



Bio Plastics Markets and Products

What is the fit?

Bob Williams

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Agenda



- Overview of Bio-Plastics
- Industry Terms and Definitions
- Certifications
- Demand Drivers for Bio-Plastics
- Market Opportunities
- Major Players in Bio-plastics
- Bio-Plastics Properties
- Bio-Plastic Part Design
- Bio-Plastic Processing



Overview of Bio-Plastics



Overview of Bio-Plastics

- The bio-plastics industry is an emerging industry which has been around for about 15 years.
- Currently, bio-plastics manufacturers globally can produce less than 500,000,000 pounds annually.
- The growth rate for bio-plastics is projected at over 20% per year to over 1.2 MM lbs by 2012
- Bio-plastics were primarily used in the food industry but are now being utilized in a variety of new industries.
- Bio-plastics are produced from both renewable resources and synthetic polymers.

Not all bio-plastics are bio-based

Why Bio-Plastics?



To manage the carbon footprint of more than 1 trillion pounds (1,000,000,000,000!) of traditional plastic resins created every year

The Time is Right for Bio-Plastics



- Bio-Plastics are an answer to the quest for sustainability in reducing our dependence on fossil fuels.
- Bio-Plastics are now affordable or competitively priced with fossil fuel based plastics.



Industry Terms and Definitions

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- **Bio-based:** An organic material in which carbon is derived from a renewable resource via biological process. Bio-based materials include all plant and animal mass derived from CO₂ recently fixed via photosynthesis, per definition of renewable resource. (ASTM)
- **Biodegradable Plastic:** A plastic in which the degradation results from the action of neutral micro-organisms such bacteria, fungi and algae (ASTM).
- **Compostable Plastic:** A plastic that degrades by biological processes during composting to yield CO₂, water, inorganic compounds and biomass at a rate consistent with other known compostable materials and leaves no visible, distinguishable or toxic residues. (ASTM)

Industry Terms and Definitions



- **Renewable:** A commodity or resource that is inexhaustible or replaceable by new growth.
- **Sustainable:** A product that “meets the needs of the present without compromising the ability of future generations to meet their own needs.” (Bruntland Commission)
- **ASTM D6400:** Standard specification for compostable plastics. The test is based on the compostability of products in an industrial compost facility.
- **ASTM 6866:** Standard test method for determining the bio-based content of natural range materials using radiocarbon and isotope ratio mass spectrometry analysis.



Certifications

Certifications



- BIODEGRADABLE-COMPOSTABLE
 - ASTM D 6400- BPI compliance
- BIOBASED CONTENT
 - ASTM D 6866-04a - (Radio-Carbon process)
- GMO ANALYSIS
 - P.C.R.Q.
- FDA COMPLIANCE



DIN CERTCO

BPS

Certifications



- BPI seal of compostability
- Biodegradable Products Institute (www.bpiworld.org)
- European Bioplastics Association (www.european-bioplastics.org)



- Specifications: ASTM 6400 D99 and ASTM 6868
- American Society for Testing and Materials - worldwide source for technical standards

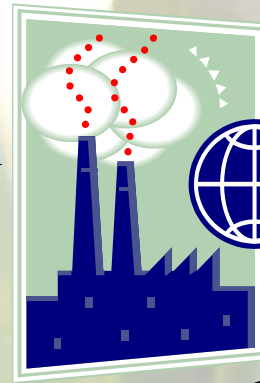
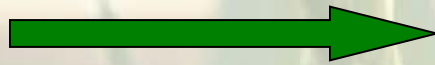


A close-up photograph of a corn cob on the stalk, set against a bright, hazy sunset background. The sun is low on the horizon, creating a strong lens flare and a warm, golden glow. The corn leaves and husk are visible, with some in sharp focus and others blurred. A horizontal green bar is positioned across the middle of the image, partially overlapping the text.

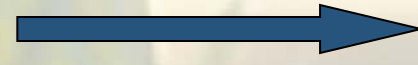
Demand Drivers for Bio-Plastics

Managing The Carbon Cycle

“Cradle to Cradle”



CO₂



METHANE

**Sanitary
Landfill**

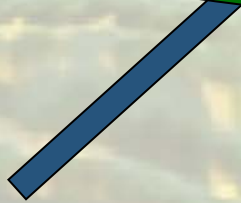
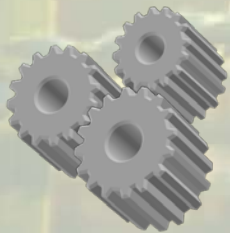
COMPOSTING

**90 to 180
Days**

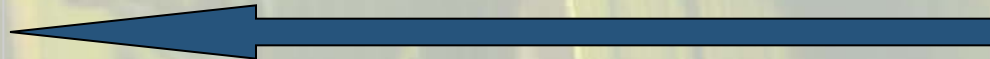
**10
Million
Years**



Oil or Gas



**Drilling
Exploitation**



Manufacturing

Long-Term Trends Driving Bioplastics Growth



- **Rising, Volatile Oil Prices and Energy Security Concerns**
 - Approximately 10% of oil is converted into plastics
- **Environmental Concerns**
 - Overfilling of landfills and degradability of plastic waste
 - Health concerns about the use of certain plastics in food and human contact
 - Lack of recycling of traditional petrochemical plastics
 - EPA estimates that less than 6% of waste plastic is currently recycled
 - Managing the carbon cycle
- **Favorable Regulatory Initiatives**
 - Federal government announced a major policy directive that designates products made from bio-based plastics as a preferred purchasing item
 - Petroleum-based plastic bans / taxes
- **Improving Performance and Competitiveness of Bioplastic Resins**

Bioplastics will rapidly displace petroleum-based plastics as commercially feasible alternatives are offered to consumers

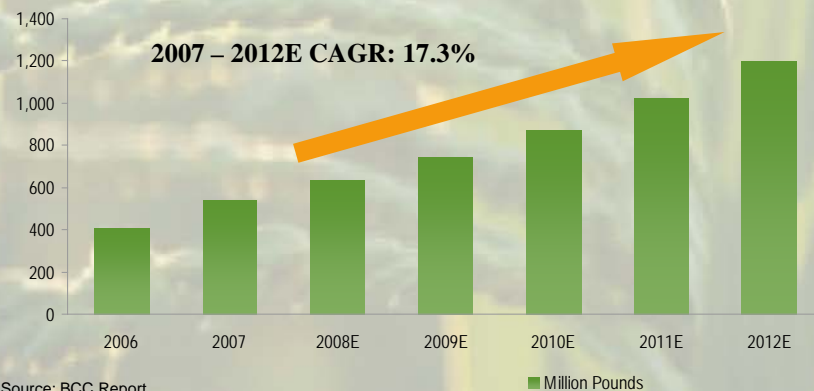


Bioplastics Market Sizing

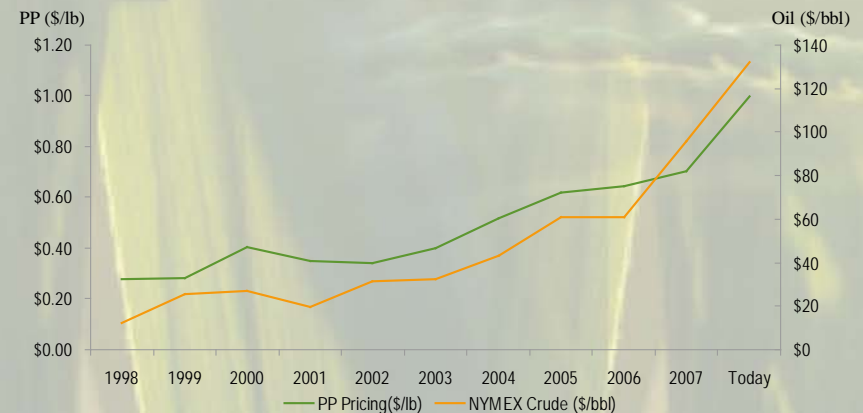
- BCC Research estimates that the global market for biodegradable plastics reached 541 million pounds in 2009 and is expected to reach 1.2 billion pounds by 2012
- Biopropylene™ Hybrid Resin Opportunity
 - Global polypropylene market is greater than 100 billion pounds
 - 1% penetration represents more than a \$1 billion market opportunity

Market Opportunities

Biodegradable Plastics Market Growth⁽¹⁾



Hybrid Resins: Increasing Opportunities⁽²⁾



(1) Source: BCC Report
(2) Wall St. Research Report dated April 11, 2008.

A close-up photograph of a cornfield at sunset. The sun is low on the horizon, creating a bright, hazy glow that filters through the green leaves and stalks of the corn plants. The foreground shows the detailed texture of the corn husks and silks, while the background is a soft, out-of-focus landscape of more corn plants under the warm light of the setting sun.

Major Players in Bio-Plastics

Major Players in Bio-Plastics



Polymer Developers

Bio-Based



Synthetic



Resin Developers



Cereplast





Major Players in Bio-Plastics

Who?	Material
➤ Tianan	PHBV
➤ NatureWorks	PLA
➤ Metabolix	PHA
➤ BASF	Ecoflex
➤ Novamont	Mater-Bi
➤ Biomer	PHA
➤ Dupont	Biomax
➤ Plantic	Thermoplastic starch

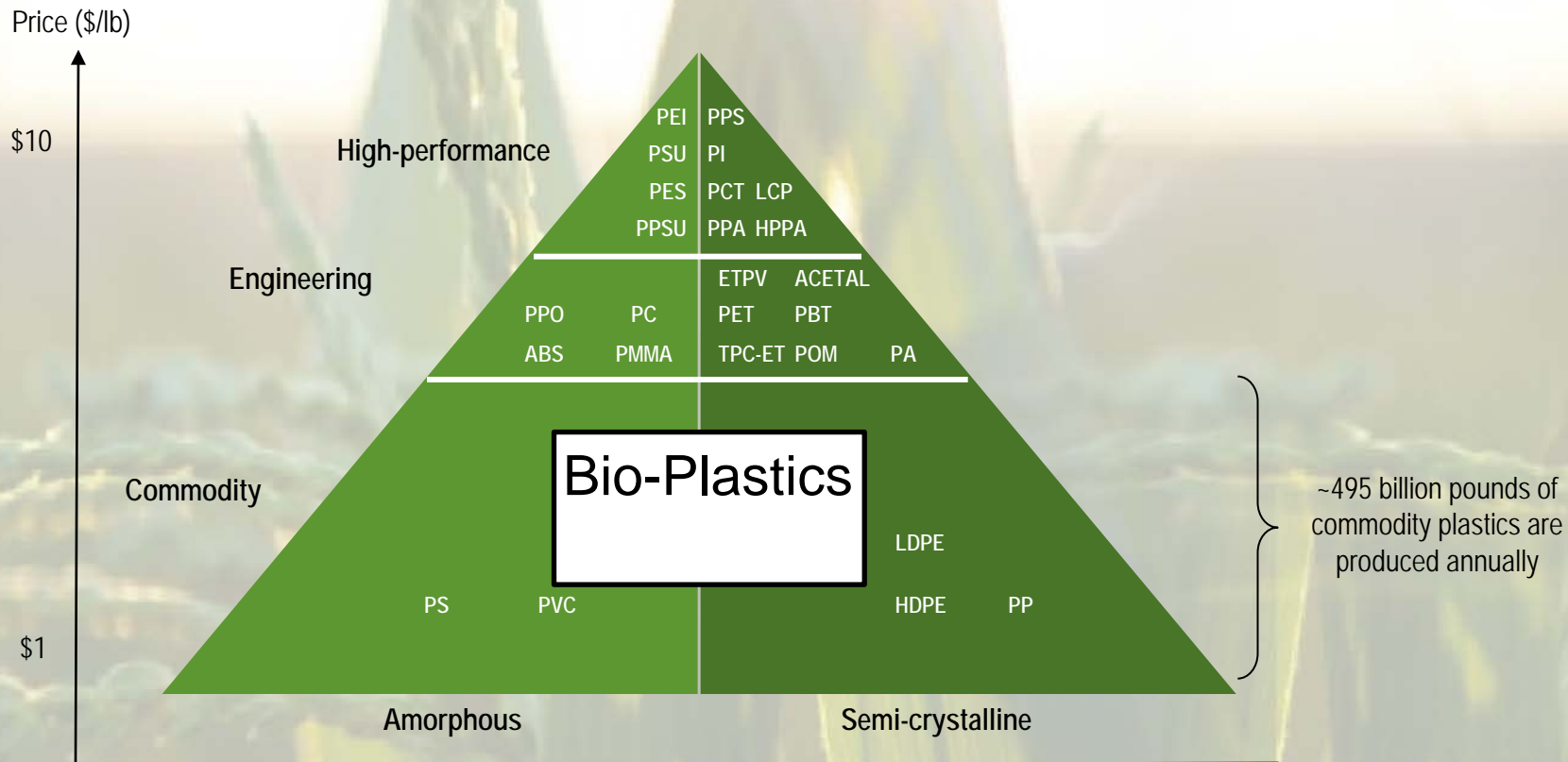


Bio-Plastic Properties



Bio-Plastic Properties

- Take market share from traditional petroleum-based plastic products through product attributes, predictable and competitive pricing, forced demand (legislation), and increased end-user demand.



Bio-Plastic resins can address a large portion of the plastic industry

Bio-Plastic Properties



- Basic material Data sheet properties are in line with traditional commodity plastics but not the same.
 - Data Sheet properties should be used for material comparison,
 - Data sheet properties do not predict application performance.
- One to One Conversion is not always possible.
 - Bio-materials must stand on their own.
- Force fit applications can have issues.
- Traditional materials have 50+ years of development.

Bio-Plastic Product Offering

Compostables Resins (Single-use applications)



100% renewable content
100% biodegradable and compostable
Can be used in all major converter processes
Applications:
Foodservice ware and packaging

Hybrid Resins (Durable applications)



> 50% renewable content
Reduced petroleum content
Can be used in all major converter processes
Applications:
Automotive, consumer goods, electronics, toys



Bio-Plastic Processing and Design

Bio-Plastic Process and Design



- Basic material properties are tested and compared to traditional polymers.
 - Parts are processed and compared with traditional polymer parts
- Proprietary bioplastic resin blends are being manufactured to meet the specific client needs
 - Priced competitively with traditional petroleum based alternatives
- Versatile manufacturing operations
 - Utilize conventional processing equipment
 - Customers able to use traditional fabrication equipment
 - No additional capital investment required



Bio-Plastic vs. Traditional Plastic

Cereplast Compostable Resin <i>Certified Biodegradable & Compostable</i>	90% + Bio-based Content	Density greater than 1.25	Runs on equipment at lower temperatures	Heat deflection temperature of 120-130F
Cereplast Hybrid Resin <i>Renewable & Sustainable</i>	50% Bio-based Content	Density of 1.04	Runs on equipment at lower temperatures	Heat deflection temperature of 175- 200F
Conventional Petroleum Plastic	0% Bio-based Content	Density between 0.9-0.99	Runs on equipment at higher processing temperatures	Heat deflection temperature above 200F

Cereplast Compostables™ Resins



- Made from renewable resources
 - Blends of biopolymers and native plant starches (corn, wheat, tapioca and potato)
- Target markets include foodservice, packaging and single use applications
- Ecologically sound substitutes
 - Replace nearly 100% of the petroleum based products
 - Used in all major converting processes such as thermoforming, injection molding, blow molding and extrusions
- Certified as biodegradable and compostable in the United States and Europe





Bio-Plastic Process Options

<u>Process</u>	<u>Applications</u>
EXTRUSION-THERMOFORMING	Plates, containers, packaging, gift cards, films
INJECTION MOLDING	Utensils, cups, containers, scoops
EXTRUSION BLOW MOLDING	Bottles, containers
BLOWN FILM	Food packaging wrap, bags, films
PROFILE EXTRUSION	Straws, stirrers, netting
EXTRUSION COATING	Paper coatings



Bio-Plastic Material Developments



- Higher heat
- Foam
- Lower density
- Improved Impact

Highlights



- Long-term global trends favor non-petroleum-based solutions
- Large addressable market
- Proprietary and patented formulations and resin manufacturing expertise
- Close relationships with industry leading customers
- Scalable manufacturing platform

Summary



- Bio-plastics are at the early stage of a long-term irreversible growth/penetration cycle
- The bioplastics sector is poised for near term significant growth
- Bio-Plastic companies are investing heavily to meet the demand from consumers for sustainable resin solutions



Thank You