

Arkema, une présence historique sur le marché des produits biosourcés.

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Scientific Director

Catalysis, Processes and Biomass Conversion

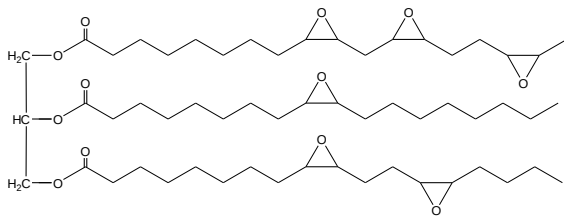
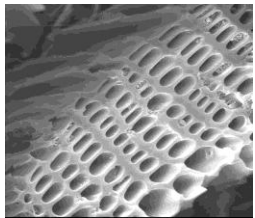
Arkema received the 2013 Award from the European Biomass Industry Association for its merits in advanced biomass processing



Three business segments

High Performance Materials

- **Specialty polyamides**
- Fluoropolymers
- **CECA**
- **Functional additives**



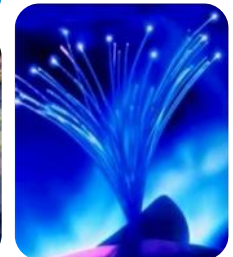
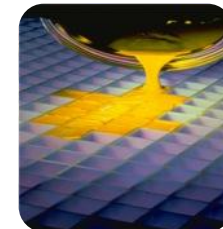
Industrial Specialties

- **Thiochemicals**
- Fluorogases
- **Altuglas International**
- Hydrogen peroxide



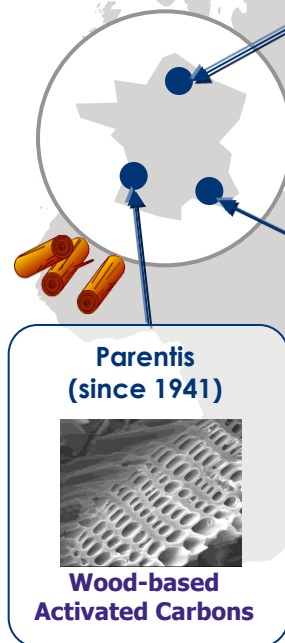
Coating Solutions

- **Acrylic monomers**
- **Coating resins**
- **Sartomer**
- **Coatex**



Arkema's Plant-Based factories

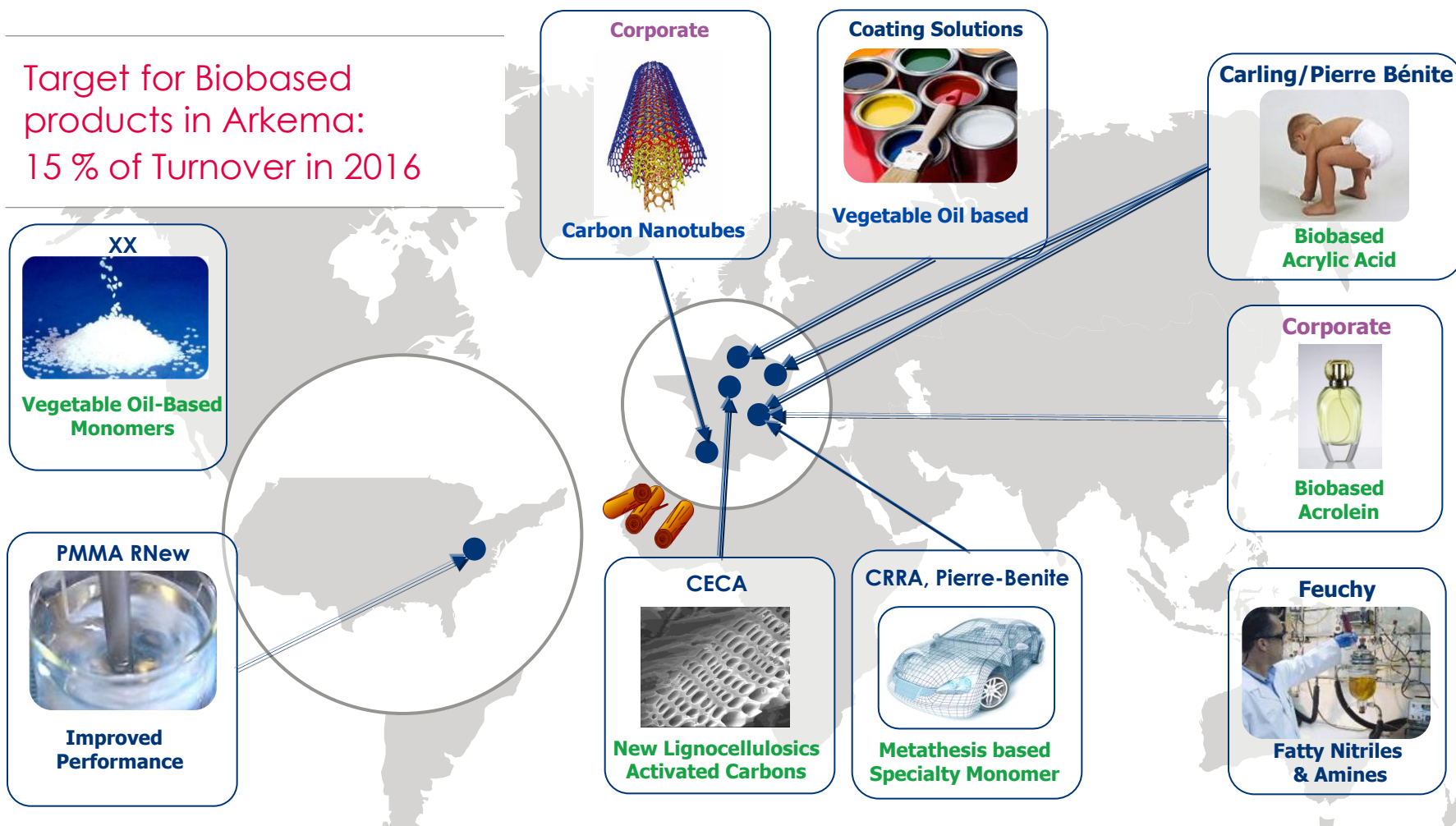
4 Vegetable Oil-based
1 Wood-based
11 % of Turnover (~ 700 M€ / 1 G\$)



Arkema's Renewable Products have technical advantages

New Biobased Products and R&D Projects

Target for Biobased products in Arkema:
15 % of Turnover in 2016



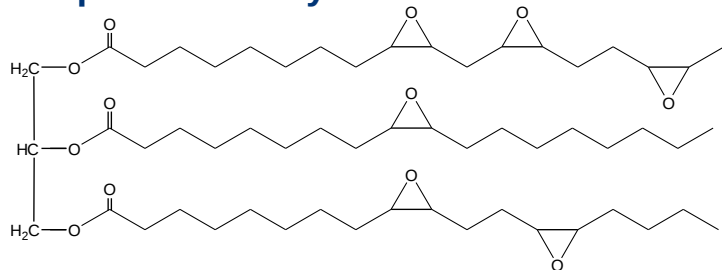
Arkema's Renewable Products have technical advantages

Products made from Biomass in Arkema

Arkema's Plant-based Factories (Marseille-Saint Menet (France), Hengshui (China), Blooming Prairie (USA), Parentis (France), Feuchy (France))

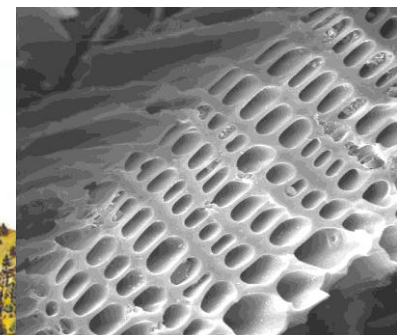
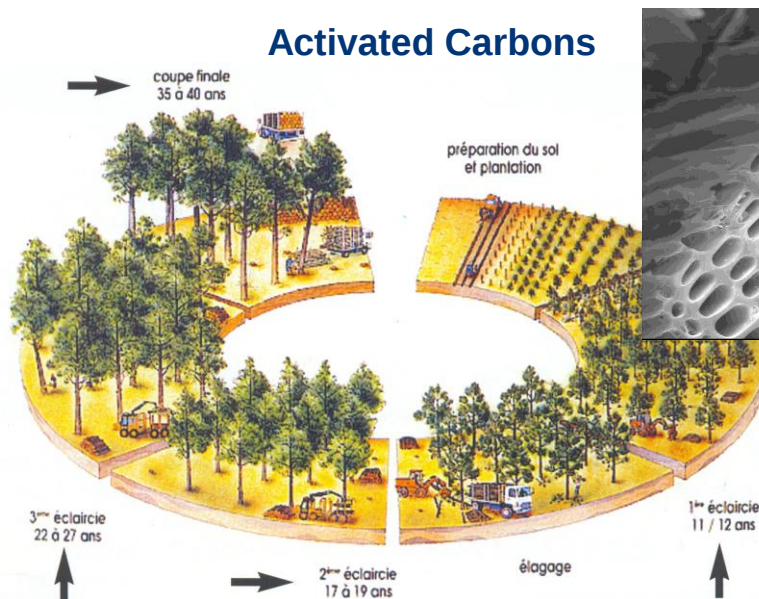
Fatty Amines

Epoxidized Soy/lin Oil

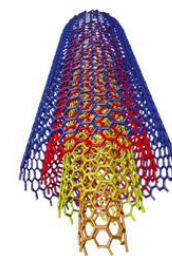


Bitumen additives

Activated Carbons



Castor Oil Products



Carbon Nano Tubes

ARKEMA
INNOVATIVE CHEMISTRY

Arkema is a member of the European Biorefinery Projects



and a member of other technology related projects.



Bio-resourced polymers (100% renewable)



Glycerol



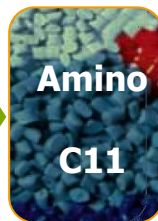
2 Octanol derivatives



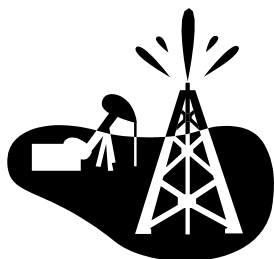
PA THT

PA HT

Bio-composites



Arkema's Renewable Long Chain Polyamides



Butadiene

CDT

Lactame-12

Polyamide-12

Castor Oil

Undecenoic Acid

Amino-11

Polyamide-11

Sebacic Acid

Diamine-10

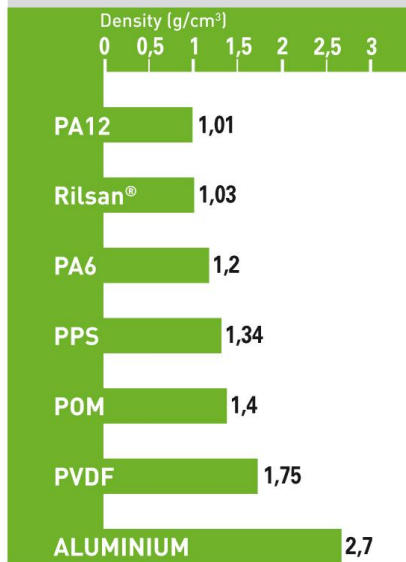
Polyamide-10.10



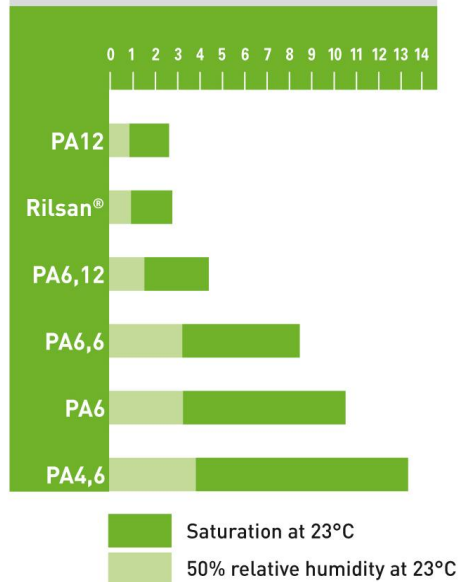
Polyamides

➤ Polyamide-11 (Rilsan) and other long chain polyamides have better technical properties

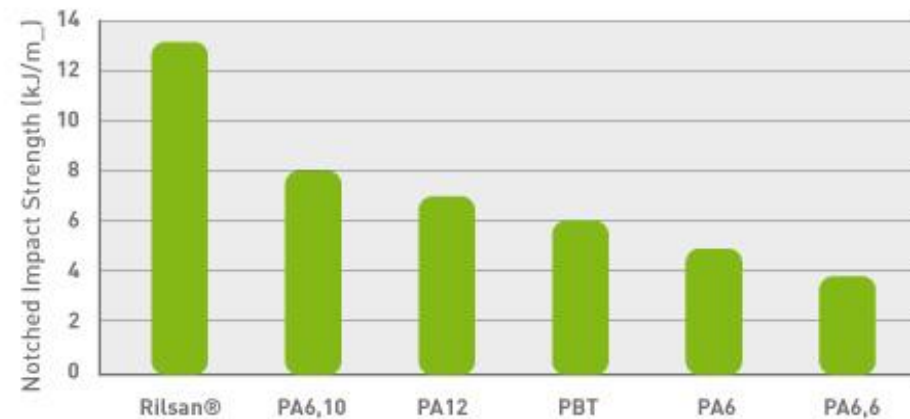
Comparative density of Rilsan® vs various engineering polymers and aluminium, per ISO 1183 standard.



Water absorption based on relative moisture rate of Rilsan® vs various polyamides, per ISO 62 standard.

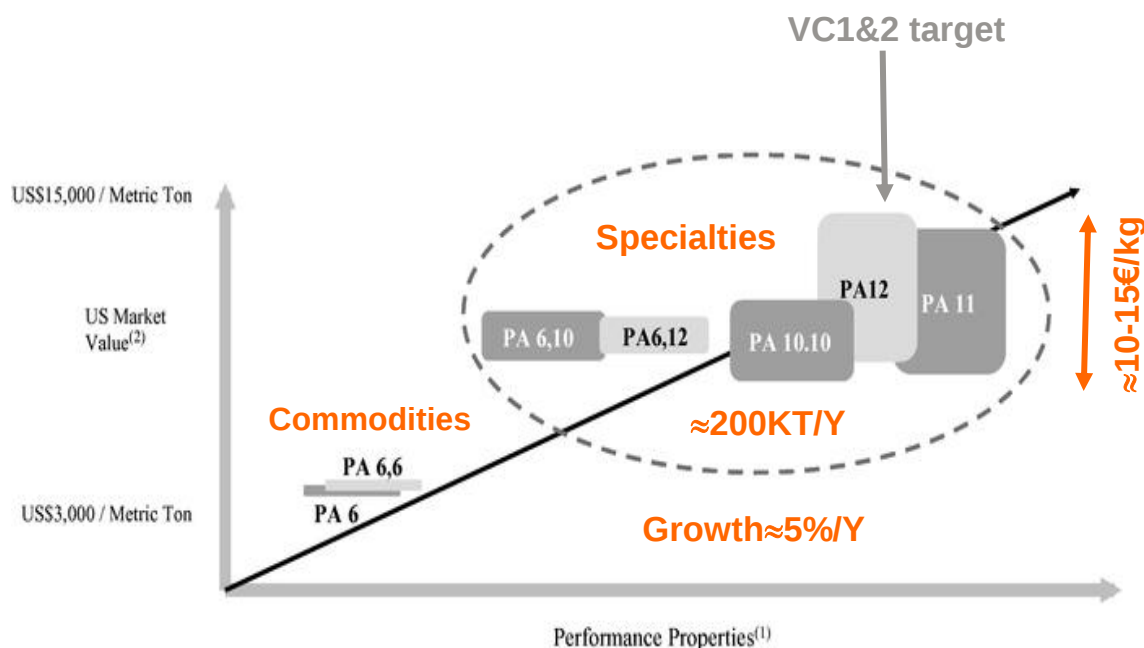


Comparative impact resistance at -30°C of Charpy notched Rilsan® and others polymers, according ISO 179-1eA – Extrusion Grade



Polyamides market

☞ Value / Performance



Source: Cathay Industrial Biotech Ltd., IPO F1 form, July 19th 2011

Main end-markets

Transportation

Fuel lines
Air brake systems



Energy

Flexible pipes for deep
off shore oil recovery



Consumer goods

Sport (shoes, ski boots,
etc..)
Cosmetics



Industrial coatings

Powder coating
Adhesives (hot melt)



Electronics

Covers for laptops and
mobile devices



Marseille Saint-Menet, France

Castor Oil-based

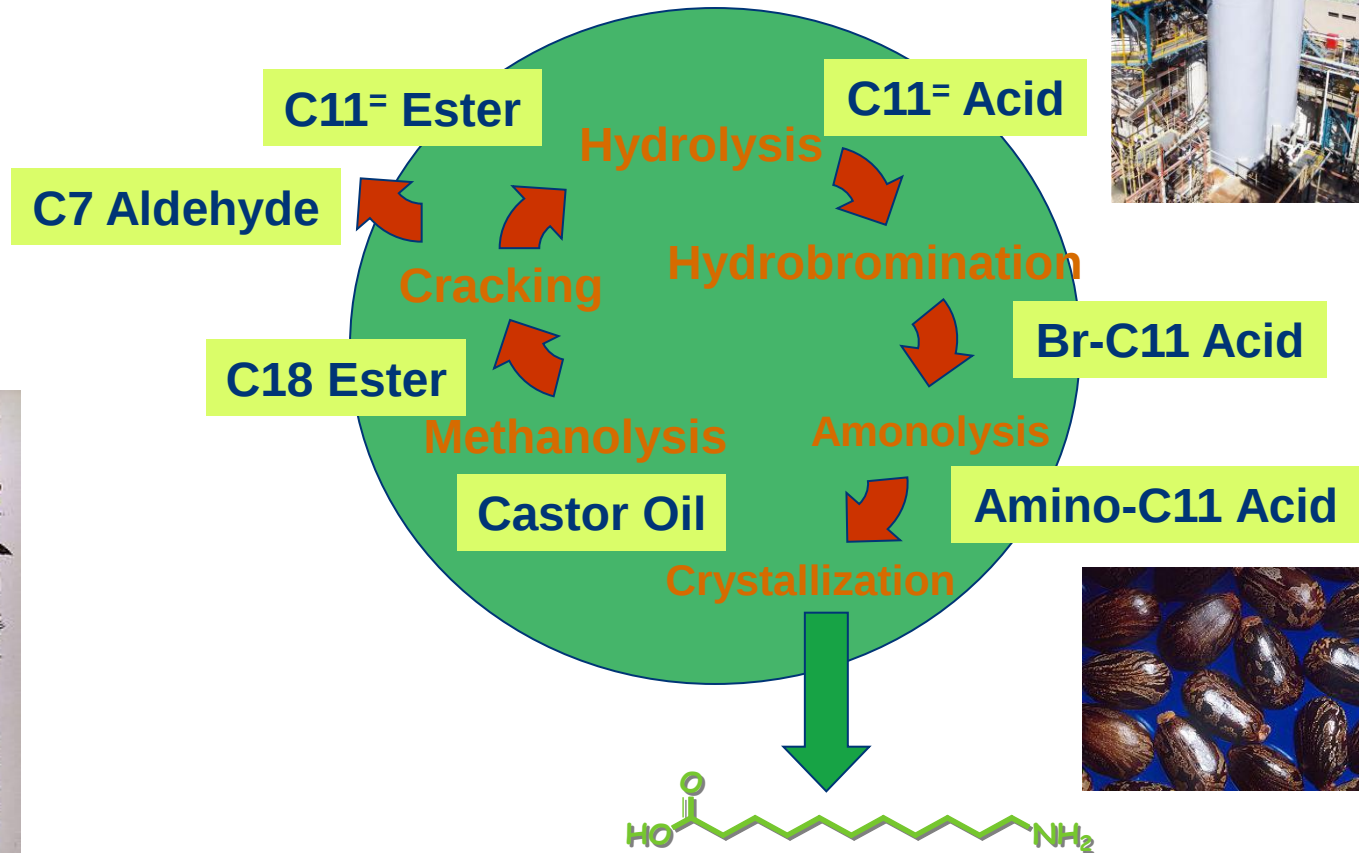


Marseille-Saint Menet

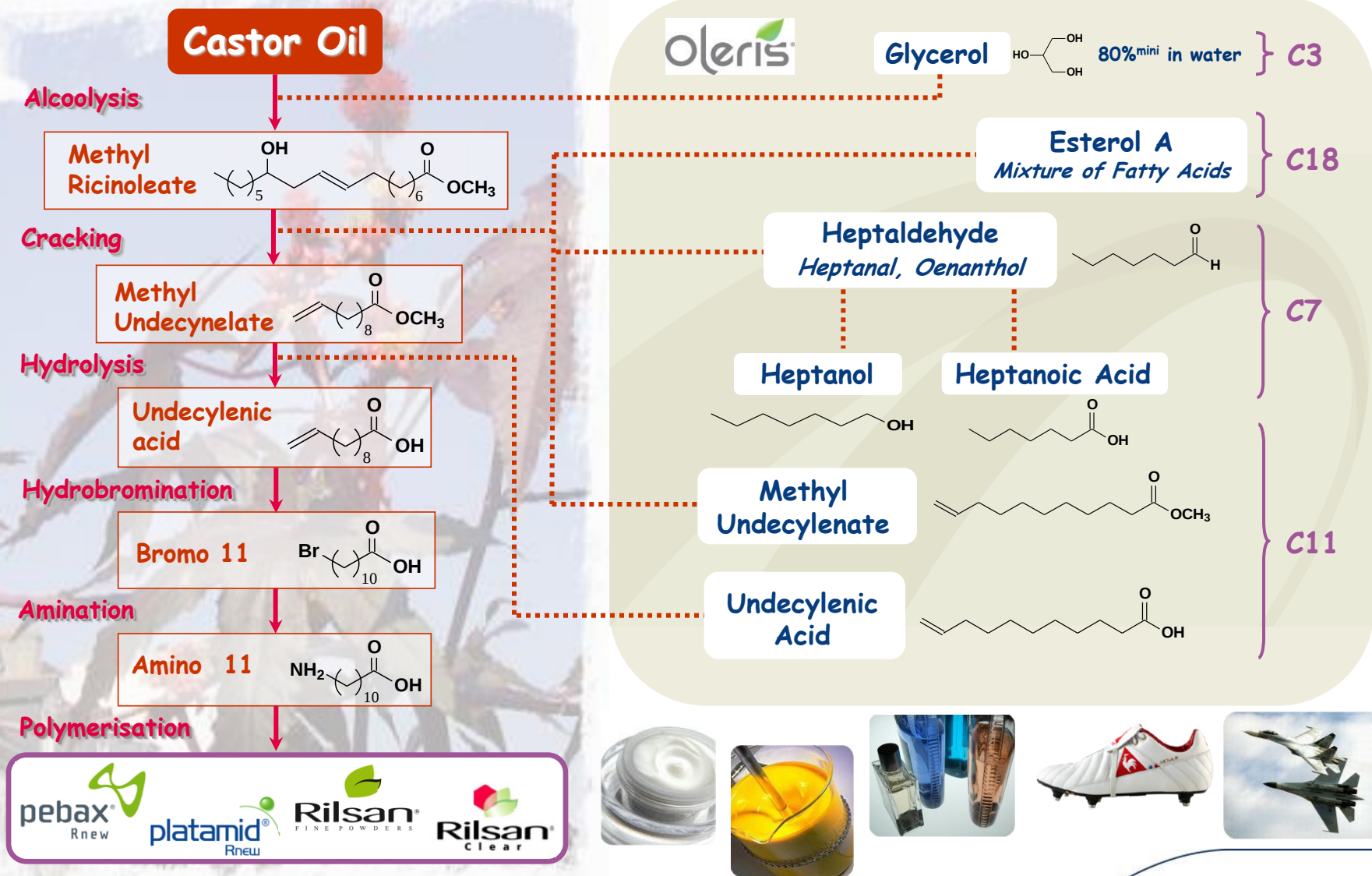


- **Production started in 1955**
- **Total plant Capacity: 22 750 tons (monomer), 25 000 tons (coproducts)**
 - From 52 000 tons (oil)
- **Employees: 319 + 24 (management)**
- **Land Area: 13 ha, including 8 ha constructed**
- **Energy: Natural gas**
- **Certifications: ISO 9001/2000 and ISO14001**
- **Plant classified as Seveso 2 high threshold (chlorine, bromine, ammonia)**
- **Processes: Transesterification, thermal cleavage, Hydrolysis, Hydrobromination, Ammonolysis, Oxidation, Hydrogenation,**
- **Key Markets: Polyamide-11, solvents, cosmetics...**

Arkema's Castor Biorefinery

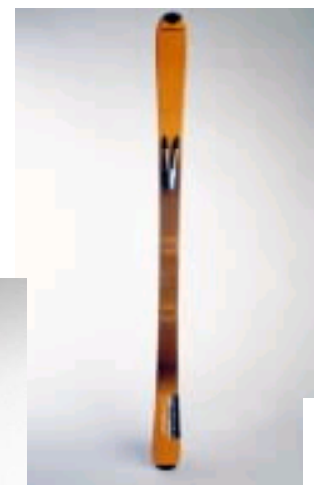


Arkema St-Menet plant's process flow



Rilsan® and its applications

- Oil drilling tubes (offshore)
- Braking and fuel tubes for cars and trucks
- Electric cable and coating for fiber optic
- Medical syringe
- Skis coating
- Food packaging films
- Anti-corrosive coating



Oleris® : Products and applications



Oleris® Undecylenic Acid

- Flavors and Fragrances,
- Cosmetics
- Polymers and modified silicones



Oleris® Methyl Undecylenate

- Aromatic chemicals,
- Modified silicones, polymers...
- Derivatives for cosmetics



Oleris® Heptaldehyde



- Flavors and Fragrances

Oleris® Esterol A



- Industrial solvents
- Cutting and greasing oils
- Treatment of leathers
- Concrete Mould Release

Oleris® Heptanoic Acid

- Industrial Lubricants (refrigeration, jetlub...)
- Corrosion Inhibition
- Cosmetics
- Aromas



Oleris® Heptanol

- Flavors and Fragrances
- Plasticizers for Polymers



Hengshui, China

Castor Oil-based



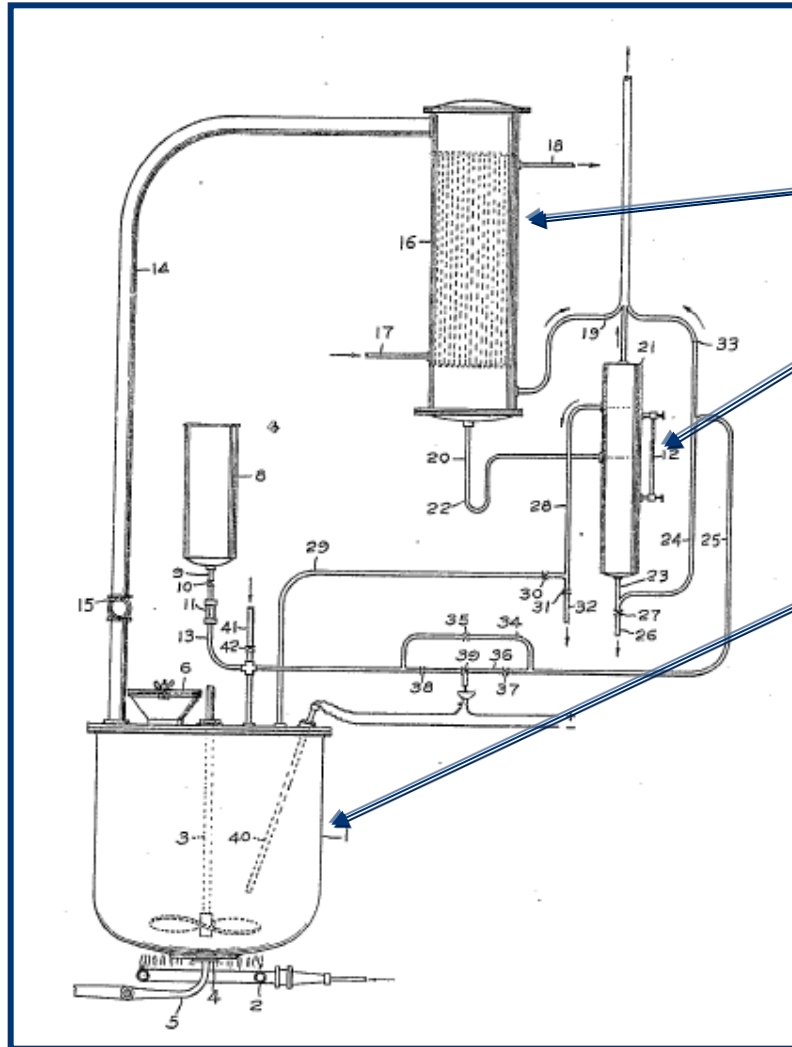
Hengshui, China



- **Production started in 2008, Formerly Casda Biomaterials**
- **Total plant Capacity:**
 - 40 000 tons (monomer), 28 000 tons (2-octanol), 80 000 tons (sodium sulfate)
- **Employees: 585**
- **Land Area: 22 ha, including 70 % occupied**
- **Energy: Coal**
- **Certifications: ISO 9001**
- **Plant not classified**
- **Processes: Hydrolysis, Alkaline cleavage, esterification.**
- **Key Markets: monomer, solvents...**



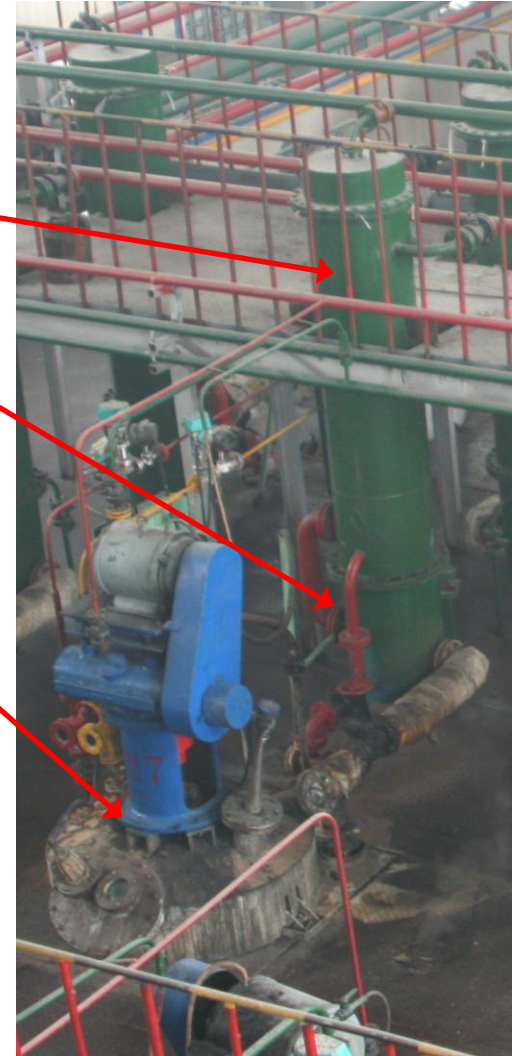
Sebacic acid (Casda Biomaterials)



Condensator

Column

Reactor



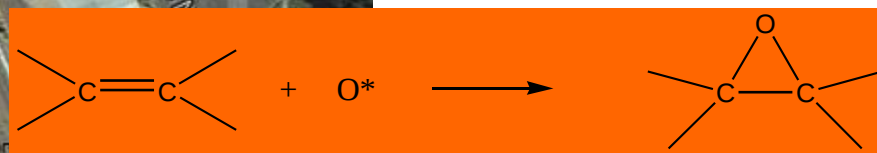
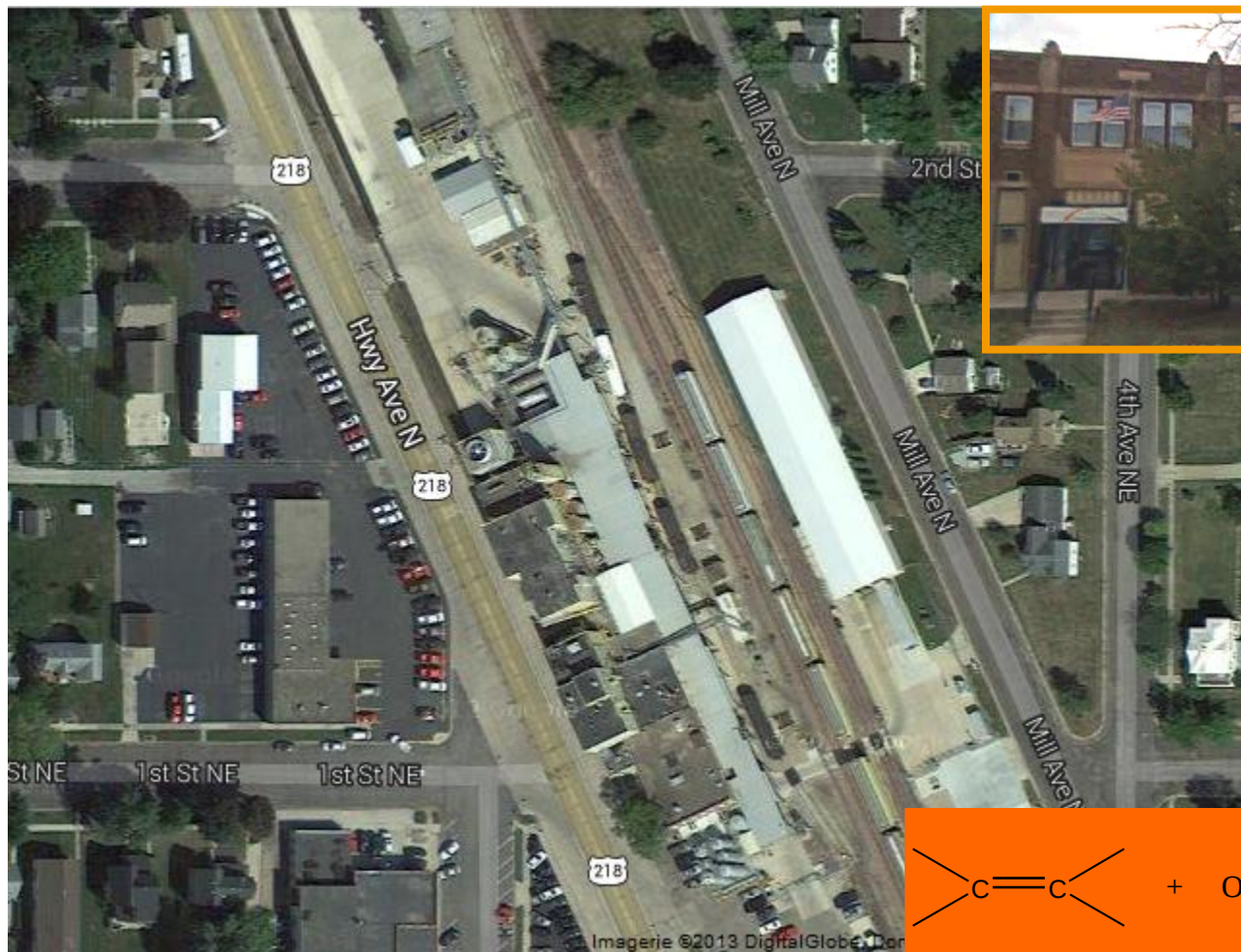


Hengshui, China



Blooming Prairie, USA

Vegetable oils, Terpenes, Pinene, Limonene..



Blooming Prairie, USA

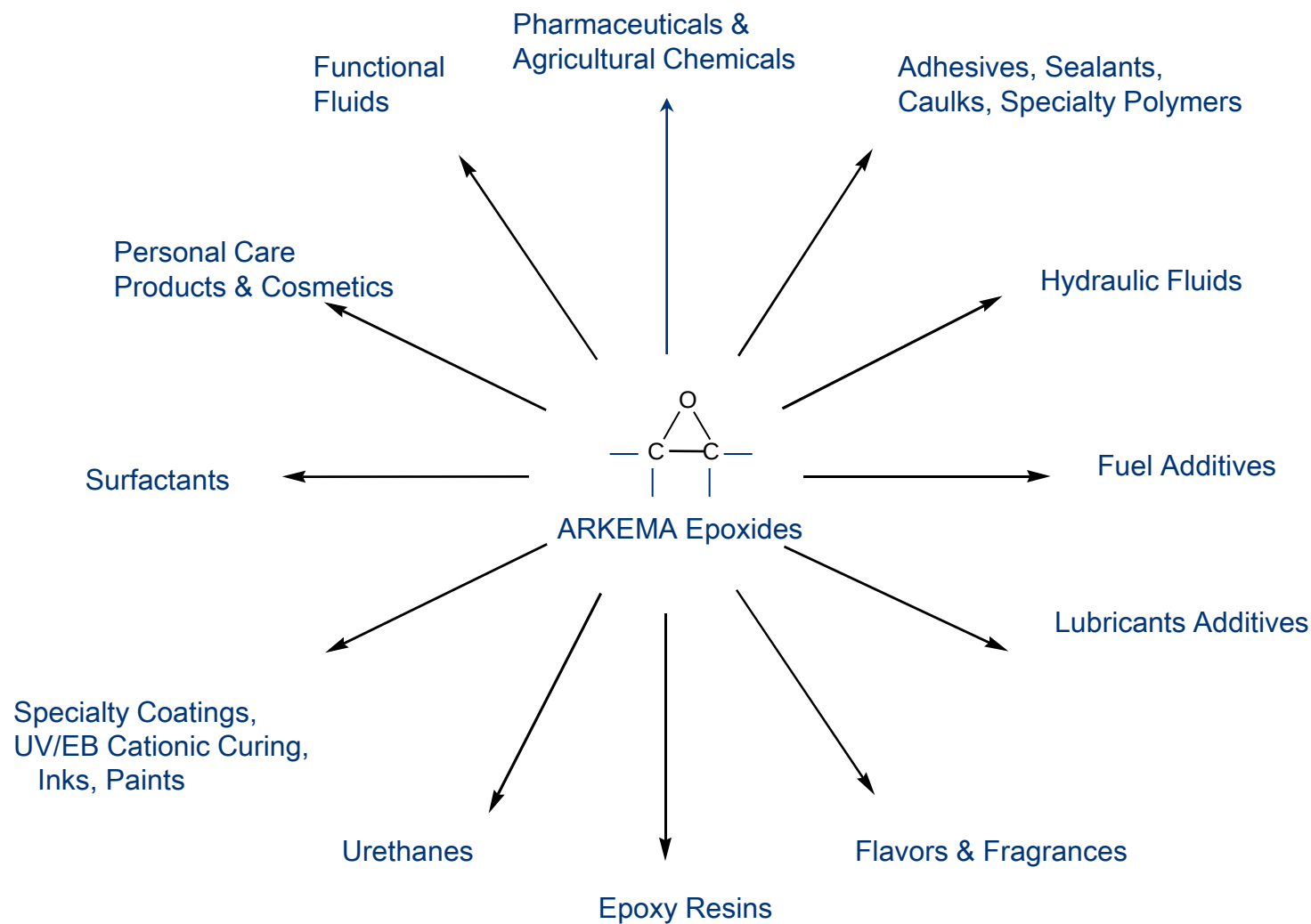


Blooming Prairie, USA

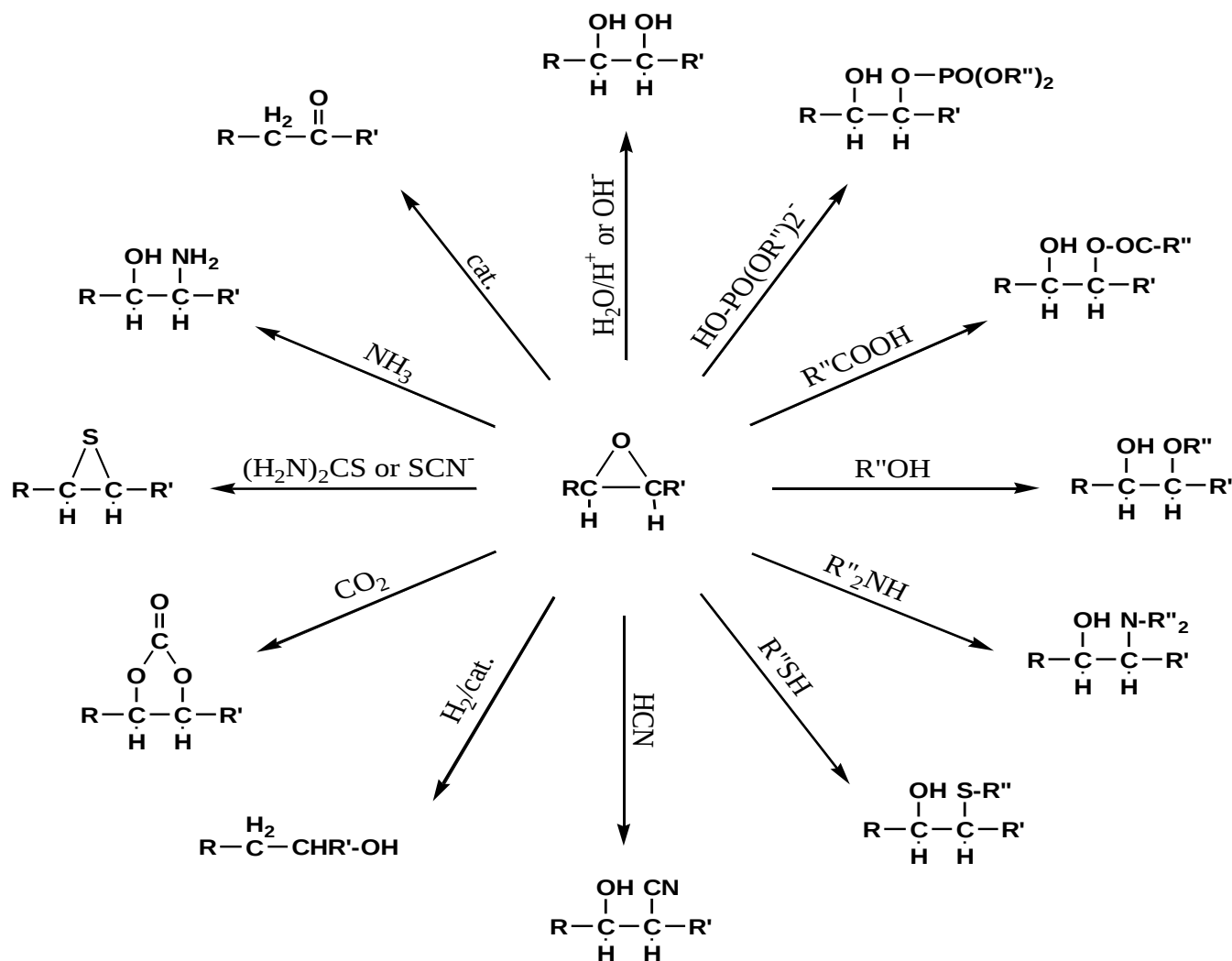


- **Production started in 1970 as Viking Chemical**
 - Previously Creamery from 1931
- **Total plant Capacity: 60 Mlb/a or 27 000 tons/a**
 - Vegetable oils (linseed oil, soybean oil), Terpenes, Limonene, Pinene...
- **Employees: 41 + 5 (management)**
- **Land Area: 4 ha, including 0.6 Ha under roof**
- **Energy: Natural Gas**
- **Certifications: ISO 9001:2008 Certified Quality Management System**
- **Plant not classified**
- **Processes: Peracetic and Performic Acids epoxidation**
- **Key Markets: Plasticizers for PVC,**

Specialty Epoxides Application and Markets



PRODUCTS FROM EPOXIDE



Feuchy, France

Fatty Acids-based



Feuchy, France



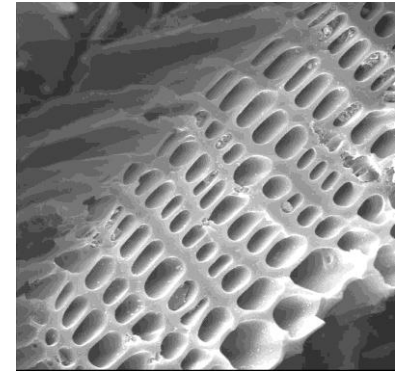
- **Production started in 1928 with fertilizers,**
 - and turned to Fatty amines in 1950
- **Total plant Capacity: 32 000 tons (products) (50 % in Bulk)**
 - Fatty amines and others
- **Employees: 120 + 10 (management)**
- **Land Area: 29 ha, including 8 occupied**
- **Energy: Gas (350-400 MWh/a) & Electricity (17000 MWh/a)**
- **Certifications: - ISO 9001/2000 , ISO 14001 and OHSAS 18001**
- **Plant classified as SEVESO II plant according to the products handled and the risks associated**
- **Processes: Ammoniation, Hydrogenation**
 - 400 products registered, 20 different reactions, 11 reactors up to 315 °C and 30 bars
 - R&D and pilot manufacturing facilities
- **Key Markets: Surfactants, Asphalt and fertilizers additives, additives for Crude oil and Natural gas production**

Parentis, France Maritime Pine Wood-based

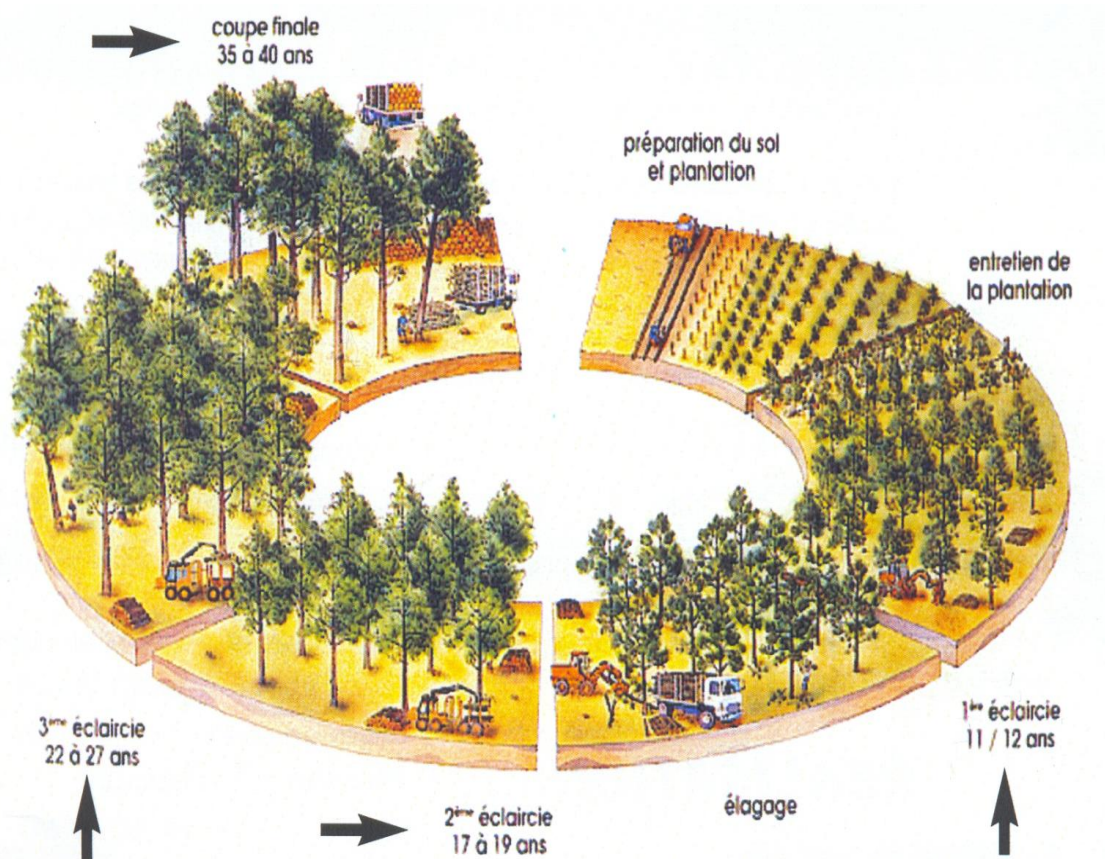


Parentis, France

- **Production started in 1941.**
 - (in 1920 as a Brick factory)
- **Total plant Capacity: n.c.**
 - From **Maritime Pine Wood** produced locally (150 kt/a)
- **Employees: n.c.**
- **Land Area: 25 ha**
- **Energy: n.c.**
- **Certifications: - ISO 9001/2000 and ISO14001 2004**
- **Plant not Seveso regulated**
- **Processes: Steam and Phosphoric Acid activation, flexible tool for tailor made products**
- **Key Markets: Agrofood, Glucose /sugar, Beverage, Catalyst support, Pharma /fine chem, Nuclear industry**



Our raw material : maritim pine wood, from Landes forest



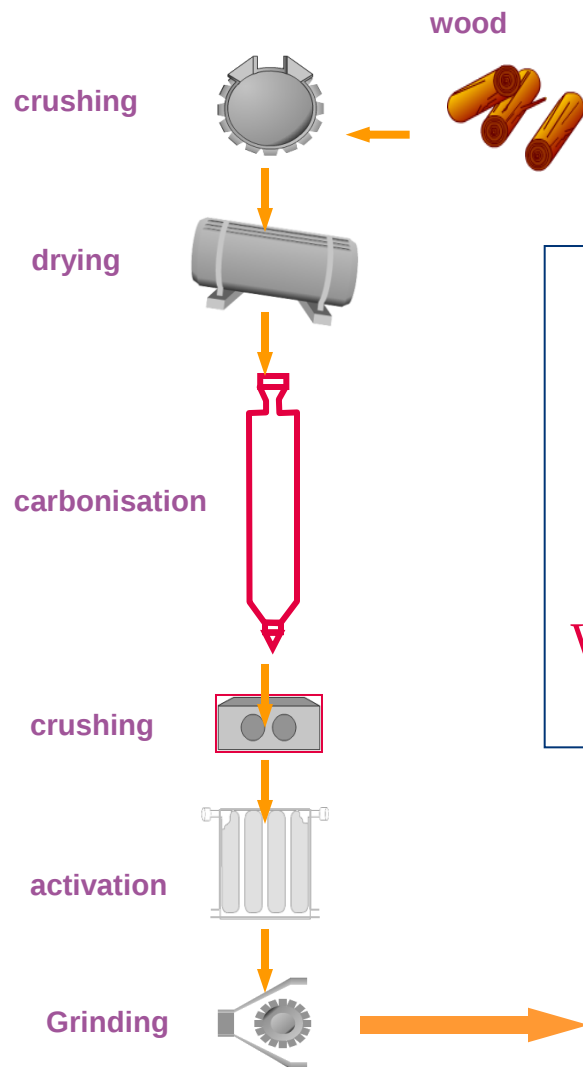
➤ **Maritime Pine trees are grown since the 19th century** (*law of June 19th 1857 from Napoléon III*)

- Ground drying
- Trade of wood & derivatives
- Wood used to build mines corridors

➤ **Largest Industrial Forest in Western Europe**

- 1 Million Ha
- 7 Million tons / year

Steam activation scheme

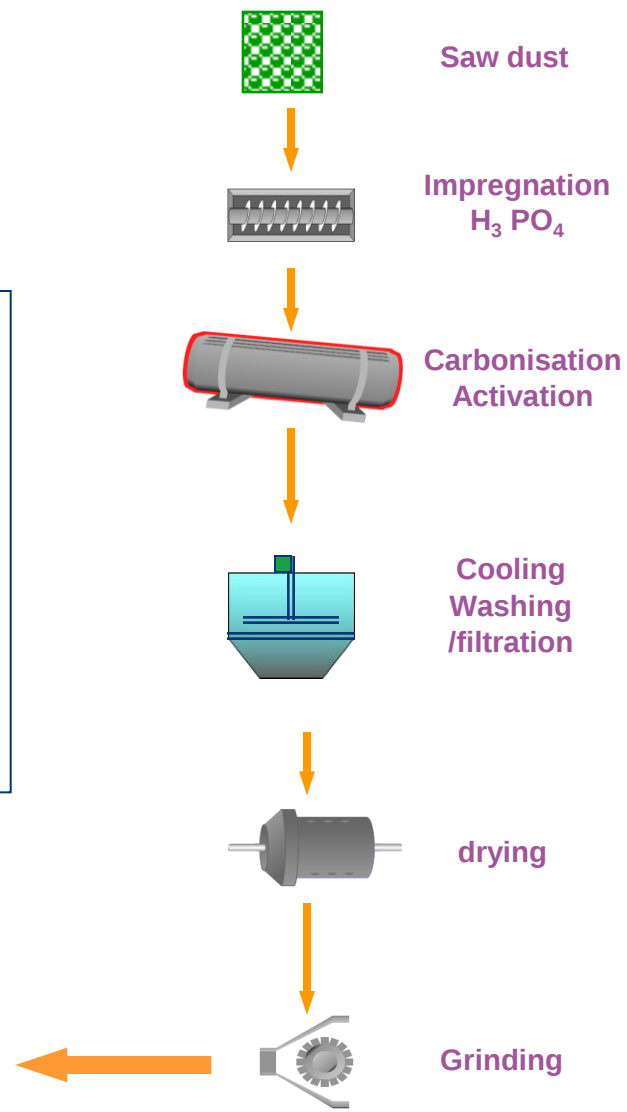


2 different activation processes (chemical and physical activations) on a single site for Activated Carbons Production.
Wood also used as source of energy

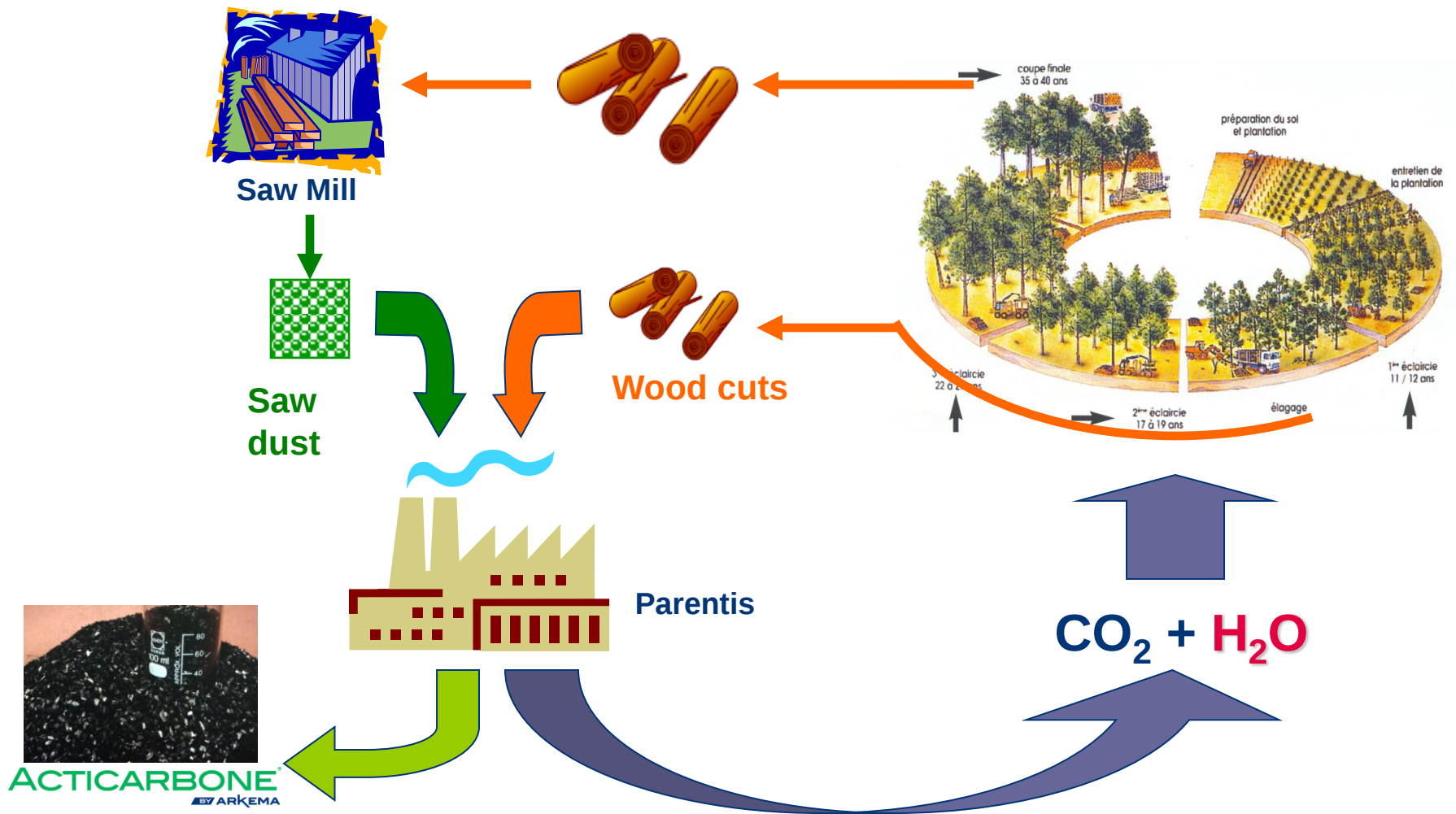


Packaging

Chemical activation scheme



CECA Parentis – Carbon Cycle



Activation Processes:

Chemical Activation :

a) Dehydration :



c) Regeneration:



b) Activation:



d) Rehydration:



Phosphoric Acid acts as a catalyst and is recovered at the end of the reaction

Steam Activation :

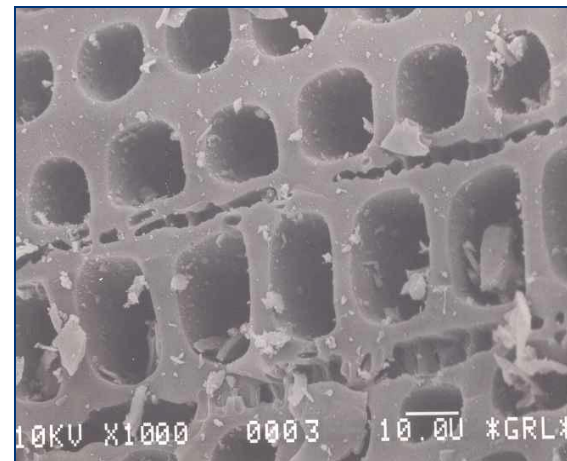
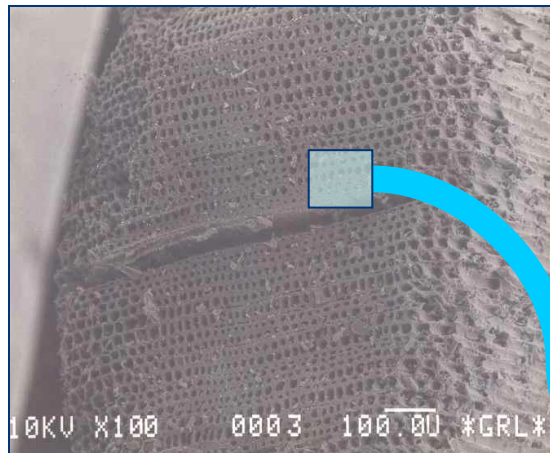
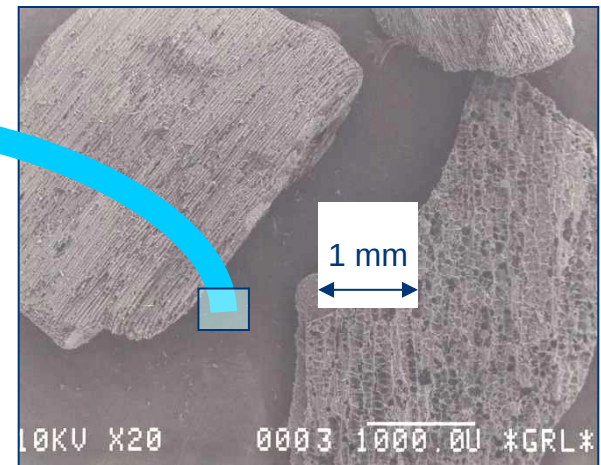
Endothermic :



Exothermic:



Acticarbone – Porous Structure



SEM Images

2 main types of Biorefineries

1) Single source of raw material

- Castor Oil-Based plants / Pine Wood-based plant
- Multiple products linked by the stoichiometry of the reactions
- Need to find the best values for all co-products
- Several markets have to grow at the same time to satisfy all coproducts

2) Multiple sourcing of starting materials

- Epoxidised oils plant / Fatty Nitriles & Amines plant
- Multiple biomass possible
- Need for a flexible plant
- Several markets for products can grow independantly
- Plant can accomodate new products and new raw materials

Thank you for your attention

