An Overview of the Bioplastics Markets, Applications and Impact to Environment

Edwin Tam
Manager, New Strategic Initiatives
Teknor Apex Company
Bioplastics Division
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Outline

- Driving Forces Behind Bioplastics
- Terminology
- Environmental Impact
- Type of Bioplastics
- Examples of Bioplastics Markets and Applications
- Summary
- Q & A

Driving Force Behind Bioplastics Industry

Generation of Solid Waste

In 2009 United States generates approximately 230 million tons of "trash" or roughly 4.6 pounds per person per day.

http://people.bu.edu

• Less than one-quarter of it is recycled; the rest is incinerated or buried in landfills.

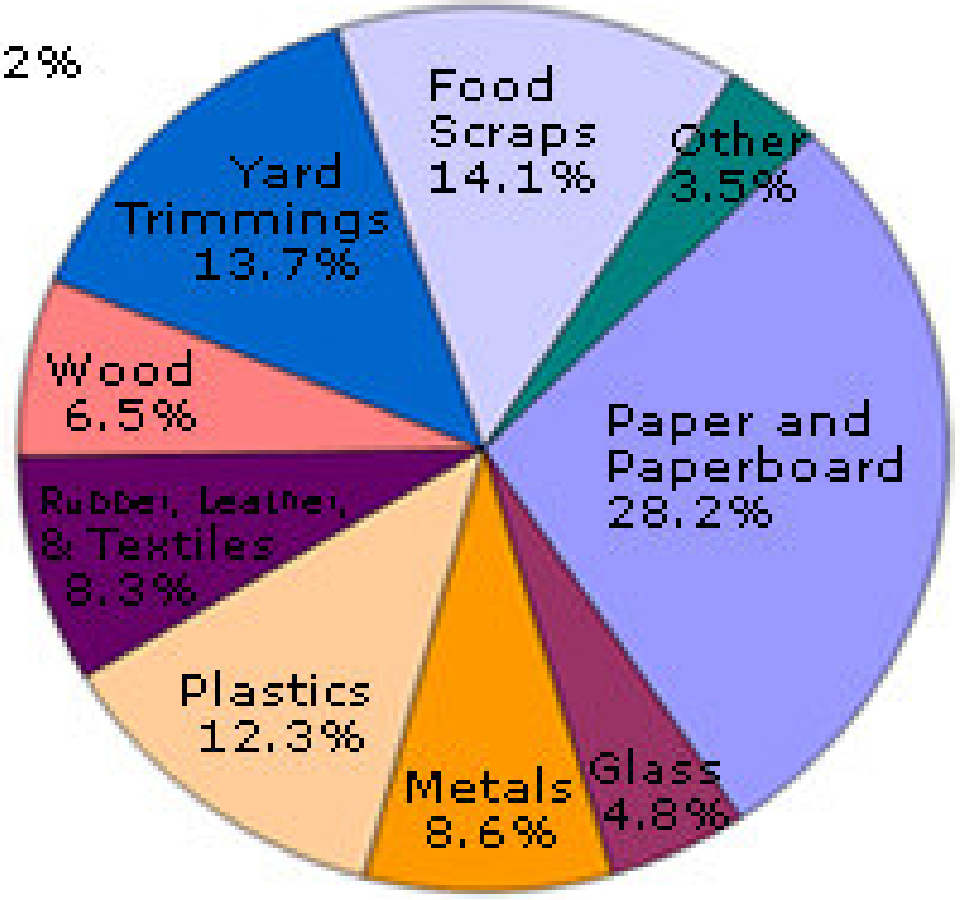
• It is believed 70% of the landfill waste can be recycled

Souce: www.learner.org/garbage/related.html

Break down of Municipal Solid Waste

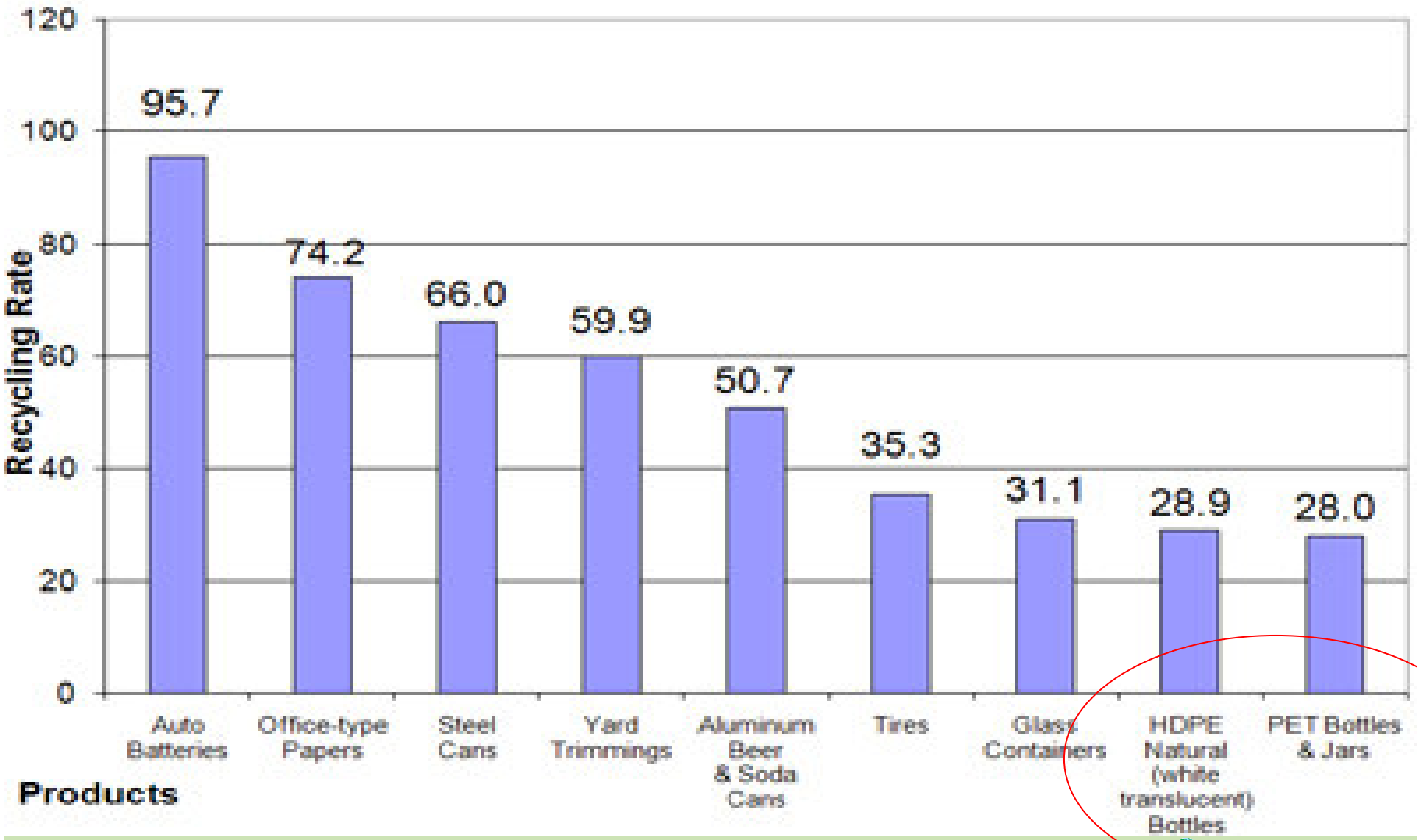
Total MSW Generation (by Material), 2009
243 Million Tons (Before Recycling)

- Paper and Paperboard 28.2%
- Food Scraps 14.1%
- Yard Trimmings 13.7%
- Plastics 12.3%
- Metals 8.6%
- Rubber, Leather, & Textiles 8.3%
- Wood 6.5%
- Glass 4.8%
- Other 3.5%



Source: epa.gov

Recycling Rates of Selected Products, 2009*



Source: epa.gov

Corporate/Consumer Desire to be More Environmental Conscious with Lower Carbon Footprint

Legislative Initiatives

1.The Kyoto Protocol:
International agreement linked to the United Nations Framework Convention on Climate Change. It sets binding targets for industrialize nations to reduce greenhouse gas (GHG) emissions .

2. **Federal Farm Bill Title IX Energy**
Mandates total funding of $1 million for FY 2008 and $2 million annually for FY2009-12 for testing and labeling of biobased products via USDA Biopreferred Program

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Legislative Initiatives

3. Local Municipalities Legislation

Communities such as San Francisco and Los Angeles County have local ordinances in reducing petroleum based plastic bags and foamed PS

PLASTIC BAG BAN

Paper or plastic? If you live in San Francisco—the first city in the country to outlaw plastic—the decision just got easier. The new green trend

THE BAN MAN
City supervisor Ross Mirkarimi crafted the bill despite objections from grocers.

Our national love affair with the flimsy, ubiquitous plastic shopping bag is on the rocks—and part of the credit goes to Ross Mirkarimi. "They're scarring our ecosystem," says Mirkarimi, 46, a San Francisco city supervisor, who spearheaded legislation that made his city the first in the nation to outlaw disposable plastic bags. The ban, which affects large grocery and drugstore chains, went into effect last December, and now other cities are rushing to jump on the ban bandwagon.

Green warriors have long had the bags in their sights: Each year Americans consume between 30 and 100 billion plastic bags—enough to encircle the planet at least 31 times. They are manufactured using over 12 million barrels of oil, and only a fraction of them make it to the recycling bin. The remainder, according to Darby Hoover of the Natural Resources Defense Council, can take a thousand years to decompose and can clog landfills and litter the oceans—killing untold thousands of sea turtles and other animals every year. Even whales have died after ingesting plastic bags that resemble jellyfish. "They create pollution to produce and cause environmental difficulties to dispose of," says Hoover. The plastic plague is so widespread that scientists routinely report seeing bags littering remote Antarctica, carried there by ocean currents.

Mirkarimi, who is single and lives with a rescued dog and cat, was committed to the environment long before green was cool. He was moved to push the ban after reading about similar ones in Bangladesh and Ireland. His efforts have clearly touched a nerve. Now more than a dozen U.S. cities and four states are pondering bag bans. (China, which uses more than 3 billion a day, has also recently outlawed them.) "I had no idea this would catch on like this," says Mirkarimi, "but it's about time."

By Johnny Dodd

WHOLE FOODS MARKET
This month, this grocer banned plastic, except for reusable models like this.

Chicobag
This woven-nylon bag holds 20 lbs. and sells for $5.95.

GREEN IS GOOD
Dozens of stylish alternatives are now available.

TRADER JOE'S
This grocer offers paper and plastic for free and sells cotton totes.

rethink
An organic cotton model from Greenzender.com.

Growing Industry

Freedonia research shows Bioplastics CAGR between 2007- 2012 is 17.3%

According to BCC Multi-client study, Bioplastics grew at a significant pace. The total worldwide use of bioplastics is valued at 571,712 metric tons in 2010.

Terminology

Terminology: Bioplastics

Bioplastics : Plastics that is biodegradable or has biobased content or both.

Biodegradable	***Biobased Content***
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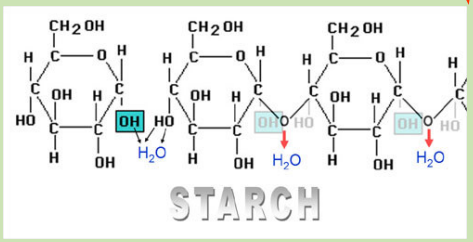
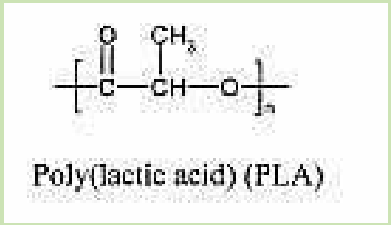
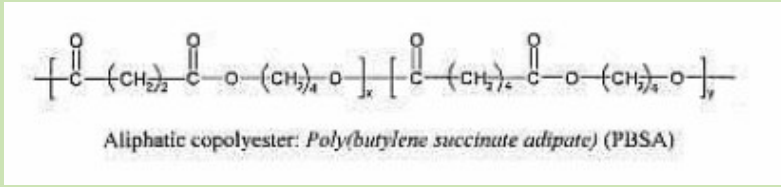
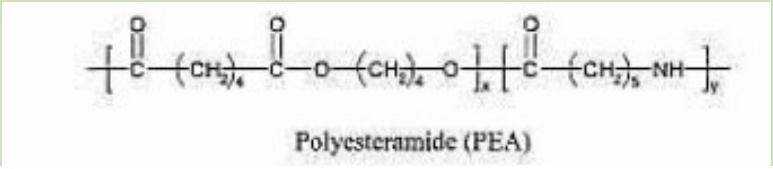
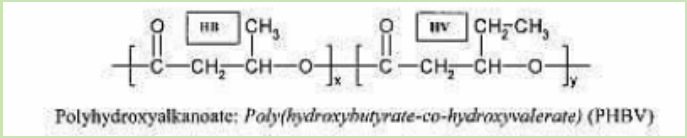
--	√
√	√











Terminology: Biobased Content

Biobased Content:
Fraction of the carbon content which is new carbon content made up of biological materials or agricultural resources versus fossil carbon content.

Biobased content is measured following the procedures set by ASTM D-6866.

USDA

BioPreferred℠

USDA CERTIFIED BIOBASED PRODUCT
PRODUCT 57%

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Terminology: Biodegradable Plastics

A plastics that undergoes biodegradation, a process in which the degradation results from the action of naturally-occurring micro-organisms such as bacteria, fungi and algae, as per accepted industry standards such as ASTM D6400 (Bioplastics), ASTM D6868 (Papers), ASTM D7081 (Marine) or EN 13432.

Environmental Impact

Compostable vs. Biodegradable

Compostable

Difference is rate Of Biodegradation

- **Time**
- **Temperature**
- **Environment (moisture)**

Vs.

Biodegradable

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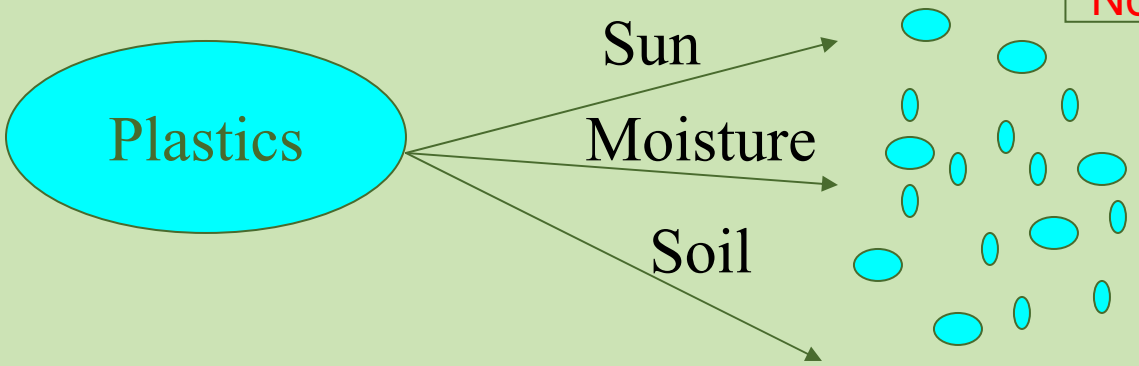
Degradation vs Biodegradation

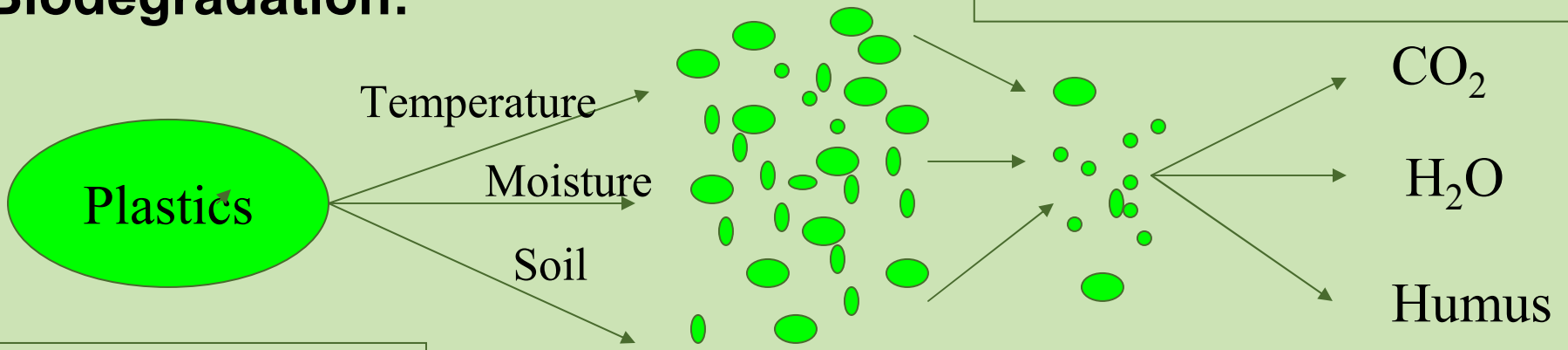
Degradation or Fragmentation:

Other visual aesthetics pleasing
No environmental benefits



Biodegradation:

Positive environmental benefits



Rate of biodegradation is time, temp & environment dependent

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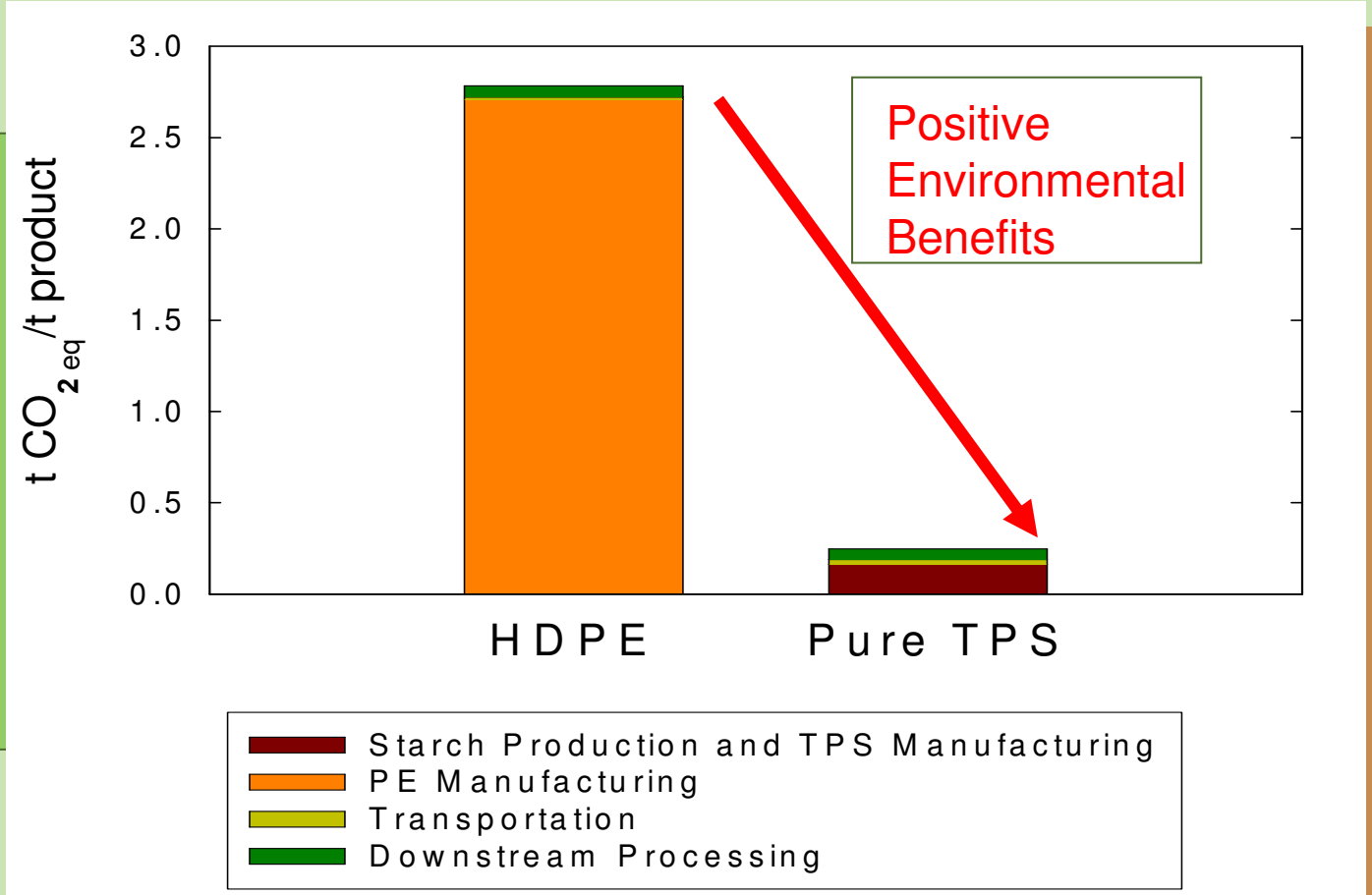
Life Cycle Analysis
GHG Reduction for HDPE



(1) GHGenius Feedstocks, Power, Fuels, Fertilizers and Materials p.25 Table 4.10
(2) Canadian Raw Materials Database, University of Waterloo, http://crmd.uwaterloo.ca/
(3) Canada's National Inventory Report 1990-2004, http://www.ec.gc.ca/pdb/ghg/inventory_report/2004_report/toc_e.cfm
(4) Canada's GHG Verification Center, 2004

Types of Bioplastics

Typical Markets and Applications

Classification of Bioplastics

	Fossil-based	Bio-based = Renewable
Non-biodegradable	PVC Commodity Plastics Engineering Thermoplastic	Starch/Polyolefin (Teknor, Cereplast) Bio-PE (Braskem) Bio-PVC (Solvay) Bio-Polyurethane (Merquinsa) Polyamide 11 (Arkema)
Biodegradable	PBAT (BASF) Starch/PBAT (Teknor, Novamont)	Starch based/PLA blend (Teknor) PLA (NatureWorks) PHA (Metabolix/Telles) PLA Blend (Teknor, FKuR)

Terraloy™ Compounds

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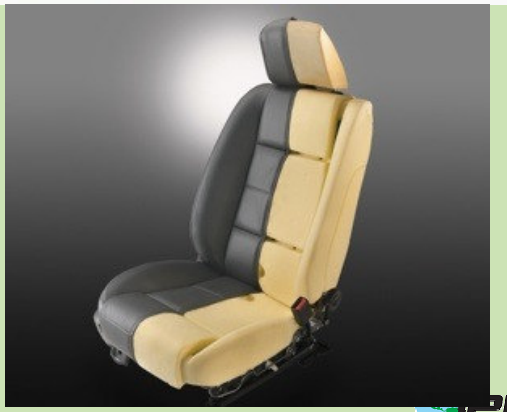
Automotive Market

Products Used

- Soya based
- Wheat Straw Bio-filled PP
- PLA
- PLA reinforced
- Bio-based TPU
- PA11

Fuel Line

The 2010 Ford Fusion Hybrid
A soy-based foam seat.
(Ford Motor)



Source: Ford

Consumer Durable market - Electronics

Products Used

- PLA
- PLA/Kenaf reinforced
- PLA/PC
- PA11

Typical Applications:

- Mobil Phone
- Laptop
- Camera components

Fujitsu's **bioplastic**
FMV-BIBLO
PLA Based

Source: Samsung
PLA

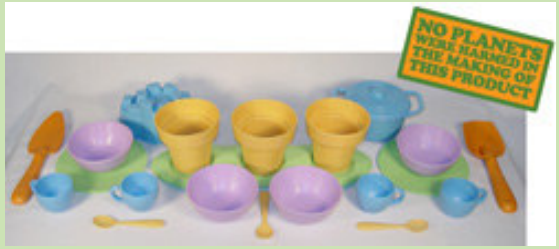
Consumer Market

Products Used
- PLA
- PLA Kenaf reinforced
- Starch blends
- PHA, PHB, PHBV
- PBS
- PBAT blend

Typical Applications:
- Toys
- Writing Instruments
- Beauty Products
- Baby Products
- Containers/Buckets

Papermate biodegradable Pen made from Mirel

Teknor Apex



Green Toys Brand Toys made from Starch blend

Source: wwww.babble.com/

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Agriculture/Horticulture Market

Products Used

- PLA blend
- PBS
- PBAT
- Starch/PBAT
- PHA

Typical Applications:

- Mulch Film

PLA based Mulch Film

Mirel PHA Mulch film

Novamont Starch/PBAT Mulch film

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Bottle Market

Products Used
- PLA
- PLA Blend

Typical Applications:
- Water Bottle
- Soda bottle

NatureWorks PLA

PLA Bottles
Source: www.petrecycling.cz/

Source:www.packaging-int.com

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Food Service Market

Products Used
- PLA
- Starch based blend
- PLA blend
- PHA, PHB, PHBV
- PBS

Typical Applications:
- Cups
- Lids
- Containers
- Caps
- Straws
- Clamshell
- Cutlery

http://www.buygreen.com

NatureWorks PLA

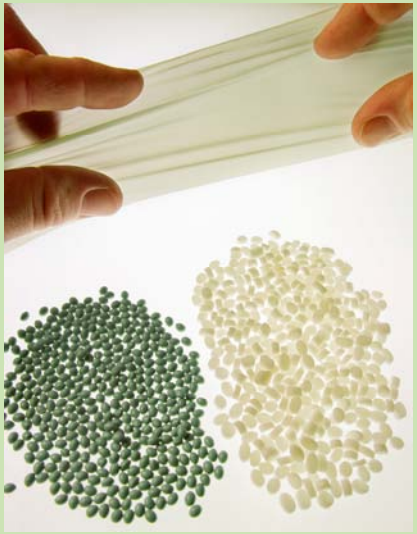
NatureWorks PLA

Film Market

Products Used
- PLA
- TPS blends
- PBAT
- PBAT Blend
- Cellulose Acetate
- PHA blend

Typical Applications:
- T-Shirt bag
- Can liners
- Organic waste bag
- Carrier bag

Teknor Apex
Starch based Trash bag



Teknor Apex

Organic waste bag
Source: BASF

Packaging Market

Products Used
- PLA
- TPS blends
- PBAT
- PBAT blends
- PBS
- CelluloseAcetate

Typical Applications:
- Food Packaging
- Rigid Packaging

Cellulosed Acetate

PBAT

NatureWorks PLA

NatureWorks PLA

Fibers Market

Products Used
•PLA

NatureWorks

This comforter is part of a new, environmentally friendly bedding collection, comprised of corn-derived NatureWorks™ fibers and developed by Pacific Coast Feather Company.
Source: Textile News

Typical Applications:
•Clothes/Apparel
•Carpet
•Furnishings
•Non-woven
•Industrial

NatureWorks PLA

Summary

- Bioplastics is a growing industry and continue to gain ground in numerous markets and applications
- Bioplastics can be bio-based or petroleum based and may or may not be biodegradable
- Environmental benefits for using Bioplastics include
  - Reducing dependency of petroleum based products
  - Some Bioplastics are biodegradable or compostable thus adding environmental benefits
  - Bioplastics products has “less” GHG than petroleum based products
- Teknor Apex has a diverse Bioplastics product portfolio that will balance price, performance and processing to meet your sustainability goals

Acknowledgement

Photo for the parts are taken from public websites, they include companies such as BASF, Biobags, Ford Motors, Frito Lay, Fujitsu, Metabolix, NatureWorks, Novamont, Samsung etc. The parts shown in these photos are not made from Teknor Apex Company's resins, if you want to know more about their products, please contact these companies directly.

Questions and Comments

www.teknorapex.com

(401) 642-3753

bioplastics@teknorapex.com

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