



Braskem





Green Polyethylene

Braskem

Antonio Morschbacker
Manager Green Polymers
Fulbright Commission
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A vision on sustainability



Social and environmental responsibility is a core value among all leading global companies



Braskem

Our vision on sustainability

The **more actions** that are taken towards sustainability, the **stronger is the positive impact on the company's image**



Sustainable Raw material

Some **biobased polymers** are already produced in **commercial scale**

| Categories | Products |
|------------|----------|
|------------|----------|

- **Modified Natural Polymers**

- Starch and derivatives
- Celluloses and derivatives

- **Polymers made directly by micro-organisms or plants**

- **Polyhydroxialcanoates**
Polyhydroxi-butyrate and copolymers (PHB / PHA)

- **Polymers made from monomers obtained by fermentation**

- **Poly(lactic acid) - PLA**
- **Polypropylene-terephthalate - PPT**
- **Polyethylene and others ethylene derivatives**



Green Polyethylene

An alternative to traditional PE



Traditional

Sustainable

Oil
&
Gas

Etha

Polyethylene

Braskem

Green Polyethylene

An alternative to traditional PE

Sustainable

Ethanol

Corn

Sugar Beet

Sugar Cane

 Braskem

Green Polyethylene

An alternative to traditional PE



Sustainable

Ethanol



Sugar Cane



Braskem

Sugar Cane, Brazil and Braskem

A unique combination



Sugar Cane, Brazil and Braskem

A unique combination



Sugar
cane

Brazil

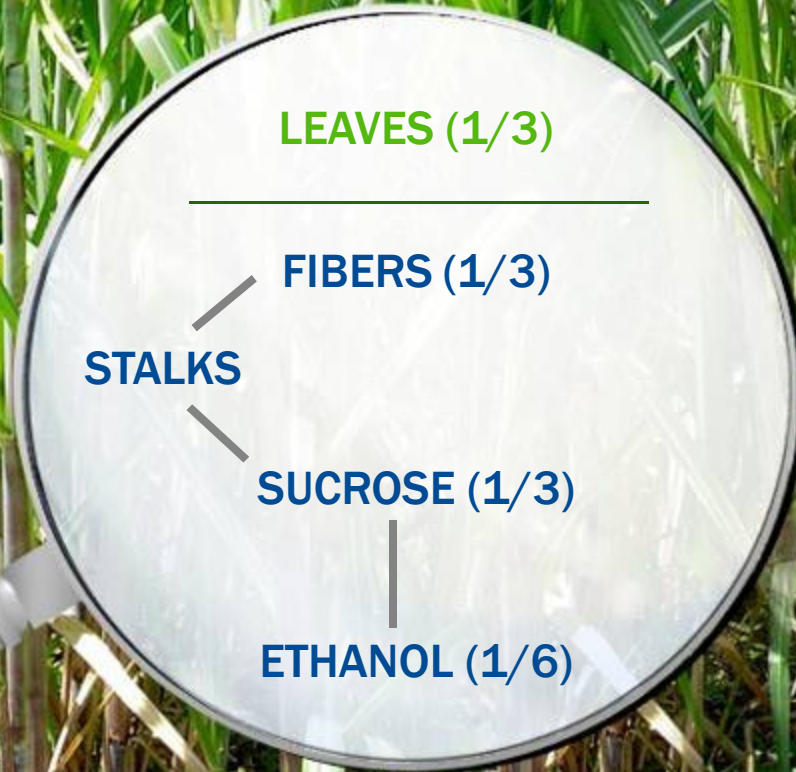
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Sugarcane as a carbon capture crop

The amount of lignocellulosic carbon in the leaves and fibers allows the ethanol process to be self-sufficient in biobased energy, when burning it



Sugarcane as a carbon capture crop

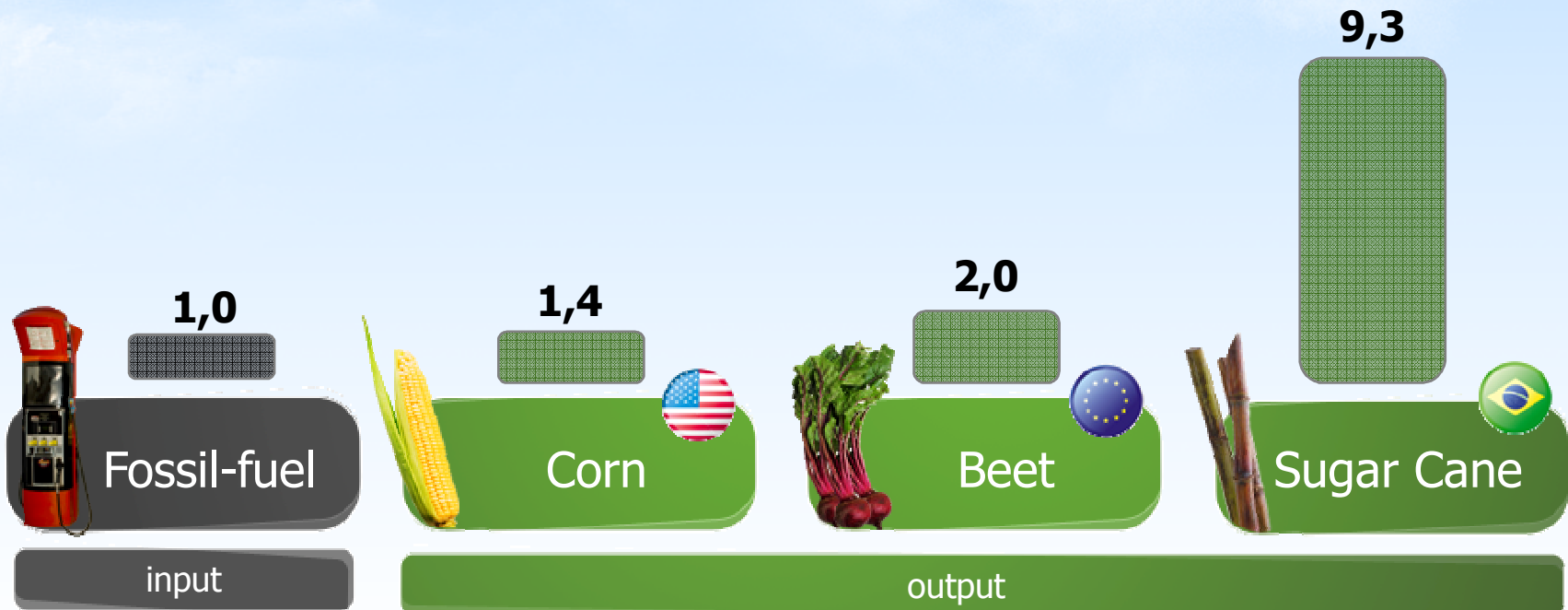


Sugar Cane

Competitive advantages with other materials



Fossil-fuel energy used to **MAKE** the fuel (input) compared with the energy **IN** the fuel (output)



Sugar cane has the **highest energy** productivity compared to **other Ethanol sources**
New technologies expected to **double productivity**

Sugar Cane, Brazil and Braskem

A unique combination

Sugar
cane

Brazil

Braskem



Braskem

Brazil

Unparallel conditions for sugar cane crop



Brazil has **22%** of arable land in the world (340 MM ha)



Only 18,6% of arable land are cultivated so far

Sugarcane: 7,8 MM ha
For Ethanol: 3,4 MM ha (1% of arable land)

Soy: 22 MM ha

Corn: 14 MM ha

Pasture/cattle: 220 MM ha
(50% degraded land)

No impact in Amazon Forest

2.500 km

No impact in the global food/energy equation

2.000 km

Triunfo

Braskem

Sugarcane based Ethanol


A reinforcement from the Press

POLICY RESEARCH V

A Note on R

Donald

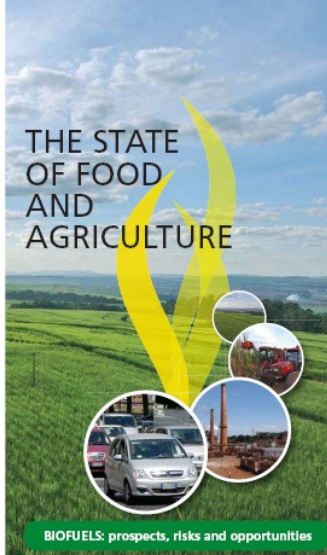
The World Bank
Development Prospects Group
JULY 2008




Biofuels production from sugar cane in Brazil is lower-cost than biofuels production in the U.S or EU and has not raised sugar prices significantly because sugar cane production has grown fast enough to meet both the demand for sugar and ethanol.

2008

THE STATE OF FOOD AND AGRICULTURE



BIOFUELS: prospects, risks and opportunities



TIME

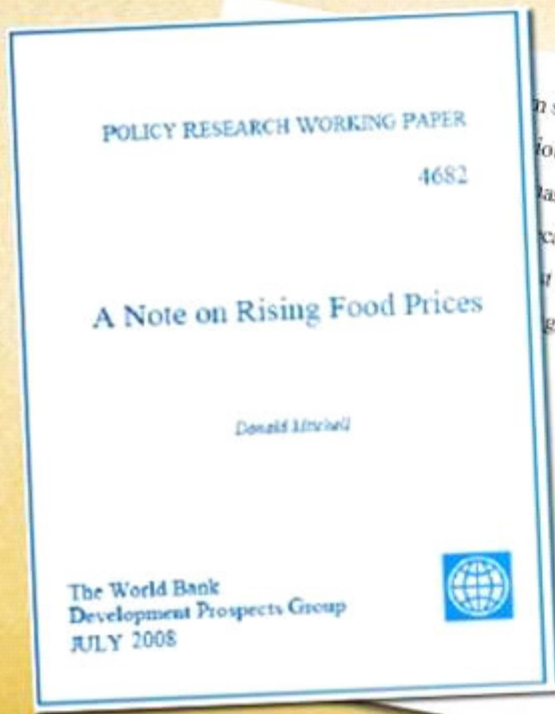


TIME



Sugarcane based Ethanol

A reinforcement from the Press



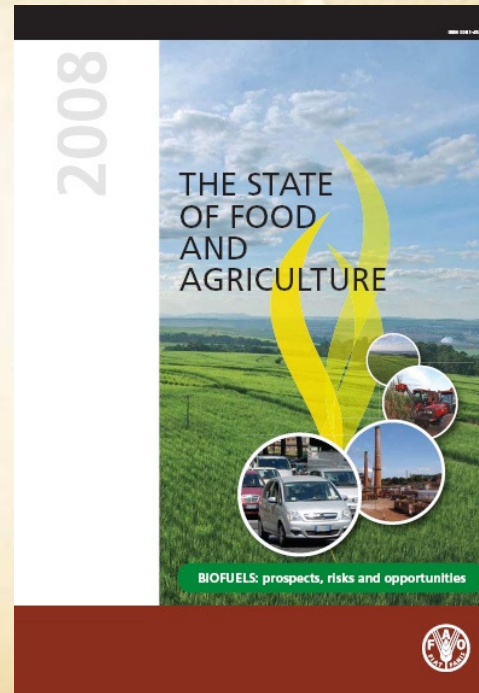
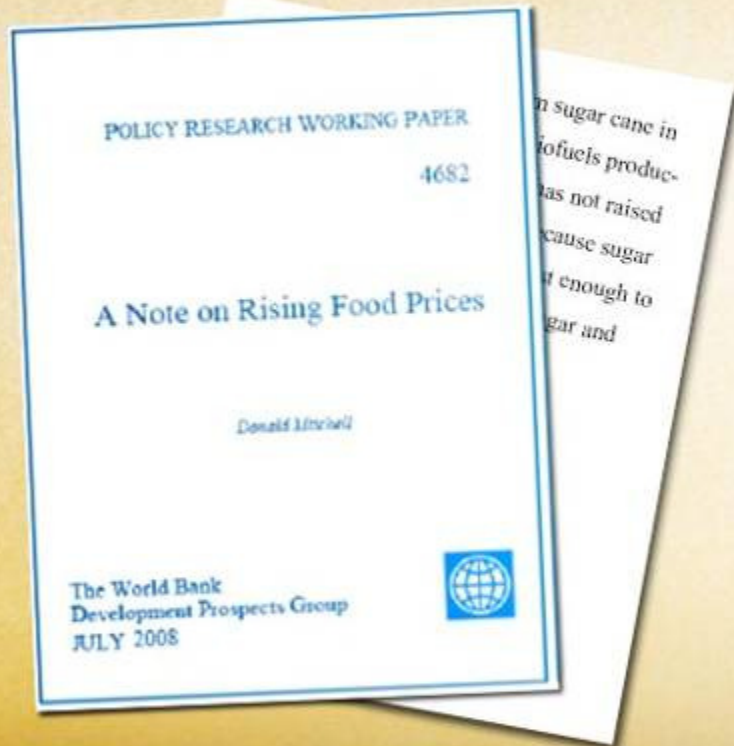
...n sugar cane in
...ofuels produc-
...as not raised
...cause sugar
...t enough to
...gar and

Among the major producers
only Brazilian sugar-cane
ethanol currently appears
to be competitive with fossil
fuel counterparts without
subsidies



Sugarcane based Ethanol

A reinforcement from the Press



Sugar Cane, Brazil and Braskem

A unique combination

Sugar
cane

Brazil

Braskem



Braskem

Braskem Strategic Vision

Growth with value creation



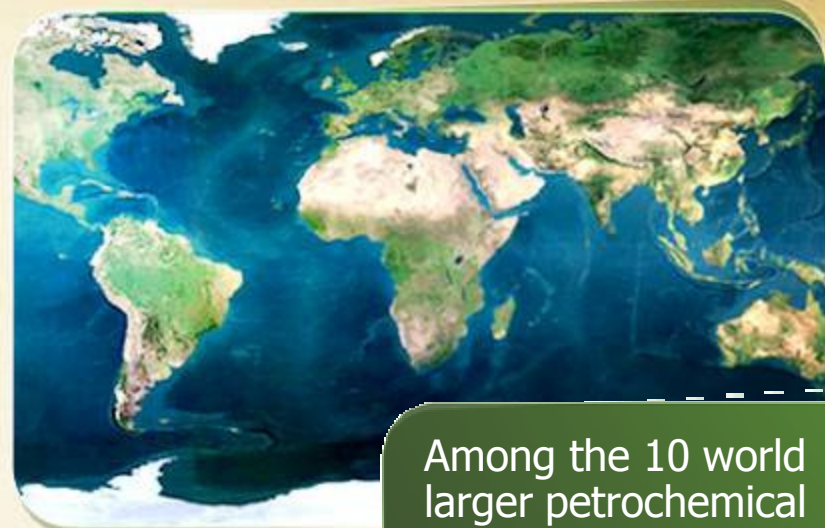
The green polyethylene project reassures Braskem's commitment with **technological innovation** and **sustainability** in its strategy

2002



Leader in Latin America in thermoplastic resin

2012



Among the 10 world larger petrochemical in market value



Braskem's key strategic drivers

Solid business model based on competitive integration

COMPETITIVE INTEGRATION



MARKET LEADERSHIP

1 Petrochemical Company in Latin America

COST COMPETITIVENESS

Integration with Scale

TECHNOLOGICAL AUTONOMY

Know-How and Innovation

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Green Polyethylene Cycle

From cradle to cradle

Sugarcane

The sugarcane crop metabolizes the CO_2 to produce sucrose (85 t/ha; 14% sugars + 28% biomass)



Green Polyethylene Cycle

From cradle to cradle

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The sugarcane crop metabolizes the CO_2 to produce sucrose (85 t/ha; 14% sugars + 28% biomass)

Ethanol $\text{CH}_3\text{-CH}_2\text{OH}$

At the distillery, the sugar juice is fermented and distilled to produce ethanol



**Stillage
Recycle**



Green Polyethylene Cycle

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Ethylene $\text{CH}_2=\text{CH}_2$

Through the dehydration, the ethanol is transformed in ethylene



**Bagasse and
Leaves
Recycle**



Green Polyethylene Cycle

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Water
Recycle



Green Polyethylene Cycle

From cradle to cradle

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Thermal
Integration



Green Polyethylene Cycle

From cradle to cradle

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Green PE [$\text{CH}_2=\text{CH}_2$]

The ethylene is polymerized in polyethylene production unities (3 t PE/ha)



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Carbon capture

The green polyethylene is transformed in final products in the same unities already existents

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Green Polyethylene Cycle

From cradle to cradle

Sugarcane

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Ethylene $\text{CH}_2=\text{CH}_2$

Through the dehydration, the ethanol is transformed in ethylene



Recycling

The green polyethylene is 100% recyclable (Mechanical / Incineration)

Carbon capture

The green polyethylene is transformed in final products in the same unities already existents

Green PE [$\text{CH}_2=\text{CH}_2$]

The ethylene is polymerized in polyethylene production unities (3 t PE/ha)



Green Polyethylene Cycle

From cradle to cradle

Sugarcane

The sugarcane crop metabolizes the CO₂ to produce sucrose (85 t/ha; 14% sugars + 28% biomass)



Ethanol CH₃-CH₂OH

At the distillery, the sugar juice is fermented and distilled to produce ethanol



Ethylene CH₂=CH₂

Through the dehydration, the ethanol is transformed in ethylene



**Very Favorable
Ecoprofile
Captures 2.0 – 2.5 t
CO₂/t PE***



Recycling

The green polyethylene is 100% recyclable (Mechanical / Incineration)

Carbon capture

The green polyethylene is transformed in final products in the same unities already existents

Green PE [CH₂=CH₂]

The ethylene is polymerized in polyethylene production unities (3 t PE/ha)

* Life Cycle Analysis from cradle to gate

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Green Polyethylene from Sugar Cane

Environmental positive impact

Reduces greenhouse effect
and global warming



Braskem

Green Polyethylene from Sugar Cane

Environmental positive impact

1 KG of **Green PE releases*** only
0.7 – 1.3 KG of CO₂

1 KG of petrochemical PE
releases* **5,6 KG of CO₂**



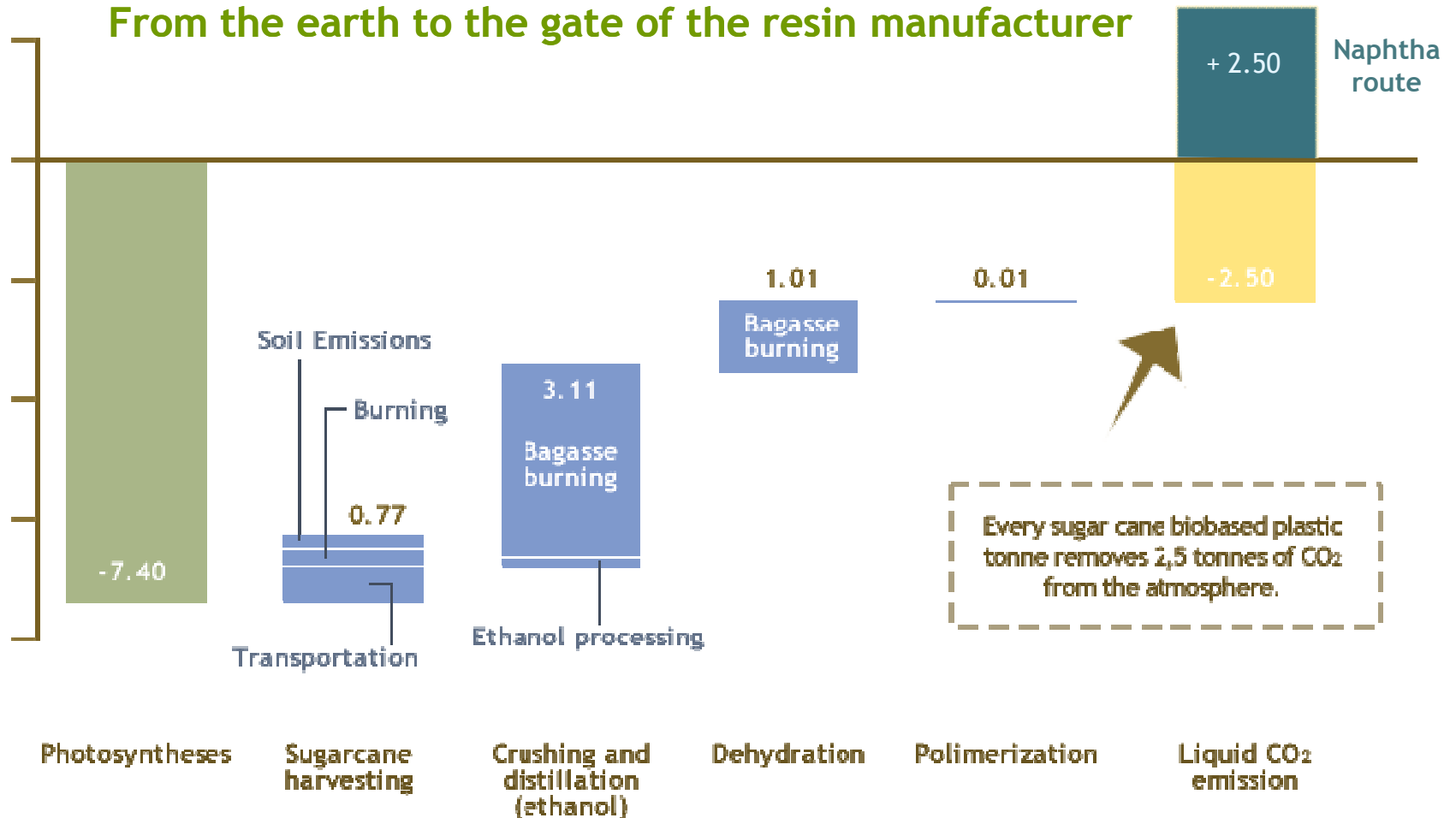
* Life Cycle Analysis from cradle to grave (incineration)

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Plastics pellets made from sugarcane ethanol are able to absorb CO₂

Total carbon dioxide (CO₂) emissions - Ethanol route
(tonnes CO₂ / tonne biopolyethylene)

From the earth to the gate of the resin manufacturer



Source: UNICAMP, CTC, Braskem, BASF, Plastics Europe

Revaluation - Best solution for the post-consumption

RECYCLE

Revaluation of solid residues

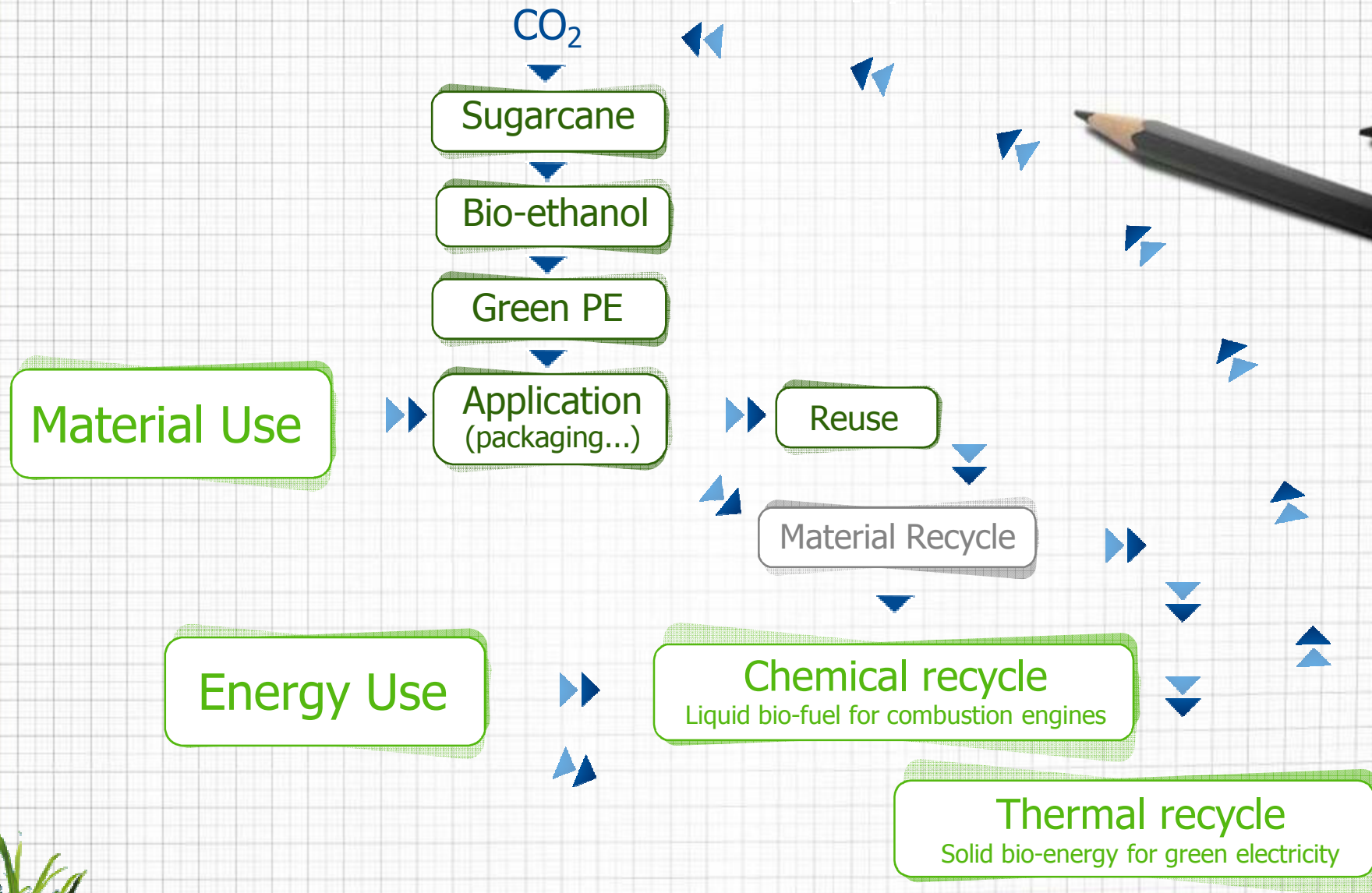
- ▶ **REDUCE AND REUSE:**
Durable Products
- ▶ **MECHANICAL:**
Material recovery
- ▶ **ENERGETIC - INCINERATION:**
Energy recovery
- ▶ **CHEMICAL:**
Transformation in other products –
Gasoline or monomers
- ▶ **ORGANIC:**
Biodegradation
Composting

1 kg of polyethylene
produces as much energy
as 1 liter of diesel oil

BETTER LCA



Life cycle – Cascade usage



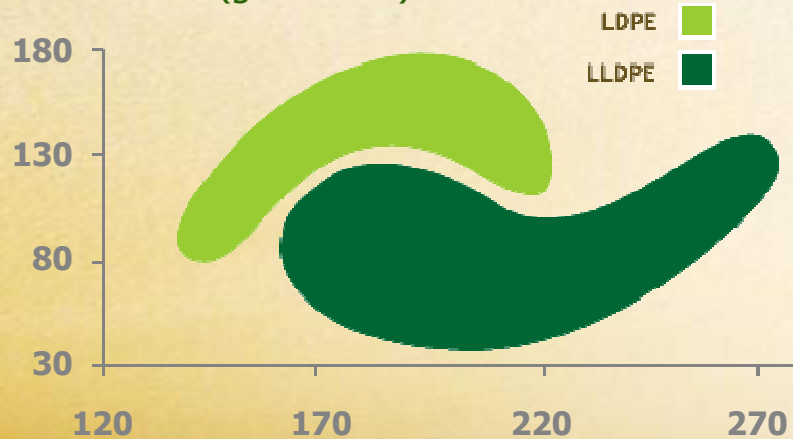
Braskem green Polyethylene Credibility

The biobased content of the green PE can be certified in any step in the chain – in the converter or directly in the supermarket shelf

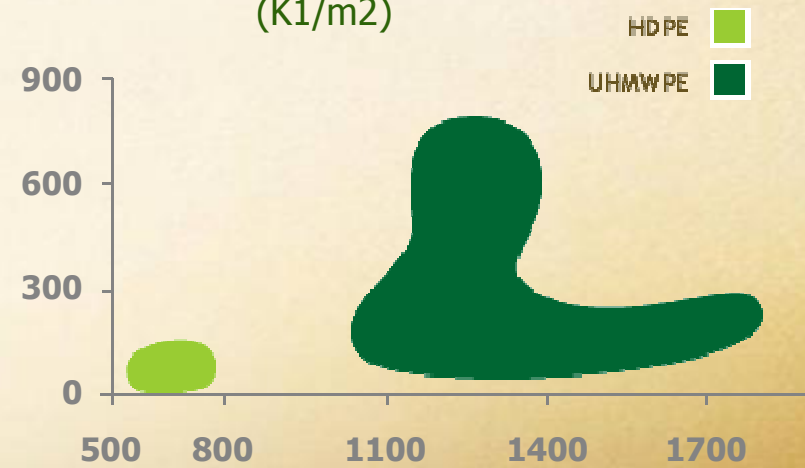


Wide Range of properties

Dart Drop Impact Strength
(gf – 50%f)



Charpy Impact Strength
(K1/m2)



- ▶ LDPE
- ▶ HDPE
- ▶ MDPE
- ▶ LLDPE
- ▶ VLDPE
- ▶ UHMWPE

- ▶ Films
- ▶ Injection
- ▶ Blow molding
- ▶ Coating
- ▶ Rotomolding

MI - 0.20 to 50 g/10 min

D – 0,910 to 0,966

Green Polyethylene Production

Certification and market development

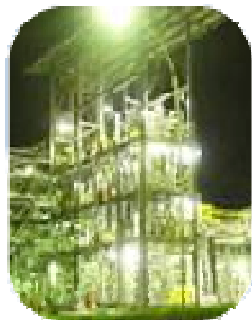
ETHYLENE PILOT PLANT



POLYMERIZATION LABORATORY



POLYETHYLENE PILOT PLANTS

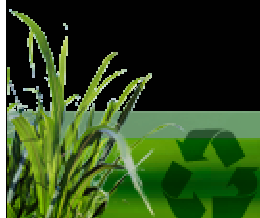


PRODUCTS



Green Polyethylene

Global Recognition



Braskem green Polyethylene

Fully identical to petrochemical PE

While several materials are offered as ecofriendly alternative to fossil Plastics

Braskem's green Polyethylene is the only fully identical alternative

Key benefits

- ▶ Converters will keep the processing parameters and productivity rate
- ▶ No change on product design required
- ▶ Faster time-to-market



Braskem and sustainability

Market Recognition



Braskem green Polyethylene

Leading global industrial scale supplier

May 2007

Pilot Plant
12 ton/year

1st Q 2011

Industrial Plant
200 kton/year

Near Future

New Plants and
New Green
Products

Braskem



Green Polyethylene

 **Braskem**



Braskem

