



Michigan Centers of Energy Excellence

Renewable Fuels Commission
Presentation

October 14, 2008



Background

- 2 year research program (ongoing) identifying industry diversification opportunities leveraging MI competitive advantages
 - International/Federal/State trends
 - Market Analysis (size, trajectory, etc.)
 - Partner input
- Worldwide best practice review in industry acceleration programs (Swedish Triple Helix, Cluster Approach)
- Advanced Energy sectors identified and included in MEDC 2008 Strategic Plan (Emerging Sector – Initial Target Clusters)
- Implementation of Cluster teams (biofuels, wind, water, advanced energy storage)
- Inclusion in Governor Granholm’s 2008 “State of the State”
- Passage of Senate Bill 1380



Key Overall US Drivers

- Climate Change
- US Energy Act
 - 36 Billion gallons by 2022
(2/3 from cellulosic)
- Potential Carbon Program
 - Reduction
 - Sequestration
- Significant Federal Support





Key Issues

- Michigan is the 8th most energy intensive state
- We expend almost \$26 billion per year to import energy -5% of our Gross State Product
- Michigan's economy is dependent on imported fossil fuels
 - 100% of coal and uranium used for power generation
 - 96% of transportation fuels
 - 75% of natural gas
- The Federal Government is moving towards a cap/trade or Carbon Tax (Lieberman/Warner, etc.)
- Fresh Water supply – worldwide crisis
- Diversification of economy – MI is 17 times more dependent on Big 3 Jobs than any other State in the US.
- MI has lost approximately 400,000 manufacturing jobs in the last 6 years
- Cleantech industry growing at 20% plus per year with unmet demand



Key Assets

- Key Anchor Companies (HSC/USO, NewPage, etc.)
- Presence of OEMs
- Top manufacturing workforce
- Top wood fiber resource (#1 in gap between growth and harvest)
- Top universities in key fields
- Sense of Urgency
- 21st Century Jobs Fund
- International relationships (Sweden, Israel, etc.)
- Existing relationship with key cleantech VC firms (Flagship, VantagePoint, Khosla, etc.)
- Fresh Water
- Outstanding Geological Formations for CO2 Sequestration



MEDC Response – 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. **BioProducts**
3. **Advanced Energy Storage**
4. **Solar/Photovoltaic**
5. **Water Technology**
6. **CO2 Capture, Reuse & Sequestration**



MEDDC Approach

- Creation of Cluster Teams, where necessary, to assist in approach strategy
- Utilize top cleantech VC firm and International Contacts (Vinnova, etc.) as front end technology screen (Flagship/Nth Power example)
- Creation of Centers of Energy Excellence (COEE) surrounding existing (or newly attracted) companies which serve as a magnet for new industry growth
 - Approach will vary by cluster depending on maturity of MI industry
 - Swedish Biorefinery Toolbox Concept
 - Attempt to consolidate technologies at COEE's
- 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 COEEs with university researchers to accelerate technology commercialization, develop workforce, and assist in company tech issues.
- Establish University Partnership with leading International research organizations (Solander Science Park – ETC, Umea Plant Science Center, etc.), National Laboratories (Oak Ridge, NREL, etc.) and DOD affiliates (TARDEC, etc.)



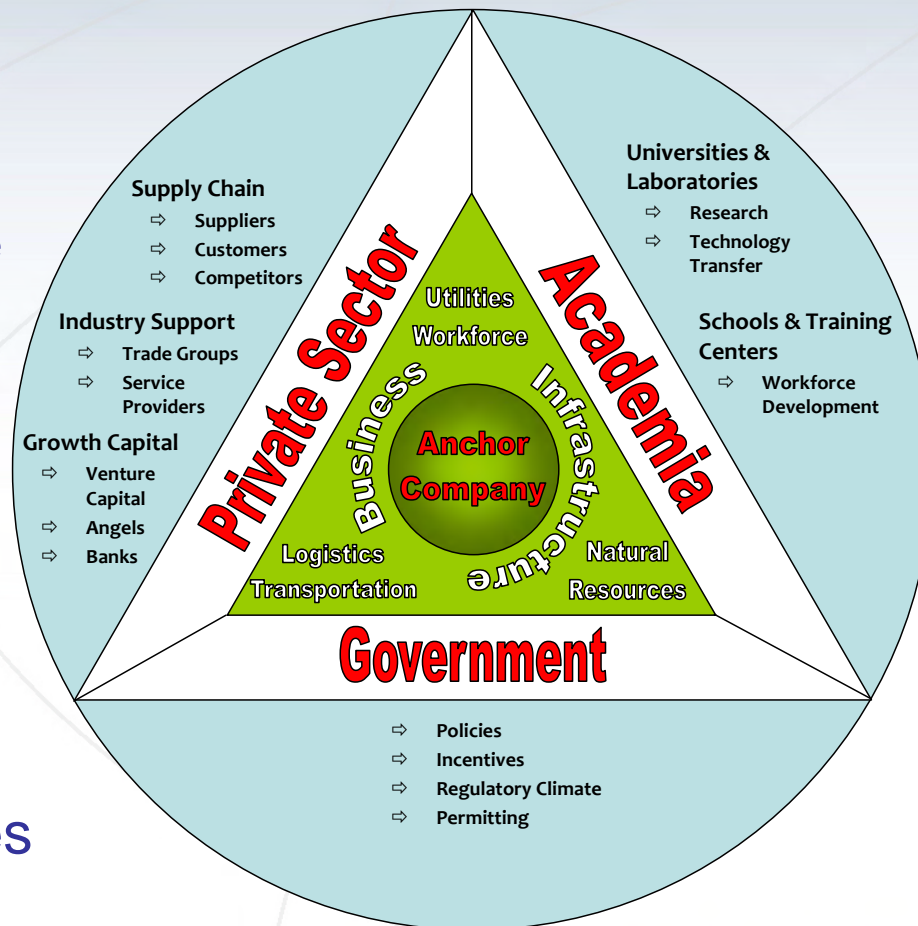
COEE Description

- Combination of private sector, university research, and public sector support to accelerate creation of advanced energy industry clusters where MI has an advantage in;
 - Workforce
 - Intellectual Property
 - Natural Resources
- Assigned to areas where there are technical or supply chain issues that prevent commercialization
- Focused on areas which have impact on Michigan's;
 - Energy security
 - Environmental profile
- Have potential for significant economic impact



Center of Excellence – ala 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





Why Sweden?

- Similar in population, geography and automotive heritage to Michigan
- Sweden got the message in the 1970's, developed bioenergy solutions, and stuck with it!
- Ambassador Wood's "One Big Thing" & the US/Swden Bilateral agreement (2007)
- Worldwide "best practices" in bioenergy
 - Biorefinery concept
 - Supply chain development



Map over the forests in Europe (EFI)

**It is easy to realize that
the large bioenergy
potential in Sweden
is in the forest!**

900 0 900 1800 Kilometers



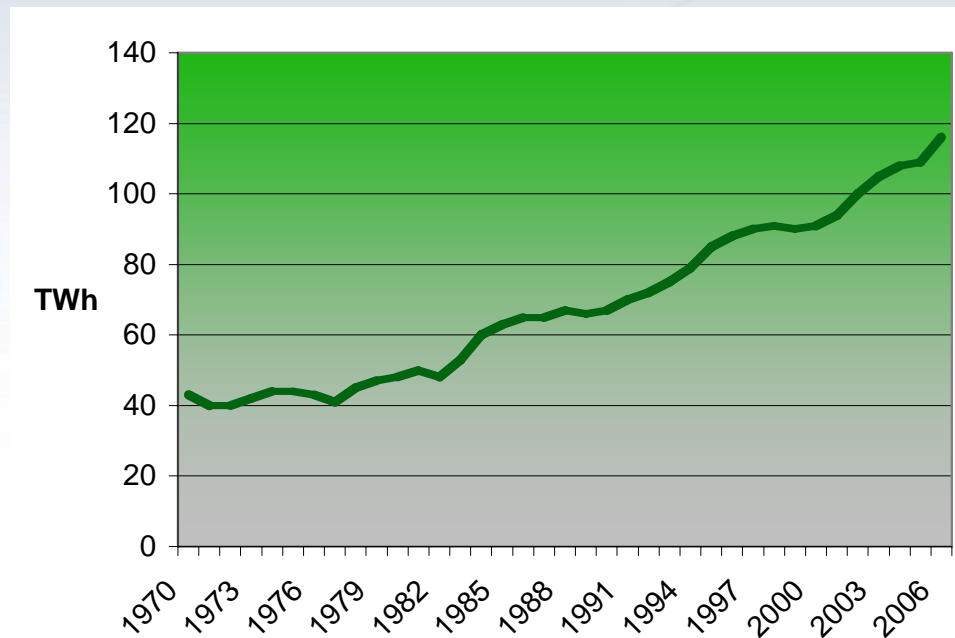
Department of Forest Resource Management
MICHIGAN ECONOMIC DEVELOPMENT CO
Section of Planning and Operational Efficiency





Bioenergy development in Sweden 1970-2005

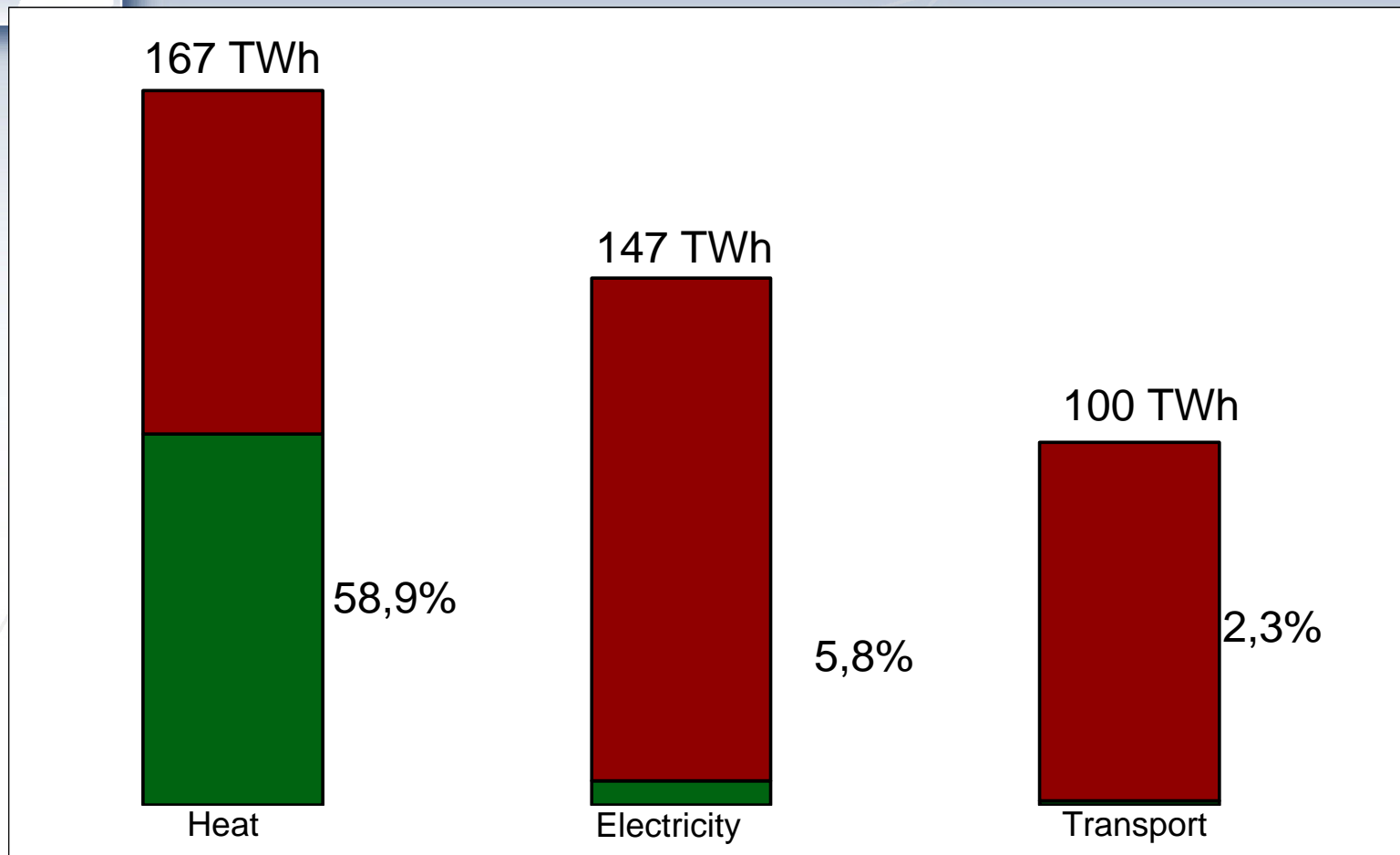
The bioenergy share of the total energy use



- 1970: 9%
- 1980: 11%
- 1990: 15%
- 2000: 20%
- 2006: 27%



Share of bioenergy in total use in 2005



The biobased economy in Växjö – today and future



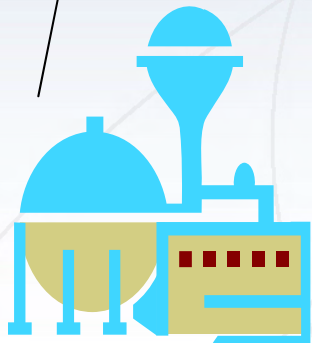
Vehicle fuel
DME



Biomass

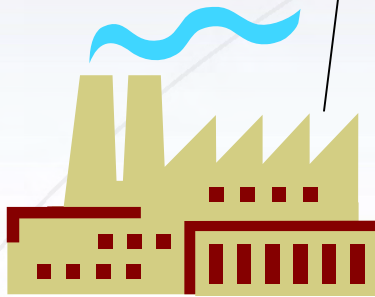
Ash

Cosmetics



Gasification to
synthesis gas

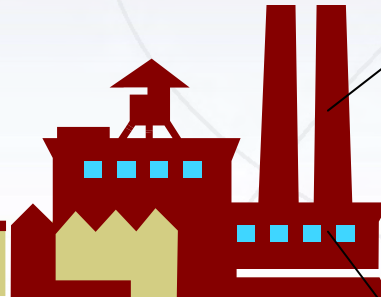
Chemicals



District heating
and power

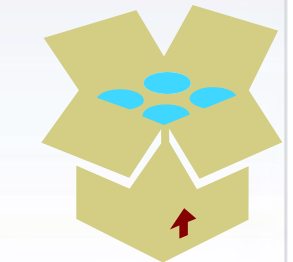


Building
material



Sawmill and pulp

Paper

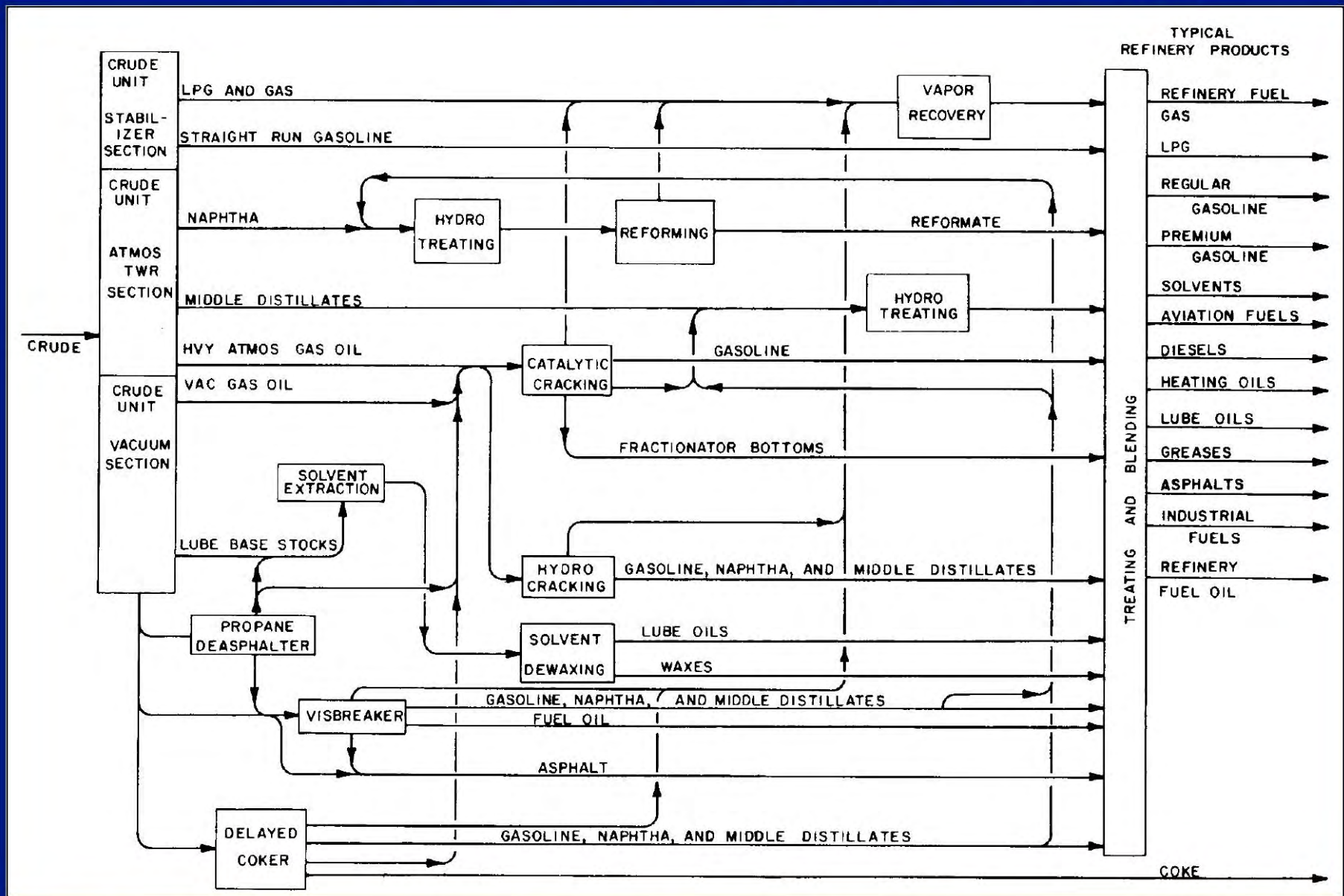


Packaging



Antioxidantes

Petroleum Refinery as Analogy



From *Petroleum Refining — Technology & Economics*, 4th ed., J. H. Gary & G.E. Handwerk, Marcel Dekker, Inc., 2001





Partners: Government, Industries, Universities

Feedstock Supplier

End Users



Authorities



Pulp&Paper Industry



11/12/2008

www.michigan.org

MICHIGAN ECONOMIC DEVELOPMENT CORPORATION



Example CHP in Ostersund



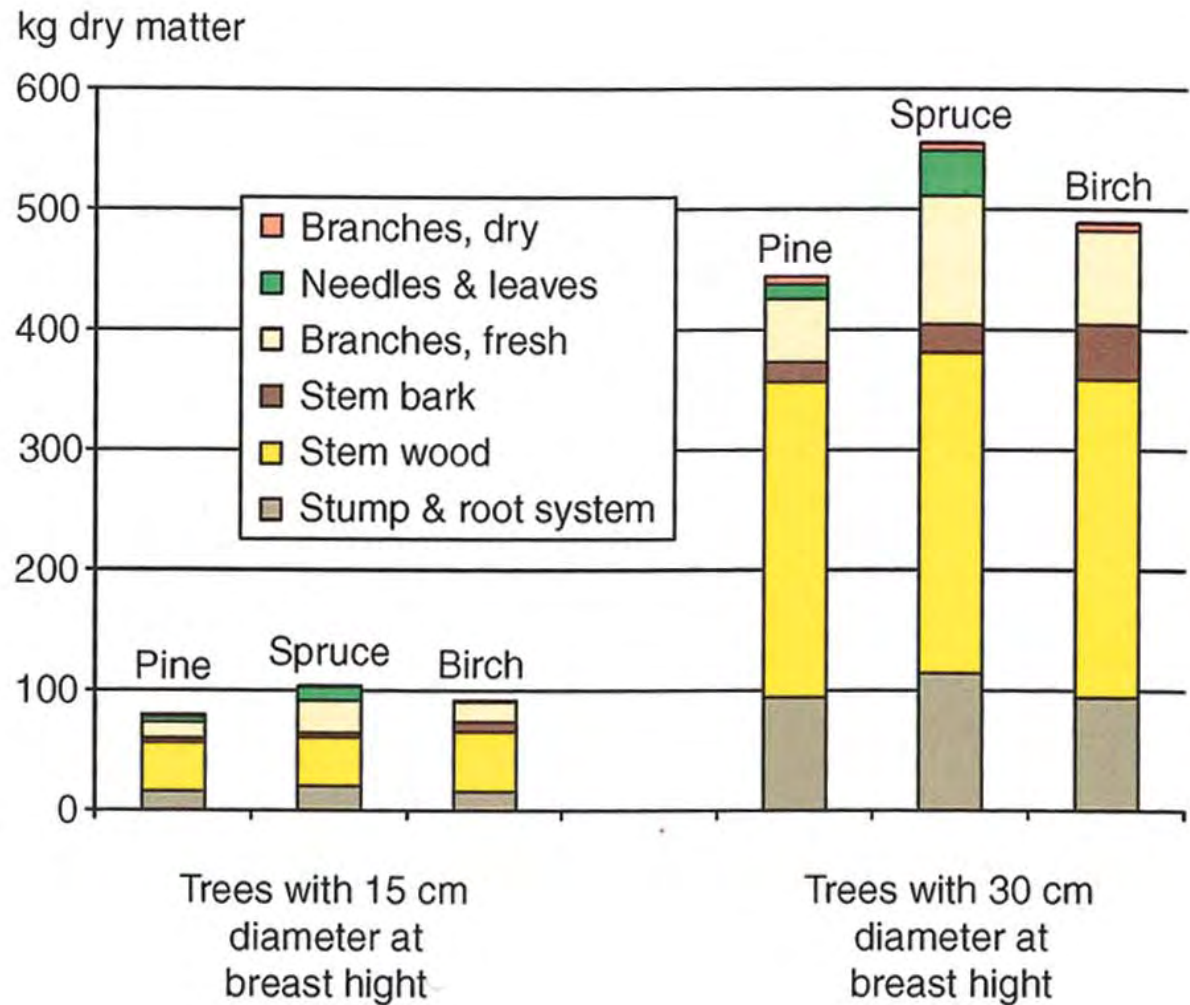
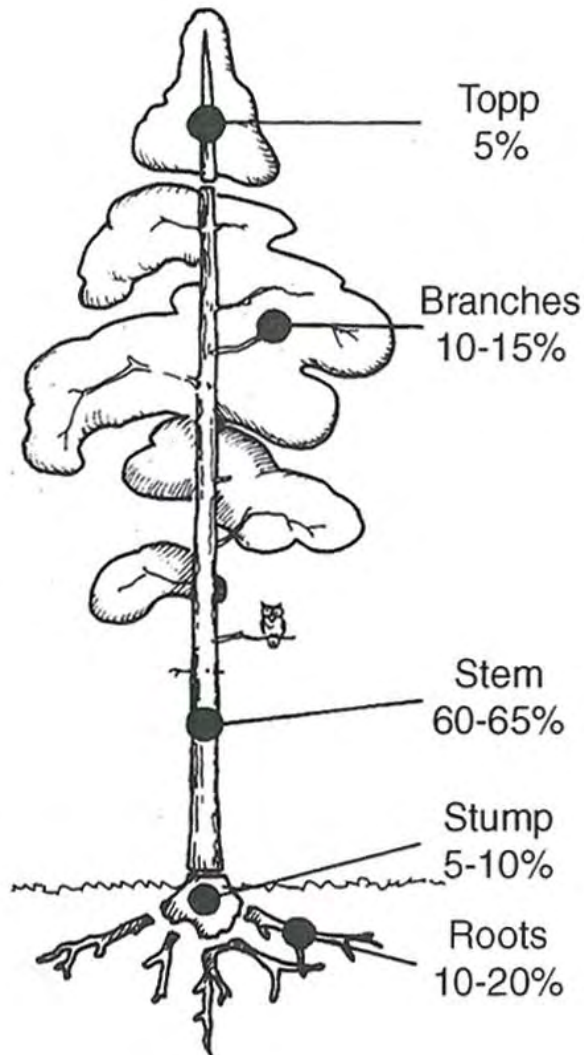


Supply Chain





Biomass available after cutting down the trees





Tops and branches harvested after clear-cutting





Handling forest residues





Bark and other residues





Recycled wood





Ash recycling from clean wood fuels

- A way to compensate for woodfuel removal
- A way to fertilize stands for higher yield
- A substitute or complement for liming
- An environmentally positive way to get rid of a waste problem

Either way - a strong increase in ash recycling is a positive development!



BIOENERGI FRÅN SKOGEN II

2005-2007



Ett **Interreg** projekt som delfinansieras av EUROPEISKA UNIONEN



EH25



There are a number of products on the market, able to accumulate 3-5 trees, before making small piles at strip road

The first simulation is done on existing technique





Michigan's Partnership With Sweden

- Joint Centers of Energy Excellence in key technology areas
 - Black Liquor Gasification to Motor Fuels (NewPage Corp, Chemrec AB)
 - Complete - Biogas to Motorfuels (City of Flint, MI & Swedish Biogas AB)
- University Partnerships (Michigan State University, Michigan Technological University, Kettering University)



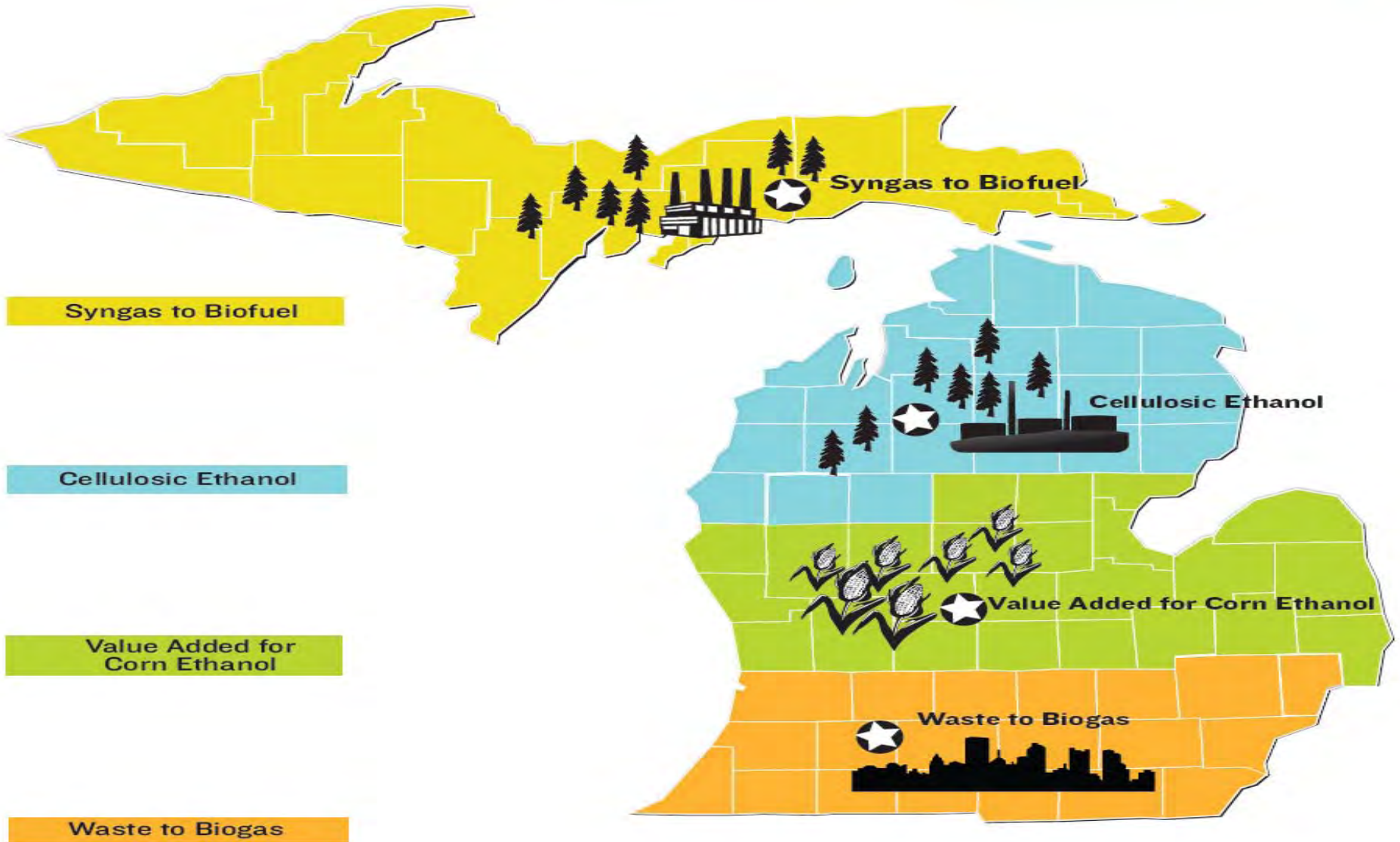
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Cellulosic Biofuels

- **Target Focus:** Bio-fuel production using cellulosic biomass as feedstock (e.g., wood waste, energy crops, ag. stover.)
- **Data-Driven Research**
 - Michigan competitive advantages (Forest and Ag products)
 - Related commercial/industrial expertise - pulp/paper mill industry
 - Relevant workforce in place
 - World class universities
- **Cluster Team** – Formed in 2007. Actively participated in the creation and implementation of a strategy.
 - 4 focus areas across multiple technologies and regions.
 - Gasification of Cellulosic Biomass to Motor Fuels
 - Biochemical Conversion of Cellulosic Biomass
 - Value-Added Products for Corn Ethanol Producers
 - Municipal Waste to Biogas/Motor Fuels





Issues

- No State funds to match Federal, Foundation, or International investments to accelerate the creation of Centers of Energy Excellence (Flint/Swedish Biogas example)
- No mechanism to provide grant dollars to compete with other States for the location of world-class advanced energy companies to serve as the anchor for a COEE (Mascoma example)



SB 1380/PA 175 – Centers of Energy Excellence

- Allow the MSF to **create and operate a COEE Program** to promote the development, acceleration, and sustainability of “energy excellence sectors” in Michigan.
- Allow the MSF board to **spend up to \$45 million** from the 21st Century Jobs Trust Fund appropriations on the COEE program. (\$18.1 million allocated for '08)
- Allow grants for the Program to be awarded **only to for-profit companies.**
- Require the inclusion of **at least one institution of higher learning**
- Require at least **50% of the funds allocated for the Program to be used to match Foundation funding, Federal funding, or International Investments.** Other purposes include;
 - Supplementing in-kind contributions provided by a person or entity other than the State
 - Accelerating the commercialization of an innovative energy technology or process that will be ready to market within 3 years of the effective date of the agreement.



Initial Awards

- Bio Products - Mascoma/MSU/MTU
- Bio Products - Swedish Biogas International/City of Flint/Kettering
- Advanced Energy Storage – Sakti3/UM



MASCOMA

▪
Bruce A. Jamerson CEO

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Addressing A Global Problem: Finding a Replacement for Petroleum

- Increasing price and tightening supplies of oil
- Energy security
- Environmental concerns & climate change
- Cellulosic fuels mandate begins 2010
- Carbon cap & trade legislation expected 2010

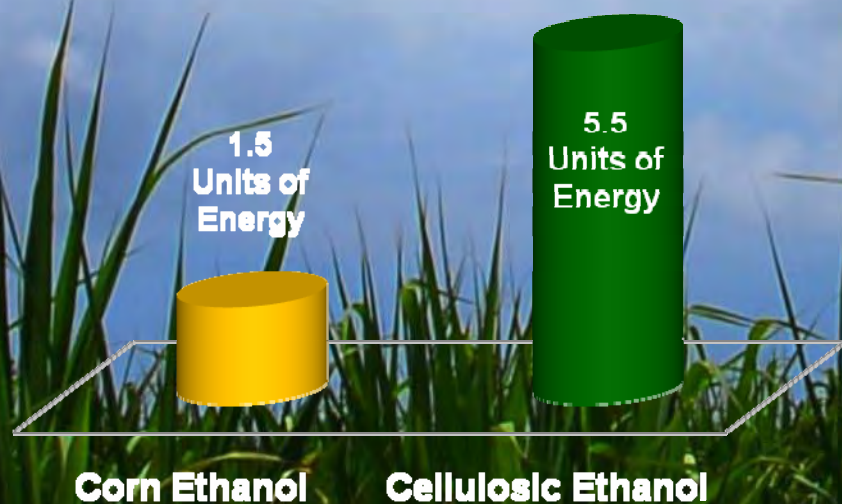
The Solution: Provide an alternative to petroleum by harvesting fuels from cellulose

Non-food Cellulosic Fuels: Profitable and Sustainable

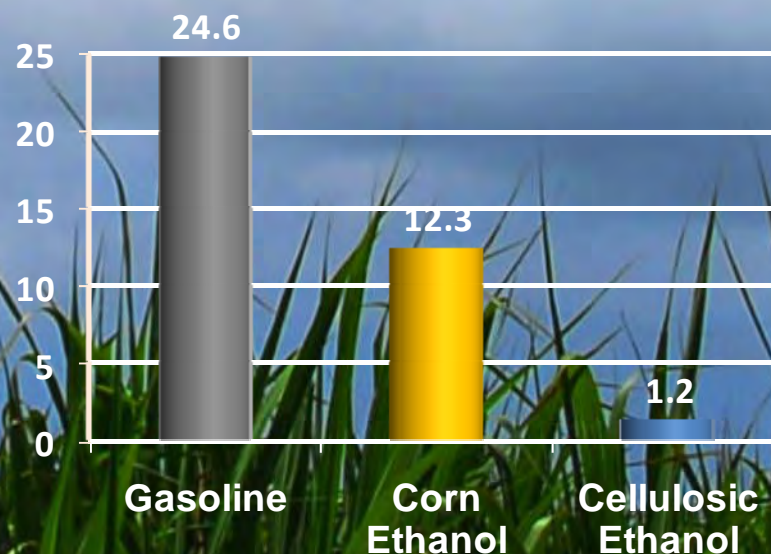
- Derived from a diverse and abundant supply of non-food biomass
- Utilizes plants to harness solar energy and capture carbon
- Renewable feedstock with proven supply logistics

Cellulosic Fuel: Environmentally Sustainable

Positive Energy Balance



95% less GHG Emissions



Pounds of CO₂ Equivalent

Source: National Resources Defense Council, citing: Hammerschlag, Roel. "Ethanol's Energy Return on Investment: A Survey of the Literature 1990-Present" *Environ. Sci. Technol.*, 40 (6), 1744-1750, Feb. 2006.

Source: Farrell, Alexander E. (UC Berkeley) and Daniel Sperling (UC Davis). "A Low-Carbon Fuel Standard for California: Part 1: Technical Analysis." May 7, 2007.

Solid Partnership Support

- Strong State government and university support
- Strategic investments by industry-leading partners
- Financial investments from top-tier venture capital funds
- Recipient of U.S. Department of Energy funding



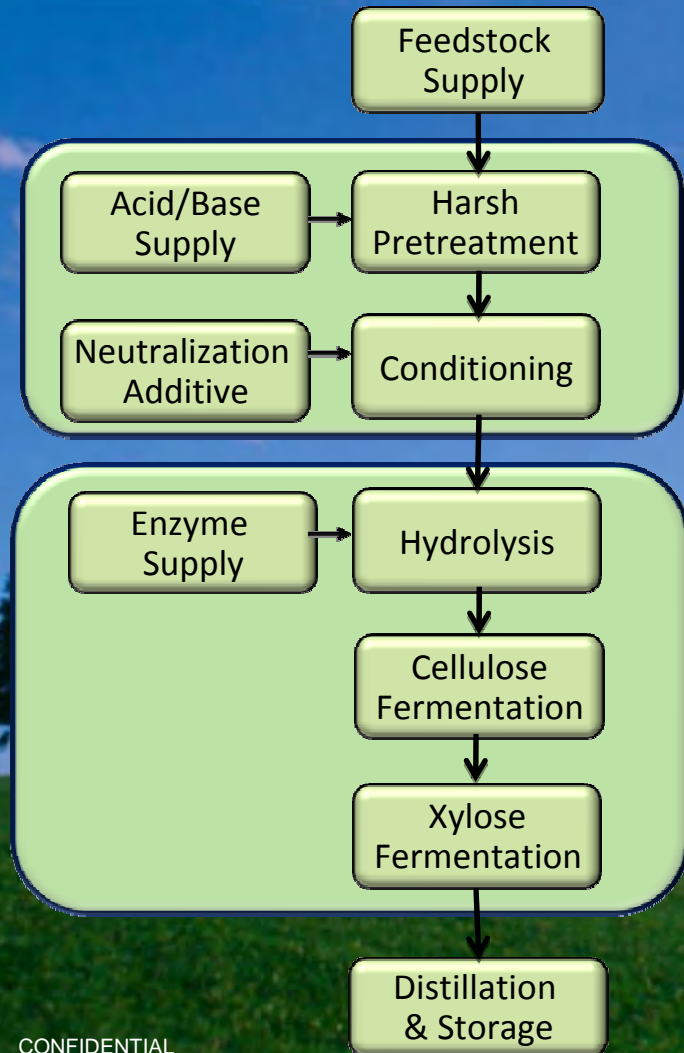
The Mascoma Difference: Experience, Teamwork & Technology



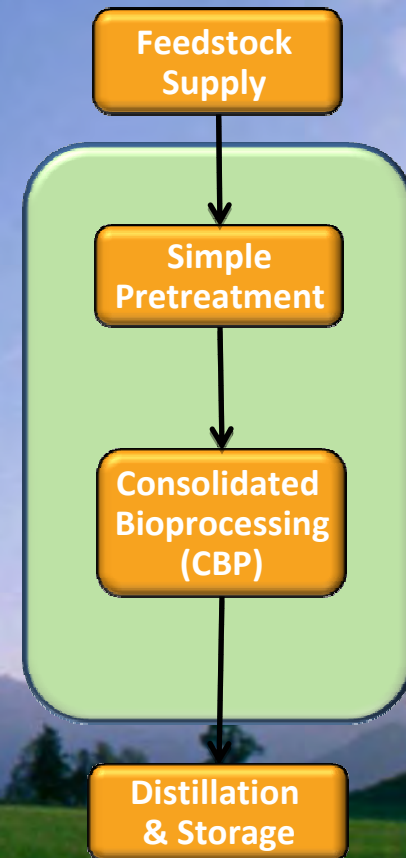
- Co-founders Lee Lynd & Charles Wyman (*Dartmouth, UCR*)
- CTO Mike Ladisch (*Purdue*)
- Colin South (*President*) & Jim Flatt (*SVP R&D*) experienced industry executives
- Distinguished scientific advisory board
- 115 employees, 80 scientists (*half Ph.D's*)
- Proven expertise in building and operating manufacturing facilities

Mascoma: Advanced Technology, Simplified Process

Traditional Approach



Mascoma Approach Consolidated Bioprocessing



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Mascoma's path to Michigan

Lebanon, NH
R&D Lab

Chippewa
County, MI
Operating Facility
In Development

Rome, NY
Operating Facility

Medford, MA
Process
Development Lab

Boston, MA
Corporate
Headquarters

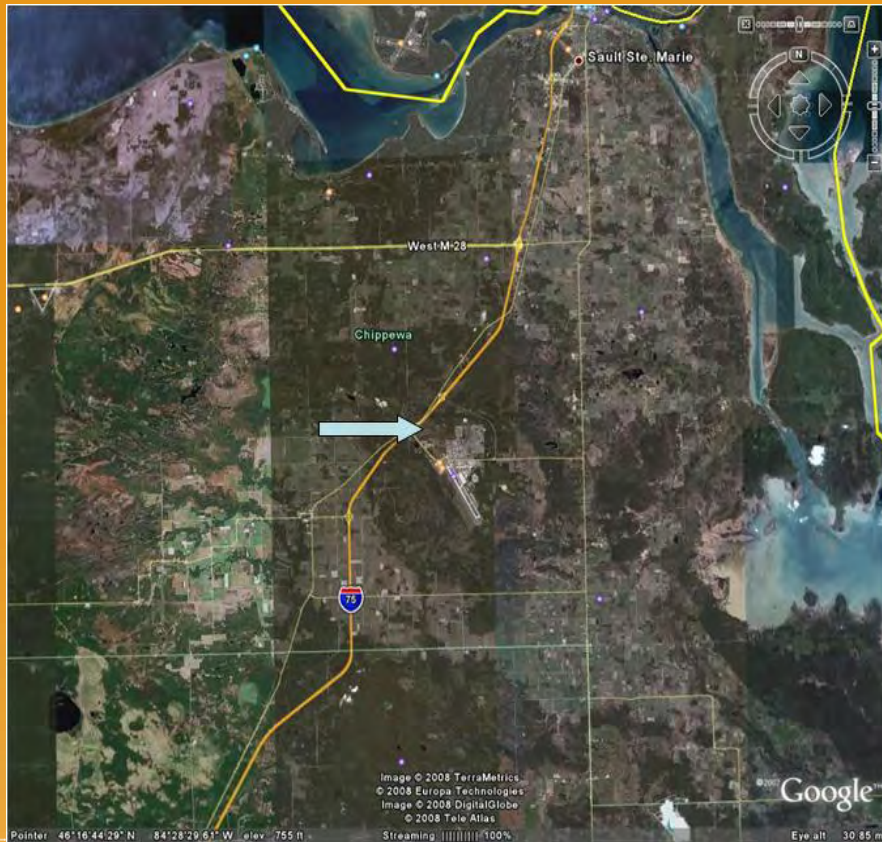
Lab
Technology

Lab
Scale-Up

Pilot
Process

Commercial
Operation

We are ready to go!



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MASCOMA

Bruce A. Jamerson, CEO

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Swedish Biogas International AB

Peter Undén

2008-09-26



- ◆ **Business Idea:**

- ◆ Design, Own and Operate biogas plants.
- ◆ Operate and Optimize biogas plants with profit sharing.
- ◆ Project manage and Examine establishment and optimization of biogas plants.

- ◆ **We Secure the Investment in:**

- ◆ Biogas from Waste Water Treatment Plants.
- ◆ Biogas from Industrial Organic Wastes (Slaughter house, food waste, etc)
- ◆ Biogas from clean organic substrate (Ethanol stillage, crops, etc)



A city similar to Flint in a country similar to Michigan:

- **Population: ~ 145 000**
 - Number of students are 26 000
 - Fifth largest town in Sweden
- **Long tradition of integrating energy and environmental solutions in full scale industrial and profitable system solutions**
- **No access to Natural Gas Pipelines**



Linköping, Sweden



Purpose of the venture was the target to improve air quality in the inner city of Linköping

- Pre-study of possible solutions 1989
- Pilot project upgrading biogas to bio-methane 1990
- First five buses on WWTP bio-methane 1992
- Full-scale production waste to bio-methane 1994
- All inner city buses (69) on bio-methane 1996
- First public fuelling station 2001
- Ethanol to bio-methane plant in Norrköping 2006
- Swedish Biogas International (private co) 2007

The venture started in a municipal company and has evolved into a regional market and international expansion in private company,



Background and Experience

- 15 years experience from process-, production, and market development of bio-methane to vehicles.
- 3 production plants, 13 public fuelling stations, and 1 bus depot.
- Bio-methane sales represent ~6% of the total vehicle fuel volume in Linköping (7,2 MNm³/yr).
- Bio-fertilizer is sold to farmers and replace fossil fertilizers.
- Employs >40 persons in production, process, and market, of which 11 persons within SBI.
- Export of knowledge, patents, and production concepts through Swedish Biogas International AB.



Development from Linköping

Production



Distribution



Sales & Marketing



Conversion



Complete Supply Chain Experience





Nykvarn WWTP sludge (Linköping)

- Digestion of sludge to get bio-methane and reduce waste products, energy consumption and N-reduction.



Åby OWP (Linköping)

- Industrial organic wastes are treated and generate bio-methane and bio-fertilizer to replace fossil fuels and chemical fertilizer.



Händelö WDGS (Norrköping)

- Clean organic rest products are treated and generate bio-methane and ecological bio-fertilizer that replace fossil fuels and chemical fertilizer and reduce internal energy consumption in ethanol plant.



One Process – Three Solutions



Example from Åby (Linköping)

SBI has exclusive rights to do business, sublicense, and develop knowledge and patents regarding biogas production and processes owned by Svensk Biogas and Tekniska Verken Group.

- ◆ Fifteen years experience from operations, service, repairs and development of full scale biogas plants on wide substrate base (co-digestion).
- ◆ Access to three full-scale production plants as references and for ongoing development.
- ◆ Modern laboratory reactors (5L, 10L) and pilot plant (40m³) for development and verification of new and improved processes.
- ◆ Patents regarding the biogas process and additives to the process.
- ◆ Expert biogas process partner in EU-project bioGASMAX.



Intellectual Properties



Feedstock/Raw Material Portfolio Development

Doug Parks

A Presentation Renewable Fuels Commission

Lansing, Michigan

October 14, 2008



Bioeconomy Opportunities

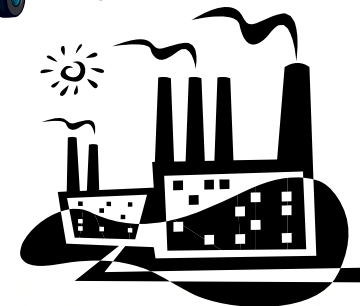
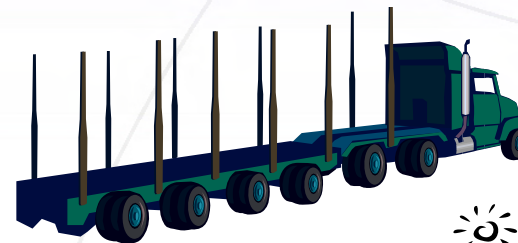
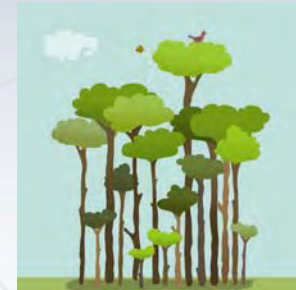
- Michigan has the 5th largest state timberland resource.
- Some forest, agricultural, and municipal woody biomass components are under-utilized (including waste/residue streams)
- Existing infrastructure utilizing and producing forest-based woody biomass
- Potential for integrated manufacturing of the variety of forest (and non-forest) based feedstocks to generate highest value
- Proven technology for electricity, heat and steam





Challenges

- Understanding feedstock/raw material availability and supply to support investor and other decisions.
- Redesign of harvest and transportation technologies
- Developing manufacturing technology for liquid fuel production
- Competitiveness of new and existing woody biomass feedstock/raw material using businesses





Examples of Biomass Sources

- Un-harvested annual above-ground growth on timberlands
- Logging residues
- Mill residues
- Energy crops (e.g. poplars, willows and perennial grasses)
- Agriculture residues
- Urban wood waste
- Municipal solid waste
- Biosolids from wastewater
- Food process waste
- Others...

... We have limited accessible databases quantifying inventory, availability, and supply (actual or potential) ...



State Energy Grant

(Issued through the Department of Labor and Economic Growth)

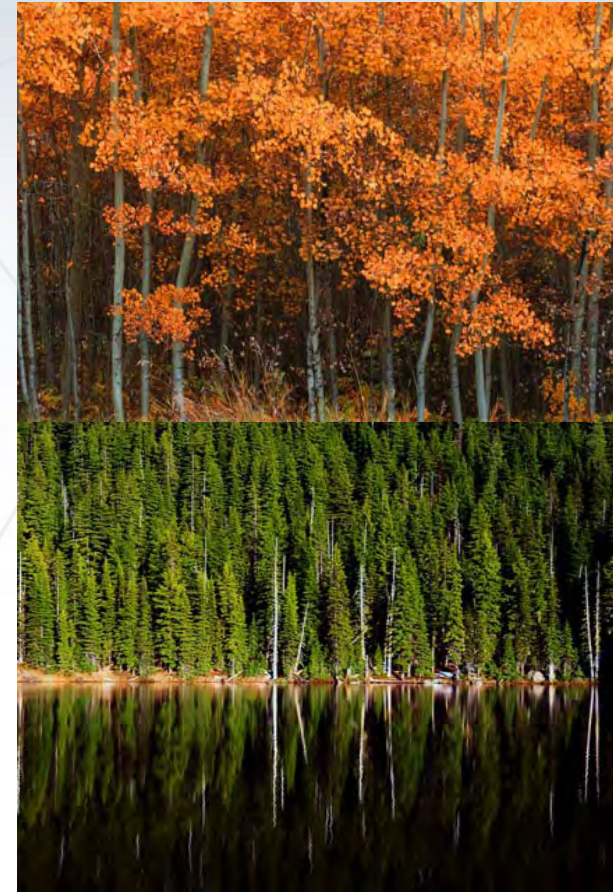
- Responses to the RFP have been received and contract to be issued shortly for a spatially based inventory of the following biomass sources:
 - Idle land
 - Corn stover
 - Sugar beet pulp
 - Animal manure
 - Straw
 - Food process waste
 - Municipal solid waste
 - Biosolids from wastewater



Forest-Based Supply

(MEDDC working w/stakeholders to complete project specifications and funding)

- **State supply (21%), Federal (14%), Private (65%)**
- **Sustainable Management Impacts on Availability**
 - Constraints implemented to for sustainability (e.g. Woody Biomass Harvesting Guidelines, Soil and Water Quality Guidelines, and third-party sustainable forest certification requirements)
- **Social Impacts on Availability**
 - Public policy impacts public and private lands
 - Landowner behavior research indicates 17% of Michigan non-industrial/non-institutional landowners unwilling to harvest (Information source: Dr. Karen Potter-Witter, MSU)
- **Supply: Economic Impacts on Availability**
 - Competition with other markets
 - Delivered wood cost (stumpage, harvest, transportation)
 - Logging infrastructure





Technical Contact

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