

MEDC
Cellulosic Biofuels

Centers of Excellence

February 15, 2008

MEDC Approach Cluster Based Economic Development

- Targeted industries
- Potential for significant growth
- Leverage state strengths
- Generally not mature
- Gap exists – requires economic assistance

1. Wind Turbine Mfg.

2. Cellulosic Biofuels

3. Advanced Energy Storage

4. Solar/Photovoltaic

5. Water Technology

6. CO2 Capture & Sequestration

Driver: Energy Act of 2007

- Increases vehicle CAFE standards to 35 mpg by 2020
- Increases federal Renewable Fuels Standard
 - 36 billion gallons of renewable fuels by 2022
 - 20 billion gallons of advanced biofuels (cellulosic) by 2022
 - For years 2023 and beyond, at least 60% must be advanced biofuels
- Establishes grant programs for refueling infrastructure corridors
- Provides funding for advanced biofuels research
 - Authorizes funding for bioreseach centers, including the \$50 Million award received by Michigan State University as part of the Great Lakes Bioenergy Research Center
- Establishes a carbon capture and storage research, development, and demonstration program

Renewable Fuels Standard

FEDERAL RENEWABLE FUELS STANDARD
H.R.6 Energy Independence and Security Act of 2007

	Total Renewable Fuels	Conventional Ethanol	Total Advanced Biofuels	(other)		
				Cellulosic Biofuels 60% GHG	Advanced Biofuels 50% GHG	Biomass-based Diesel
2006	4.00	4.00	-	-	-	-
2007	4.70	4.70	-	-	-	-
2008	9.00	9.00	-	-	-	-
2009	11.10	10.50	0.60	-	0.10	0.50
2010	12.95	12.00	0.95	0.10	0.20	0.65
2011	13.95	12.60	1.35	0.25	0.30	0.80
2012	15.20	13.20	2.00	0.50	0.50	1.00
2013	16.55	13.80	2.75	1.00	1.75	
2014	18.15	14.40	3.75	1.75	2.00	
2015	20.50	15.00	5.50	3.00	2.50	
2016	22.25	15.00	7.25	4.25	3.00	
2017	24.00	15.00	9.00	5.50	3.50	
2018	26.00	15.00	11.00	7.00	4.00	
2019	28.00	15.00	13.00	8.50	4.50	
2020	30.00	15.00	15.00	10.50	4.50	
2021	33.00	15.00	18.00	13.50	4.50	
2022	36.00	15.00	21.00	16.00	5.00	

Cellulosic Biofuels

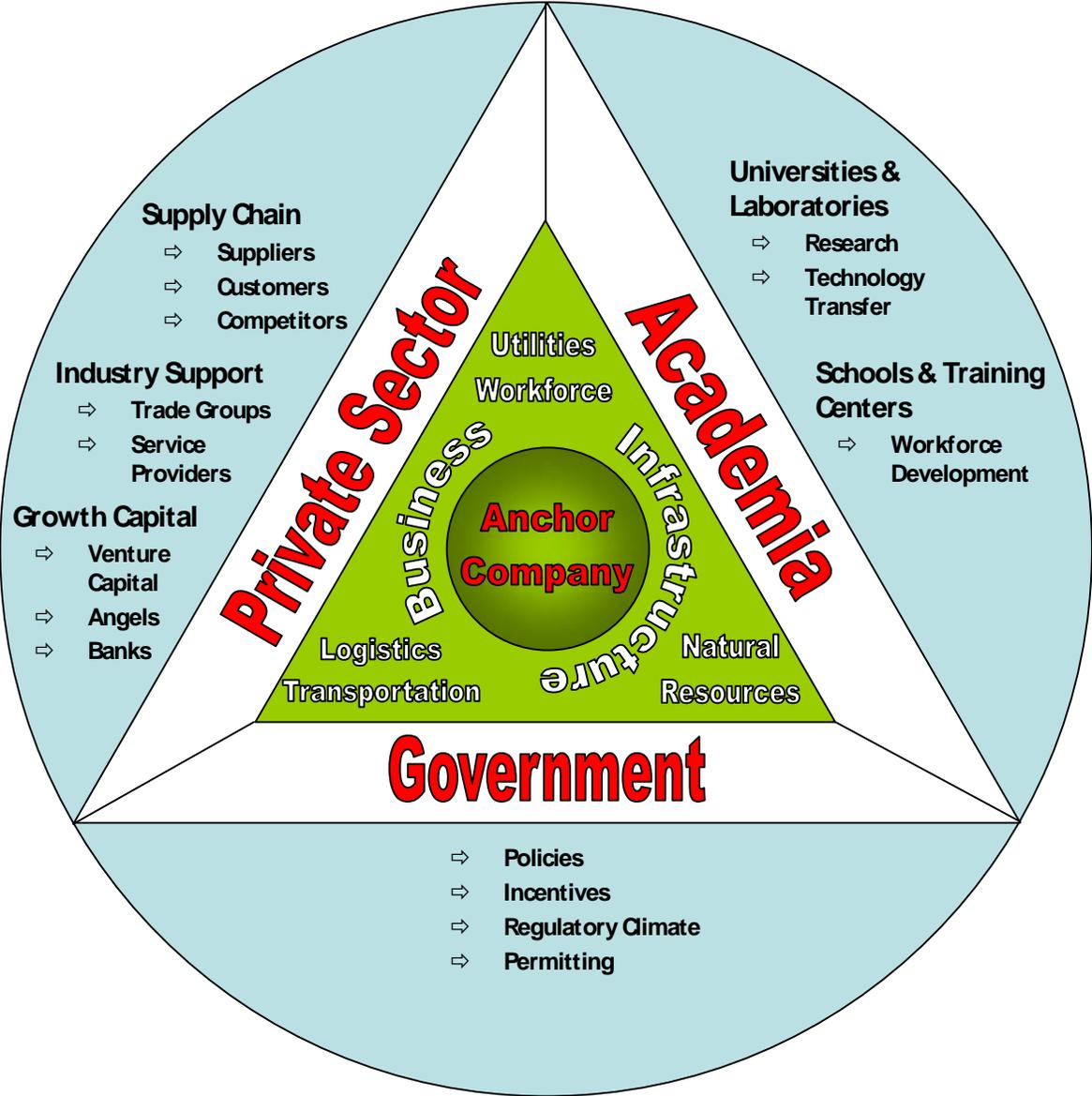
- Target Focus:
 - Bio-fuel production using cellulosic biomass as feedstock (e.g., wood waste, ag. waste, energy crops)
- Data-Driven Research
 - Michigan competitive advantages (forest products, diverse agriculture)
 - Industry infrastructure
 - Relevant workforce in place
 - World class universities
- Cluster Team
 - Formed in 2007
 - Actively participated in the creation and implementation of strategy
- 4 Centers of Excellence across multiple technologies and regions
 - Gasification of Cellulosic Biomass to Motor Fuels
 - Biochemical Conversion of Cellulosic Biomass to Motor Fuels
 - Value-Added Products for Corn Ethanol Producers
 - Municipal Waste to Biogas/Motor Fuels

COE Methodology

- Creation of Cluster Teams, where necessary, to assist in approach strategy
- Creation of Centers of Excellence (COE) surrounding existing (or newly attracted) companies which serve as a magnet for new industry growth
- Creation of incentives to enable anchor companies to serve as key industry cluster attraction magnets
- Focus on federal dollars to spur development in 'high risk' areas – bridge gap between early development and commercialization
- Surround COE's with university researchers to accelerate technology commercialization, develop workforce, and assist in company tech issues

Center of Excellence Swedish “Triple Helix”

- Goal is to rapidly grow an industry cluster
- Includes high profile anchor company at the center
- Geographically located in area with strong business infrastructure
- Surrounded by private sector companies, academic institutions, and government entities



MICHIGAN'S Centers of Excellence

Syngas to Biofuel

- Lorem ipsum dolar hie dneiood didi
- hdje dbke dskjheu dsh aa eio
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Cellulosic Ethanol

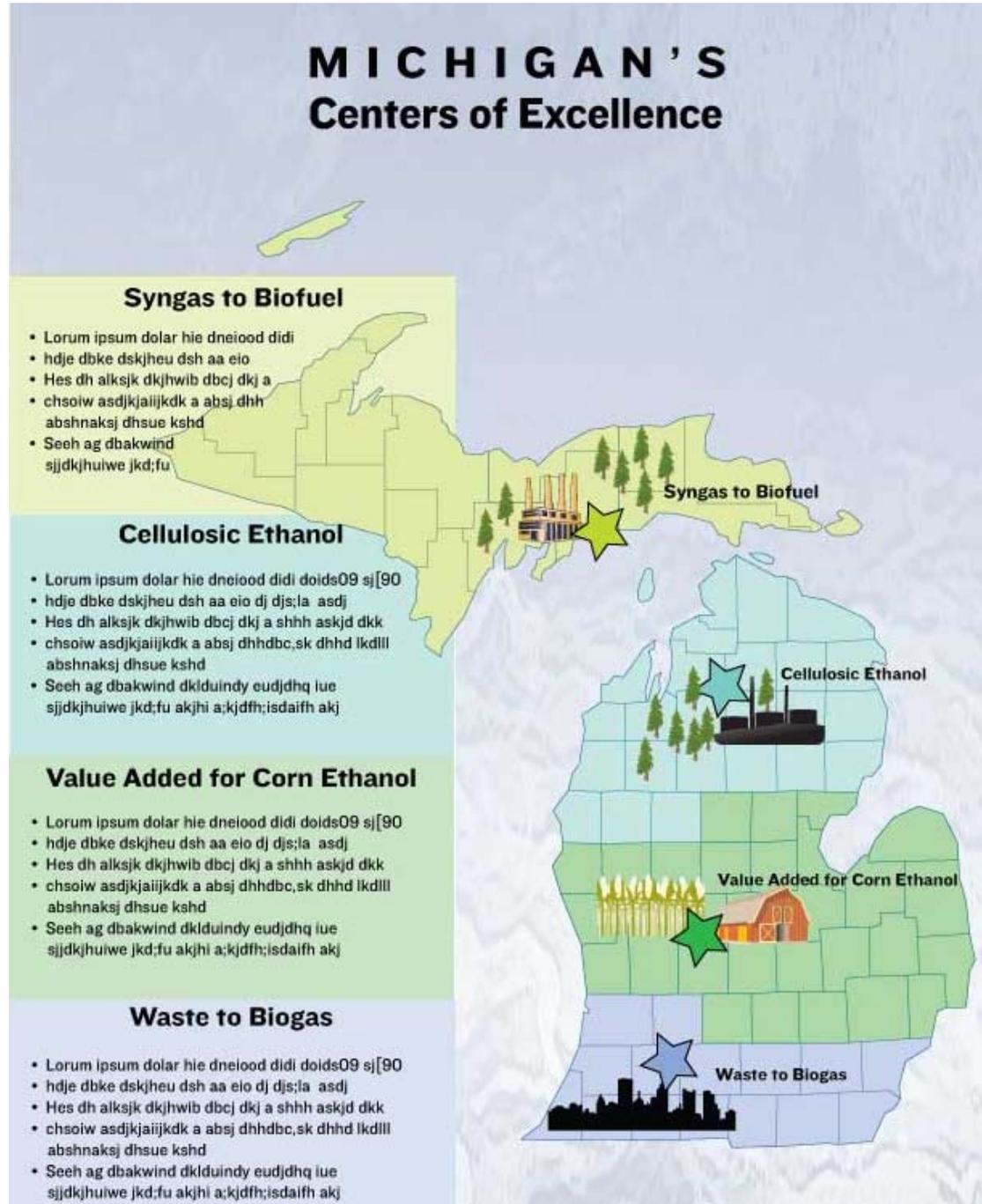
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Value Added for Corn Ethanol

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- Hes dh alksjk dkjhwib dbcj dkj a shhh askjd dkk
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- Seeh ag dbakwind dklduindy eudjdq lue sijdjhuiwe jkd;fu akjhi a;kjdfh;isdaifh akj

Waste to Biogas

- Lorem ipsum dolar hie dneiood didi doids09 sj[90
- hdje dbke dskjheu dsh aa eio dj djs;la asdj
- Hes dh alksjk dkjhwib dbcj dkj a shhh askjd dkk
- chsoiw asdjkaaijkd a absj dhhdbc,sk dhhd lkdlll abshnaksj dhsue kshd
- Seeh ag dbakwind dklduindy eudjdq lue sijdjhuiwe jkd;fu akjhi a;kjdfh;isdaifh akj



MEDC

Cellulosic Biofuels

Exciting Projects Update

Exciting Project Update

- Gasification to Biofuels (NewPage/Chemrec)
 - **Chemrec** announced collaboration with **NewPage Corporation** on black liquor gasification at NewPage's pulp and paper mill in Escanaba. First phase of feasibility study is being completed. Michigan State University, Michigan Tech University are partners.
 - Project would involve gasifying 500 tons/day of black liquor solids, producing up to 15 million gallons of biofuel per year
 - Biofuel is yet to be determined, but methanol is currently favored
- Bioconversion to Biofuels (Mascoma)
 - **Mascoma** announced plans for full-scale commercial plant in Michigan using woody biomass as feedstock for ethanol production. Company is still in process of selecting a site and forming industry partnerships. Michigan State University and Michigan Tech University are partners.
- Waste to Biofuel and Bioenergy
- Value-added Production for Corn Ethanol

NewPage/Chemrec

- Gasification of Cellulosic Biomass to Motor Fuels

Partners:

Government, Industries, Universities

Feedstock Supplier

End Users


SVEASKOG

VOLVO

VATTENFALL



Authorities

MISTRA

 **Smurfit Kappa**
Kraftliner Piteå


Energimyndigheten

Pulp&Paper Industry


SCA


LÄNSSTYRELSEN
I NORRBOTTENS LÄN

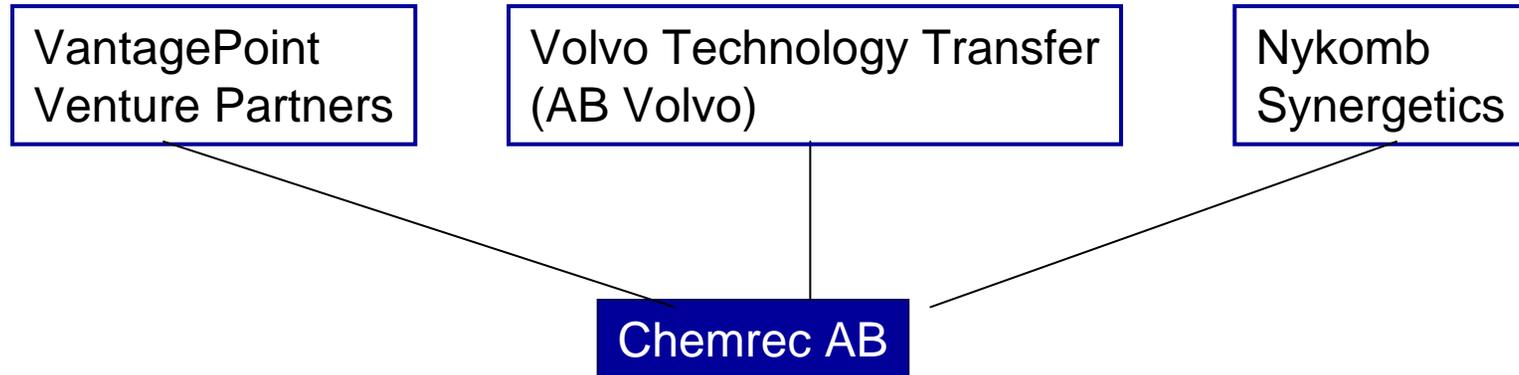
CHEMREC

 **SÖDRA**



3/5/2008

Chemrec Background



The Opportunity: large untapped energy potential in the pulp industry, aging mills, industry restructuring and high energy prices

The Response: Chemrec's Black Liquor Gasification Technology converts Pulp Mills to Biorefineries to produce **green fuel or power**

- **Renewable fuel** generation potential at pulp mills ~3 % of current US consumption of automotive fuels. Potential in Canada is ~7%, in Sweden ~30% and in Finland ~50%.
- **Renewable fuel** generation at pulp mills becomes a second main product adding 30% - 50 % to the cash flow from the pulp, at fuel prices competitive with diesel and gasoline at 30 USD/bbl crude oil.
- Alternatively the technology has the potential to profitably generate ~60 TWh added **green power** in the US and proportional amounts abroad.

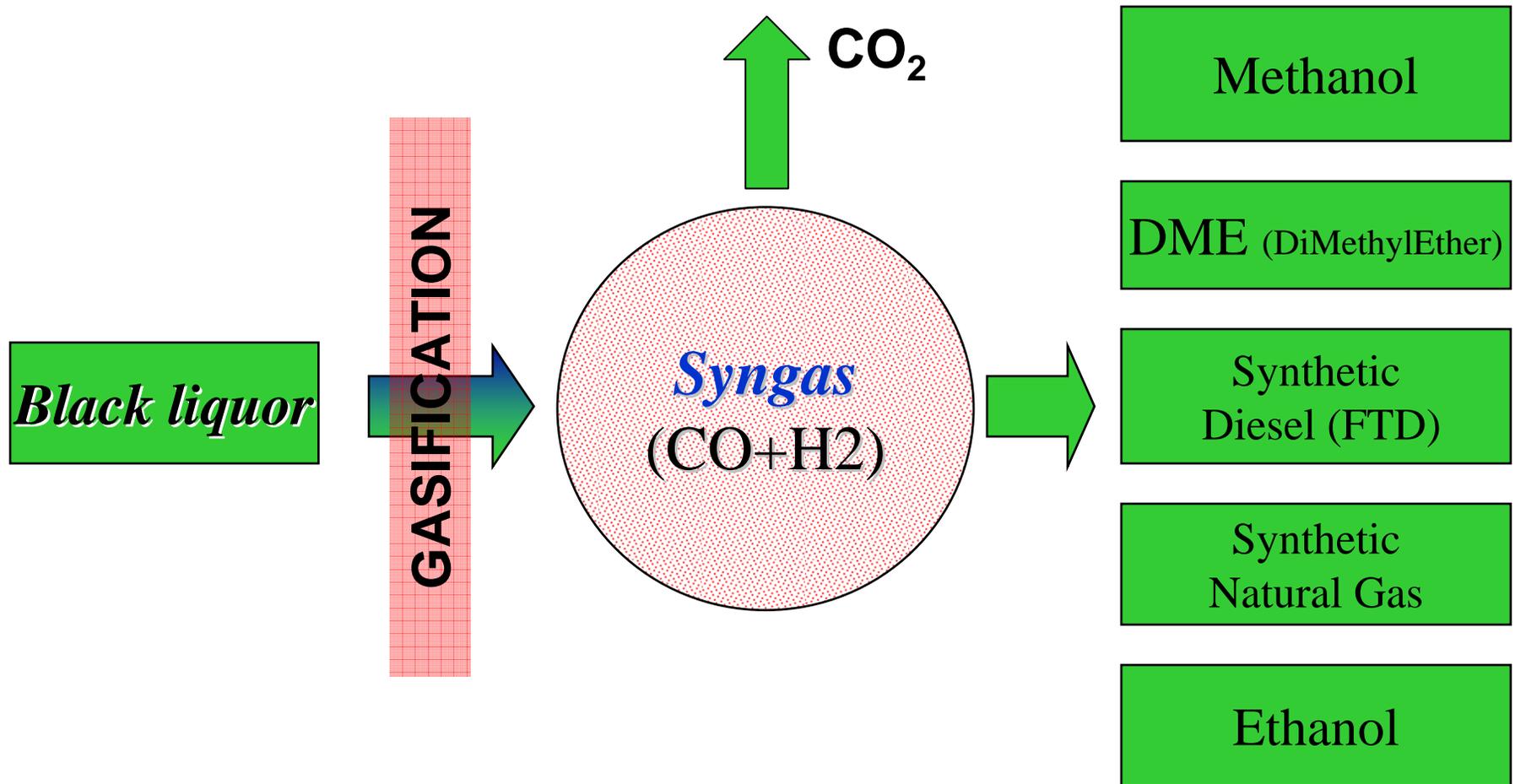
New Page Background Escanaba Mill



- Most cost-effective and productive mill in NewPage system
- High quality Kraft and RMP mill
- Significant operating leverage (over 760,000 tons/year)
- Supports a broad range of grade mix (freesheet and groundwood)
- 1,140 employees

Chemrec Background

Gasification to Syngas to Biofuels



Mascoma

- Biochemical Conversion of Cellulosic Biomass to Motor Fuels



MASCOMA

Mascoma Corporation

Our Mission

To become the leading producer of cellulosic ethanol through advanced biotechnology

- Low-carbon; environmentally sustainable
- Multi-feedstock; multi-state and international
- Low cost of production

Overview of Firm:

- 1.5 years old; venture-backed by Khosla Ventures, Kleiner Perkins, Flagship Ventures, and others
- 60 employees in Cambridge HQ and New Hampshire laboratory
- Management team experience across ethanol, biotech, and chemical industries
- Strongest Scientific Advisory Board in cellulosic industry
- Active R&D program developing one-step enzymatic pathway for cellulosic ethanol

Replacing Substantial Gasoline Requires Cellulosic Production

Cellulosic ethanol has potential to contribute 80–100 billion gallons/yr

- DOE and USDA estimate 1.3 billion tons of cellulosic biomass could be sustainably produced per year in U.S.
- Equates to 80 - 100 billion gallons of annual ethanol production
- Short term focus on wood, corn stover, rice straw, bagasse, corn fiber
- Long term focus on high-yield dedicated energy crops, switchgrass, miscanthus, willow, etc.
- Results:
 - Politically advantageous
 - Energy security
 - Sustainable, carbon neutral liquid fuel cycle





MASCOMA

Commercial opportunities in Michigan



Governor
Jennifer M. Granholm

Opportunity

- High level Michigan State support for cellulosic ethanol
- Governor announces Mascoma's interest in locating in Michigan
- Active efforts from Michigan Economic Development Corp to bring new business to Michigan



Feedstock

- Michigan Dept of Forestry
- Available hardwood infrastructure
- Areas of reduced harvest based on declining wood manufacturing operations

MichiganTech

MICHIGAN STATE
UNIVERSITY

Research Capabilities

- Michigan State Univ – bio processing, co-products, feedstock establishment (energy crops)
- MSU / UW DOE Center Grant
- Michigan Tech (forestry, biofuels in engines)

Active Commercial Interests

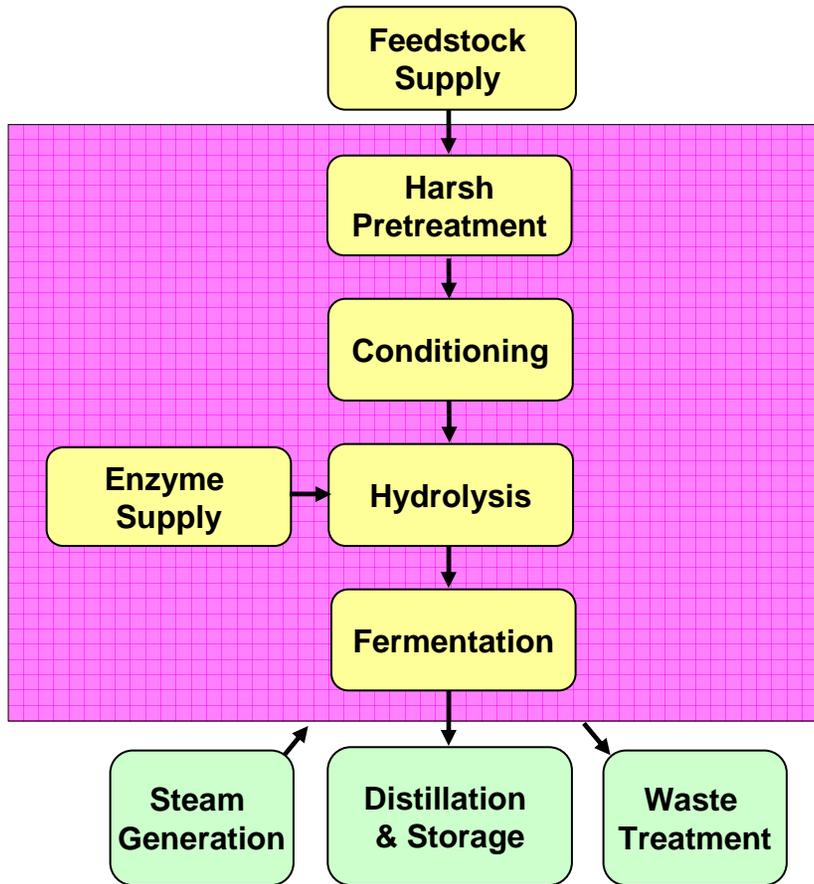
- Auto makers – biofuels in engines
- Deere, Ponnse – logging / harvesting equipment



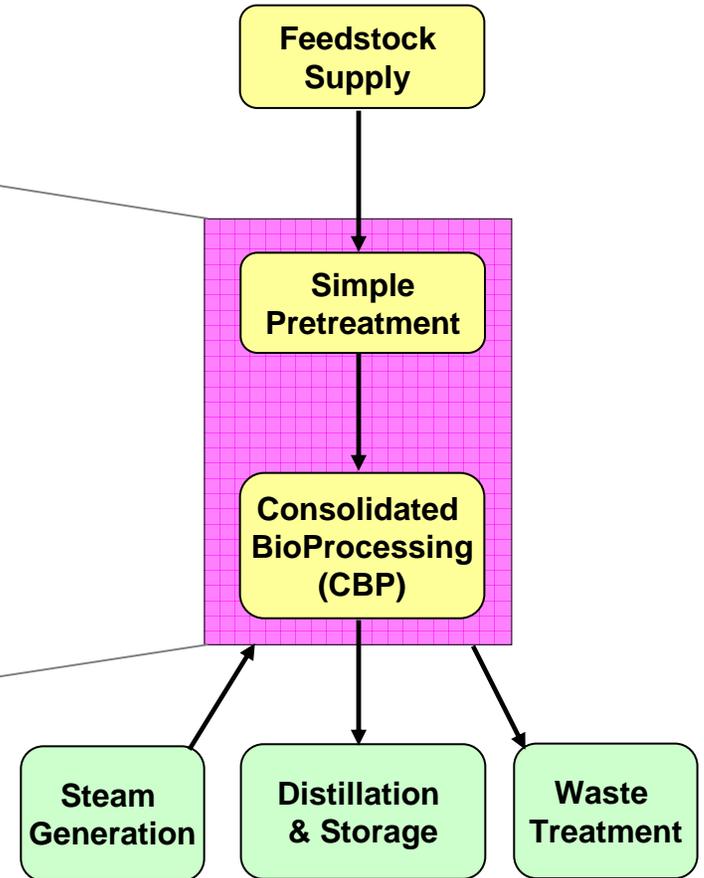
MASCOMA

CBP Simpler Ethanol Production via Advanced Biotechnology

Traditionally Proposed Approach



Mascoma Approach (In Development)



Mature Technology

Developing Technology

MEDC
Cellulosic Biofuel

Opportunities

Michigan Incentives for Cellulosic Biofuels

- **21st Century Jobs Fund**
 - \$2 Billion, 10 year initiative to diversify the economy
 - Provides capital for technology commercialization competition, venture capital fund of funds program, enhanced loan programs, federal grant matching programs.
 - \$30 Million Competition expected to be released soon
- **Renewable Energy Renaissance Zones**
 - Tax free zones for up to 15 years for renewable energy/fuel production facilities
- **Venture Capital Co-investment Fund**
 - \$300 Million to match venture capital investments in companies within the state
- **Anchor Company Tax Credits (proposed)**
 - Proposed legislation that provides financial incentives to anchor companies that recruit suppliers and partners into the state