ARKEMA

WMF 2022
Bio-Materials

16/6/2022

ARKEMA INNOVATIVE MATERIALS FOR A SUSTAINABLE WORLD

Summary

Bio-materials : why ?

Bio and sustainability: a demanding journey

Bio-materials: the paths forward

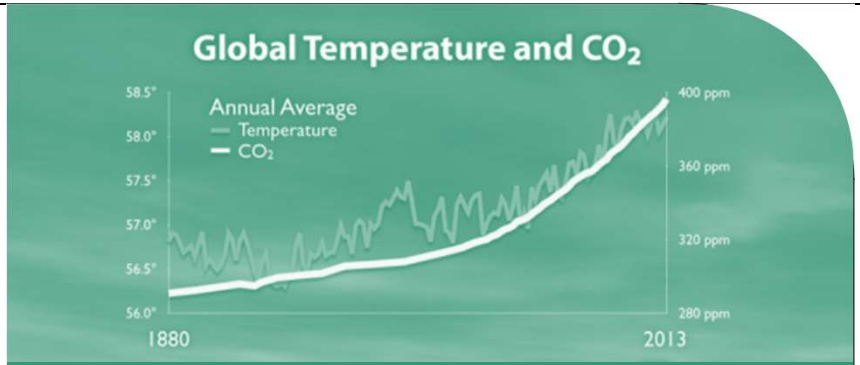
Bio-materials @Arkema

All data in this presentation are estimated in good faith, but have not been audited. They are indicative and meant as guidelines only.

An urgent need to address the environmental challenges

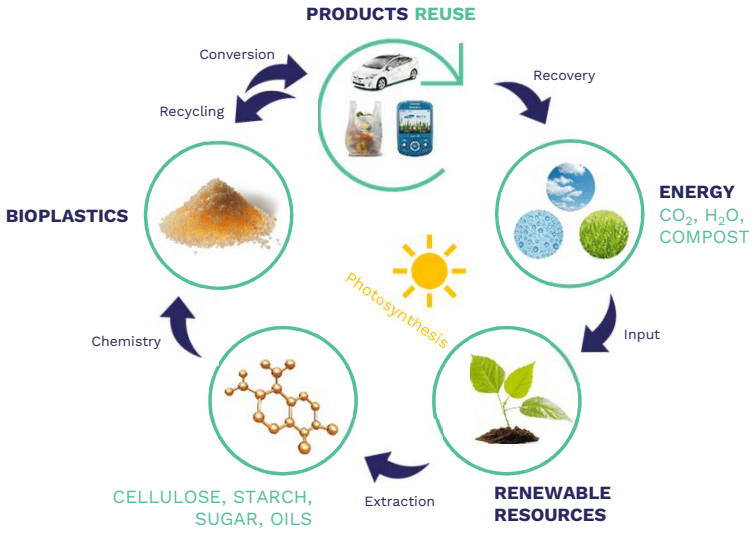
We need to:

- → Reduce the GHG emissions of mankind to limit global warming and its consequences
- → Address resources scarcity and availability



Temperature vs. CO2, 1880-2013
(U.S. National Climate Assessment, via Climate Central)

- → Many paths are being explored
  - energy efficiency
  - new energy production and storage
  - lightweighting
  - circular economy....
- → **A bio-based economy is a natural candidate**



Already a reality today

- **Bio-based chemicals** are already established, mostly for biofuels
  - Bio-ethanol (#100MT/y WW), bio-diesel (#35MT/y WW)

- **Bio-plastics** are growing steadily
  - Bio-plastics: already around 5MT/y WW
  - With important newcomers (e.g. PLA)

NatureWorks

A growing global demand for bio-materials

There is a demand from economic actors at all levels:

- **Consumer** demand pushes the bio-based materials growth
- In the **B to B** context, environmental commitments bring companies to seek for low CO_2 solutions

Nike Strides Toward Ambitious Sustainability Goals

By Jessica Binns

PRESS RELEASE
July 21, 2020

Apple commits to be 100 percent carbon neutral for its supply chain and products by 2030

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Bio-based chemicals are not necessarily fully virtuous

→ Let's compare the CO_2 emissions of Acrylic Acid from two routes

	RM contribution	Yield loss contribution	Energy contribution	Total CO_2 (kg/kg)
PEN > ACO > AA	0,87%	42%	-29%	100%
Glucose > Lactic acid > AA	-29%	50%	121%	142%

analysis done for a specific location

These data are indicative and meant as guidelines only.

→ Even if CO_2 emissions are lower, biodegradability may still be an issue

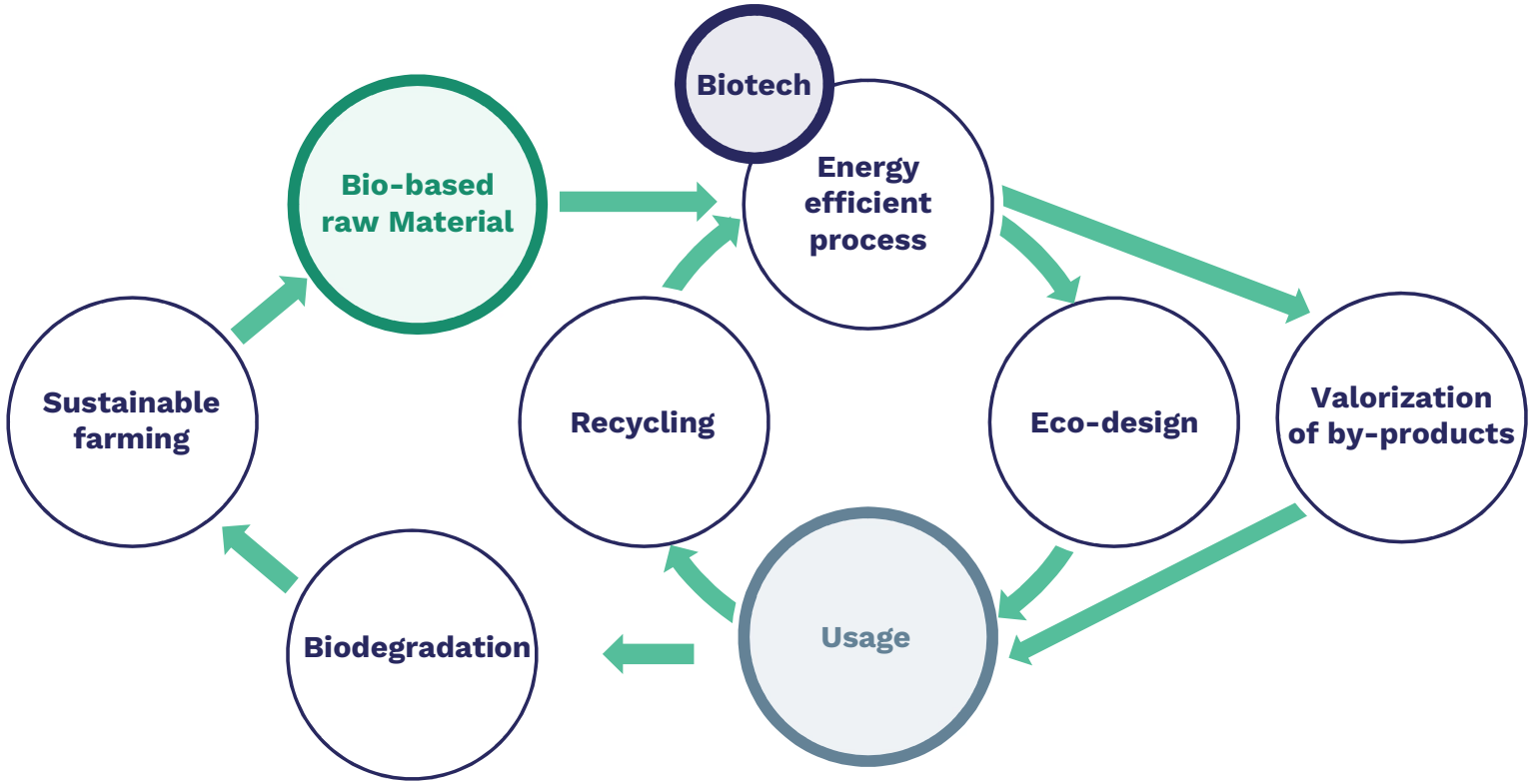
- Not all bio-based polymers are spontaneously biodegradable
- There are technologies using additives to promote bacteria activity

Radical PLASTICS

→ Cost of goods, and resource availability, will add difficulties

Sustainability, along the entire life cycle

→ The key point for a sustainable bio-based product, is to be sustainable during the entire life cycle: **from a sustainable agriculture, to a full recycle loop**



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The many resources of bio-based materials

Many challenges: performance, cost, availability, competition for resources

→ Exploration of many sources, chemical paths and processes

Many sources: « wood or food »?

→ Ligno-cellulosic compounds : less expensive, more difficult

- Natural fibers of wood / starch / hemp are already used
- Bio-refineries based on pyrolysis have been extensively studied but still elusive

→ Sugar and vegetal oil chemistry: more expensive, easier to process

avantium

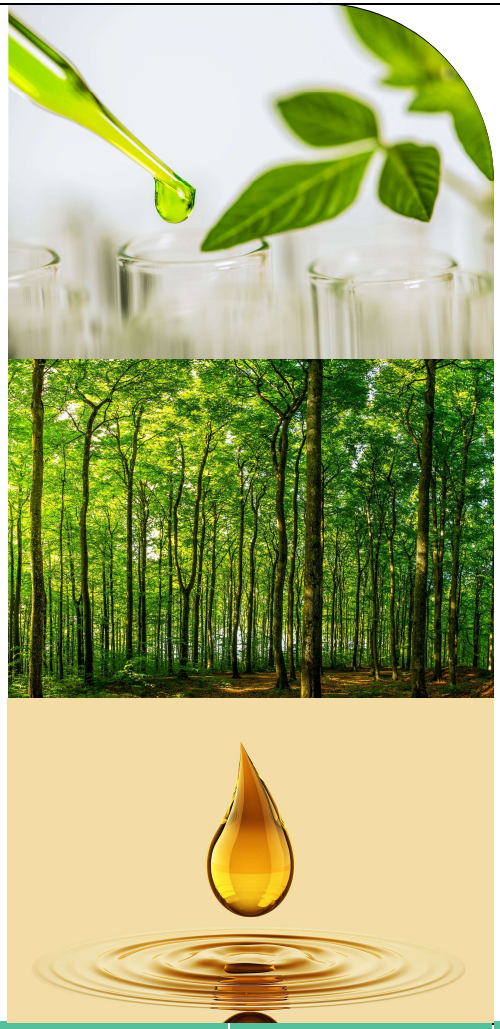
RELEMENT
Adding the R-element.

ABOLIS
BIO-SYNTHESIS ARCHITECTS

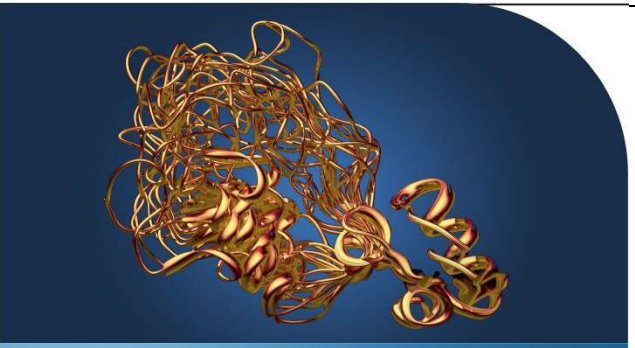
polykey
innovative solutions for polymer chemistry

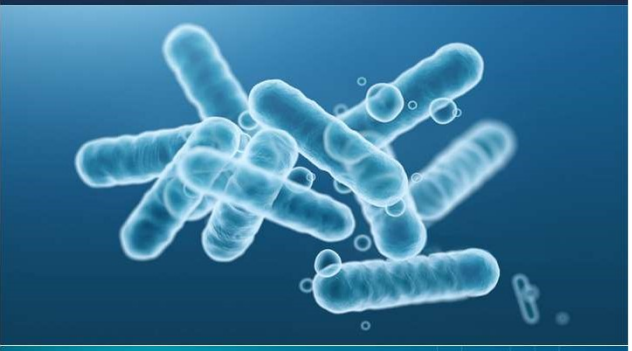
INDUSTRIAL MICROBES

VISOLIS
CARBON NEGATIVE MATERIALS



The many processes for Bio-based materials





Another segmentation of the landscape: according to process

→ **Enzymatic processes**

- Pros: Catalytic technology, with life science power
- Cons: Kinetics may be low

→ **Fermentation processes**

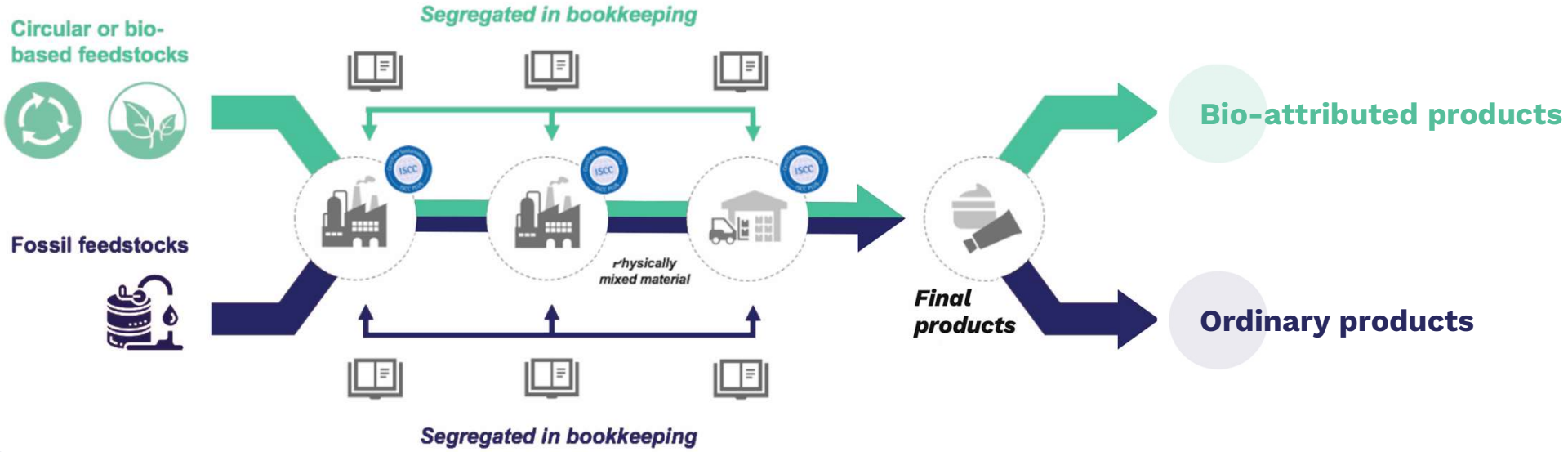
- Pros: Water based process, low temperature, high selectivity, « one pot synthesis »
- Cons: Low concentration of product, high separation costs, long developping times

→ **And also… Chemical processes**

- Pros: Operational efficiency, assets already existing
- Cons: Not always adapted to bio-based complicated products

The investment wall, and the Mass Balance approach

- Developing a new « industry » for fully segregated bio-based products would require significant industrial investments, in time and money
- The mass balance approach, similar to the green electricity credit, allows to kick-start bio-markets at reasonable cost



inspired by ISCC report

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Arkema Corporate Social Responsibility Policy

OUR 3 COMMITMENTS

Deliver sustainable solutions driven by innovation

- Solutions that address societal challenges
- Innovation at the heart of the activities
- Product stewardship

Manage our activities as a responsible manufacturer

- Safety of people and processes
- Health
- Environmental footprint reduction

Cultivate an open dialogue and close relations with our stakeholders

- Ethics
- Human rights
- Diversity & Employee development
- Responsible value chain
- Corporate citizenship

Innovative materials for a sustainable world

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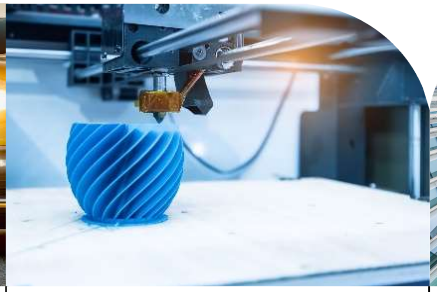
New energies and clean mobility



Lightweight materials and design

Living comfort and home efficiency

Natural resources and the circular economy

Electronics solutions

→ Natural resources irrigates all ARKEMA innovation platforms, allowing environmental benefit and technical performance

Bio-materials @Arkema : Performance and Sustainability

RILSAN®
PA11

A high performance bio-based polymer, invented in 1947

PEBAX®
RNEW

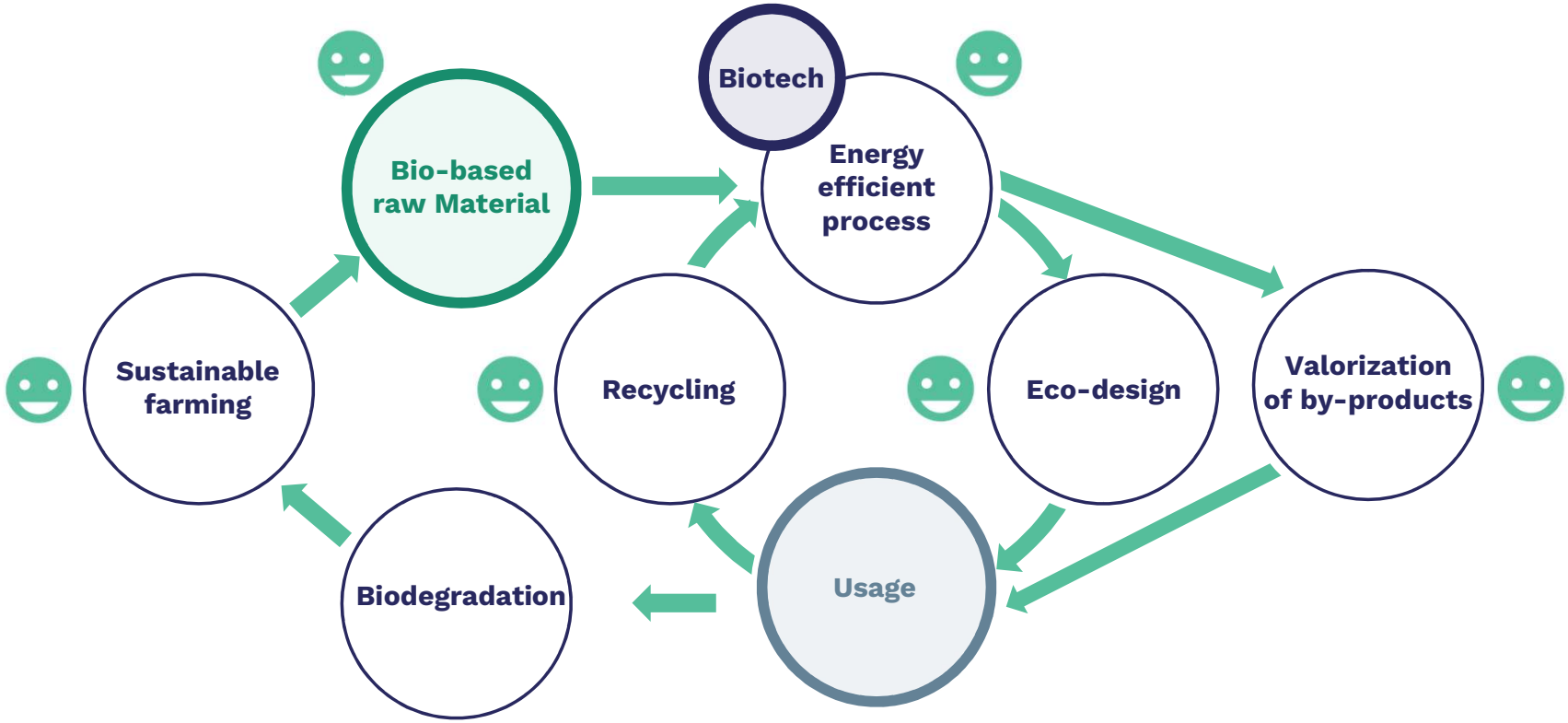
KYNAR®
PVDF CTO

NUPLAVIVA
C75

BIO ACRYLICS

Movie: the virtuous PA11 loop

The virtuous loop of bio-based products



Partnerships are key to achieve such solutions, within existing value chains and beyond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