Sustainable Communities Need Sustainable Biomaterials

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“Plastics: The Wonderful World of Sustainability and Recycling”
Outline

- What’s wrong with fossil-fuel-based plastics?
- Are biomaterials sustainable?
- Sustainable Biomaterials Collaborative and sustainability framework
- Purchasing specifications for sustainable biomaterials
- Survey of biobased food service ware
- Working Landscape Certificates
What’s wrong with fossil-fuel-based plastics?
Fossil-Fuel-Plastic Woes

- Non-renewable (geological timeframes to produce but consume in 1 to 10 years)
- Health impacts (polymers differ)
- Generally nonbiodegradable with devastating affects on ocean life
- Demand and production skyrocketing
- Plastics industry supports more drilling
- Recycling and reuse low
- Plastics industry supports incineration
## Petro-Plastics & Health

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Common Applications</th>
<th>Health Issues</th>
</tr>
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<tbody>
<tr>
<td><strong>Polycarbonate (PC)</strong></td>
<td>baby bottles, sports water bottles</td>
<td>can leach out bisphenol A, a hormone disruptor</td>
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<tr>
<td><strong>Polystyrene (PS)</strong></td>
<td>foam insulation, packaging peanuts, plastic utensils, meat trays, egg cartons, take-out containers, single-use disposable cups</td>
<td>uses benzene, styrene and 1,3-butadiene. Styrene is a neurotoxin and is known to be toxic to the reproductive system. PS releases toxic chemicals when burned.</td>
</tr>
<tr>
<td>Polytinyl Chloride (PVC or vinyl)</td>
<td>building pipes, siding, membrane roofing, flooring, and window frame; shower curtains, beach balls, credit cards, cooking oil bottles</td>
<td>made from the vinyl chloride monomer; high chlorine and additive content. Toxic additives such as phthalate softeners leach out. PVC releases dioxin and other persistent organic pollutants.</td>
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24 January 2006

Bottled Waters Contaminated with Antimony from PET

Prof. William Shotyk and co-workers at the Institute of Environmental Geochemistry, University of Heidelberg, measured the abundance of antimony in fifteen brands of bottled water from Canada and forty-eight from across Europe.

Bottled waters in PET containers are contaminated with antimony (Sb), a potentially toxic heavy metal with no known physiological function. Antimony trioxide is used as a catalyst in the manufacture of PET (polyethylene terephthalate), and PET typically contains several hundred mg/kg of Sb. For comparison, most of the rocks and soils at the surface of the earth contain less than 1 mg/kg Sb.

Prof. William Shotyk and co-workers at the Institute of Environmental Geochemistry, University of Heidelberg, measured the abundance of Sb in fifteen brands of bottled water from Canada and forty-eight from across Europe. His team also measured Sb in a pristine groundwater from a rural region of Canada, three brands of deionized water in PET bottles, as well as a new brand of water from Canada bottled commercially in polypropylene. Measuring Sb in pristine waters is quite a challenge because of the very low natural abundance of this element. This was not a problem for Dr. Michael Krachler, a leading expert for the analysis of Sb in environmental samples. Dr. Krachler used the unique clean laboratory facilities available at the University of Heidelberg which had earlier allowed him to measure Sb in polar snow and ice from the Canadian arctic.

The pristine groundwater was found to contain only two parts per trillion of Sb, with the bottled waters typically showing values a few hundred times greater. The water in polypropylene was comparable to the pristine water, suggesting that the PET bottle was in blame for the high Sb.
6 times more plastic than plankton by mass

Source: Captain Charles Moore, Agalita Marine Research Foundation
Source: Captain Charles Moore, Agalita Marine Research Foundation
Discarded plastic packaging accounts for one third of the trash in U.S. landfills and also ends up in oceans where marine wildlife accidentally consumes or becomes ensnared in the debris. Fragments are often mistaken for jellyfish and seabirds sway up small pieces with fish. These pieces are made from petroleum, reducing their use is part of reducing dependence on oil.

The average AMERICAN throws away 29,700 pounds of plastic packaging each year.
Plastic Packaging Discarded

Thousands of tons

Benefits of Bioplastics

- Can replace many harmful conventional plastics
- Can be fully biodegradable (capable of being utilized by living matter)
- Can be made from a variety of renewable resources
- Can be composted locally into a soil amendment
- Can help capture food discards and thus reduce methane from landfills
- Can contribute to healthier rural economies
- Can complement zero waste goals
Biomaterial – wonder material?

- “renewable”
- “green”
- “eco-friendly”
- “sustainable”
- “environmentally neutral”
- “safe and better”
- “easy on the environment”
- “return to nature without a trace”
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
Challenges with Bioplastics

- Concern over genetically modified organisms (GMOs)
- Desire for sustainably grown biomass
- Need to develop composting programs
- Concern with nanocomposites and fossil-fuel-plastic blends
- Lack of adequate labeling
- Concern over contamination of recycling systems
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
Tiny #7 & PLA

Photo courtesy of Sunset Scavenger, San Francisco
Noble Juice Bottle
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)
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.”
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.
The Framework for Sustainable Biomaterials

- Sustainably grown feedstocks
- No hazardous inputs and impacts during production
- Healthy and safe during use
- Recyclable or compostable and actually recycled and composted
## Blends: Steps to Best Practices

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
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<tbody>
<tr>
<td>Avoid</td>
<td>Plastics w/POPs in life cycle or manufactured w/high hazard chems (PVC, PS, ABS, PC, PU)</td>
</tr>
<tr>
<td>OK</td>
<td>Blend with more preferable plastics (e.g., PE, PP, PET)</td>
</tr>
<tr>
<td>Improving</td>
<td>Compostable</td>
</tr>
<tr>
<td>Better</td>
<td>Blend only bioplastics</td>
</tr>
<tr>
<td><strong>Best</strong></td>
<td>Pure bioplastic  &lt;br&gt; Fully compostable &amp; recyclable</td>
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### HCWH Food Service Ware Materials: Environmentally Preferable Purchasing Hierarchy

<table>
<thead>
<tr>
<th>Preference Hierarchy</th>
<th>Criteria</th>
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<tbody>
<tr>
<td>Most Preferred</td>
<td>Reusable</td>
</tr>
<tr>
<td>More Preferred</td>
<td>Biobased products - <strong>Beyond Baseline</strong></td>
</tr>
<tr>
<td>Preferred</td>
<td>Biobased products - <strong>Baseline Sustainability Criteria</strong></td>
</tr>
<tr>
<td>Less Preferred</td>
<td>Biobased products (do not meet sustainability criteria)</td>
</tr>
<tr>
<td>Least Preferred</td>
<td>Fossil fuel &amp; disposable</td>
</tr>
</tbody>
</table>
### Feedstock Production Criteria

1. Maximize use of organic carbon content derived from biobased materials (food ware min. 95% biobased carbon content)

2. Use GMO-free feedstock (certified GMO-free) OR sustainable agriculture offset program that includes GMO offset program.

3. For wood-based feedstocks, product must maximize post-consumer recycled content and, when using virgin fiber, must meet be FSC certified
## Baseline Sustainability Criteria for "Preferred" Biobased Products

**Manufacturing & Use Criteria**

4. No chlorine or chlorine compounds in production processes
5. No highly hazardous additives (e.g., PBTs, carcinogens)
6. No untested engineered nanomaterials
7. No organohalogens intentionally added to the product
8. Avoid unhealthy exposure:
   a. Limit VOC emissions to meet strictest applicable STDs
   b. Use no materials that emit highly hazardous organic compounds into the environment
Baseline Sustainability Criteria for "Preferred" Biobased Products

End of Life Criteria

9. Product must be:
   a. certified as compostable by an acceptable certification organization or program, OR
   b. recyclable (where claims of recyclability must be qualified)
### Feedstock Production & Manufacturing Criteria

1. Maximize use of organic carbon content derived from biobased materials

2. (a) Must be GMO-free and 
   (b) agricultural feedstocks must be sustainably grown; 
   (c) wood-based feedstocks must meet higher post-consumer recycled content

3. Must protect worker health and safety in feedstock production and manufacturing
### End of Life

4. Marine biodegradable

### Other Life Cycle Criteria (must meet one)

5. (a) Feedstocks should be grown regionally

5. (b) Final product should be produced regionally

5. (c) All chemical inputs must be comprehensively tested for the hazards they post to human health and the environment

5. (d) Clearly labeled as compostable when composting infrastructure exists.
Food Service Ware Survey

- Hot cups
- Cutlery
- Plates
- Salad containers
- Plates
- Trays
- Hot food containers
- Clamshells
- Straws
- Flower pots
- Sheets
- Bags
- Take-out containers
- Deli-ware
- Pie/muffin pans
- Trays
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)
Observations: End-of-Life

- Conformance with compostability STDs is common
- Referenced STDs are not limited to ASTM D6400
- Need to verify that product is fully meeting requirements of STD
- Certification of compliance is commonplace
- Need to verify that it is the final product that is in compliance (not the resin)
- Ability to backyard compost is not commonplace, partly due to lack of recognized STD
- Ability to biodegrade in marine environment is not commonplace, partly due to lack of recognized STD
Color-coded compostable design for 400k at SF Festival

Courtesy of City of San Francisco
Working Landscape Certificates

• Use of non-Genetically Modified crop
• No continuous annual crop production on same acreage
• Soil testing on contracted acres
• No use of chemicals that are known human or animal carcinogens
• Use of cover crops or at least 60 percent of crop residues remain on the entire field
• Creation of whole farm sustainability plan
Support existing family farmers economically to transition to sustainable farming practices

- Farmers receive a higher and more stable price for sustainable crop production
- Expanded production of sustainable feedstocks
- Do not require “identity-preserve” infrastructure and additional transaction costs
WLC Corn Production Criteria

• 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
WLC available to companies

• A pound for pound answer to food vs. materials

• Assisting businesses to transition to truly green materials and products

• Enable bioplastic customers to support more sustainable crop production

Joe, WLC Farmer

Contact: david.levine@greenharvesttechnologies.com
A Sustainable Bioeconomy

• Provides the food, fuel, fiber and materials we need
• Protects and enhances the environment
• Benefits family farms, rural communities and society
• Is fair and responsive