Alternative and Renewable Energy Cluster Analysis

A Growth Opportunity for West Michigan

December 2007

WEST MICHIGAN STRATEGIC ALLIANCE
Collaborating to secure our future

GREATER Grand Rapids
THE RIGHT PLACE, INC.
A REGIONAL ECONOMIC DEVELOPMENT ORGANIZATION

EOS
ENERGY OPTIONS & SOLUTIONS

The Right Place, Inc. in collaboration with the West Michigan Strategic Alliance commissioned this analysis of the Alternative and Renewable Energy cluster for the purpose of leveraging the region's commitment to sustainability, assessing the economic development potential of this growing sector and to develop strategies to capture market share for West Michigan.

We are grateful to the following people who provided material input, support and guidance to this study as individuals and as representatives of their organizations:

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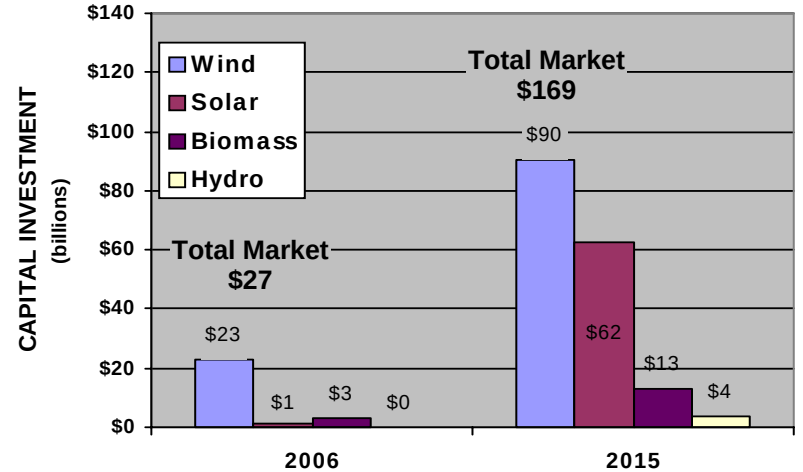
EXECUTIVE SUMMARY

There is tremendous interest in the Alternative and Renewable Energy industry sector. This is the fastest growing market in the US. Heightened awareness of the impact of greenhouse gases, depletion of oil and gas reserves, increasing dependence on unreliable, costly foreign oil supply, and increasing demand for energy, are driving the development of this once largely ignored industry sector.

There is long-term potential in this market. However, **this analysis and the resulting recommendations are purposely focused on what the region could realistically expect to achieve over the next 3 to 5 years based on a proactive, cohesive and aligned set of economic development strategies.** The region's economic development professionals working with our business, governmental, research and educational leaders have the expertise and capability to seize this opportunity now.

Chart 1



Source: REPP Report "Component Manufacturing: Michigan's Future in the Renewable Energy Industry", November 2006, http://www.crest.org/index.html

The worldwide Alternative and Renewable Energy market has grown rapidly over the last few years into a $71 billion market. The 2006 US investment in Alternative and Renewable Energy exceeded $28 billion and the total estimated Alternative and Renewable Energy market between now and 2015 is estimated at almost $170 billion. (See Chart 1.)

As of June 2007, 24 states and the District of Columbia are already ahead of Michigan in the Alternative and Renewable Energy market because they have implemented aggressive energy policies. According to the US Department of Energy, this group of 25 has adopted a Renewable Portfolio Standards policy. This policy requires those who sell electricity to have a certain percentage of renewable power in their energy mix. These policies often start around 1-5% in the first year and require an increasing percentage of renewables in each energy supplier's mix (a 1% increase per year is average), often aiming for a goal of 4-20% in approximately 10 years.

Right now, the Alternative and Renewable Energy market is not looking at Michigan as a place to do business. The region needs to take immediate steps to establish itself in this market. For example, much of the US investment in wind turbine manufacturing has gone to other states. (See Figure 1 on page 6.)

West Michigan's best opportunity for growth over the next five years is to capture market share valued in excess of $800 million by leveraging our manufacturing strengths to produce components for the Alternative and Renewable Energy industry sector. This will result in the creation of over 4,250 new manufacturing jobs. This opportunity will require implementation of a proactive set of economic development strategies. Our projections are based on data, as published by Renewable Energy Policy Project, a public policy organization based out of Washington DC and our analysis of the region's potential.

In the power production arena, the best opportunity for the region is to pursue the installation of wind turbine power generating capabilities with a potential investment of $400 million, creating approximately 85 jobs. There is additional long-term potential in the development of wind turbine power generation in the region.

The region, its businesses and regional leaders, have the demonstrated capability and capacity to be successful in the Alternative and Renewable Energy market. Our strengths include:

- An established world-class manufacturing sector
- A strong commitment to sustainable business practices
- A trained workforce with a strong work ethic
- A competitive business climate
- A group of committed economic development and research organizations
- A national leadership position in the construction of LEED certified buildings.

The Right Place, Inc. and the West Michigan Strategic Alliance with their partners need to take the following steps to effectively capture and leverage our strengths in this rapidly growing market. Specific actions include:

- Market West Michigan as a sustainable region
- Capitalize on the international reverse investment attraction capabilities and success of The Right Place, Inc.
- Market our manufacturing supply chain expertise and capabilities to the Alternative and Renewable Energy industry sector
- Seek to develop power production projects and ensure standardized and competitive site and zoning ordinances where appropriate
- Expand West Michigan's sustainable, alternative energy research and education programs
- Aggressively implement InnovationWorks, a new and dynamic commercialization strategy developed for West Michigan designed by The Right Place, Inc. and its partners, funded by WIRED West Michigan
- Develop Biofuels distribution capabilities at the retail level and achieve "Clean City" designation
- Encourage and support research on cellulosic ethanol production and related commercialization strategies
- Advocate for balanced and competitive state and national alternative and renewable energy policies.

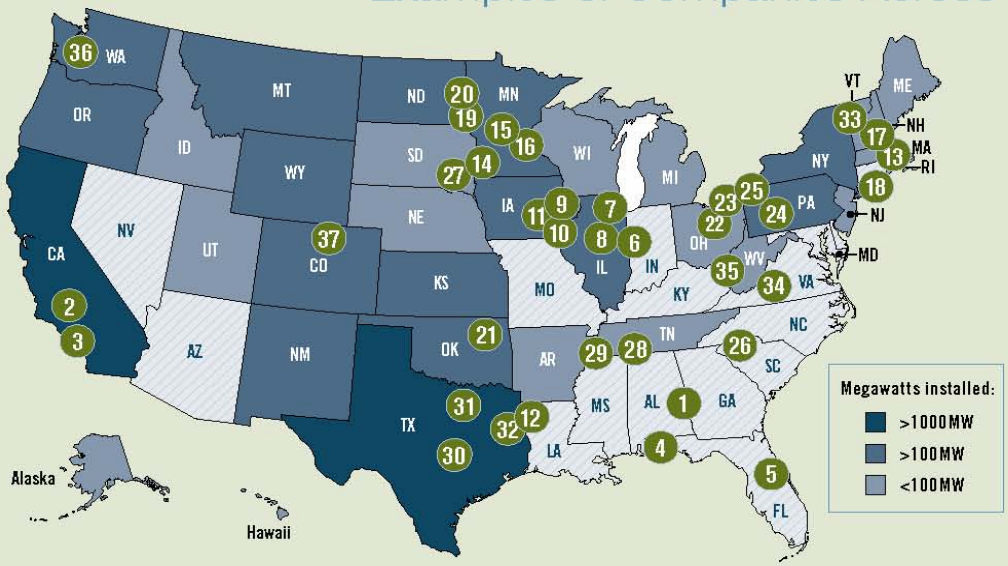
This report is intended to provide a foundation for the West Michigan region to build an Alternative and Renewable Energy cluster in the next three to five years. This analysis suggests a strong potential for success as part of a strategic transition into this market. West Michigan has the opportunity to become a world-class leader in this sector, just as we have in the automotive and office furniture sectors.

This analysis concentrates on those Alternative and Renewable Energy technologies with the most relevance to West Michigan's potential. Several technologies such as Hydro power generation, Municipal Solid Waste conversion and Geothermal power generation, which do not hold a strong potential for West Michigan, were considered and are explained in Appendix I.

Energy conservation and efficiency, which are critical elements of a sustainable energy strategy, are not part of this study. Further analysis of the opportunities which exist in this segment of the energy market is required.

Figure 1

Utility-scale Wind Turbine Manufacturing and Supply Chain: Examples of Companies Across the U.S.



Wind power creates manufacturing jobs even in regions like the Southeast that do not have a large wind resource.

1 **Vectorply**, Phenix City, AL (composites for blades)
2 **GE Energy**, Tehachapi, CA (wind turbine manufacturing facility)
3 **Bragg Crane & Rigging Service**, Long Beach, CA (cranes, rigging, transportation)
4 **GE Energy**, Pensacola, FL (blade technology development)
5 **Mitsubishi Power Systems**, Lake Mary, FL (gear boxes)
6 **White Construction Inc.**, Clinton, IN (construction services)
7 **Winergy Drive Systems Corporation**, Elgin, IL (gear units, generators, power converters)
8 **Trinity Industries**, Clinton, IL (towers)
9 **Clipper Windpower**, Cedar Rapids, IA (turbine manufacturing, assembly)
10 **Siemens**, Fort Madison, IA (blades)
11 **Acciona Energia**, West Branch, IA (planned) (turbine manufacturing)
12 **Beaird Industries**, Shreveport, LA (towers, tower flanges and bolts)
13 **Second Wind Inc.**, Somerville, MA (anemometers, electronic controllers, sensors/data loggers)
14 **Suzlon Wind Energy**, Pipestone, MN (blade manufacture, turbine assembly)
15 **D.H. Blattner & Sons**, Avon, MN (construction)
16 **M.A. Mortenson Co.**, Minneapolis, MN (construction)
17 **Hendrix Wire & Cable Inc.**, Milford, NH (cables to substations)
18 **Hailo LLC**, Holbrook, NY (ladder and lift systems)
19 **DMI Industries**, West Fargo, ND (towers)
20 **LM Glasfiber**, Grand Forks, ND (blades)
21 **Trinity Structural Towers**, Tulsa, OK (towers)
22 **Owens Corning Composites**, Granville, OH (composites for blades)
23 **Hamby Young**, Aurora, OH (substations and high voltage applications)
24 **Gamesa**, Ebensburg, PA (blade, nacelle, tower manufacturing)
25 **GE Energy**, Erie, PA (wind turbine components)
26 **GE Energy**, Greenville, SC (turbine assembly plant)
27 **Knight & Carver**, Howard, SD (blade manufacturing)
28 **Aerisyn Inc**, Chattanooga, TN (towers)
29 **Thomas & Betts Corp.**, Memphis, TN (towers, tower flange and bolts)
30 **DeWind, Inc./TECO Westinghouse**, Round Rock, TX (wind turbine manufacturing)
31 **Trinity Structural Towers**, Fort Worth, TX (towers)
32 **CAB Incorporated**, Nacogdoches, TX (blade extender, hub, nacelle frame, tower flange and bolts)
33 **NRG Systems**, Hinesburg, VT (anemometers, sensors/data loggers)
34 **GE Energy**, Salem, VA (wind turbine components)
35 **Tower Logistics**, Huntington, WV (lifts for turbines)
36 **PowerClimber**, Seattle, WA (traction hoists, rigging equipment)
37 **Vestas**, Windsor, Colorado (planned) (blade and turbine manufacturing)

Source: America Wind Energy Association, "Wind Outlook 2007"

INTRODUCTION

The energy picture in the US is changing rapidly and the capital investment over the next decade will be significant. The Energy Information Administration has forecasted overall demand for energy to grow at and average rate of 1.1% between now and 2030. (See Chart 2.) Because of pricing, availability and environmental market concerns, investment in the Alternative and Renewable Energy market sector is growing at 30% a year, making it the fastest growth market in the US.

Evidence of the dramatic changes occurring is well documented. Major global energy companies are making large investments in new US Alternative and Renewable Energy projects. Congress is considering new legislation on a Renewable Portfolio Standards policy, vehicle fuel efficiency and the regulation of carbon emissions. Hybrid vehicle sales increased over 17% in 2006 and 2007 sales exceeded 2006 sales in September of this year. General Motors has moved up the introduction date of its all electric vehicle to 2010. The US Department of Energy announced in February of this year that it will fund six Cellulosic Ethanol Plants instead of the three it originally was intending to fund. Unfortunately, none are proposed for the Midwest.

Increased competition from developing countries is depleting oil and natural gas reserves and causing rapid increases in pricing of those commodities. In addition, public concern for global warming is already having an impact on the use of traditional fossil fuels such as coal and oil. The state of Kansas recently denied a clean air permit for a coal-fired plant in the western part of the state because of CO_2 emissions issues. In another instance, Southern Company just announced it will abandon a clean coal project in Florida because of potential CO_2 legislation, only a month after groundbreaking ceremonies that included the Governor of Florida and the US Secretary of Energy.

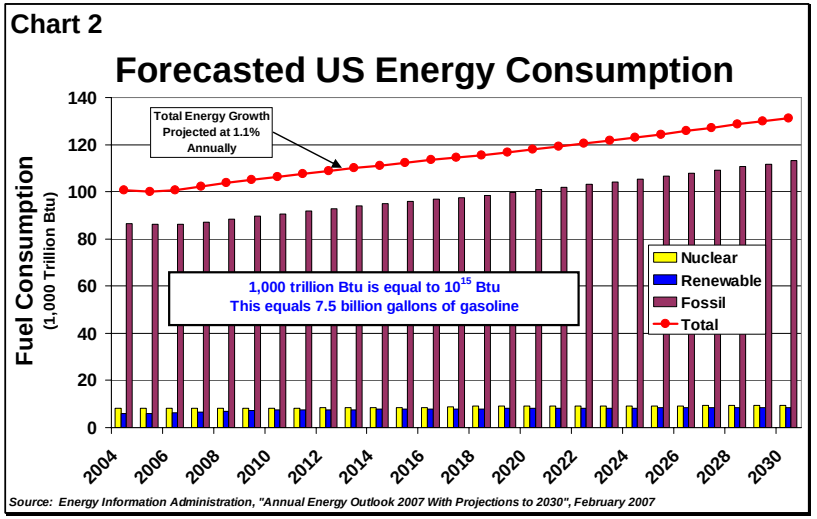
While Michigan and West Michigan have been on the sidelines during much of the initial development in the Alternative and Renewable Energy market, there is nothing to stop the region's pursuit of the very realistic opportunities available to us over the next three to five years. Western Michigan's world-class manufacturing sector should expect to capture a growing share of this market.

The factors driving Alternative and Renewable Energy cluster development and investment in other parts of the country are:

- State legislation establishing a Renewable Portfolio Standards policy, which provides investment and market certainty
- Proximity to other component sources and final assembly
- Available commodities and feedstock (mainly Biofuels)
- Transportation infrastructure
- Available and trained work force
- Local businesses or entrepreneurs willing to invest in the market
- State and/or local incentives or tax abatements.

West Michigan has many of these attributes. The passage of a Renewable Portfolio Standards policy for the State of Michigan would help to advance development of this market, however, not having it in place should not inhibit the ability of the region to capitalize on this growing market. It is anticipated that the State and/or Federal government will pass a Renewable Portfolio Standards policy within the next three to six months, providing additional certainty and clarity. Regardless of Michigan's decision, the market is being driven by international and national demand. **The time to act is now!**

Chart 2



Source: Energy Information Administration, "Annual Energy Outlook 2007 With Projections to 2030", February 2007

ENERGY MARKET

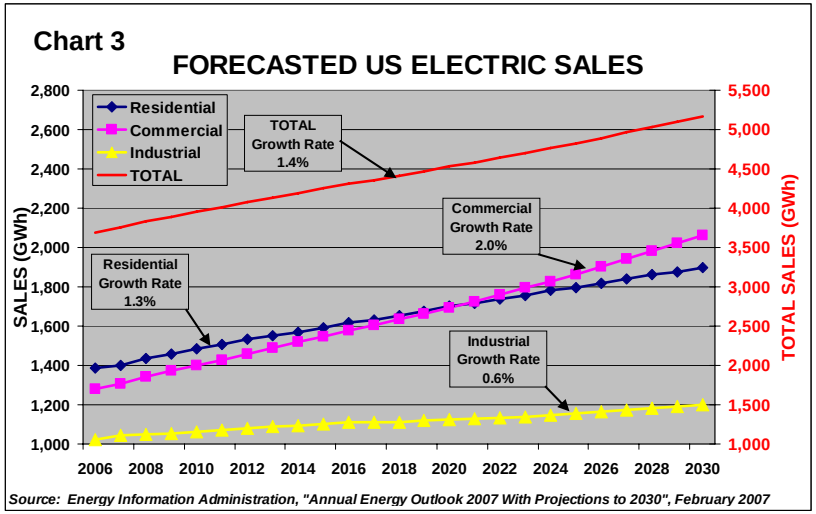
OVERALL

The nation's investment in the electric industry infrastructure, research and supply will see unprecedented growth in the next 10 to 15 years. Alternative and Renewable Energy will continue to see its rapid rate of growth due to concern with climate change and in an effort for the US to reduce its dependence on foreign energy sources.

The Energy Information Administration is projecting the US will need to add over 10,750 megawatts of new electric power generation annually to resolve current electric needs, future growth and retirement of older plants. This would require an estimated capital investment of approximately $412 billion (2005 dollars) between now and 2030.

In his 2007 State of the Union Address, President Bush proposed that the US replace 15% of its gasoline with fuel derived from renewable resources. The US Congress is considering passage of a 15% national Renewable Portfolio Standards policy and legislation on carbon emissions. The cost of fossil fuels and new fossil electric generation has risen to the point that Alternative and Renewable Energy options are now cost competitive with fossil energy options. At this time, the US is likely to see the start of construction of the first nuclear power plant in over 35 years. Clearly we are trying to understand how best to meet our continuing needs for secure, reliable and cost effective energy.

Chart 3



Source: Energy Information Administration, "Annual Energy Outlook 2007 With Projections to 2030", February 2007

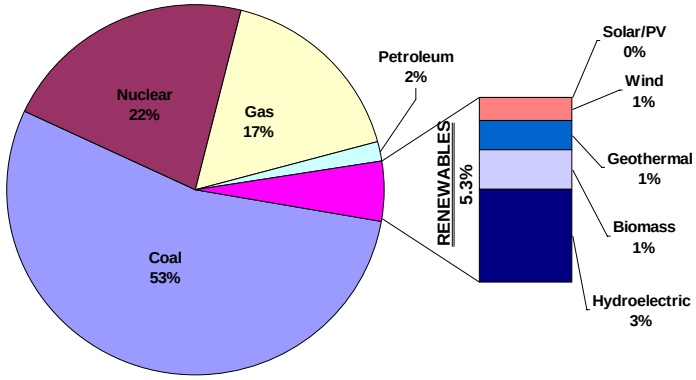
ELECTRIC MARKETS

The use of electricity is still growing in the US at the average rate of 1.5% annually. The Energy Information Administration is projecting electric consumption to increase at the rate of 1.4% between now and 2030. (See Chart 3.) The projected growth rates assume the US will not change consumption patterns nor implement any new programs to increase energy conservation.

The electric industry consumes the most fossil fuels and the most total fuel. This industry also consumes more natural gas then any sector except the industrial manufacturing sector. In 2006, 54.3% of electric power was produced for coal, 21.8% from nuclear, 18.7% from natural gas and petroleum, and 5.3% from renewables. (See Chart 4.) Currently, most renewable power comes from hydroelectric, which accounts for 2.6% of total power production.

The Energy Information Administration also completed a study of the impact in the event Congress was to pass the 15% Renewable Portfolio Standards policy by 2020 contained in the legislation currently in Congress. This study indicates that the US will need to add 55,000 megawatts of new renewable generation by 2030 to meet the 15% Renewable Portfolio Standards target. Adding this to the existing 24,000 megawatts of renewables (not counting conventional hydro) will result in a 300% increase in renewable generation. To achieve these targets, wind capacity would have to increase by 150%, Biomass capacity would need to increase by 270% and solar capacity would have to increase by 1,900%.

Chart 4



Source: Energy Information Administration, "Annual Energy Outlook 2007 With Projections to 2030", February 2007

TRANSPORTATION FUELS (BIOFUELS)

The US used about 300 billion gallons of fuel in transportation in 2006, the majority of which is petroleum-based. (See Chart 5.) Michigan's fuel use is not much different from national fuel use patterns. (See Chart 6.)

Nationally, there is a large effort to find replacements for petroleum based fuels in the transportation sector. As of January 2007, the US had 111 ethanol refineries and an additional 78 under construction. Over the next two years, US ethanol production will double to over 11.4 billion gallons, a seven fold increase since 2000. The majority of ethanol production in the US is from corn. As a result, corn prices in the US have nearly doubled in the last year. Biodiesel production has grown from essentially zero in 2000 to over 91 million gallons in 2005.

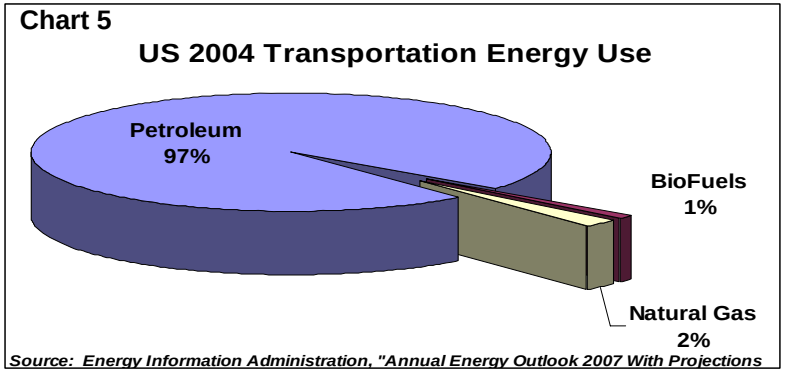
In 2006, corn-based ethanol used 12% of the available corn production in the US to produce 5.4 billion gallons of ethanol or only 2% of the total transportation fuel used. It is projected that if every acre of corn in the US were used for ethanol production, it would only reduce transportation fuel consumption by between 10% and 20%. The US produced about 75 million gallons of Biodiesel in 2006, less then 1% of total diesel fuel consumption.

Cellulosic ethanol appears to be the favorite choice for replacing the nation's use of petroleum for transportation. Cellulosic ethanol is produced from urban wood waste, forestry residue, paper and pulp liquors, and agricultural residue. In a cellulosic ethanol plant, cellulose and hemicellulose in Biomass can be broken down into fermentable sugars by either acid or enzymatic hydrolysis prior to being used in ethanol production. Meeting President Bush's goal, "Twenty in Ten" has a goal of producing 25 billion gallons of cellulosic ethanol by 2017.

One technology with the potential to significantly reduce oil consumption is the Plug-In Hybrid Electric Vehicle. Plug-In Hybrids are outfitted with a battery pack sufficient to power the vehicle for 35 miles or more on battery power alone. The Plug-in is recharged by plugging into a standard electrical outlet. The vehicle will use a small engine for power generation once the initial charge on the batteries is used up.

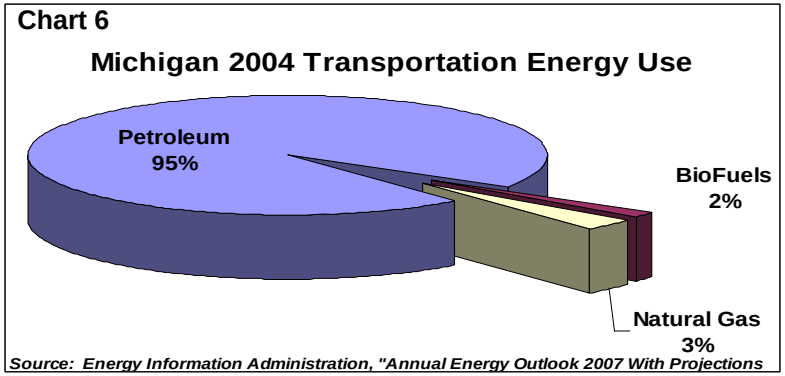
The difference between the Plug-in Hybrid and the Hybrid vehicles on the market today is the use of common household electricity to charge the batteries instead of always relying on the engine to do the charging. Use of electricity to charge the battery saves even more gasoline then current hybrid vehicles. Because opportunities for the region in Plug-In Hybrids over the next three to five years are very limited, this technology is not addressed in this study.

Chart 5



Source: Energy Information Administration, "Annual Energy Outlook 2007 With Projections

Chart 6



Source: Energy Information Administration, "Annual Energy Outlook 2007 With Projections

THERMAL ENERGY

Thermal energy includes uses of energy such as natural gas for heating and process heat. Heating includes the use of fuel for maintaining a comfortable environment in our homes and businesses. Process heat includes the use of energy for manufacturing, processing waste, emissions controls, and other processes need to develop goods. It does not include electric energy used for space conditioning or electric energy used in processes or manufacturing.

Thermal Energy is not addressed in this study. Most of the opportunities in the Thermal Energy market are in energy conversion or switching between energy types, as in from natural gas to electric.

ALTERNATIVE AND RENEWABLE ENERGY MARKET

There are several viable technologies in the Alternative and Renewable Energy market. The following presents a summary of the market opportunities for each technology within the total US market. The market potential figures in this section are the global potential market size. Appendix 1 of this document contains a more detailed description of various Alternative and Renewable Energy technologies.

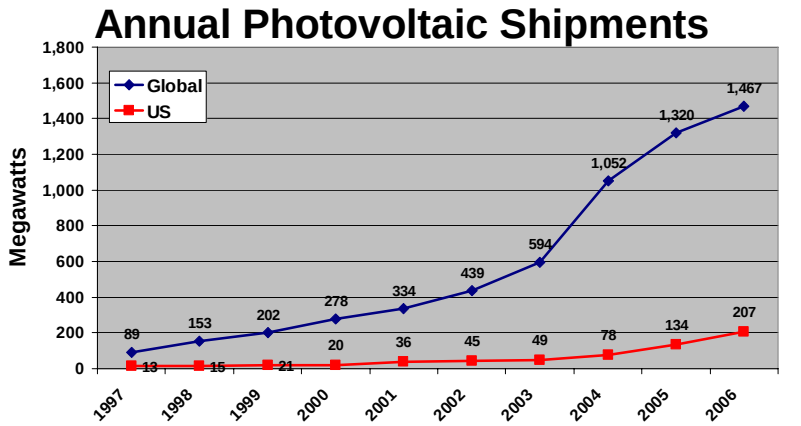
SOLAR

Market Potential: $51 billion
270,000 Jobs

The solar energy market has the fastest growth rate of any Alternative and Renewable Energy market today. The solar market has been growing at an average rate of 35% per year since 1990. Last year's growth rate was 19%. (See Chart 7.)

Global Investment in solar energy in 2006 was over $10.6 billion. Installed global solar energy capacity increased by 1,744 megawatts to 6,000 megawatts in one year (33%). The solar energy market is projected to grow to $51 billion by 2015. There are now two segments in the solar energy market for electric production, Photovoltaic and Thermal Solar. These two technologies have different applications and different market opportunities.

Chart 7

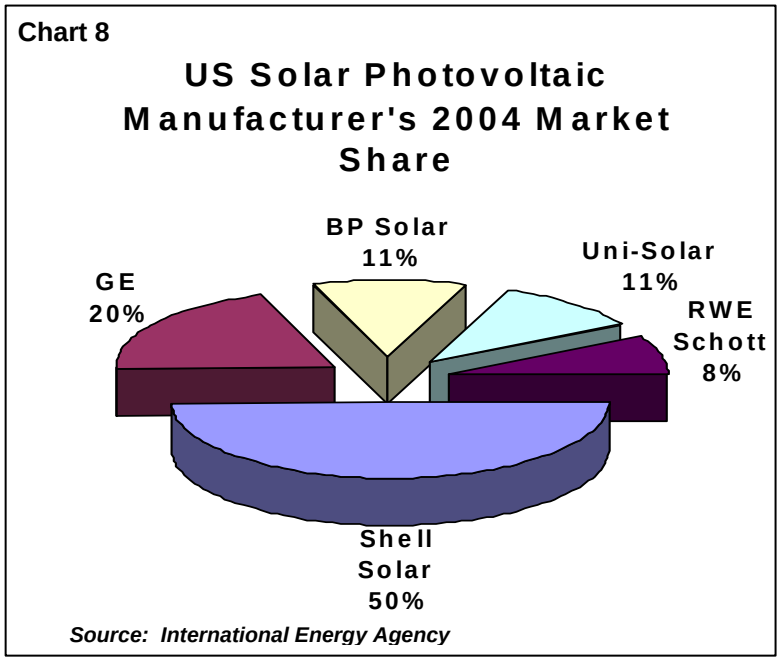


Source: Energy Information Administration, http://www.awea.org/pubs/documents/Outlook_2007.pdf
European Photovoltaic Industry Association (EPIA), http://www.epia.org/

Photovoltaic

The total installed solar power generation capacity in the US was 610 megawatts at the end of 2006, making it the third largest market in terms of installed capacity. During 2006, 140 megawatts of capacity was added in the US. Key drivers for Solar power include state and federal incentives to encourage increased manufacturing interest in Solar energy, increased venture capital funding and state level Renewable Portfolio Standards targets.

Chart 8



Source: International Energy Agency

Globally, the solar Photovoltaic market is dominated by Sharp with a market share of around 27.1%. Kyocera, Q-Cells and Sanyo are other major companies with a global market share of 8.8%, 6.3% and 5.4% respectively. The largest US-based company is Shell Solar, which is sixth on the list of top 10 global solar Photovoltaic manufacturers and the largest in the US. (See Chart 8 on page 11.) Michigan-based United Solar Ovonic is the leader in thin-film Photovoltaic with an estimated 120 megawatts installed worldwide.

Thermal Solar

This type of solar power generation concentrates sunlight to produce steam for driving turbines for electric generation. (See Appendix I.) Worldwide thermal solar installed capacity reached 350 megawatts at the end of 2006. Thermal Solar is also growing in the US. The area of solar concentrator is a measure of the amount of product shipped. Shipments of thermal solar in the US have increased by 60% form 1979 – 2006. (See Table 1.) Pacific Gas and Electric recently announced it is planning to build over 2,000 megawatts of thermal solar power.

Table 1

Solar Thermal Collector Domestic Shipments 1997-2006

	Shipments (Thousand Square Feet)
1997	7,759
1998	7,396
1999	8,046
2000	7,857
2001	10,349
2002	11,004
2003	10,926
2004	13,301
2005	14,680
2006	19,532

Source: Energy Information Administration

US SOLAR MARKET DRIVERS

- **Federal investment tax credit of 30% of the capital cost of solar installation.**
- **Solar percentage targets in six states.**
- **$168 million US Department of Energy 50-50 funding available to expand US solar manufacturing capability.**
- **Increased venture capital funding the solar market.**

WIND

Market Potential: $62.3 billion
398,000 Jobs

Globally, in 2006, installed wind energy capacity reached 74,200 megawatts. (See Chart 9.) The 15,200 megawatts of new global wind energy capacity installed in 2006**,** increased total wind energy capacity by 32%. It is estimated that the 2006 global investment in wind energy reached $23 billion.

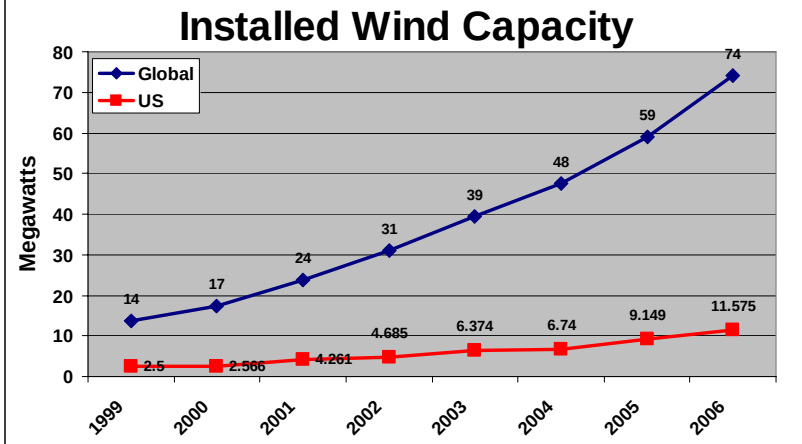
The US now has the third largest amount of wind energy capacity in the world. At the end of 2006, the cumulative installed wind energy generating capacity in the US was 11,603 megawatts. The 2,400 megawatts of new wind capacity added in the US in 2006 was the most of any country. 2006 investments in wind energy are estimated to be over $4.0 billion. In 2007, expenditures on wind energy projects are expected to exceed $9.6 billion.

The Energy Information Administration projects that if the 15% National Renewable Portfolio Standards policy is passed, the portion of renewable generation from wind would require the installation of approximately 15,000 additional wind turbines in the US by 2030, doubling the current number. The Energy Information Administration also predicts that if the 25% National Renewable Portfolio Standards policy is passed, the portion of renewable generation from wind would require the installation of approximately 67,000 additional wind turbines in the US, quadrupling the current number.

Wind energy's expansion in the last few years reflects the effectiveness of continuity in the availability of Production Tax Credit in encouraging investment in wind. Historically, the lack of predictability about the fate of the Production Tax Credit has resulted in erratic growth of wind energy in the US. Long-term predictability for the Production Tax Credit should therefore enhance investments. Wind energy is increasingly popular in rural America as it creates new jobs in rural communities and has become an important source of income for farmers besides adding to local tax revenues. According to recent estimates from the American Wind Energy Association, every 100 megawatts of wind capacity creates 200 construction jobs, two to five permanent jobs, and up to $1.0 million in local property tax revenue.

The cost of wind power has decreased to the point where it is now competitive with traditional forms of energy. Projected costs of wind energy in many areas of the US are expected to drop to $0.06 per kilowatt-hour. In Michigan, wind power may well be equal to or below the cost of new coal and nuclear generation, when configured with combustion turbines.

Chart 9



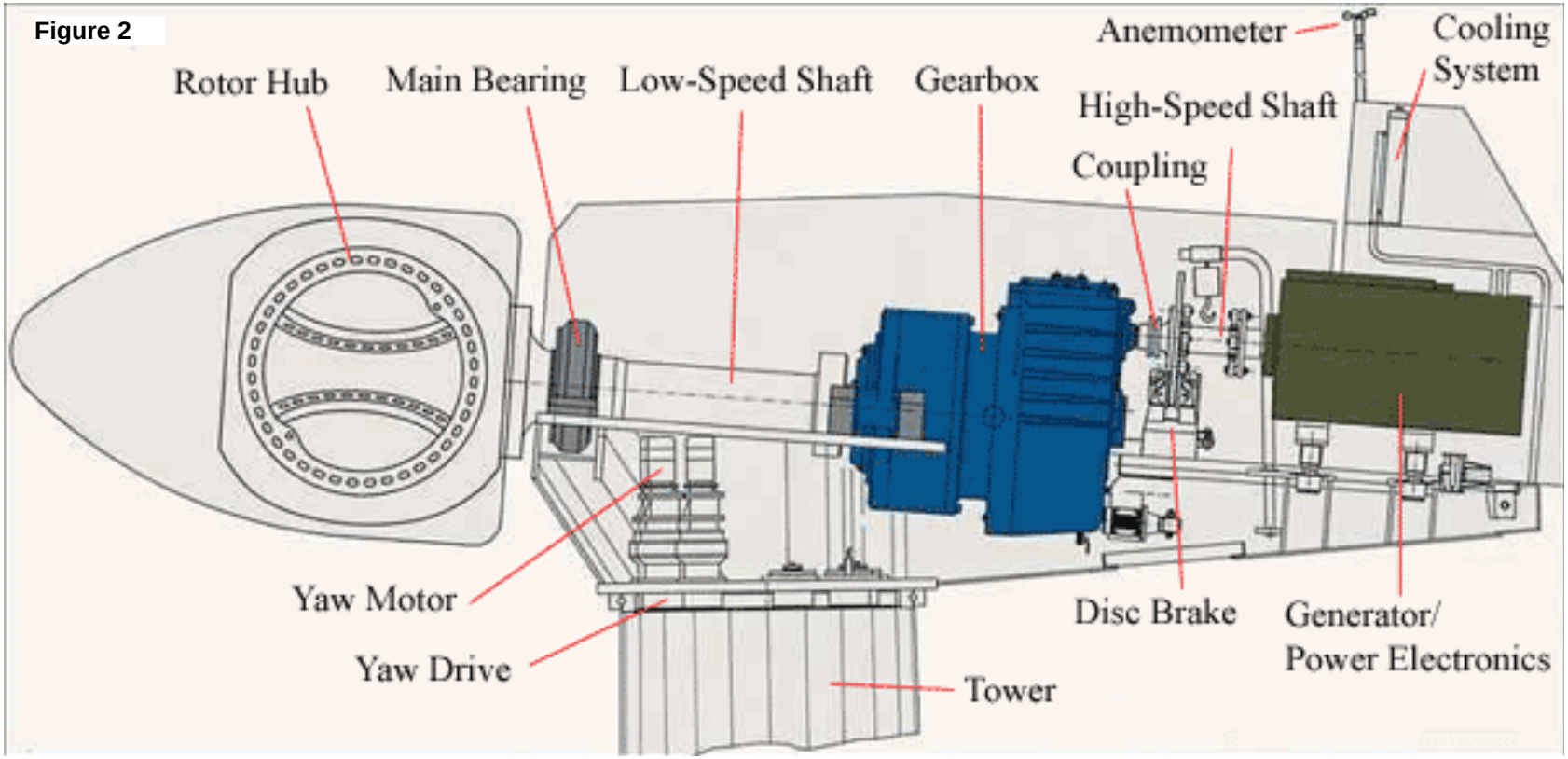
Source: Energy Information Administration, http://www.awea.org/pubs/documents/Outlook_2007.pdf

US WIND MARKET DRIVERS

- **The Production Tax Credit provides wind power producers about 1.2¢ per kilowatt-hour for every kilowatt-hour produced.**
- **24 states and the District of Columbia have passed Renewable Portfolio Standards legislation.**
- **Wind power is now cost competitive with coal, nuclear and gas-fired electric generation.**

Wind turbines are basically simple machines. Many of the components are produced using traditional machining and assembly techniques. (See Figure 2.)

Figure 2



GEOTHERMAL

Market Potential: $15.3 billion
72,000 Jobs

Geothermal power production uses very hot sections of the earth to boil water for power generation. The location for this type of generation is mostly in the West. (See Figure 3.)

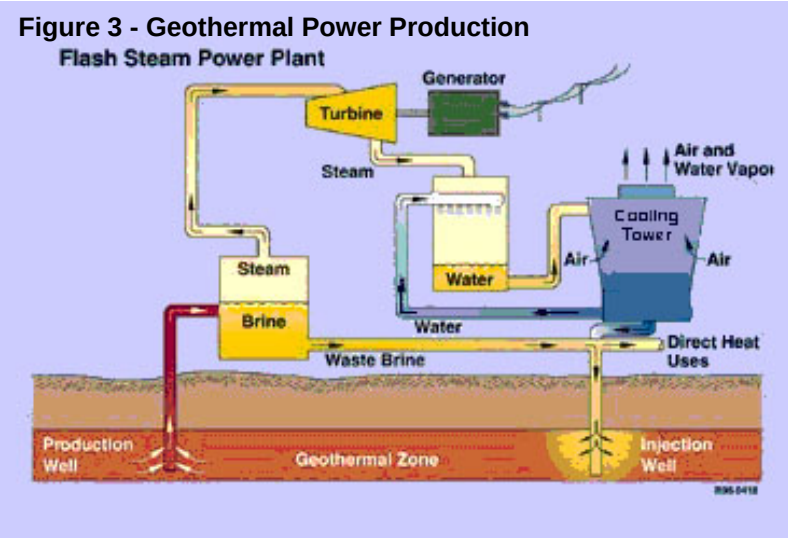
Over 8,900 megawatts of Geothermal energy is being generated worldwide, annually. Little Geothermal generation was added in 2006. It is estimated that in the next 10-15 years, $25 billion could be spent worldwide on new Geothermal projects.

The US is the world leader in Geothermal energy and, at the end of 2006, had a cumulative installed capacity of 2,830 megawatts generating well over 16,000 gigawatt-hours of energy. The US accounts for approximately 28.5% of the total world's installed capacity of Geothermal energy. The Western Governors' Association estimates that around 5,588 megawatts of capacity can be developed economically by 2015.

A survey conducted by Geothermal Energy Association found that around 51 new Geothermal power projects in various stages of development which have a potential to produce nearly 2,000 megawatts of new Geothermal power plant capacity in next three to five years. The Renewable Energy Policy Project estimates the manufacturing value of Geothermal to be about $15.3 billion over the next 10 years.

The US Department of Energy has set a goal of increasing economically viable Geothermal resources, including Enhanced Geothermal Systems and Hydrothermal Systems, to 40,000 megawatts by 2040. This places the market potential of Geothermal in the range of $110 billion.

Figure 3 - Geothermal Power Production



US GEOTHERMAL MARKET DRIVERS

- **The Production Tax Credit is available to new Geothermal projects.**
- **The US Department of Energy has set a goal of increasing Geothermal capacity by 40,000 megawatts by 2040.**
- **Public concerns with climate change.**

BIOMASS

Market Potential: $33 billion
81,000 Jobs

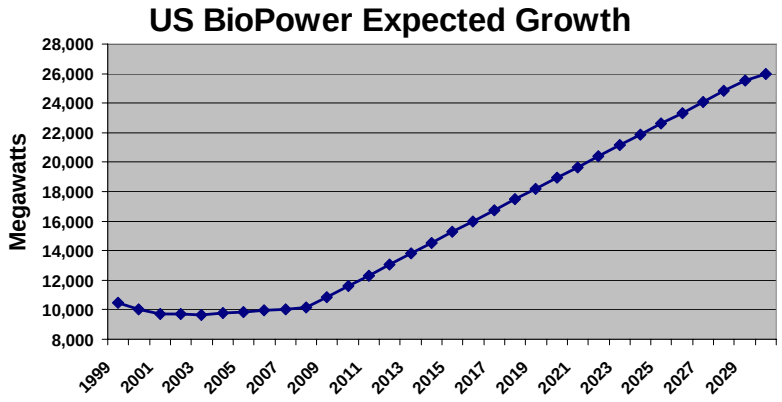
As an energy source, Biomass includes anything that is agriculturally grown and can include Municipal Solid Waste. Biomass has many different options in terms of its use to replace conventional forms of energy. For purposes of this study, we will divide the discussion on Biomass into electric production, termed Biopower and transportation fuels, termed Biofuel.

Biopower

At the end of 2006, the US had an installed capacity of more than 10,100 megawatts of Biopower making it the largest producer of Biopower worldwide. The 10,100 megawatts of capacity consists of about 9,700 megawatts of direct combustion facilities and 400 megawatts of co-firing facilities that burn wood and coal. Michigan already has five power plants which use Biopower in the form of wood to generate electricity.

The Energy Information Administration in its projection of renewable generation needed to achieve a 15% Renewable Portfolio Standards policy, indicates the US needs 26,000 megawatts of wood and other Biomass generation by 2030. (See Chart 10.) Co-firing of existing coal power plants is causing an increase in Biopower. Existing coal plants can use up to 5.0% wood for fuel at very low incremental cost. The market value of this amount of generation is in excess of $13 billion.

Chart 10



Source: Department of Energy EIA Report: "Impacts of a 15-Percent Renewable Portfolio Standard", June 2007

US BIOPOWER MARKET DRIVERS

- **Co-firing of existing coal power plants burning wood and coal.**
- **24 states and the District of Columbia with Renewable Portfolio Standards.**
- **Employment required for Biopower is up to 20 times higher then natural gas generation.**
- **The US Department of Energy has a $149 million program for Biopower research.**

Biofuels

As noted on page 6 under Transportation Fuels, Biofuels has been a fast growing market. Most of this growth has been in food-based fuels such as ethanol and Biodiesel. It appears that for the near-term, food-based ethanol has reached its peak due to impacts on crop prices and other factors. Biodiesel has room for some growth over the next few years.

Cellulosic ethanol is the next major market in Biofuels. The US Department of Energy is providing $385 million in funding for six demonstration cellulosic ethanol projects. Commercial production scale plants are not anticipated to be available until 2012.

The total market potential for Biofuels varies depending on the data source. The Energy Information Administration has estimated this market to be in the range of $20 billion.

US BIOFUELS MARKET DRIVERS

- **The President's program of "20 in 10."**
- **US Department of Energy's $385 million funding of six cellulosic ethanol projects.**
- **Farmer interest in increase crop prices.**
- **Public interest in reducing the US dependency on foreign oil and reduction in CO_2 emissions.**
- **Auto industry desires to reduce impact of increases in CAFE standards.**

WEST MICHIGAN OUTLOOK

The remainder of this document focuses on West Michigan's business and economic development opportunities in the Alternative and Renewable Energy industry sector. This analysis looks at internal and external factors affecting our ability to take advantage of opportunities in this market. This approach analyses West Michigan's strengths, weaknesses, opportunities and threats (SWOT). By better understanding these aspects of the region's situation, West Michigan can better leverage its strengths, overcome its weaknesses, capitalize on opportunities, and deter potential threats.

This cluster analysis combines global and national projections of the Alternative and Renewable Energy market with the capabilities of West Michigan businesses and the strengths of the region.

Resulting potential opportunities were narrowed down to focus on the near-term potential over the next three to five years. For each of the market opportunities, the analysis first established the amount of business West Michigan could expect to gain from this market based on what is equivalent to its existing market share of the manufacturing market using the appropriate Alternative and Renewable Energy North American Industry Classification System (NAICS) codes.

The Renewable Energy Policy Project produced an assessment of Michigan's manufacturing potential in the Alternative and Renewable Energy. This cluster analysis indicates that West Michigan has approximately 4.8% of the firms in the NAICS codes of industries providing components to the Alternative and Renewable Energy market. West Michigan has about 0.8% of the total number of firms nationally in NAICS codes capable of providing components into this same market. Using these relationships, this analysis identified the market share West Michigan could obtain with a proactive approach to gaining new business from the Alternative and Renewable Energy market. The original estimate assumed the region could capture .25% by doing nothing more than mirroring the market.

The data presented for the "Market Potential" in the following sections, represents the opportunities for West Michigan businesses resulting from obtaining only 1% of the total potential US market over the next five years utilizing a proactive approach to the market.

WEST MICHIGAN STRENGTHS

West Michigan is one of America's premier locations for business. The region's highly collaborative business community and sophisticated and diverse manufacturing base are complemented by a geographic proximity to major markets, highly developed infrastructure, highly trained workforce, and excellent quality of life.

Although five Forbes 500 (private) and four Fortune 1,000 companies call Greater Grand Rapids home, no one company or industry dominates this diverse business community. Nearly every type of industry is represented by the more than 2,100 manufacturers located here. An additional 82,000 establishments complete the region's business community.

West Michigan's strengths include:

- **Business Climate** – Manufacturing capabilities, labor force, the competencies and the business environment of West Michigan.
- **Location** – How West Michigan's location impacts decisions to do business in the area.
- **Resources** – Resource availability in West Michigan to new and existing businesses.

BUSINESS CLIMATE

West Michigan is home to world-class manufacturing companies, many leaders in their markets. In spite the retrenchment which has occurred in the automotive and office furniture sector, the region advanced manufacturing capabilities remain world class. West Michigan has built a strong base of support for its businesses. This support comes from the policy makers, various organizations, the people of the region and business itself.

Interviews with various business leaders show a strong belief that to maintain the status quo is not acceptable. While the region shows a tendency toward conservative policies and ideals, its business leaders are innovative and progressive. The cooperation among businesses in the region shows a strong sense of internal support for West Michigan.

SUSTAINABILITY

West Michigan recognized the need for the region to establish a balance between economic prosperity, social justice and the need to maintain and protect the area's environment. As early as 1995, the region had begun to adopt the concept of "sustainable business" with the creation of the West Michigan Sustainable Business Forum launched by the West Michigan Environmental Action Council. In 2003 Aquinas College in Grand Rapids became the first institution in the US to offer a Bachelor of Science degree in Sustainable Business.

The understanding and acceptance of sustainable business practices is one of the key strengths of West Michigan in attracting Alternative and Renewable Energy business. The region is one of the few to integrate its commitment to sustainability into the operation and strategies of its businesses. This is demonstrated by companies across the region and reflected in the membership of the West Michigan Sustainable Business Forum.

The adoption of sustainable business practices in the West Michigan business region is far ahead of most of the nation's businesses. This is a mindset that needs to be promoted in West Michigan's efforts to recruit Alternative and Renewable Energy business.

MANUFACTURING CAPABILITY

West Michigan has world-class manufacturing capability and a workforce with a strong work ethic. More than 22% of all jobs in the region are in manufacturing. There are 771 companies capable of producing components for Alternative and Renewable Energy technologies. There is a severe shortage in manufacturing capacity within the growing markets of Alternative and Renewable Energy technologies. Currently, wind turbine manufacturing capacity is sold out and today's orders with three lead times for new orders. The main wind turbine manufacturers are trying to bring on-line additional manufacturing of parts and components to increase total wind turbine production.

The supply of components to the wind energy industry and potential manufacturing of wind turbines is a strong opportunity for West Michigan.

There was a need identified by several leaders of Alternative and Renewable Energy companies for better quality control methods. West Michigan companies have superior knowledge of quality control in a variety of manufacturing systems. This knowledge could lead to new business in West Michigan.

WORKFORCE

West Michigan has a well-trained, large workforce with a strong work ethic. West Michigan manufacturing workforce is dominated by collaborative and cooperative employees, who clearly understand the competitive nature of today's global business model. More importantly, the region's is fortunate to have a strong base of employees with significant technical skill sets. West Michigan employees believe in doing their job well and working hard.

LOCATION

West Michigan is located in an area of rich natural environment that include beautiful lake shores, beaches, sand dunes, rivers and lakes. This area is often referred to as Michigan's "West Coast" because of its beauty. It is a favored destination for recreation by people all over the Midwest. This is one of the reasons why West Michigan is making an effort to protect and preserve the natural environment in the region.

ECONOMIC DEVELOPMENT RESOURCES

West Michigan is fortunate to have economic development professionals, who consistently, demonstrate and utilized best practices for retaining, attracting and nurturing business in the region. These organizations offer single point of contact and access to resources in support of existing and new businesses in the region.

The principal economic development organizations directly serving West Michigan are: (See Appendix V for detail contact information):

- The Right Place, Inc.
  Birgit M. Klohs, President
  www.rightplace.org

- Muskegon Area First
  Ed Garner, President
  www.muskegon.org

- Lakeshore Advantage
  Randy Thelen, President
  www.lakeshoreadvantage.com

- Newaygo County Economic Development Office, Inc.
  Andrew Lofgren, Executive Director
  www.ncedo.org

- Ionia County Economic Alliance
  Diane Smith, Executive Director
  www.msu.edu

- Chamber of Commerce of Grand Haven,
  Spring Lake & Ferrysburg
  Joy Gaasch, President
  www.grandhavenchamber.org

- Barry County Economic Development Alliance
  Valerie Byrnes, Executive Director
  www.barrychamber.com

- Allegan County Economic Development – MSU Extension
  Mark Thomas, Extension Educator
  www.msu.edu

TRANSPORTATION

Michigan's location presents both benefits and problems with transportation. Given our proximity to the Midwest wind market and access to the Great Lakes for shipping components, the region can potentially use its advantage. This may also be the case for shipment of large and bulky Photovoltaic assemblies. For this reason, West Michigan has the potential to move freight by water through its ports in Muskegon, Grand Haven and Holland. All of these ports have the capability to handle lake freighters.

For all land transportation from West Michigan must travel south before moving throughout the US. Despite the peninsular geography, land transportation is widely available through the abundant interstate road system and rail network in the area. The Gerald R. Ford International Airport is the 17th largest "small" air hub in the US and is served by major airlines.

INFRASTRUCTURE

West Michigan has abundant water and generally adequate sewer and electric supplies. The region's growth is requiring renewed look at expansion of sewer systems. Maintaining a clean environment is a priority for West Michigan and preventing contamination of water systems is critical. Fresh water supplies are widely available due to existing aquifers and access to Lake Michigan. New designs for lake water intakes have eliminated problems created by Zebra Mussel introduction into the great Lakes.

Electric infrastructure for West Michigan is designed to provide the area adequate electric supplies. The region has a robust electric transmission structure composed of both 345 kilovolts and 138 kilovolts transmission lines. The region's investor-owned utility, Consumers Energy, serves the majority of the area. The cities of Grand Haven, Holland, Lowell, and Zeeland have municipal utilities. Grand Haven and Holland both own generating stations. Great Lakes and Tri-County Electric Cooperatives also operate in several of the counties in West Michigan.

WEST MICHIGAN WEAKNESSES

This analysis has found various weaknesses that will impact West Michigan's ability to take advantage of the opportunities in the fast growing Alternative and Renewable Energy market. None of these weaknesses will prevent the region from participating and growing market share in this industry.

LACK OF MAJOR ENERGY INDUSTRY CORPORATE BASE

West Michigan's only notable producer of equipment for the energy industry is United Solar Ovonic. While this is an excellent asset in the growing solar field, other manufacturers of equipment and components for Alternative and Renewable Energy technologies are not located in West Michigan. Michigan and West Michigan have little if any history as a home to a major manufacturer of energy equipment. Companies are not looking to Michigan for the expertise and manufacturing of this type of equipment. This impacts the region's ability to attract new business.

If West Michigan intends to be successful in the Alternative and Renewable Energy Industry sector, it will be critical to market the region's capabilities—not only in the production of components for Alternative and Renewable Energy technologies—but also in industry knowledge.

LACK OF INVESTMENT CAPITAL

Venture capital is the fuel on which new companies run. Alternative and Renewable Energy is still a relatively new industry, with a large amount of research and development. Lack of venture capital impacts West Michigan's ability to attract some of the newer companies with technologies that need to go through second stage "proof of concept." Without venture capital, West Michigan will have to be creative in putting packages together to lure potential new companies. These can include:

- Special options on land or buildings
- Providing incubation space for new companies
- Providing low cost support services
- Links to research facilities to test new concepts
- Access to quality talent that understands the energy market.

LACK OF NOTABLE RESEARCH UNIVERSITIES

It is no surprise regions with strong university research capabilities in a certain field are able to draw companies to tap into the available intellectual capital. West Michigan has excellent colleges and universities, but they are not known, in general for their pure research capability, especially in the energy industry. The Michigan Alternative and Renewable Energy Center and the launch of Michigan State University's new BioEconomy Institute in the latter part of 2008 provide resources to offset this weakness. (See the section on Commercialization on page 25.)

PROXIMITY TO MANY ALTERNATIVE AND RENEWABLE ENERGY MARKETS

West Michigan's location on a peninsula in the upper Midwest of the US is remote from much of the Alternative and Renewable Energy markets in California and the Plains States. Most of the solar photovoltaic market is being sold to states with high levels of sun in the southern half of the country. The major wind turbine manufacturers are locating their operations in Iowa, Texas and Minnesota because some of the windiest areas in the US are west of the Mississippi. Almost all of the activity in Geothermal energy is in the western US.

MICHIGAN PERCEPTION

The perception of Michigan as a "rust belt state" continues to be of concern because it creates the wrong image of the State in the mind of potential new West Michigan business investors. The region has been working aggressively to change this perception. Current marketing efforts acknowledge this weakness and future campaigns will have to build upon advanced manufacturing and sustainability image of the region.

WEST MICHIGAN OPPORTUNITIES

MANUFACTURING OPPORTUNITIES

Market Potential: $800 million
4,250 jobs

Global manufacturing capacity of Alternative Energy components is currently severely constrained. With the rate of growth in solar, wind, and Biopower, lead times for new units is in excess of two to three years. Several announcements have been made in recent months about new manufacturing facilities or expansion of existing facilities that manufacture components for wind turbines.

It is estimated that to meet a US Renewable Portfolio Standards commitment of 15%, wind turbine capacity will need to more then double. Currently, wind turbine manufacturers are unable to supply units for new orders until 2011. The situation in the solar markets is similar. United Solar Ovonic, with production facilities located in Greenville, MI, is currently looking at expansion to meet demand for its thin-film photovoltaic.

West Michigan's manufacturing capability is needed by the Alternative and Renewable Energy Industry sector. It is estimated that the national market for components in the Alternative and Renewable Energy Industry is over $160 billion for the next ten years.

Appendix II is a matrix of NAICS codes determined to be capable of providing components in each of the Alternative and Renewable Energy technologies. Using the NAICS codes, there are over 2,000 firms in Michigan capable of producing components for the Alternative and Renewable Energy industry. ***West Michigan is estimated to have 771 firms that are in the Alternative and Renewable Energy Industry NAICS Codes.***

Based on the analysis conducted and using data published by the Renewable Energy Policy Project, West Michigan's potential opportunity over the next five years in the manufacturing of components using a proactive set of strategies is in excess of $800 million and could create over 4,250 new jobs.

This analysis assumes that West Michigan is able to secure 1% market share of the Alternative and Renewable Energy components at a rate based upon the percentage of manufacturing it provides in the US. The project's estimate is conservative, based upon the number of firms in each viable NAICS code, equal to only .25% of the market. There was no attempt made to factor into the estimates actions as proposed in this cluster analysis. Table 2 shows the manufacturing potential for manufacturers in the Alternative and Renewable Energy Industry sector.

Table 2

ALTERNATIVE ENERGY MANUFACTURING POTENTIAL

	INVESTMENT (millions)				
	WIND	SOLAR	GEOTHERMAL	BIOMASS	TOTAL
US	$62,300	$69,600	$15,300	$13,200	$160,400
MICHIGAN	$3,450	$1,250	$270	$350	$5,320
WEST MICHIGAN	$247.7	$90.8	$11.5	$34.7	$384.7

	NEW JOBS				
	WIND	SOLAR	GEOTHERMAL	BIOMASS	TOTAL
US	398,500	298,200	72,300	81,600	850,600
MICHIGAN	24,300	6,600	1,500	2,300	34,700
WEST MICHIGAN	1,779	851	74	231	2,935

United Solar Ovonic – Greenville's Success Story

In 2006, following the announcement that Electrolux was closing its plant in the city of Greenville, Governor Granholm, the Michigan Economic Development Corporation and local officials worked to bring the United Solar Ovonic's planned manufacturing expansion to Greenville, Michigan.

In the 1st phase of this project, United Solar Ovonic invested $129 million in the facility and employs about 250 people. The plant went on line in November 2007, a month earlier then expected. The rapid rate of growth for United Solar Ovonic is already causing them to plan additional plants in the Greenville area. United Solar Ovonic plans to increase its production from 60 megawatts to 300 megawatts by 2010.

PRODUCTION OPPORTUNITIES

Electric Production Opportunities

Market Potential: $400 Million
85 Jobs

Michigan will need sites at which to produce Alternative and Renewable Energy. Currently, only 2.3% of Michigan's electricity comes from renewable sources. The 21st Century Electric Energy Plan for Michigan recommended a Renewable Portfolio Standards policy of 10% renewable energy by 2015.

The energy legislation being considered by the US Congress includes a 15% RPS by 2020. In early December 2007, the Michigan Senate Energy and Technology Committee moved proposed Renewable Portfolio Standards legislation to the Senate floor that would require 20% of Michigan's electricity to be from renewable fuels.

There are two opportunities for West Michigan in the production category. The region's economic development organization should seek to identify Alternative and Renewable Energy sites and develop partnerships with Alternative and Renewable Energy producers. The location of an Alternative and Renewable Energy project needs a customer to buy the power, adequate fuel supply within the region, electric transmission capacity and other project specific characteristics. There are plenty of sites with in West Michigan that will meet the needs of respective Alternative and Renewable Energy technologies.

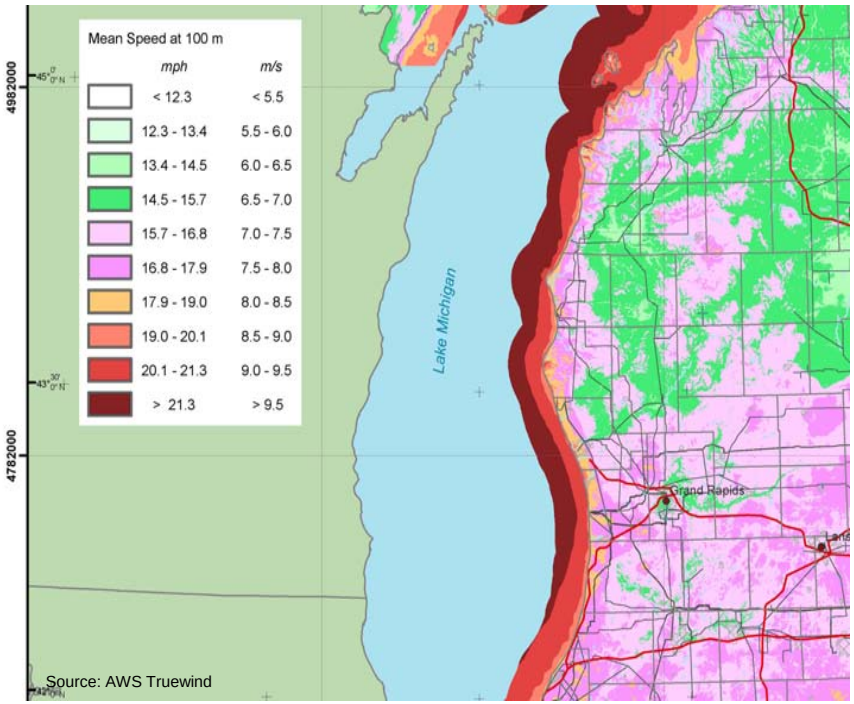
Other factors affecting site selection include zoning issues and local taxes. Communities should consider and evaluate changes to zoning ordinances to remove obstacles to the development of Alternative and Renewable Energy projects. Local and state incentives will be required to attract these investments.

Several counties in West Michigan may have wind conditions capable of supporting wind farms. In Figure 4 the AWS Truewind wind speed maps for 70 meters and 100 meters. Several areas in West Michigan seven counties have proper wind conditions to support wind power project development. Preliminary indications are this area could support 200 megawatts of wind power. This would bring approximately $400 million of investment to the area.

Further detailed analysis and gathering of actual wind meteorological data is necessary to verify the potential for this area. The potential exist to create up to 85 jobs based on these estimates.

While not addressed in detail in this analysis, the long-term outlook for offshore wind generation in Lake Michigan has great potential. Initial investigation and preliminary projections of 2000 – 4000 megawatts with capital investments of $2-4 billion could be feasible. Based on various scenario wind turbines would be barely visible or not all and wind speeds would support improved efficiencies, offset by issues of submerged cables required for transmitting power back to mainland. (See MAREC and MSU BioEconomy Institute under the Commercialization heading on pages 25 - 26.)

Figure 4



Biopower Production Opportunities

Market Potential: $12.5 Million
No estimated Jobs

The primary opportunity for power production from Biomass in West Michigan would be in anaerobic digestion of animal waste. There are approximately 10 farms in the seven county area of sufficient size to support installation of anaerobic digesters and generators. This could produce over 5 megawatts if properly operated. Capital investment for these projects would be in the range of $12.5 million. Not only does this process create electric power, but it significantly improves our region's environmental performance.

Biofuels Production Opportunities

Market Potential: $5 Million
15 Jobs

Because of growing concern with food crop based fuels, near-term development opportunities in Biofuels are likely limited to installation of infrastructure for Biofuels delivery. Ethanol produced from corn has significantly raised crop prices and are affecting food prices. It is also questionable whether the energy required to produce corn based ethanol, is justified use of energy. Biodiesel has been slow to develop and it is also suffering from impacts on food prices.

West Michigan's current opportunity in Biofuels is investment in infrastructure. New dispensing methods, transportation and associated infrastructure is needed to get the Biofuels to the consumer. The region will need to invest in this infrastructure in the very near future.

West Michigan's long-term opportunity in Biofuels lies in the cellulosic ethanol market. The first opportunity is in the production of the enzymes used to break down cellulose so it can be used to manufacture ethanol. West Michigan's future expertise in bio-sciences makes it a prime candidate to develop and obtain licenses to manufacture these enzymes.

The launch of the Michigan State University's BioEconomy Institute in the ladder part of 2008 will significantly enhances our competitive position. (See page 25 for more detailed information.) As noted earlier the capabilities provided by a major research university will provide our region a significant competitive advantage.

The second opportunity will be to secure a cellulosic ethanol plant. Ethanol's limitations on transportation will require local production. The seven county area of West Michigan has sufficient cellulosic feed stock to support a cellulosic ethanol plant.

RESEARCH AND COMMERCIALIZATION OPPORTUNITIES

West Michigan is fortunate to have access to critical research and development infrastructure to support the commercialization and manufacturing of Alternative and Renewable Energy technologies.

Research

The following institutions and resources provide valuable research into Alternative and Renewable Energy. West Michigan needs to capitalize on these resources to extend its expertise in the Alternative and Renewable Energy Industry sector.

Michigan State University's BioEconomy Institute

Bioeconomic activity takes place when companies produce goods, services or energy from raw materials derived from renewable plant-based sources. A bioeconomy for Michigan will help reinvigorate the state's economic base by connecting strengths in agriculture, forestry and natural resources with traditional strengths in the manufacturing and industrial sectors.

Final approval of Michigan State University's BioEconomy Institute's launch is anticipated by year-end and expected to begin commercial operation in the latter part of 2008. A significant part of their focus will be to conduct research and development targeted in part to the Biofuels market. Representatives from Pfizer Inc., Michigan State University, and Earlier in 2007, Lakeshore Advantage reached an agreement in principle, for the new research and development center in Holland, which will be based in an advanced-research facility donated by Pfizer.

Previously used for drug development, the three-story, 138,000-square-foot building includes modern laboratories for up to 100 researchers, a 125-seat auditorium, a library, atrium, offices and a pilot plant. According to Pfizer, the facility has a replacement value of $50 million.

The pilot plant has a total chemical reactor capacity of 37,000 liters and centralized automatic controls. The pilot plant will permit initial production of bio based products in volumes sufficient for commercial prototyping and testing by Michigan companies in furniture, automotive plastics and other industries.

When fully operational, the MSU facility is expected to employ 100 people—most of who will come from scientific and technical backgrounds—and will serve as a hub for the growth of BioEconomic activity in the region.

Research work at the facility is expected to focus on:

- The economical production of useful Biomass.
- Biofuel refining.
- Use of Biomass feedstock for production of specialty, foundational and commodity chemicals.
- Bioeconomy standards compliance and quality assurance. Social, environmental and workplace safety issues in the emerging bio-economy.

Western Michigan University's Manufacturing Research Center (MRC) and Alternative and Renewable Energy Laboratories

The MRC is a multidisciplinary operation within the College of Engineering and Applied Sciences at West Michigan University in Kalamazoo, MI. MRC supports manufacturing industries by providing opportunities for collaboration with faculty and students and serving as a resource and partner to its constituents. The MRC emphasizes applied research in engineering and the sciences, with expertise in energy conservation and the wind energy market.

The Alternative and Renewable Energy Laboratories conducts research into alternative fuels, wind, solar, Biofuels, and cellulose.

National Renewable Energy Laboratory

The National Renewable Energy Laboratory (NREL) is the nation's primary laboratory for renewable energy and energy efficiency research and development.

NREL's mission and strategy are focused on advancing the US Department of Energy's and our nation's energy goals. The laboratory's scientists and researchers support critical market objectives to accelerate research from scientific innovations to market-viable alternative energy solutions.

At the core of this strategic direction are NREL's research and technology development areas. These areas span from understanding renewable resources for energy, to the conversion of these resources to renewable electricity and fuels, and ultimately to the use of renewable electricity and fuels in homes, commercial buildings, and vehicles. The laboratory thereby directly contributes to our nation's goal for finding new renewable ways to power our homes, businesses, and cars.

Working with MAREC and Next Energy it is anticipated West Michigan will have direct access to NREL capability to further enhance the region's competitive position.

COMMERCIALIZATION

Working through the region's economic development organizations and Michigan Alternative and Renewable Energy Center, businesses in West Michigan can obtain direct access to critical research, data and expertise designed to accelerate the commercialization process in our region.

InnovationWorks

The launch of the region's Alternative and Renewable Energy cluster coincides with the introduction of InnovationWorks. This totally new and exciting program is designed specifically to enable the commercialization of emerging and advanced renewable and alternative energy sources.

Based on specific project needs of a client the InnovationWorks team working with their economic development partners and other technical experts can connect developers, manufacturers and investors with the right tools to ensure project success. This is including intellectual property mining, brokering, coaching and mentoring. For information about InnovationWorks, go to www.innovationworkswestmichigan.com.

Grand Valley State University's Michigan Alternative and Renewable Energy Center (MAREC)

The center, located in one of Michigan's 11 Smart Zones, is a breakthrough vision conceived by Grand Valley State University to achieve a successful shift to the new Alternative and Renewable Energy economy in our region and State.

MAREC's personnel have skills in material science, chemical engineering, biological sciences, and electrical controls engineering. MAREC focuses on selecting and demonstrating the technological and economic performance of some key emerging renewable energy technologies.

MAREC has been very successful at defining these technologies in the areas of fuel cells, combined heat/power micro turbines, battery technology, Photovoltaic solar panels, and wind power. MAREC also launched a Biomass-to-electricity initiative which resulted in the construction of the most advanced Biomass plant in the US. The region and our State have a large Biomass resource that can be converted to electric power, while protecting our environment, and creating jobs. MAREC is engaged in an offshore wind initiative that could significantly impact our region's power generation and job creation. MAREC's recent installation of its wind turbine is the seed technology for this initiative.

MAREC's staff has the entrepreneurial experience needed to create and attract start-up companies within our region. Start-up companies are the key accelerators to the technology transfer and economic development within this new Alternative and Renewable Energy market. MAREC is uniquely positioned and proven to rapidly test Alternative and Renewable Energy technologies and start up new companies in this field. It is anticipated that two new Alternative and Renewable Energy based technology companies will be launched from MAREC by early next year.

While renewable education needs to grow significantly in our region, MAREC has demonstrated success as a technical and entrepreneurial resource for West Michigan.

NextEnergy

NextEnergy is a non-profit corporation founded to enable the commercialization of energy technologies that positively contribute to economic competitiveness, energy security and the environment. NextEnergy can be relied upon for objective, technically balanced thought leadership on pressing energy issues and opportunities facing West Michigan, filling critical knowledge gaps between industry and institutions. NextEnergy stands ready to assist Michigan's government and economic development leaders in attracting, nurturing and retaining alternative energy businesses and employment opportunities.

EMPLOYMENT AND TRAINING OPPORTUNITIES

The energy industry is starting to suffer from a lack of skilled employees in several major sectors. In the utility industry, many of its qualified electric line workers are retiring and it takes nearly two years for a utility to sufficiently train new workers to be effective. It has been over twenty years since a utility has built a large coal or nuclear power plant. These facilities require roughly 1,100 workers of various trades over a seven year or longer period to complete. There is currently a lack of trained welders and pipe fitters capable of working on power plant projects.

The alternative energy sector is woefully understaffed and seeking ways to accelerate its training related requirements. This issue needs further investigation, but certainly present significant opportunities for expanded employment.

West Michigan's colleges, Michigan Technical Education Centers and community colleges are addressing some of these, but the region should look at the potential to expand its capabilities tied to further development of the Alternative and Renewable Energy Industry sector.

Aquinas College's Center for Sustainability
The Center for Sustainability at Aquinas College is a student-run and faculty-directed organization providing a web-based clearinghouse of information for consumers, business people, non-profit organizations, students, and governmental agencies interested in sustainable practices. The Center is located at Aquinas College, the first institution in the US to offer undergraduate degrees in sustainable business.

In addition to collecting and disseminating information, the Center also conducts conferences and workshops, maintains an extensive list of publications on sustainability, and organizes the Campus Sustainability Initiative at Aquinas. The Aquinas Sustainable Business Degree program fosters ecological and social intelligence in all business decisions and is the only undergraduate program of its kind in Michigan and possibly the US.

Grand Valley State University's Sustainability Initiative
The Sustainability Initiative of Grand Valley State University has helped not only the university, but is actively pursuing and supporting community-based initiatives. Grand Valley's Business and Engineering schools are actively supporting initiatives in the Alternative and Renewable Energy Industry sector. They will host an event in the spring of 2008 working with regional partners designed to help West Michigan better understand these opportunities.

Ferris State University's College of Technology
The university possesses an exceptional blend of technology and education programs, laboratory resources, faculty expertise and graduates that can provide leadership in addressing West Michigan's energy challenges. The College of Technology has been active in energy related activities for many years. The university has committed to conduct an annual conference to help the region focus on this critical sector.

THREATS TO ALTERNATIVE AND RENEWABLE ENERGY IN WEST MICHIGAN

Multiple states and other organizations are already pursuing strategies to attract, expand and retain the Alternative and Renewable Energy Industry sector. Michigan's lack of a Renewable Portfolio Standards policy is a significant barrier. Most of the major wind turbine suppliers have already established final assembly operations in other states, where a Renewable Portfolio Standards policy has been approved. As one would expect, the desire to be close to primary suppliers is causing development for manufacturing of new wind turbine components in other states.

MANUFACTURING THREATS

As with most markets, location is a critical issue in the Alternative and Renewable Energy Industry sector. The following are key threats to manufacturing for Alternative and Renewable Energy technologies in the region:

- Most of the wind turbine manufacturing is already established in Iowa, Texas and the upper Midwest.
- Michigan's distance to major Photovoltaic markets is an impediment to attracting additional solar business.

PRODUCTION THREATS

Electricity Production

West Michigan faces the following threats regarding development of Alternative and Renewable Energy electric production:

- Population density limits wind power generation sites.
- Other areas of Michigan may have better geography and wind conditions.
- Biomass capable of being used in power generation is relatively scarce in West Michigan.

Fuels Production

Wood-based cellulosic ethanol processes are a threat to West Michigan's ability to become a site for future cellulosic ethanol production. The US Department of Energy has already issued grants to six cellulosic ethanol plants in other states.

THE ACTION PLAN

This plan creates an initial framework for developing an Alternative and Renewable Energy cluster in West Michigan. The region's economic development organizations working in cooperation business, government and institutional leaders will take primary responsibility for implementing this action plan.

MANUFACTURING

Based on findings of this analysis, the region's manufacturers are well-suited to provide components for wind turbines and solar systems. The value of the new business in these two sectors of the Alternative and Renewable Energy Industry sector is conservatively estimated at $800 million and could lead to the creation of 4,250 jobs over the next three to five years.

West Michigan is already a major player in the manufacture of solar Photovoltaic products with United Solar Ovonic. The region needs to expand the component manufacturing market share in this sector.

Building on the expertise and capabilities of the region's economic development organizations, the region should focus its efforts on helping existing manufacturers to obtain component manufacturing and machining business for wind energy technologies. Current constraints and rapid growth in wind energy development are increasing pressure on existing wind turbine manufacturers to add additional capacity.

Michigan's lack of a Renewable Portfolio Standards policy may delay attracting some Alternative and Renewable Energy technology manufacturers from developing facilities in West Michigan. The lack of a State policy should not prevent the region from aggressively promoting West Michigan's supply chain advantages. Efforts already underway by The Right Place, Inc. and NextEnergy to meet with wind turbine companies will encourage the development of new business.

Steps to pursue to develop the Alternative and Renewable Energy manufacturing cluster:

- Conduct a survey of West Michigan manufacturing businesses to develop a database of firms interested and capable of being suppliers in this market. (The Right Place, Inc. and NextEnergy have a draft the document, see Appendix III.)
- Develop supply chain strategies connecting local manufacturing companies with Original Equipment Manufacturers.
- The Right Place, Inc. will continue to conduct international reverse investment business attraction initiatives.
- Market the commercialization services to be offered by InnovationWorks (a WIRED West Michigan funded innovation, designed by The Right Place, Inc. and its partners) to regional, national and international entrepreneurs and companies.
- Educate local manufacturers about the opportunities, technology and components required by this industry.
- Conduct and host meetings with Original Equipment Manufacturers.
- Attend industry events to promote West Michigan's capabilities and assets.
- Connect new and existing businesses through the Muskegon Alternative and Renewable Energy Center with the research and development resources of our region, state and federal partners.

POWER PRODUCTION

West Michigan is well positioned to attract and locate up to $400 million in capital investment at potential sites in West Michigan for wind turbine powered generation.

There are many notable wind energy project developers in Michigan. Consumers Energy, along with a number of other companies have announced intentions to construct new wind power projects in Michigan. Once Michigan passes its Renewable Portfolio Standards policy, the opportunities will develop quickly.

Steps to pursue to develop Alternative and Renewable Energy production:

- Identify and contact wind energy project developers.
- Identify potential sites for wind power generation with pre-approved zoning.
- Install a few meteorological towers in the better wind areas of West Michigan to begin data collection.

BIOFUELS

Cellulosic ethanol is going to become a major alternative fuel in the US and Michigan. Vehicle manufacturers are already producing flex-fuel vehicles for this market.

Steps to pursue to develop Alternative and Renewable Energy Biofuels:

- Initiate installation of infrastructure to supply ethanol to the market. This includes supply terminals, delivery systems and point of sale fueling.
- Initiate efforts to capture the Cellulosic ethanol market in the Midwest. These would require assembling a team to develop and fund a Cellulosic Ethanol Plant.
- Encourage a West Michigan company to seek the license to produce the enzymes used to breakdown cellulose in the cellulosic ethanol production process.

RESEARCH

West Michigan needs to leverage the existing research capability in the region and establish strong relationships with the National Renewable Energy Laboratory and other organizations performing pure research into Alternative and Renewable Energy technologies.

These relationships need to link the research community with West Michigan.

Steps to pursue to develop Alternative and Renewable Energy research capability:

- Communicate and market our existing research capabilities
- Link the research community with West Michigan businesses.
- Conduct seminars targeted to national and international companies and potential investors.

LEGISLATIVE EFFORT

The West Michigan Strategic Alliance, the region's economic development organizations, and business associations will work with legislators from the region to help them understand the urgency and importance that a State Renewable Portfolio Standards policy and related progressive energy policies hold for our region.

OTHER ACTIONS

- Develop training programs in West Michigan's community colleges and Michigan Technical Education Centers to train workers for the Alternative and Renewable Energy Industry sector and for other energy industry jobs.
- Conduct further investigation into energy conservation and efficiency.
- Develop and expand educational programs targeted at expanding our region's sustainability capabilities.

CONTACT LIST

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About EOS:
This cluster analysis was managed by Energy Options and Solutions, a consulting group, with projects in energy analysis, energy auditing, utility regulation and rate making, and Alternative and Renewable Energy. Past and present clients include:

- Spartan Stores
- Domino's Pizza
- Third Planet Wind, LLC
- Dow Corning Corporation
- Michigan Department of Environmental Quality
- Energy Michigan
- NextEnergy, Inc.
- Nobel Environmental Power

About The Right Place, Inc. (www.rightplace.org): The Right Place, Inc., organized in 1985, is a private/public partnership for economic development dedicated to job retention and job creation in the greater Grand Rapids area. Its strategic priorities include: leading business retention, expansion and attraction; identify and develop emerging growth opportunities; strengthen manufacturing leadership and innovation; lead urban redevelopment vital to business retention and attraction; lead regional initiatives in economic development.

About West Michigan Strategic Alliance (www.wm-alliance.org): The West Michigan Strategic Alliance is a diverse group of residents and business, government, and institutional leaders who are working together to be a catalyst for regional collaboration. Since its founding, the West Michigan Strategic Alliance has focused its efforts on the following strategic priorities: regionalism, economic growth, diversity, sustainability, urban revitalization, and regional growth. The alliance focuses its effort on the seven counties which make up our Combined Statistical Area of Kent, Ottawa, Allegan, Muskegon, Newaygo, Barry and Ionia.

Appendices

APPENDIX 1:

DESCRIPTION OF ALTERNATIVE AND RENEWABLE ENERGY TECHNOLOGIES

ELECTRIC ENERGY

Solar

The solar energy market has the fastest growing rate of any Alternative Energy market today. The solar market has been growing at an average rate of 35% per year since 1990 and last year's growth was 19%. Investment in solar energy in 2006 was over $10.6 billion. Installed solar energy capacity has risen from 1,656 megawatts to 2,204 megawatts in one year (33%). The solar energy market is projected to grow to $51 billion by 2015. There are now two segments in the solar energy market for electric production, Photovoltaic and Thermal Solar. These two technologies have different applications and market opportunities.

Photovoltaic

Prices of all forms of solar energy systems are dropping. New technologies are projected to drop the installation cost of Photovoltaic systems to under $3.00 per watt by 2010. Recent presentations by various companies at the NREL's Industrial Growth Forum indicate they expect the cost of lifecycle electricity from photovoltaic to drop to around 10 cents per kilowatt hour by 2012.

The price reduction in Photovoltaic is coming from two sources, reduction in the cost of the solar cell itself and application of concentrated sunlight. New thin film systems have been developed which increase the intensity of light on the solar cells. This increases the electric output per cell. The result is a reduction in the number of solar cells needed to produce a kilowatt of power. One such film technology concentrates sunlight and selects the best wavelengths for the solar cell. Another thin film system uses a prism to concentrate the light on the solar cell.

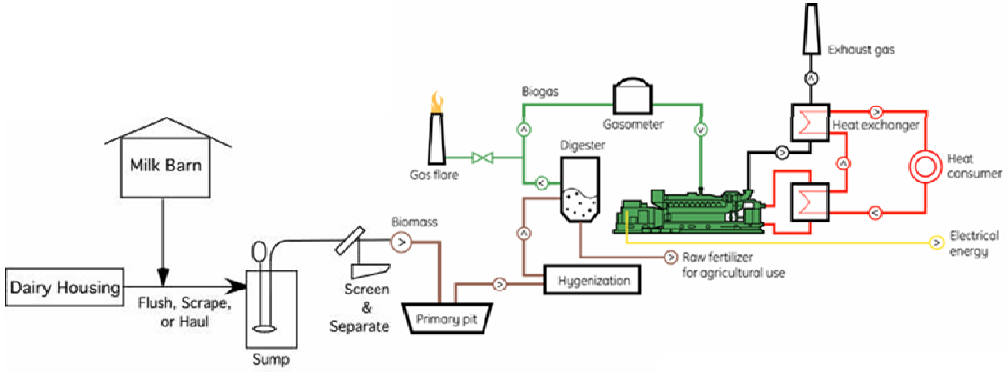
Thermal Solar

Thermal Solar relies on the concentration of sunlight to heat water into steam for powering steam turbines. Concentrated solar power appears to now have reached the point where it is cost competitive with traditional forms of energy. This technology uses mirrors to concentrate sunlight on vessels containing water, resulting in 1,000 degree steam for powering traditional steam turbines. There are three kinds of concentrating solar power systems—troughs, dish/engines, and power towers—that are classified by how they collect solar energy. All of these technologies are only applicable in areas in which sunlight is intense and available a high percentage of the year. Power tower uses mirrors to concentrate the sunlight on a central tower. Solar troughs use parabolic mirrors to concentrate the sunlight on a tube that runs the length of the mirror. An 80 megawatt project has been built in Kramer Junction, CA.

Dish/engines use a dish to concentrate the sun's energy on a Stirling Engine. NREL is expecting this technology to drop to about 7 cents per kilowatt hour by 2010. Pacific Gas and Electric has plans to build over 2,000 megawatts of Thermal Solar power.

Biopower

Biomass power, also called "Biopower," is electricity produced from Biomass fuels. Biomass consists of plant materials and animal waste products. The US Department of Energy includes in Biomass fuels, residues from the wood and paper products industries, residues from food production and processing, trees and grasses grown specifically as energy crops, and gaseous fuels produced from solid Biomass, animal wastes, and landfills. Biopower plants currently installed in the US have a combined capacity of 7,000 megawatts. These plants use roughly 60 million tons of Biomass fuels (primarily wood and agricultural wastes) to generate 37 billion kilowatt hours of electricity each year. As with conventional power from fossil fuels, Biopower is available 24 hours a day, seven days a week. All of Michigan's utility Biopower projects are fueled by wood and wood waste. For the purposes of this study, landfill gas projects will be included in the Municipal Solid Waste category. The on-site projects are those which use the majority of electric output on-site and only export a small share of electricity to the grid. These projects are dominated by farm based anaerobic digestion systems.



Utility Biopower Projects

Utility Biopower projects are typically wood fired. There is growing interest in also using agricultural waste such as corn stalks and switch grass. Michigan currently has seven Utility Biopower plants producing 159.2 megawatts from wood. The 21st Century Energy Report produced by the Michigan Public Service Commission projected Michigan could add over 500 megawatts of generation from wood and agricultural waste by 2015. The key requirement for selecting a location for a Utility Biopower plant is the availability of fuel within a radius of 150 miles. Transportation costs for movement of fuel beyond this radius significantly impact project economics. A typical 25 megawatt Biopower project needs to consume about 250,000 tons per year of wood.

West Michigan's potential for developing a utility Biopower project is low due to its lack of available fuel at this time. An assessment of available land for wood and creating proper management is needed. A single 25 megawatt project will create over $60 million in investment, with annual revenues of about $14 million and the addition of about 95 full time jobs. The jobs created would be both in the plant and in the management and harvesting of fuel for the plant.

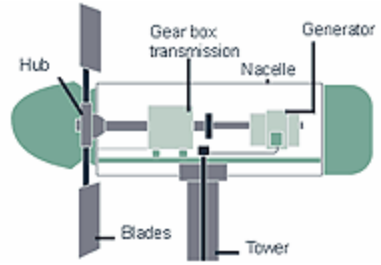
On-Site Projects

Michigan only has a few on-site projects in operation. The refusal of utilities to purchase on-site generation and rules for net metering has discouraged the development of this resource. The primary source of fuel for on-site power is anaerobic digestion of animal waste. Anaerobic digestion projects use the methane created by the breakdown of organic material by a microbial population that lives in an oxygen free environment, to fuel an internal combustion engine-generator. Farms are under increased pressure to reduce the use of manure on fields because of the concern with environmental hazard. The 21st Century Energy Report indicates Michigan has the potential for about 51 megawatts of new anaerobic digestion power projects. West Michigan contains about 10% of this potential or about 5 megawatts. This would equate to about $12.5 million of new investment in the region, produce 35,000 megawatt hours annually and potential produce annual revenues of $2.8 million.

Wind

Electric production from wind is the fastest growing segment of the renewable energy market. In 2006, the US added 2,400 megawatts of new wind generation. Much of the new wind generation added has been in utility size projects. Utility size units range from 1,200 kilowatts to over 3,000 kilowatts.

The three key elements of any wind turbine are the rotor, the nacelle—which contains the gearbox, the generator and control and monitoring equipment — and the tower.



Modern utility-scale wind turbines typically are equipped with three-bladed rotors ranging from 42 to 80 meters (138 to 262 feet) in diameter, contain generators with rated capacity of between 600 kilowatts and 2 megawatts, and are mounted on towers that are between 131 and 328 feet) tall. A utility-scale wind installation, called a wind farm or wind park, consists of a collection of these turbines.

Accurate estimates of wind speed are critical to assessing the wind power potential at any location. Wind resources are characterized by wind power density classes, which range from Class 1 (lowest) to Class 7 (highest). The US Department of Energy has developed a map that identifies areas with good wind potential in the US (available at: http://rredc.nrel.gov/ wind/pubs/atlas/). These areas (class 3 and above) are found along the East Coast, the Appalachian Mountain chain, the Great Plains, the Pacific Northwest and in some other locations. In total, they cover more than 1 million square kilometers, or about 14% of the land area of the 48 contiguous states. However, estimates suggest that wind power generation on only 43,000 square kilometers of land—with less than 5% of this actually occupied by turbines, electrical equipment and access roads—could supply about 560 billion kilowatts of electricity annually, equivalent to about 15% of total US demand.

Offshore Wind Resources

Average wind speeds over water are typically 20% higher than nearby locations on land. Thus, due to the cubic relationship between velocity and power, an offshore turbine can expect to capture 50% more wind energy than a similar onshore turbine. In addition, because of the lower wind shear at a given height above water compared to that same height above land, offshore turbines can be built with shorter towers and can last longer.

Hydro

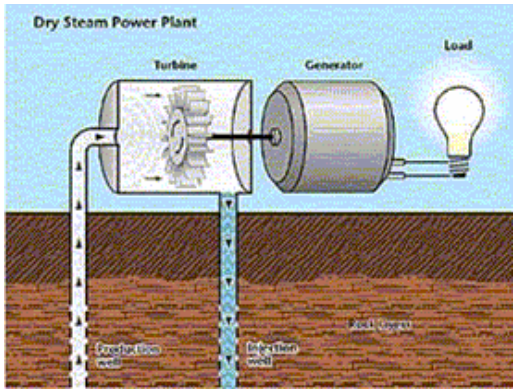
Much of the available US hydro generation has already been developed. Environmental opposition to new hydro generation is likely to prevent additional hydro addition to the US market. Improvement in existing hydro units is the only added hydro generation projected to be added in the US between now and 2030.

Geothermal

Utility-scale Geothermal power production employs three main technologies. These are known as dry steam, flash steam and binary cycle systems. The technology employed depends on the temperature and pressure of the Geothermal reservoir. Unlike solar, wind, and hydro-based renewable power, Geothermal power plant operation is independent of fluctuations in daily and seasonal weather.

Dry Steam

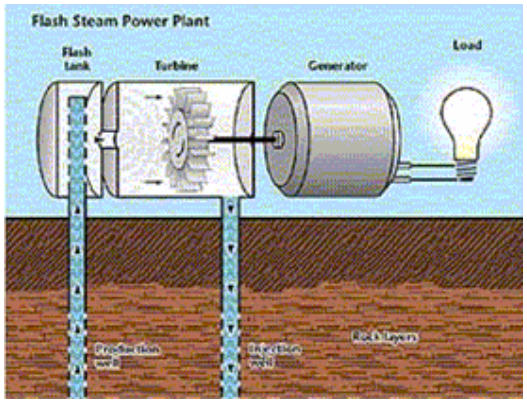
Dry steam power plants use very hot (>455 °F, or >235 °C) steam and little water from the Geothermal reservoir. Steam goes directly through a pipe to a turbine to spin a generator that produces electricity. This type of Geothermal power plant is the oldest, first being used at Lardarello, Italy, in 1904. Below is a schematic of a typical dry steam power plant.



Source: National Renewable Energy Laboratory

Flash Steam

Flash steam power plants use hot water (>360 ºF, or >182 ºC) from the Geothermal reservoir. When the water is pumped to the generator, it is released from the pressure of the deep reservoir. The sudden drop in pressure causes some of the water to vaporize to steam, which spins a turbine to generate electricity. Both dry steam and flash steam power plants emit small amounts of carbon dioxide, nitric oxide, and sulfur, but generally 50 times less than traditional fossil-fuel power plants. Hot water not flashed into steam is returned to the Geothermal reservoir through injection wells.

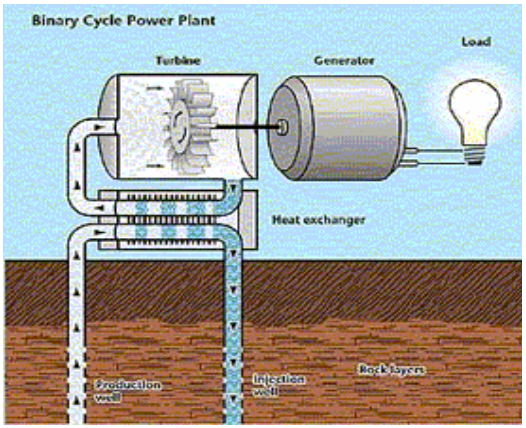


Source: National Renewable Energy Laboratory

Binary-Cycle

Binary-cycle power plants use moderate-temperature water (225 ºF–360 ºF, or 107 ºC–182 ºC) from the Geothermal reservoir. In binary systems, hot Geothermal fluids are passed through one side of a heat exchanger to heat a working fluid in a separate adjacent pipe. The working fluid, usually an organic compound with a low boiling point such as Iso-butane or Iso-pentane, is vaporized and passed through a turbine to generate electricity. An ammonia-water working fluid is also used in what is known as the Kalina Cycle. Makers claim that the Kalina Cycle system boosts Geothermal plant efficiency by 20–40% and reduces plant construction costs by 20–30%, thereby lowering the cost of Geothermal power generation.

The advantages of binary-cycle systems are that the working fluid boils at a lower temperature than water does, so electricity can be generated from reservoirs with lower temperature, and the binary-cycle system is self-contained and therefore, produces virtually no emissions. For these reasons, some Geothermal experts believe binary cycle systems could be the dominant Geothermal power plants of the future.



Source: National Renewable Energy Laboratory

MUNICIPAL SOLID WASTE/LANDFILL GAS

There are four methods of using Municipal Solid Waste to produce Energy: landfill gas, incineration, digestion and gasification. All of these technologies need to be combined with a full recycling of reusable materials before the Municipal Solid Waste goes to any of these processes.

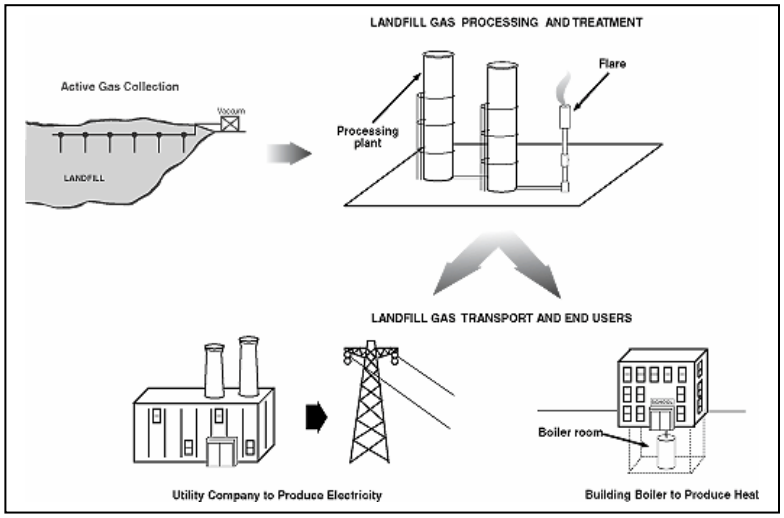
Landfill Gas

Electric production from existing landfills will continue to increase over the next several years. This process will burn the gases generated in the landfill through anaerobic digestion, in a reciprocating engine or combustion turbine. Michigan also has 12 projects producing 148 megawatts using landfill gas and municipal incineration. Additional electric production through incineration of municipal solid waste is not likely to occur due to environmental concerns.

Large municipal or industrial landfills produce gas that can be tapped to generate electricity. Microorganisms that live in organic materials such as food wastes, paper or yard clippings cause these materials to decompose. This produces landfill gas, typically comprised of roughly 60% methane and 40% carbon dioxide (or "CO_2").

Landfill gas energy recovery systems have three basic components: (1) a gas collection system; (2) a gas processing, treatment, and conversion system; and (3) a means to transport the gas or final product to the user.

Gas is collected from the landfill by the use of active vents. It is then transported to a central point for processing. Processing requirements vary, depending on the gas composition and the intended use, but typically include a series of chemical reactions or filters to remove impurities. For direct use of landfill gas in boilers, minimal treatment is required.



Combustion-based technologies that recover energy include boilers, process heaters, gas turbines, and internal combustion engines. For example, landfill gas can be piped to a nearby industry, commercial business, school or government building where it is combusted in a boiler to provide steam for an industrial process or heat for a building. It may be combusted in an industrial process heater to provide heat for a chemical reaction. Turbines and internal combustion engines can combust landfill gas to generate electricity. The electricity can be used to meet power needs at the landfill or a nearby facility, or the electricity may be sold to the power grid.

Waste Gasification

The process of gasification of Municipal Solid Waste is gaining favor as the cost of this process decreases and the cost of fossil generation increases. Plasma gasification of Municipal Solid Waste economics have improved such that it is gaining in popularity due to its ability to breakdown the toxic chemicals in Municipal Solid Waste into benign elements. Several large scale plasma gasification projects are currently in development in the US.

At the most basic level, a plasma waste converter (See Illustration on VIII of Appendices) is a plasma torch applied to garbage. A plasma torch uses a gas and powerful electrodes to create plasma, sometimes called the fourth state of matter. Plasma is an ionized gas—in other words, it's a gas with free-roaming electrons that carries a current and generates a magnetic field. On earth, we can see natural displays of plasma fields in lightning. The temperatures generated by a plasma torch can be hotter than the surface of the sun (more than 6,000 degrees Celsius). At these temperatures, garbage doesn't stand a chance. Molecules break down in a process called molecular dissociation.

When molecules are exposed to intense energy like the heat generated by a plasma torch, the molecular bonds holding them together become excited and breaks apart. The elemental components of the molecules are left. With cyanide, for example, you'll end up with atoms of carbon and nitrogen.

The hydrocarbon material in Municipal Solid Waste is depolymerized into carbon and hydrogen molecules by the plasma generated heat and undergoes partial oxidation to be released as a mixture of H_2 and CO. The syngas has a heating value varying from 150 to 300 BTU/scf, which is about 1/3 to 1/6, that of natural gas. All inorganic or non-hydrocarbon based material in the feedstock are simultaneously vitrified into an inert glassy slag, suitable for use as construction materials including aggregate, tile, or bricks. The process can produce multiple usable products.

The plasma gasifier is integrated into a power plant called an Integrated Plasma Gasification Combined Cycle (IPGCC). The syngas from the Plasma gasifier must be cooled down and cleaned before it can be used as a gas turbine fuel. This cooling and clean-up process typically involves the efficient removal of any sulfur compounds, chlorides, mercury, other volatile metals, acid gas, and any particulate matter in order to reduce air pollution and to meet the gas turbine fuel specifications.

Consequently, in the IPGCC process harmful pollutants from the feedstock, particularly when using toxic wastes or coal waste, are removed from the syngas stream (pre-combustion) rather than from the flue gas (post-combustion). Because these pollutants are much more concentrated in the significantly smaller volume of the syngas stream than the exhaust flue gas, the IPGCC clean-up process is more efficient and has a significantly lower cost than the post-combustion clean-up as employed in most steam-boiler plants.

Electricity is produced in the IPGCC in two ways. First, the syngas is used to fuel a combustion turbine generator. Second, heat from cooling the syngas and from the exhaust of the combustion turbine generator are used to produce steam which drives a steam turbine generator. This combination of heat and fuel use creates one of the most energy efficient electric generator systems possible.

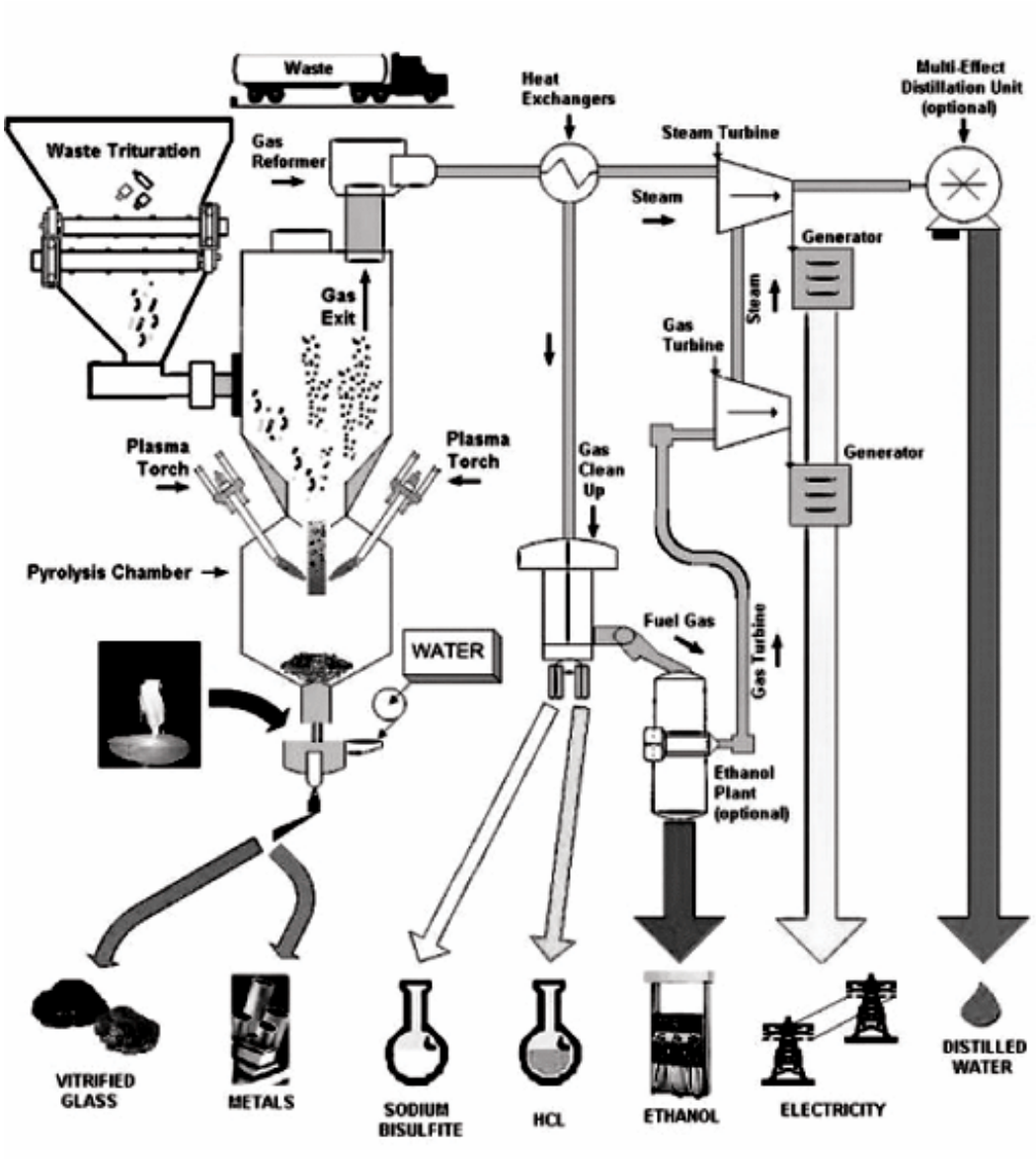
The use of Municipal Solid Waste in an IPGCC has the following attributes:

- Eliminates hazardous chemicals
- Reduces Municipal Solid Waste to a reusable and inert material
- Produces electricity form a waste product
- Is environmentally clean.

Municipal Solid Waste Incineration

The Kent County Waste-to-Energy facility accepts non-hazardous wastes from municipal and commercial operations which are combusted in water-cooled furnaces to produce up to 18 megawatts of electricity. The electricity is first used onsite to power the facility, with the balance being sold to Consumers Energy for use on the state's electric grid. The facility employs an advanced air pollution control system and expects to process its 3 millionth ton of Municipal Solid Waste by June, 2006.

Plasma Waste Converter

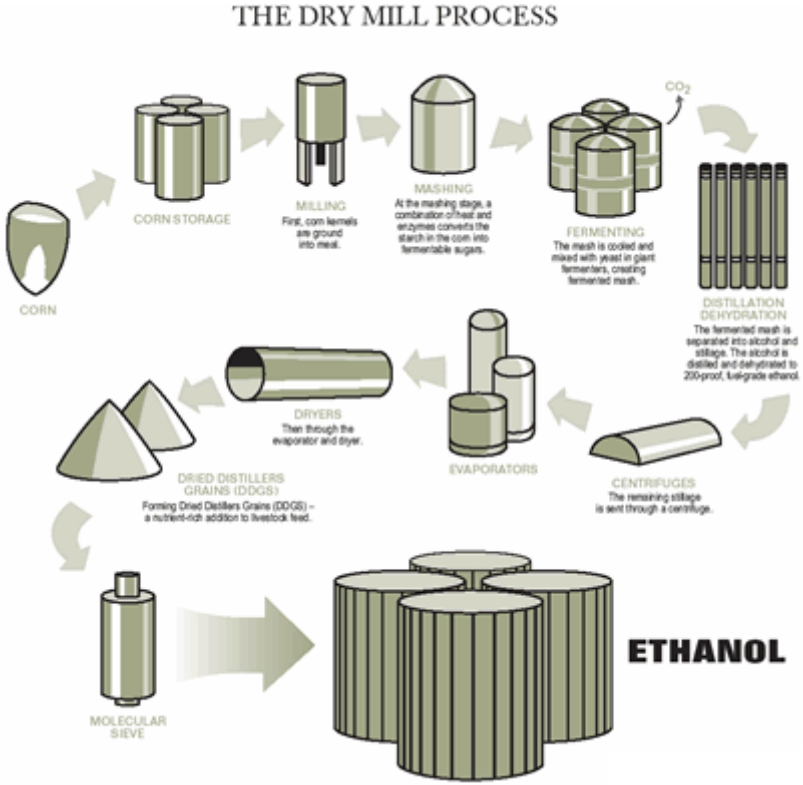


TRANSPORTATION SECTOR

Ethanol

United States ethanol production currently comes primarily from fermentation of corn. The production of ethanol from corn is very controversial because the net energy gain is minimal, corn is a very valuable food commodity and a large amount of water is consumed in the process. The impact of ethanol production from corn is already caused a significant increase in corn prices of over $2.00 per bushel in the last two years.

Ethanol is created by fermenting feed corn or other plant material. The most common method used is called the “Dry Method.” This process grinds corn into meal and ferments it – converting the starch to clean-burning ethanol.



The issues associates with corn ethanol production are driving research into other methods of ethanol production. Significant research is being done in creating ethanol from other agricultural products such as saw grass and cellulosic ethanol production.

Cellulosic ethanol is a fuel produced from the stalks, wood and stems of plants (rather than only from sugars and starches, as with corn ethanol). Cellulose is also made up partly of sugars, but they are linked tightly in a more complicated chain. Breaking them up requires several enzymes. Manufacturers rely on a variety of organisms to make the necessary enzymes. They are the product of gene splicing, turning out enzymes in quantities far greater than any natural organism would. Unlocking the sugar represents a gold mine. Once the sugars are released, the ethanol production process is the same as it is for corn.

Biodiesel

Biodiesel is a renewable fuel made by a chemical reaction of alcohol and vegetable or animal oils, fats, or greases. Through a refinery process called transesterification, the reaction removes the glycerin—a by-product that is not good for your engine—which can be made into soap. Biodiesel can be used in any diesel engine in pure form or blended with petroleum diesel at any level. Biodiesel is usually blended with diesel fuel in a 20% Biodiesel- 60% diesel blend.

There are three basic routes to biodiesel production from oils and fats:

- Base catalyzed transesterification of the oil.
- Direct acid catalyzed transesterification of the oil.
- Conversion of the oil to its fatty acids and then to biodiesel

APPENDIX 2: ALTERNATIVE AND RENEWABLE ENERGY MANUFACTURING NAICS CODES

NAICS CODES	DESCRIPTION	ALTERNATIVE ENERGY INDUSTRY		
		Wind	Solar	Biomass
326122	Plastics Pipe and Pipe Fitting Manufacturing		x	x
326191	Plastics Plumbing Fixture Manufacturing		x	x
326220	Rubber and Plastics Hoses and Belting Manufacturing		x	x
327113	Porcelain Electrical Supply Manufacturing	x	x	x
327124	Clay Refractory Manufacturing		x	x
327125	Nonclay Refractory Manufacturing		x	x
331316	Aluminum Extruded Product Manufacturing	x	x	
331319	Other Aluminum Rolling and Drawing	x	x	
331421	Copper Rolling, Drawing, and Extruding	x	x	x
331491	Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding	x	x	
331512	Steel Investment Foundries	x		
331513	Steel Foundries (except Investment)	x		
331521	Aluminum Die-Casting Foundries	x		
331522	Nonferrous (except Aluminum) Die-Casting Foundries	x		
331524	Aluminum Foundries (except Die-Casting)	x		x
331525	Copper Foundries (except Die-Casting)	x	x	x
331528	Other Nonferrous Foundries (except Die-Casting)	x		
332111	Iron and Steel Forgings	x		x
332112	Nonferrous Forgings	x		x
332114	Custom Roll Forming	x	x	x
332117	Powder Metallurgy Part Manufacturing	x	x	x
332311	Prefabricated Metal Building and Component Manufacturing	x	x	
332313	Plate Work Manufacturing	x		x
332321	Metal Window and Door Manufacturing	x	x	

NAICS CODES	DESCRIPTION	ALTERNATIVE ENERGY INDUSTRY		
		Wind	Solar	Biomass
332323	Ornamental and Architectural Metal Work Manufacturing	x	x	
332710	Machine Shops	x		x
332912	Fluid Power Valve and Hose Fitting Manufacturing	x	x	x
332913	Plumbing Fixture Fitting and Trim Manufacturing		x	x
332919	Other Metal Valve and Pipe Fitting Manufacturing		x	x
332996	Fabricated Pipe and Pipe Fitting Manufacturing		x	x
333994	Industrial Process Furnace and Oven Manufacturing			x
333996	Fluid Power Pump and Motor Manufacturing		x	x
334220	Radio and Television Broadcasting and Wireless Communications Equipment Mfg	x	x	
334419	Other Electronic Component Manufacturing	x	x	x
334512	Automatic Environmental Control Mfg for Residential, Commercial, and Appliance Use		x	
334514	Totalizing Fluid Meter and Counting Device Manufacturing	x	x	x
335314	Relay and Industrial Control Manufacturing	x	x	x
335929	Other Communication and Energy Wire Manufacturing	x	x	x
335991	Carbon and Graphite Product Manufacturing	x	x	x
336322	Other Motor Vehicle Electrical and Electronic Equipment Manufacturing			
336412	Aircraft Engine and Engine Parts Manufacturing	x		
336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing	x		
336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Mfg	x		
339991	Gasket, Packing, and Sealing Device Manufacturing	x	x	x
	In the future, we plan to add these 3 for advanced vehicles/storage:			
336340	Motor Vehicle Brake System Manufacturing			
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing			
336391	Motor Vehicle Air-Conditioning Manufacturing			

APPENDIX 3: MANUFACTURER'S SURVEY

NEXTENERGY
Economic Security through Energy Diversity

MMTC

Alternative Energy Technology Supplier Survey

Instructions:

In order to be listed in the *Michigan Directory of Alternative Energy Suppliers* – and to receive RFQs and invitations to supplier events – you must fill out this form completely. Note that you may skip sections that do not apply to your company. **Especially critical is an e-mail address, as RFQ alerts and invitations will be distributed via e-mail.**

If you would prefer to complete this questionnaire online, go to www.nextenergy.org/rfqsurvey.asp and click the link that says: "Click Here to Get on the List!"

Please return this questionnaire and direct any questions to:

Dan Luria
MMTC
47911 Halyard
Plymouth, MI 48170
(P) 888-414-6682
(F) 734-451-4202
E-mail pbs@mmtc.org

Please keep a copy of this questionnaire in the event that we need to contact you for clarification.

General Plant and Company Information:

Please provide the mailing address for this plant/facility:

Company Name_____
Division/Facility_____
Address_____
Address_____
City, State (MI)_____
Zip_____
Phone_____
Fax_____
Company Website_____

Does your website include an equipment list? ❑Yes ❑ No

Please provide the name, title and contact information for the person who will serve as your primary contact with the NextEnergy AET Supplier Development program. This should be the person with primary responsibility for new business development.

Name_____
Title _____
Phone_____
Fax _____
Email_____
Mailing address (if different from plant address, left):
Company_____
Division/Facility_____
Address_____
Address_____
City, State_____
Zip _____

How large is this facility? Specifically:

- What are your approximate annual sales at this location?
- What is the approximate total employment at this location? Please include your own employees, plus any long-term contractors or temps who work on-site. Please convert part-time employees into full-time equivalents (FTEs).
- What is the size of your production or factory area?

Annual sales $_____

Total employment _____FTEs

Production or factory area _____square feet

Is this the only location of your company? ❑Yes ❑ No

[If No:] (check one)
What are your approximate annual sales, company-wide?)

- ❑ < $10 Million
- ❑ $10 – $99 Million
- ❑ $100 Million or more

Current Products/Services:

Please describe the products or services provided by this location.

Description:_____

Please provide your industry code (NAICS or SIC), if you know it.

_____ ❑ SIC ❑ NAICS (Check one.)

For a typical product or job, roughly how many units of a particular product do you make? For very long-term orders or products, please answer based on annual volumes. (Check one box.)

[If you are in a **process industry**, think of a "unit" as one of whatever ends up on your customers' shelves, or – for output packaged into very large containers – whatever your customer handles as one item.]

(Check one.)

- ❑ One or very few
- ❑ A dozen, or several dozen, or hundreds
- ❑ Thousands or tens of thousands, or more
- ❑ No such thing as "typical" – our volumes are unpredictable and can vary from a few to many thousands

In the past year, in which of the following ways did you serve your customers?

- Engineer-to-Order Work (one-of-a-kind items: dies, prototypes, special machines, etc) ❑Yes ❑ No
- Job Shop Products and Services (short-term or non-repeating orders) ❑Yes ❑ No
- Make-to-Order Jobs Run Regularly (long-term, repeating orders) ❑Yes ❑ No
- Make-to-Stock Work (orders fulfilled from inventory) ❑Yes ❑ No

In-House Processes:

Which of the following processes do you do at this location? For each major process category, please describe your capabilities or equipment that might be relevant for the AET market. Then list the materials with which you have experience. For example, if you make aluminum gears, you should check "machining." You might then specify "broaching machines" or "5-axis machining" as your special capabilities, and list "aluminum" under the materials heading.

Material formulation (e.g., the making or customization of resins, polymers, alloys, chemicals, glass, ceramics, composites, etc.):
❑Yes ❑ No

Material Formulation:

Capabilities and Equipment_____

_____

_____

Materials_____

_____

_____

Part or Component Manufacturing:

❑Yes ❑ No Casting or Molding (e.g., metal casting, plastic thermoforming)
❑Yes ❑ No Forming or Fabricating (e.g., rolling, drawing, stamping, bending, extruding, shaping, shearing)
❑Yes ❑ No Machining (e.g., milling, grinding, boring, broaching, drilling.)
❑Yes ❑ No Joining (e.g., welding, brazing, adhesive bonding)
❑Yes ❑ No Electronic component manufacturing (e.g., printed circuit board etching, printed circuit board assembly, making inductors)
❑Yes ❑ No Other processes ***(describe)***

Part or Component Manufacturing:

Capabilities and Equipment_____

_____

_____

Materials_____

_____

_____

Hardening, Plating, Coating, & Other Finishing:

❑Yes ❑ No Hardening
❑Yes ❑ No Plating or anodizing
❑Yes ❑ No Coating/painting
❑Yes ❑ No Polishing
❑Yes ❑ No Other finishing ***(describe)***

Hardening, Plating, Coating, or Other Finishing:

Capabilities and Equipment_____

_____

_____

Materials_____

_____

_____

Assembly, Build and Test:

❑Yes ❑ No

Assembly, Build and Test:

Capabilities and Equipment_____

_____

_____

Materials_____

_____

_____

In-House Design and Engineering:

In which of the following areas do you have significant in-house experience and capability?

- Part, component or product design ❑Yes ❑ No
- Raw material selection/specification ❑Yes ❑ No
- Large tooling design/engineering (e.g., dies, molds) ❑Yes ❑ No
- Large tooling build (e.g., in-house die build capability) ❑Yes ❑ No
- Vibration or aerodynamics analysis ❑Yes ❑ No
- Other process design/engineering ❑Yes ❑ No

If Other, please describe:_____

_____

_____

Outside Subcontracting and Procurement:

With which of the following services do you have significant subcontracting and procurement experience? By this, we mean that you manage subcontractors who provide these services for you, but for whose work *you* are ultimately responsible.

- Design/engineering of large tooling — ❑Yes ❑ No
- Large tooling build — ❑Yes ❑ No
- Other process engineering — ❑Yes ❑ No
- Heat treating — ❑Yes ❑ No
- Plating/coating/anodizing/finishing — ❑Yes ❑ No
- Specialized machining — ❑Yes ❑ No

If yes, please describe_____

_____

- Other specialized processing — ❑Yes ❑ No

If yes, please describe_____

_____

Product Size or Scale:

For some AET developers – particularly for utility-scale systems or equipment–the ability to produce very large components is a critical supplier selection issue.

What are the approximate dimensions (length by width by height, or diameter by length) of the largest product, component or assembly you can make using your current equipment?

_____ x _____ x _____

(Please remember to specify your units.)

What is the approximate weight of the largest product/component/assembly you can make using your current equipment? _____ lbs

Please provide any other pertinent information on your capabilities relevant to component size or scale.

_____

_____

_____

_____

_____

_____

_____

_____

_____

Markets:

In the past year, roughly what percent of the sales *from this plant* went to customer locations:

_____% Less than 100 miles away
_____% Between 100 and 499 miles away
_____% More than 500 miles away, but within North America
_____% Outside of North America
Total 100%

Do you have experience in serving customers in any of the following markets or supply chains? (Check all that apply.)

- ❑ Food or agricultural processing
- ❑ Chemicals processing or petroleum refining
- ❑ Biomass/Biofuels processing
- ❑ Industrial process heat generation
- ❑ Electric power generation or gas turbine equipment
- ❑ Wind turbines
- ❑ Commercial HVAC or hot water equipment/appliances
- ❑ Residential HVAC or hot water equipment/appliances
- ❑ Vehicle batteries/energy storage
- ❑ Other batteries/energy storage
- ❑ Vehicle engine or fuel system components
- ❑ Aircraft engine or exterior surface parts
- ❑ Photovoltaics or solar collectors
- ❑ Biomass/Biofuels processing

Please provide any other pertinent information on your experience with supply chains that might be relevant to Alternative Energy Technologies.

_____

_____

_____

_____

_____

_____

_____

_____

_____

Wind Turbine Supply Chain

Are you interested in serving as a supplier to makers of wind turbine equipment? ❑Yes ❑ No
If No, please skip the rest of this page.

If Yes, please indicate in which of the following segments of the wind turbine supply chain you think that your company might participate. Note that you need not be a complete component supplier, but might participate at a sub-component level. For example, a company that provides specialized gear-cutting services might check "Gearbox" even though it does not intend to supply complete gearboxes.

Wind Turbine Component Systems	System Components
Mechanical/Aerodynamics System	❑ Gearbox ❑ Bearings ❑ Blades ❑ Rotor hub ❑ Main shaft ❑ Brakes ❑ Yaw and pitch control mechanical components ❑ Nacelle housing ❑ Other ***(describe below)***
Electrical Power System	❑ Generator ❑ Power Converter ❑ Transformer ❑ Power Cables ❑ Substation equipment or construction ❑ Other ***(describe below)***
Controls and Instrumentation	❑ Yaw, pitch or brakes electrical controls ❑ Turbine/gearbox monitors and controls ❑ Power- or grid-related controls ❑ Other ***(describe below)***
Structure & General	❑ Tower fabrication/construction ❑ Tower ancillaries (ladders, doors, etc.) ❑ Lifts, rigging, cranes, etc. ❑ Floor plates ❑ Screws/fasteners (especially high load) ❑ Flanges/couplings/seals ❑ Other ***(describe below)***

Please provide additional detail as you wish.

Biofuels/Biomass Supply Chain

Are you interested in serving as a supplier to makers of Biofuels/Biomass-related technology? ❑Yes ❑ No
If No, please skip the rest of this page.

If Yes, please indicate in which of the following segments of the Biofuels/Biomass supply chain you think that your company might participate. Note that you need not be a complete component supplier, but might participate at a sub-component level. For example, a company that does fabrication work for makers of distillation units should check "Distillation/fermentation/refining units" even though it does not intend to supply complete units.

Major Systems for Biofuels/Biomass Processing or Use	**System Components**
Pre-Processing of Raw Feedstocks	❑ Feedstock handling & storage ❑ Conveyors, feeders ❑ Equipment for pulverizing, cutting, grinding, mixing, screening, compacting, pelletizing, etc. ❑ Drying/evaporating ❑ Other ***(describe below)***
Direct Combustion	❑ Equipment for generating industrial process heat (furnaces, boilers, fluidized bed combustors, etc.) ❑ Electricity generation or co-generation equipment (steam or biogas-fired turbines) ❑ Commercial/residential heat or hot water equipment (e.g., pellet stoves) ❑ Other ***(describe below)***
Chemical or Biological Processing of Biofuels (e.g., ethanol distillation, biodiesel production, anaerobic digestion)	❑ Tanks, process chambers, pressure vessels ❑ Distillation/fermentation/refining units ❑ Gasifiers, pyrolysis units ❑ Processing instrumentation and controls ❑ Other ***(describe below)***
General/Ancillary Process Equipment	❑ Pipes ❑ Valves ❑ Flanges, couplings ❑ Seals ❑ Gauges ❑ Pumps/motors ❑ Filters, scrubbers ❑ Heat exchangers ❑ Fans, blowers ❑ Other ***(describe below)***
Materials, Equipment for Storage, Distribution and Consumption of Processed Biofuels	❑ Biofuel-compatible materials development (e.g., make materials resistant to E85 corrosion) ❑ Biofuel-compatible vehicle components (e.g., supply fuel system tubing) ❑ Biofuel distribution equipment (e.g., for retail pumps) ❑ Biofuel storage equipment ❑ Other ***(describe below)***
Please provide additional detail as you wish.	

Solar Energy Supply Chain

Are you interested in serving as a supplier to makers of solar equipment and technology? ❑Yes ❑ No
If No, please skip the rest of this page.

If Yes, please indicate in which of the following segments of the solar technology supply chain you think that your company might participate. Note that you need not be a complete component supplier, but might participate at a sub-component level. For example, a company that provides specialized coatings for thermal absorbers should check "Absorbers" even though it does not intend to manufacture the absorbers themselves.

Major Solar or Photovoltaic Systems	System Components/Options
Thermal Collectors	❑ Flat glazing ❑ Glass tubes ❑ Metal absorber plates or tubes ❑ Absorbers made from engineered materials (e.g., composites, multi-layered, etc.) ❑ Building-integrated collectors (e.g., absorbers integrated into roofing materials) ❑ Other ***(describe below)***
Thermal Balance-of-System Components and End Use Equipment	❑ Heat exchangers ❑ Pumps, motors ❑ Pipes, valves ❑ Flanges, couplings, seals ❑ Fans, blowers ❑ Hot water tanks ❑ Instrumentation and controls for these components ❑ HVAC equipment for use with solar thermal energy ❑ Other equipment for use with solar thermal energy ***(describe below)***
Solar Photovoltaic (PV) Cells/Modules	❑ Processing of silicon/single-crystal or thin-film (e.g., CdTe, CIGS, CIS) PV cells and modules ❑ Processing of materials for use by PV makers ***(describe below)*** ❑ Machines used by PV makers ***(describe below)***
PV Balance-of-System Components	❑ Battery or energy storage system ❑ Inverter ❑ Wiring/fuses/switchgear ❑ Grid-tie system ❑ Instrumentation and controls ❑ Off-grid end-use applications: lighting ❑ Off-grid end-use applications: pumping ❑ Off-grid end-use applications: other ❑ Other ***(describe below)***
Mounting Structures, Trackers	❑ Framing (e.g., aluminum profiles for flat panels) ❑ Towers ❑ Parabolic dish or trough structure ❑ Mechanical system for solar tracking ❑ Instrumentation and controls for tracking ❑ Other ***(describe below)***
Please provide additional detail as you wish. _____ _____ _____ _____ _____ _____ _____	

Alternative Energy Vehicles/Advanced Vehicle Energy Storage Supply Chain (Includes Fuel Cell Vehicles, Hybrid Electric Vehicles, Electric Vehicles, etc.)

Are you interested in serving as a supplier to makers of alternative energy vehicles and/or advanced vehicle energy storage technologies?
❑Yes ❑ No
If No, please skip the rest of this page. Thank you for submitting your survey.

If Yes, please indicate in which of the following segments of the alternative energy vehicles/advanced energy storage supply chain you think that your company might participate. Note that you need not be a complete component supplier, but might participate at a sub-component level. For example, a company that provides bearings for flywheels should check "Flywheels" even though it does not intend to supply complete flywheels themselves.

Major Hybrid/Advanced Energy Storage Vehicle Systems	System Components
Advanced/Alternative Primary Power Units	❑ Fuel cells ❑ Advanced internal combustion engines ❑ Gas turbines ❑ Other advanced/alternative vehicle engines *(describe below)*
Motor/Generator Systems	❑ Regenerative braking systems ❑ Traction electric motors/generators ❑ Motor power controllers ❑ Braking components ❑ System & charging controls ❑ Other *(describe below)*
Energy Storage Systems	❑ Advanced batteries or battery modules (usually NiMH) ❑ Ultracapacitors ❑ Flywheels ❑ Controls for thermal or electrical management of energy storage systems ❑ Other *(describe below)*
Exhaust Heat Recovery Systems	❑ Cooling fans ❑ Heat exchangers ❑ Heat pumps (e.g., for converting waste heat for vehicle air conditioning or other cooling) ❑ Thermoelectric generators ❑ Turbine driven components ❑ Other ***(describe below)***
Power Electronic Devices & Controls	❑ Converters ❑ Inverters ❑ Switches and switch timing controls ❑ Wire harness systems ❑ Other ***(describe below)***
Other Systems Related to Alternative Energy Vehicles ***(describe systems below)***	❑ Advanced transmissions ❑ Other advanced powertrain components ❑ Special materials development ❑ Other ***(describe below)***
Please provide additional detail as you wish. _____ _____ _____ _____ _____ _____ _____	

Thank you for submitting your survey

APPENDIX IV
GLOSSERY OF TERMS

Biofuels - Broadly defined as solid, liquid, or gas fuel consisting of, or derived from Biomass. It is principally discussed in the form of liquid or gas transportation fuel derived from Biomass.

Biomass - Refers to living and recently dead biological material that can be used as fuel or for industrial production. Most commonly, Biomass refers to plant matter grown for use as Biofuel, but it also includes plant or animal matter used for production of fibers, chemicals or heat. Biomass may also include biodegradable wastes that can be burnt as fuel. It excludes organic material which has been transformed by geological processes into substances such as coal or petroleum.

Biopower - Electricity produced using Biomass as its fuel source.

Capacity - Used to define the total amount of electricity that a power plant can produce, usually given in kilowatts or megawatts.

Cellulosic Ethanol - Biofuel produced from lignocellulose, a structural material that comprises much of the mass of plants. It is composed mainly of cellulose, hemicellulose and lignin. Corn stover, switch grass, miscanthus and woodchips are some of the more popular cellulosic materials for ethanol production.

EGS - Enhanced Geothermal Systems

ITC - Investment Tax Credit

kW - Kilowatt equal to one thousand watts.

kWh - Kilowatt-hour is equal to 1,000 watt-hours. One watt-hour is the amount of (usually electrical or natural gas) energy expended by a one-watt load (like a light bulb) drawing power for one hour.

LEED - Leadership in Energy and Environmental Design is a Green Building Rating System, developed by the US Green Building Council. It provides a suite of standards for environmentally sustainable construction.

MAREC – Grand Valley State University's Michigan Alternative and Renewable Energy Center

MW - Megawatt is equal to one million watts.

MWh - Megawatt-hour is equal to 1,000,000 watt -hours. One watt-hour is the amount of (usually electrical or natural gas) energy expended by a one-watt load (like a light bulb) drawing power for one hour.

NREL - National Renewable Energy Laboratory

PTC - Production Tax Credit provides a 1.9-cent per kilowatt-hour benefit for the first ten years of a renewable energy facility's operation.

PV - Photovoltaic

REPP - Renewable Energy Policy Project seeks to define growth strategies for renewables that respond to competitive energy markets and environmental needs.

RPS – A Renewable Portfolio Standards policy is a regulatory policy that requires the increased production of renewable energy sources such as wind, solar, Biomass, and geothermal energies.

SWOT - Strengths, Weaknesses, Opportunities and Threats is a tool used to assess business opportunities.

APPENDIX V
ECONOMIC DEVELOPMENT PARTNERS LISTING

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