Wisconsin Biorefining Development Initiative

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Wisconsin Biorefining Development Initiative

www.wisbiorefine.org

Funded by the U.S. Department of Energy

Applied for and managed by the Energy Division of the Wisconsin Dept. of Administration

Goal: To expand biorefining in Wisconsin by introducing new opportunities for refining multiple, higher-value products from biomass materials and waste streams.

Wisconsin Biorefining Development Initiative

Built the foundation for an Industry-led Biorefining Consortium that includes State & Federal Governments, Universities, and NGOs.

1. Drafted the Initiative's Working Concepts on Biorefining in Wisconsin
2. Targeted Industry Clusters based on Working Concepts
3. Compiled Biorefining Information into an easy to use format on:
    - Feedstocks of Target Industry Clusters,
    - Conversion Platforms for target feedstocks, and
    - Potential Products
4. Begun Education and Outreach to key stakeholders
5. Engaged State Officials, Regulators and Financial Community

Key People Who Made it Happen

Center for Technology Transfer

Project Advisor: Masood Akhtar

Energy Center of Wisconsin

Technical researchers: Kevin Grabner, Sean Weitner

Research and editing: Melanie Lord
Web site: Andrea Minniear
Videoconference: Kate Anderson, Jaime Barbian, Brenda Jessen
Oversight: Karen Meadows

University of Wisconsin

Technical researchers: Douglas Reinemann, Patrick Walsh, Jennifer Hermans, Stephanie Larsen

Project Reviewers: Thomas Jeffries, William Kenealy, James Converse, Brian Holmes

Today's Topics

U.S. Dept. of Energy's Vision

What Makes Sense for Wisconsin?

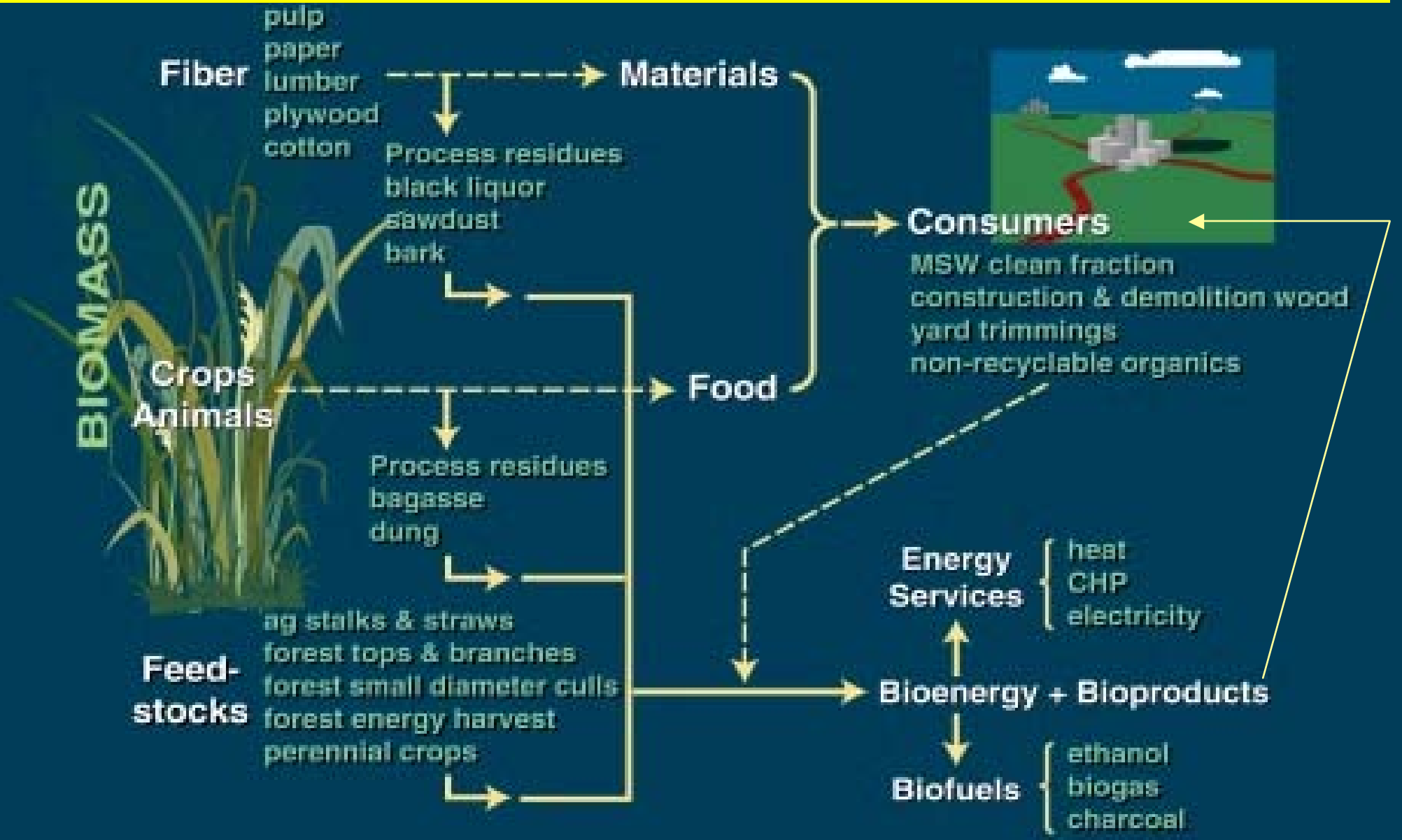
Where do we go from here?

“The promotion of "biorefineries" as a major new domestic biomass industry is, along with reducing dependence on imported oil, the major objective of the Biomass Program.”

- US Dept. of Energy

www.eere.energy.gov/biomass/biomass_basics.html

CONCEPT OF BIOREFINING FROM 10,000 FEET



U.S. DOE's Two Main Biorefinery platforms

Sugar - Uses chemical and biological processes to convert biomass to sugars, then to products

Thermochemical - Uses heating of biobased feedstocks under low oxygen to convert biomass to its chemical components, then to products

Biorefining - It's More than Ethanol

- **Old** technology to ferment sugar to ethanol has been around for centuries
- **NEW** technologies to convert **cellulose to sugar** economically are **under development**
- **Next generation biorefineries** will use enzyme technologies to make sugar from cellulose that will then be converted to **multiple products** – fine chemicals, bulk chemicals, polymers and ethanol will be produced.
- **Multiple products means better economics**

Sugar Platform

- Plant matter – made of tightly bonded sugars (cellulose & hemicellulose) and lignin
- Cellulose is made of sugar building blocks – but is a tough nut to crack
- Pre-treatment + enzyme (cellulase) treatment = technological breakthrough

Cellulose after pre-treatment

Sugar Platform: biomass (hemicellulose, cellulose, lignin)

Use thermochemical (steam/acid) pretreatment of hemicellulose and enzymatic hydrolysis of cellulose to break those two carbohydrate sources down to their component sugars. Fermentation or other processing is then used to make fuels, high-value chemicals, and materials.

Separated lignin — comprises the bulk of biomass material. It can also be processed into valuable products or can be burned in a CHP unit to provide heat, steam, and electricity for the process operation.

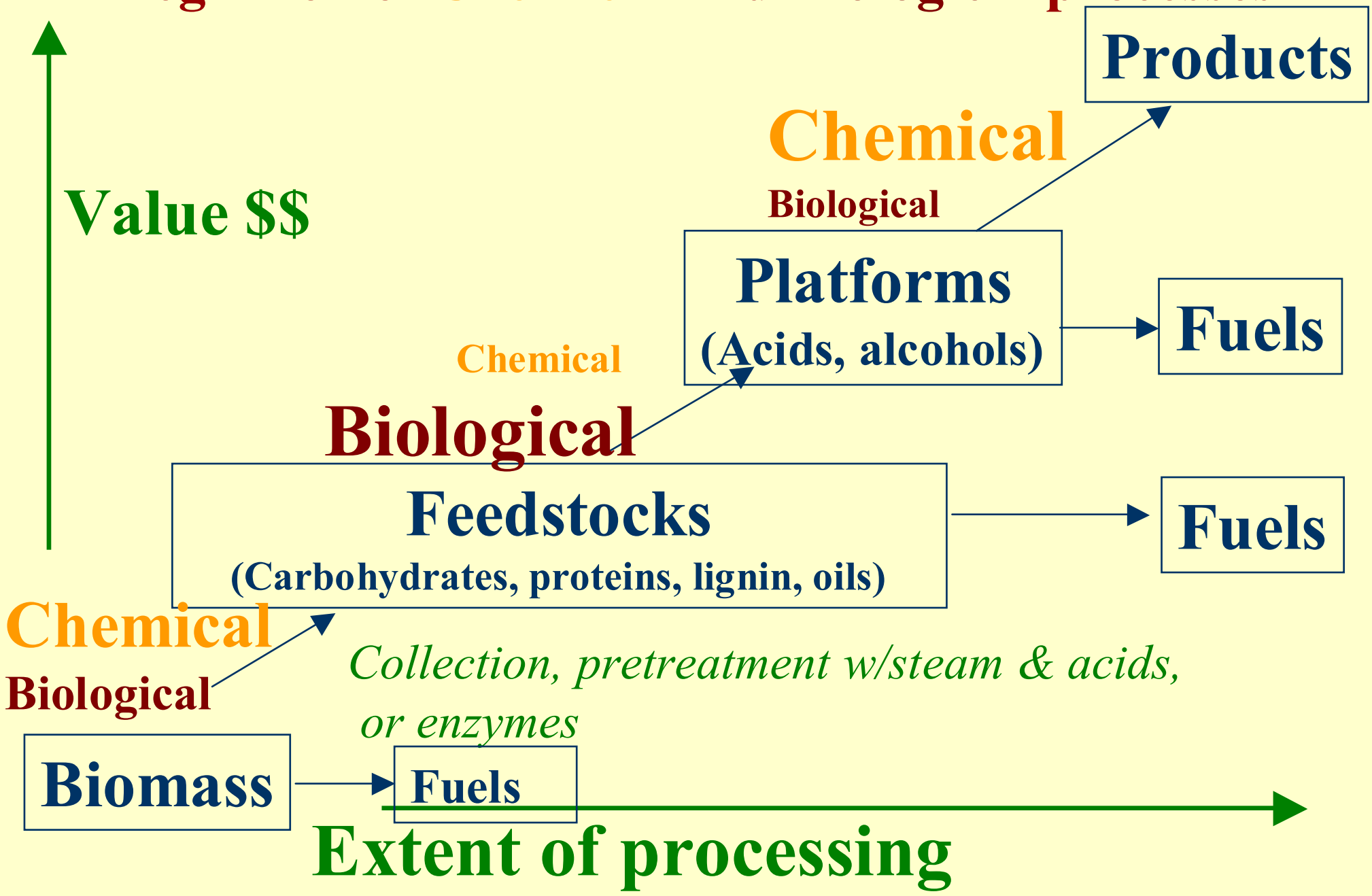
Products That Can Be Made From Cellulosic / Sugars

- **Ethanol & bio-oils**
- **Polymers – PLA, PHA, PDO**
- **High Value Chemicals**

Source: Dennis Miller, Ph.D., Michigan St. University

Biorefinery Sugar Platform

Integration of Chemical and Biological processes



Case Study

Cargill – a grain processing company developed process to make plastic from corn

Sugar ⟶ lactic acid ⟶ polylacticacid (PLA)

polymer ⟶ many plastic consumer products

Cargill Spent $25 Million Developing PLA Technology

But commercialization not completed

Department of Commerce – NIST – Advanced Technology Program (ATP) provided an additional $5 million for R&D; **Department of Energy** also provided R&D funding.

Result of gov't assistance – technical barriers were overcome facilitating **commercialization** activities

As a Result of Government Assistance and Formation of Strategic Partnership

Cargill-Dow Biorefinery

Dedicated Spring 2002

Blair, Nebraska

Thermochemical platform

Heats feedstocks with limited oxygen to gasify it to synthesis gas (a mixture of carbon monoxide and hydrogen) or liquefy it to pyrolysis oil.

Biomass converted to synthesis gas, pyrolysis oil, or hydrothermal liquid (from another thermochemical platform process) burns more efficiently and cleanly than if it were in its original solid state.

Or, instead of burning them, these bio-derived gases or fluids can be catalytically converted to other valuable fuels, chemicals, or materials.

Thermochemical platform

Pyrolysis

Thermal degradation of waste in the absence of air to produce char, pyrolysis oil and syngas, e.g. the conversion of wood to charcoal.

Gasification

Breakdown of hydrocarbons into a syngas by carefully controlling the amount of oxygen present.

Thermochemical platform

Both pyrolysis and gasification turn wastes into energy rich fuels by heating the waste under controlled conditions.

Pyrolysis and gasification are related processes of heating with limited oxygen. Conditions for producing pyrolysis oil are more likely to include virtually no oxygen.

Pyrolysis oil or other thermochemically-derived biomass liquids can be used directly as fuel, but also hold great promise as platform intermediates for production of high-value chemicals and materials.

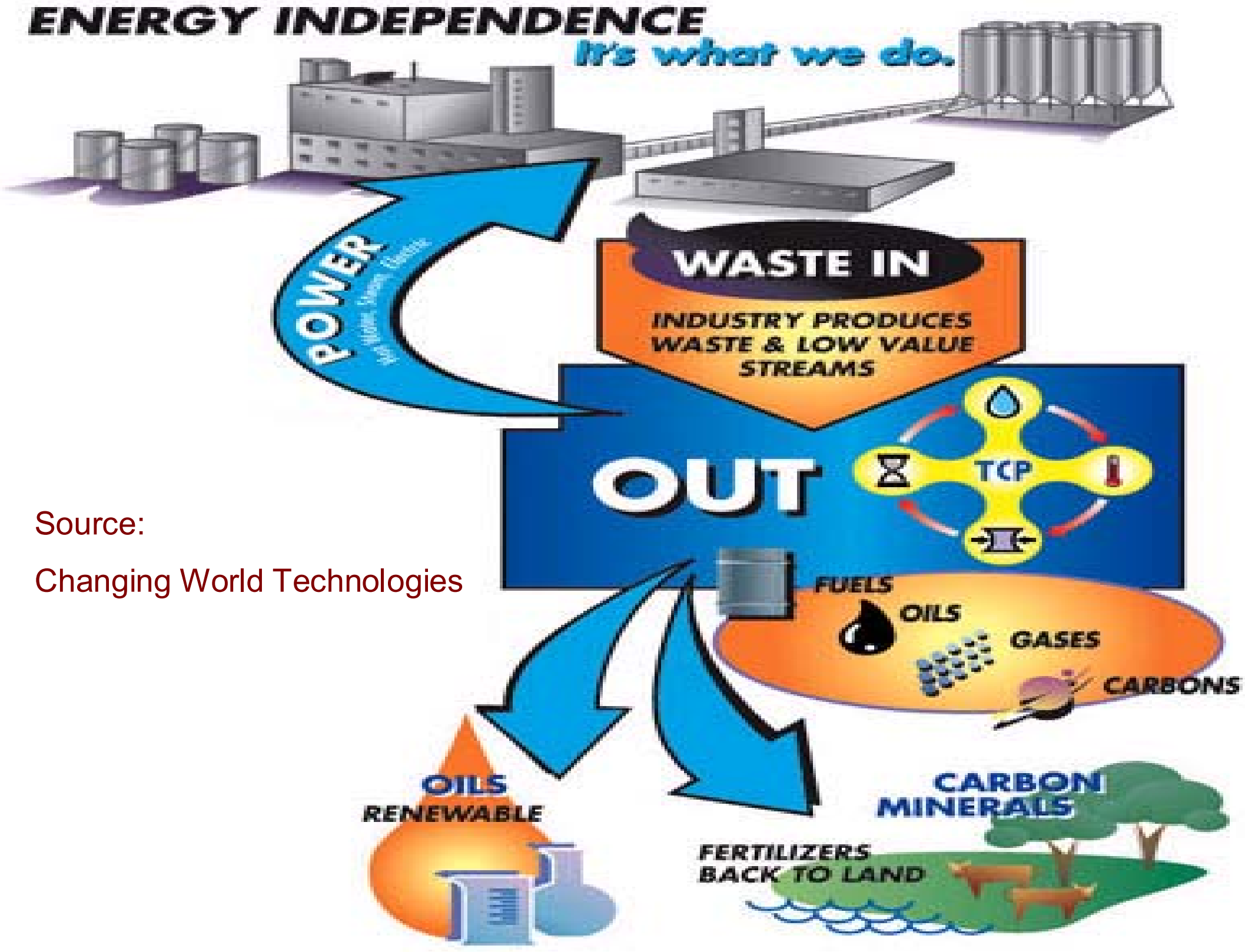
Commercial RTP™
Wood Conversion Plants - WI, USA

40 dry Tpd RTP

50 dry Tpd RTP

Together equivalent to 600 - 2000 bbl heavy oil/day

(a function of the resid content)



Source:

Changing World Technologies

Economic Development via Biorefining

What Makes Sense for Wisconsin?

Technologies and business models are emerging that can:

- help reinvigorate Wisconsin's established industries,
- create new product streams and, at the same time,
- move the state forward toward sustainable economic development.

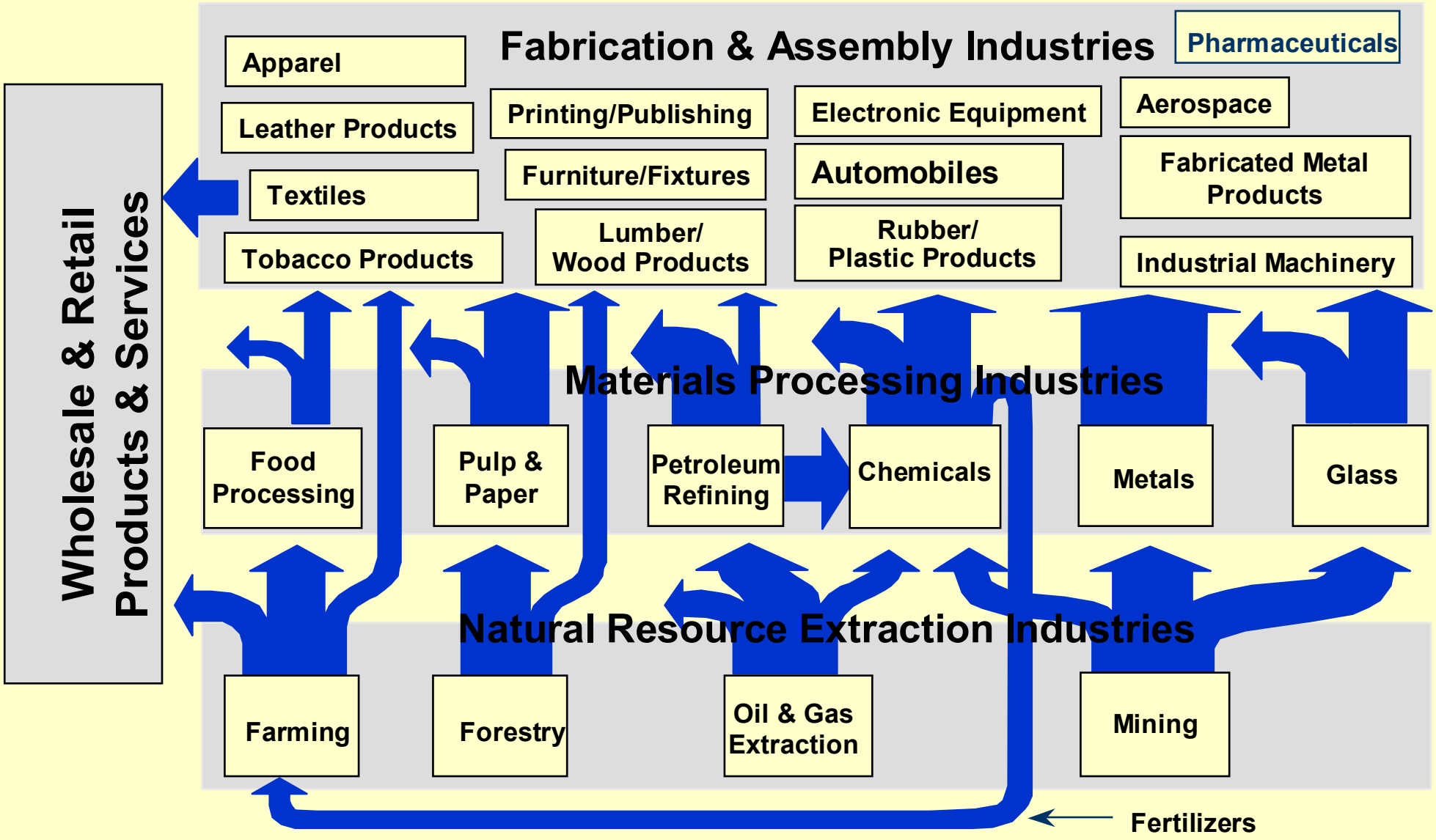
Example: Papermakers become wood fiber refiners

Five Strategies for Economic Development

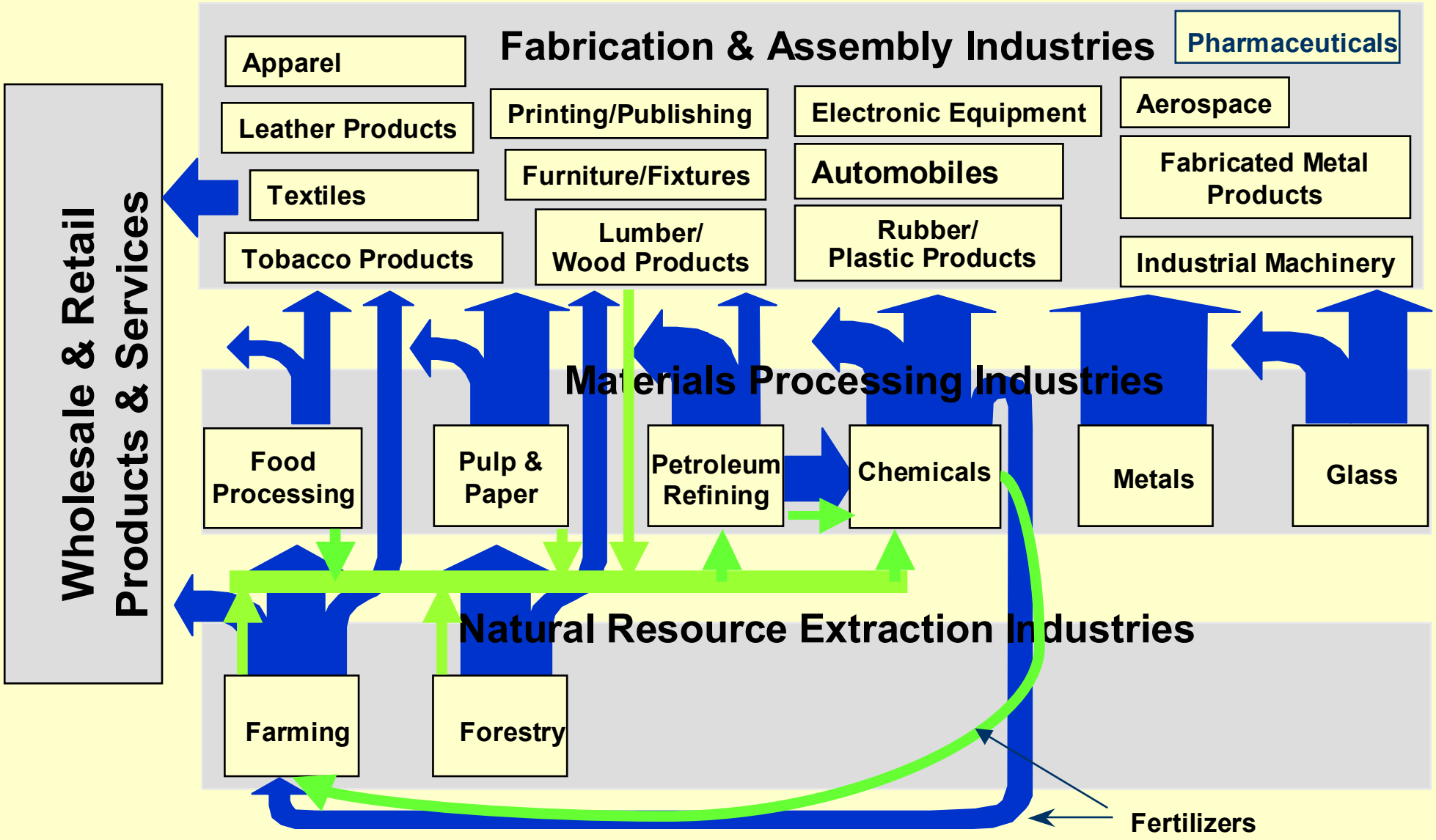
- Improve the efficiency of existing firms, (i.e. reduce waste & costs, new products, remove market barriers)
- Improve the ability to capture in-state dollars (i.e. reduce leakage of WI dollars for out of state goods & services),
- Attract new basic employers from other states or nations, (attraction costs < economic development benefits)
- Foster innovation and new business formation, and
- Increase aids from broader units of government (i.e. attract more federal dollars).

Source: Steven Deller, University of Wisconsin

Role of Industries in the Economy



Biorefining's Effects in Wisconsin's Economy



Biorefining Development:

What Makes Sense for Wisconsin?

Draft Concept #1:

Wisconsin's modern biorefinery concept should look to integrate existing and emerging technologies and business practices with the tried and true, established processes used by Wisconsin's biobased industry clusters.

Breweries	**Dairy**	**Grains & crops**
Meat products	**Pulp & paper**	**Solid wood products**

These mature clusters have already solved feedstock collection and transportation problems. They have waste disposal issues and need new product streams.

Biorefining Development:

What Makes Sense for Wisconsin?

Draft Concept #2:

Develop in-state and regional partnerships or alliances for modern biorefinery concepts that:

- **use low value, local, sustainable feedstocks,**
- **emphasize producing multiple products,**
- **help solve waste disposal problems, and**
- **use modular technologies designed to be easily replaced as science or technology improves.**

Biorefining Development:

What Makes Sense for Wisconsin?

Draft Concept #3:

Target RD&D efforts where WI's existing industries, intellectual and natural resources converge:

- **forest products and food processing industry waste streams**
- **forest products residues**
- **production agriculture waste streams**
- **agricultural crop residues and forages**

Converging Intellectual & Natural Resources

Wisconsin has about 16 million acres of cropland and 16 million acres of forest land

University of Wisconsin

USDA Forest Products Laboratory

US Dairy Forage Research Center

Companies and Countries are in a Technology Race

- To develop the best biomass conversion enzymes
- To improve pyrolysis and gasification technologies
- To design, fund and build biorefineries

Industry - Government - University - NGO Consortium

- **Private sector is making great strides** in developing new biorefining processes
- **Government policies matter** – can help or hinder progress
- **Government leadership and assistance is needed** to help solve technical and financial problems
- U.S. Dept. of Energy, U.S. Dept.of Commerce (NIST), and USDA involved in **funding biorefining RD&D activities**

Wisconsin Biorefining Development Initiative

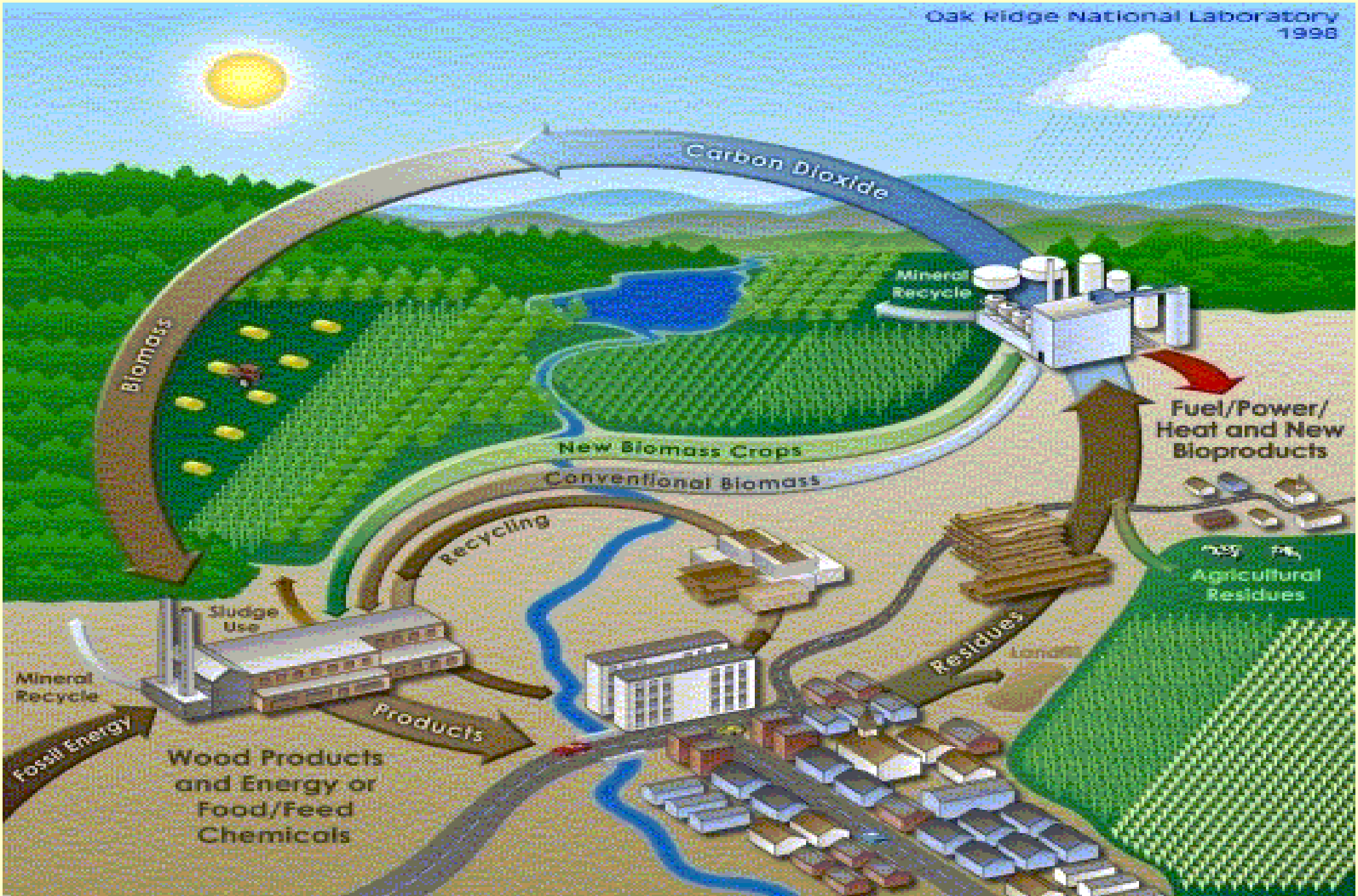
Where do we go from here?

1. Industry leadership and support for a Biorefining Consortium
2. Incorporate industry feedback on Draft Concepts
3. Gov't leadership and support to match industry's
4. Develop regional efforts with entities having aligned motivations
5. Get biorefining projects funded and operating in WI

Next Generation of Sustainable Industries

- Will be **fully integrated facilities** that can process grain or biobased feedstocks into a full range of products

Our Future: Integrated, Sustainable Systems



Thank you!

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