Ingeo™ Innovations

Providing Ingenious Solutions

GFA Power Session

December 17, 2009

S Davies
D Kunnemann
Established in 1997
- Global stand-alone organization wholly owned by Cargill
- Several hundred million dollar capital investment
  Unique and extensive patent position protects the science behind the technology
- World’s first and largest biopolymer manufacturing facility
  300 million pound name plate capacity
Need for innovation?

Approximately 2.5 billion barrels of oil are used for plastics.

"It is estimated that 4% of the world's annual oil production is used as a feedstock for plastics production and an additional 3-4% during manufacture." *

* [http://www.wasteonline.org.uk/resources/InformationSheets/Plastics.htm](http://www.wasteonline.org.uk/resources/InformationSheets/Plastics.htm)
The future?

“$4/Gallon Gasoline Have (and will) Affected Our Nation”

Consumers expect retailers and brands to take small steps on their behalf to provide them with more environmentally friendly products.

Biopolymers can transform packaging from a functional commodity cost item to a differentiable marketing feature.

- *Truth in Marketing*
- *Not Green washing*
Although many reference 3R’s
- Reduce
- Reuse
- Recycle
We provide the 4th R: “Renewable!”
Ingeo™ requires sugar
Today - No. 2 feed corn is our sugar source

Blair, NE. - 140,000 ton/year

- Strain on commodities is a result of several factors - Energy prices globally; growing middle class; economies in China and India; severe weather; corn exports; farmer crop selection; and other!

- NatureWorks footprint is small: At full capacity Ingeo will use less than 0.2% of the US corn production

- NatureWorks goal is to transition into cellulosic and other future raw materials

This innovation is a journey, in which plant sugars is a starting point, not the destination!
NatureWorks LLC

Science

Converter Partners

Carbon dioxide and water

Plants

Plants

100% annually renewable sources

Ingeo™ fibers and natural plastics created

Production

Sugar (dextrose)

Ingenious materials from plants not oil

Ingeo™ biopolymer

Fibers and natural plastics

Less fossil fuel used in production

Ingeo™

Converter Partners

Environment
NatureWorks LLC

Flexible, Films & Coatings

Rigid Containers

Bottles

Serviceware

Consumer Goods

Textile

Apparel

Cards
April 16, 2009 –
Frito-Lay’s SunChips Brand Changes the Future of Snack Food Packaging. 
PepsiCo Division Revolutionizing Packaging Starting with Ingeo™ Outer Layer
Our Plan is to use Ingeo™ film in our SunChips bag as our Launch Platform...

1/3 Printed Ingeo™

2/3 Degradable Adhesive

3/3 Barrier Ingeo™

Compostable Renewable 2011

Renewable, Degradable Reduced GHG

XXL SunChips Nat’l Target P2, 2009

Targeting H2, 2009

Targeting 2010
Specifically for foodservice:
So why innovate with Ingeo?

Environment
- Reduced footprint
  - Made from plants – not oil
  - Environmental leadership
  - Validated eco profile
  - New after-use options

Performance
- Clarity and optics
- Form and stiffness
- UV Stable
- Non-allergenic
- Printability
- Ability to light-weight

Emotion
- Natural origins
- Annually renewable
- Pure innovation
- **Brand differentiator**
- Enables consumer choice
- Feels right
- Supports consumer values and beliefs
Eco-profile - Resin
Cradle to pellet

Life Cycle Assessment - Resin
Cradle to cradle
We created an entirely new production system for polymers based on renewable resources. **Ingeo 2005** represents the 2005 cradle-to-pellet Ingeo production system (= the benchmark).

Ingeo 2009 represents the “Next Generation”, cradle-to-pellet Ingeo production system:

- Based on a package of technology improvements, e.g. new lactic acid technology.
- Implementation started in 2009.

Further future improvements associated with:

- Production using new carbohydrate feedstock
- Further process optimization
- On site renewable energy (e.g. wind, biomass)
- Plant II
Comparing Environmental Footprints: Greenhouse Gas Emissions

<table>
<thead>
<tr>
<th>Material</th>
<th>Ingeo target</th>
<th>Ingeo 2009 - current technology</th>
<th>Ingeo in 2005</th>
<th>PVC (suspension)</th>
<th>Polypropylene</th>
<th>LD Polyethylene</th>
<th>PET (amorphous)</th>
<th>PET (SSP)</th>
<th>Polystyrene (HIPS/GPPS Avg)</th>
<th>Polycarbonate</th>
<th>Nylon 6</th>
<th>Nylon 66</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse gas emissions (kg CO₂ eq. / kg polymer)</td>
<td>0.8</td>
<td>1.3</td>
<td>2</td>
<td>1.9</td>
<td>1.9</td>
<td>2.1</td>
<td>3.2</td>
<td>3.4</td>
<td>3.4</td>
<td>3.2</td>
<td>7.9</td>
<td>9.1</td>
</tr>
</tbody>
</table>

Fossil based polymers:
PlasticsEurope;
www.lca.plasticseurope.org

Classification factors used for Climate Change

NatureWorks® polylactide (PLA) production.
### Comparing Environmental footprints: Non-renewable Energy Requirements

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Energy Use [MJ/kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingeo target</td>
<td>35</td>
</tr>
<tr>
<td>Ingeo 2009 - current technology</td>
<td>42</td>
</tr>
<tr>
<td>Ingeo in 2005</td>
<td>50</td>
</tr>
<tr>
<td>PVC (suspension)</td>
<td>59.3</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>73</td>
</tr>
<tr>
<td>LD Polyethylene</td>
<td>76.9</td>
</tr>
<tr>
<td>PET (amorphous)</td>
<td>80.3</td>
</tr>
<tr>
<td>PET (SSP)</td>
<td>82.2</td>
</tr>
<tr>
<td>Polystyrene (HIPS/GPPS Avg)</td>
<td>86.8</td>
</tr>
<tr>
<td>Polycarbonate</td>
<td>112.5</td>
</tr>
<tr>
<td>Nylon 6</td>
<td>119.9</td>
</tr>
<tr>
<td>Nylon 66</td>
<td>137.7</td>
</tr>
</tbody>
</table>

- **Fossil based polymers**: *PlasticsEurope*; [www.lca.plasticseurope.org](http://www.lca.plasticseurope.org)
Comparing Environmental Footprints: Total Water Use

<table>
<thead>
<tr>
<th>Material</th>
<th>Process water</th>
<th>Cooling water*</th>
<th>Irrigation water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingeo target</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingeo 2009 - current tech</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingeo in 2005</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PVC (suspension)</td>
<td>9</td>
<td>454</td>
<td></td>
</tr>
<tr>
<td>Polypropylene</td>
<td>5</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>LD polyethylene</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>PET (amorphous)</td>
<td>5</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>PET (SSP)</td>
<td>5</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>PS (HIPS/GPPS average)</td>
<td>10</td>
<td>129</td>
<td></td>
</tr>
<tr>
<td>Polycarbonate</td>
<td>14</td>
<td>129</td>
<td></td>
</tr>
<tr>
<td>Nylon 6</td>
<td>14</td>
<td>177</td>
<td></td>
</tr>
<tr>
<td>Nylon 66</td>
<td>167</td>
<td>495</td>
<td></td>
</tr>
</tbody>
</table>

* This is the total volume of once-through cooling water + the tap up water for cooling towers to compensate for evaporation losses. (The total quantity of water circulated in closed systems is not reported)


Fossil based polymers: PlasticsEurope; www.lca.plasticseurope.org
A comparison of Clamshell food packaging made from Ingeo™ and R-PET

Recycled PET

Ingeo™

Life Cycle Analysis performed by the IFEU Institute in Heidelberg, Germany
**Objective:**

- Compare the environmental performance of clamshells made of Ingeo™ bioplastic with clamshells made of varying levels of recycled PET (r-PET).

### Variables Assessed

<table>
<thead>
<tr>
<th>Variables Assessed</th>
<th>Recycled PET</th>
<th>Ingeo™</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Material Type</td>
<td>• 0 %, 50 %, 100 % PET</td>
<td>• Ingeo-2005 ----→ • Ingeo-2009</td>
</tr>
<tr>
<td>2. Clamshell Weight</td>
<td>• 19.9 g</td>
<td>• 19.9 g (functionally overdesigned)</td>
</tr>
<tr>
<td>3. End-of-Life treatment</td>
<td>• Landfill</td>
<td>• 15.0 g (functionally identical)</td>
</tr>
<tr>
<td></td>
<td>• Incineration</td>
<td>• Landfill</td>
</tr>
<tr>
<td></td>
<td>• EU vs US power grid</td>
<td>• Incineration</td>
</tr>
<tr>
<td></td>
<td>• EU vs US landfill practices</td>
<td>• EU vs US power grid</td>
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<td></td>
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<td>• EU vs US landfill practices</td>
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</table>

**Over 40 Clamshell Scenarios Assessed**
Conclusions:

- Even with an equivalent weight Ingeo™ clamshell, today’s virgin Ingeo™ is still better than 100% rPET
- Difference increases significantly if rPET content is less than 100%.
Conveying the message to the consumer

Data Sources:

NatureWorks Eco Profile
Plastics Europe www.lca.plasticseurope.org (industry averages for production data)
BREW Report (Publication for production values)
EPA – US inventory of greenhouse gas emissions and sinks.
It’s the natural selection for packaging. Better for the planet, so better for you, your family and business too.

“Did you know that if you convert just 500,000 medium sized deli containers to ones made with Ingeo™ the fossil energy savings is equivalent to 5,400 gallons of gasoline, and greenhouse gas savings are equivalent to driving a car over 122,000 miles?”

These benefits are provided as an example and are based on the eco-profile of NatureWorks® and available data on PET. Assumptions include replacement of a 30 gram PET deli container, with an equal weight Ingeo™ with no changes in the eco-footprint associated with the downstream processing from polymer to finished container.
With over 70 Ingeo™ packaging SKUs in the produce aisle, Wal-Mart has reduced greenhouse gas emissions by an amount equal to driving a car 12,000,000 miles and the fossil fuel savings equivalent of 549,000 gallons of gasoline.
The Coca-Cola® ecotainer™ Meets the City of Seattle’s Requirement That All Packaging Must Be Recyclable or Compostable!

- Introducing… the ecotainer™ Coca-Cola® cup: the first compostable paper soft drink cup and lid made from renewable resources. The new cup and lid are an important next step in the University of Washington’s achievement of its environmental sustainability goals.
- Through the collaborative efforts of the University of Washington, Coca-Cola®, Cedar Grove Composting, International Paper, DaniMer LLC and NatureWorks LLC— the Coca-Cola® ecotainer™ is available at the University of Washington’s Seattle campus.

Diverting Waste from the Landfill

- HFS implemented composting and recycling programs in residential and dining facilities in January 2007. Working with partners, they created an almost entirely compostable product line.
- NOTE: The only thing not compostable at Cedar Grove (local composting facility), was the Coca-Cola® fountain drink cup—the cup was coated with petrochemical-based polyethylene, which does not break down in composting systems.
- After nearly two years of testing and market research, they launched the first compostable paper soft drink cup made from renewable resources during 1Q09. With it, potentially 150,000 cups and 150,000 lids will be diverted from landfills.
Some resins are of bio-based / agricultural origin.

*Ingeo™*

Is Both Bio-based and Offers End Of Life Options

NatureWorks LLC and our partners can provide customers products with superior front-end *and* end of life options.

**End of Life Options**

- Recycle
  - Mechanical
- Chemical (Hydrolysis)
- Compost
Disposal options for Ingeo™ and petrochemical based polymers

**Traditional Polymers**
- Incineration
- Mechanical recycling
- Landfill
- Chemical recycling (very limited)

**Ingeo™**
- Incineration (Clean burning, Energy recovery)
- Mechanical recycling (Reuse of materials)
- Landfill (no toxic leachate)
- Chemical recycling (permanent reuse)
- Composting (no toxics, volume reduction, C sequestration, water mgmt, soil fertility)

More flexibility (local situation: infrastructure collection & processing, legislation, waste stream composition, public perception, available volume in the market..)

⇒ More sustainable solutions can be created
43,000 tons of food are thrown out in the U.S. everyday.
Food scraps make up 32 million lbs of MSW

Plastics makes up 31 million lbs of MSW

- Combined = 24.6% or 62.5 million lbs of MSW

Many Food Service Operators and Venues focus on recycling but continue to contribute to a growing waste issue

We ask you to consider a food waste/packaging diversion from landfill journey!
- Ingeo™ based renewable/compostable food serviceware (NW partners)
- Evaluate and engage composting (extend anaerobic digester activities)
The Genesis of Cedar Grove Packaging

COMPOSTER

BROKER/DISTRIBUTOR

Food Service Supplier

MANUFACTURER
Which package is compostable?

A.

B.

C.

D.

Ingeo™ to the RESCUE in Seattle…
A Credible Closed Loop Solution Exists In Seattle...
EOL

- **Recycling**
  - Separation of PET vs Ingeo™ (and other polymers) can easily occur through IR or Optical sortation
    - PRIMO water bottle tested as noted at [www.natureworksllc.com](http://www.natureworksllc.com)
  - Few are
    - Willing to pay for this added cost vs what today is a manual labor sorting operation
    - End market (and mass of volume to support this market) not there - yet!
  - Chemical Recycling is the future (i.e. hydrolyze the final part)!
  - ASTM is close to introducing a new CODE FOR PLA (to be defined shortly)

- **Compostability**
  - BPI certification requires the respective part to be tested (resin approval means little vs. the part)
  - In Seattle, BPI certification allows you to be tested for Cedar Grove approval/use. (i.e. operating from a business model that makes $’s)
  - It’s the responsibility of each Ingeo™ part producer to have their part(s) certified if they are promoting COMPOSTABLE

**NOTE:** This is key for Food Serviceware (especially for cities like Seattle and San Francisco that seek this verbiage and BROWN or GREEN markings on compostable food serviceware and rigid packaging!)
NatureWorks LLC and Food Service Partners

- It’s no longer just focusing on composting packaging!
- Food waste diversion from land fills provides an opportunity to also pursue the use of compostable food serviceware as both are industrial compost friendly!
  - Benefits?
    - No longer need to separate food waste from food serviceware
    - Reduce the number of collection bins
    - Reduce the number of waste pick-ups
      - Combine food waste and packaging into one waste stream

  OPPORTUNITY TO REDUCE BACK-END COSTS!
  COMPOSTABLE BASED PACKAGING CAN ASSIST COMPOSTERS

- City of Seattle has moved into this space
  - San Francisco is implementing this
  - Atlanta is assessing options (i.e. Zero Waste Zones!)
    - GreenCo
Key Take-Away’s

- As you assess future food waste and food service applications, there’s an opportunity to position compostable food serviceware/packaging as a solution to landfill use
  - This requires a BPI Certified compostable food serviceware product line
- We want to see demonstrated success from Cedar Grove, Recology (NORCAL), and new initiatives from GreenCo, Harvest Power and others to be assessed in Atlanta (and the nation as a whole)
  - We encourage you to consider the use of compostable food serviceware and packaging as part of current Net Zero Waste efforts
- We work with many food service operators, distributors and NatureWorks LLC converting partners that can assist you:
  International Paper    Dixie (GP)    Solo    Reynolds
  Pactiv              Asean Corp    Eco-Products    Bunzl    (www.natureworksllc.com)
- How can NatureWorks LLC and our partners work together to expand a new chapter in food waste and compostable packaging diversion from landfills?
So why innovate with Ingeo?

- **Environment**
  - Reduced footprint
    - Made from plants – not oil
    - Environmental leadership
    - Validated eco profile
    - New after-use options

- **Performance**
  - Clarity and optics
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Thank You!

www.natureworksllc.com