

# Ingeo™ Innovations *Providing Ingenious Solutions*

GFA Power Session

December 17, 2009

S Davies  
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- **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://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=5&pid=53&aid=1>

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## The future?



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

*U.S. News and World Report – June 2008*

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

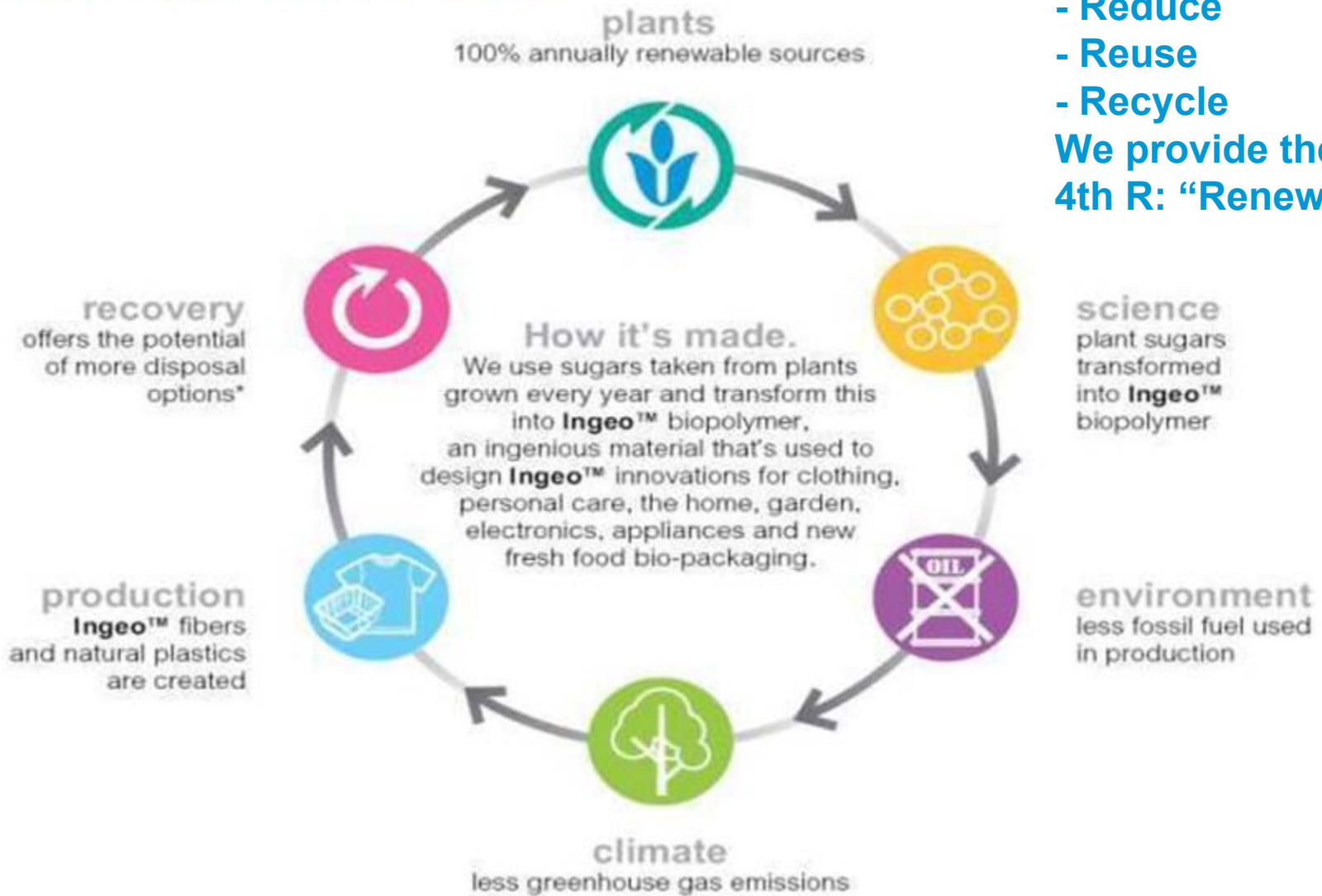


Biopolymers can transform packaging from a functional commodity cost item to a *differentiable marketing feature*.

- *Truth in Marketing*
- *Not Green washing*



Although many reference 3R's  
 - Reduce  
 - Reuse  
 - Recycle  
 We provide the  
 4th R: "Renewable!"



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Ingeo™ requires sugar  
Today - No. 2 feed corn is our sugar source



Blair, NE. - 140,000 ton/year



Corn use  
for ethanol -  
20%

Corn use  
for Ingeo™  
< 0.2%

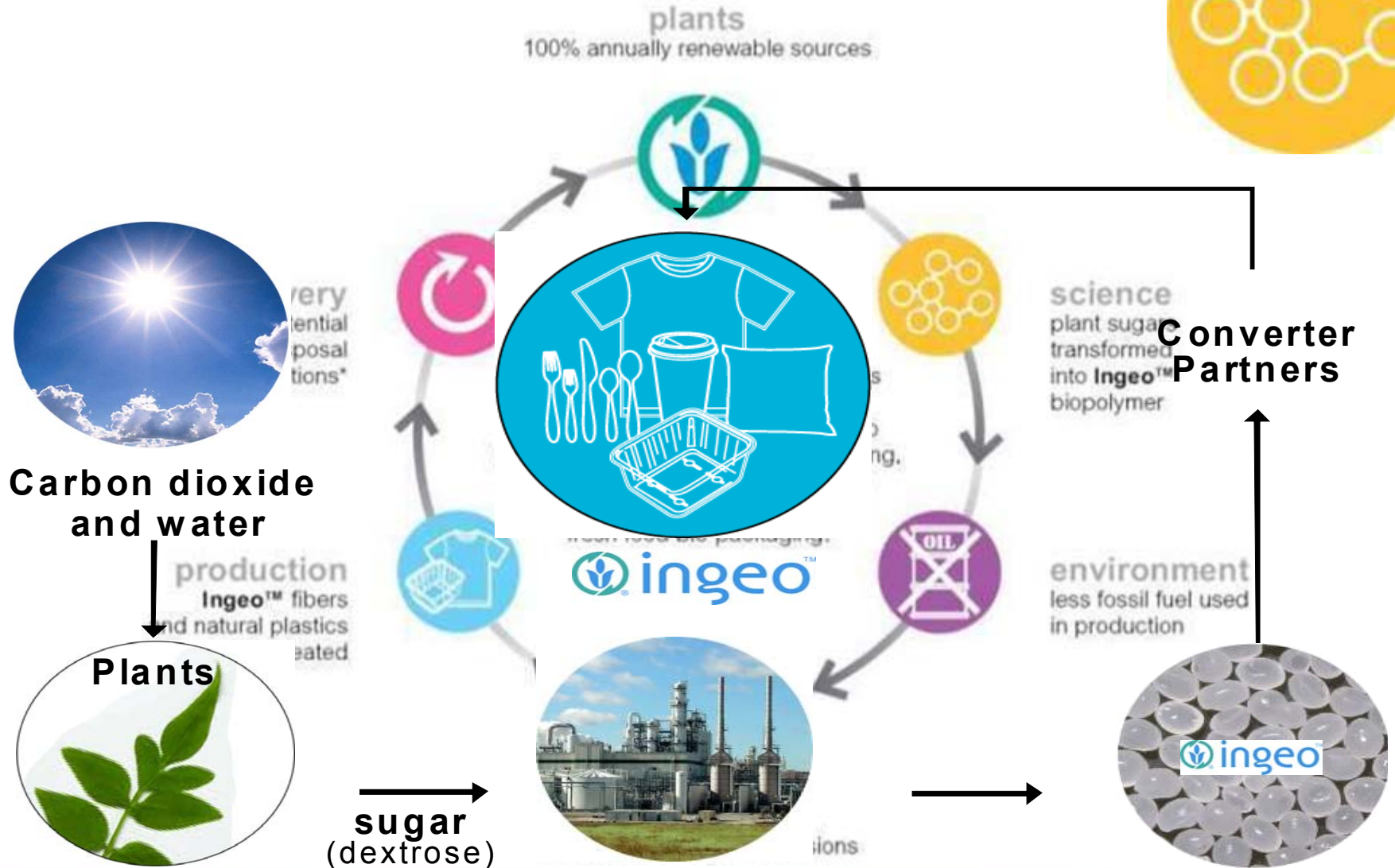
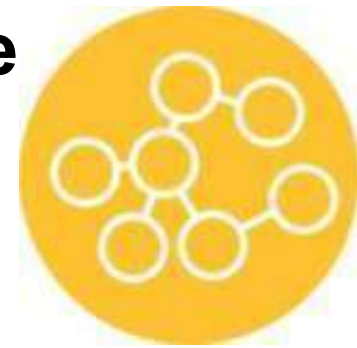
- Strain on commodities is a result of several of factors - Energy prices globally; growing middle class; economies in China and India; severe weather; corn exports; farmer crop selection; and other!
- NatureWorks footprint is small: At full capacity Ingeo will use less than 0.2% of the US corn production
- 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!**

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## Serviceware



## Bottles



## Rigid Containers



## Flexible, Films & Coatings



## Consumer Goods



## Textile



## Apparel



## Cards



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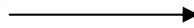






April 16, 2009 –

**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™



**XXL SunChips**  
**Nat'l Target P2,**  
**2009**

2/3

Degradable  
Adhesive



**Targeting**  
**H2, 2009**

3/3

Barrier Ingeo™



**Targeting**  
**2010**

Renewable,  
Degradable  
Reduced  
GHG

**Compostable**  
**Renewable**  
**2011**

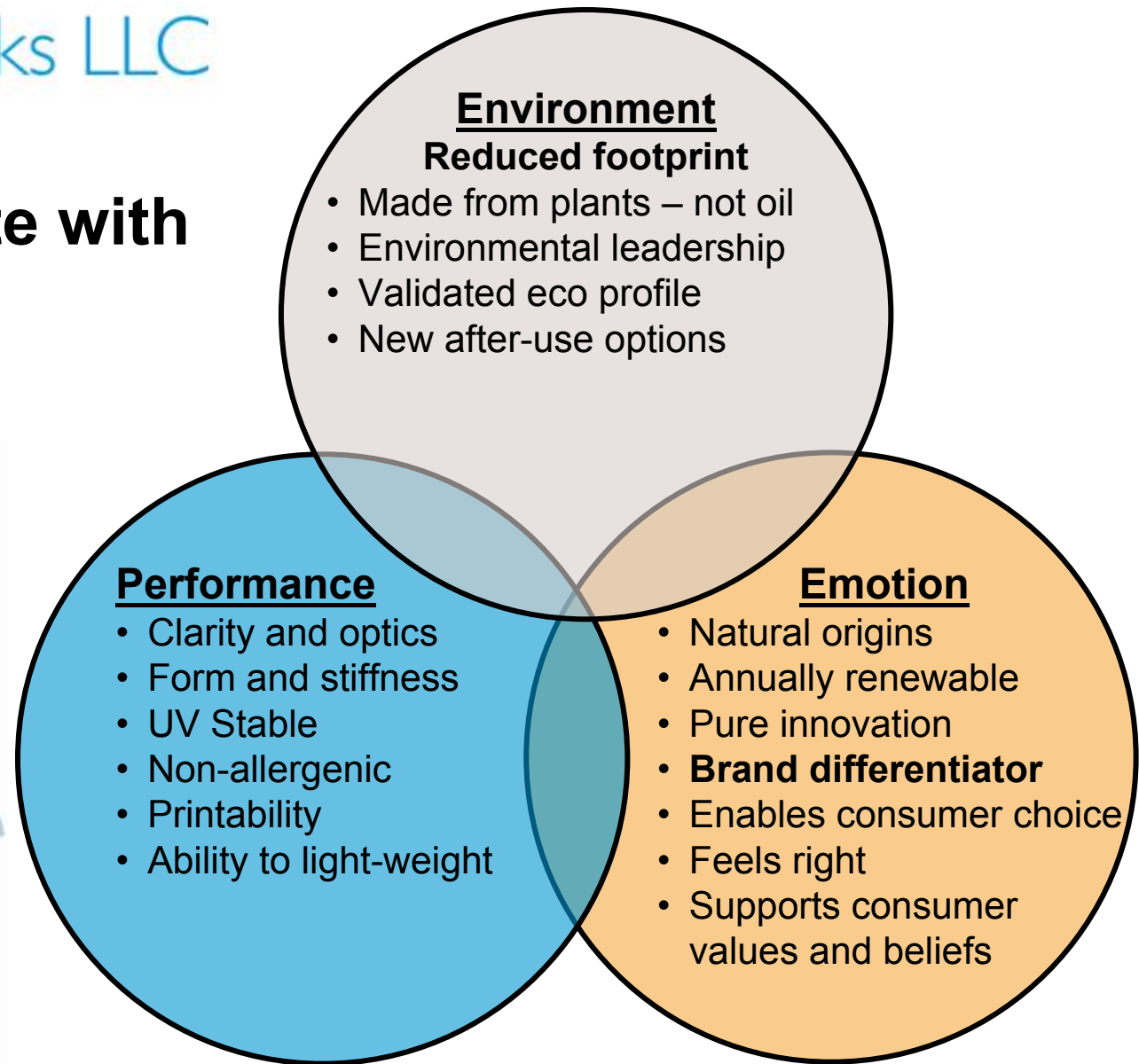


## Specifically for foodservice:





# So why innovate with Ingeo?





## Eco-profile - Resin

**Cradle to pellet**

## Life Cycle Assessment - Resin

**Cradle to cradle**

# Evolving the Ingeo™ eco-profile

Further future improvements associated with:

- Production using new carbohydrate feedstock
- Further process optimization
- On site renewable energy (e.g. wind, biomass)
- Plant II

**FUTURE**  
Long term

**Implementing  
Now**  
Ingeo 2009

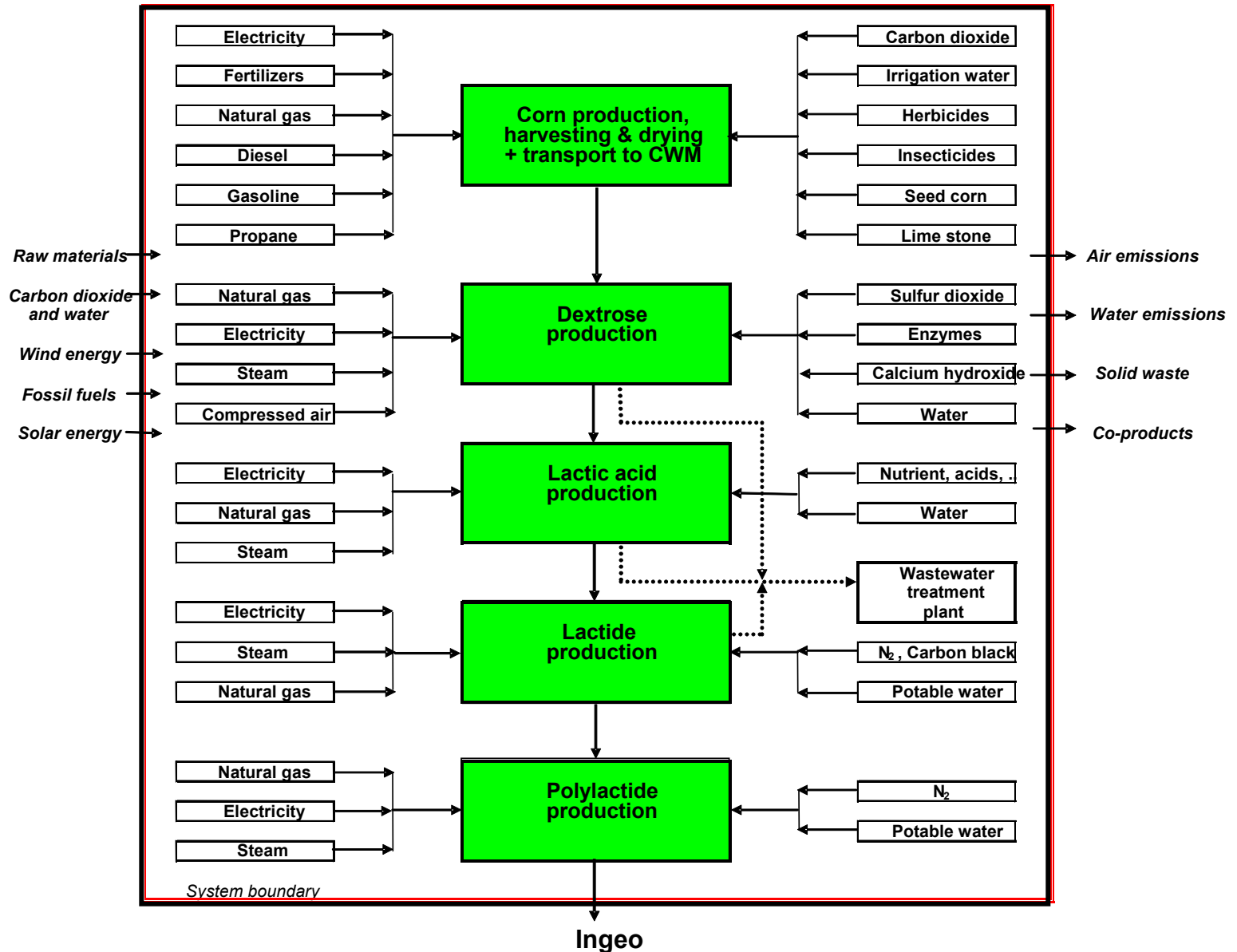
Ingeo 2009 represents the “Next Generation”, cradle-to-pellet Ingeo production system:

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

**PAST**  
Ingeo in 2005

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).

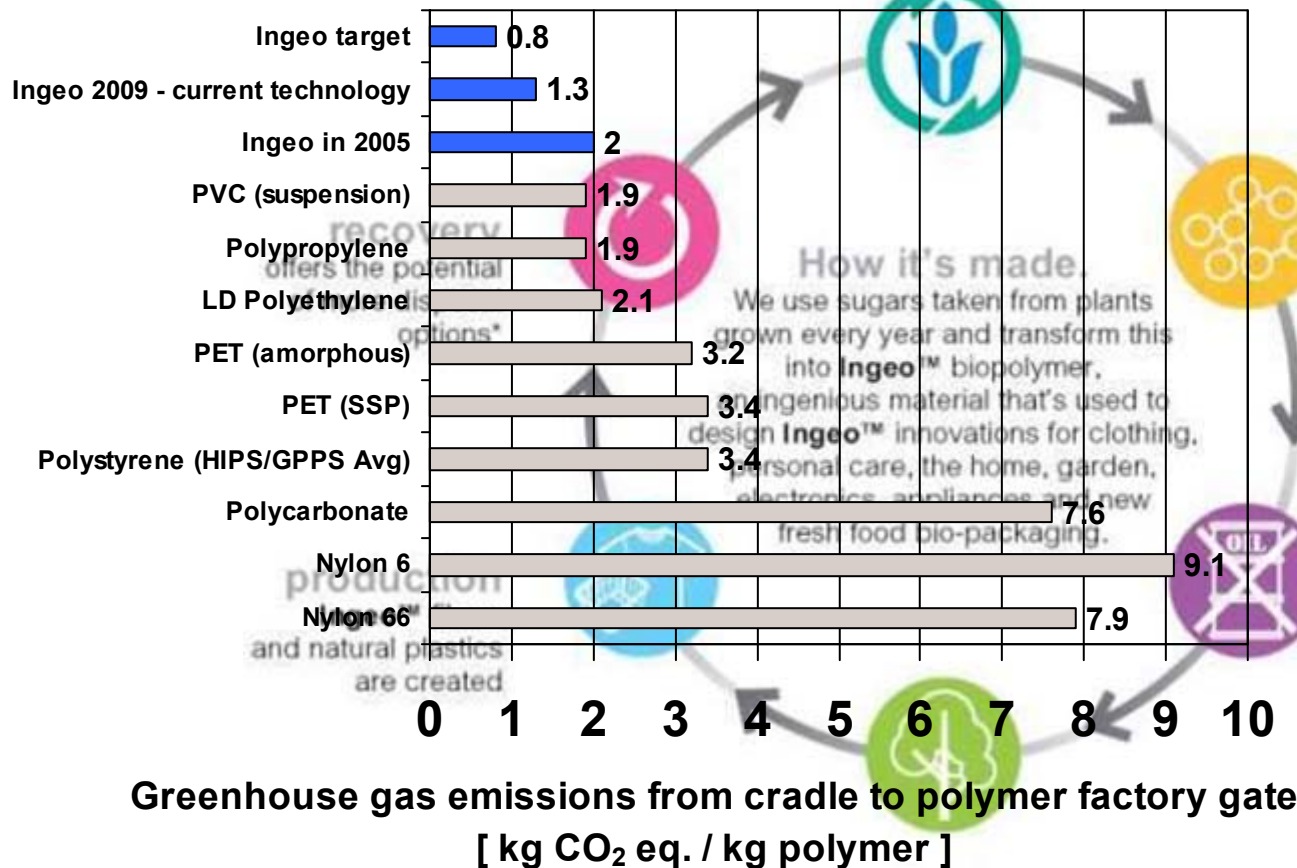








## Comparing Environmental Footprints: Greenhouse Gas Emissions



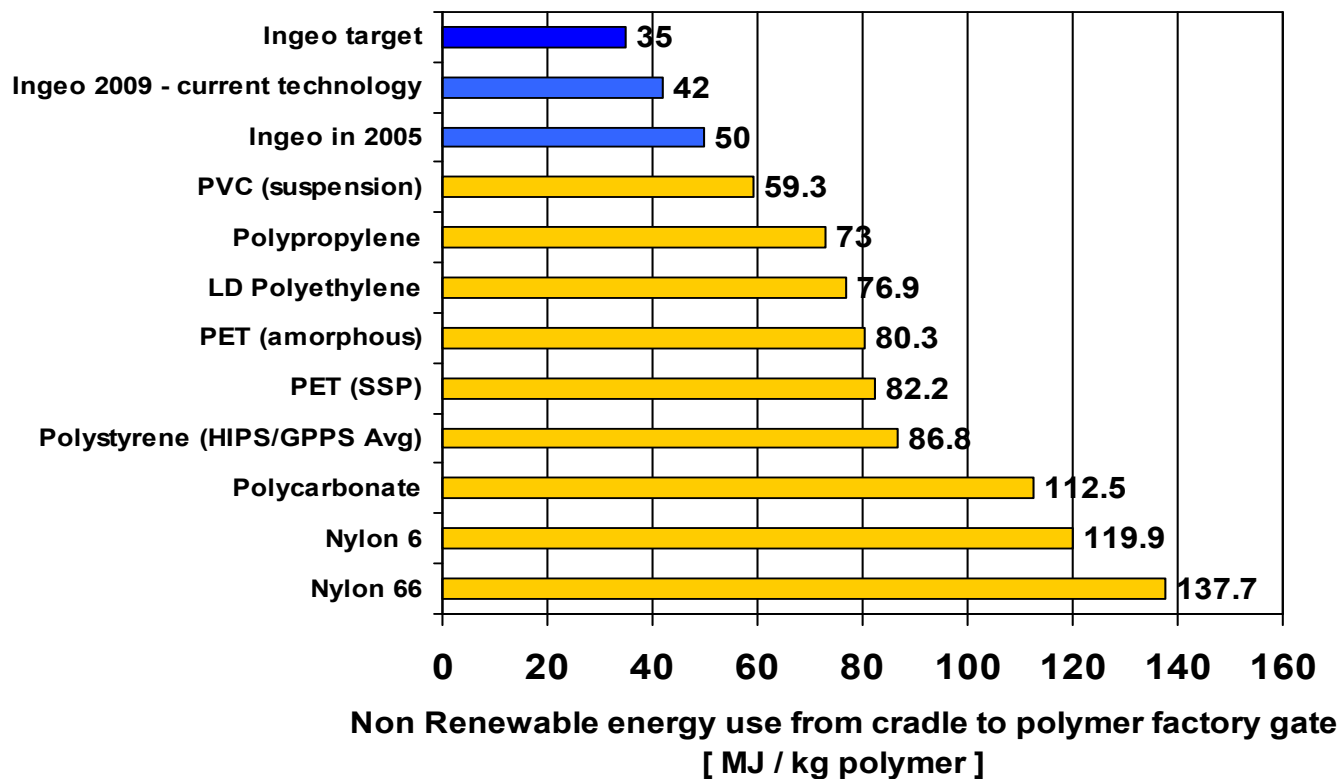
Ingeo: Vink E.T.H. et al.  
The eco-profiles for current and near-future NatureWorks® polylactide (PLA) production. Industrial Biotechnology, Volume 3, Number 1, 2007, Page 58-81.

Fossil based polymers:  
PlasticsEurope;  
[www.lca.plasticseurope.org](http://www.lca.plasticseurope.org)

Classification factors used for Climate Change  
Guinee J.B., Handbook on Life Cycle Assessment, Kluwer Academic Publishers

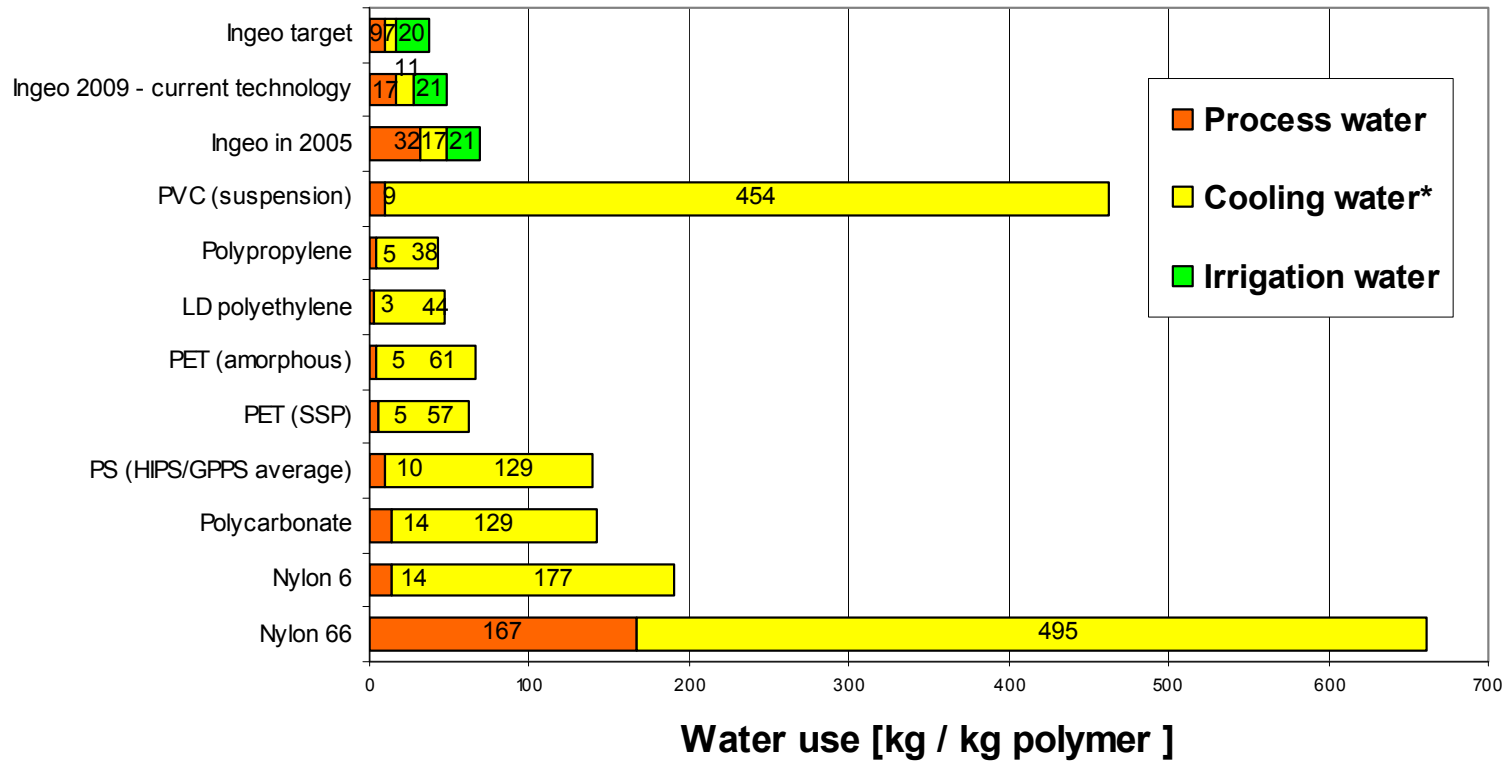


## Comparing Environmental footprints: Non-renewable Energy Requirements



- Ingeo: Vink E.T.H. et al. The eco-profiles for current and near-future NatureWorks® polylactide (PLA) production. Industrial Biotechnology, Volume 3, Number 1, 2007, Page 58-81.
- Fossil based polymers: [PlasticsEurope; www.lca.plasticseurope.org](http://www.lca.plasticseurope.org)

## Comparing Environmental Footprints: Total Water Use



Ingeo: Vink E.T.H. et al. The eco-profiles for current and near-future NatureWorks® polylactide (PLA) production. Industrial Biotechnology, Volume 3, Number 1, 2007, Page 58-81.

Fossil based polymers:  
PlasticsEurope;  
[www.lca.plasticseurope.org](http://www.lca.plasticseurope.org)

\* 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)



# 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).

*Over 40 Clamshell Scenarios Assessed*

## Variables Assessed

1. Material Type

- 0 %, 50 %, 100 % PET

2. Clamshell Weight

- 19.9 g

3. End-of-Life treatment

- Landfill
- Incineration

4. Location

- EU vs US power grid
- EU vs US landfill practices

## Recycled PET



## Ingeo™

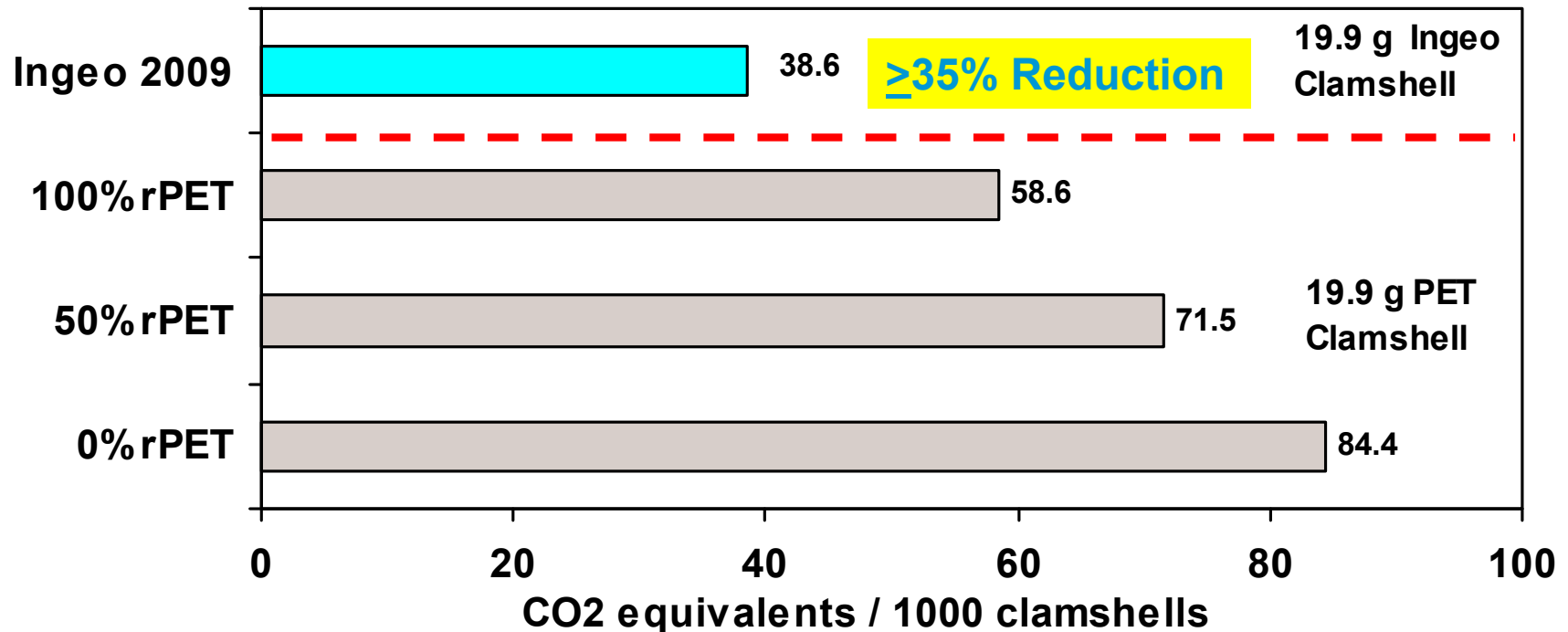


- Ingeo-2005 ----→ Ingeo-2009

- 19.9 g (functionally oversized)
- 15.0 g (functionally identical)

- Landfill
- Incineration

- EU vs US power grid
- EU vs US landfill practices



US EOL: clamshell land filled after use

## Conclusions:

- ***Even with a 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](http://www.lca.plasticseurope.org)  
(industry averages for production data)

BREW Report (Publication for production values)

EPA – US inventory of greenhouse gas emissions and sinks.

### ESTIMATED ENVIRONMENTAL BENEFITS CALCULATOR

Select a conversion process. Then select a traditional polymer to convert to Ingeo™ biopolymer. Next, fill in part weight, units and number of parts to convert. Click "Go" to view the resulting values below.

\* Required

#### Process & Polymer Selection

Conversion Process: <span>Pellet</span>	
Convert from: <span>aPET</span>	To: <span>Ingeo™ biopolymer</span>
Part Wt: <span>56</span> <span>g</span>	Part Wt: <span>56</span>
<input checked="" type="radio"/> Total Number of Parts to Convert: <span>1,000,000</span>	
<input type="radio"/> Total Weight to Convert: <span></span> <span>g</span>	

GO

Converting **1,000,000** parts from **aPET** to Ingeo™ biopolymer results in the **fossil fuel savings** equivalent to:

- ... burning **17,095** gallons of gasoline
- ... burning **59,833** liters of gasoline
- ... the electricity consumed per month by:
  - 550** residents of the U.S.
  - 1,268** residents of Western Europe
  - 1,149** residents of Japan
  - 13,163** residents of China
  - 2,944** residents of South Korea
- ... saving **423** barrels of oil per year
- ... **227** years powering a single 100 watt light bulb

Converting **1,000,000** parts from **aPET** to Ingeo™ biopolymer results in the **greenhouse gas savings** equivalent to:

- ... driving a new vehicle:
  - 379,917** miles in the U.S.
  - 945,634** km in Western Europe
  - 1,177,189** km in Japan
  - 744,583** km in China
- ... not driving **30** passenger cars in the U.S. in one year
- ... **32** acres of pine or fir forest storing carbon for 1 year
- ... **5,777** propane cylinders used for home barbecues
- ... **3,555** tree seedlings being grown for 10 years
- ... **1** acres of forest preserved from deforestation

[Tabulated numerical results >](#)  
[Export to Excel >](#)

[References](#)

CLOSE WINDOW







plants  
100% annually renewable sources



**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. Assumes 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.

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to™  
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oil fuel used  
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At Wal-Mart, we are dedicated to continually improving our products and services. This package is made from Ingeo™, an ingenious plastic made from plants - not oil.

This means it's renewable, so it's better for you and your family. Our choices do make a difference.



To learn more about this package, go to [www.natureworkslc.com](http://www.natureworkslc.com)



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.







card passes to purchaser. No cash value. No cash back. No cash resulting from lost or stolen card. No cash back to licensees, affiliates, and licensors. No cash back to card or the iTunes Store and iTunes Store. These limitations may not apply to all purchases. For full terms and conditions, see iTunes Store. iTunes Store purchased from the iTunes Store is for personal use only. © 2008 Apple Inc. All rights reserved. A121

have no value until activated at the register.

④ ingeo plant-based card

NBL





## 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.



**Ingeo™**

Some resins are  
of bio-based /  
agricultural origin.

**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   Ingeo™

Incineration

Mechanical recycling

Landfill

Chemical recycling (very limited)

Incineration (Clean burning, Energy recovery)

Mechanical recycling (Reuse of materials)

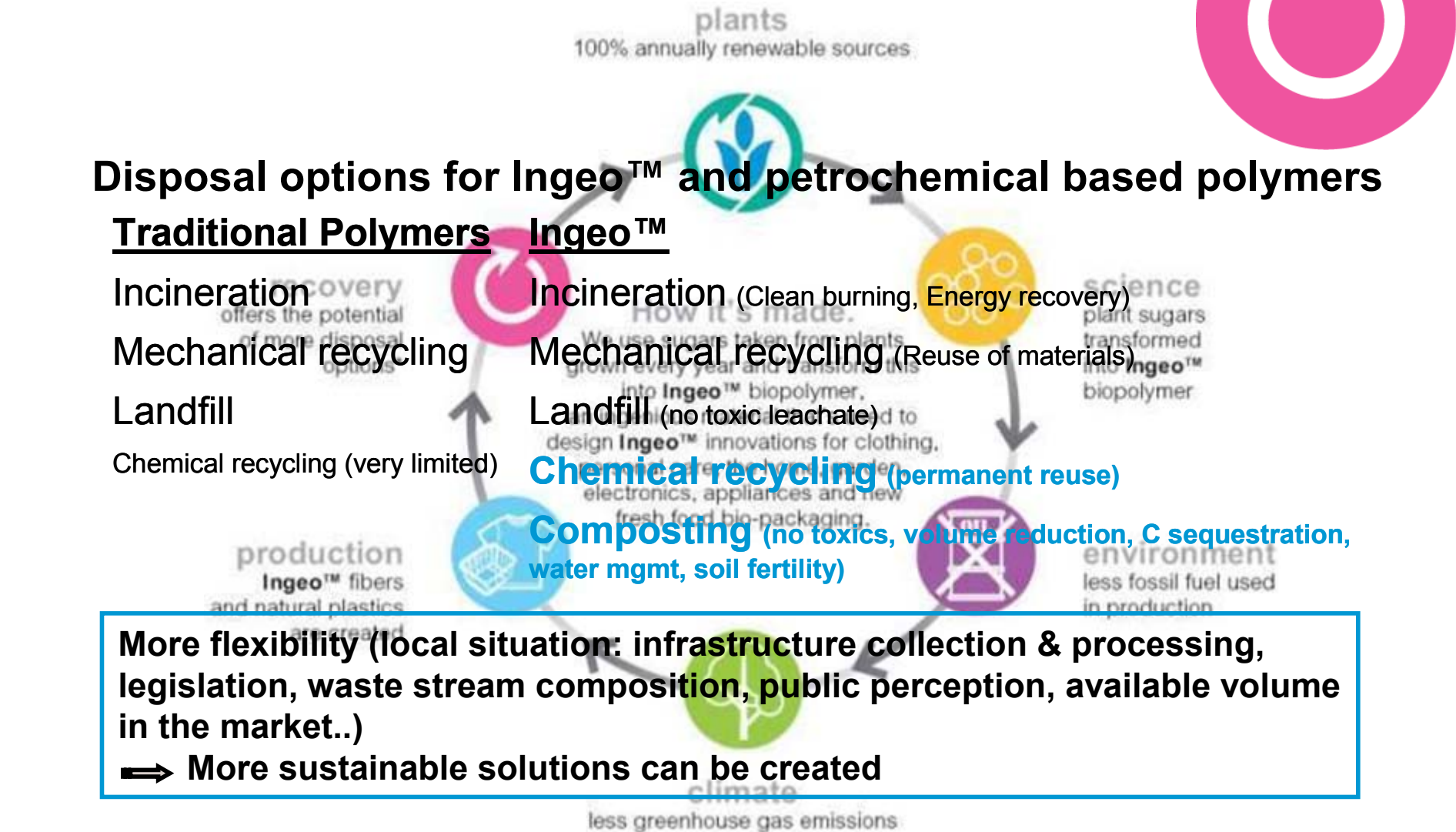
Landfill (no toxic leachate)

**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**

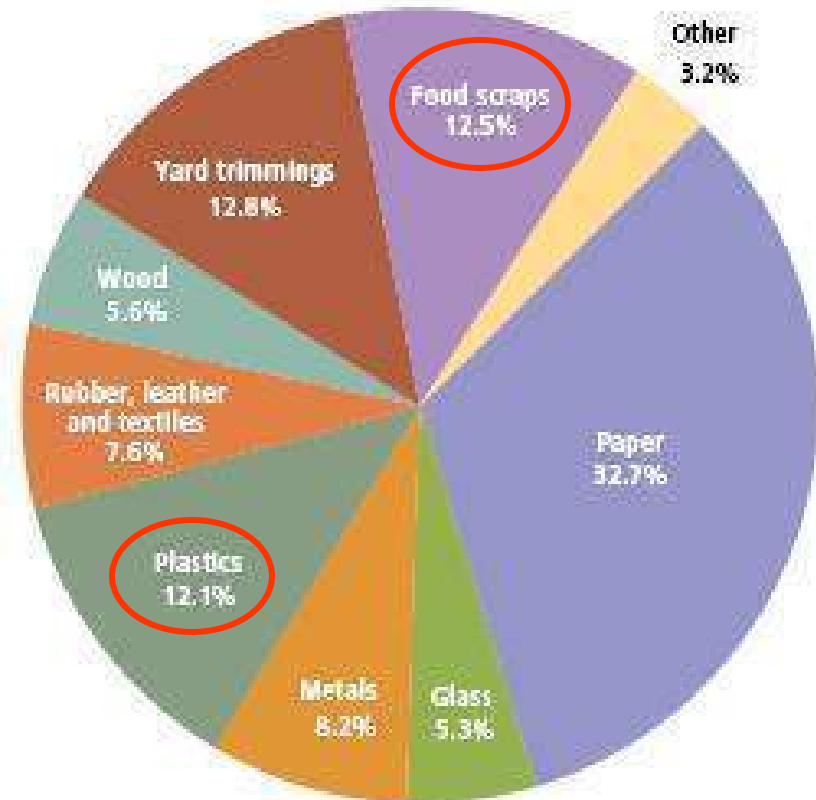




**43,000 tons of food are  
thrown  
out in the U.S. everyday.**



Figure 5. Total MSW Generation (by material), 2007  
254 Million Tons (before recycling)



**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)

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COMPOSTER

Food Waste Separator  
**Win/Win!**  
BROKER/DISTRIBUTOR

MANUFACTURER



**Which package is compostable?**

**A.**



**C.**

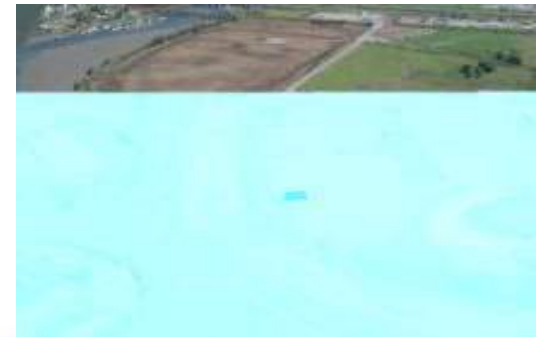
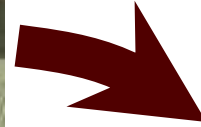


**B.**



**D.**





## 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.natureworkslc.com](http://www.natureworkslc.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!)**





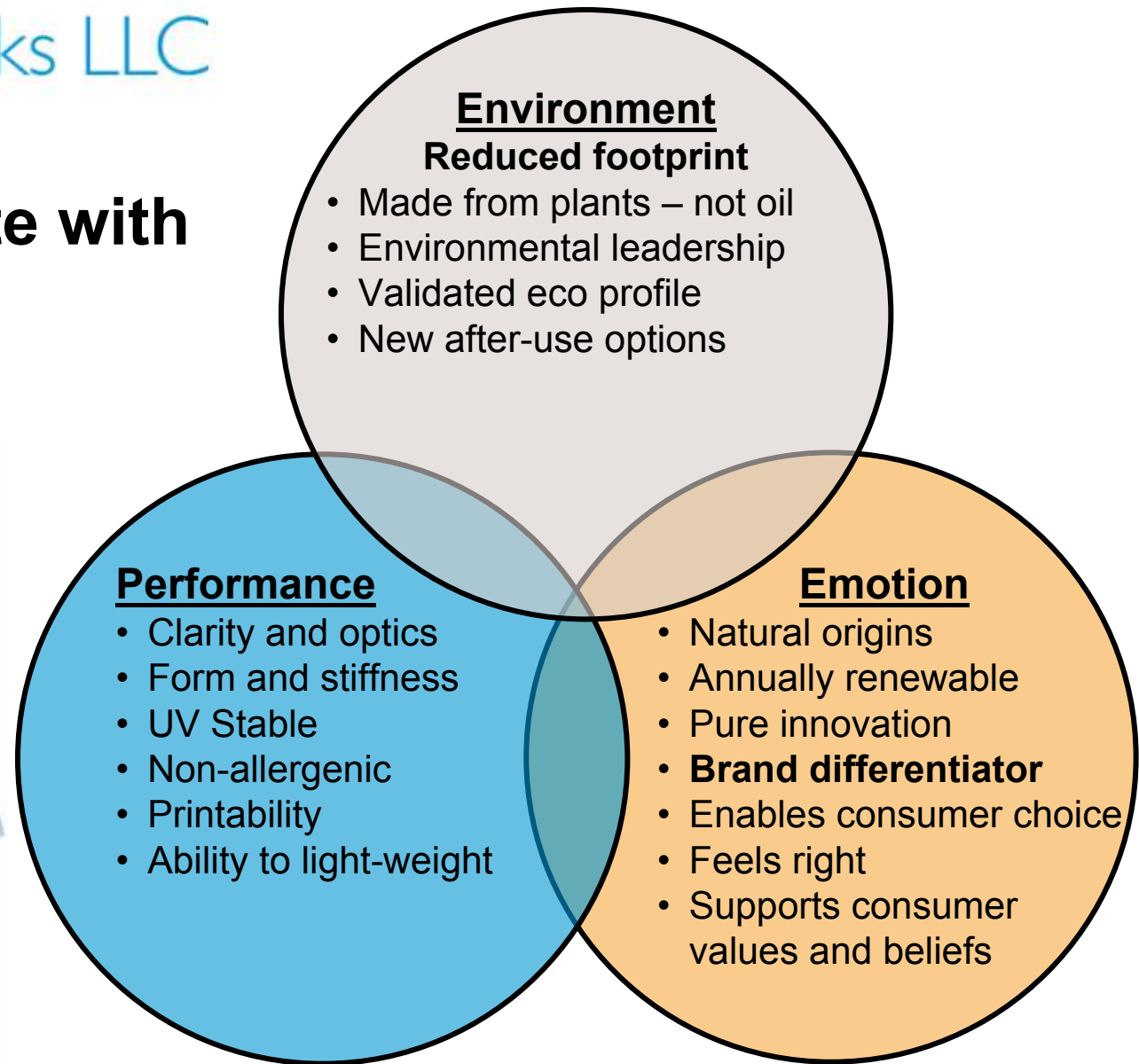
# NatureWorks LLC and Food Service Partners

- 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](http://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?





# Thank You!

[www.natureworksllc.com](http://www.natureworksllc.com)



