What Makes a Sustainable Biomaterial? Criteria and Market-based Tools

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***Bioplastics: Reshaping an Industry*, Las Vegas**

Overview

- Not all biobased products are created equal
- Intro to the Sustainable Biomaterials Collaborative
- Framework for Sustainable Biomaterials
  - Biomass Feedstock Sourcing
  - Production and Use
  - End of Life
- Market-Based Tools
  - Working Landscape Certificates
  - Purchasing Specifications

The Good News on Biobased Alternatives

- Variety of resins available
- Performance improving
- Experience and R&D growing
- Growth expected
- Programs such as the federal biobased procurement will open up new markets
- Standards in place
- Price competitiveness improving
- Demand increasing

ASTM Standards

- D 6866 – defines and quantifies biobased content
- D 6400 – specification for biodegradation in commercial composting systems
- D 7081 – specification for biodegradation in the marine environment
- D 5988 – test method for biodegradation in soil
- D 5511 – test method for biodegradation in anaerobic digesters

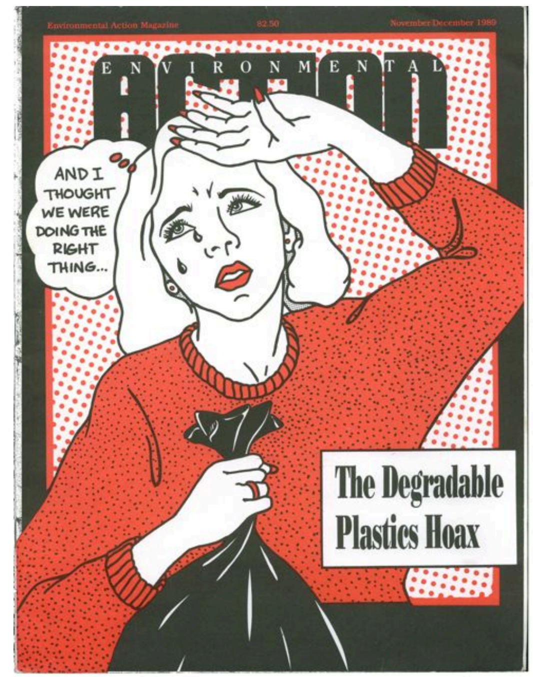
Degradable Vs. Biodegradable

Degradable

- May be invisible to naked eye
- Fragment into smaller pieces
- No data to document biodegradability within one growing season
- Migrate into water table
- Not completely assimilated by microbial populations in a short time period

Biodegradable

- Completely assimilated into food and energy source by microbial populations in a short time period
- Meet biodegradability standards

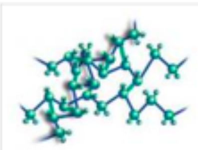


Source for definitions: Dr. Ramani Narayan, Michigan State Univ.

Biodegradable vs. Biobased

MONDAY, JUNE 25, 2007

The bioeconomy at work: Braskem develops polyethylene from sugarcane ethanol



Braskem, the leading company in Latin America's thermoplastic resins segment and Brazil's second largest privately owned industrial company, announces it has produced the first internationally certified polyethylene made from sugarcane ethanol. Given the fact that petroleum-derived polyethylene is so widely used in our daily lives, this may be called an important breakthrough for the bioeconomy. 60 million tonnes per year of the polymer end up in hundreds of plastic products. We now have a bio-based, renewable alternative with a low carbon footprint.

Brazil has been ahead of most other countries in the development of a genuine bioeconomy in which oil-based products are replaced by renewable carbohydrate and vegetable oil based substitutes. Government initiative (with a fund of almost US$5 billion for the bioeconomy) as well as an innovative private sector that is being supported by a growing number of

Dow and Crystalsev Announce Plans to Make Polyethylene from Sugar Cane in Brazil

Renewable Resource Used in Production Process Will Significantly Re Footprint

(CSRwire) SAO PAULO, BRAZIL - July 24 polyethylene, and Crystalsev, one of Brazil' manufacture polyethylene from sugar cane.

Under the terms of a memorandum of under venture in Brazil to design and build the firs in 2011 and will have a capacity of 350,000 with Crystalsev's know-how and experience be international interest.

"We are excited to partner with a great com will use a renewable feedstock," said Andre how Dow's innovation and industry leadersh agenda in a way that fully supports our 2015

The new facility will use ethanol derived fr raw material required to make polyethylene, either naphtha or natural gas liquids, both of produce significantly less CO2 compared to

"This joint venture will provide Crystalsev w development of value-added products made Lacerda Ferraz, president of Crystalsev. "Th and professional growth opportunities. For s Dow, the global leader in the polyethylene r

Non-biodegradable biobased plastics are here

Confusion

Making Plastic Bottles Environmentally Friendly

In an effort to help reduce the tons of discarded plastic bottles accumulating in our nation's landfills, ENSO Bottles™, in partnership with Resilux America is bringing a biodegrable technology to the plastic packaging industry available in specially formulated additive, preforms and blown plastic bottles. ENSO Bottles™ is dedicated to providing earth friendly packaging solutions to customers seeking a biodegradable packaging alternative.

ENSO bottles are not Oxo biodegradable or PLA plastic (corn based) bottles. ENSO bottles are plastic containers that biodegrade in anaerobic (landfill) environments, breaking down through microbial action into biogases and inert humus leaving behind no harmful materials. ENSO bottles are recyclable and can be mixed into the recycling stream with other plastic bottles.

To learn more about our products check out our Products page or speak on one of our Sales Representatives. We would be happy to assist you.

ENSO Bottles™

Bottles for a Healthier Earth™

Source: www.ensobottles.com

Biomaterial – Wonder Material?

- "renewable"
- "green
- "eco-friendly"
- "sustainable"
- "environmentally neutral"
- "safe and better"
- "easy on the environment"
- "return to nature without a trace"

Biobased content alone ≠ sustainable

Not All Bioproducts Created Equal

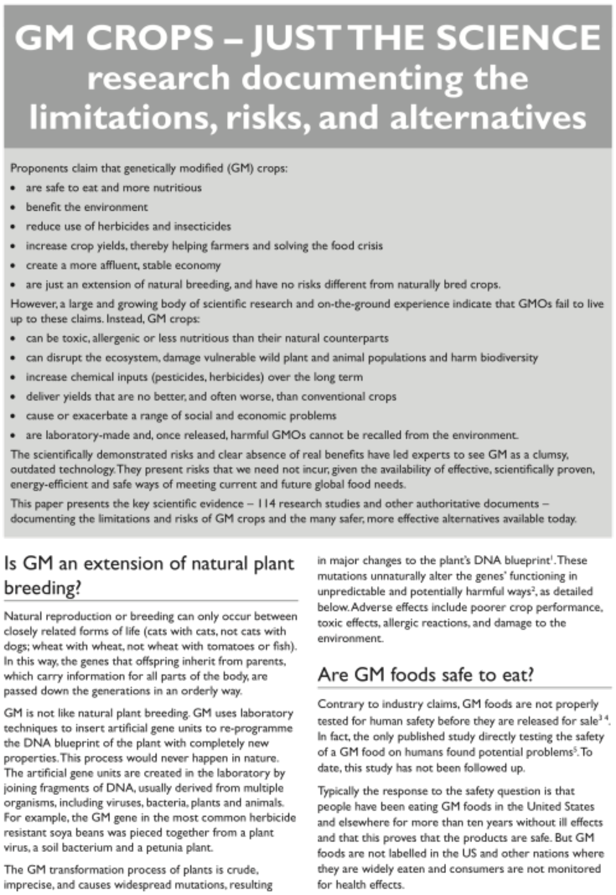
- Biobased content
- Material feedstock type
- Feedstock location
- Biodegradability
  - Commercial compost sites
  - Home composting
  - Marine environment
  - Anaerobic digestion
- Additives and blends
- Recyclability
- Performance
- Products

PLASTIC 7 ADDITIVES

Challenges with Biobased Products

- Concern over genetically modified organisms (GMOs)
- Desire for sustainably grown biomass
- Need to develop adequate recycling and composting programs
- Concern with nanomaterials and fossil-fuel-plastic blends
- Lack of adequate labeling
- Concern over contamination of recycling systems

Genetically Modified Crops



GM CROPS – JUST THE SCIENCE
research documenting the limitations, risks, and alternatives

Proponents claim that genetically modified (GM) crops:

- are safe to eat and more nutritious
- benefit the environment
- reduce use of herbicides and insecticides
- increase crop yields, thereby helping farmers and solving the food crisis
- create a more affluent, stable economy
- are just an extension of natural breeding, and have no risks different from naturally bred crops.

However, a large and growing body of scientific research and on-the-ground experience indicate that GMOs fail to live up to these claims. Instead, GM crops:

- can be toxic, allergenic or less nutritious than their natural counterparts
- can disrupt the ecosystem, damage vulnerable wild plant and animal populations and harm biodiversity
- increase chemical inputs (pesticides, herbicides) over the long term
- deliver yields that are no better, and often worse, than conventional crops
- cause or exacerbate a range of social and economic problems
- are laboratory-made and, once released, harmful GMOs cannot be recalled from the environment.

The scientifically demonstrated risks and clear absence of real benefits have led experts to see GM as a clumsy, outdated technology. They present risks that we need not incur, given the availability of effective, scientifically proven, energy-efficient and safe ways of meeting current and future global food needs.

This paper presents the key scientific evidence – 114 research studies and other authoritative documents – documenting the limitations and risks of GM crops and the many safer, more effective alternatives available today.

Is GM an extension of natural plant breeding?

Natural reproduction or breeding can only occur between closely related forms of life (cats with cats, not cats with dogs; wheat with wheat, not wheat with tomatoes or fish). In this way, the genes that offspring inherit from parents, which carry information for all parts of the body, are passed down the generations in an orderly way.

GM is not like natural plant breeding. GM uses laboratory techniques to insert artificial gene units to re-programme the DNA blueprint of the plant with completely new properties. This process would never happen in nature. The artificial gene units are created in the laboratory by joining fragments of DNA, usually derived from multiple organisms, including viruses, bacteria, plants and animals. For example, the GM gene in the most common herbicide resistant soya beans was pieced together from a plant virus, a soil bacterium and a petunia plant.

The GM transformation process of plants is crude, imprecise, and causes widespread mutations, resulting in major changes to the plant's DNA blueprint[1]. These mutations unnaturally alter the genes' functioning in unpredictable and potentially harmful ways[2], as detailed below. Adverse effects include poorer crop performance, toxic effects, allergic reactions, and damage to the environment.

Are GM foods safe to eat?

Contrary to industry claims, GM foods are not properly tested for human safety before they are released for sale[3,4]. In fact, the only published study directly testing the safety of a GM food on humans found potential problems[5]. To date, this study has not been followed up.

Typically the response to the safety question is that people have been eating GM foods in the United States and elsewhere for more than ten years without ill effects and that this proves that the products are safe. But GM foods are not labelled in the US and other nations where they are widely eaten and consumers are not monitored for health effects.

- Can be toxic, allergenic or less nutritious than their natural counterparts
- Can disrupt the ecosystem, damage vulnerable wild plant and animal populations and harm biodiversity
- Increase chemical inputs (pesticides, herbicides) over the long term
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- Are laboratory-made and, once released, harmful GMOs cannot be recalled from the environment.

Source: http://www.nongmoproject.org/

What We Put Into Corn…

- Average of over 120 lbs. nitrogen fertilizer per acre
- Among the highest levels of herbicide and pesticide use for conventional crops
- Irrigation water
- Proprietary hybrids

What Else is Produced

- Soil erosion and nutrient run-off and leaching
- Water, air, soil, health and biodiversity impacts of chemical use
- Pressure on alternate land uses
- Reduced rural economic benefit from agricultural production

Survey Data: feedstock types and sources

- China
  - Bulrush
  - Bagasse
  - PSM (Plastarch Material)
  - Corn
  - Chinese PLA
  - PHBV*
  - PBS**
  - Cornstarch
- India
  - Fallen palm leaves
- Thailand/Vietnam
  - Tapioca starch
  - Grass fiber
  - Bagasse
- Malaysia
  - Palm fiber
- USA
  - NatureWorks PLA
  - "Natural total chlorine-free pulp"
  - Recycled wood fiber

*polyhydroxybutyrate-polyhydroxyvalerate

**polybutylene succinate (petrochemical + succinic acid)

Path from Field to Producer

"The source product is from Brazil,
then turned into cornstarch in China,
then the starch is used in
our manufacturer's facility."

"Feedstocks grown in Midwestern US.
Manufacture the resin
in Hawthorne, CA today,
but plan to manufacture
in Seymour, IN shortly."

Recyclable?


NOBLE
Organic


Mother Earth's future is in your hands
This innovative product is the 1st All Natural Lemonade to be poured into an ALL NATURAL BOTTLE. Noble is simply too good to be poured into a plastic bottle made from oil, so our team of juiceologists went to work to find a container worthy of Noble. They explored the world to find the "E Bottle," an eco - friendly bottle made from nature. Not only is our bottle better for our juice, it is better for the environment.
Better Earth.
Better Juice.
Better Bottle.
BOTTLE MADE FROM
NatureWorks PLA
BOTTLE


NOBLE
USDA ORGANIC
Strawberry
Lemonade
Sweetened with Agave

Where's Waldo?

Identifying and Sorting Bio-Bottles

Courtesy of Eureka Recycling, Minneapolis, MN (www.eurekarecycling.org)

Tricky?

At 120 feet per minute on a 30" wide conveyor line – It sure is!

Courtesy of Eureka Recycling, Minneapolis, MN (www.eurekarecycling.org)

Sustainable Biomaterials Collaborative

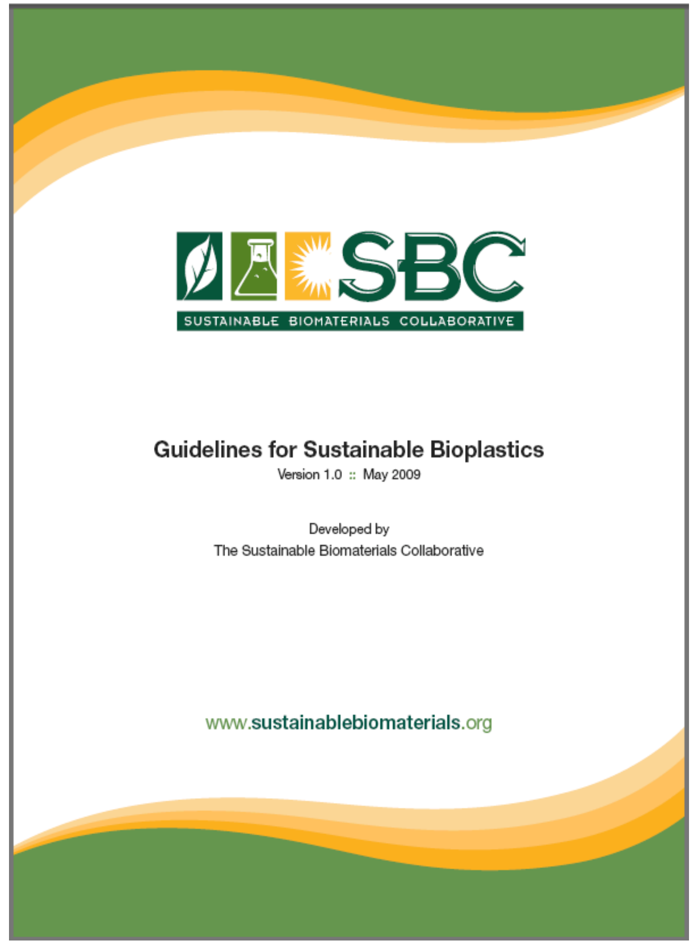
The Sustainable Biomaterials Collaborative is a network of organizations working together to spur the introduction and use of biomaterials that are sustainable from cradle to cradle. The Collaborative is creating sustainability guidelines, engaging markets, and promoting policy initiatives.

As You Sow
Center for Health, Environment and Justice
Clean Production Action *
Environmental Health Fund *
Green Harvest Technologies
Health Care Without Harm
Healthy Building Network
Institute for Agriculture and Trade Policy *
Institute for Local Self-Reliance*
Lowell Center for Sustainable Production *
Sustainable Research Group
Pure Strategies
RecycleWorld Consulting
Science & Environmental Health Network
Seventh Generation
National Campaign for Sustainable Ag.
Whole Foods
City of San Francisco

* Steering committee

Defining Sustainable Life Cycles by Principles

- Sustainable feedstocks / Sustainable agriculture
- Green Chemistry / Clean Production
- Closed Loop Systems / Cradle to Cradle / Zero Waste



"Just because it's biobased, doesn't make it green"

Biomass Feedstock

- Avoid hazardous chemicals
- Avoid GMOs
- Conserve soil & nutrients
- Biological diversity
- Sustainable agriculture plan
- Protect workers

SBC SUSTAINABLE BIOMATERIALS COLLABORATIVE

PRACTICE Greenhealth

Manufacturing

- Support sustainable feedstock
- Reduce fossil energy use
- Avoid problematic blends & additives
- Avoid untested chemicals and engineered nano particles
- Design for recycling & composting
- Maximize process safety/reduce emissions
- Green chemistry
- Protect workers

End of Life

COMPOSTABLE
Biodegradable Products Institute | US COMPOSTING COUNCIL

- Compostable or recyclable
- Biodegradable in aquatic systems
- Adequate product labeling
- Adequate recovery infrastructure

Blends: Steps to Best Practices

Avoid	Plastics w/ POPs in life cycle or manufactured w/ high hazard chems (PVC, PS, ABS, PC, PU)
OK	Blend with more preferable plastics (e.g., PE, PP, PET)
Improving	Compostable
Better	Blend only bioplastics
Best	**Pure biobased plastic** **Fully compostable & recyclable**

WORKING LANDSCAPES CERTIFICATE

www.workinglandscapes.org

- Support existing family farmers economically to transition to sustainable farming practices
- Enable bioplastic customers to support more sustainable crop production
- Do not require "identity-preserve" infrastructure and additional transaction costs

WORKING LANDSCAPES CERTIFICATE

2010 Corn Production Criteria

www.workinglandscapes.org

- No GMO varieties
- No continuous cropping
- Soil testing and fertilization according to state criteria and test results
- No use of known human or animal carcinogenic chemicals
- Use of cover crops or at least 70% of residues left on entire field
- Creation of whole farm plan that includes biodiversity and energy aspects

WORKING LANDSCAPES CERTIFICATE

- 8,680 lbs of corn per acre, anticipated average yield
- 3,472 lbs of PLA per acre
- 2.5 lbs of corn for 1 lb of PLA
- Each certificate is equivalent to 1 acre

WORKING LANDSCAPES CERTIFICATE

WLCs in 2010

- Stonyfield Farm is first major buyer of WLCs
  - Shifted to PLA for multipack yogurt cups
- Supports over 500 acres of more sustainable corn production
  - Equivalent to 200 million cups

Institute for Agriculture and Trade Policy

WORKING LANDSCAPES

WLC

CERTIFICATE

Certifies farm practices

Farmers

Contracts with farmers

Companies

Since 1983 Stonyfield Organic

Contracts for WLC

greenharvest TECHNOLOGIES

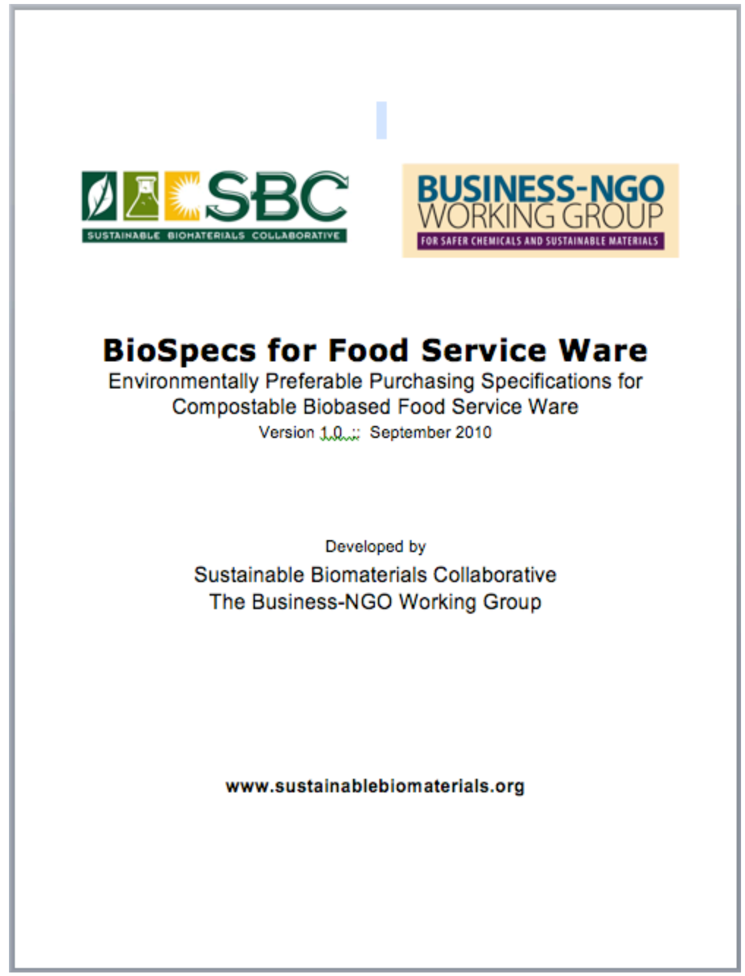
WLC available to companies

Joe , WLC Farmer

green harvest TECHNOLOGIES

- A pound for pound answer for transition
- Assisting businesses to transition to biobased materials and products
- Enable bioplastic customers to support more sustainable crop production
- A pathway to more sustainable biobased production

Development of Environmentally Preferable Purchasing Specifications



SBC SUSTAINABLE BIOMATERIALS COLLABORATIVE

BUSINESS-NGO WORKING GROUP FOR SAFER CHEMICALS AND SUSTAINABLE MATERIALS

BioSpecs for Food Service Ware

Environmentally Preferable Purchasing Specifications for Compostable Biobased Food Service Ware

Version 1.0 :: September 2010

Developed by

Sustainable Biomaterials Collaborative

The Business-NGO Working Group

www.sustainablebiomaterials.org

Recognition Levels

- Bronze
  - → Baseline criteria
  - → Easily verifiable criteria
- Silver
- Gold
  - → Highest level
  - → More challenges to verify criteria

Criteria: Biomass Production (food service ware)

Criteria	Recognition Level
Biobased (organic) carbon content	
Product must be >90%	Bronze
Product must be >95%	Silver
Product must be >99%	Gold
Genetically Modified Plants	
No plastics may be made directly in plants	Bronze
GM crops allowed in field with offsets	Bronze
No GM biomass allowed in field	Silver
Sustainably grown biomass	
Forest and brushland-derived biomass	Bronze
Agricultural crop biomass	Gold
Protection of biomass production workers	Gold

Criteria: Manufacturing (food service ware)

Criteria	Recognition Level
Wood- or fiber-based products	
Non-food-contact products: 100% recycled, 40% PCR	Bronze
Cups: 10% PCR content	Silver
Other food-contact products: 45% recycled content	Bronze
No organohalogens added	Bronze
Additives and Contaminants of High Concern	
Declare whether nanomaterials present	Bronze
No additives that are chemicals of high concern	Bronze
No engineered nano without health risk assessment	Silver
All additives must be tested	Gold
No chlorine or chlorine compounds	Silver
Protection of biomass production workers	Gold
Local ownership and production	Gold

Criteria: End of Life (food service ware)

Criteria	Recognition Level
Product must be 100% commercially compostable	Bronze
Product labeled for compostability	
"Commercially Compostable" if facility exists	Bronze
Verification logo on product	Bronze
Clearly compostable	Bronze
Additional labeling if facility does not exist	Bronze
100% backyard or home compostable	Silver
100% biodegradable in aquatic environment	
Marine biodegradable	Gold
Freshwater biodegradable	Gold

OK compost VINÇOTTE

compostable EN13432:2000

COMPOSTABLE Biodegradable Products Institute | US Composting Council

COMPOSTABLE www.compostable.info

Next Steps

- Vetted List of Products
  → Clear process for manufacturers to assess conformance to criteria
  → Beta-test conformance process
- Work with purchasers to beta-test bid specs
- Develop Biospecs for biobased bags and another for durable biobased products
- Expand Working Landscape Certificates

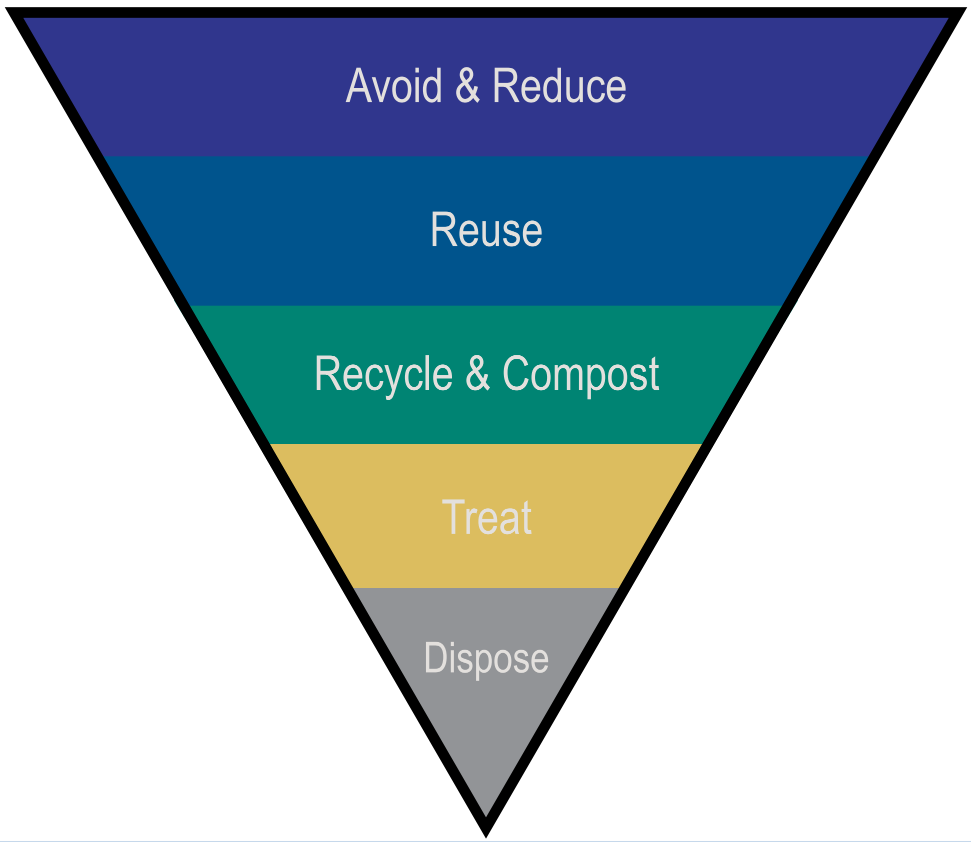
Parting Thoughts

- Life cycle thinking – taking a "principle-based" approach to sustainable materials
  - Define what we want
  - Set priorities
    - Sustainable feedstocks
    - Green chemistry
    - Cradle to cradle
- Need to expand recycling, composting and anaerobic digestion capacity
  - corporate support for infrastructure and policies
- Transitioning from fossil fuels to renewable, biobased feedstocks
  - Biobased not inherently better
  - Need criteria & standards for defining sustainable biomaterials and plastics across their life cycle
    - No GMOs in field
    - Inherently safer chems
    - Concerns with nano
    - Reuse, recycle, compost

Single use has got to go

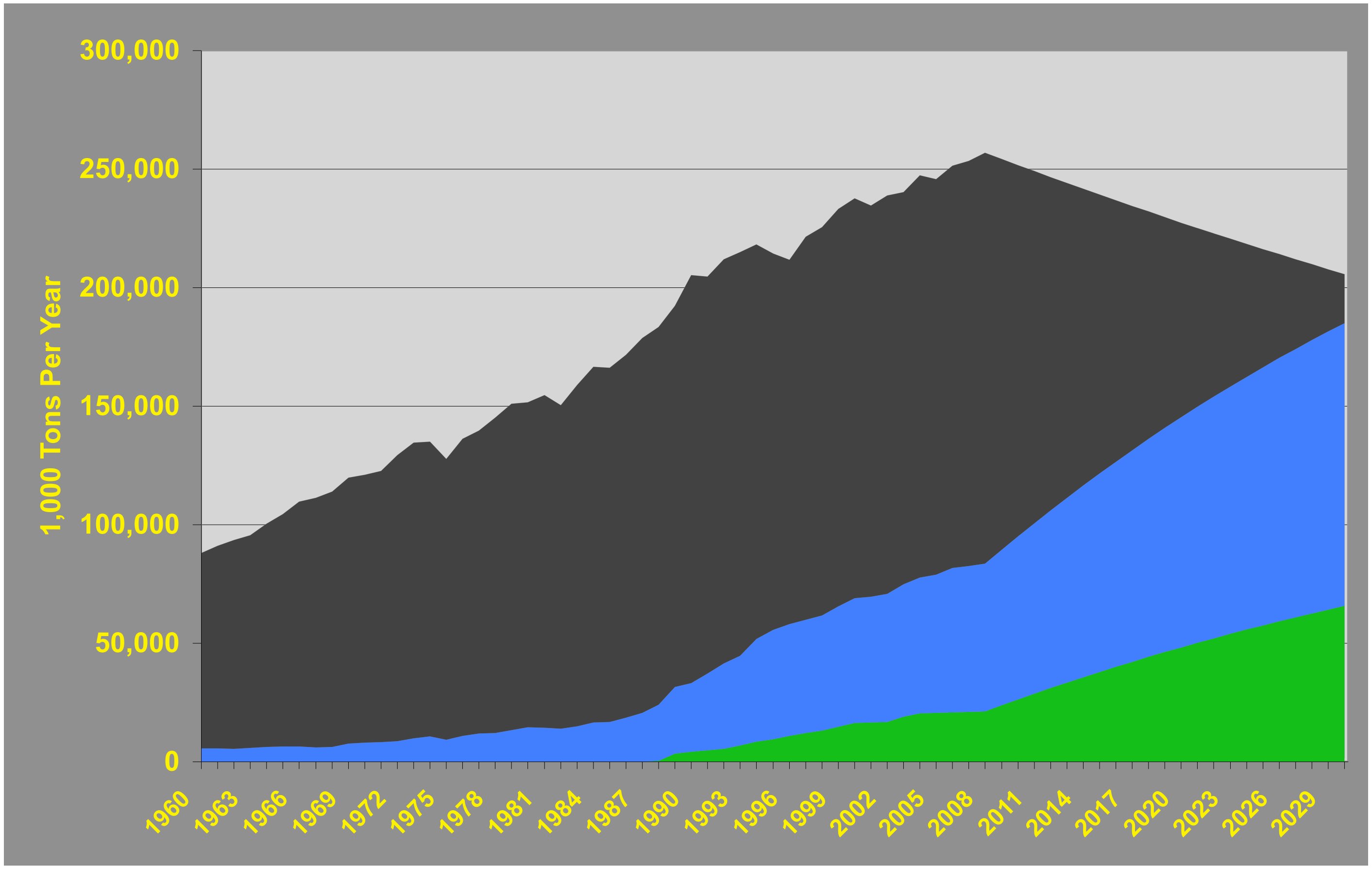
Resource Conservation Hierarchy

Most Preferable



Least Preferable

Zero Waste Path



Source: ILSR, GAIA, and Eco-Cycle, *Stop Trashing the Climate* (2008).

Aiming for zero waste is key GHG abatement strategy

Abatement Strategy	Megatons CO_2 eq.	% of Abatement Needed in 2030 to Return to 1990
Reducing waste via prevention, reuse, recycling, composting	406	11.6%
Lighting	240	6.9%
Vehicle Efficiency	195	5.6%
Lower Carbon Fuels	100	2.9%
Forest Management	110	3.1%
Carbon Capture & Storage	95	2.7%
Wind	120	3.4%
Nuclear	70	2.0%

Source: ILSR, GAIA, and Eco-Cycle, *Stop Trashing the Climate* (2008), and McKinsey & Company, *Reducing U.S. Greenhouse Gas Emissions: How Much and at What Cost? (2007)*

Comments? Questions?

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