Tomorrow's biorefineries in Europe

Integrated biorefineries in the European Landscape

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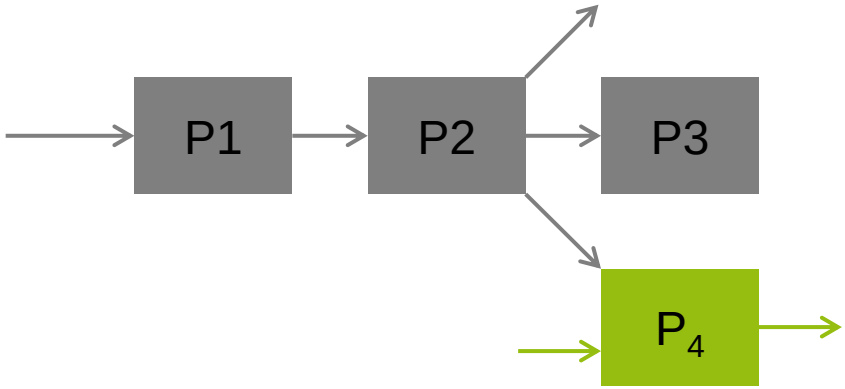
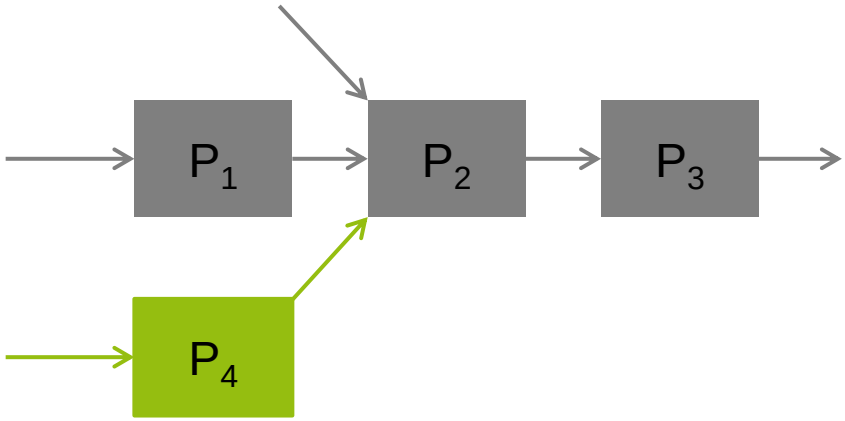
Integration in existing plants

Integration upstream



Integration in existing plants

Integration downstream



Integration in existing plants

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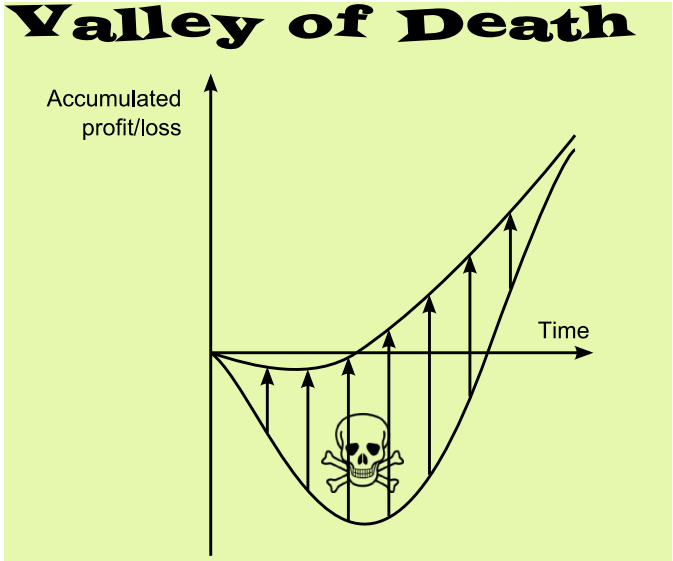
- Savings on CAPEX,
  Infrastructure, utilities, logistics present
- Skilled personnel on site
- Mitigation of operational and market risks
- Target industries facing a fading market:
  Save jobs and production in Europe



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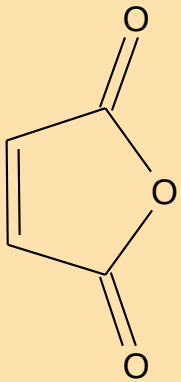
- Product may have an incomplete and variable degree of renewability
- Reluctance of industry to alter process

Example: renewable maleic anhydride

CIRCC Interuniversity Consortium CHEMICAL REACTIVITY and CATALYSIS	Catalysis: dehydration, partial oxidation
Orgachim® since 1901	Pilot tests, process knowledge
ARKEMA INNOVATIVE CHEMISTRY	Catalyst preparation, process knowledge
PDC	Conceptual process design
TUHH Technische Universität Hamburg-Harburg	Fermentation to BuOH

Example: renewable maleic anhydride

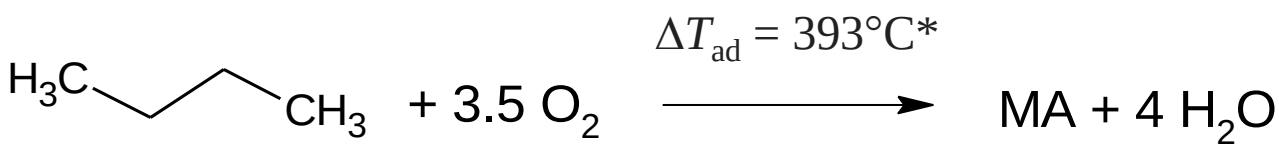


Raw material for:

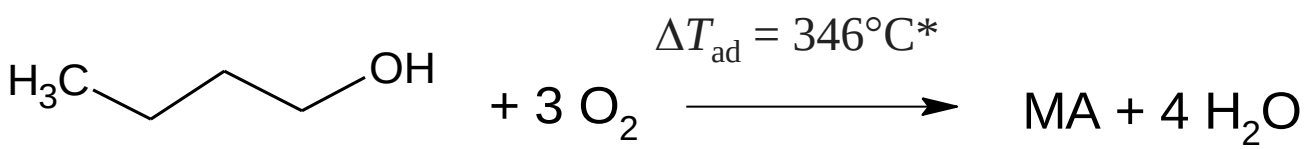
- Unsaturated polyester resins
- Alkyd resins
- Malic acid, fumaric acid: food acidulents
- Agricultural chemicals

Market structurally short in Europe
Need for renewable MA

Maleic anhydride: conventional production



Idea 1. Use renewable alternative: bio-n-butanol

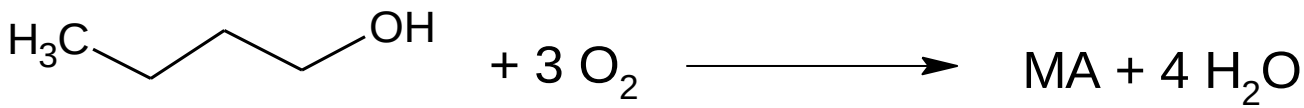


Advantages:

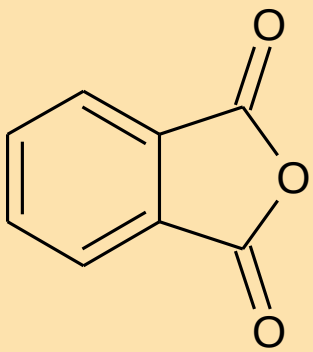
- Less exothermic: less cooling required
- 1-Butanol much more reactive than n-butane

* 1 vol% organic in atmospheric air

Maleic anhydride: conventional production



Idea 2. Revamp **Phthalic Anhydride** plant

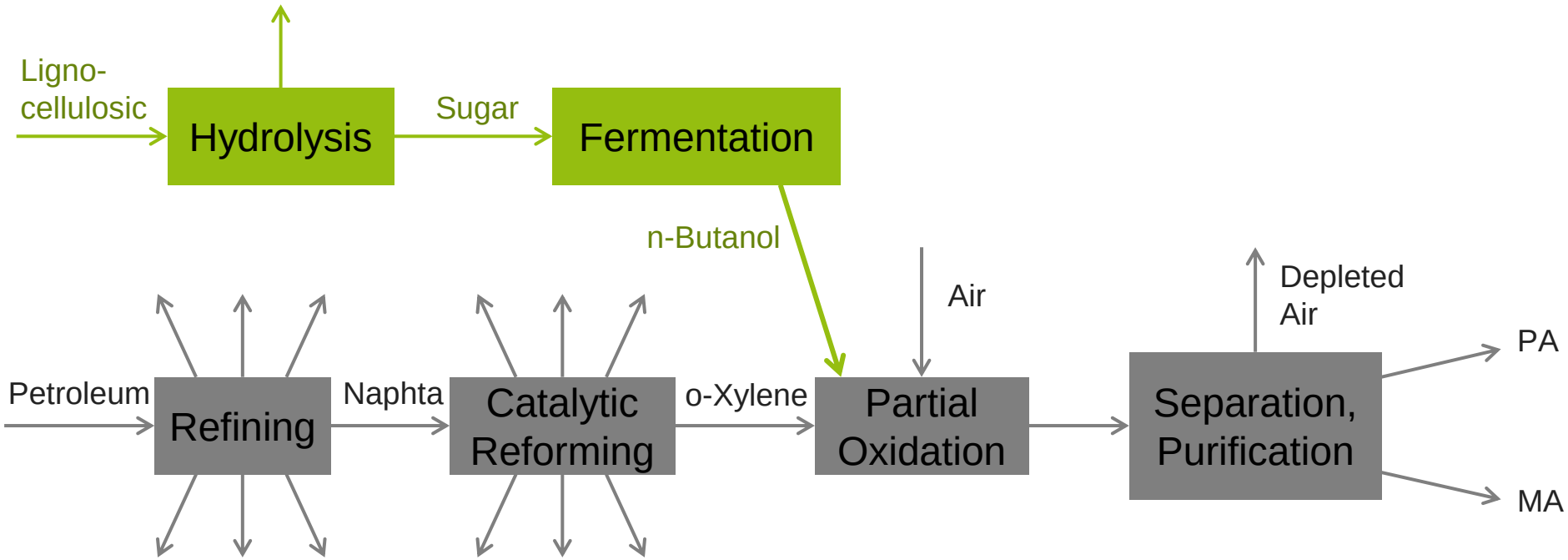


Raw material for:

- Plasticizers
- Unsaturated polyester resins
- Alkyd resins

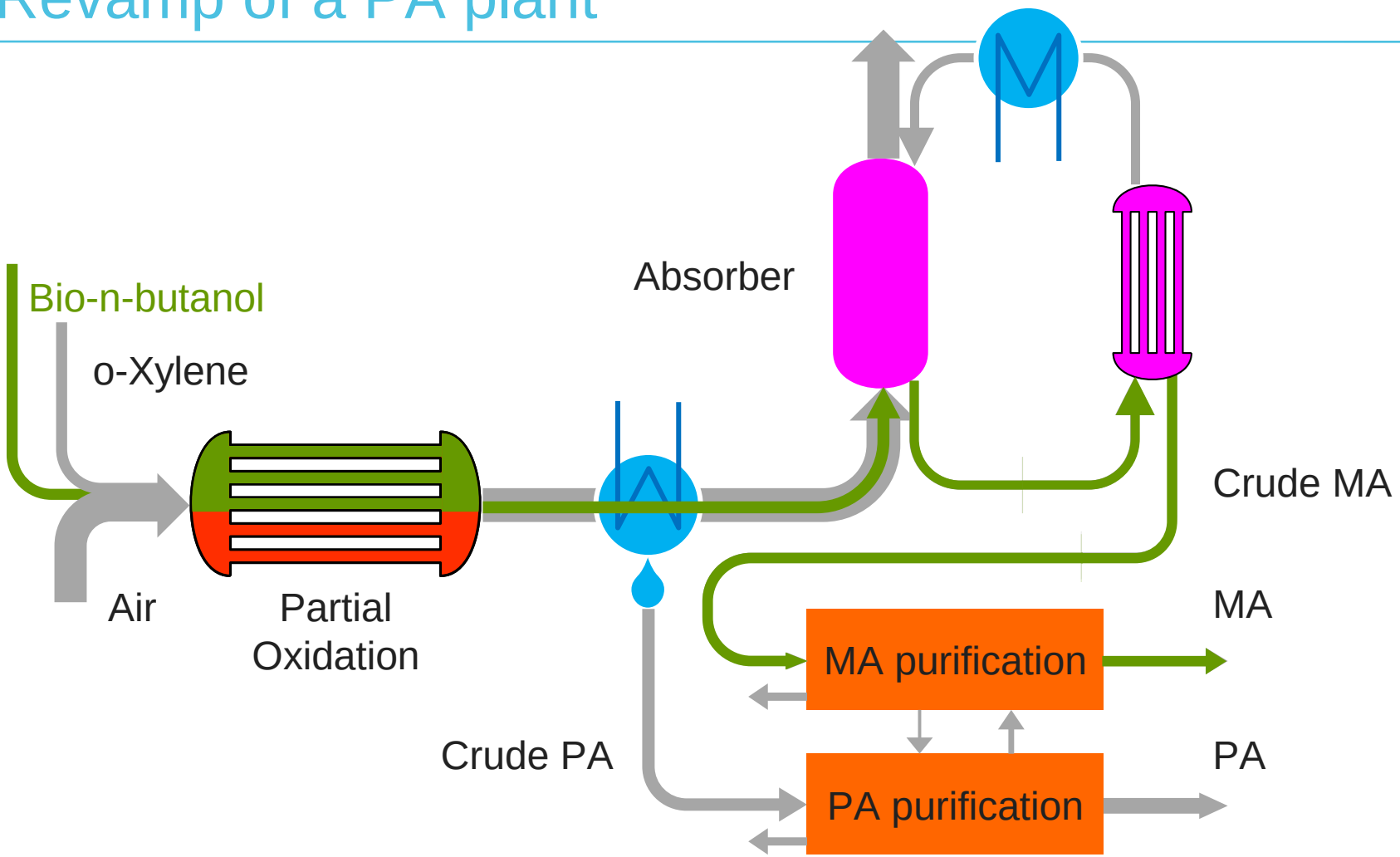
- PA, phthalates : toxic
  → Facing future bans
  → Already an **oversupply** of 100 kta in Europe

Revamp of a PA plant



Possibility to tune MA/PA ratio

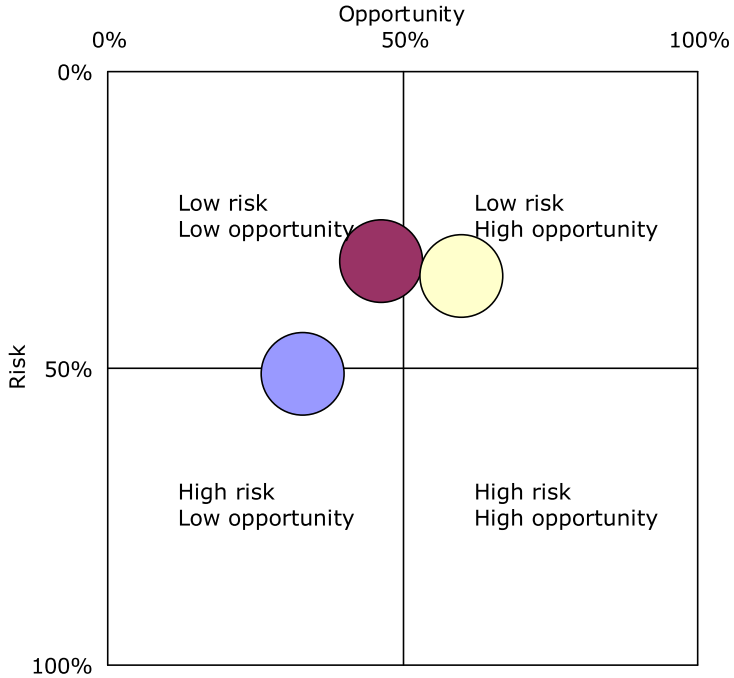
Revamp of a PA plant



Risk/opportunity profile

IPscore®

Diagnostic report on risk and potential factors



Butanol to MA in revamped PA plant

Conventional butane to MA

Conventional benzene to MA

Competitors

Volumes (kta)

100

Band of commercial production scales in EU

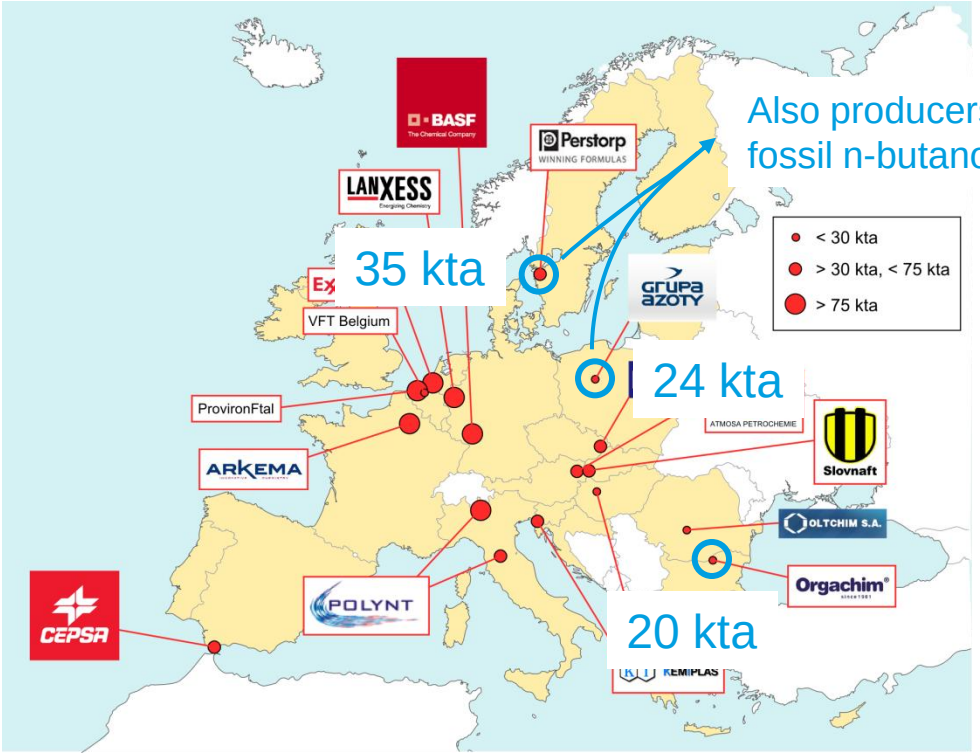
3

0.002

(2 l POX reactor, biobutanol fed)

R&D	Pilot	Demonstration	Commercial

Target PA plants



Evaluation

Case: 50 kta PA plant to a $\left.\begin{array}{l} 27\,\text{kta PA} \\ 10\,\text{kta MA} \end{array}\right\}$ plant

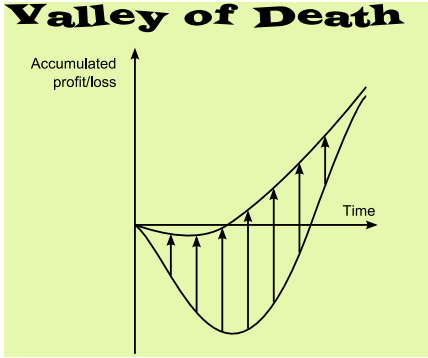
- 18.8 million Euro total capital investment needed for revamp

- 2.6 €/kg MA production cost for a BuOH price of 1.1 €/kg
  → Can be reduced to market price (± 1.5 €/kg) by
  - Increasing catalytic yield
  - Feeding cheaper BuOH
  - Refining revamp design

- Potential number of direct jobs saved in PA plant: ± 28

Conclusion

Integration of bio-based technologies in existing European plants:



- Relatively easy way to introduce bio-based technology
- Bonus: save jobs and production in Europe

- Product may have an incomplete and variable degree of renewability
- Reluctance of industry to alter process

ACKNOWLEDGEMENT

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