Product Sustainability

I'm green™ polyethylene

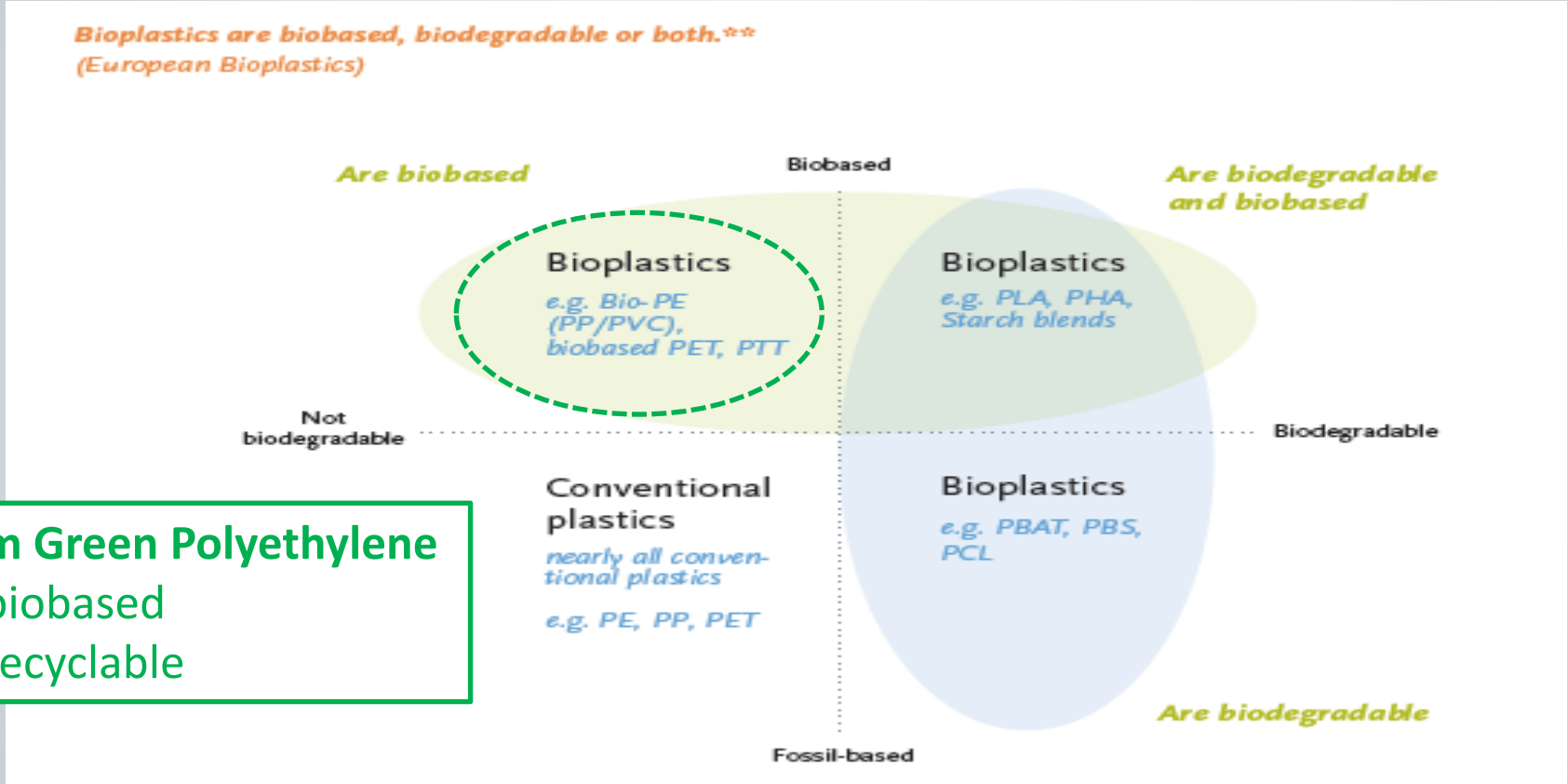
Beatriz Luz
Sustainability

July 2014

Agenda

- Brazilian Scenario
- Product Sustainability
  - Renewable feedstock
  - LCA
  - WFT and LUC
  - Recyclability
- Responsible sourcing
- Communication and education
- Key learning
- Conclusion

Biopolymers



I´m Green Polyethylene

- biobased
- recyclable

Market drivers

A dynamic industry growing at a rate of roughly 20 percent per year

european bioplastics

"Biopolymers is the **evolution of plastics** that will contribute significantly to a sustainable society."

"**IB is key to creating a low-carbon economy** and it provides a sustainable, commercially viable route out of over-dependence on fossil fuels and on financial services for economic growth."

Jonathon Porrit

forum for the future
action for a sustainable world

SBC
SUSTAINABLE BIOMATERIALS COLLABORATIVE

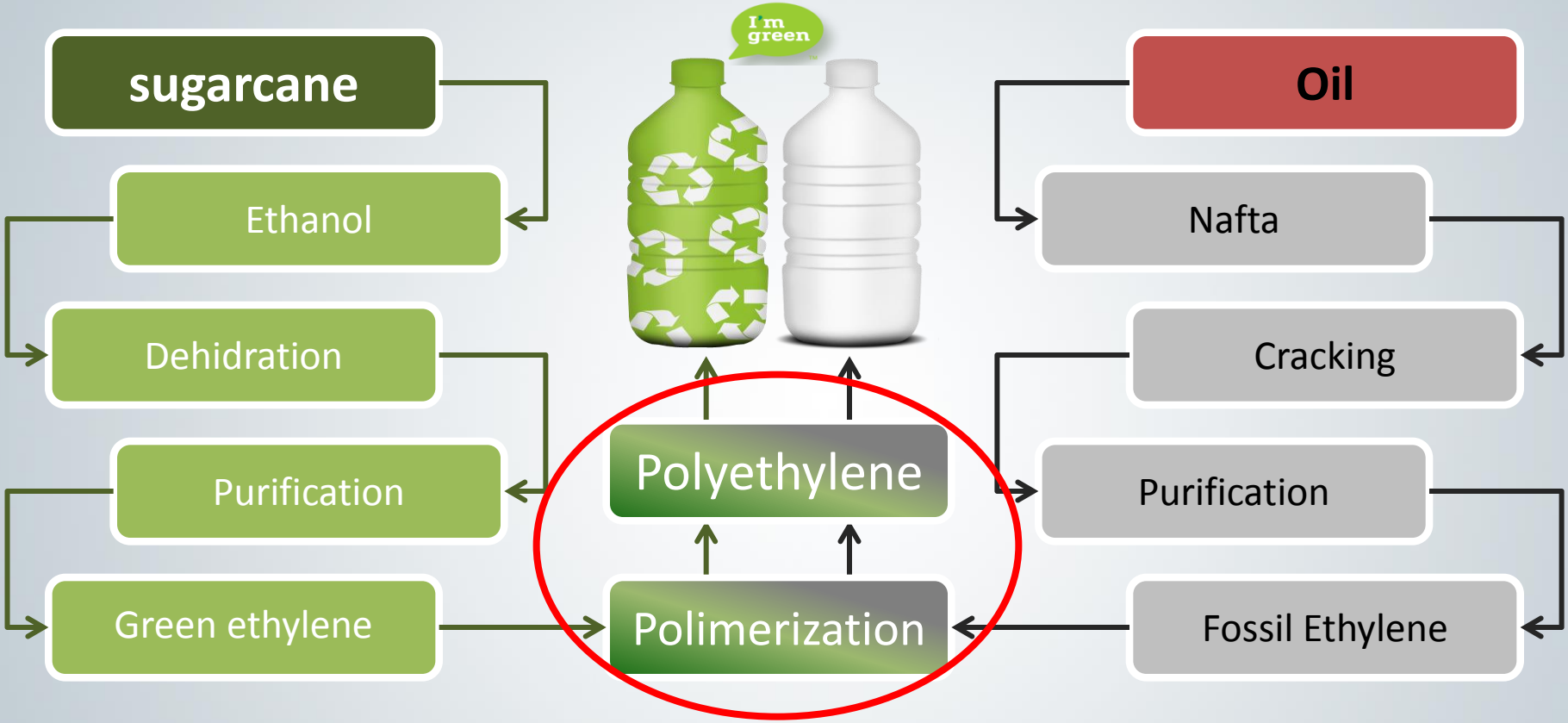
BioPreferred
www.biopreferred.gov

USDA United States Department of Agriculture
BioPreferred Program

USDA CERTIFIED BIOBASED PRODUCT
PRODUCT 57%
PACKAGE 32%

The **US Biobased Products Preferred Procurement Program** is **to increase the development, purchase and use of biobased products** through government procurement programmes and voluntary product certification and labeling for consumers.

Green Polyethylene x Fossil Polyethylene



Technology: The production route for green polyethylene and the fossil polyethylene are exactly the same, therefore the green polymer has got the same characteristics, quality and properties than the fossil equivalent.

How do we define product sustainability?

If the green Economy is to bring the necessary changes to guarantee a future for Life on Earth, decision making on sustainable products, investmente, and policies must be made using Life Cycle Thinking and operationalized through life cycle management, approaches and tools.

Life Cycle Initiative

CEBDS

SETAC

UNEP

Vision 2050: LCA will become the main tool to define product sustainability

Building the Single Market for Green Products

European Commission

PLASTICS RECYCLERS EUROPE

RecyClass

Eco-design, design for recycling, RecyClass, circular economy, new business models ...

ELLEN MACARTHUR FOUNDATION
Rethink the future

Agenda

- **Brazilian Scenario**
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    - Renewable feedstock
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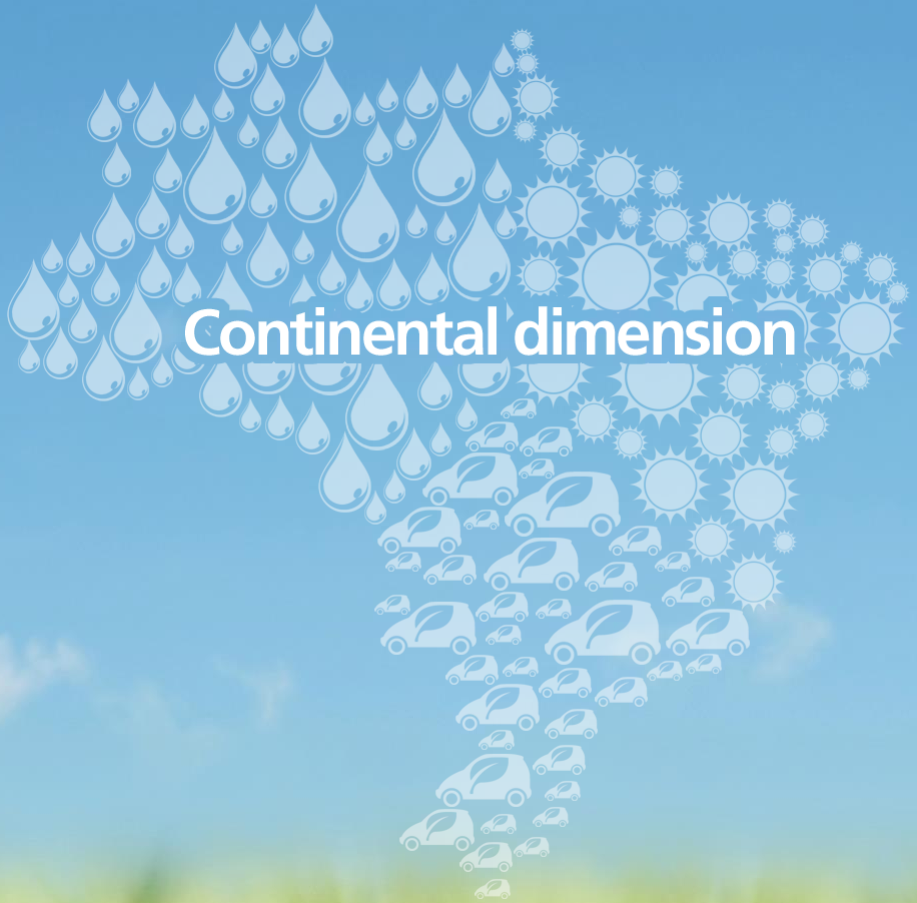
Brazilian Scenario

Favorable aspects for the development of biopolymers



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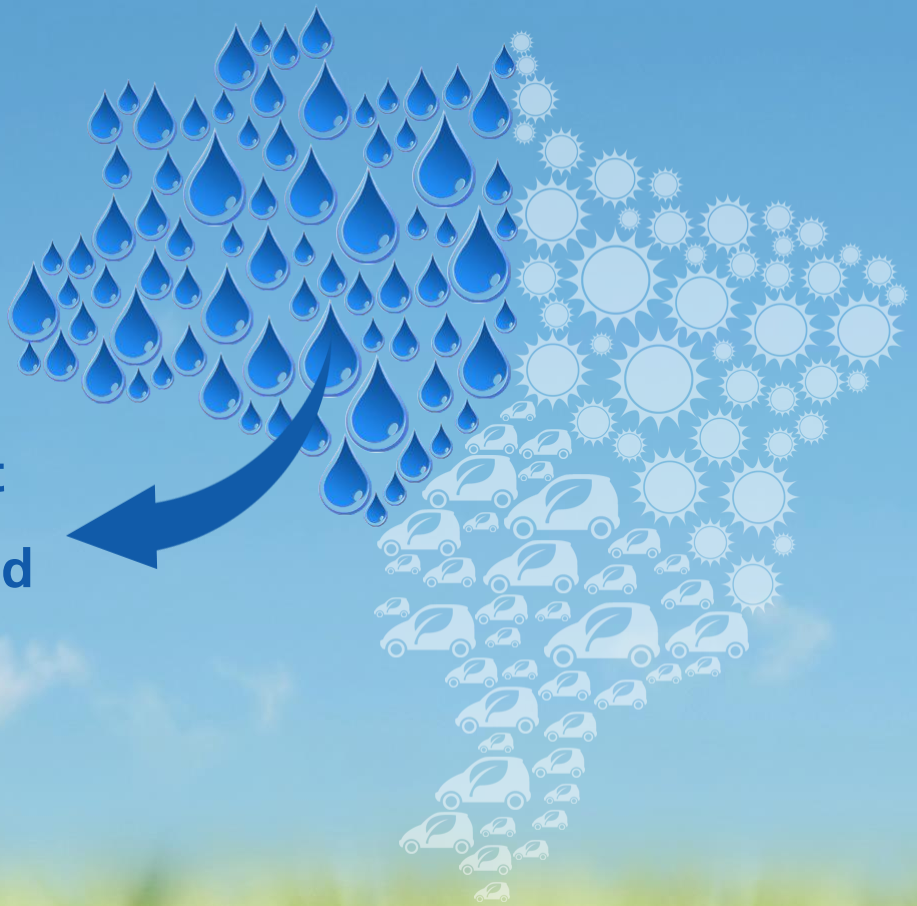
Brazilian Scenario

Favorable aspects for the development of biopolymers



The largest watershed in the world

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Brazilian Scenario

Favorable aspects for the development of biopolymers

Intense solar radiation and climate diversification

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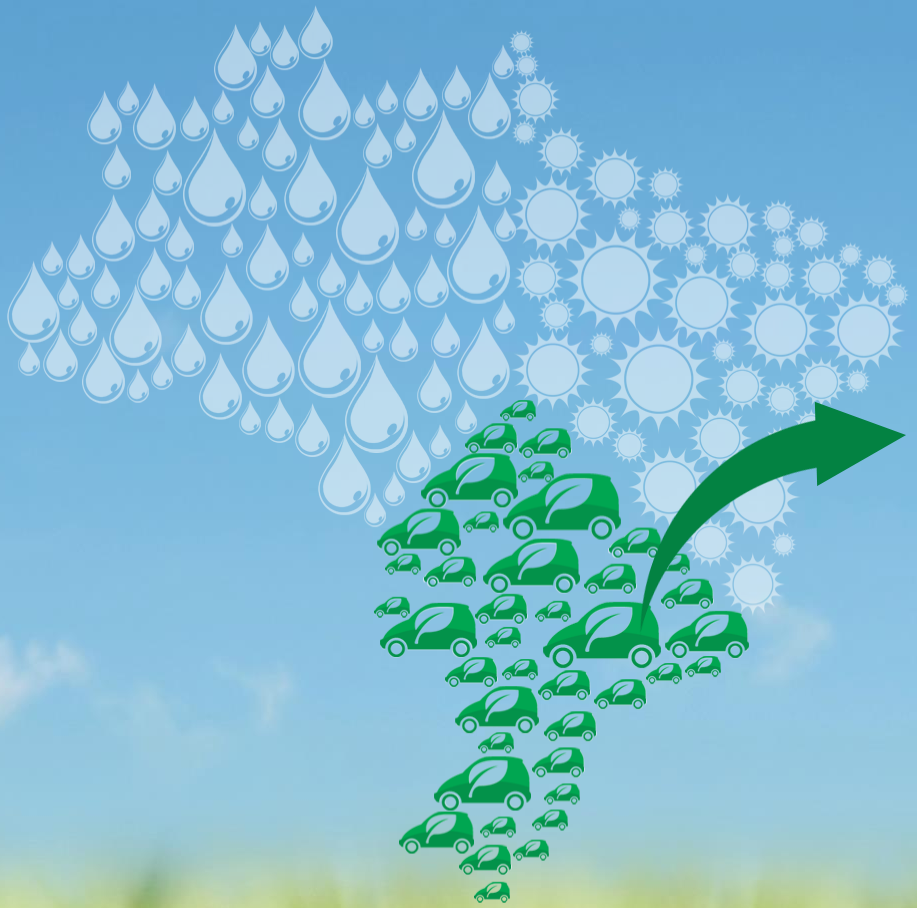
Brazilian Scenario

Favorable aspects for the development of biopolymers



Pioneer in research and development of biofuels

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The product sustainability journey

July 2007
Preliminary investigation

environmental assessment based on secondary data

PHASE 0

September 2010
Plant start up

Code of conduct established

Biobased carbon verification

PHASE 1

99% biobased content verified by ASTM D6866

April 2011
Product validation

Product certified by Vinçotte

PHASE 2

October 2013
Environmental Assessment

LCA, WFT, LUC

Primary data

Key suppliers

Critically reviewed

ISO 14040

PHASE 3

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Agenda

Brazilian Scenario

- Product Sustainability
  - Renewable feedstock
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  - WFT and LUC
  - Recyclability

Responsible sourcing

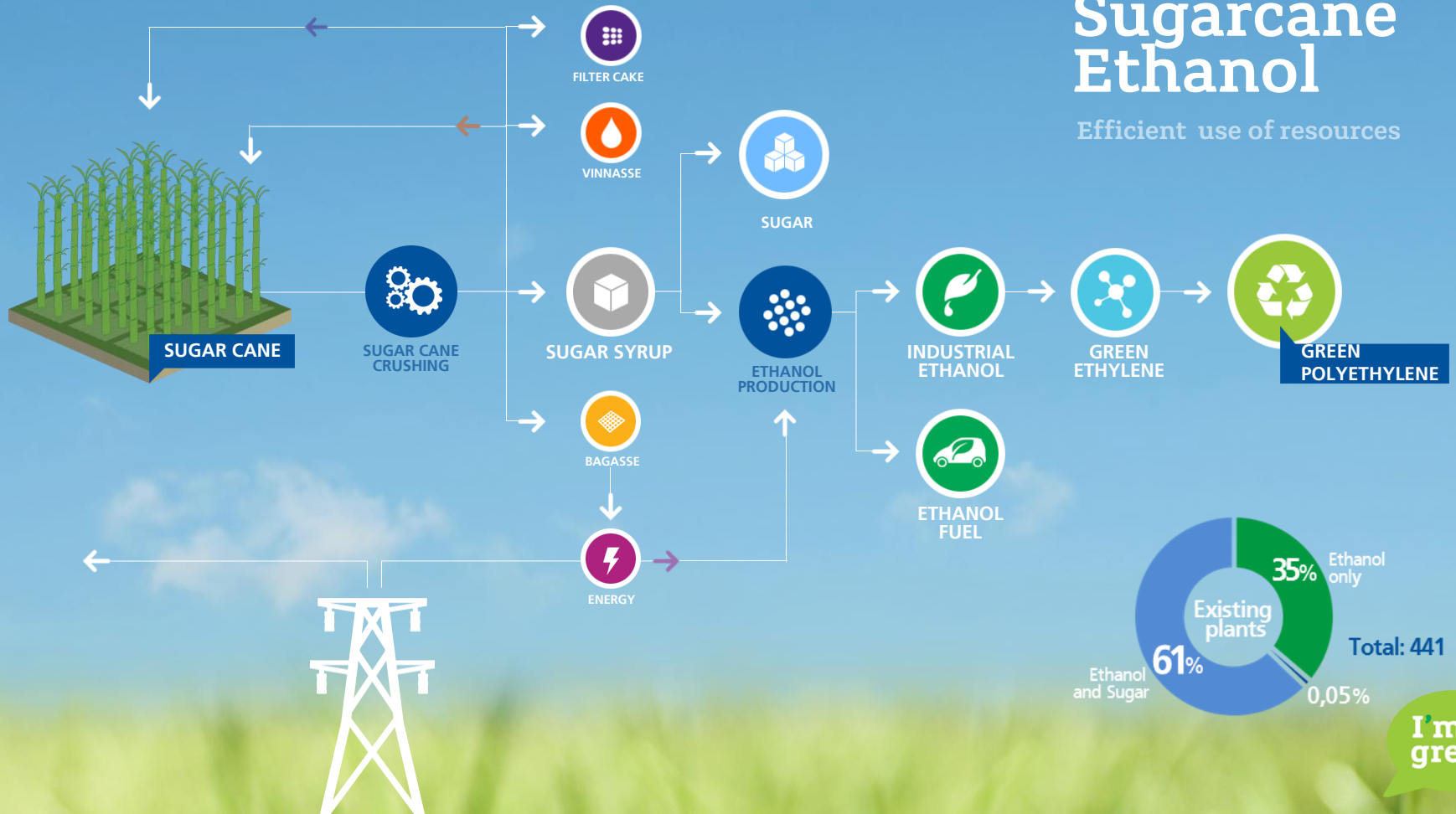
Communication and education

Key learning

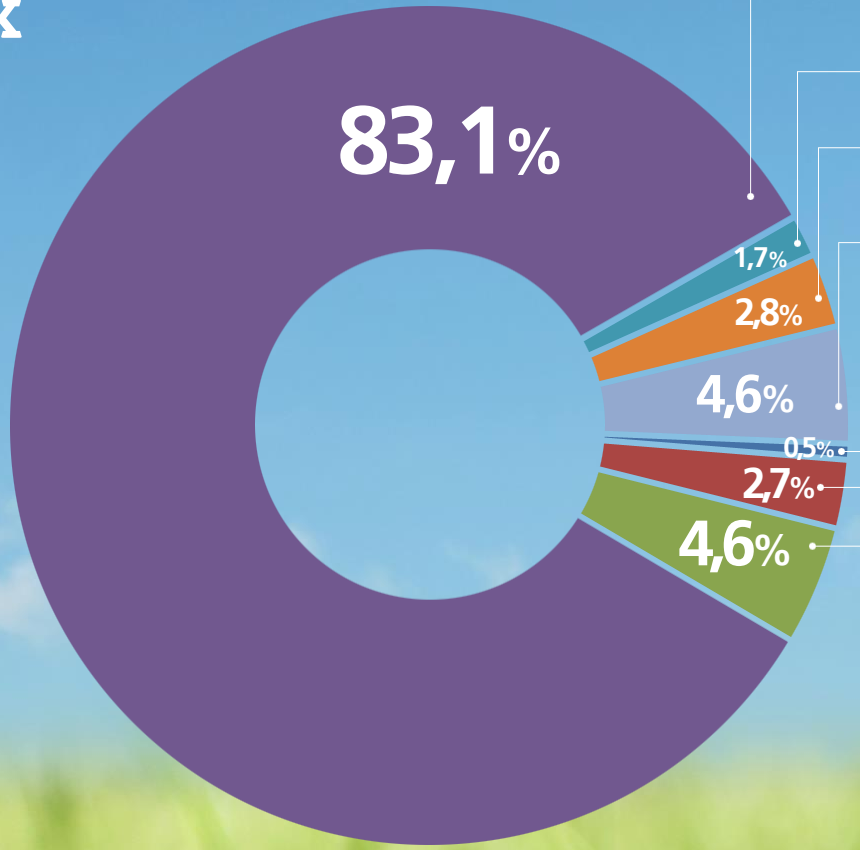
Conclusion

Sugarcane Ethanol

Efficient use of resources



Brazilian Electricity Matrix



- Hydropower
- Hard coal
- Oil, Petroleum based
- Natural gas
- Wind
- Nuclear
- Bagasse: the same contribuition as natural gas

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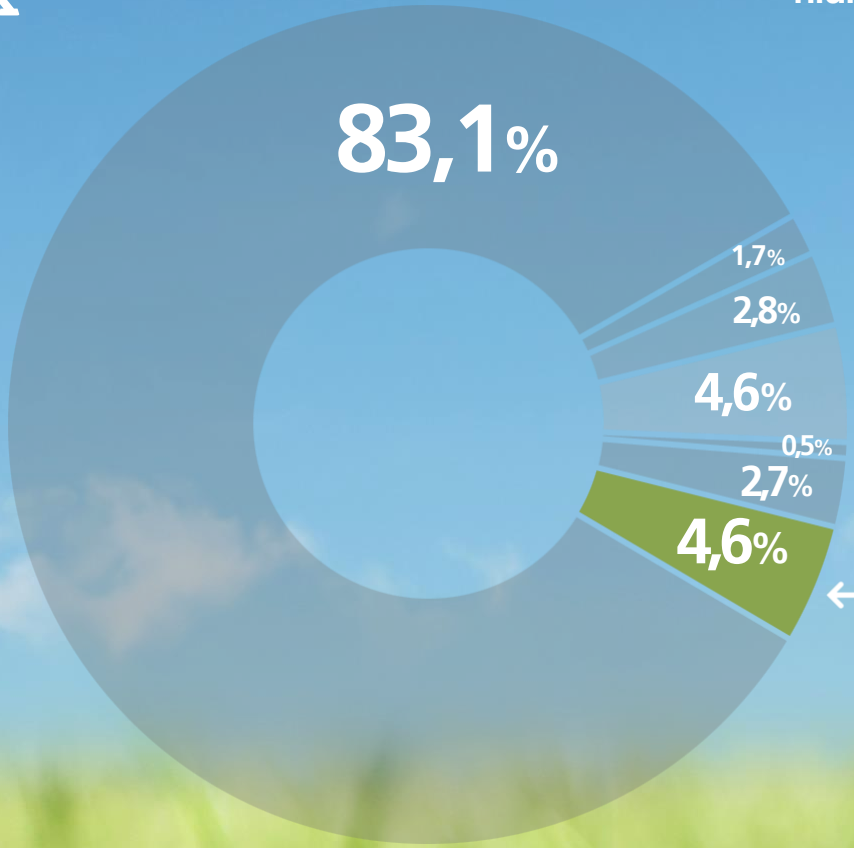
Brazilian Electricity Matrix

The sugarcane harvesting happens during the dry season when water reservoirs for hidropower electricity is low.



- Bio-electricity from bagasse is essential for the Brazilian Energy Matrix
- Energy Credits: replacement for natural gas
- Economic factor: export additional electricity to the grid generate additional revenue

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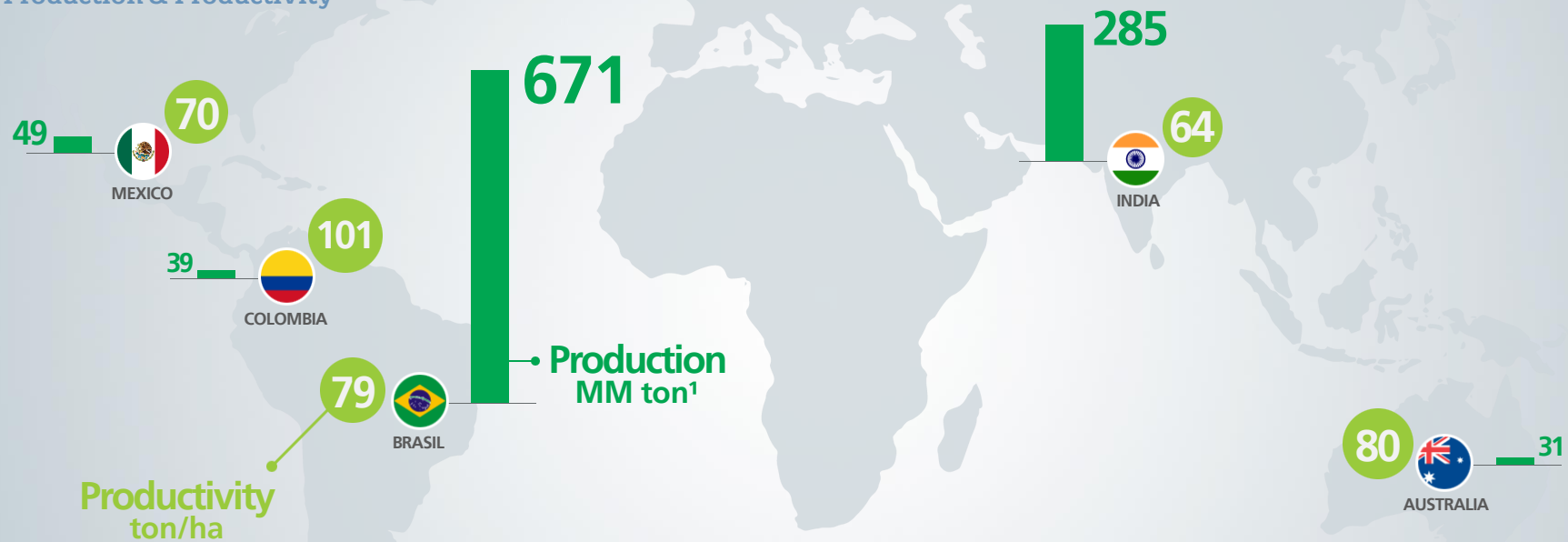
Sugarcane Ethanol

Production & Productivity



Reference: FAO STAT, Crystalsev; Sindpeças; Global Insight; Bear Stearns; McKinsey analysis, UNICA, Raizen

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Land Usage

Significant potential for sustainable growth

Total Area
851.48
Millions of hectares

Arable Land
329.94 (39%)

0,02% Braskem

Sugar Cane
8.14
(2.4%)
50% Sugar
50% Ethanol

Agriculture
51.7
(16%)

Pasture
158.75
(48%)

Available
111.34
(33%)

Other
25.92 (3%)

Protected/ Native
554(58%)

Braskem's capacity of I'm green™ polyethylene production: 200 kton/year

460 millions liters of Ethanol = approx. 68 thousand hectares

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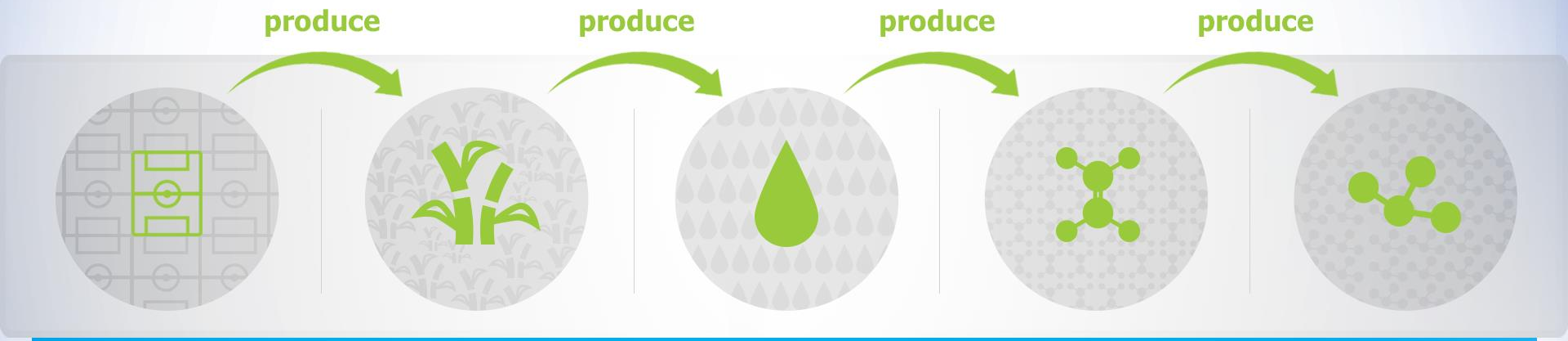
Land use: from sugarcane to I'm green™ polyethylene



1 hectare of land	**77** tons of Sugarcane	**6700** liters of Ethanol(1)	**3** tons of Green Ethylene(2)	**3** tons of I'm Green™ Polyethylene(2)

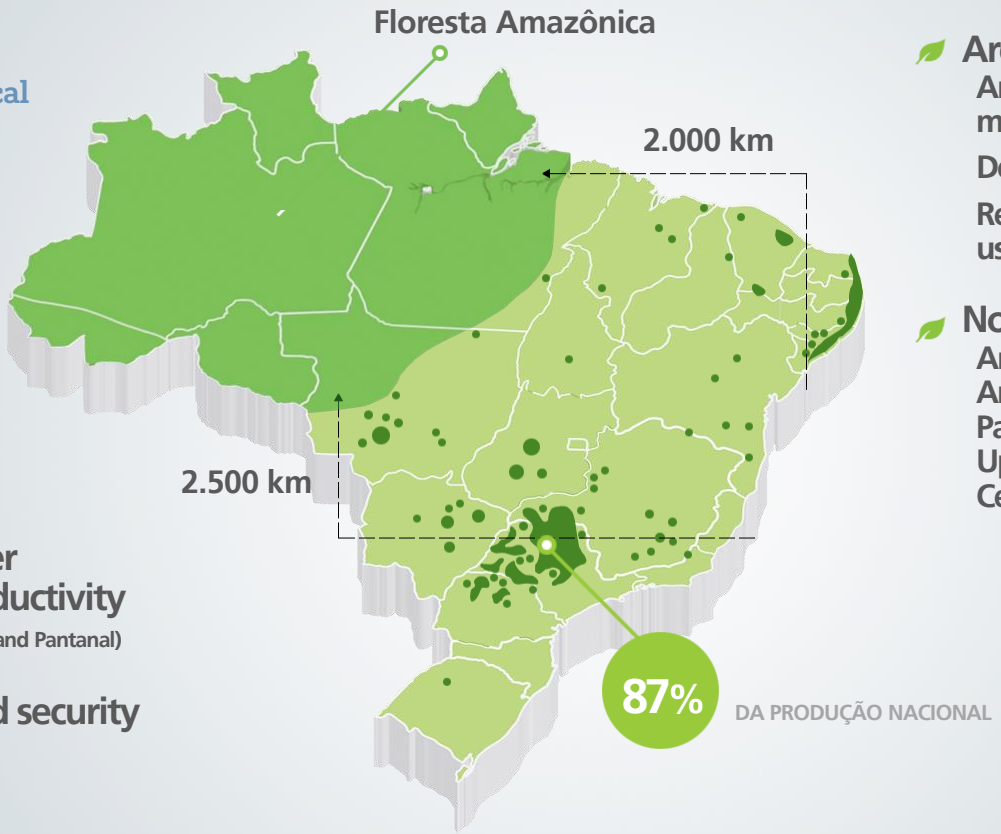
<2,0% of Brazilian ethanol production ← Braskem → 0,02% of Brazilian arable land

(1) NIPE/UNICAMP/UNICA
(2) Braskem's project data

Braskem

Sugarcane Ethanol

Brazilian Agroecological Zoning Programme



- **Areas for sugarcane expansion:**
  - Areas with proper conditions for mechanical harvesting
  - Degraded pasture land
  - Regions with lower need for water usage in production
- **No sugarcane expansion**
  - Areas with sensitive ecosystems
  - Amazon Forest
  - Pantanal Wetlands
  - Upper Paraguay river basin
  - Cerrado areas

- **Soil and weather condition = productivity**
  (no expansion to Amazon and Pantanal)
- **Respect for food security**

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Sugarcane Ethanol

Vinçotte - French certification

- The renewable content is validated through the C-14 test – Beta analytics. BETA
- Star system based on % of renewable content
- Green polyethylene got a 4 start rating indicating more than 80% renewable content

OK biobased VINÇOTTE	OK biobased VINÇOTTE	OK biobased VINÇOTTE	OK biobased VINÇOTTE
between 20 and 40 % Biobased	between 40 and 60 % Biobased	between 60 and 80 % Biobased	more than 80 % Biobased

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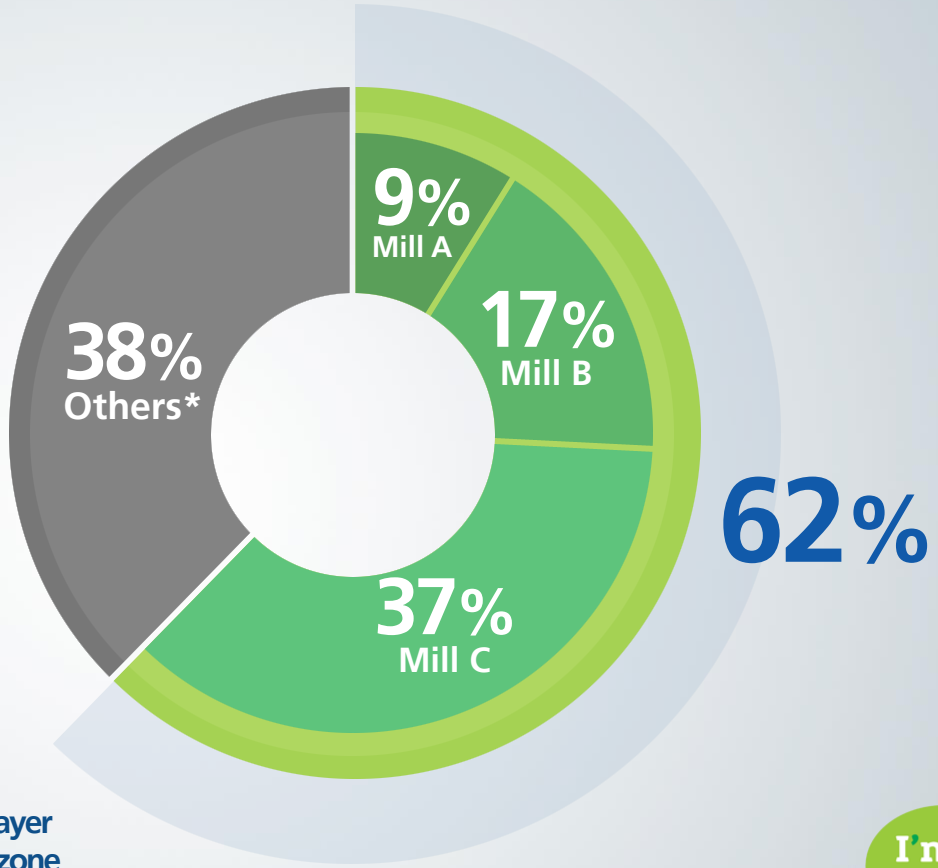
Life Cycle Analysis

Study Premisses

- **Functional Unit::** 1 kg of resin
- **Boundary:** cradle to gate
- **Data coverage – Brazilian Scenario**
  3 ethanol suppliers + Centre-South Average (Jan a March 2012)
  Green PE Plant (Feb, March and April 2012)
- **Software:** SimaPro
- **Method**
  CML 2001
  Substitution credit methodology – system expansion

6 Impact categories: GWP, Fossil energy demand, Ozone layer depletion, Eutrophication, Acidification, Photochemical Ozone Potential + Water Footprint and LUC



*Brazil Centre South dataset

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Life Cycle Analysis

The Base Case

"1 kg of Green HDPE (slurry process, average ethanol supply) when a substitution credits methodology is applied to the surplus electricity co-product and when CO2e credits for dLUC carbon storage on land and CO2 removal into the polymer resin are accounted for in the model".

The LCA Practitioners Team

Study prepared by:

E4tech

LCAworks

Brazilian experts:

UNICAMP

nipe Núcleo Interdisciplinar de Planejamento Energético

Critical Review Panel

Andreas Detzel (Chair - IFEU)

Martina Krueger (IFEU)

Ranami Narayan (Michigan State University)

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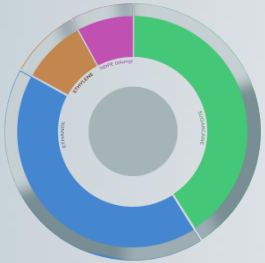
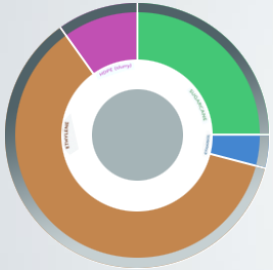
LCA
Main Impact Categories

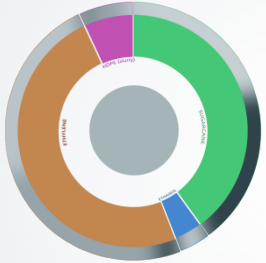
Impact by process stage



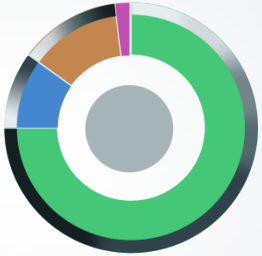
Global Warming Potential



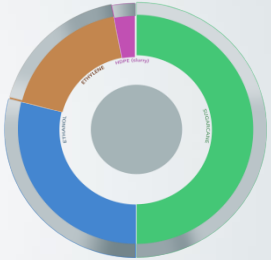
Fossil Energy Consumption



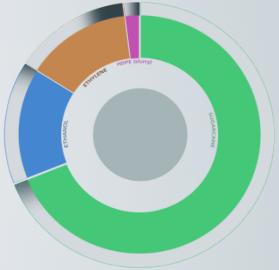
Ozone Layer Depletion Potential



Eutrophication Potential



Acidification Potential



Photochemical Ozone Creation Potential

Sugarcane Ethanol Green Ethylene HDPE

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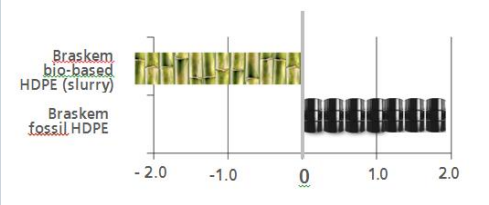
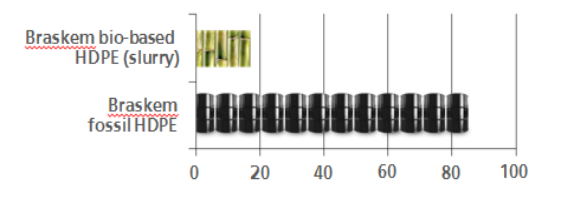
LCA
Main Impact Categories

Comparative view

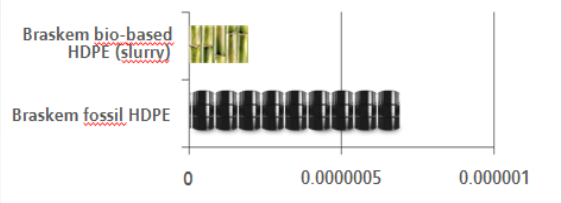
Global Warming Potential



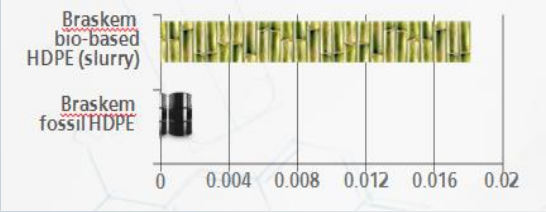
Fossil Energy Consumption



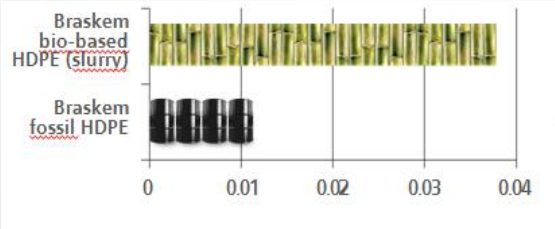
Ozone Layer Depletion Potential



Eutrophication Potential



Acidification Potential



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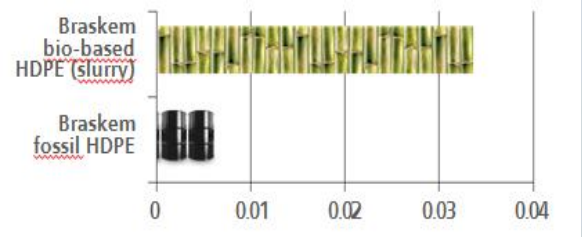

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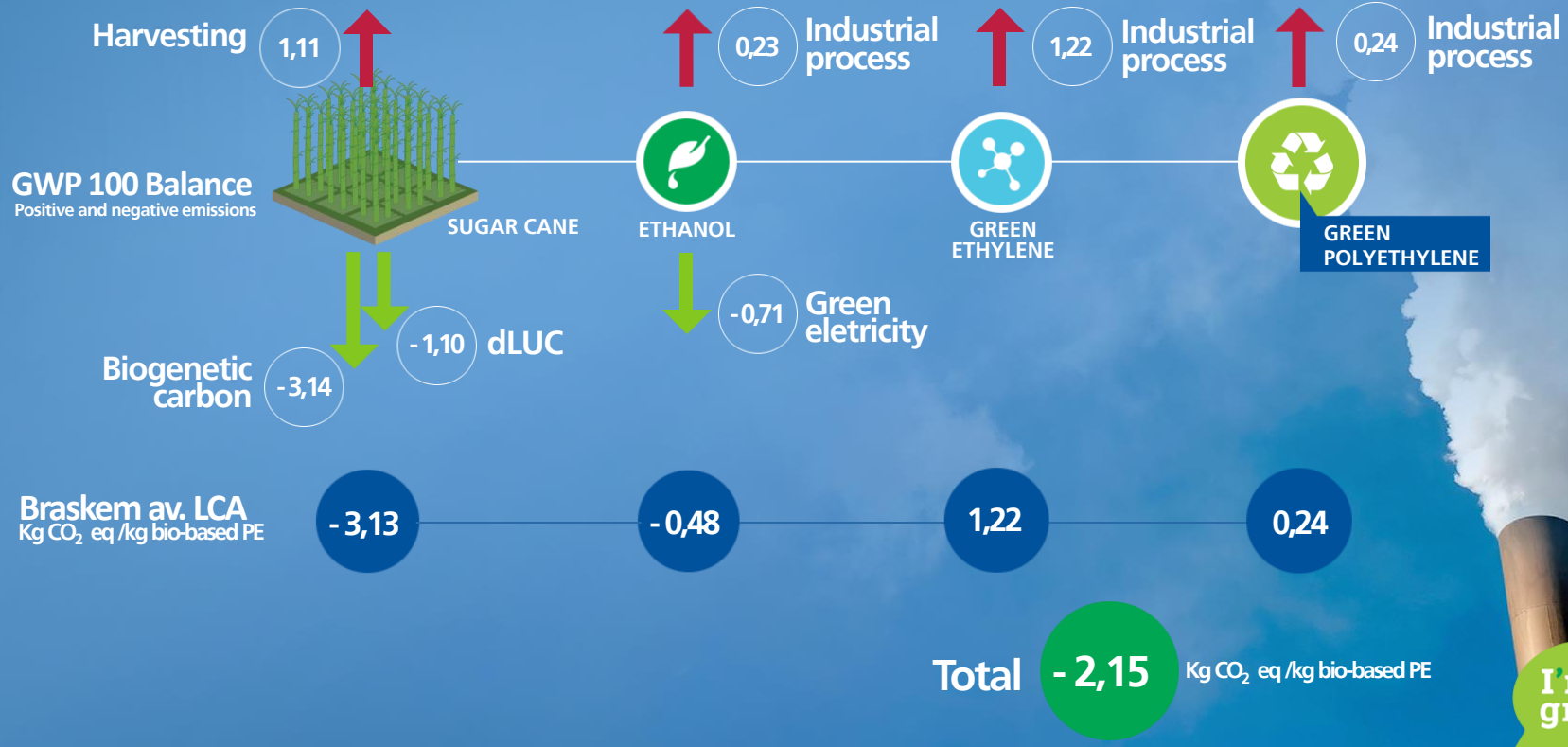
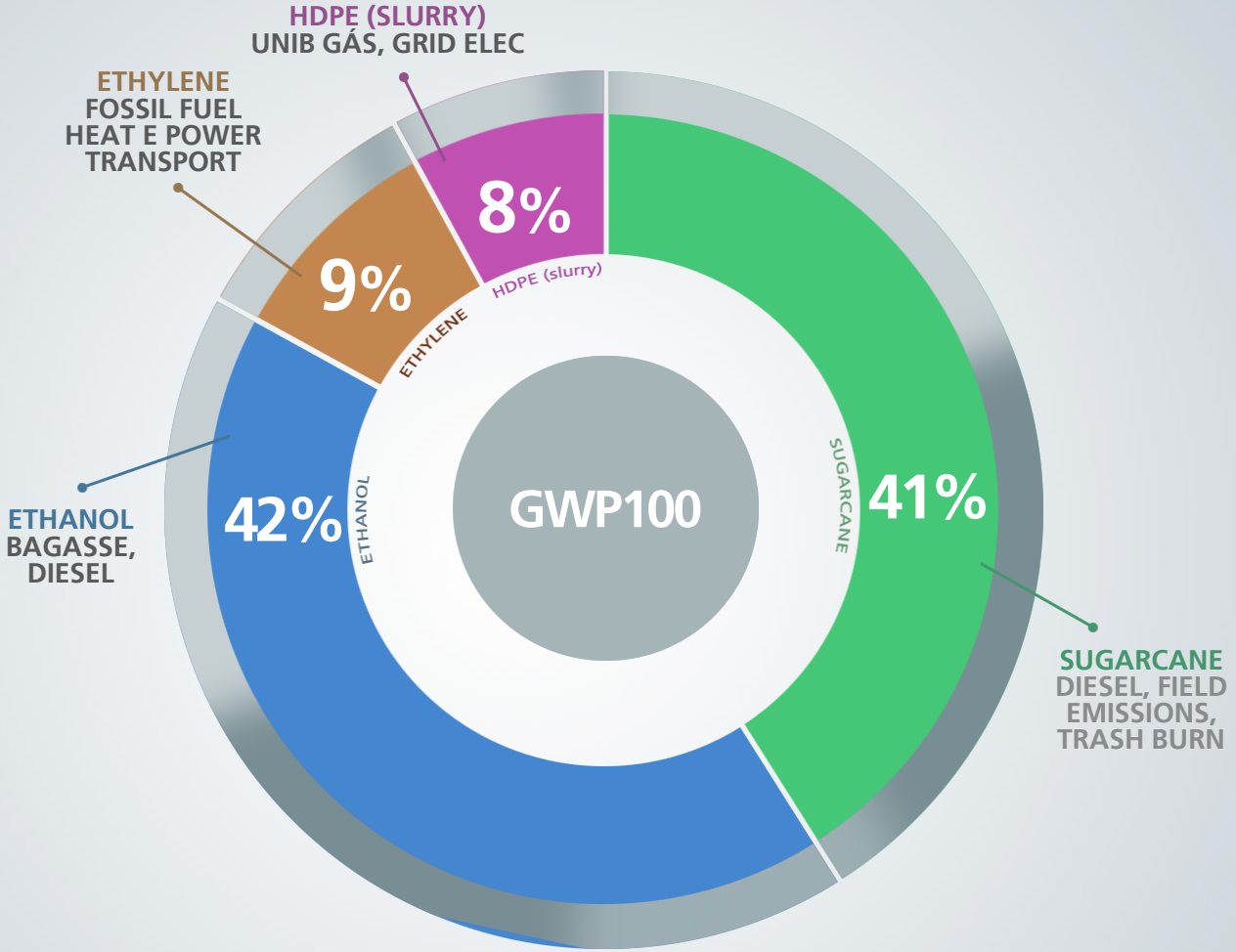
Global Warming Potential

LCA Results

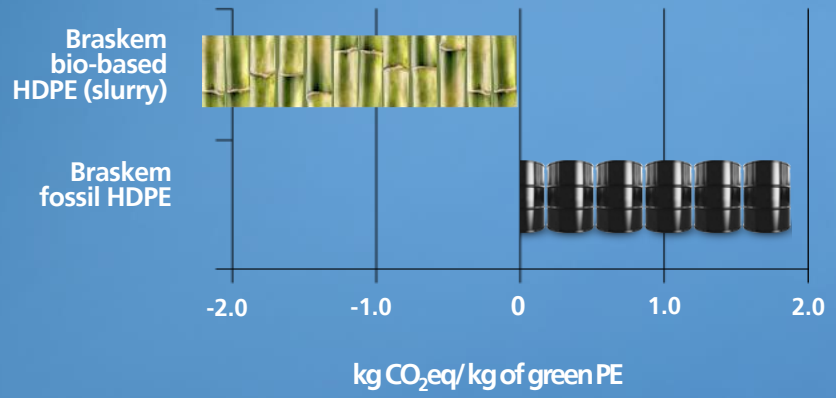


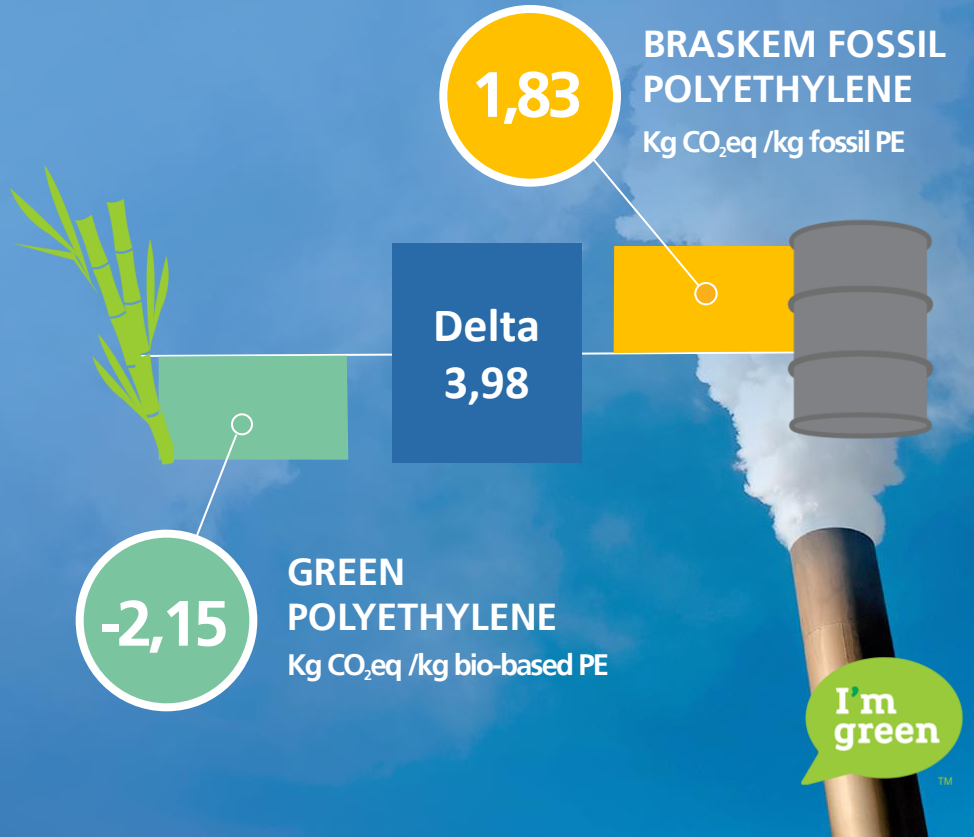
Global Warming Potential



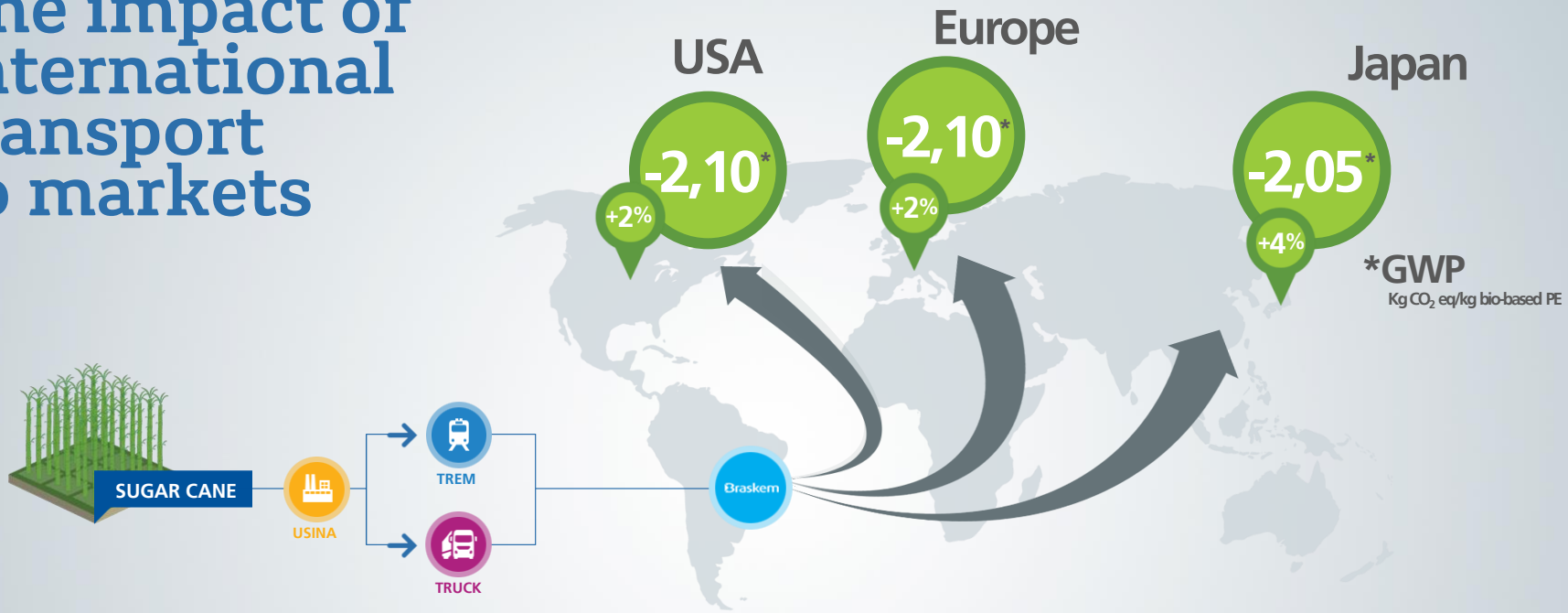
Global Warming Potential

Comparative view: Biobased x Fossil based





The impact of international transport to markets



The transport impact throught the life cycle accounts to **9%**

Brazil -2,15

The impact of international transport.

Kg CO_2 eq/kg bio-based PE

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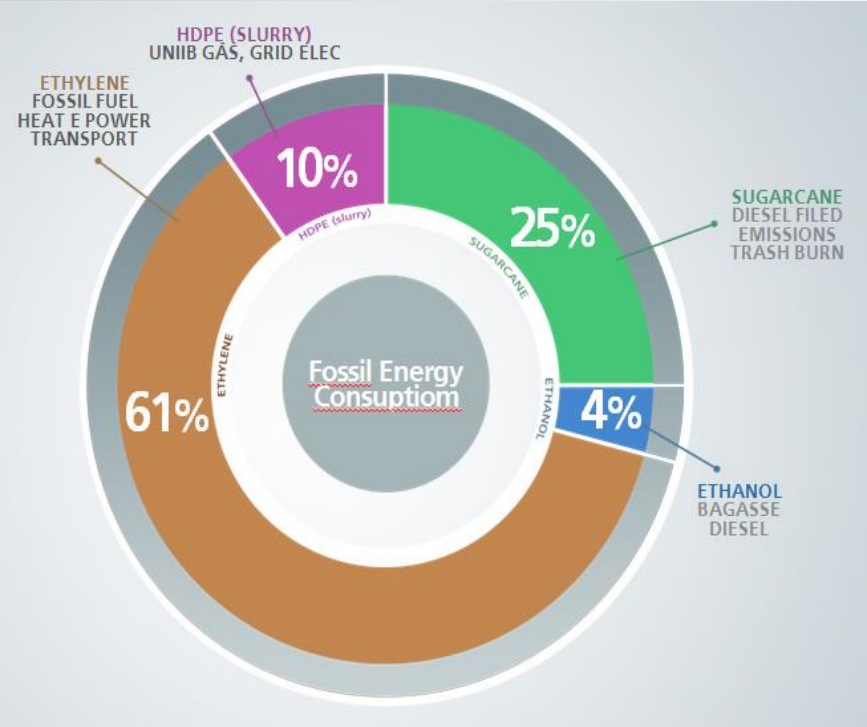
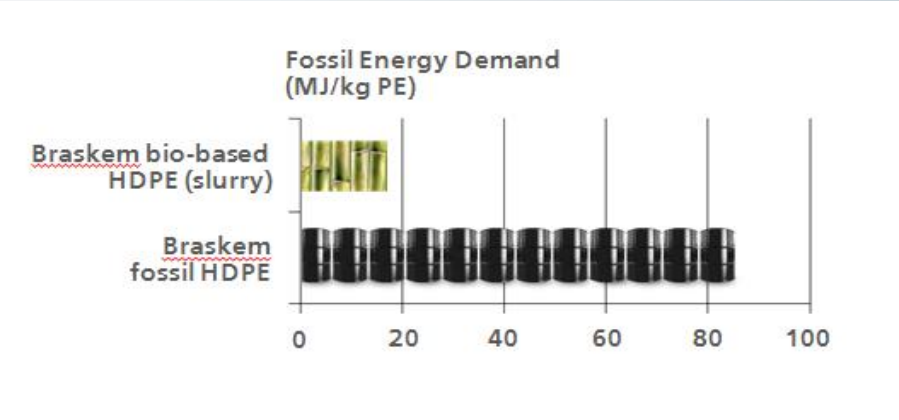
Fossil energy consumption





- Sugarcane ethanol generates bioelectricity contributing to reduce fossil energy demand
- More than 80% of energy used for green PE production is renewable energy

Water Footprint Accounting

Plantation & Mill

Green WFP
Rain water, plant intake

Direct
- Main component: evapotranspiration of sugarcane
- Vinasse and filter cake "recycling" relatively minor impact
- Note data gaps and non-linear relationship

Indirect
- Bio-diesel blend for field operations

Blue WFP
Production water, from rivers

Direct
- Processing of sugarcane in the mill (e.g. washing of cane, steam generation for processing)

Indirect
- Inputs such as biodiesel & grid electricity

Grey WFP
Water needed to dilute effluent

Direct
- Phosphorus, nitrogen, potassium from fertilisers

Indirect
- Only data for biodiesel available

Allocation
Ethanol & electricity exported to the grid by the mills

Data provided by: ETH Bioenergia, Tarumã and GASA operated by Raízen (Cosan) located in the west of São Paulo State, within the catchment area of the **Paraná Basin**.

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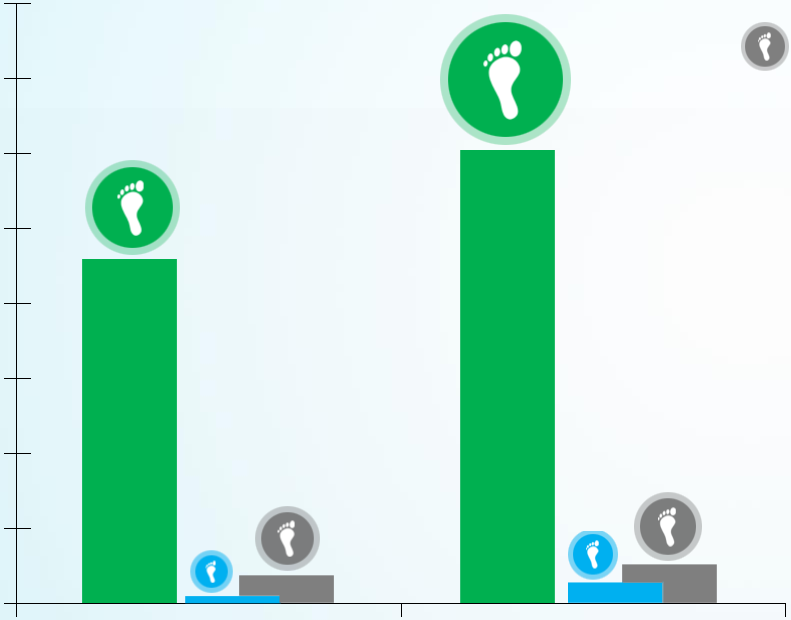
Water Footprint

Green (data from Cabral et al., 2012)

Blue

Grey



Water for industrial use Blue

1992
5m³/ ton. cane crushed

2007/ 2008
1,89 m³/ ton. cane crushed

2009/2010
1,49 m³/ ton. cane crushed

2012
Our study = 1,10 m³/ ton. cane crushed

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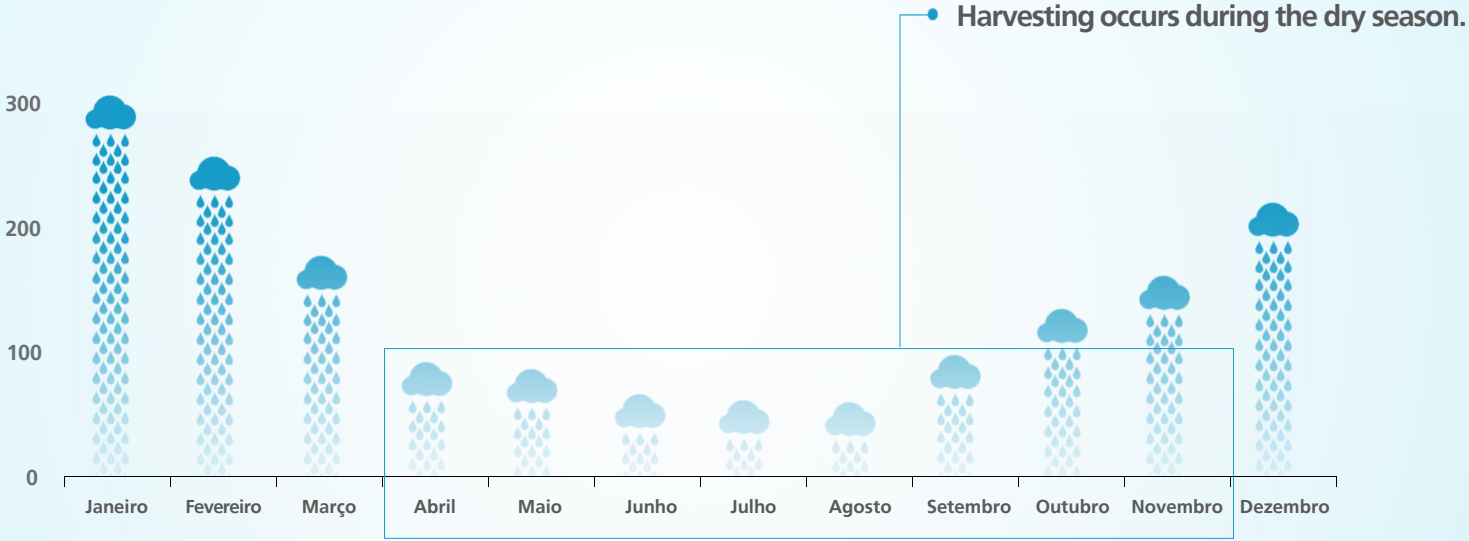
Water Sustainability

Annual precipitation data



Annual Precipitation Data

(Average 1993 – 2009)

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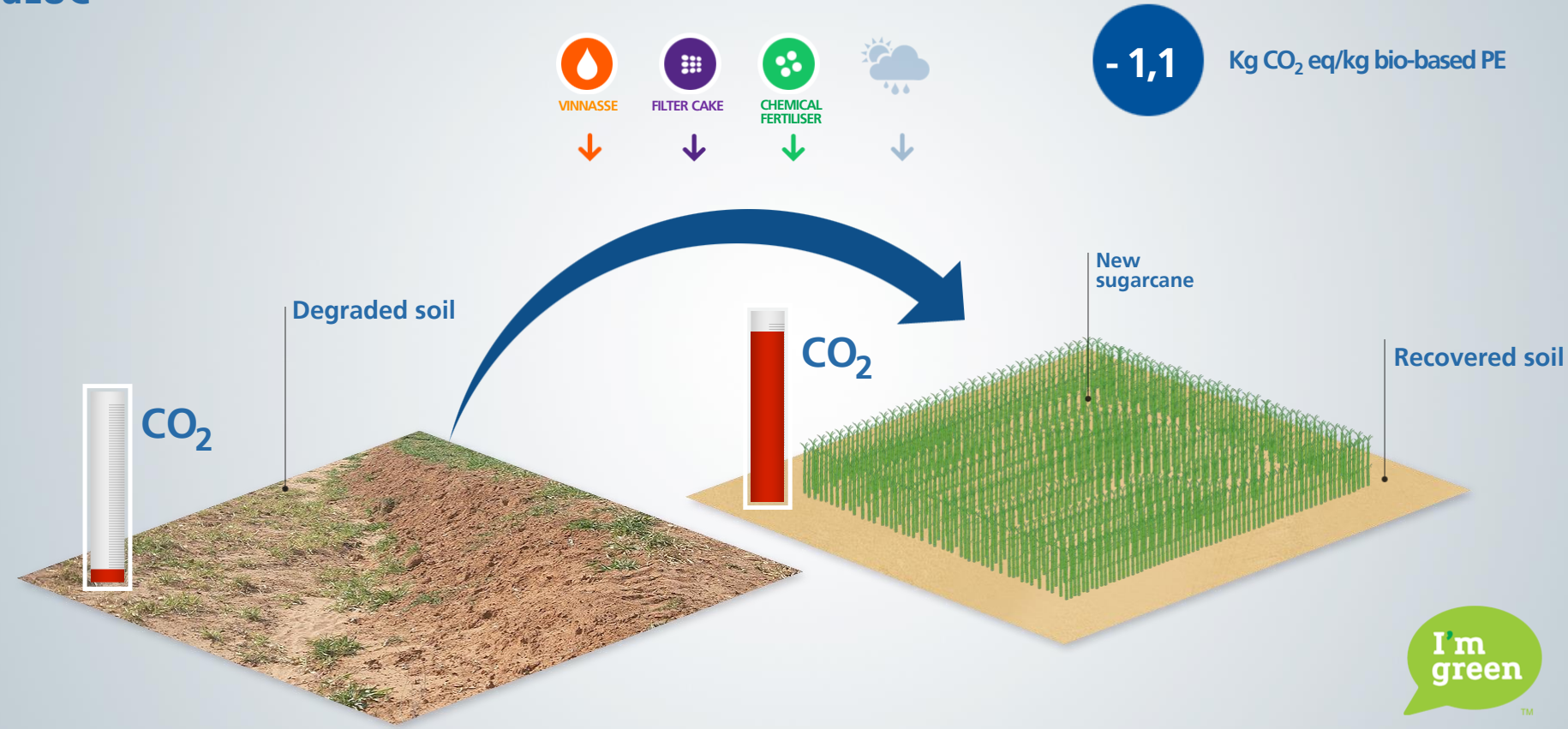
Land use change

dLUC



Product Reciclability

End of life – Closed Loop

- I'm green™ polyethylene is 100% recyclable. It can be disposed on the existing recycling schemes for traditional PE
- I'm green™ polyethylene can generate bio-electricity if send to EfW plants

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Agenda

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- Product Sustainability
  - Renewable feedstock
  - LCA
  - WFT and LUC
  - Recyclability
- **Responsible sourcing**
- Communication and education
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Responsible Sourcing

Code of conduct for ethanol suppliers

The 5 pilars

1. Reduction of Cane Burning
2. Conserving biodiversity
3. Good Environmental Practices
4. Respect for Human Rights
5. Life Cycle Assessment (LCA)

In line with Brazilian Legislation

Uso da Terra
Zonamento Ambiental

ETANOL verde
Federal Policy to reduce trash burning by 2017

Ambiente Agro
Protocolo Agro Ambiental

Compromisso Nacional
APERFEIÇOAR AS CONDIÇÕES DE TRABALHO NA CANA-DE-AÇÚCAR

Social

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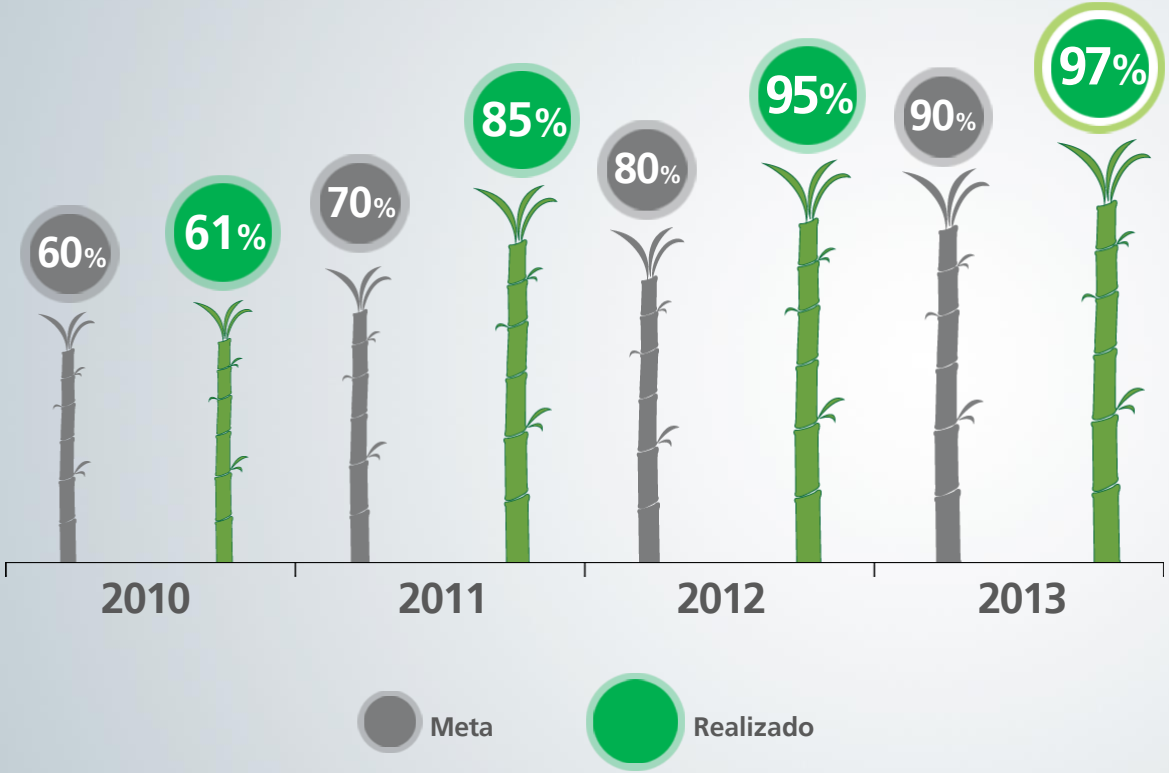
Responsible Sourcing

Managing the Code of Conduct



Guaranteed by a 3rd party support

3rd party auditing

Suppliers committed with a action plan for improvement

proforest

CONTROLUNION

Responsible Sourcing

NGO partnerships

- **WWF USA**
  - BFA – Biobased Feedstock Alliance
    "helping to build a more sustainable future for the bioplastics industry"
  - Brand Owners led initiative
  - Feedstock scorecard for risk management
  - Tailored pilot with Braskem supplier

BFA Methodology Scorecard
BRASKEM PILOT
September 2013

I'm green Plastic Renewable source Carbon reduction Braskem

Goal
An ideal bioplastic feedstock is one that:

1. Is legally sourced, conforms to UDHR and is produced in a safe and healthy way for workers and surrounding communities	Feedstock 1/Region			Feedstock 2/Region		
Indicator	Score	Total	% Met	Score	Total	% Met
Legal Production	8,31	64,31	92%		0	0%
Occupational Health & Safety	10					
Labor Rights	10					
Chemical Use: Nutrients & Pest Management	7,36					
Water Management	10					
Land Use Change Impacts	10					
Co-product and Waste Management	8,64					

2. Is one that is derived from renewable biomass whose production is sustainably managed	Feedstock 1/Region			Feedstock 2/Region		
Indicator	Score	Total	% Met	Score	Total	% Met
Cradle to Gate GHG	8,58	54,58	91%		0	0%
Land Use Change Impacts	10					
Chemical Use: Nutrients & Pest Management	7,36					
Soil Management	10					
Water Management	10					
Co-product and Waste Management	8,64					

3. Does not adversely impact food security or affordability and maintains or improves social and economic conditions along with ecosystem services in producing communities**	Feedstock 1/Region			Feedstock 2/Region		
Indicator	Score	Total	% Met	Score	Total	% Met
Food Security/Affordability	10	50	100%		0	0%
Local & Indigenous Communities	10					
Water Management	10					
Soil Management	10					
Ecosystem Services	10					

4. Does not result in destruction of critical ecosystems, loss of HCV habitats or deforestation	Feedstock 1/Region			Feedstock 2/Region		
Indicator	Score	Total	% Met	Score	Total	% Met
Biodiversity	8,03	63,97	91%		0	0%
Cradle to Gate GHG	8,58					
Land Use Change Impacts	10					
Chemical Use: Nutrients & Pest Management	7,36					
Soil Management	10					
Water Management	10					
Local & Indigenous Communities	10					

5. Provides tangible environmental benefits with minimal environmental impacts* **	Feedstock 1/Region			Feedstock 2/Region		
Indicator	Score	Total	% Met	Score	Total	% Met
Biodiversity	8,03	62,61	89%		0	0%
Cradle to Gate GHG	8,58					
Land Use Change Impacts	10					
Chemical Use: Nutrients & Pest Management	7,36					
Soil Management	10					
Water Management	10					
Co-product and Waste Management	8,64					

Water Footprint Data	Blue	Green	Grey
Feedstock 1/Region			
Feedstock 2/Region			

Solidaridad

- **Solidaridad**
  - Solidaridad Global Farmer Support Programme (FSP) - emerging countries focus
  - Sugarcane supply chain engagement: farmers, ethanol mills, Braskem and its clients
  - Increase awareness about sustainability and promote transparency in the sector
  - Development of tools to promote sustainable practices in the farms, to support the improvement in the field and to monitor progress

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Agenda

- Brazilian Scenario
- Product Sustainability
  - Renewable feedstock
  - LCA
  - WFP and LUC
  - Recyclability
- Responsible sourcing
- **Communication and education**
- Key learnings
- Conclusion

Communication And Education

I´m green ™: applied to indicate % of renewable content

Agenda

- Brazilian Scenario
- Product Sustainability
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- **Key learnings**
- Conclusion

Key Learnings

- LCA is an essential tool to measure product sustainability
- Data gaps still exists - the best available information has been used.
- Identification of hot spots for continuous improvement
- The full picture: Understanding the value chain
- Study transparency: Methodologies and premises must be clearly stated

Agenda

- Brazilian Scenario
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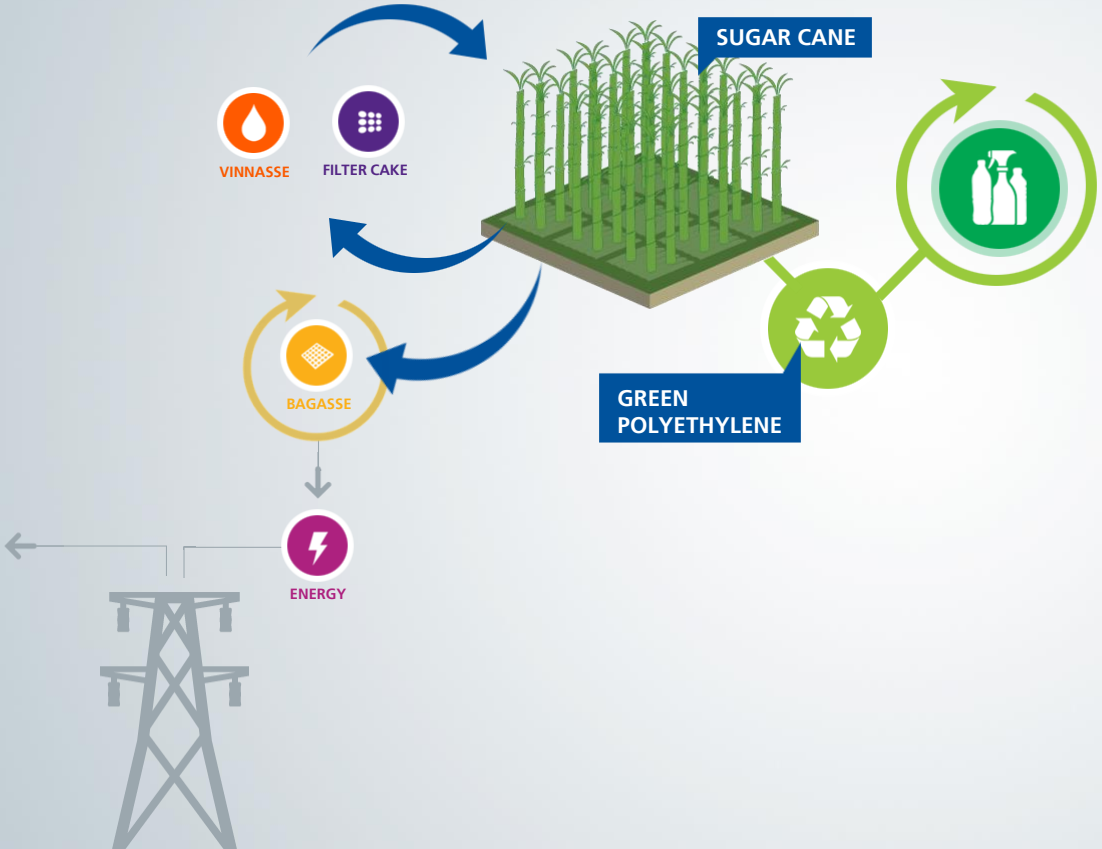
  - WFT and LUC
  - Recyclability
- Responsible sourcing
- Communication and education
- Key learnings
- ▸ **Conclusion**

Conclusion



- Life cycle thinking and the circular economy
- Responsible claims – LCA based communication
- Sustainable sourcing – co-responsibility avoiding burden shift. Add value.
- Continuous improvement at the Green Ethylene plant
- Working with clients for product development and understanding the value proposition

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South America Applications

Tetra Park
Coating/Beverages
Cartons

Estrela
Pieces / Toy
Banco Imobiliário (monopoly)

Grupo Raymundo da Fonte

Embalixo
Raymundo da Fonte/ Brilux
Trash Bags

Pilecco
Technical bobin/Food
Arroz Grãos Nobres

SURYA Brasil

Surya
Flexible Tubes/Personal Care
Sapien Women

Adimax
Pet Food
Magnus Eco
Fórmula Natural

NobelPack
NobelPack
Durable bags
Retailers:Cacau Show
Ofner
Marisa
Spicy
Centauro
Others

BASF
The Chemical Company

BASF agrochemical
Container/Agribussines
Regent

Tetra Pak
Caps / Beverage
Ninho (Nestlè)

Braskem

South America Applications

Walmart
Bom Preço
Trash Bags

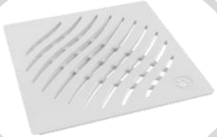
Zafari
T-Shirt bags
Bags for Zafari supermarket

Panvel
Flexible Tubes/ Personal Care
Vert

Acinplas
Star Bags/Retailing
Bags for vegetables

Johnson & Johnson
Bottles/Personal Care
Sundown

Kimberly Clark
Packaging for toilet paper/Personal Care
Neve



Tigre
Grid
Eco Tigre

Natura
Bottles/Personal Care
Ekos
TodoDia

Ipiranga
Packaging for oil lubricant
Ipiranga F1 Master Performance

MSA
Helmet
V-Gard

Prysmian
Wires and Cables
Afumex Green

Braskem

South America Applications

Faber Castell
Case for pencils

Luvex
Bottles/Personal Care
Sunscreen as a protective equipment

FMC Agricultural Products
Container/ Agricbussines
Boral

Eletrolux
Appliance for washing machines
Ecologic

Coca Cola
Coating/Beverages
Del Valle

La Papelera del Plata
Packaging for kitchen paper
Sussex tendencia

Zandei
Rigid Packaging/Personal Care
Packaging for Personal Care products

Piracanjuba
Caps/ Beverages
Milk Piracanjuba

Unilever
Coating/Beverages
Ades

Braskem

Europe Applications

Tetra Pak
Caps / Beverages
Valio and others

Plastic Omnium
Rigid Container
Waste Containers

ECOVER
Ecover
Bottle/Home Care
Ecover

Sphere
Trash Bags
Alfapac Vegetal Origin

L'Occitane
Bottles/ Personal Care
Bonne Mère

Nomacorc
Closures/Beverages
Wine Corc: Select Bio

McCain
Multi layer Packaging Film/Food
Frozen Fresh Fries

Papier Mettler
Durable Bags
Retailers: Kaiser's
REWE
Rossmann

Braskem

Asia and Oceania applications

Yuhan-Kimberly

Yuhan Kimberly
Packaging film/Personal Care
Huggies

AJINOMOTO

Ajinomoto
Caps/Food
Ajinomoto

CALPIS

Calpis
Beverage packaging
Calpis

KAO

KAO
Stand Up Pouch/ Personal Care
Ascience's
Segreta
Merit

morinaga

Morinaga
Internal straw/Beverage
Energy

SHISEIDO

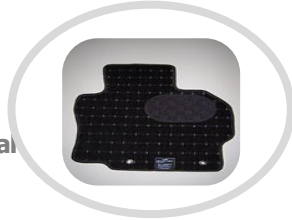
Shiseido
Packaging/Personal Care
Super Mild
Tsubaki
Elixir
Uno Fog Bar

AEON

Aeon
Retailing
Single use bags and baskets

Takeda

Takeda
Packaging/Pharmaceutical
Takeda



MITSUBISHI

Mitsubishi
Fiber/Automotive Carpets
Mitsubishi

Braskem

Asia and Oceania applications

Nepia
Tissue packaging/Personal Care
Nepia

Bubble Pack
Bubble Wrap Film/Consumer good
Bubble Pack

Nature Organics
Packaging for pre wash stain remover/Home Care
Earth Choice

Toyota
Fiber/Automotive Carpets
Toyota

Samsung
Packaging for cables
Samsung

Osang
Packaging to involve the fruit
Osang

Kia
Front dashboard and door trims/ Automotive
Kia Soul EV

Kosé Cosmeport
Multilayer Packaging Film/Personal Care
Kosé Cosmeport

Japan Gateway
Multilayer Film/Home Care
Choice

Braskem

North America Applications

General Millls
Packaging Food
Cascadian Farm Cereal

Protecter & Gambler
Packaging/Personal Care
Pantene Nature Fusion Shampoo

Aveda
Cosmetic
Dry Remedy

Coca Cola
Bottle/Beverages
Odwalla