the development of bio-products and bio-manufacturing processes.
    - Identify and access funding to promote innovation in bio-products and bio-manufacturing.
    - Identify companies interested in making immediate investments in the development and marketing of bio-products,
    - Work with local economic development officials on initiatives to support bio-manufacturing processing improvements, pilot scale production, testing and evaluation, commercial-scale production, and market development of regionally-produced bio-products.
    - Assist small and medium size businesses in evaluating the performance of new regionally-produced bio-products.
- Work to educate public officials and policymakers about the emerging bio-manufacturing sector so that sound planning and economic development decisions are supported consistent with the growth of a bio-manufacturing sector in the region.
- Formulate strategies to raise private-sector capital and leverage the capacity of the new regional bio-manufacturing industry network to administer community financing efforts and establish a regional bio-manufacturing cooperative.

The Tri-County Region's outstanding manufacturing, agriculture and research capacity makes the region a potential major

player in the emerging bio-manufacturing sector of the global bioeconomy. A collaborative public-private partnership that can leverage the region's strengths while working to fortify areas of regional weaknesses can help strengthen the agricultural, manufacturing and intellectual connections and ensure that the Lansing Tri-County Region competes successfully in the emerging global bio-manufacturing sector.

The research team expresses its sincere gratitude to our collaborating partners and supporters who assisted the development of this feasibility study, and are already providing visionary leadership to grow a strong regional bioeconomy. As we work creating, disseminating, and applying knowledge to improve quality of life and realize the region's full economic potential, we are very appreciative for the invaluable support of those who shared their expertise and insights. Bold leadership is needed to help our region continue its pursuit of creating a vibrant, healthy economy that balances the environmental, social and economic domains while seizing new opportunities for regional growth in the emerging bioeconomy. Our partners and supporters remain integral parts of our capacity to effectively implement, evaluate, and communicate innovative strategic approaches through responsive engagement and collaborative learning.

As the Lansing Tri-County Region continues to cultivate the seeds of bioeconomy development, we hope that the findings of this feasibility study instigate future dialogue to spur innovative strategic partnerships that are critical to the region's future in the bioeconomy.

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Appendices

Appendix A
Glossary

Biodiesel: A liquid biofuel suitable as a diesel fuel substitute or diesel fuel additive or extender. Biodiesel is typically made from oils (e.g., soybean, rapeseed, or sunflower) or animal fats. Biodiesel can also be made from hydrocarbons derived from agricultural products such as rice hulls.

Biofuels: Liquid fuels and blending components produced from biomass (plant) feedstocks, used primarily for transportation.

Biomass: "Any organic matter that is available on a renewable or recurring basis, including agricultural crops and trees, wood and wood wastes, plants (including aquatic plants), grasses, residues, fibers, and animal wastes, municipal wastes, and other waste materials." (Biomass Research and Development Act of 2000 7 USC 7624 Note.)

Biopolymers: A polymer comprised, at least in part, of building blocks called monomers, produced in a biorefinery from renewable feedstocks such as corn.

Biorefineries: "A biorefinery is a facility that integrates biomass conversion processes and equipment to produce fuels, power, and chemicals. The biorefinery concept is analogous to petroleum refineries, which produce multiple fuels and products from petroleum." (National Renewable Energy Laboratory, Biomass Research.)

Biotechnology: The use of enzymes and metabolic processes of living organisms (often micro-organisms) to produce chemicals that have medical, environmental, or economic value. "Biotechnology is the integrated application of natural and engineering sciences for the technological use of living organisms, cells, parts thereof and molecular analogues for the production of goods and services." Biotechnology thus consists of the use of living organisms or parts thereof, to make or modify products, improve plants and animals, or develop micro-organisms for specific purposes. (European Federation for Biotechnology as cited by Royal Belgian Academy of Applied Science. [2004, January]. *Industrial Biotechnology and Sustainable Chemistry*.)

Enzymes: Biologically-derived, biodegradable proteins that speed up chemical reactions. For example, in a biorefinery producing cellulosic ethanol and other chemicals, a group of enzymes called cellulases needed to break down cellulose into sugars that can be fermented to produce desired products.

Ethanol: A clear, colorless, flammable, oxygenated hydrocarbon (CH3-CH2OH). In addition to its uses as a chemical, ethanol is also a liquid biofuel that can be used as a substitute for, or blended with, gasoline. It is produced by fermenting sugars from carbohydrates found in agricultural crops and cellulosic residues. In the U.S., the biofuel is produced mainly from corn. Cellulosic ethanol is produced from lignocellulosic feedstocks (cellulosic residues), including agricultural residues (e.g., corn stover), forestry residues (e.g., wood chips), energy crops (e.g., switchgrass), and municipal waste. It is also used in the U.S. as a gasoline octane enhancer and oxygenate (blended up to 10 percent concentration, also called E10). Ethanol can also be used in high concentrations (E85, a blend of 85 percent ethanol and 15 percent gasoline) in vehicles designed for its use, which are usually called flex-fuel vehicles.

Fermentation: The use of micro-organisms to break down complex compounds into simpler ones.

Flex-fuel vehicle: A vehicle that can operate on:

1) alternative fuels (such as E85),
2) 100 percent petroleum-based fuels, or
3) Any mixture of an alternative fuel (or fuels) and a petroleum-based fuel.

Flex-fuel vehicles have a single fuel system to handle alternative and petroleum-based fuels.

Greenhouse gases (GHG): Those gases, such as water vapor, carbon dioxide, nitrous oxide, methane, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride, that are transparent to solar (short-wave) radiant energy but opaque to long-wave (infrared) radiation, thus preventing long-wave radiant energy from leaving the Earth's atmosphere. The net effect is to trap absorbed radiation and warm the planet's surface.

Industrial Biotechnology (or white biotechnology): Distinct from medical (red biotech) and agricultural biotechnology (green biotech), industrial biotechnology is "the application of modern biotechnology for the industrial production of chemical substances and bioenergy, using living cells and their enzymes, resulting in inherently clean processes with minimum waste generation and energy use." (Royal Belgian Academy of Applied Science. [2004, January]. *Industrial Biotechnology and Sustainable Chemistry*.)

Patent: A set of exclusive rights granted by the government to an inventor or his assignee for a fixed period of time, usually 20 years, in exchange for the public disclosure of an invention.

Trademark: A word, symbol, device that is used in trade with goods to indicate the source of the goods and to distinguish them from the goods of others.

Source: United States International Trade Commission. (2008, July). *Industrial Biotechnology: Development and Adoption by the U.S. Chemical and Biofuel Industries* (USITC Publication No. 4020). Washington, DC: Author.

Appendix B
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Appendix C
Tri-County Precipitation and Average Daily Temperatures

Tri-County Precipitation
2001 – 2007

Month	2001	2002	2003	2004	2005	2006	2007
January	0.65	0.98	0.24	0.91	4.39	4.14	2.13
February	2.79	1.37	0.32	0.55	2.02	1.72	0.47
March	0.14	1.67	1.57	3.35	1.35	2.64	2.66
April	2.68	2.29	2.82	0.68	1.05	1.82	3.37
May	6.06	3.56	3.97	10.44	1.72	4.74	3.49
June	3.64	1.67	1.88	3.08	5.49	1.60	3.09
July	1.25	4.37	1.84	3.80	5.76	4.05	0.71
August	2.33	1.94	1.27	3.19	0.74	3.41	6.42
September	3.23	0.65	2.06	1.02	2.78	3.07	1.86
October	5.69	1.21	1.84	1.92	0.57	2.95	3.36
November	2.25	1.43	5.62	4.02	4.53	3.75	1.36
December	1.13	0.79	1.43	1.84	1.91	3.07	1.26
Total	**31.84**	**21.93**	**24.86**	**34.80**	**32.31**	**36.96**	**30.18**

Tri-County Temperatures
2001-2007

Month	2001	2002	2003	2004	2005	2006	2007
January	24.7	30.5	17.6	16.4	21.8	33.2	26.4
February	26.5	29.7	19.9	23.3	28.2	25.4	17.2
March	31.9	31.5	32.3	38.8	30.8	35.7	39.4
April	48.9	47.3	45.3	48.3	50.2	50.3	44.6
May	59.2	51.8	53.8	58.2	54.7	58.2	60.5
June	66.3	68.6	63.5	65.0	72.7	66.6	68.9
July	69.7	73.2	69.0	68.9	72.8	73.7	70.3
August	70.8	69.3	69.7	65.1	72.8	69.8	71.4
September	58.6	64.6	60.8	64.7	66.8	59.1	64.5
October	49.9	46.4	48.2	51.3	52.6	46.4	56.4
November	46.3	36.3	41.2	40.4	41.8	40.9	37.6
December	34.2	26.8	30.7	28.2	25.3	34.8	25.7
Total Average	**48.9**	**48.0**	**46.0**	**47.4**	**49.2**	**49.5**	**48.6**

Source: National Oceanic and Atmospheric Administration, National Weather Service.

Appendix D
Tri-County Regional Road Data

Rural Mileage

County	Interstates	Principal Arterials (Non-Freeway)	Principal Arterials	Minor Arterials	Major Collectors	Minor Collectors	Local Roads	Total
Clinton	23.326	17.827	28.430	46.292	246.612	44.729	757.060	1,164.326
Eaton	31.336	1.778	0.000	84.700	246.570	48.557	668.474	1,081.415
Ingham	74.422	19.605	55.055	184.564	731.504	111.197	2,014.269	3,190.616

Urban Mileage

County	Interstates	Principal Arterial Freeways	Principal Arterials (Non-Freeways)	Minor Arterials	Urban Collectors	Local Roads	Total
Clinton	56.107	22.591	19.305	52.862	22.023	156.985	329.873
Eaton	70.213	0.000	24.749	84.631	62.925	252.336	494.854
Ingham	194.209	50.008	122.357	292.137	197.778	1,099.976	1,956.456

Tri-County Total Mileage: 8,217.549

Source: Tri-County Regional Planning Commission

Appendix E
Venture Capital Firms in Michigan

Firm	City	County	Type
Detroit Community Loan Fund	Detroit	Wayne	Venture
Dearborn Capital Corporation	Dearborn	Wayne	Venture
Detroit Investment Fund	Detroit	Wayne	Venture
Nationwide Business Consultants	Flat Rock	Wayne	Venture
Peninsula Capital Partners	Detroit	Wayne	Venture
Ralph Wilson Equity Fund	Grosse Pointe Park	Wayne	Venture
Sterling Capital Funding	Dearborn	Wayne	Venture
Small Business Administration (SBA)	Detroit	Wayne	Venture
Masco	Taylor	Wayne	Private Equity
Oracle Capital Partners	Detroit	Wayne	Private Equity
DTE Energy	Detroit	Wayne	Corporate Venture
Sweet Angel Vending	Detroit	Wayne	Angel
Arbor Partners	Ann Arbor	Washtenaw	Venture
Arboretum Ventures	Ann Arbor	Washtenaw	Venture
Ardesta	Ann Arbor	Washtenaw	Venture
EDF Ventures	Ann Arbor	Washtenaw	Venture
Endurance Ventures	Ann Arbor	Washtenaw	Venture
MacBeedon Partners	Ann Arbor	Washtenaw	Venture
Plymouth Venture Partners	Ann Arbor	Washtenaw	Venture
Wolverine Venture Fund	Ann Arbor	Washtenaw	Venture
Center for Venture Capital and Private Equity	Ann Arbor	Washtenaw	Venture
Enterprise Development Fund	Ann Arbor	Washtenaw	Venture
Essex Woodlands Health	Ann Arbor	Washtenaw	Venture
North Coast Technology Investors	Ann Arbor	Washtenaw	Venture
Syneptics	Ann Arbor	Washtenaw	Venture
The Toxicology Group	Ann Arbor	Washtenaw	Venture
Tullis-Dickerson & Co., Inc	Ann Arbor	Washtenaw	Venture
Waypoint Ventures	Ann Arbor	Washtenaw	Venture
White Pines Venture	Ann Arbor	Washtenaw	Venture
RPM Ventures	Ann Arbor	Washtenaw	Venture
Ann Arbor Angels	Ann Arbor	Washtenaw	Angel
MarketPoint Investers	Ann Arbor	Washtenaw	Angel
Bank of Ann Arbor	Ann Arbor	Washtenaw	Angel
Makati Capital Management	New Haven	Shiawassee	Venture
Bluewater Financial Services	East China	Saint Clair	Angel
Wirt-Rivette Finance	Saginaw	Saginaw	Venture
Grand Angels	Holland	Ottawa	Angel
Seneca Partners	Birmingham	Oakland	Venture
Valenti Capital	Bloomfield Hills	Oakland	Venture
Blue Water Capital	Birmingham	Oakland	Venture
Detroit Technology Ventures	Bloomfield Hills	Oakland	Venture
Economic Energy Solutions	Rochester Hills	Oakland	Venture
Long Point Capital	Royal Oak	Oakland	Venture
MedCap Leasing	Troy	Oakland	Venture

Options Investment Group	Troy	Oakland	Venture
Parr Enterprises	Rochester Hills	Oakland	Venture
Real Estate Investor Solutions	Southfield	Oakland	Venture
Sandad	Birmingham	Oakland	Venture
Sloan Ventures	Birmingham	Oakland	Venture
Strength Capital Partners	Birmingham	Oakland	Venture
Vacation Finance	Birmingham	Oakland	Venture
Wind Point Partners	Southfield	Oakland	Venture
Wingspan Venture Partners	Troy	Oakland	Venture
Beringea	Farmington Hills	Oakland	Private Equity
Delphi Corporation	Troy	Oakland	Corporate Venture
Great Lakes Angels	Bloomfield Hills	Oakland	Angel
Hennessey Capital Solutions	Huntington Woods	Oakland	Angel
David Stradal & Associates	Muskegon	Muskegon	Venture
Dow Chemical	Midland	Midland	Corporate Venture
Telkite Inc	Gwinn	Marquette	Venture
Goodman Factors	Sterling Heights	Macomb	Venture
Entrepreneurial Funding	St. Clair Shores	Macomb	Angel
Accelelrus Technology Group	Green Oak	Livingston	Venture
Bridge Street Capital	Grand Rapids	Kent	Private Equity
NYP Excavating & Construction	Wyoming	Kent	Angel
Apjohn Ventures	Kalamazoo	Kalamazoo	Venture
SWMF Life Science Fund	Kalamazoo	Kalamazoo	Venture
Stryker	Kalamazoo	Kalamazoo	Corporate Venture
First Angels	Kalamazoo	Kalamazoo	Angel
Capital Area Investments	Lansing	Ingham	Venture
Michigan Homeland Security Consortium	Lansing	Ingham	Venture
Capital Community Angels	East Lansing	Ingham	Angel
Digium Cards	Traverse City	Grand Traverse	Venture
The Intelligence Agency	Traverse City	Grand Traverse	Venture
Aurora Angels	Petosky	Emmet	Angel
Hannahville Indian Community	Wilson	Charlevoix	Angel
Maezi's Gifts	Battlecreek	Calhoun	Venture
Raphael Massage Therapy and Bodywork	Three Oaks	Berrien	Angel
Great Lakes Entrepreneur's Quest	Ann Arbor	Washtenaw	Venture
Planned Innovation Institute	Midland	Midland	Angel

Appendix F
Financial Contributors

Meridian Twp EDC
5151 Marsh Road
Okemos, MI 48863

Capital Area United Way
1111 Michigan Ave
East Lansing MI 48823

St Vincent Catholic Charities
2800 W. Willow
Lansing MI 48917

Ingham County EDC
121 E. Maple Street
Mason MI 48854

Delhi Charter Township
2074 Aurelius Road
Holt MI 48842

Charter Township of Lansing
3209 W. Michigan Ave
Lansing MI 48917

MSU Office of the President
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E. Lansing MI 48824-7046

Prima Civitas Foundation
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Lansing MI 48912

Williamstown Twp
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Williamston MI 48895-8180

Michigan State University
Office of Bio-Based Technologies
109 Ag Hall
East Lansing MI 48824

Delta Charter Township
7710 W Saginaw
Lansing MI 48917

Clinton County
100 E. State Street
St Johns MI 48879

Appendix G
Bio-Manufacturing-Related Centers at MSU

MSU-DOE Plant Research Lab
http://www.prl.msu.edu/
East Lansing, MI 48824
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Center for Biobased Renewable Energy
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Steven Pueppke
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Biomass Conversion Research Lab
http://www.everythingbiomass.org/
3270 Engineering Building
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Composite Materials & Structures Center
http://www.egr.msu.edu/cmsc/
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Center for Microbial Technology
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Energy & Automotive Research Laboratories
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(517) 353-9861
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Long-Term Ecological Research Project
http://www.lternet.edu/
3700 East Gull Lake Drive
Hickory Corners, MI 49060
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Phil Robertson
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Center for Nanostructured Biomimetic Interfaces
http://www.biomimetic.org/
2527 Engineering Building
East Lansing, MI 48824
(517) 353-9015

Product Center for Agriculture & Natural Resources
http://www.productcenter.msu.edu/
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http://ced.msu.edu/
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Lansing, MI 48912
(517) 353-9555
Rex LaMore
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Appendix H
State and Federal Incentives for Bio-based Enterprises

Biomass Energy Program Grants

- State
- Incentive Type: State Grant Program
- Target Sector: Nonprofits, schools, local governments, state government
- Description: Provides funding for state bioenergy and biofuels projects on a regular basis
- Source: Michigan Dept. of Labor and Economic Growth

21st Century Jobs Fund

- State
- Incentive Type: State Grant Program
- Target Sector: Universities, non profit research institutions, university research transfer, commercial entities.
- Description: The 21st Century Jobs Fund basic research at universities and non-profit research institutions, applied research, university technology transfer, and the commercialization of products, processes, and services.
- Source: Michigan 21st Century Investment Fund, LP

MEGA High-Tech Jobs Creation Tex Credit

- State
- Incentive Type: Tax Credit
- Description: The objective is to attract new, innovative and cutting-edge companies that specialize in new technologies, such as firms doing advanced computing, biotechnology, electronic device technology, engineering and laboratory testing related to product development, medical device technology, engineering and laboratory testing related to product development, medical device technology, product research and development, advanced vehicle technology or technology which assists in the assessment or prevention of threats or damage to human health or the environment.
- Source: Michigan Economic Development Corporation

Small Business Innovation Research (SBIR)

- Federal
- Incentive Type: Federal Grant
- Target Sector: Michigan companies with matching grants from STTR (Small Business Technology Transfer)
- Description: Grants support the SBIR?STTR Emerging Business Fund Matching Funds Program, for sectors including pharmaceuticals, medical devices, instrumentation, diagnostics and biotechnology, among others
- Source: Small Business Administration

The Economic Development Job Training (EDJT)

- State
- Incentive Type: State Tax Credit
- Description: Not necessarily bio tech
- Source: Michigan Economic Development Corporation

Michigan Economic Growth Authority Tax Credit

- State
- Incentive Type: State Tex Credit
- Target Sector: Instate business, and businesses trying to relocate in Michigan

Michigan Economic Growth Authority

- State
- Incentive Type: State Tax Credits
- Target Sector: Industries in mining, high-tech, research and development, wholesale trade, and office operations
- Description: Tax credits are provided for a maximum of 20 ears
- Source: The Geography of Incentives, Good Jobs First

Transportation Economic Development Fund

- State
- State Grant Program
- Incentive Type: Agriculture, food processing, tourism, forestry, high-tech, research manufacturing, mining and office centers.
- Description: Provide grants to county road commissions, city and village street agencies and/or self administered by Michigan Dept. of Transportation. Grants are for developing transportation infrastructure which will help in creating and/or retaining permanent jobs.
- Source: The Geography of Incentives, Good Jobs First

Industrial Facility Property Tax Exemption

- State
- Incentive Type: Property Tax Reduction
- Target Sector: Industrial or high-tech businesses
- Description: Tax reductions are given as an incentive to create new facilities and/or expand or restore existing ones.
- Source: The Geography of Incentives, Good Jobs First

Renaissance Zones

- State
- Incentive Type: Tax Credit
- Description: To encourage economic activity in designated urban and rural areas of the state by waiving virtually all state and local taxes for up to 15 years. Businesses with a presence in Michigan choosing to relocate Michigan-based jobs to a zone may do so by meeting notification requirements load out in the law
- Source: Michigan Economic Development Corporation

Job Creation Tax Credit

- State
- Incentive Type: Tax Credit
- Description: Each credit may be awarded for up to 20 years. 100 percent of the incremental SBT liability and/or personal income tax attributable to the project.

- Source: Michigan Economic Development Corporation

Capital Access Program

- State
- Incentive Type: Indirect Financing Loan
- Description: The program allows banks to provide access to bank financing for many businesses that might otherwise not qualify. There are no loan size limits. The average loan is approximately $56,000.
- Source: Michigan Economic Development Corporation

Employee Ownership Program

- State
- Incentive Type: Indirect Financing, Business Assistance
- Description: To provide technical assistance to firms, business owners and employees interested in employee ownership and Employee Stock Ownership Plans (ESOPs). To assist business owners with transition strategies involving sale of businesses to Employee Stock Owner
- Source: Dept. of Labor and Economic Growth

Industrial Development Revenue Bonds (IDRB)

- State
- Incentive Type: Direct Financing Bond
- Target Sector: Industrial Development Revenue Bonds (IDRB) can be used as a financing vehicle for manufacturers, solid waste/cogeneration companies and certain private or non-profit corporations.

Singles Business Tax

- State
- Incentive Type: Tax Abatement
- Description: The SBT was instituted in 1975 to consolidate and streamline the tax system for businesses. Businesses with gross receipts of less than $250,000 are not required to file the SBT

Michigan Smart Zones

- State
- Incentive Type: Tax
- Target Sector: The Michigan Economic Development Corporation designated Smart Zones throughout the state. The zones are intended to stimulate the growth of technology-based businesses.
- Description: To stimulate the growth of technology-based businesses and jobs by aiding in the creation of recognized clusters of new and emerging businesses, those primarily focused on commercializing ideas, patents, and other opportunities surrounding universities.
- Source: Michigan Economic Development Corporation

Urban Land Assembly Program

- State
- Incentive Type: Indirect Financing Loan
- Target Sector: Priority is given to proposed projects that have the greatest immediate economic impact.
- Description: The Urban Land Assembly Program is a revolving fund directed toward revitalizing the economic base of cities experiencing distress and decline. It provides loans to eligible municipalities in the acquisition of certain retail property for economic development purposes.

- Source: Michigan Legislature

Michigan Life Sciences Corridor

- State
- Incentive Type: Direct Financing
- Target Sector: Forty percent of the fund (Category I) is allocated for basic research, to be distributed on a competitive basis to Michigan universities or Michigan non-profit research institutes for basic research in health-related areas.
- Description: The purpose is to create, over the next two decades, a Michigan Life Sciences Corridor encompassing the best of academic science along with a robust, entrepreneurial private sector of new and established firms, thereby enhancing economic opportunities and health and well-being.

Economic Adjustment Assistance

- Federal
- Incentive Type: Project Grants
- Target Sector: State, city, county or other political subdivisions
- Description: To address the needs of distressed communities experiencing ad verse economic changes that may occur suddenly or over time, and generally result from industrial or corporate restructuring , new federal laws or requirements; reduction in defense expenditures, depletion of natural reSource: s, or natural disasters.
- Source: http://www.eda.gov/

Indian Employment Assistance

- Federal
- Incentive Type: Direct Payments
- Target Sector: Federally recognized Indian Tribal Governments and Native American Organizations authorized by Indian Tribal Governments may apply to administer the program. Individual American Indian applicants must be a member of a Federally Recognized Indian Tribe, be in need of financial assistance, and reside on or near an Indian reservation under the jurisdiction of the Bureau of Indian Affairs.
- Description: Members of Federally Recognized Indian Tribes who are unemployed, underemployed, or in need of training to obtain reasonable and satisfactory employment. Complete information on beneficiary eligibility is found in 25 CFR, Parts 26 and 27.

Economic Development Technical Assistance

- Federal
- Incentive Type: Project Grants
- Target Sector: Recipients are private or public nonprofit organizations and educational institutional units of political subdivisions, or a consortium, and Economic Development District organization, a private or public nonprofit organization or association.
- Description: EDA oversees three technical assistance programs (national, local and University Center) that promote economic development and alleviate unemployment, underemployment, and out-migration in distressed regions. These programs provide funds to: 1) invest in institutions of higher education to meet the goal of enhancing local economic development; 2) Support innovative approaches to stimulate economic development in distressed regions; 3) Disseminate information and studies of economic development issues of national significance; and 4) Finance feasibility studies and other projects leading to local economic development.
- Source: http://www.eda.gov/

Grand for Public Works and Economic Development Facilities

- Federal
- Incentive Type: Project Grants
- Target Sector: State, city, county or other political subdivisions of a state or a consortium of such political subdivision, an institution of higher education or a consortium of institutions of higher education; an Economic Development District organization, a private or public nonprofit organization or association, an Indian Tribe, or a consortium of Indian Tribes.
- Description: To enhance regional competitiveness and promote long-term economic development in regions experiencing substantial economic distress. ED.A. provides Public Works investments to help distressed communities and regions revitalize, expand, and upgrade their physical infrastructure to attract new industry, encourage business expansion, diversify local economies, and generate or retain long-term private sector jobs and investment. Current priorities include proposals that help support existing industry clusters, development new emerging clusters, or attract new economic drivers.
- Source: http://www.eda.gov/

Economic Development Support for Planning Organizations

- Federal
- Incentive Type: Project Grants
- Target Sector: District Organization, Indian Tribe or a consortium of Indian Tribes; State, city or other political subdivision of a state, including a special purpose unit of a state or local government engaged in economic or infrastructure development activities, or a consortium of political subdivisions; institution of higher education or a consortium of institutions of higher education; or public or private non-profit organizations or associations acting in cooperation with officials of a political subdivision of a state.
- Description: Support short-term planning efforts and state plans designed to create and retain higher-skill, higher-wage jobs, particularly for unemployed and underemployed in the nation's most economically distressed regions

Trade Adjustment Assistance

- Federal
- Incentive Type: Direct Payments
- Target Sector: A petition for Trade Adjustment Assistance may be filed by a group of adversely affected works and be signed by at least three workers; alternatively, a petition may be filed by a company official.
- Description: To provide adjustment assistance to qualified workers adversely affected by foreign trade this will assist them to obtain suitable employment.

Appendix I
Shared Automotive Team Assemblers and Chemical Occupational Skills

Knowledge

Production and Processing — Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.

Skills

Quality Control Analysis — Conducting tests and inspections of products, services, or processes to evaluate quality or performance.

Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.

Operation Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Abilities

Oral Comprehension — The ability to listen to and understand information and ideas presented through spoken words and sentences.

Oral Expression — The ability to communicate information and ideas in speaking so others will understand.

Information Ordering — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).

Near Vision — The ability to see details at close range (within a few feet of the observer).

Control Precision — The ability to quickly and repeatedly adjust the controls of a machine or a vehicle to exact positions.

Problem Sensitivity — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.

Deductive Reasoning — The ability to apply general rules to specific problems to produce answers that make sense.

Work Activities

Controlling Machines and Processes — Using either control mechanisms or direct physical activity to operate machines or processes (not including computers or vehicles).

Communicating with Supervisors, Peers, or Subordinates — Providing information to supervisors, co-workers, and subordinates by telephone, in written form, e-mail, or in person.

Identifying Objects, Actions, and Events — Identifying information by categorizing, estimating, recognizing differences or similarities, and detecting changes in circumstances or events.

Inspecting Equipment, Structures, or Material — Inspecting equipment, structures, or materials to identify the cause of errors or other problems or defects.

Getting Information — Observing, receiving, and otherwise obtaining information from all relevant sources.

Performing General Physical Activities — Performing physical activities that require considerable use of your arms and legs and moving your whole body, such as climbing, lifting, balancing, walking, stooping, and handling of materials.

Monitor Processes, Materials, or Surroundings — Monitoring and reviewing information from materials, events, or the environment, to detect or assess problems.

Work Context

Wear Common Protective or Safety Equipment such as Safety Shoes, Glasses, Gloves, Hearing Protection, Hard Hats, or Life Jackets — How much does this job require wearing common protective or safety equipment such as safety shoes, glasses, gloves, hard hats or life jackets?

Importance of Being Exact or Accurate — How important is being very exact or highly accurate in performing this job?

Face-to-Face Discussions — How often do you have to have face-to-face discussions with individuals or teams in this job?

Sounds, Noise Levels Are Distracting or Uncomfortable — How often does this job require working exposed to sounds and noise levels that are distracting or uncomfortable?

Contact With Others — How much does this job require the worker to be in contact with others (face-to-face, by telephone, or otherwise) in order to perform it?

Work Styles

Attention to Detail — Job requires being careful about detail and thorough in completing work tasks.

Dependability — Job requires being reliable, responsible, and dependable, and fulfilling obligations.

Cooperation — Job requires being pleasant with others on the job and displaying a good-natured, cooperative attitude.

Integrity — Job requires being honest and ethical.

Initiative — Job requires a willingness to take on responsibilities and challenges.

Self Control — Job requires maintaining composure, keeping emotions in check, controlling anger, and avoiding aggressive behavior, even in very difficult situations.

Achievement/Effort — Job requires establishing and maintaining personally challenging achievement goals and exerting effort toward mastering tasks.

Adaptability/Flexibility — Job requires being open to change (positive or negative) and to considerable variety in the workplace.

Shared Automotive Team Assemblers and Chemical Occupational Skills Matrix

Knowledge

Skills

Work Abilities

Category	Automotive Team Assemblers	Chemical Occupational Skills
Problem Sensitivity	X	X
Near Vision	X	X
Selective Attention		X
Information Ordering	X	X
Oral Comprehension	X	X
Oral Expression	X	X
Auditory Attention		X
Control Precision	X	X
Deductive Reasoning	X	X
Far Vision		X
Manual Dexterity	X	
Arm-Hand Steadiness	X	
Finger Dexterity	X	

Work Activities

Category	Automotive Team Assemblers	Chemical Occupational Skills
Monitor Processes, Materials, or Surroundings	X	X
Controlling Machines and Processes	X	X
Getting Information		X
Communicating with Supervisors, Peers, or Subordinates	X	X
Inspecting Equipment, Structures, or Material	X	X
Making Decisions and Solving Problems		X
Identifying Objects, Actions, and Events	X	X
Performing General Physical Activities	X	X
Evaluating Information to Determine Compliance with Standards		X

Work Context

Category	Automotive Team Assemblers	Chemical Occupational Skills
Wear Common Protective or Safety Equipment such as Safety Shoes, Glasses, Gloves, Hearing Protection, Hard Hats, or Life Jackets		X
Indoors, Environmentally Controlled		X
Face-to-Face Discussions	X	X
Consequence of Error		X
Contact With Others	X	X
Frequency of Decision Making		X
Importance of Being Exact or Accurate	X	X
Telephone		X
Exposed to Hazardous Conditions		X
Sounds, Noise Levels Are Distracting or Uncomfortable	X	X
Spend Time Using Your Hands to Handle, Control, or Feel Objects, Tools, or Controls	X	
Spend Time Making Repetitive Motions	X	
Spend Time Standing	X	
Time Pressure	X	
Work With Work Group or Team	X	

Work Styles

Category	Automotive Team Assemblers	Chemical Occupational Skills
Attention to Detail	X	X
Dependability	X	X
Cooperation	X	X
Initiative	X	X
Integrity	X	X
Self Control	X	X
Adaptability/Flexibility	X	X
Stress Tolerance		X
Achievement/Effort	X	X
Analytical Thinking		X
Independence	X	
Concern for Others	X	

* Highlighted skills apply to both Automotive Team Assemblers and Chemical Occupational Skills

Source: O*NET OnLine. Retrieved February, 2008, from http://online.onetcenter.org

Appendix J
Commercial Annual Average Daily Traffic (CAADT)
by County

Ingham County

Route	To	CAADT
Lansing Rd	JCT M-99	5,370
JCT M-99	E. JCT 1-96 BL Lansing	5,536
E JCT 1-96 BL Lansing	JCT I-496, US 127	5,536
JCT I-496, US 127	Okemos Rd	6,179
Okemos Rd	Williamston Rd	6,179
Williamston Rd	JCT M-52	6,179
JCT M-52	Fowlerville Rd	5,437
W of I-96 BL, Cedar St	Trowbridge Rd	5,163
Trowbridge Rd	Dunce Rd	5,163
Dunckel Rd	E JCT I-96	5,163

Clinton County

Route	To	CAADT
JCT Connector 96	Airport Rd	5,470
Airport Rd	Dewitt Rd	5,470
Dewitt Rd	JCT Old US-27	5,470
JCT Old US-27	JCT US-127	5,470
JCT US-127	Webster Rd	5,758
Webster Rd	E. JCT I-69 BL Lansing	5,758
E. JCT I-69 BL Lansing	Woodbury Rd	5,978
JCT M-100	JCT. Connector 96	5,759

Eaton County

Route	To	CAADT
N Drive North	JCT M-78	5,659
JCT M-78	Ainger Rd	5,659
Ainger Rd	S JCT I-69 BL Charlotte	5,659
S JCT I-69 BL Charlotte	JCT M-50	5,659
JCT M-50	S JCT I-69 BL Charlotte	5,659
S JCT I-69 BL Charlotte	JCT M-100	5,691
JCT M-100	Lansing Rd	5,691
Lansing Rd	W JCT I-96	5,691
J I-69 (Clinton/Eaton Co. LN)	JCT M-43	8,030
JCT M-43	JCT I-496	7,962
JCT I-496	S JCT I-69	7,894
S JCT I-69	Lansing Rd	5,370
Lansing Rd	JCT M-99	5,370

Source: MDOT Bureau of Transportation Planning.

Appendix K
Biofuel Market Development

Cellulose-based ethanol for motor fuel is expected to become a major market by 2020.

The current U.S. corn-based ethanol market is growing. Production reached 778.8 million gallons in May, 2008, up 47% from the 2007and up 10% from the preceding month, according to the U.S. Energy Information Administration's (EIA) latest Oxygenate Production report. Total ethanol fuel production for 2007 was 6.498 billion gallons according to the Renewable Fuels Association (RFA) and 6.521 billion gallons according to the EIA.[a]

In a 2007 economic study conducted by the U.S. Department of Commerce International Trade Administratio,[b] U.S. consumption expenditures in 2020 would be 0.08% higher (or $12.6 billion) with the use of cellulosic ethanol (19.5 billion gallons). These are substantial gains, the report emphasized. The yearly reduction in U.S. oil imports would be $8.4 billion (in 2004 dollars) and the price of gasoline would be reduced by 2% than what it would otherwise have been by 2020. These projections were predicated on the assumption that the price of motor vehicle gasoline would be $2.08 per gallon.

The production of 19.5 billion gallons of cellulosic ethanol would lower both the domestic cost of fuel and worldwide price of oil and would lower U.S. crude oil imports by 4.1% over baseline projections, or 460,000 barrels per day, in 2020. The U.S. crop producing sector would see a 4.3% rise in output over baseline projections. As U.S. demand for crude falls, U.S. petroleum producers would see their output fall as prices decline.

In a best-case scenario based on annual ethanol production of 60 billion gallons in 2020, specific benefits would include:

- Annual U.S. consumption would increase by about $33.5 billion in 2020.
- U.S. fuel prices would fall by 5.2%
- World oil prices would decline by 3.1%.
- U.S. oil imports would decline by 10.7%, or 1.2 million barrels per day.
- U.S. agriculture would gain 54,000 jobs.

The study's baseline oil price assumption was $50 per barrel and the predicted economic benefits would be even greater with higher petroleum prices.

Federal ethanol fuel mandates of 7.5 billion gallons in the U.S. vehicle fuel supply by 2012 and at least 16 billion gallons of cellulose ethanol by 2022 are providing a powerful impetus to the rapid development of ethanol fuel markets. These mandates are now matched too by significant levels of federal research expenditures to overcome the technical barriers in achieving viable commercial production of cellulosic ethanol in the next few years.

The federal Department of Energy's road map for biomass-based alternative renewable fuel calls for displacing 30% of U.S. gasoline consumption by ramping up biofuel production to 60 billion gallons by 2030.[c] After years of minuscule actions by the Administration and Congress, the Department of Energy has mapped out an extremely ambitious strategy to take meaningful steps to reduce the country's dependence on foreign oil by creating new U.S. markets in renewable, low-carbon fuels and reduce adverse impacts on global climate change.

a Green Car Congress. *U.S. Fuel Ethanol Production Up 47% in May from Year Prior*. Retrieved July 31, 2008, from http://www.greencarcongress.com/2008/07/us-fuel-ethanol.html

b United States Department of Commerce International Trade Administration. (2007, November). *Energy in 2020: Assessing the Economic Effects of Commercialization of Cellulosic Ethanol* (pp. 12-14).

c United States Department of Energy and U.S. Department of Agriculture. (2005, April). *Biomass as Feedstock for a Bioenergy and Bio-Products Industry: The Technical Feasibility of a Billion-Ton Annual Supply*.

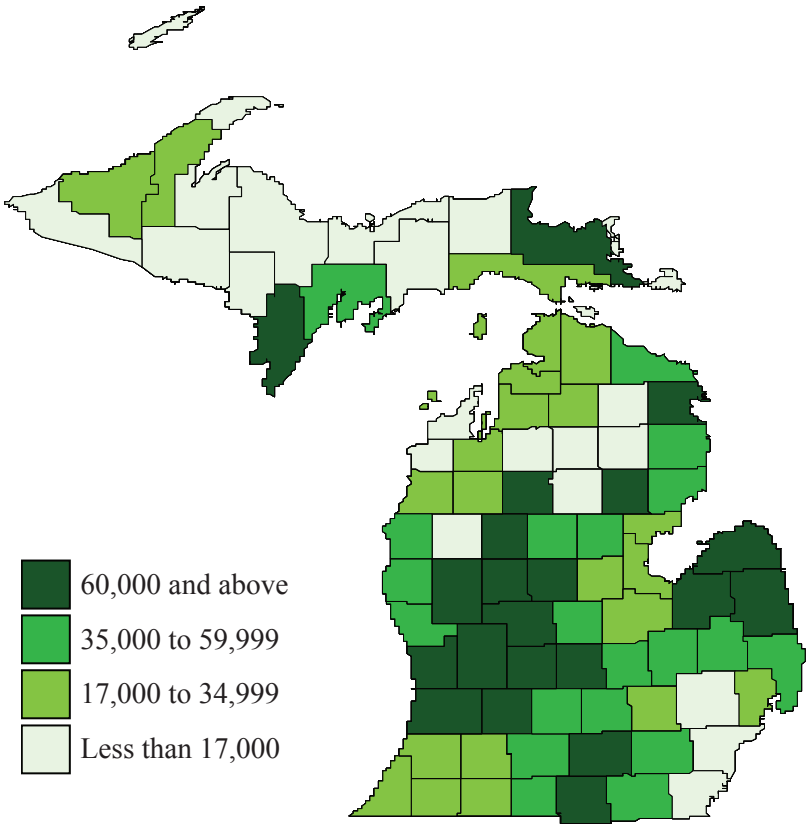
Appendix L
Tri-County Regional Forage and Forest Data

Forage Yield
2002

County	Tons
Clinton	78,089
Eaton	51,876
Ingham	56,550
Michigan Average	**42,866**

Source: United States Department of Agriculture. (2002). *2002 Census of Agriculture*.

Forage Yield
(in Tons)
2002

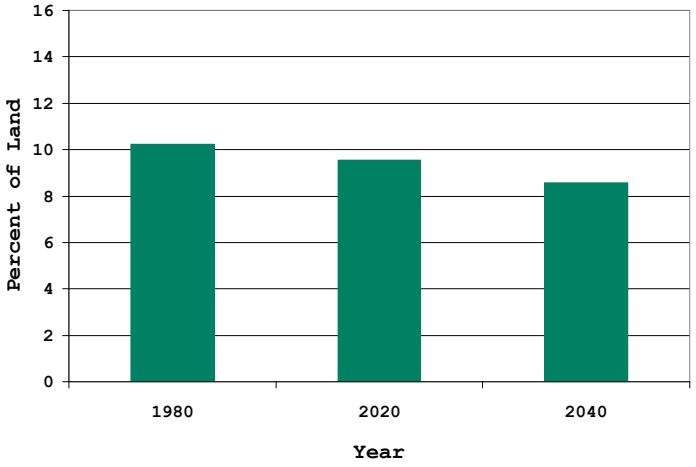


Source: United States Department of Agriculture. (2002). *2002 Census of Agriculture*.

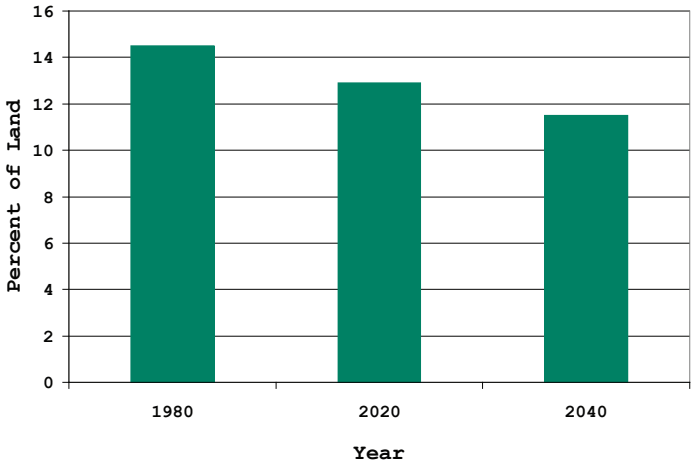
Tri-County Projected Forest Resources
(in Acreage)

County	2020	2040
Clinton	35,190	31,580
Eaton	48,150	43,350
Ingham	41,520	35,100
Michigan Average	203,619	203,338

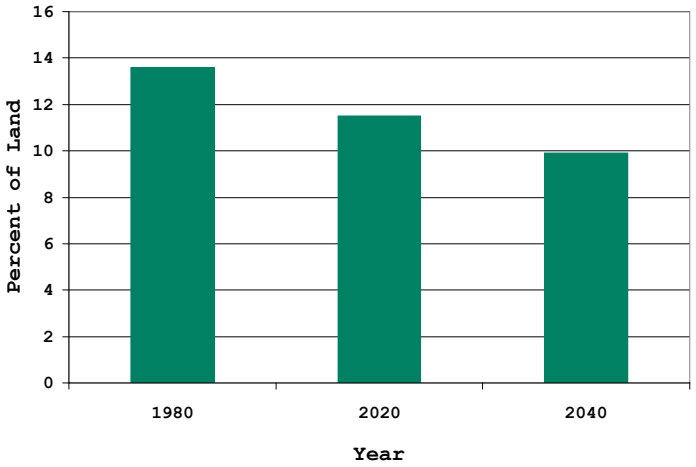
Clinton County Forest
(as % of Land)



Eaton County Forest
(as % of Land)



Ingham County Forest
(as % of Land)



Source: Picture Michigan Tomorrow.

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