

New Opportunities: Renewable Chemicals and Biobased Products

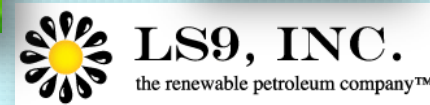
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NASEO Winter Policy Outlook Conference

Some Industrial and Environmental Section Members



Industrial Biotechnology

- The application of life sciences to conventional manufacturing and synthetic processes
- Industrial biotech uses genetically enhanced bacteria, yeasts, and other organisms.
- Biobased production processes result in:
 - lower production costs
 - reduction or prevention of pollution
 - enhanced resource conservation

Industrial Biotechnology and the Biobased Economy

- A biobased economy has the basic building blocks for industry and the raw materials for energy derived from plant/crop-based (i.e. renewable) sources and processed using industrial biotechnology
- Components include biofuels, bio-polymers and bio-plastics, specialty chemicals, bioremediation, commodity chemicals, and marine biotechnology
- Biobased economy values at \$1.25T nationally

Renewable Chemicals & Biobased Products

- Higher value products getting much more attention...

- Bio-polyethylene



- Bio-succinic acid



- Bio-isoprene



- Bio-acrylic acid



- Bio-butanediol



- Bio-isobutene



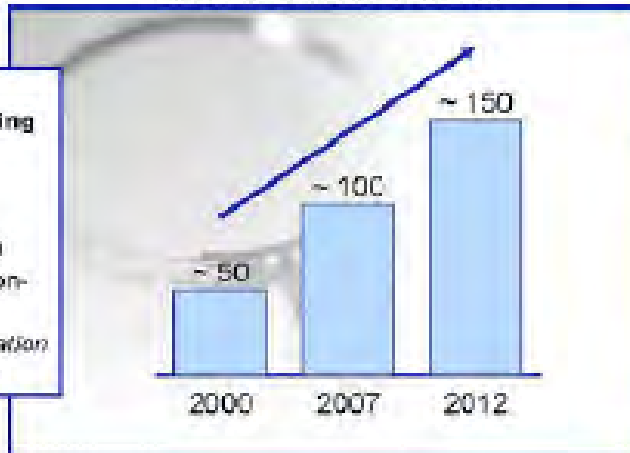
Bioproducts Success Factors

- The success of new biobased materials relies upon three factors
 - ✓Economics & performance are generally required
 - ✓Performance matches/exceeds petroleum counterpart
 - ✓Environmental aspects are typically valued as added benefit



Industrial Biotechnology Fruits of Labor

Sales in Billions of Euros



Chemical products relying on either:

- Bio-based feedstock
- Fermentation
- Enzymatic conversion

Or a combination of the above





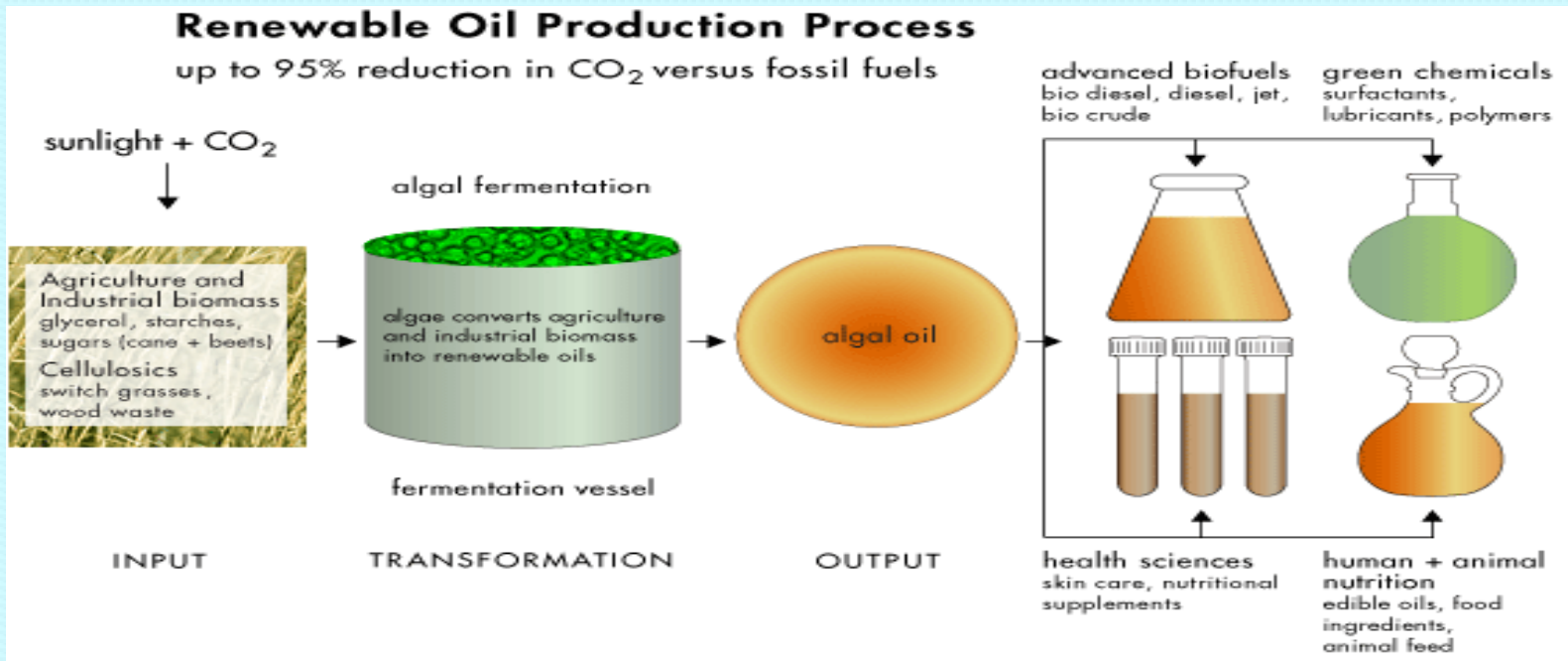
Sorona[®] Polymer in Carpet: Mohawk SmartStrand[®]

- For residential carpet applications, Sorona[®] delivers:
 - Softness and luxurious feel
 - Built-in permanent stain resistance
 - Exceptional durability and crush resistance
- Strong market penetration



Microalgae Converts Biomass to Bio-based Chemicals

- Indirect photosynthesis bio-production
- Process uses microalgae to convert biomass directly into bio-based chemicals and biofuels
- A process performed in standard commercial fermentation facilities cleanly, quickly, and at low cost and large scale
- Manufactured thousands of gallons of oil and hundreds of tons of bio-chemicals for replacing fossil petroleum and plant oils in a diverse range of products from oleo chemicals to cosmetics and food





A History of Breakthrough Innovation

Biochemicals Commercialized from DuPont

- Lysine, Threonine, Tryptophan, Indigo, Biotin, Ascorbic Acid
- **PDO polymer DuPont Tate & Lyle**
 - Sorona™ carpets, cosmetics, etc.
 - 40% less energy, GHG reduced 20%
- **Bioisoprene™: strategic biobased alternative**
 - Major potential to reduce tire & rubber industry dependence on oil, natural rubber
 - 2 B lbs/year isoprene used in tires and other products
 - Broad applications in rubber, adhesives, fuel
 - LCAs to ensure process will be sustainable



Concept Bioisoprene™ Tire
for the UN Climate Summit, Dec 2009,
CPH



Trends in Industrial Biotechnology

- **Renewable chemical platforms development is surging as a result of:**
 - More start-ups on horizon; Partnerships globally are forming and strengthening the value chain
 - ✓ **Dow & OPX Biotechnologies; Dow & Solazyme; BASF & Ford**
 - Biofuel companies are moving into high value add renewable chemicals – offers improved value proposition
 - Technologies are mature, and ready for scale-up
- **Innovative development of industrial enzyme technologies continue in :**
 - Food ingredients, Pharmaceutical intermediates for health care, Industrial catalysts
- **Biopolymers continue to penetrate new markets**
- **Algae technologies are maturing**
- **IPOs filed by startup companies in 2010 and 2011, showing a positive financial signal: Codexis, Gevo, Amyris, Solazyme, Myriant, Genomatica, KiOr, Inc.**

Future of Renewable Chemicals and Biobased Products

Challenges

- Takes time to commercialize new technology (from feedstock to consumer) but may be faster than biofuels
- The limits of government policy are more apparent
- Fully integrated bio-refineries are in the nascent stage

Opportunities

- Cost effective solutions
 - ✓ Continued R&D investment
 - ✓ Establishment of supply chain
 - ✓ Compatibility with existing infrastructure / investment
- Renewable chemicals and bioproducts from bio-refineries are growing
 - ✓ Projected to gain about 15% of market by 2025 (C&NEWS Oct 12, 2009)
- Compliment petroleum refineries

THE BIOBASED ECONOMY *CURRENTLY*

Circa 2011	Market	Jobs
Biofuels	~ 10% of U.S. transport fuel market	~ 400,000 in U.S.
Renewable Chemicals / Biobased Products	~ 3 to 4% U.S. chemicals sales	~40,000 U.S. jobs

THE BIOBASED ECONOMY *FUTURE*

Circa 2025	Market	Jobs
Biofuels	~ 25% of U.S. transport fuel market under RFS	~ 800,000 additional jobs in U.S.
Renewable Chemicals / Biobased Products	>20% U.S. chemicals sales (USDA)	237,000 additional direct jobs in U.S.



Potential for Biobased Products: *World Biobased Market Penetration 2010-2025*

CHEMICAL SECTOR	2010	2025
Commodity Chemicals	1-2 percent	6-10 percent
Specialty Chemicals	20-25 percent	45-50 percent
Fine Chemicals	20-25 percent	45-50 percent
Polymers	5-10 percent	10-20 percent

Source: USDA, U.S. Biobased Products Market Potential and Projections Through 2025

Local Growth and Job Creation Potential

- Industrial biotech can revitalize manufacturing infrastructure to help states become leaders in building the biobased economy
- Industrial biotechnology is a key to creating good jobs in research and development, and manufacturing
- Growth¹ of biobased products has created 50,000 new jobs – doubling in just the past two years. It could create tens of thousands of additional jobs in coming years

1. survey from Iowa State University released last year showed 50,000 U.S. jobs

Biobased Products Market Pull

- The Farm Security and Rural Investment Act (FSRIA) of 2002 included two programs that launched the BioPreferred™ program:
 - ✓ A voluntary program for biobased intermediates and products having USDA labels



- ✓ Federal procurement of biobased intermediates and products by Federal agencies that **are required by FSRIA to purchase biobased products and intermediates over their petroleum-based counterparts**, as long as the biobased intermediates and products are:
 - Reasonably available
 - Reasonably priced
 - Comparable in performance

State Incentives are Driving Industrial Biotech Advancements

- **“Grow it here, make it here”** initiative by Senator Stabenow to advance emerging Michigan manufacturing industry
- **Michigan-MI S 1764**, bill to extend advanced energy project credit to renewable chemicals and biobased products. Gives 30% tax cut for new, expanded, or re-equipped bio-manufacturing projects
- **Colorado-CO S 177** Promotes biomass energy development (property tax exemptions)
- **Indiana-IN H 1261** Agricultural biomass infrastructure grants
- **Missouri-S 420** Creates a state income tax credit for the purchase of processed biomass engineered fiber fuel

Federal Policy Priorities

- **Funding / Eligibility:**

- Maintain funding for renewable biomass and biorefinery programs at USDA and DOE which increases investment in biorefinery projects and provides most promising opportunities for high quality domestic job creation
- The next Farm Bill needs to ensure that programs support the full range of biorefinery products
 - USDA Loan Guarantee Program needs new legislative authority to include renewable chemicals and biobased products and not just focus on biofuels
 - USDA and DOE need to ramp up their investment in renewable chemicals

- **Tax Incentivize Innovation in Tax Code:**

- Tax policy can effectively promote advanced biofuels commercialization by providing the long term opportunity similar to renewables such as wind and geothermal – producer credit or refundable tax credit
- Tax code should incentivize commercialization of innovative renewable chemicals and biobased products – investment/production credits

Conclusions

- Industrial biotechnology can create thousands of new green jobs
- Supportive, consistent and enduring government policy is necessary to bring the vision of fully integrated biorefineries to reality
- Renewable chemical platforms and biobased products are surging and providing investors with new options and products with higher margins than biofuels (and this will help the development of multi-product biorefineries evolve)
- Climate change can be a driver for industrial biotechnology innovation
- There is more growth and success ahead for industrial biotechnology despite the economic challenges

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