

# BIOREFINERY IN BIOPLASTICS

**-STATE OF THE ART AND NEW DEVELOPMENTS OF  
NOVAMONT TECHNOLOGY -**

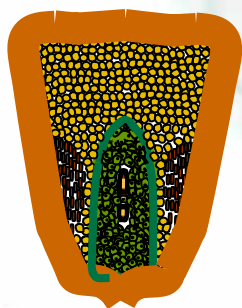
**Anaheim Forum March, 2007**



Chimica Vivente per la Qualità della Vita.

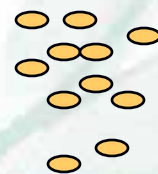
# MATER-BI STARCH-BASED TECHNOLOGY

CORN KERNEL (GMO FREE)



MILLING

STARCH

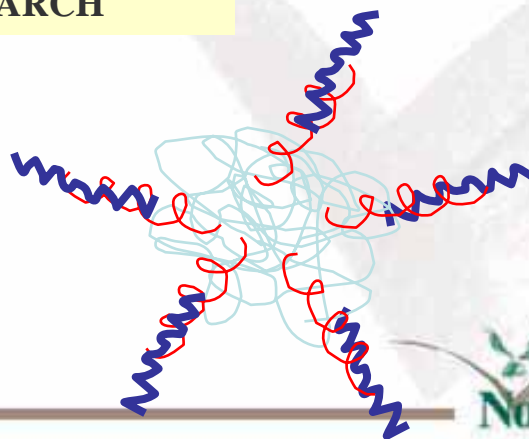


DESTRUCTURIZED STARCH  
+ CHEMICAL MODIFICATIONS

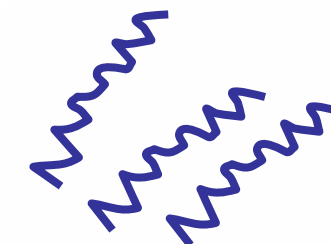


AMORPHOUS  
AMYLOSE AND  
AMYLOPECTINE

COMPLEXED  
STARCH



+

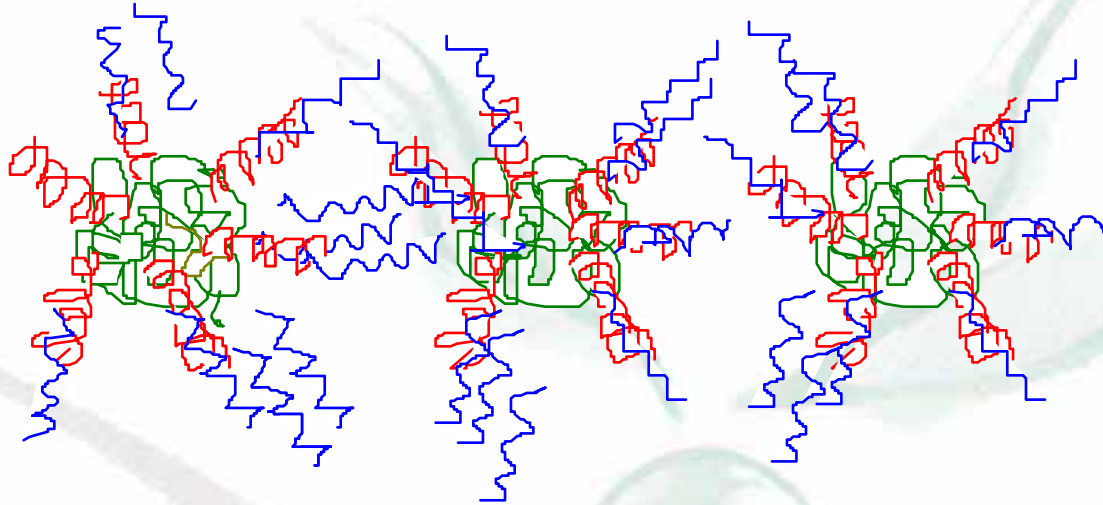


POLYMERIC  
COMPLEXING  
AGENTS

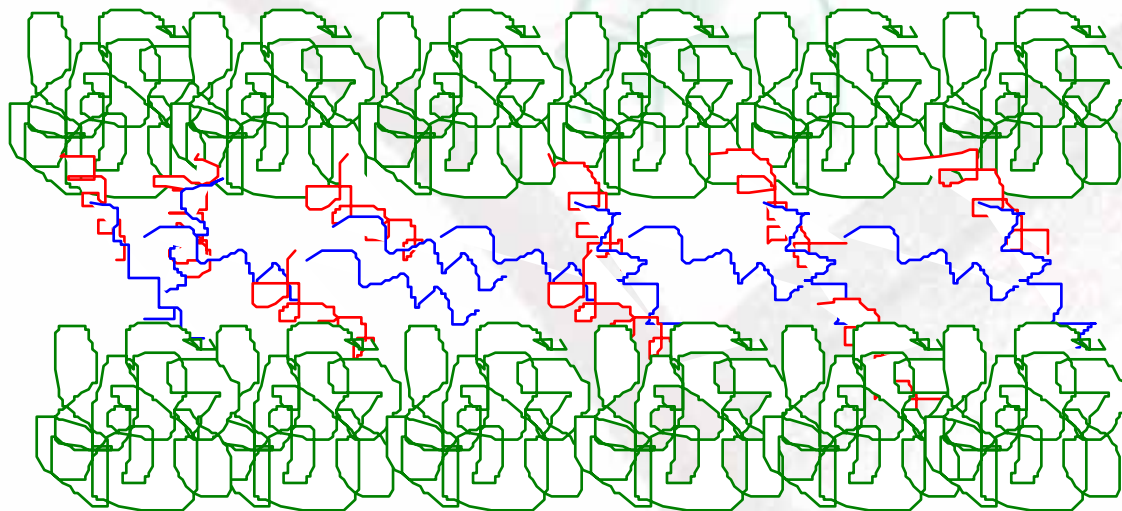


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# SOVRAMOLECULAR STRUCTURES OF COMPLEXED STARCH

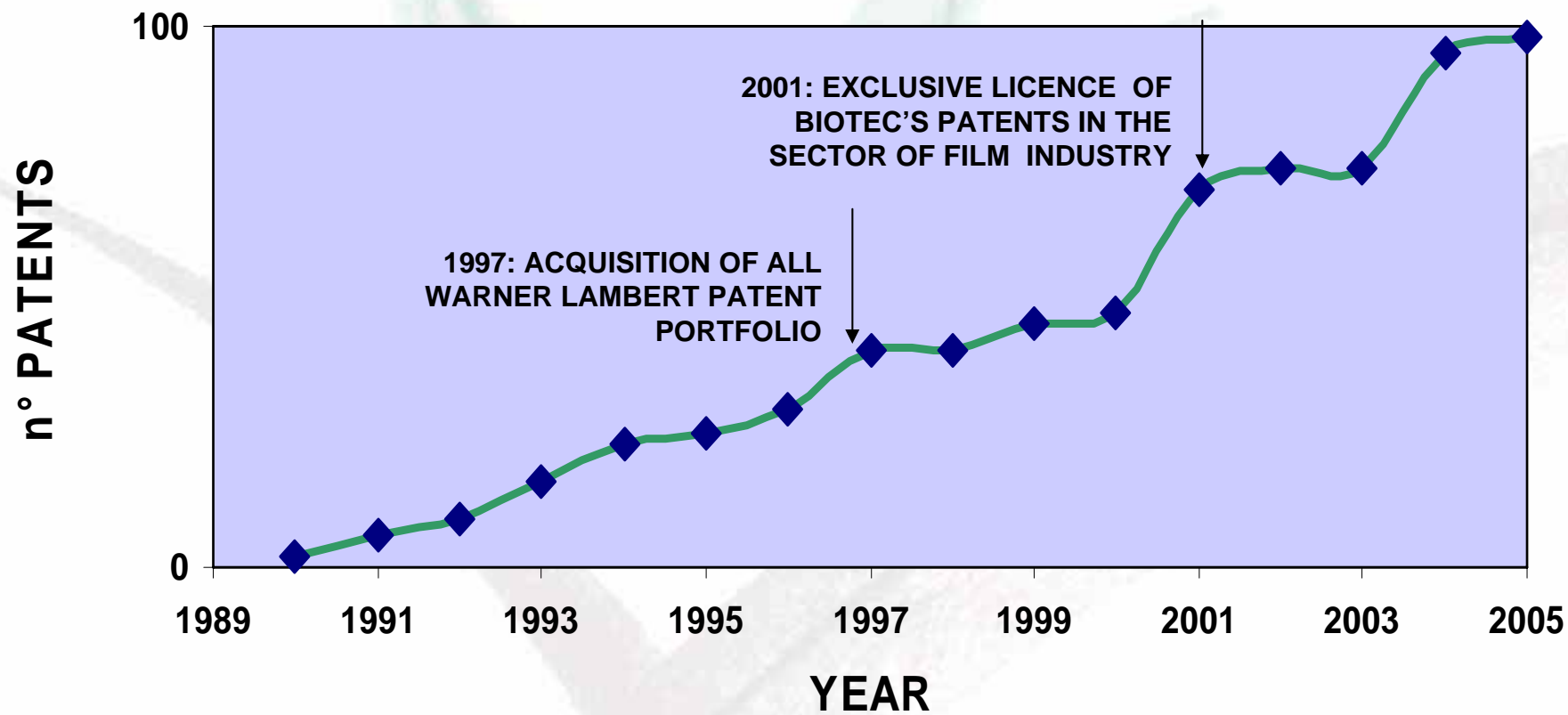


**COMPLEXED STARCH  
IN A DROPLET LIKE  
STRUCTURE**



**COMPLEXED STARCH  
IN A LAYERED STRUCTURE**

# NOVAMONT PATENT PORTFOLIO



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# MATER-BI: MAIN CHARACTERISTICS

- **BIODEGRADABLE AND COMPOSTABLE IN DIFFERENT ENVIRONMENTS**
- **PERFORMANCES COMPARABLE WITH TRADITIONAL PLASTICS**
- **PROCESSABILITY WITH STANDARD MACHINES AS FOR TRADITIONAL PLASTICS**
- **HIGH BREATHABILITY (>1000 gr30um/24h m2 (ISO 2528 condition B) WITH BIOLOGICAL BARRIER**
- **REDUCED ENVIRONMENTAL IMPACT (energy saving, resources saving, reduction of greenhouse gas emissions (epd) ) VS STANDARD AND BIODEGRADABLE NON RENEWABLE PLASTICS**



# MATER-BI GRADES FOR FILM -BIODEGRADATION BEHAVIOUR-

TOTALLY BIODEGRADABLE IN DIFFERENT  
ENVIRONMENTS:

- **INDUSTRIAL COMPOSTING (EN13432, ASTM 6400-99, UNI15782)**



- **HOME COMPOSTING**

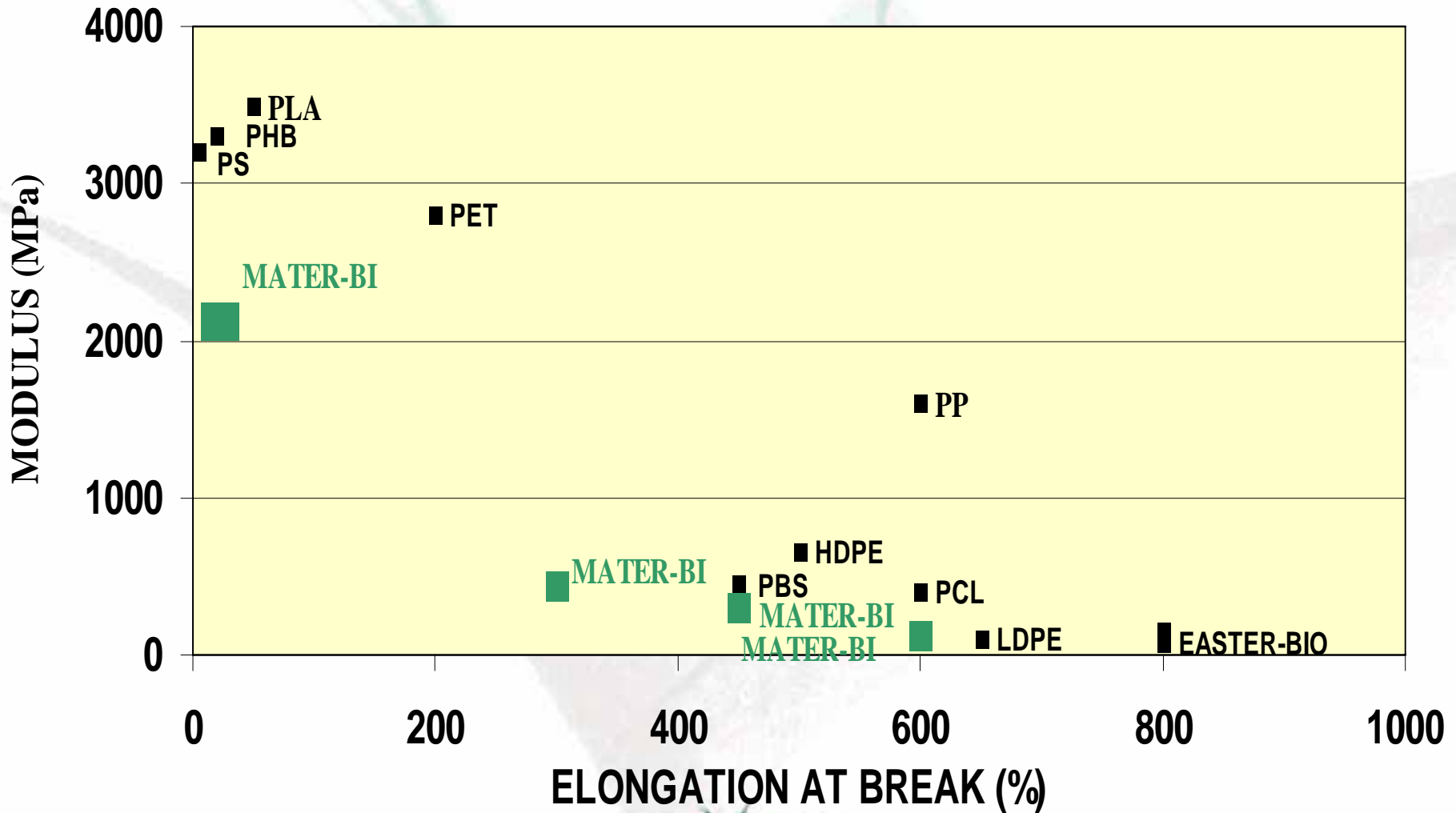


- **SOIL**

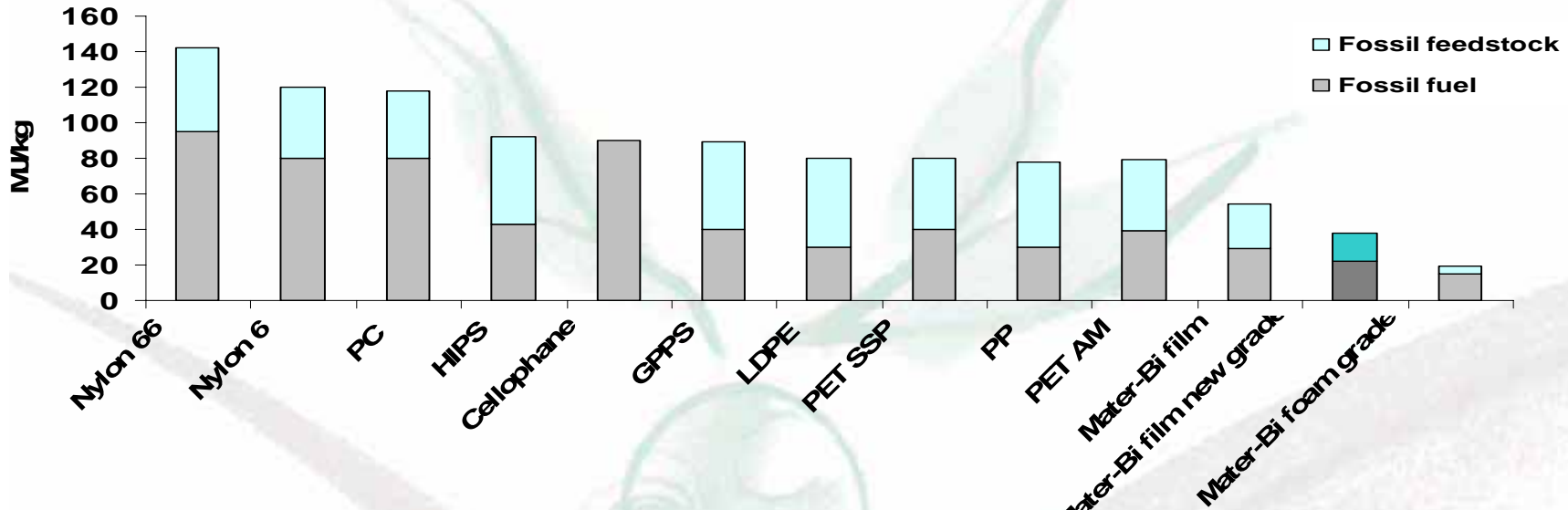


# MATER-BI

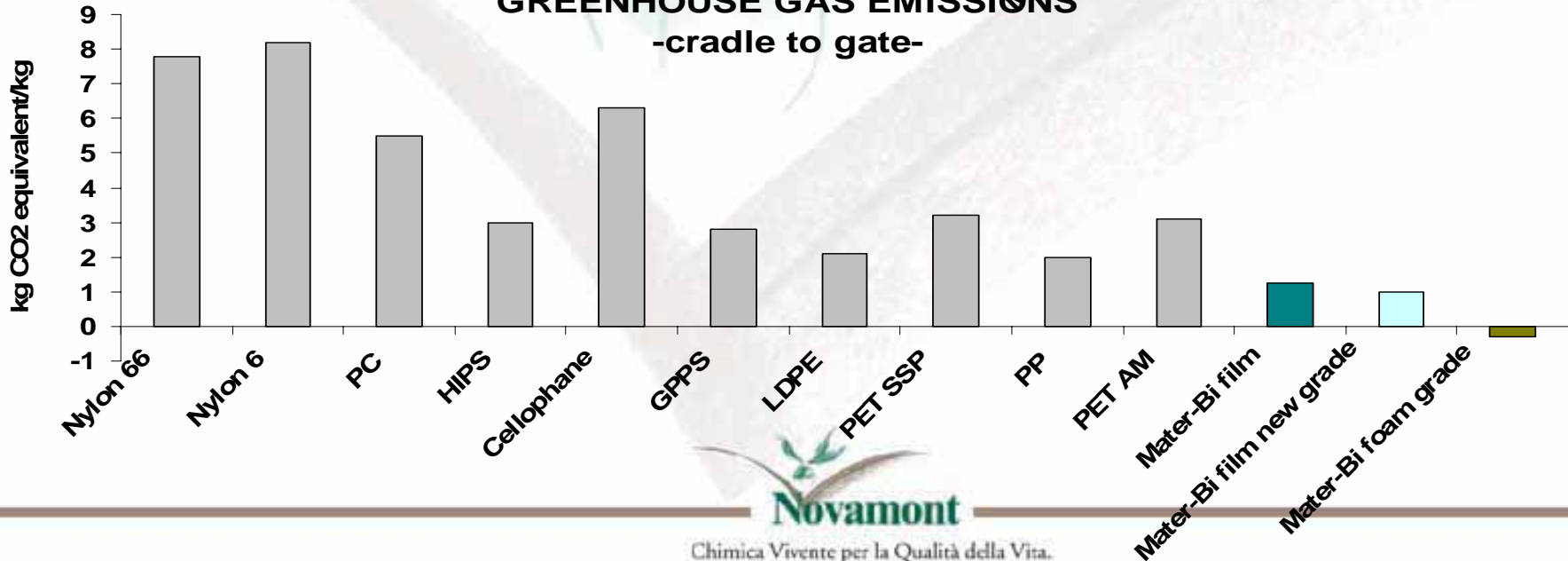
## MECHANICAL PERFORMANCES COMPARABLE WITH TRADITIONAL PLASTICS



## ENERGY CONTENT OF MATER-BI PRODUCTS VS DIFFERENT PLASTICS -cradle to gate-



## GREENHOUSE GAS EMISSIONS -cradle to gate-



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# REDUCED ENVIRONMENTAL IMPACT: THE STARCH EFFECT

(Martin Patel, Utrecht University)

	Energy savings, MJ/kg bio-based polymer*)	GHG savings, kg CO <sub>2</sub> eq./kg bio- based polymer*)
<b>Bio-based plastics (pellets)</b>		
TPS	<b>51</b>	<b>3,7</b>
TPS + 15% PVOH	52	3.1
TPS + 52.5% PCL	28	1.4
TPS + 60% PCL	24	1.2
Mater-Bi foam grade	42	3.6
Mater-Bi film grade	33	2.6
PLA	<b>19</b>	<b>1,0</b>

\*) Max. +/- 15% depending on whether LDPE or LLDPE according to APME is chosen as reference

SAVINGS RELATIVE TO PETROCHEMICAL COUNTERPARTS

Novamont

# ORIGO-BI™: THE NOVAMONT POLYESTERS FROM RRM

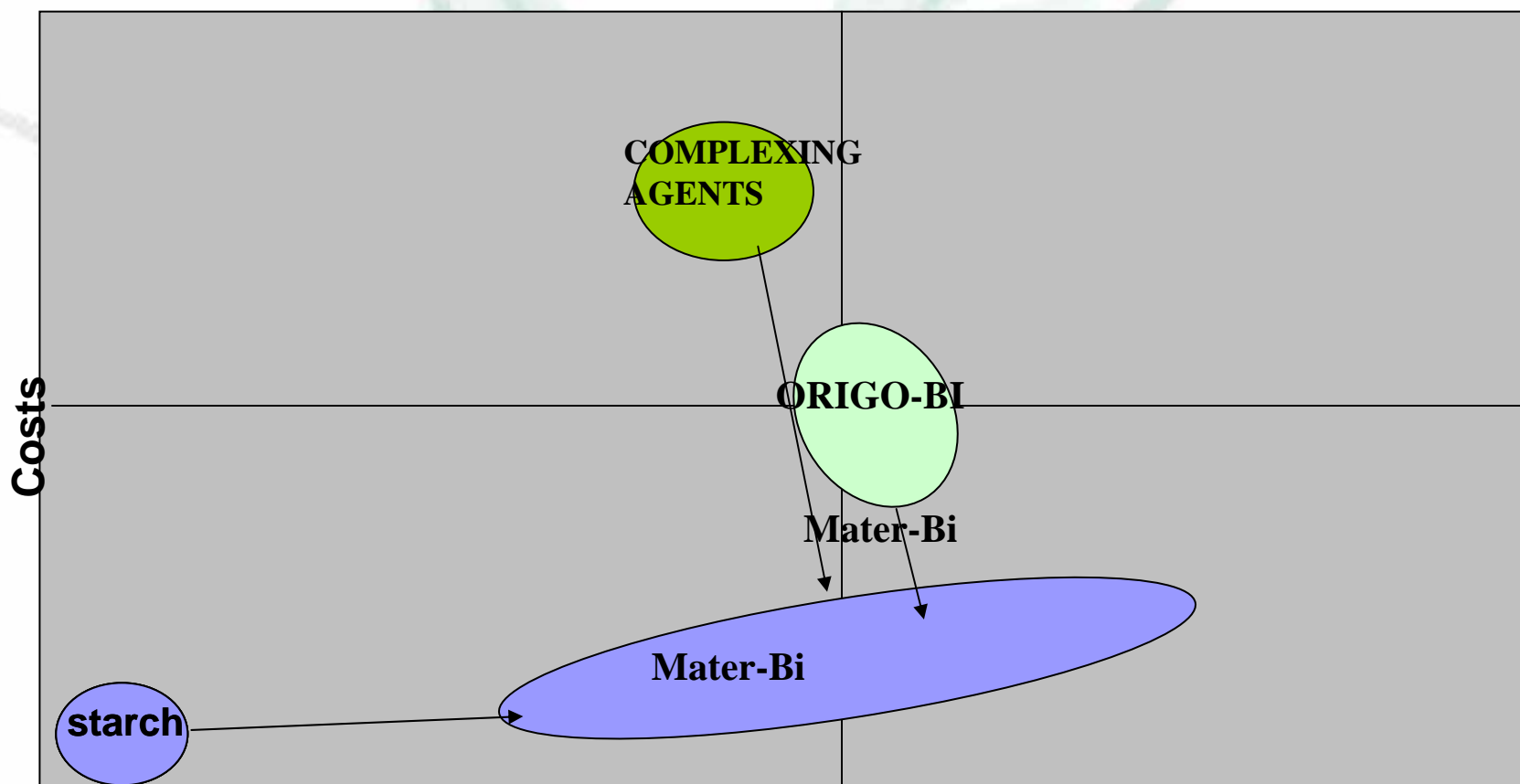
A RESULT OF THE INTEGRATION OF NOVAMONT'S  
TECHNOLOGY ON RENEWABLE RAW MATERIALS FROM  
VEGETABLE OILS WITH EASTMAN'S TECHNOLOGY  
PLATFORM (EASTAR-BIO Patent portfolio, Know-how )  
(8/2004)



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# ORIGO-BI™ vs MATER-BI™

Environmental Costs vs technical performances

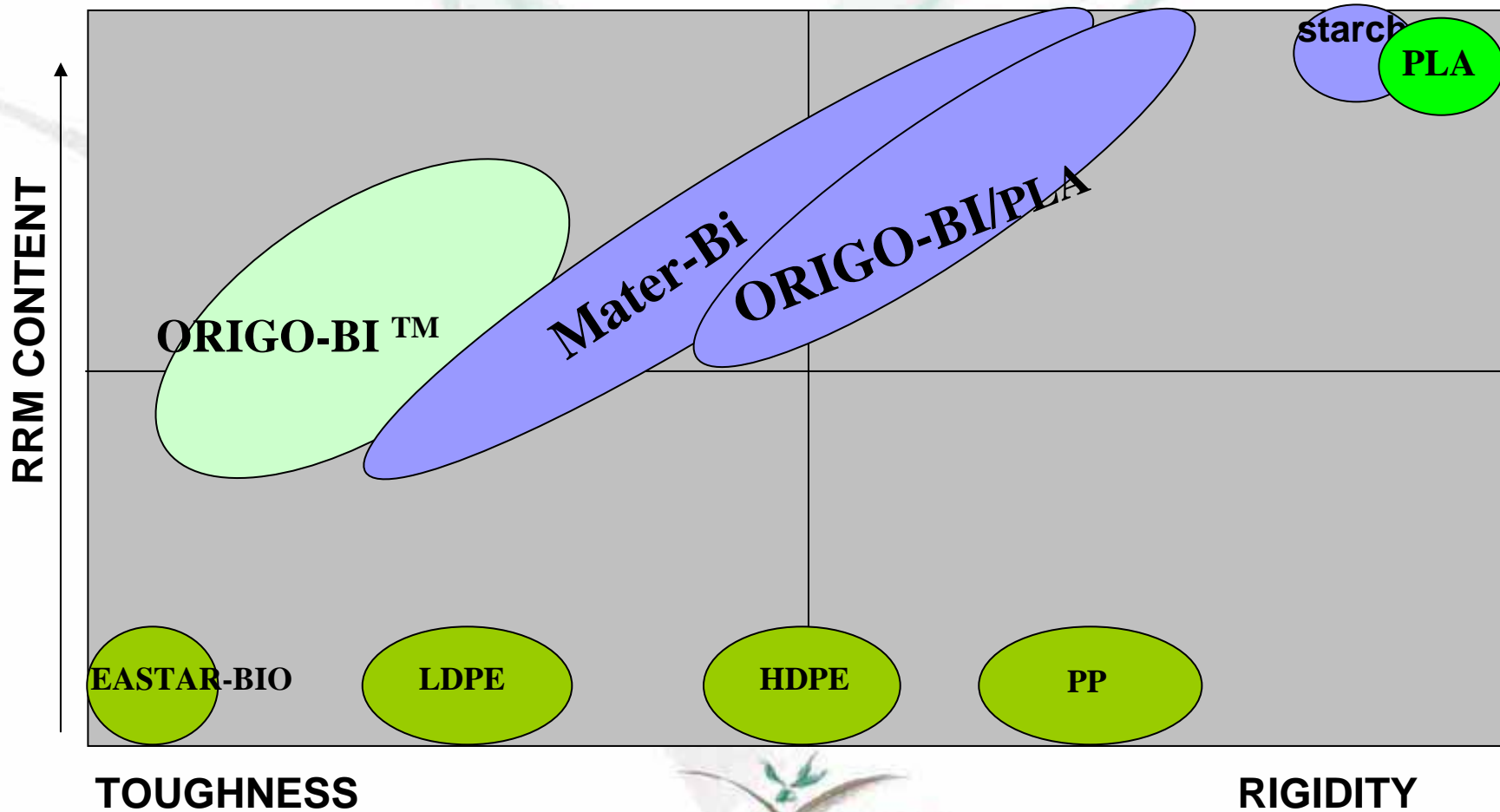


Technical Performances

# NOVAMONT'S PRODUCTS FAMILY

## (COMPARATIVE ANALYSIS)

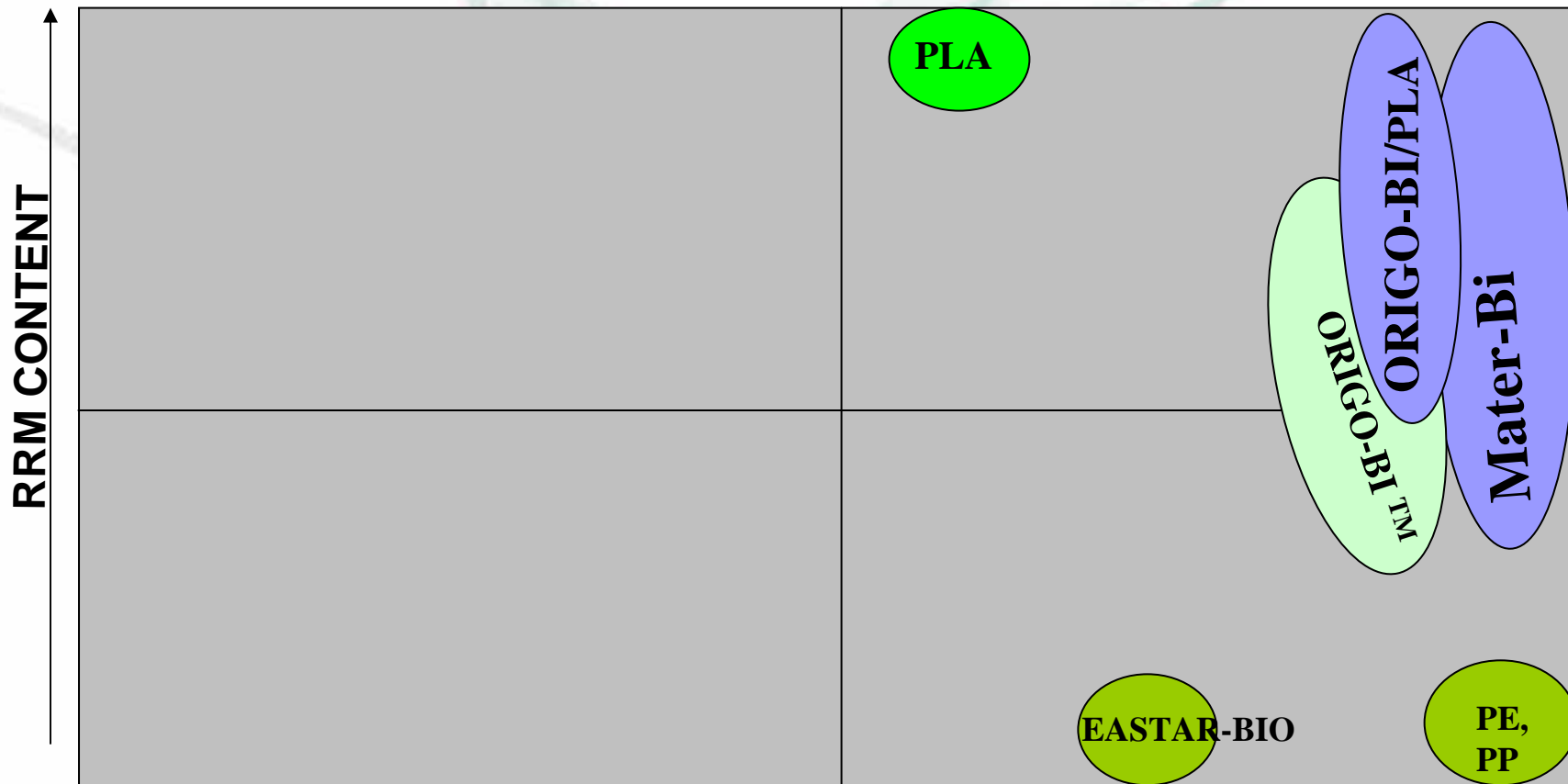
### RRM CONTENT vs RIGIDITY



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# NOVAMONT'S PRODUCTS FAMILY (COMPARATIVE ANALYSIS)

## RRM CONTENT vs PROCESSABILITY



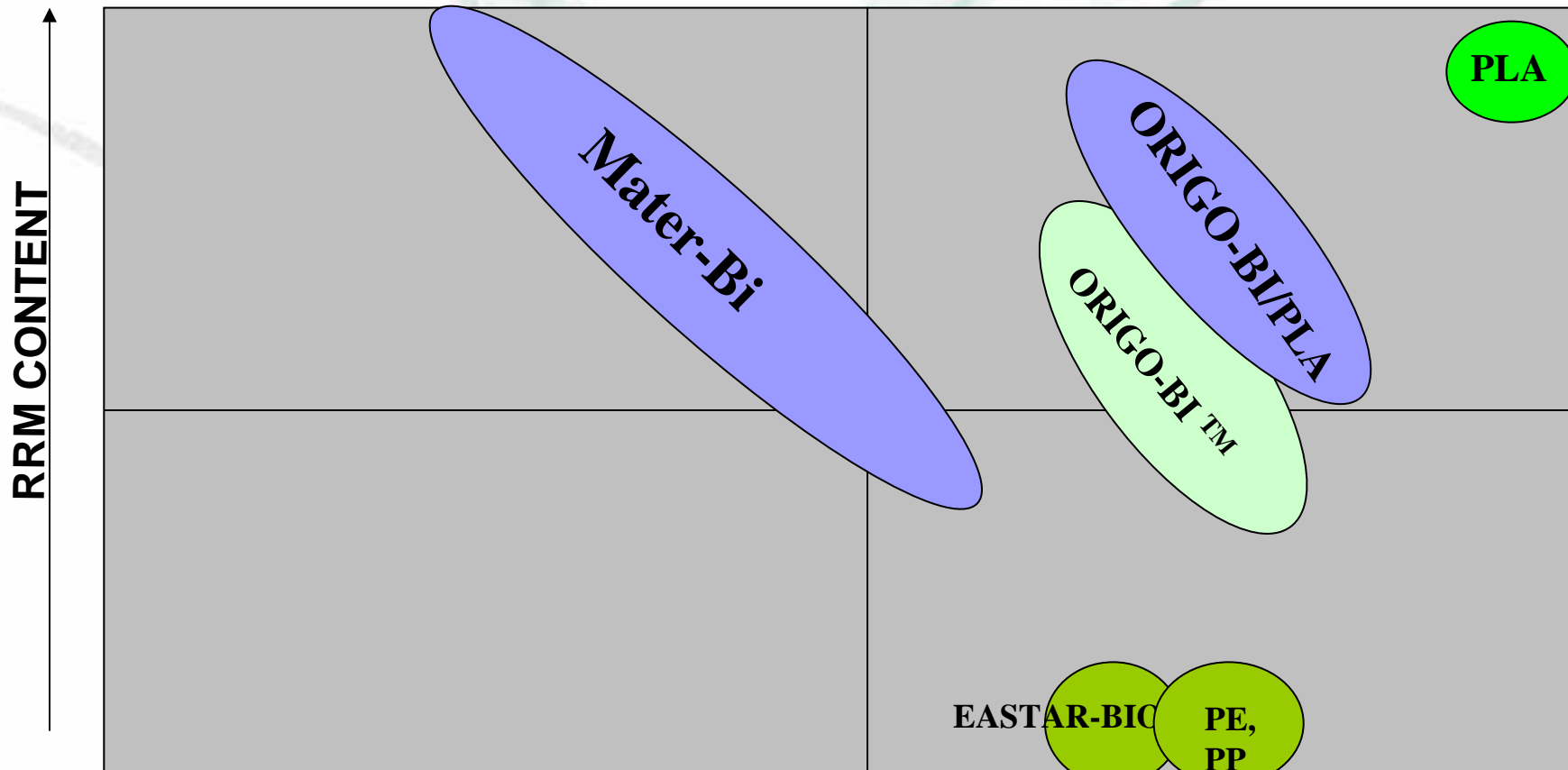
PROCESSABILITY



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# NOVAMONT'S PRODUCTS FAMILY (COMPARATIVE ANALYSIS)

## RRM CONTENT vs TRANSPARENCY



TRANSPARENCY

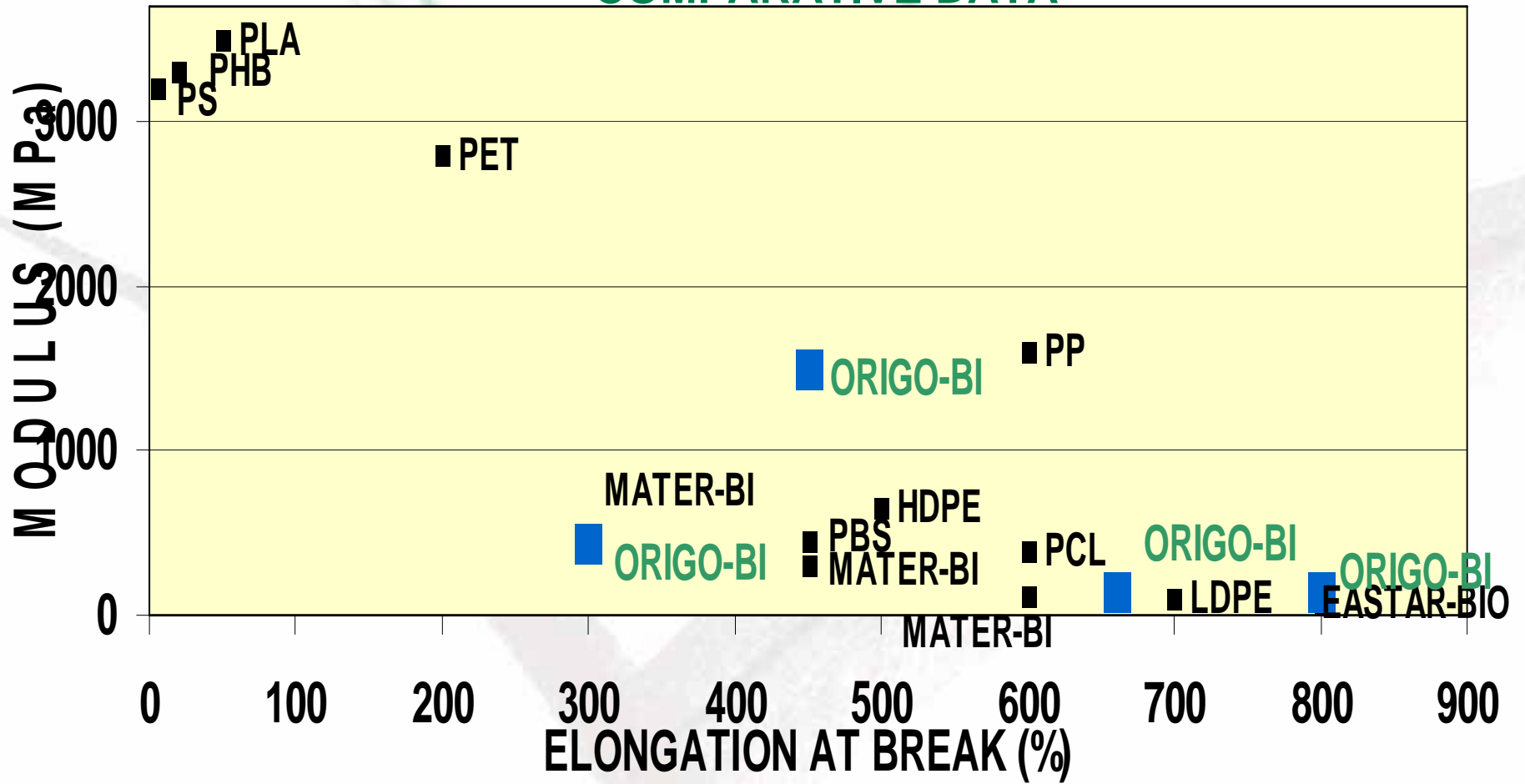


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# TENSILE PROPERTIES

## -MODULUS vs ELONGATION AT BREAK-

### COMPARATIVE DATA



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# CONCLUSIONS

- **MATER-BI : A RANGE OF TAILOR MADE MATERIALS WITH EXCELLENT TECHNICAL PERFORMANCES AND MINIMIZED ENVIRONMENTAL IMPACT**
- **NOVAMONT TECHNOLOGY READY FOR THE BUILD-UP OF BIOREFINERIES INTEGRATED WITH THE TERRITORY IN A PARTNERSHIP**
- **ORIGO-BI™ THE NEW FAMILY OF RENEWABLE POLYESTERS (30-70%) TO ENLARGE THE RANGE OF NOVAMONT'S TAILOR MADE MATERIALS AND TO FURTHER STRENGTHEN THEIR TECHNICAL, ECONOMICAL AND ENVIRONMENTAL PERFORMANCES**







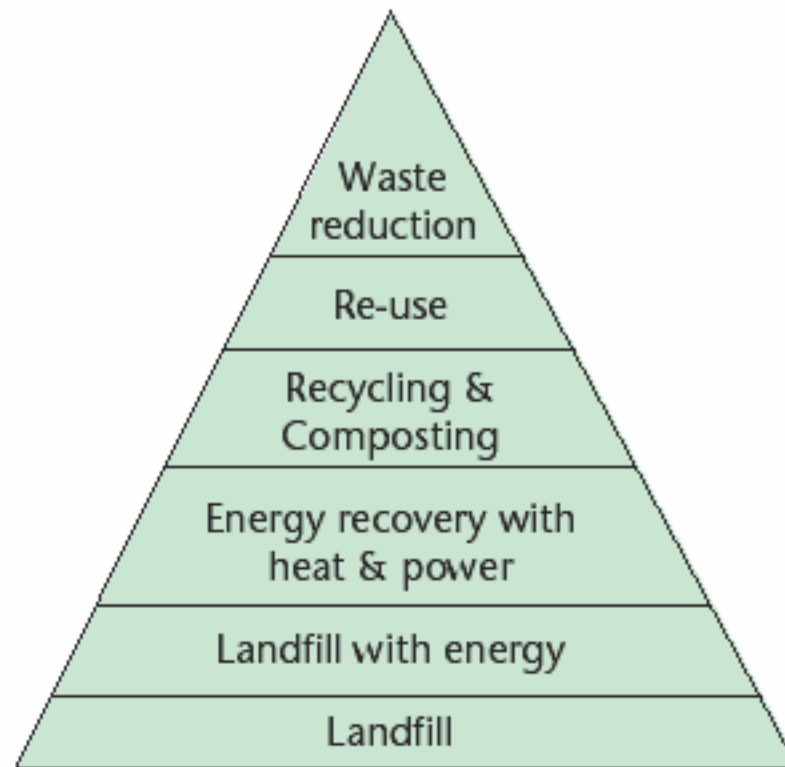
**WASTE MANAGEMENT SYSTEMS  
INNOVATIVE COLLECTION STRATEGIES  
WITH **MaterBi**<sup>®</sup> BAGS**



Living Chemistry for Quality of Life.

# The European waste management policy and its waste hierarchy

## The Waste Hierarchy



# Why biowaste source separation?

- **Fulfillment of European directives on waste 91/156/EEC and on landfills 99/31/EC**
  - **50% diversion of 1995 biodegradable waste by 2009 and 65% by 2016**
  - **Biowaste source separation potentially the quickest and cheapest way of achieving this**



# Why biowaste source separation?

- **Climate Change and Soil Fertility increasingly assumed as a priority (EU Thematic Strategy on Soil Protection)**
  - **Biowaste recovery for compost production and greenhouse gas emission reduction**
  - **Reduction of methane and leachate production and related treatment costs at landfill sites**



# Why biowaste source separation?

- **Increasing value of energy from residual waste (energy recovery).**
  - **above 17.000 kJ/kg in well established Curbside organic waste collection systems**



# Evaluation factors for Collection Systems

- **EFFICIENCY** (amount of waste collected for recovery)
- **QUALITY** (purity of waste materials to be recycled)
- **COST EFFECTIVENESS** (reduction of expenses associated to waste management)



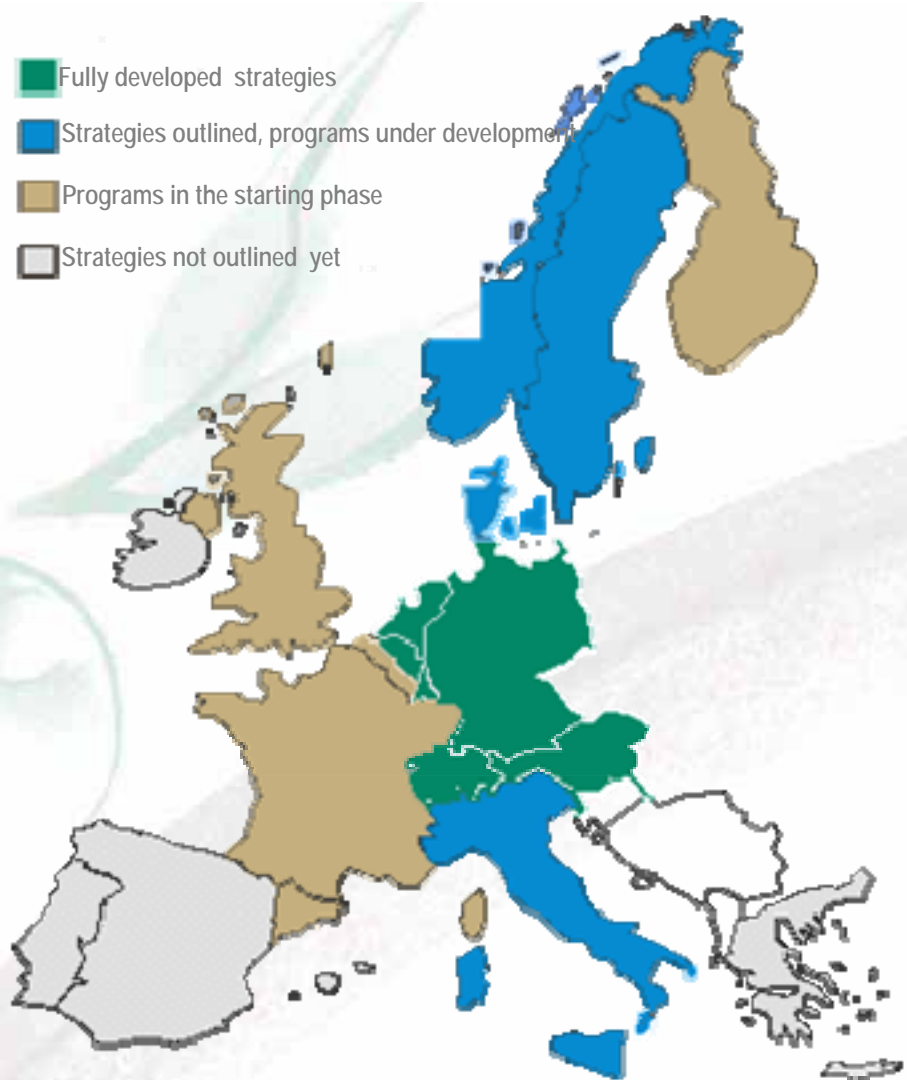
# Food waste collection systems

- intensive curbside collection of food waste – when made “comfortable” for households – generate high capture rates (leaving only 5% to 15% organics in the residual)
- the new separate collection needs to be integrated into the established waste management system, e.g. reducing frequencies and volumes of residual waste collection



# Organic waste source separation in Europe

- Fully developed strategies
- Strategies outlined, programs under development
- Programs in the starting phase
- Strategies not outlined yet



From Barth, L. "European Compost Production - Sources, Quantities, Qualities and Use in Selected Countries" **modified**



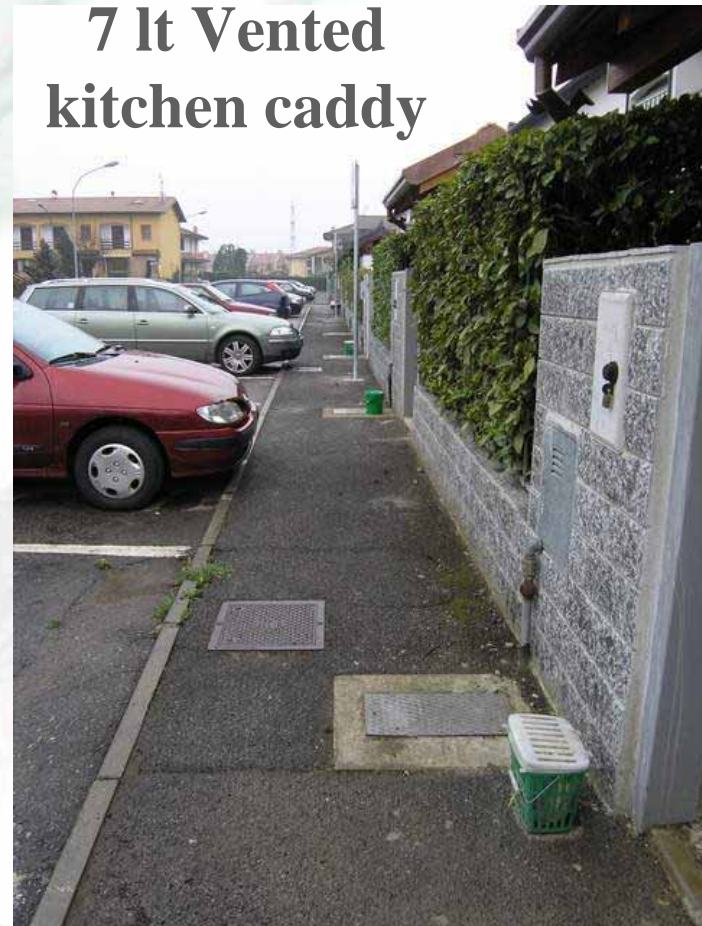
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# Caddies



**30 lt outdoor bucket**



**7 lt Vented  
kitchen caddy**



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# KITCHEN WASTE

Open vehicle with 1 driver-collector



Hand pick-up of buckets



Emptying of trolley bins by use of lifting device



A picture of collected materials

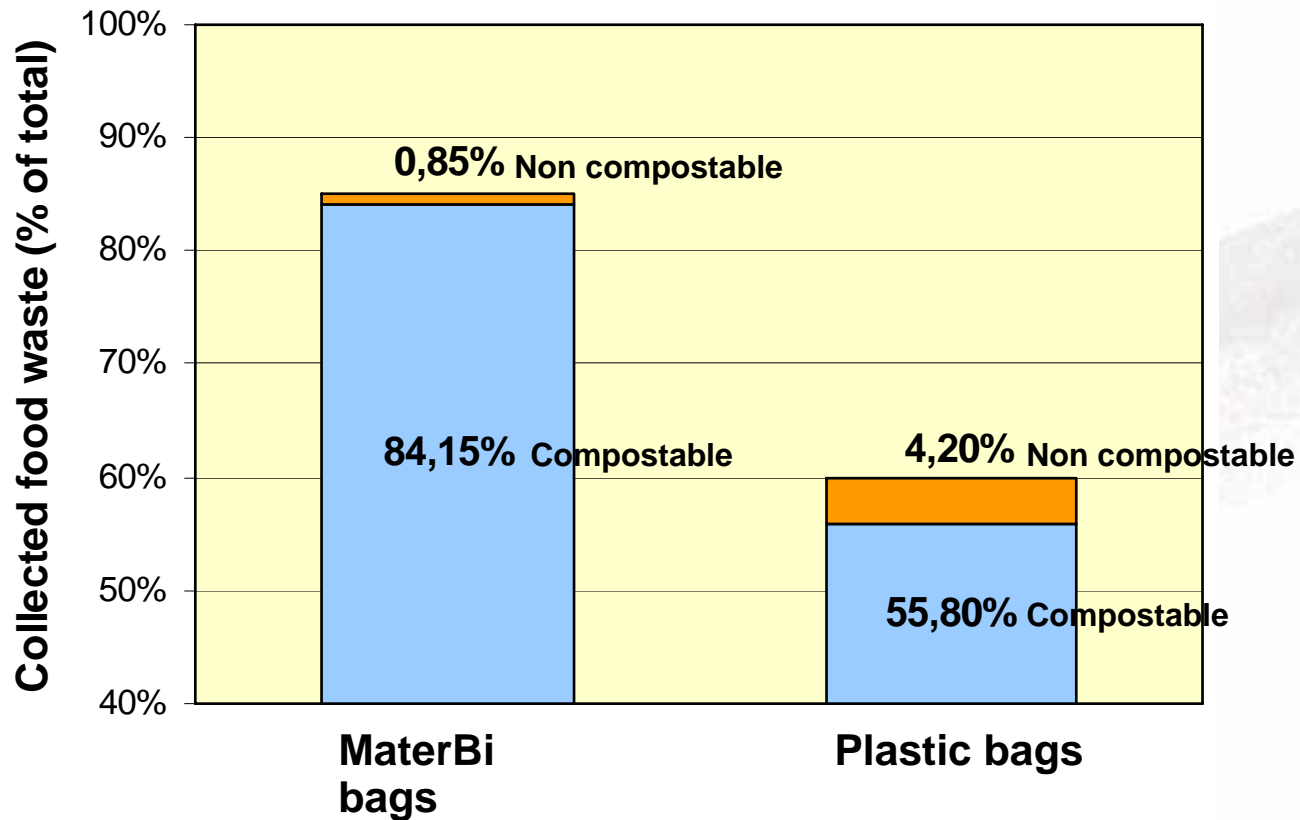


# Role that Mater-Bi bags can play

- **CONVENIENCE** and **HYGIENE** in the household with easier participation to the collection scheme
- **HYGIENE** and **SAFETY** for the operator collecting the food waste
- **QUALITY** and **QUANTITY** of recovered material



# % of collected food waste with MaterBi<sup>®</sup> bags VS plastic bags

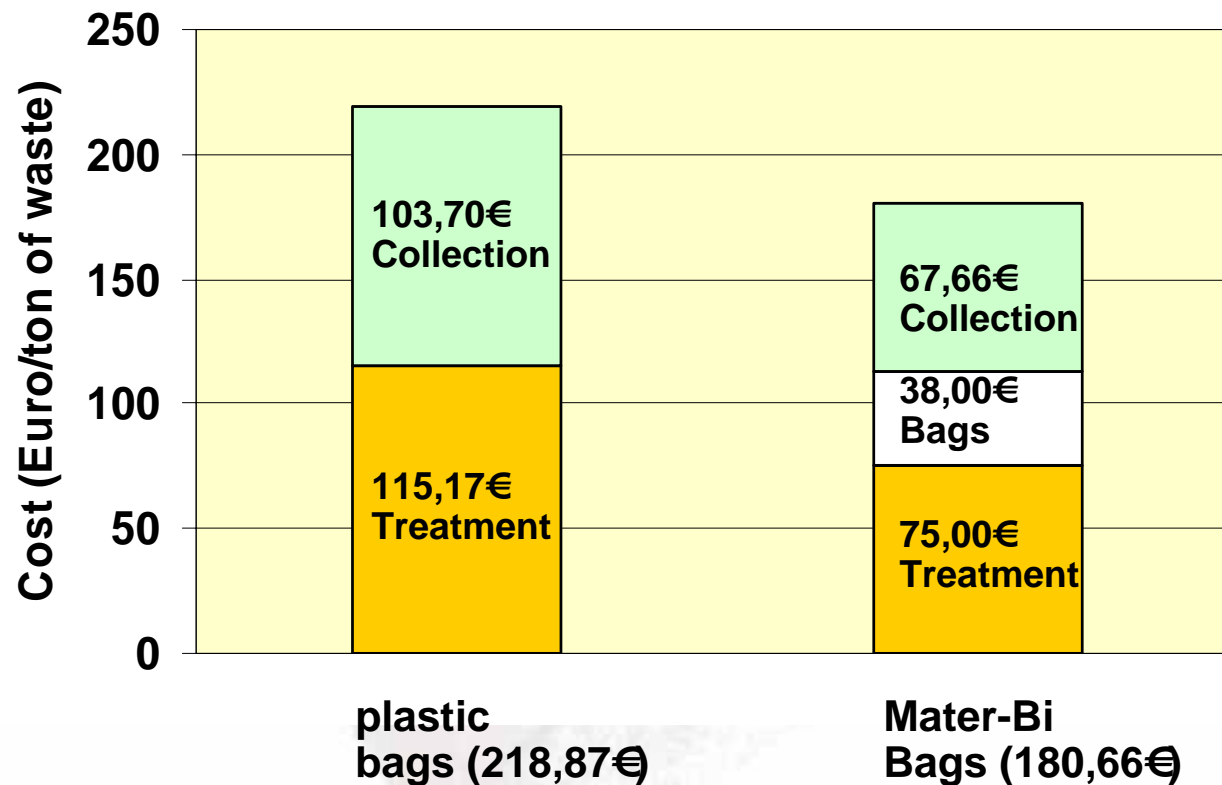


Source: Environmental Protection Agency of Regione Veneto (IT)



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# Example of management costs with MaterBi<sup>®</sup> bags VS plastic bags



Source: Federambiente 2000 – Number of municipalities in sample: 50



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# Cost efficiency of the MaterBi® collection system

- **INCREASED PRODUCTION OF MORE VALUABLE COMPOST** (higher collection rates of high purity biowaste)
- **REDUCED TREATMENT AND DISPOSAL COSTS IN COMPOSTING PLANTS** (no plastic)
- **LOWER COLLECTION EXPENSES FOR RESTWASTE** (less food scraps in restwaste ⇒ reduced collection frequency)



# **Most evident advantages of the MaterBi<sup>®</sup> bags system**

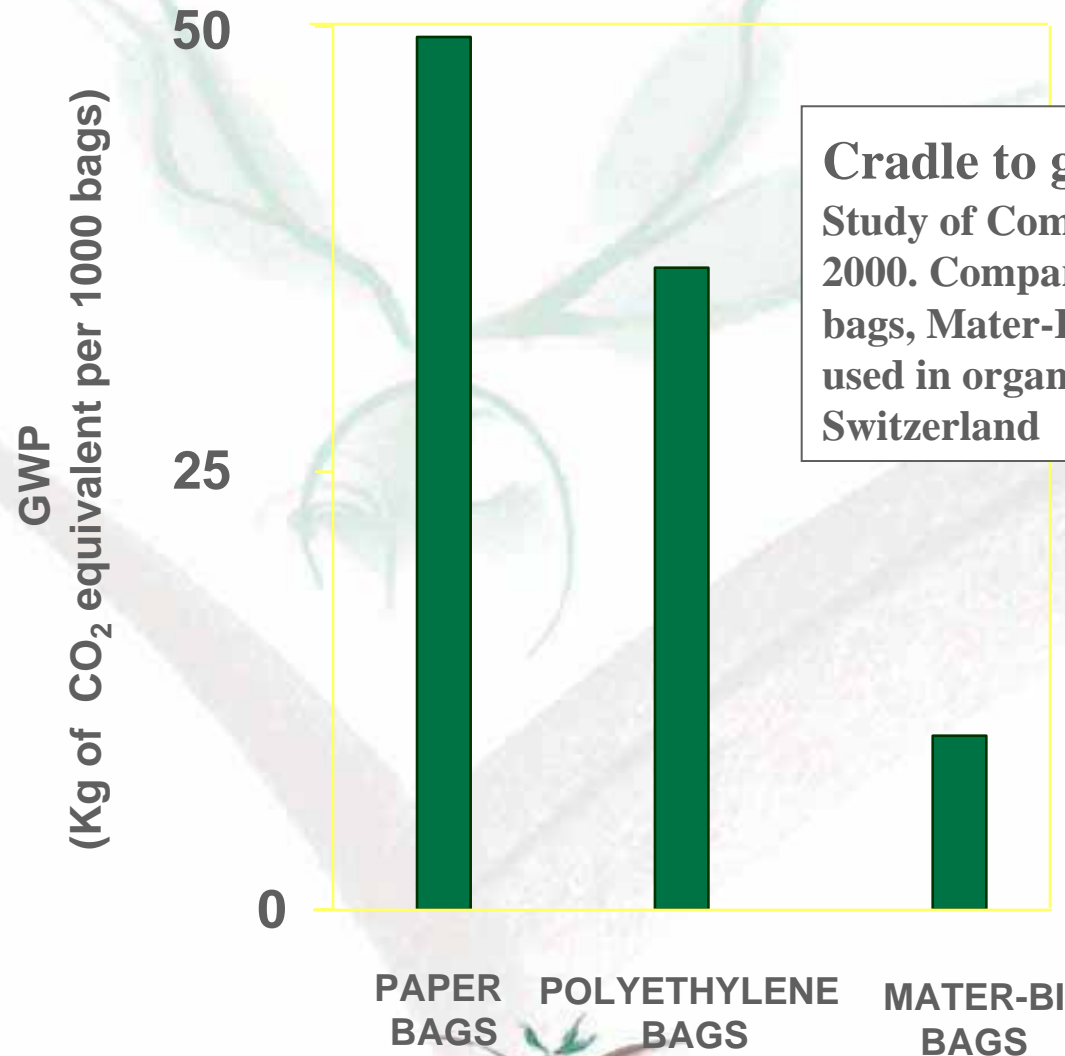
- **HIGH COLLECTION EFFICIENCY**  
(collection rate: up to 85% of total food waste,  
in Curbside collection schemes)
- **HIGH WASTE QUALITY**  
(average of 1% of non compostable materials)

Source: Environmental Protection Agency of Regione Veneto (IT)



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# Global Warming Potential of paper, PE and Mater-Bi bags\*

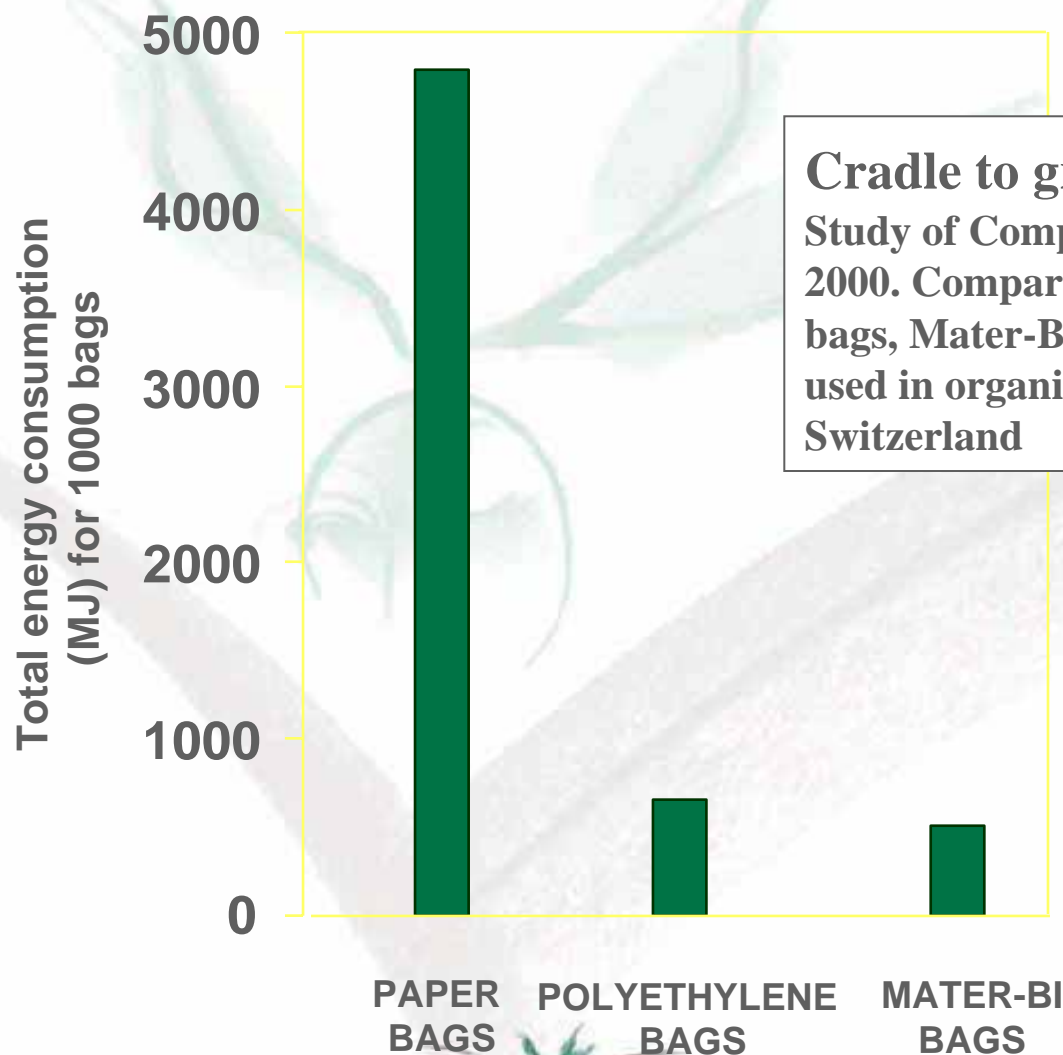


**Cradle to grave approach**  
Study of Composto, Switzerland  
2000. Comparison among paper  
bags, Mater-Bi bags and PE bags  
used in organic waste collection in  
Switzerland





# Total energy consumption of paper, PE and Mater-Bi bags\*



**Cradle to grave approach**  
Study of Composto, Switzerland  
2000. Comparison among paper  
bags, Mater-Bi bags and PE bags  
used in organic waste collection in  
Switzerland



# Conclusions

- **Recovery of organic waste is already a key issue for sound waste management solutions**
- **Curbside collection schemes are the most efficient answer for its separation**
- **MaterBi<sup>®</sup> based systems are the optimum choice when considering user convenience, quantity and quality of collected waste and general expenses of the system**





**Vented and  
solid sided  
kitchen caddies**



**Novamont**

Living Chemistry for Quality of Life.

# Most evident advantages of the MaterBi<sup>®</sup> bags system

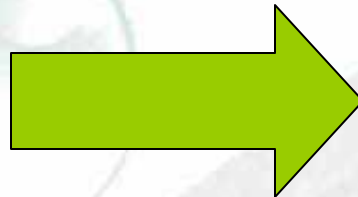
- **HIGH BREATHABILITY in VENTED SYSTEMS**  
**Biobags in vented kitchen caddies allow the drying**  
–Water loss is higher  
**of food waste in the kitchen and a significant**  
**reduction of weight and odour production**

Source: Environmental Protection Agency of Regione Veneto (IT)



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# Actual trend: vented kitchen caddies are replacing solid sided ones



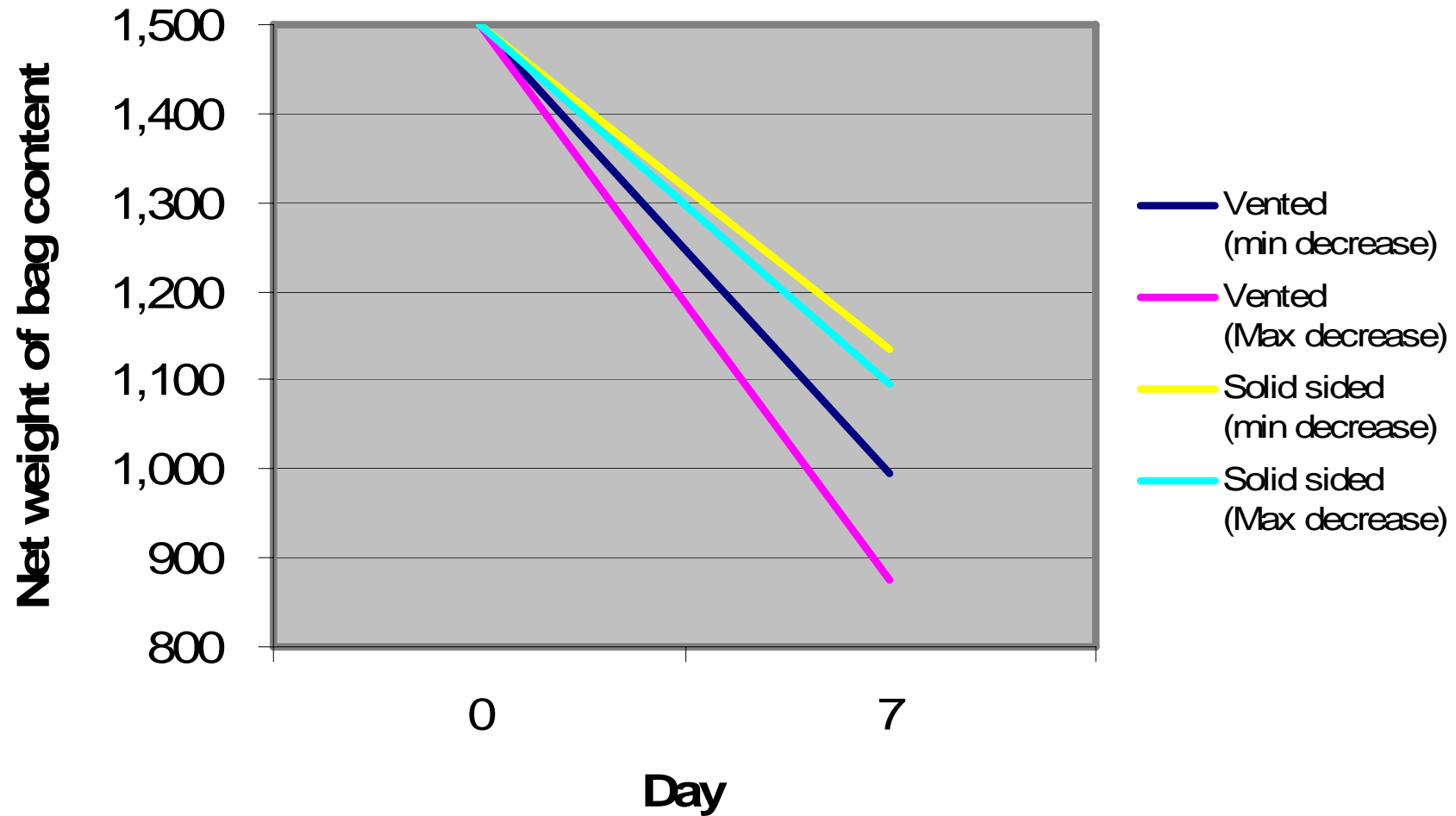
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# Examples of vented caddies



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## Water loss in 7 days at 30°C and 75% r.h.





# Comparative performance test: vented vs solid sided

- As expected, in vented systems:
  - Water loss is higher
  - Fermentation is slower
  - Bags perform better
  - Odours are less
  - Condensation inside the caddy is reduced or absent



## Beneficial to:

- Households
- Staff of the collection service
- Municipality
- Composting facility



**A real sign  
of  
sustainable development.**

