I’m green™
Polyethylene
Innovation and differentiation for your product
By using Green Polyethylene, Braskem’s partners can offer unique products made from renewable resources that make a significant contribution to reducing the level of greenhouse gas emissions throughout the chain. Green Polyethylene is a renewable alternative to Polyethylene, a thermoplastic resin largely used for packaging in consumer goods industries, such as food and beverage, cleaning and personal care products, as well as toys, trash containers and plastic bags. At the end of its lifespan, Green Polyethylene can be recycled in the same chains already developed for conventional Polyethylene.

The I’m green™ seal can be applied to finished packaging and products that have Green Polyethylene in their composition.

Different source, same properties

Green Polyethylene is a drop-in biopolymer. Substituting conventional Polyethylene with Green Polyethylene does not require investments in new plastics manufacturing machinery.

The Green Polyethylene portfolio features approximately 30 grades in the HDPE, LLDPE and LDPE families that cover a wide range of applications. The vast majority of these grades have renewable carbon content between 80% and 100%, based on their biogenic carbon content measured in accordance with the standard ASTM D6866.

There are a number of recognized certifiers in Europe, the USA and Asia that offer labels for the renewable content of a material or products based on ASTM D6866.

The raw material used to make Braskem’s Green Polyethylene is sugarcane ethanol.
<table>
<thead>
<tr>
<th>Life cycle of plastic</th>
<th>Bioplastics</th>
<th>Conventional Plastics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning of life</td>
<td>Bioplastics</td>
<td>Fossil-based</td>
</tr>
<tr>
<td></td>
<td>Bio-based</td>
<td>Recyclable</td>
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<tr>
<td></td>
<td>Biodegradable</td>
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</tr>
<tr>
<td>End of life</td>
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</tr>
<tr>
<td></td>
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</tbody>
</table>
Life Cycle Analysis

To address the challenges of today's modern world and society's growing demands for more sustainable solutions, "Life Cycle Thinking" is one of the major challenges faced by industries and governments when designing their products and proposing new regulations.

To learn more about the impacts associated with the production of Green Polyethylene, Braskem conducted Life Cycle Analysis, Water Footprint and Land Use studies of the product. The latest LCA study was concluded in 2016, with the effort drawing on the participation of specialists in the sugarcane industry, ethanol suppliers and specialized consulting firms.

The LCA was conducted in accordance with the standards NBR ISO14040:2009 and NBR ISO14044:2009 and a panel of specialists were charged with reviewing the work. Six categories of impacts were covered representing the entire process, from the cultivation of sugarcane to the product's arrival at Braskem's factory gate: The new study encompasses more categories: climate change, ozone layer depletion, inhalable inorganics, photochemical ozone formation, acidification, water use, soil use, natural resources consumption, ecotoxicity, human toxicity, eutrophication. The data used was in large part obtained from primary sources in the production processes of both Braskem and ethanol suppliers.

To gain a better understanding of the differences in the impacts between fossil-based and bio-based plastics, the results of conventional Polyethylene and Green Polyethylene were compared for all six categories.
Responsibility in the chain

Braskem’s relationship with the ethanol supply chain is guided by its Responsible Ethanol Sourcing, updated in 2017, with the support of ProForest, a UK-based sustainability management consulting firm with expertise in natural resources.

The social and environmental practices established in the code aim seek continuous improvement in sugarcane and ethanol production and, most importantly, respect for Brazilian laws and regulations. For this, the code drew on the models of good practices described in the UN Global Compact, the São Paulo State Agricultural and Environmental Protocol, Brazil’s Sugarcane Agroecological Zoning and the National Commitment to Improve Labor Conditions for Sugarcane Workers.

Braskem conducts regular audits of its suppliers using third-party verification to ensure they comply with its code of conduct and works jointly with them to draft action plans to correct any gaps.

Brazil’s sugarcane industry

Brazil is the world’s largest sugarcane producer and second-largest ethanol producer.

Approximately 50% of the sugarcane produced is used to make sugar, with Brazil a leading player in world sugar trade, with the remaining 50% used to make ethanol. The sugarcane industry also makes an important contribution to Brazil’s energy matrix: 16% of the energy consumed in Brazil comes from renewable resources derived from sugarcane, both from the use of bagasse as a fuel for sugar mills and for electricity generation exported to Brazilian grid and from ethanol used mostly as fuel for vehicles.

Land use in Brazil

Ninety percent of Brazil’s sugarcane cultivation is concentrated in the country’s Center–South region. The expansion in sugarcane planted area is regulated by the Sugarcane Agroecological Zoning Policy, which is a regulatory framework implemented by the federal government in 2009 that prohibits the expansion of sugarcane cultivation into high-biodiversity areas, such as the Amazon Rainforest and the Pantanal Wetlands. Sugarcane cultivation currently occupies 8 million hectares of Brazil’s land mass and there are still 65 million hectares identified as suitable for this activity. Brazil currently has 358 hectares of arable land available for agricultural activities.

The Sugarcane Agroecological Zoning Policy identifies the best use of the areas available for agriculture in Brazil and for sustainable expansion, which puts into context any aspects related to improving food security and reducing the use of water and agrochemicals.

Genetically modified (GMO) sugarcane is currently not commercially cultivated in Brazil.
Product portfolio

The broad product portfolio enables Green Polyethylene to be used in rigid and flexible applications that are already well consolidated in the market as well as in growth applications. Braskem’s technical teams provide support for the development of new products and ensure shorter approval times for Clients and the achievement of high renewable-content levels in final products.

The technical information on the grades that meet the needs of Blow Film and Cast Film Extrusion, Fiber Extrusion, Injection Molding, Blow Molding and Tubing processes can be found in this catalog.

See some of the industries where I’m green™ Polyethylene is used:

- Beverages
- Retailing
- Home care
- Agriculture and industry
- Cosmetics
- Food
- Hygiene and beauty
Braskem is a world leader in terms of biopolymer production capacity through its Green Polyethylene, which it has marketed since 2010.

Around the world, Braskem has a dedicated team to serve, provide technical assistance and build solid relationships with its Clients.

**I’m green™ seal: transparent communication and guarantee of origin**

The I’m green™ seal can be applied to finished products that use Green Polyethylene in their composition.

The seal can be used by Clients at their discretion. However, its use must be accompanied by communication of the renewable content of the product or packaging verified based on C14 analysis in accordance with standard ASTM D6866.
Braskem is the largest thermoplastic resin producer in the Americas. With 40 industrial plants in Brazil, United States, Germany and Mexico, the company produces over 16 million tons of thermoplastic resins and other petrochemicals each year. Braskem is the world’s leading biopolymer producer, with annual production capacity of 200 kton of polyethylene made from sugarcane ethanol.

Pillars of sustainable development
• More sustainable resources and operations
• More sustainable product portfolio
• Solutions for a more sustainable life

Braskem is a component of the Dow Jones Sustainability Index Emerging Markets, the Carbon Efficient Index (ICo2) and the Corporate Sustainability Index of the BM&FBovespa – Securities, Commodities and Futures Exchange. Braskem is a member of the United Nations’ platform for more sustainable industries and its sustainability annual report is rated level A+. It also was elected one of the 50 most innovative companies in the world in 2014 by the U.S.-based magazine Fast Company for substituting some of its fossil-based feedstocks with biobased feedstocks for plastics production.
### Injection Molding

**Typical Properties**

<table>
<thead>
<tr>
<th>ASTM Method</th>
<th>Melt Flow Rate (190 °C/2.16 kg)</th>
<th>Melt Flow Rate (190 °C/21.6 kg)</th>
<th>Density</th>
<th>Tensile Strength at Yield a)</th>
<th>Tensile Strength at Break a)</th>
<th>Flexural Modulus (1% secant) a)</th>
<th>Shore D Hardness c)</th>
<th>Notched Izod Impact Strength b)</th>
<th>Vicat Softening Temperature b)</th>
<th>Deflection Temperature Under Load (0.455 MPa)</th>
<th>Minimum C14 content</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE</td>
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</tbody>
</table>

**Units**

- g/10 min
- g/cm³
- MPa
- MPa
- J/m
- h/F50
- h/F50
- %

**Notes**

- Pails and basins; caps and closures; toys; thin-walled parts; Housewares; rigid containers for cosmetics and pharmaceutical applications (compliant with USP37 and EURP).
- Industrial containers and boxes for general use; safety helmets; toilet seats; housewares; toys; caps & closures; pallets; boxes for beverages, bottles, boxes for frozen food and agricultural products; rigid containers for cosmetics and pharmaceutical applications (complies with USP 37).
- Boxes for frozen food and horticultural products; Industrial containers and boxes for general use.
- Masterbatches; injected parts with large flat area; caps and closures.
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- Masterbatches; injected parts with large flat area; caps and closures.
- Bottles and tubes.

**NB** = No Break. Test specimens prepared from compression molding, according to ASTM D 4703. Tests performed on samples of:

- a) 2mm
- b) 3mm
- c) 6mm
- d) 2mm at 50 °C
- e) 3mm at 50 °C

### Blown Molding and Tubing

**Typical Properties**

<table>
<thead>
<tr>
<th>ASTM Method</th>
<th>Melt Flow Rate (190 °C/2.16 kg)</th>
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<tbody>
<tr>
<td>LDPE</td>
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<td>NB</td>
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<td>95</td>
<td>45</td>
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</tr>
</tbody>
</table>

**Units**

- g/10 min
- g/cm³
- MPa
- MPa
- J/m
- h/F50
- h/F50
- %

**Notes**

- Canisters from 2 to 20L for chemical products; bottles for concentrated detergent; bottles for food; tanks for wind shield and air ducts.

**NB** = No Break. Test specimens prepared from compression molding, according to ASTM D 4703. Tests performed on samples of:

- a) 2mm
- b) 3mm
- c) 6mm
- d) 2mm at 50 °C
- e) 3mm at 50 °C
- f) Value obtained by ASTM method D1505 (gradient column)
**Fiber Extrusion**

<table>
<thead>
<tr>
<th>Typical Properties</th>
<th>HDPE</th>
<th>LLDPE</th>
<th>PEBD</th>
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<tbody>
<tr>
<td><strong>ASTM Method</strong></td>
<td>D 1238</td>
<td>D 1238</td>
<td>D 1238</td>
</tr>
<tr>
<td><strong>Units</strong></td>
<td>g/10 min</td>
<td>g/10 min</td>
<td>g/cm³</td>
</tr>
</tbody>
</table>

**HDPE SHA2760**

- Bicomponent nonwoven fibers: general fibers.
- Raschel: shading and protecting nets; ropes.

**SHE150**

- Value obtained by the ASTM D1505 method

<table>
<thead>
<tr>
<th>Properties</th>
<th>HDPE</th>
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<tbody>
<tr>
<td><strong>Melt Flow Rate</strong></td>
<td>1,0 g/10 min</td>
<td>0,33 g/10 min</td>
<td>0,32 g/10 min</td>
</tr>
</tbody>
</table>

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**Extrusão de Filmes Tubulares e Extrusão de Filmes Planos**

<table>
<thead>
<tr>
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**Extrusion Coating**

<table>
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<td><strong>Units</strong></td>
<td>g/10 min</td>
<td>g/10 min</td>
<td>g/cm³</td>
</tr>
</tbody>
</table>

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**DM** = Machine Direction; **DT** = Transverse Direction. Additives: **AB** = antiblocking; **D** = sliding; **AF** = flow aid. a) Value obtained by the ASTM D1505 method.

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