Bioplastics: Hype or Hope?

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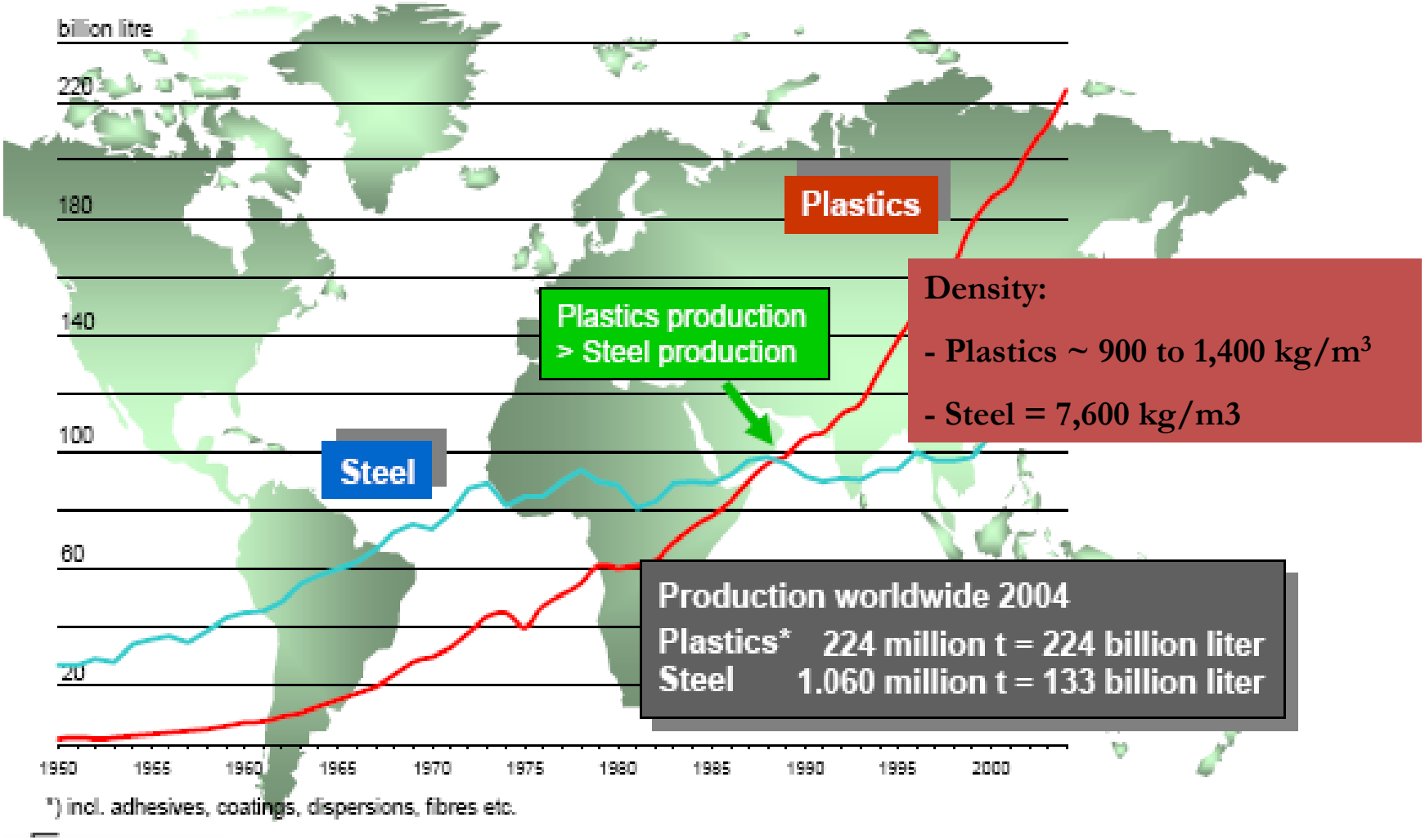
(Bio)based plastics:

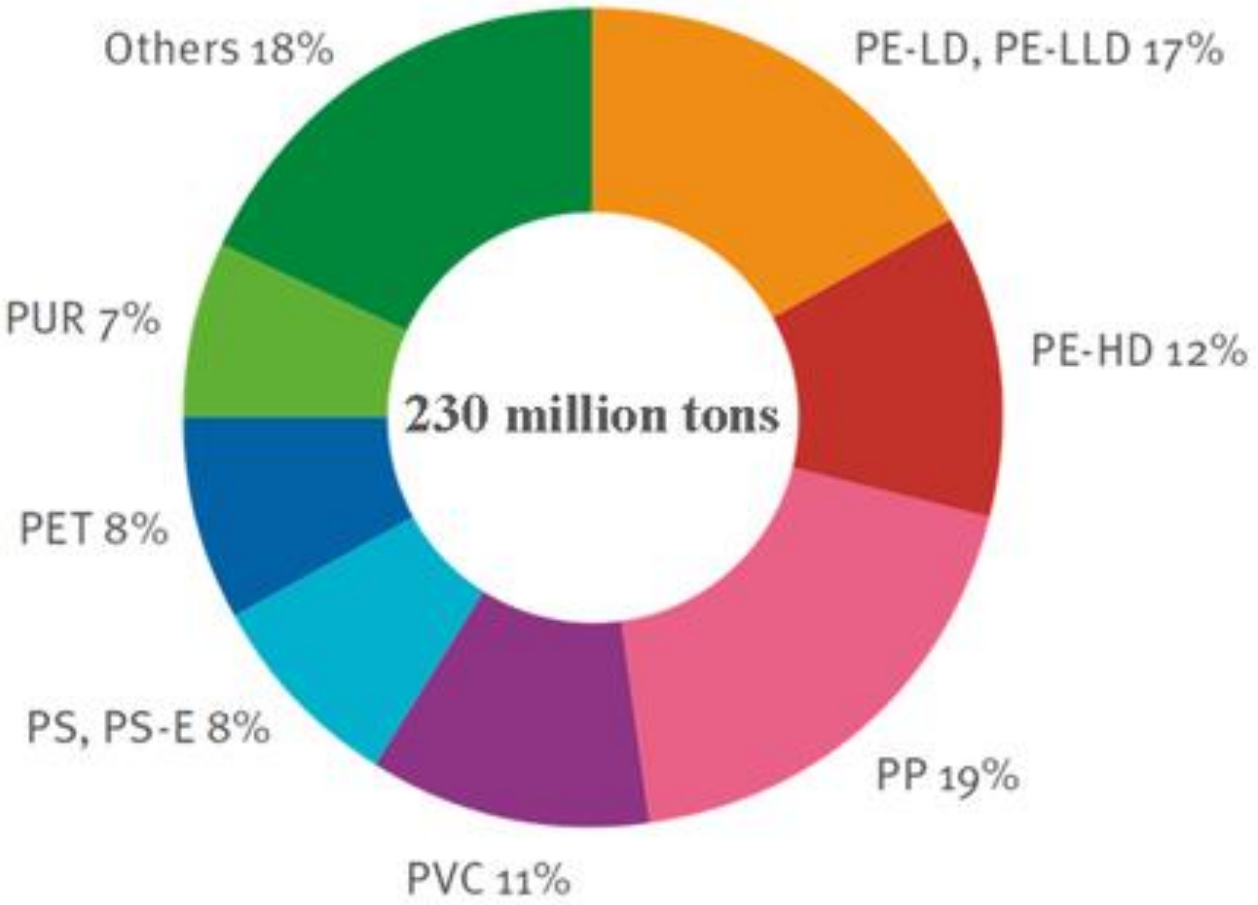
General issues about plastics

Are plastics the future materials?

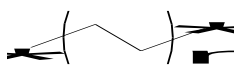


Annually growing rate : from 6.5 to 7.0% (over the last 25 years)
(to be compared with 6% for electronics and 4% for automobile)

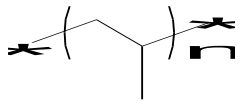
Family of plastics



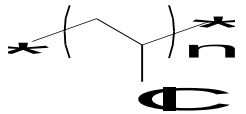
PE:



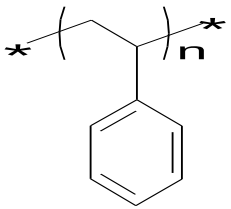
PP:



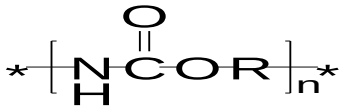
PVC:



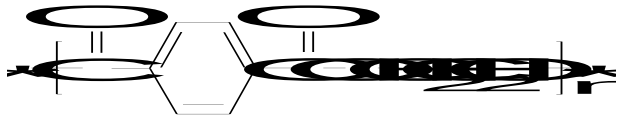
PS:



PUR:



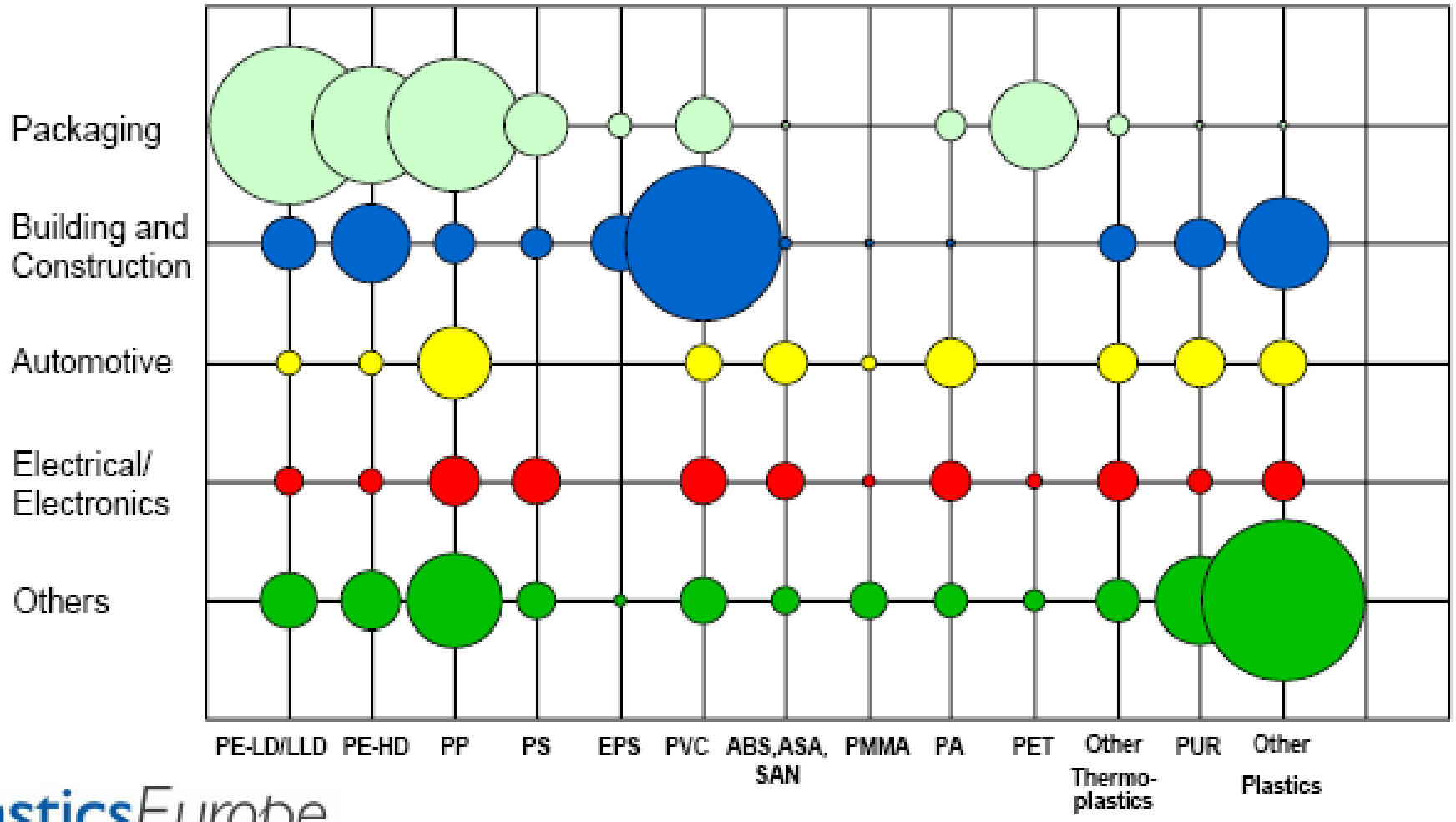
PET:



Others:

epoxy resins, phenolic resins, etc.

Sectors of applications

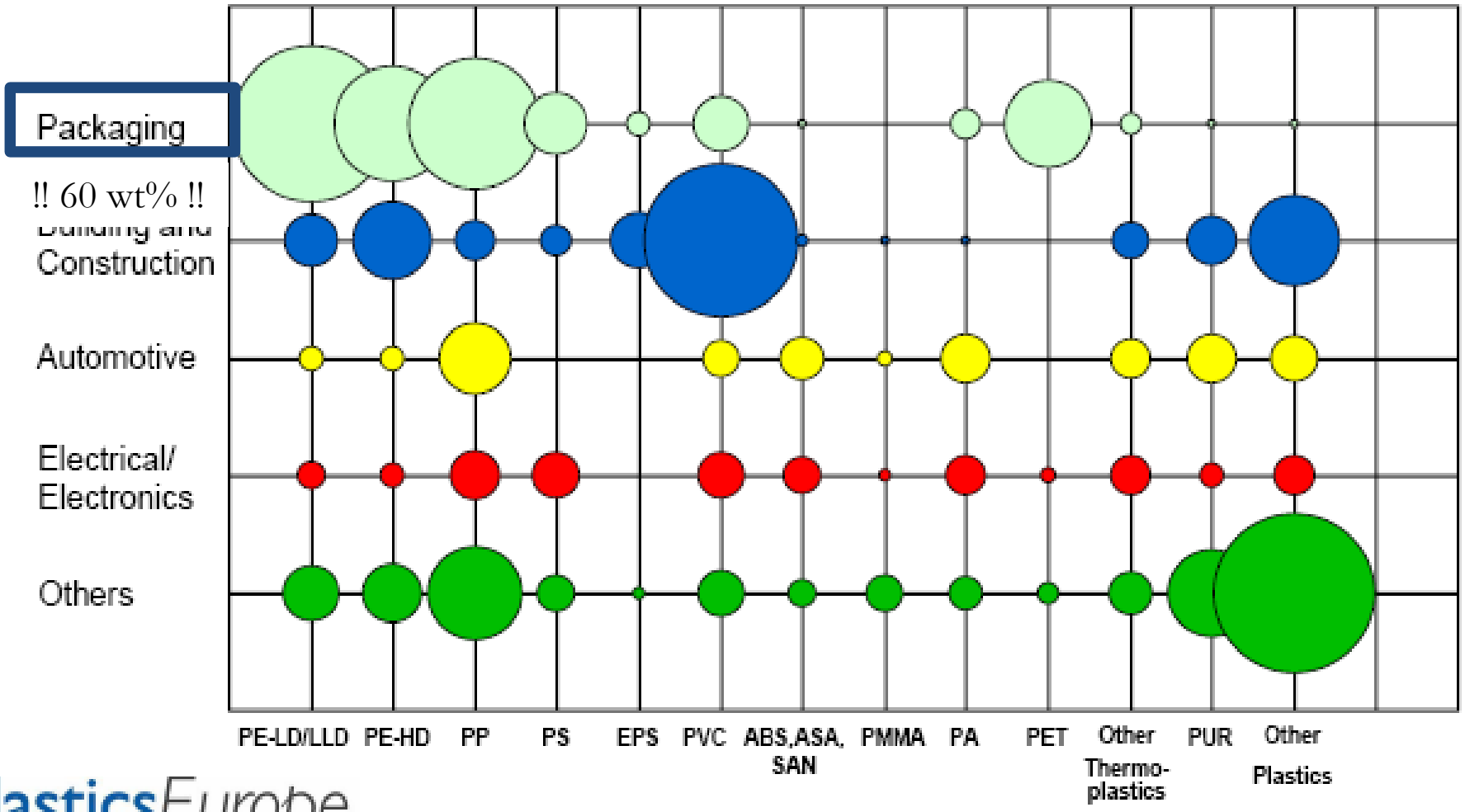


PlasticsEurope
Der Verband der Kunststofferzeuger

Source : PlasticsEurope

Others: medical, pharmaceutical, agriculture, transport, textiles…

Sectors of applications



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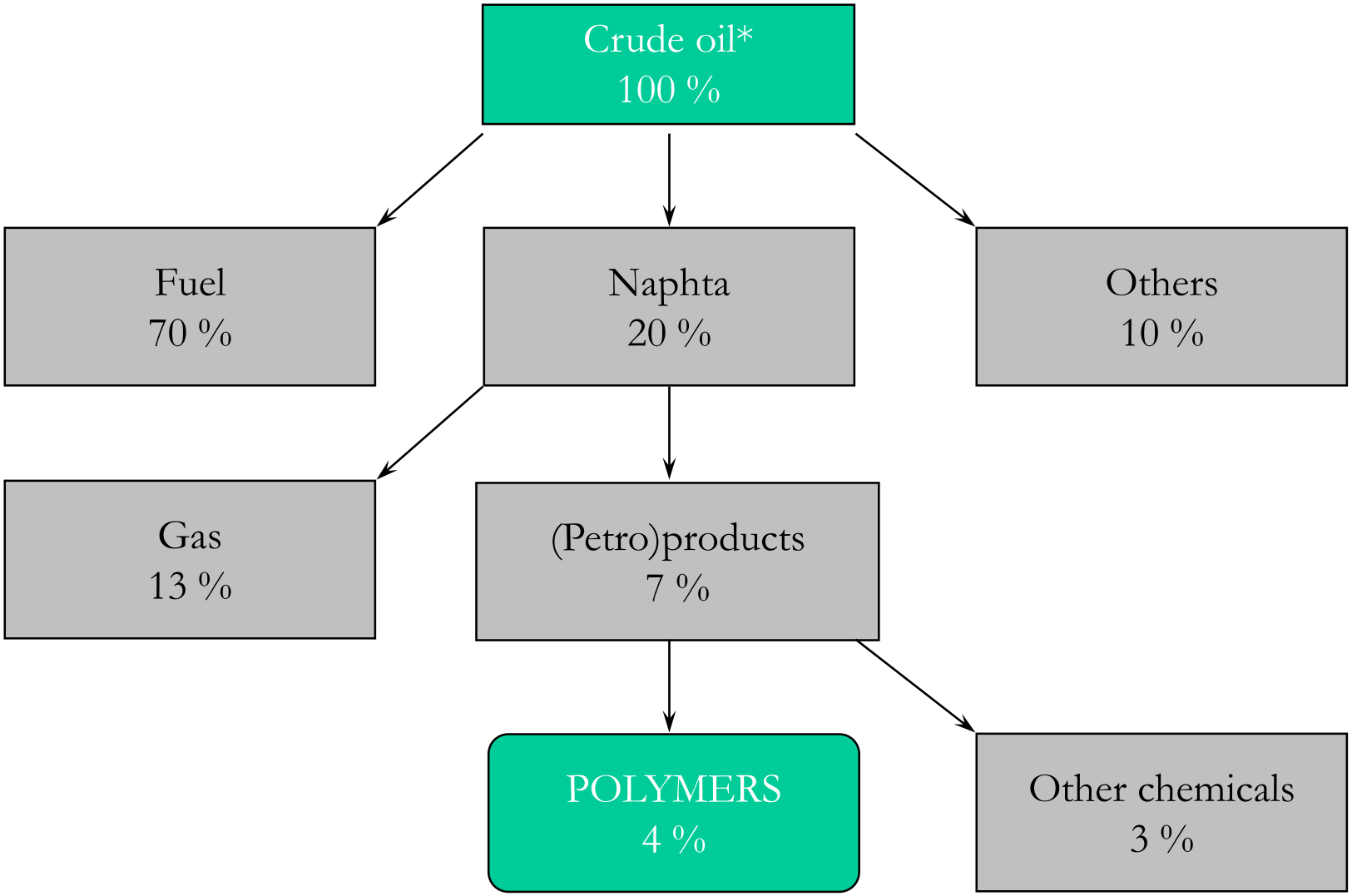
Source : PlasticsEurope

Others: medical, pharmaceutical, agriculture, transport, textiles…

PLASTIC CONSUMPTION : WHAT IMPACT TO THE ENVIRONMENT ?

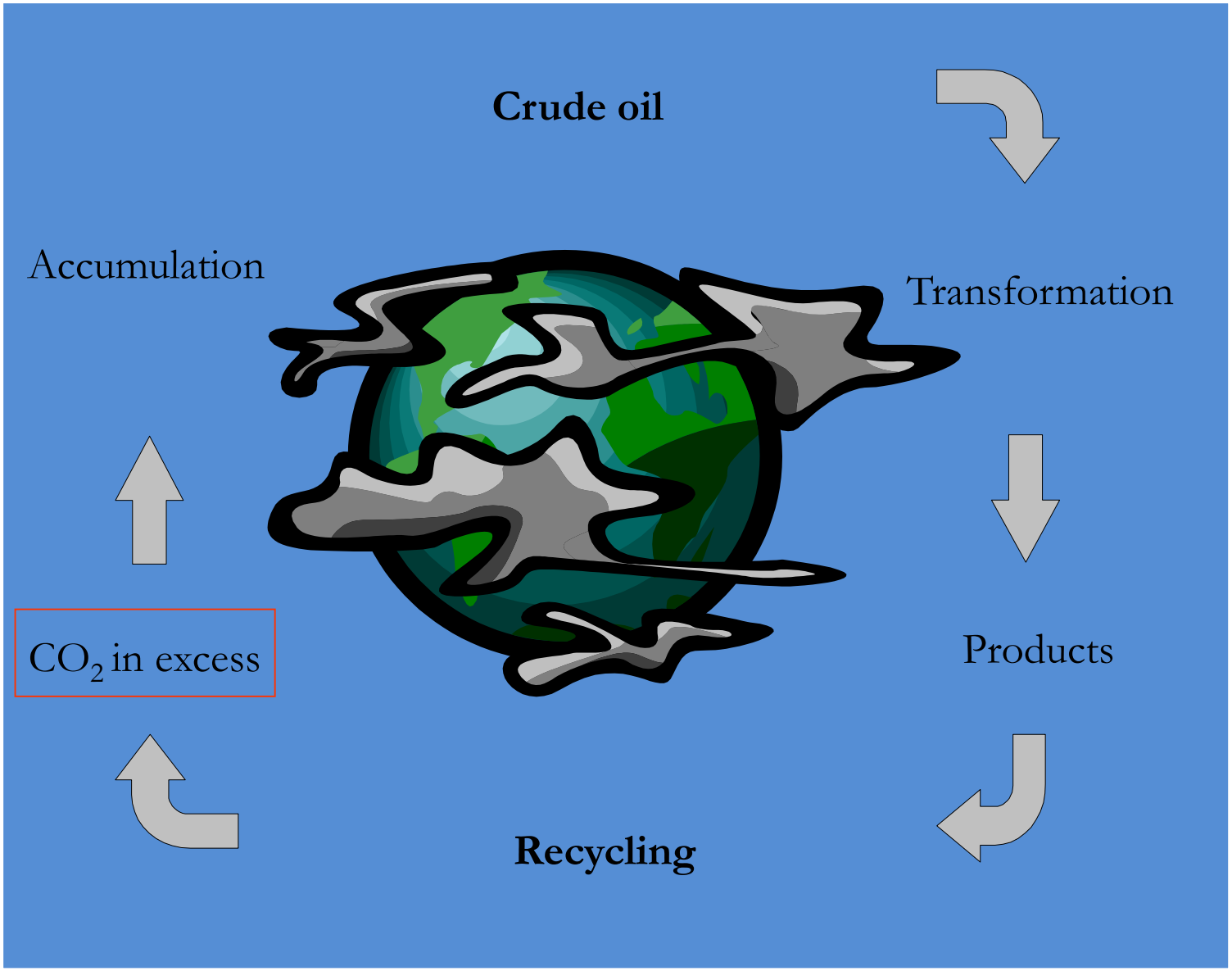
LANDFILLS AND OCEANS ARE CONTAMINATED BY PLASTIC RESIDUES

Plastics are made from oil



(Production ~ 4 10^9 tonnes / an)*

Non-Close Loop of CO2?



Global warming impact

1950 — 2005 — 2050

$CO_2^{atm.} \sim 280_{ppm}$ 380_{ppm} 500_{ppm}

~1.3 ton in CARBONE per person/year

Source : Quelfutur.org (2008)

Any more sustainable plastics ?

The solution: bioplastics ?

- **Bioplastics***: polymers derived from renewable resources (agriculture)

- **Biodegradable** : polymers of controlled and limited lifetime…

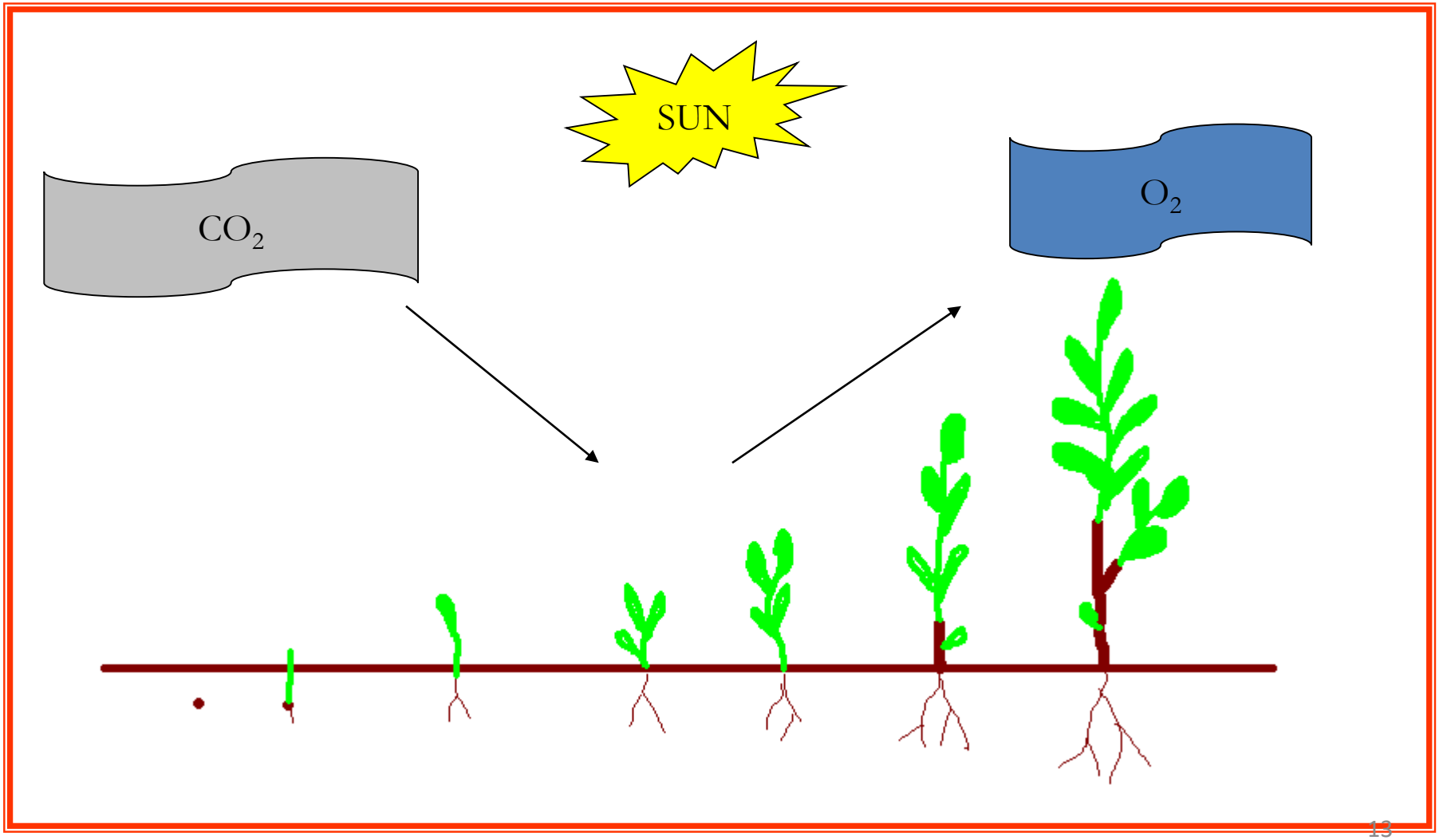
* *Aussi dénommés '**Biosourced plastics**'*

i.e. containing a certain content of biosourced carbon

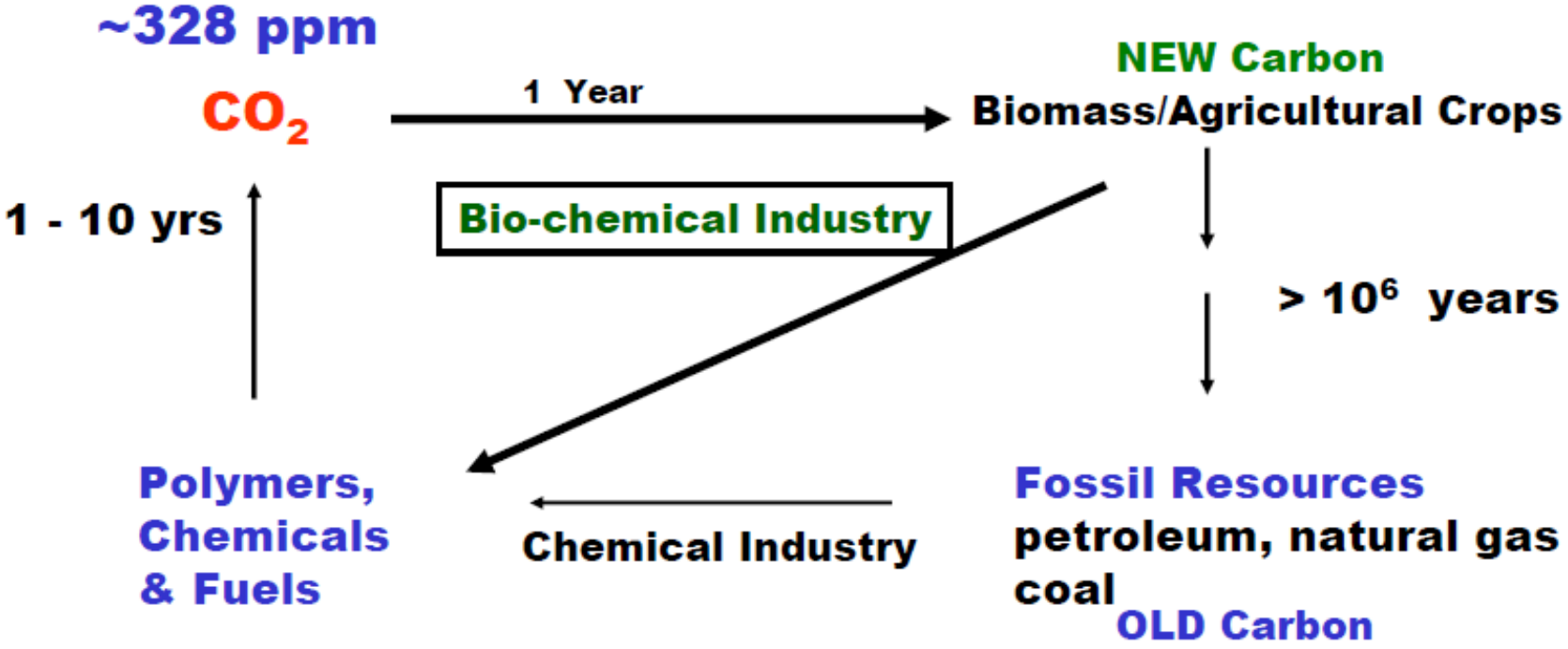
(source : Prof. R. Narayan, nov. 2007)

Biomass: CO_2 entrapping

$$6CO_2 + 6H_2O \xrightarrow{h\nu} C_6H_{12}O_6 + 6O_2$$



Global Carbon Cycling



Life sustaining heat trapping value of CO_2 in the atmosphere is changing to life threatening because of increasing man made carbon and other heat trapping gas emissions to the atmosphere.

BIODEGRADATION: CLASSIFICATION

« **Biodegradation** » is a process in which the degradation results from the action of naturally occurring microorganisms such as bacteria, fungi, and algae.

C-substrate + 6 O_2 ⟶ 6 CO_2 + 6 H_2O

Standards: ASTM D6400, ASTM D6868, ASTM D7081 or EN 13432

- Conversion into CO_2, water and biomass
- 90 % conversion into CO_2
- Degradation rate ~ that of vegetables
- Duration < 180 days
- Non-toxic (plants)

OK compost VINÇOTTE

SOIL OK bio-degradable VINÇOTTE

WATER OK bio-degradable VINÇOTTE

HOME OK compost VINÇOTTE

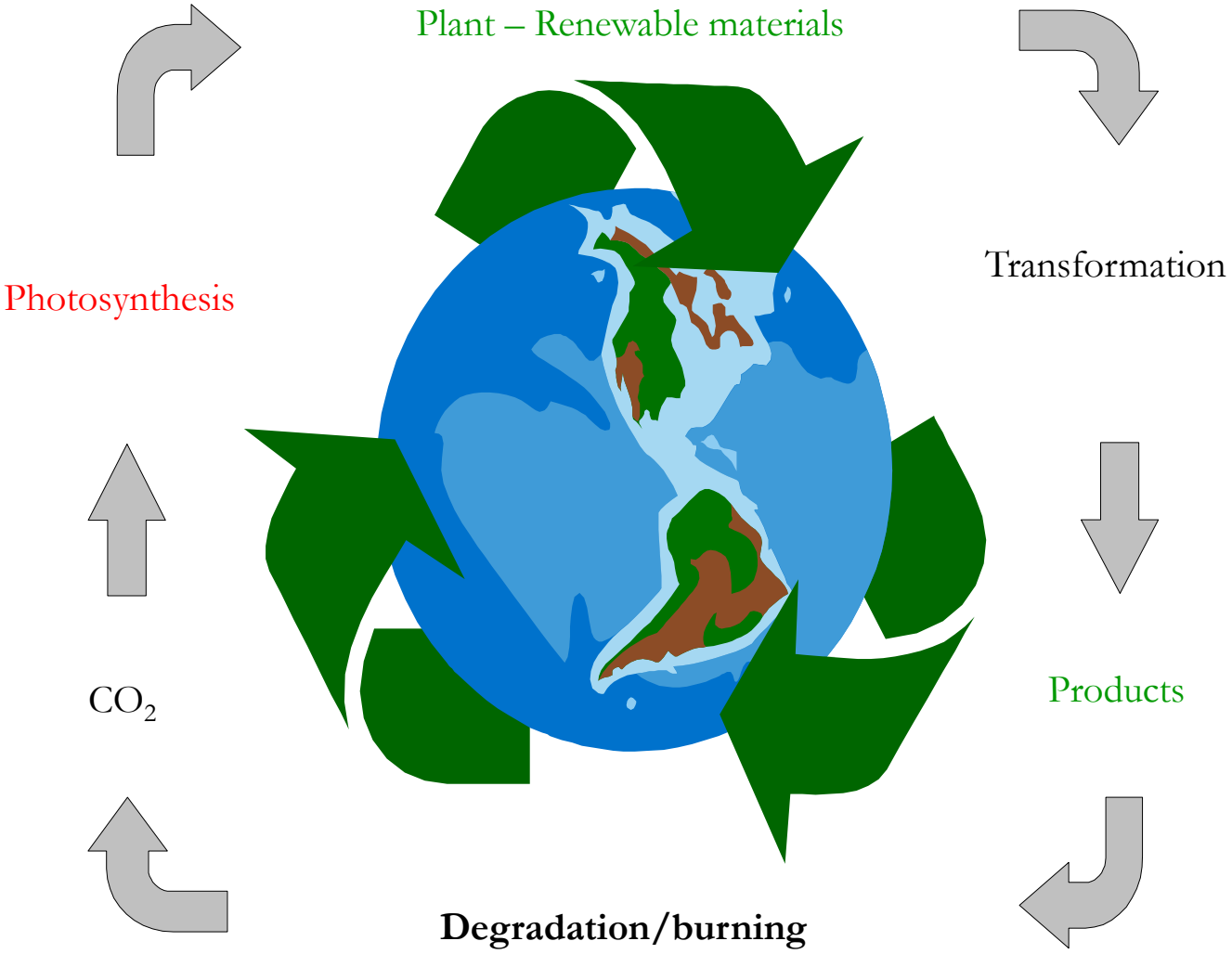
Bottles PLA: Recyclable & Compostable

From Primo Water Coportation (USA)

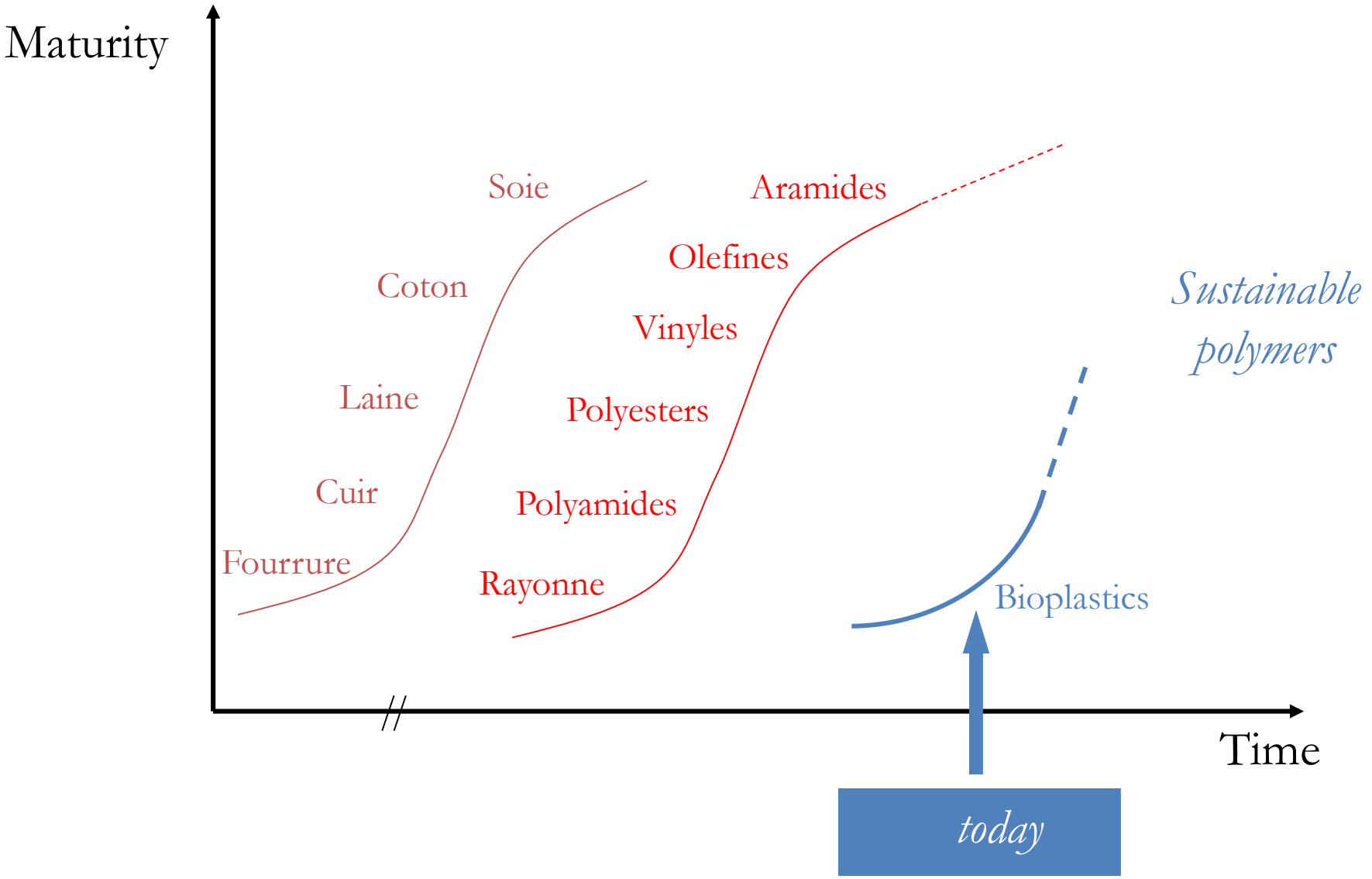
… complete decomposition into CO_2, water and biomass less than 60 days

Bioplastics MAGAZINE, vol. 4 (2009)

Close loop of carbon



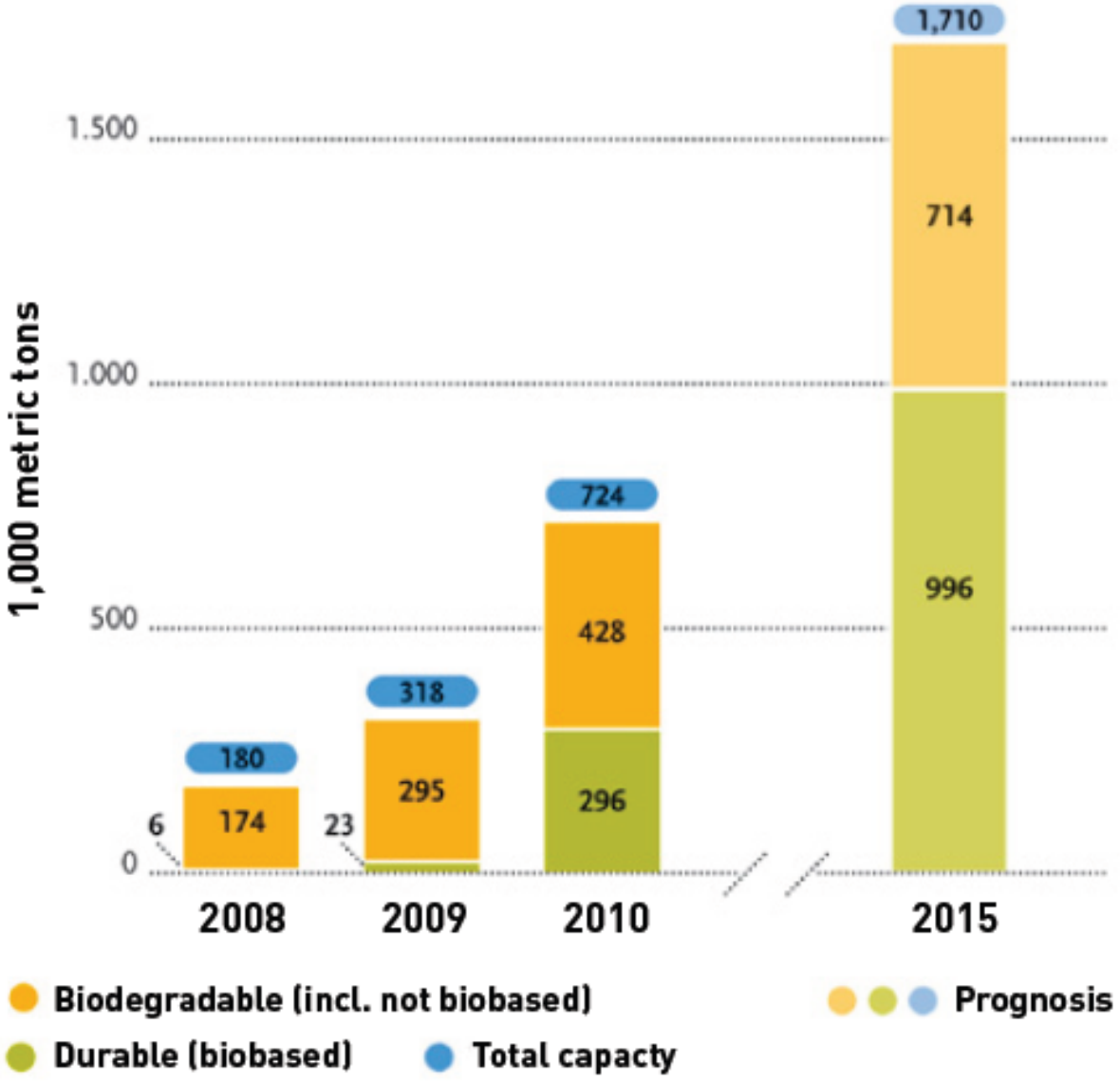
Evolution of polymeric materials with time



(Bio)based plastics:

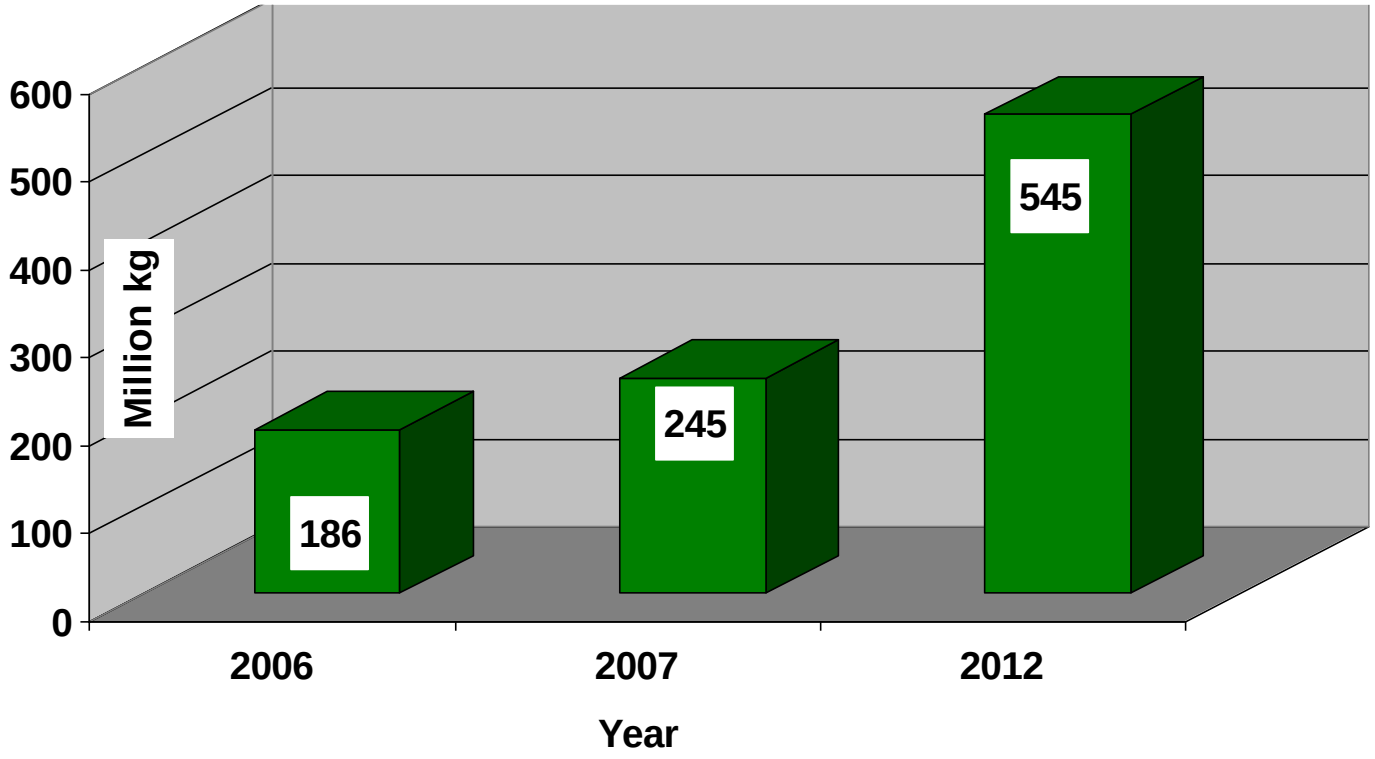
New trends in the design of biobased plastics

Global production capacity of bioplastics



Against 250 mio tons in polymers

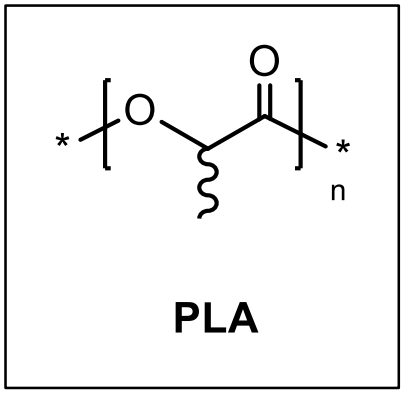
Leadership in bioplastic market



- PLA : 43% volume ! ⟵ **Via renewable resources**
- Polysaccharides *(starch)*
- Other polyesters *(PCL, PBAT, PBS, PHA,…)*

Poly(lactic acid) (PLA)

PLA is the most representative biodegradable and bio-based polymer on the market

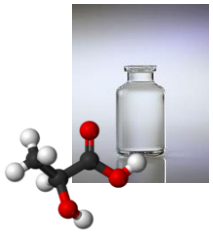


Raw material

Extraction

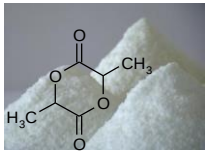
Sugar

Fermentation



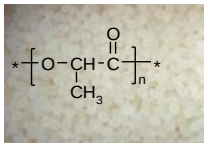
Lactic acid

Polycondensation/ Cyclization



Lactide

Polymerization



Polylactide

Production

Applications

Chemical recycling

Compostage

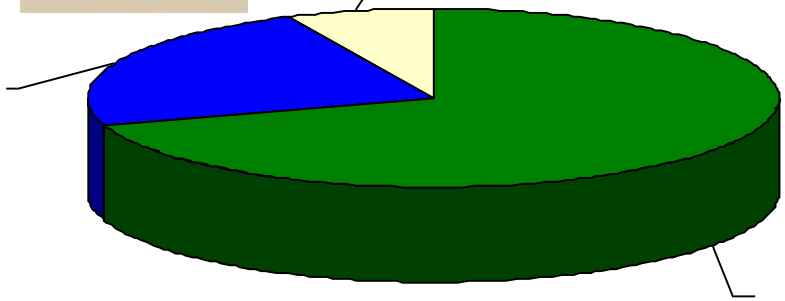
Derived from sugar beet, but also from agricultural wastes

Applications of PLA-based materials

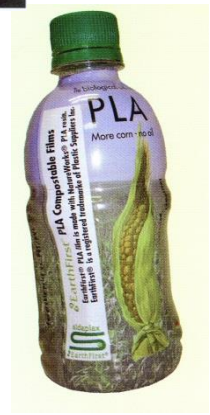
Industrial realm of PLA-based materials

Others
7%

Fibres
23%



Packaging
70%



Source : D. Platt, "*Biodegradable Polymers Market Report*", Smithers Rapra Ltd., 2006

Packaging made in PLA

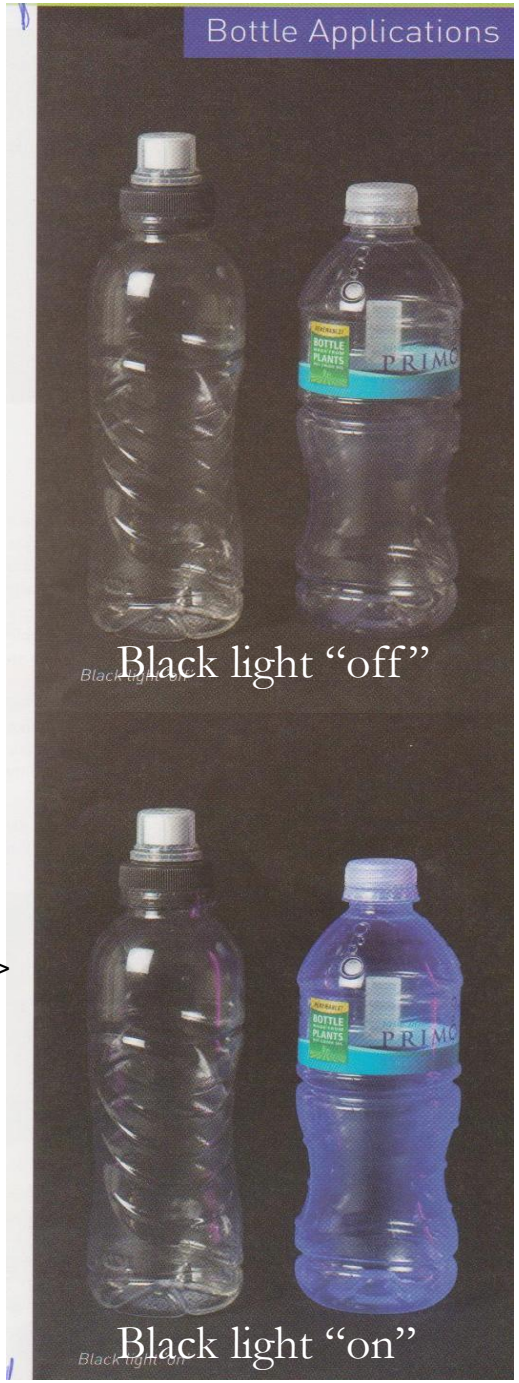
Bioplastics Magazine (05 & 6/2008)

Bottles made in PLA :
Recycling & Compostable

From Primo Water Coportation (USA)

The bottles made in PLA can be readily identified and automatically sorted using NIR equipments (existing set-up in most industries working in Recycling

Moreover, Primo added a fluorescent agent in PLA >>>>

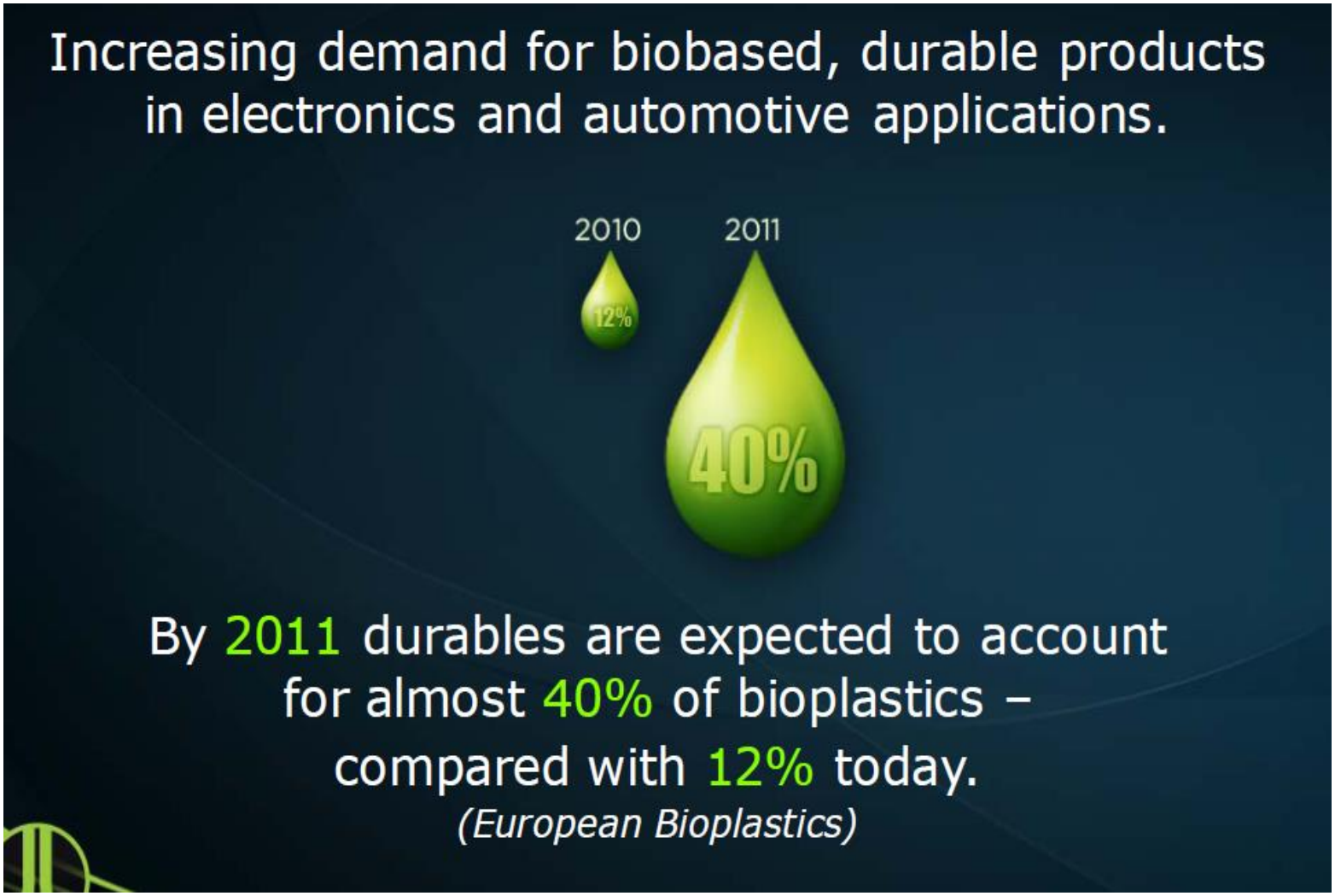


Bioplastics MAGAZINE, vol. 4 (2009)

(Bio)based plastics:

The future?

Long-term applications for PLA-based materials



The increasing demand is related with electronics and automotive applications

(Source: Dr. Jim Lunt, The World of Bioplastics, Plastics News Executive Forum in Tampa, Florida, 7-10.03.2010)

Electronics made in PLA

En 2010 : ca. 10^9 GSM (10% recyclé, temps de vie ~ 1.5 an)

Bioplastics Magazine (2008)

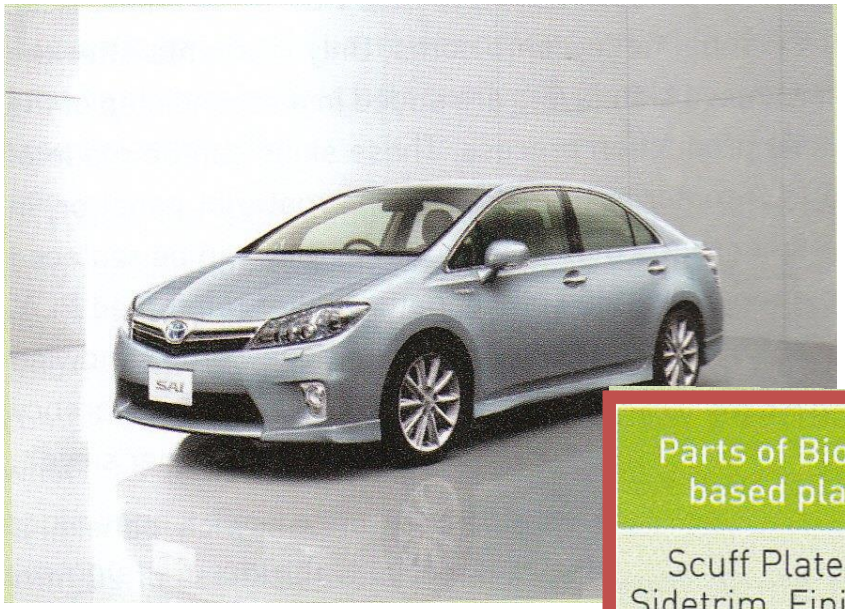
Electronics made in PLA

CANON

NEC

Bioplastics Magazine (Dec. 2010)

Automotive parts made in PLA (Toyota)



Parts of Biomass-based plastics	Materials		
	Biomass-based	Petroleumbased	Technology
Scuff Plate, Cowl Sidetrim, Finish Plate	PolyLactide (PLA)	Polypropylene (PP)	Compatibilized Compound
Tool Box			
Ceiling, Front Pillar, Center Pillar	Biomass-based Polyester	Polyethylene Terephthalate	Conjugated Fiber
Roofside trim, Sunvisor			
Baggage Trim, baggage Sidetrim	PolyLactide (PLA)	Polyethylene Terephthalate	Composit Fiber
baggage Doortrim, baggage Floormat			
Door Trim	PolyLactide (PLA) /Kenaf		Composit Product
Seat Cushon	Caster Oil based Polyol	Polyol / Isocyanate	Polyurethane

Bioplastics Magazine, vol. 5 (2010)

Last trend: combinaison between both biobased and petroleum-based polymers

SAMSUNG RECLAIM (Sprint, USA)

Blend with polycarbonate (petroleum-based) and PLA (40%)

From : www.samsung.com (dec. 2009)

Shoes Ecotrekker from Bayer Material Science

The content in biobased materials is higher than 70%.

From PRW.COM (Sept. 14, 2010)

Ecovio FS (BASF): Blend between Ecoflex and PLA

Paper cups and shrink film are the first two applications for BASF's new biodegradable plastic Ecovio® FS

High-Performance and Biodegradable

From : www.ecovio.com (dec. 2009)

Certification "OK Biobased"

Communication from the label : 1 to 4 'stars'

- principe : *more stars more biobased content*

	content in biobased polymers
1 star :	20 – 40%
2 stars :	40 – 60%
3 stars :	60 – 80%
4 stars :	> 80%

From : www.okbiobased.be (dec. 2009)

(Bio)based plastics:

The price?

PLA – at the price of PET ...

... through the new technology of Uhde Inventa-Fischer

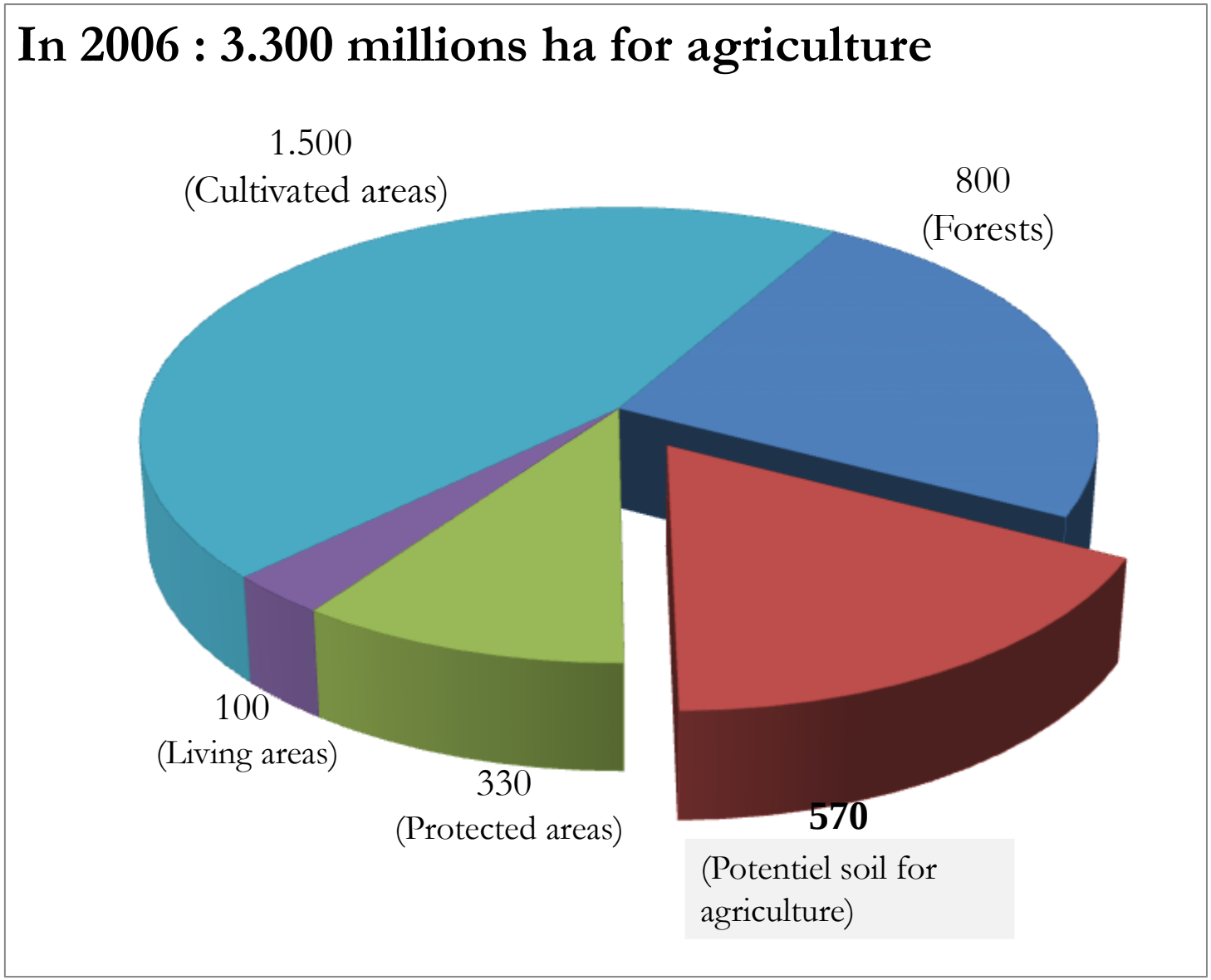
Petrochemical feedstock prices are further climbing, while our resources are shrinking. PLA, independent from crude oil, bio-degradable and made of renewable resources such as corn and sugar can be used for any number of different applications: Thermoformed packaging, bottles and fibers, for film, for agricultural applications as well as structural medical engineering applications such as suture material, screws and meshes for bone fastening.

Bioplastics Magazine (01/2007)

(Bio)based plastics:

Enough renewable resources?

Agriculture soils available for biobased monomers

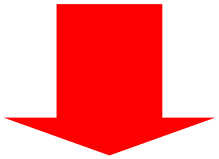


Sources : FAO 2008, OECD 2007, FAPRI 2007, nova 2007

Expressed in million hectares

Worlwide production in biomass:

170 10^9 tons/year



3.5 %

Biomass USED in 2010 :

6 10^9 tons/an

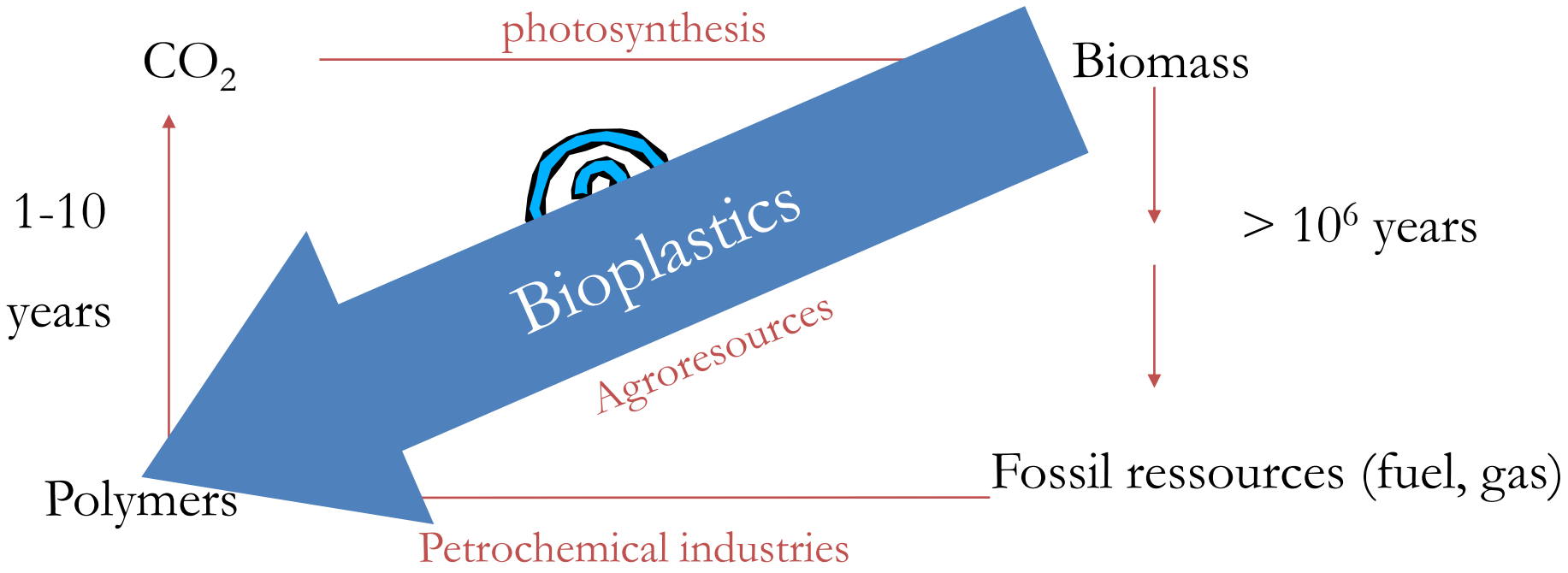
- 62% food applications
- 33% wood (papier, construction & furnitures)
- 5% non-food applications (chemicals, textiles,…)

From « Amar Mohanty », Canada, Dec. 2010

Recently the impact of bioplastics has been about 250 times lower than the impact of biofuels, hence lower than 0.1%. Therefore, the impact of bioplastics on the world food market is negligible. Additionally, producing biofuels or bioplastics means in most cases also producing high value protein-rich by-products that can be used as animal feed.

Bioplastics MAGAZINE, vol. 4 (2009)

Summary



… But time is still necessary…