2008

The « Usines de Melle » biorefinery story

What lessons for the future ?

Rhodia

Centre de Recherches
& Technologies de Lyon

RHODIA 2007 key figures*

Net Sales	Recurring EBITDA(1)
€ 4,781 m	€ 758 m
Net Profit Group Share	**Operating Profit**
€ 129 m	€ 448 m
Employees worldwide	**Percentage of Net Sales from new products (< 5 years old)**
15,000	22% of sales

* After reclassification of discontinued operations
(1) Recurring EBITDA before restructuring and other operating income and expenses

A refocused group, a simplified organization

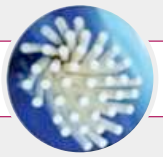
Polyamide
41% of Net Sales

Novecare
20% of Net Sales

Silcea
15% of Net Sales

Energy Services
4% of Net Sales

Acetow
9% of Net Sales



Eco Services
5% of Net Sales

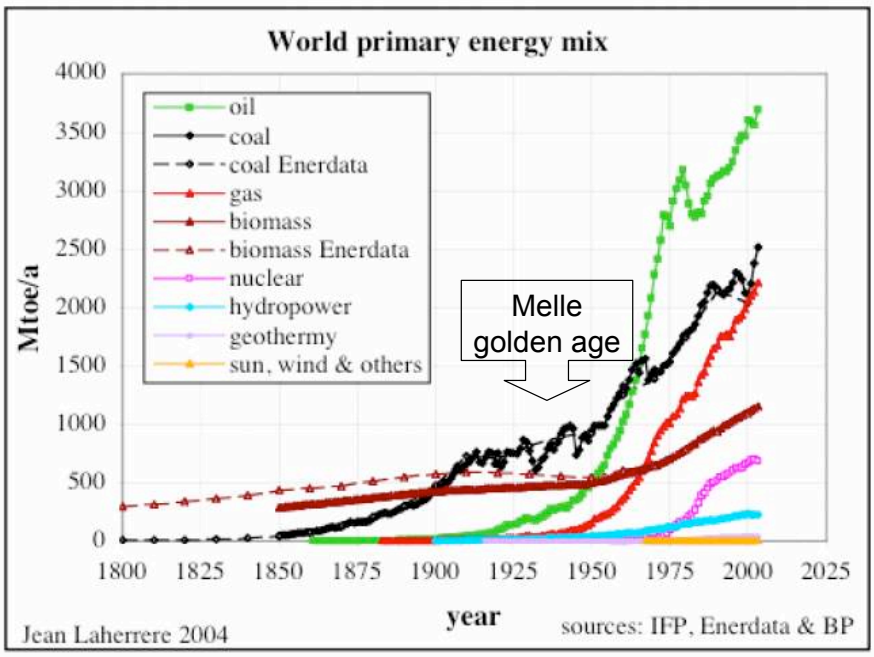
The remaining Fine Organics businesses are incorporated within "Corporate & Others" and represent 6 percent of Net Sales

RhodiaWay: a structured approach

- A framework of sustainability commitments rolled out throughout the Group
- A tool to promote responsibility at each level of the organization

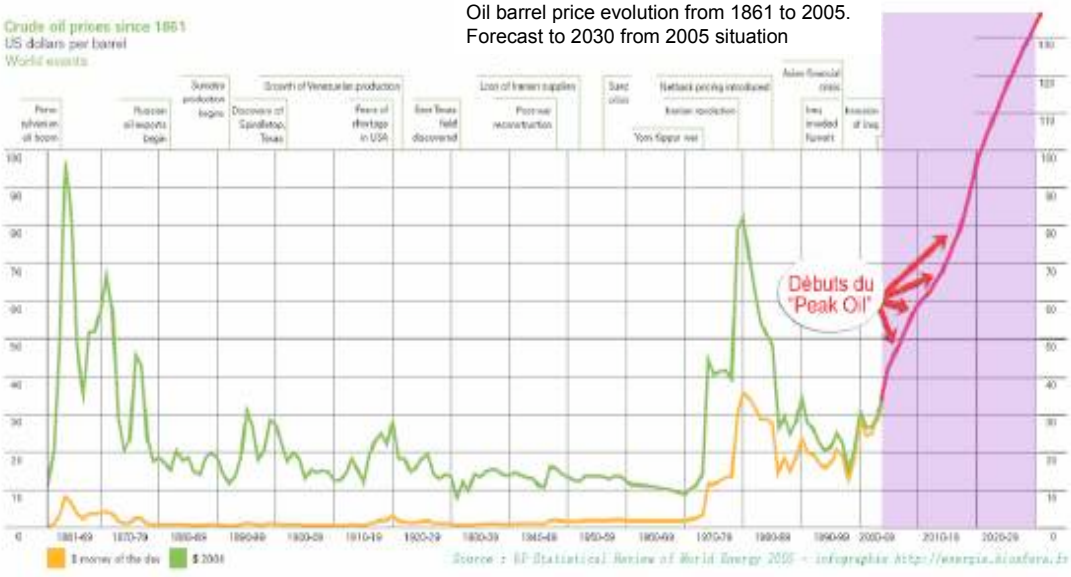
Setting continuous improvement targets addressing all stakeholders worldwide

The History of the world energy sources from 1800 up to now



Economy is always the driving force to change !

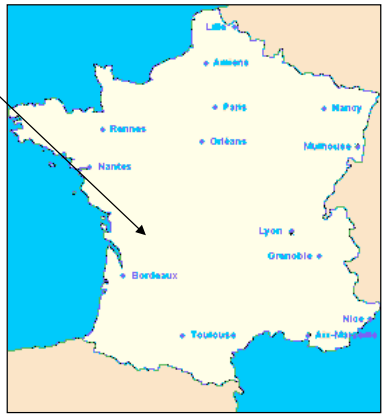
Oil barrel price evolution from 1861 to 2005.
Forecast to 2030 from 2005 situation



Good opportunity to shift for more virtuous processes and raw materials

The Melle case : An industrial story through the 20th century

MELLE plant location



MELLE HISTORY

Sugar plant 1872-1885

Ethanol distillery
From 1886

From ethanol to chemical products
1910-1923 : first steps
1923-1948 : world player

Full reconversion & connection with Rhone Poulenc (RP)
1948-1971

Complete Integration in RP in 1973

Become Rhodia in 1998. Part of plant (food ingredients ie xanthan gum) sold to Danisco in 2004

MELLE : A strong culture of innovation (starting from 1910)

- Important R&D center in the plant
  - Fermentation (bacteriology teams)
  - Chemistry and catalysis (including catalyst production)
  - Processes
- Strong culture on experimentation and pilots
- Strong patents portfolio : 611 patents till 1936
- Strong policy of manufacturing licenses
  - 856 plants including 470 licenses for ethanol (50/50 fermentation technology and pure alcohol distillation technology)
- Famous researchers led the MELLE R&D teams
  - F.Boinot : one expert for ABE fermentation (Strain Boinot), for ethanol fermentation (optimisation by yeast recycle)
  - M. Savarit : the inventor of Ponchon-Savarit method for distillation calculation
  - H.Guinot, one of the most creative industrial researcher

Focus on biotechnologies processes designed in MELLE

- Ethanol by fermentation (the historical production)
- Butanol and acetone by ABE fermentation
- Amylase process to transform starch in sugar : 1st process industrialized in Melle
- Citric acid by fermentation
- Lactic acid by fermentation
- Itaconic acid by fermentation
- Xanthan gum by fermentation (now Danisco)
- BioVanillin by fermentation (the most recent one)

An illustration : The ABE Fermentation in Melle

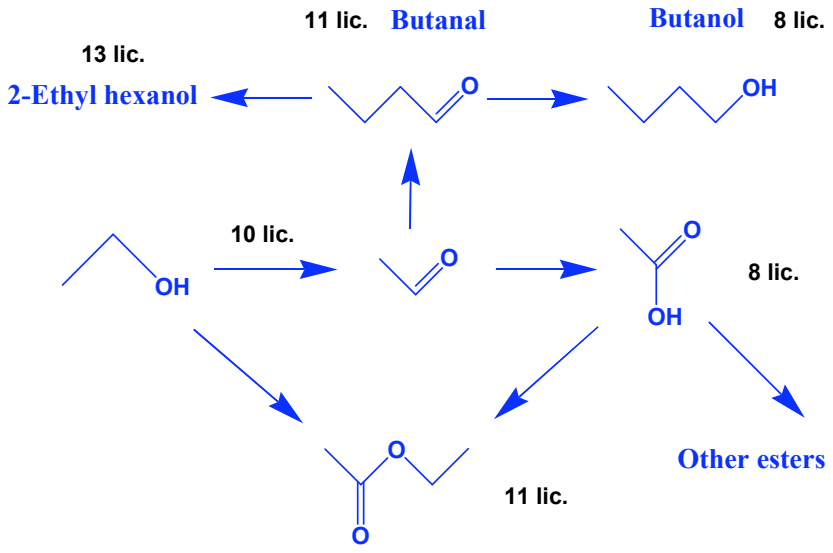
- Clostridium Acetobutylicum discovered by Fernbach and Weizman
- Process optimized by Firmin Boinot in Melle in 1917 with a fermentation ratio acetone / butanol = 0,5 w/w
- Production started first in Melle with valorization of all products including hydrogen
- Other licenses have been sold after
- Shutdown of theses processes in late 40's due to the cheap oil allowing new routes to these intermediates

- These processes are reviving since 1990's due to butanol potentialities for fuels (Du Pont BP, Metabolic Explorer, Cobalt biofuels)

Bioproducts produced by chemical transformation in MELLE

- Acetaldehyde from ethanol
- Acetic acid and acetate esters from ethanol
- Crotonaldehyde by chemical transformation of ethanol
- Butanal by chemical transformation of ethanol
- Butanol from ethanol
- Ethylhexanol by chemical transformation of ethanol
- Lactates esters
- Anhydrides of acids from fermentation
- Furfural and derivatives from cellulosic wastes

The chemistry from ethanol : A chemical tree was born !



And new possibilities could be opened : the actual ethylene story in Brazil…

Duality between chemical and fermentation routes
Case of butanol

RAW MATERIAL	BUTANOL	ABE FERMENTATION	CHEMICAL TRANSFORMATION OF ETHANOL
SUGAR	GLOBAL YIELD vs GLUCOSE (mol%)	37%	77%
	ENERGY TRANSFORMATION (per ton BuOH)	100%	50%
GRAINS	GLOBAL YIELD vs GLUCOSE (mol%)	34%	52%
	ENERGY TRANSFORMATION (per ton BuOH)	108%	71%

Main Challenges are still to be adressed : global yield and energy (dilution issues)
Still Current Events !

MELLE had to face to strong challenges

- Raw material crisis
  - Era of cheap oil after 1945 killed the EtOH and ABE fermentation plants
  - Bad years for sugar (weak harvest = problem of agro trading) : direct impact on prices and problem of competition with food

Same questions have to be addressed today !
Answers are at a world scale

DOES BIOTECH COULD ADRESS THE FUTURE CHALLENGES ?

- Driving force is the difference between sugar price and oil and gas prices
  - Integration is key for stabilization of economic data
  - Visibility is key.
- No green premium have to be considered except for market niches : Need for economic competitiveness
- Product performances should be tackled
  - Two different positions : Polyéthylène from ethanol or PLA and PHA as new materials
- Possibilities to obtain the same intermediate by new routes avoiding fermentation technologies except those for 2nd generation biofuels
  - CO/H_2 tree as the starting raw materials
- Biotechnologies Key issues : Productivity, Dilution (energy intensive) and salts (carboxylic acids production leading to environment issues).

CONCLUSIONS

- MELLE STORY TEACHES US
  - Strong R&D, pluridisciplinary, close to plants (pragmatic) is the solution to address the main challenges we have : the oil prices, the competition on agroressources between food and fuel…
  - Economy is the driving force (integration on raw materials is important)
- THE WIN WIN solution for building a new chemistry starting from biomass should be a partnership between chemical company, and agro or biotech company also in order to share investment (and risk)
  - Chemical company : downstream process, product tree, manufacturing excellence…
  - Agro company : Agroresources trading and handling, Biotechnologies…
  - Biotech company : Biotechnologies from metabolic engineering to strain modification and fermentation first steps…
- OPEN INNOVATION with Universities, Start ups is today one important key factor for success