

# Case study – a new starch-based biorefinery

Linde Engineering

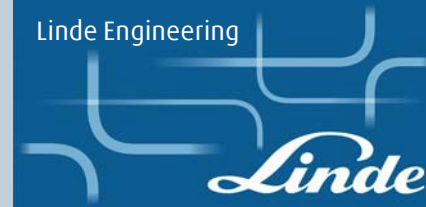
*Linde*

Dr. Karin Bronnenmeier, Know-how Manager  
Jens-Peter Mendelsohn, Project Manager Zeitz  
Linde-KCA-Dresden GmbH



## Agenda

- The Linde Group
- Linde-KCA-Dresden GmbH – competence center BIOTECHNOLOGY
- Starch – a major feedstock for biorefineries
- Case study „Zeit“ – a first generation biorefinery
  - Project overview
  - Project structure/organisation
  - Technology & products
  - Integration in local infrastructure
  - Picture from the site
- Conclusion



## The Linde Group

Sales: 12.3 billion EUR (2007)  
Employees: > 50 000

### Gases Division

Leading supplier  
of industrial gases

### Engineering Division

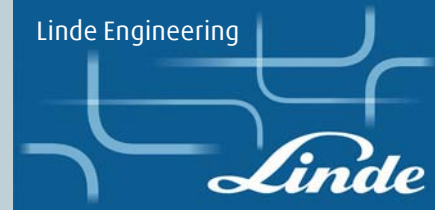
Engineering &  
contracting specialist

Linde-KCA

- ▶ Chemical and gas plants
- ▶ Biotech & pharma plants  
competence center Linde-KCA

### Gist Division

Leading provider  
of logistics solutions



Synergistic cooperation of divisions — Integration of biotechnology & chemistry

## Biotechnology Plants (B)

- Biotechnology
  - process technology
  - basic know-how
- design & construction of large-scale biotech plants
- process technology fine chemistry

## Chemical and Gas Plants (C)

- Chemistry
  - process technology
  - basic know-how
- design & construction of large-scale chemical plants

„key to success“ for BIOREFINERY projects

# Selected reference BIOPHARMA – Large-scale cell culture plant for production of MABs

Linde Engineering

Linde

## Client

F. Hoffmann-La Roche AG

## Location

Basle/Switzerland

## Type of plant

New cell culture plant for production of monoclonal antibodies (MAB)

## Investment

400 mio CHF

## Product

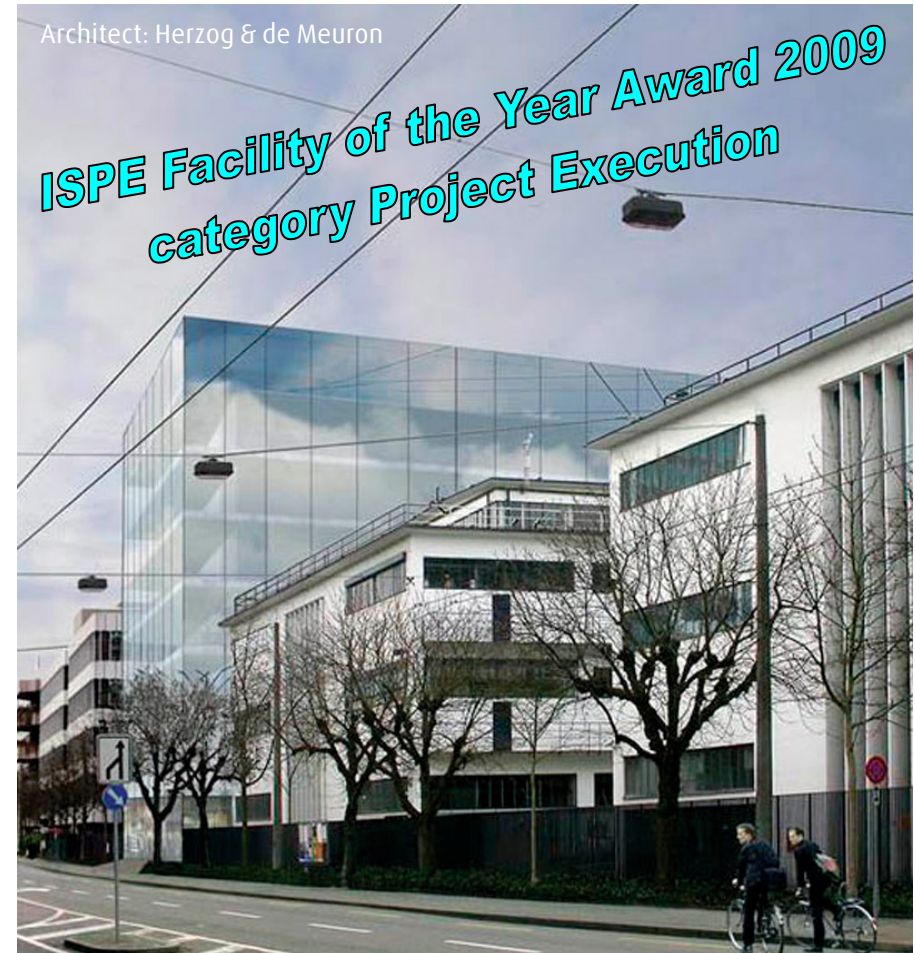
Anticancer drug Avastin

## Scope of work

Project coordination, Conceptual design,  
Basic engineering, Detail engineering,  
Support in procurement,  
Engineering support during  
installation and commissioning

## Commissioning

2007



# Selected reference INDUSTRIAL BIOTECH – Plant for the Production of Pectin

## Client

CITRICO Deutschland GmbH  
(today: CARGILL-Group)

## Location

Malchin/Germany

## Type of plant

Turnkey plant for the production of Pectin

## Scope of work

Assistance in Basic engineering,  
Project and Quality management,  
Detail engineering, Procurement,  
Installation, Preparation of  
commissioning

## Commissioning

2001



# Selected reference REFINERY – Linear alpha olefin plant

## Client & development partner

United Petrochemical Company

## Location

United Olefins Complex in Al-Jubail/Saudi Arabia

## Process

Sabic Linde “ $\alpha$ -Sablin” Process

## Capacity

150 000 t/a  $\alpha$ -Olefine

## Process steps

Feedstock and catalyst handling, reaction and catalyst removal, primary separation, product separation

## Scope of work

Turnkey lump sum: Detail engineering, procurement, construction, precommissioning, commissioning support

## Start-up

2006



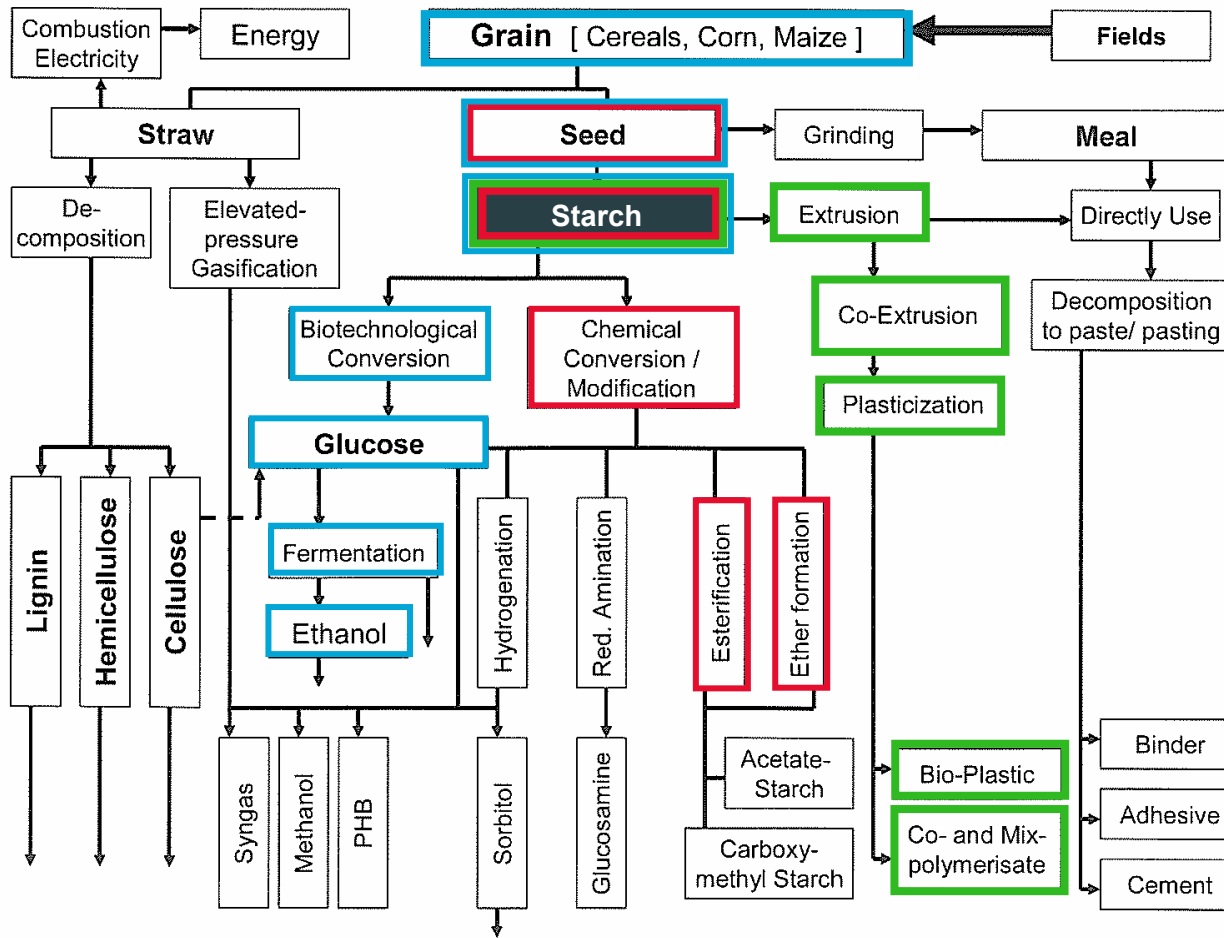
# Starch – a major feedstock for biorefineries

Linde Engineering

*Linde*



# Biorefinery – starch as a central component & Linde-KCA starch-based project approaches



- Project Zeitz
- Project NN
- Project NN

Source: Kamm & Kamm, Appl. Microbiol. Biotechnol. (2004) 64: 137-145, modified

# Industrial starch platform – TODAY

- STARCH is the most abundant storage carbohydrate on earth



seeds



tubers



roots



fruits

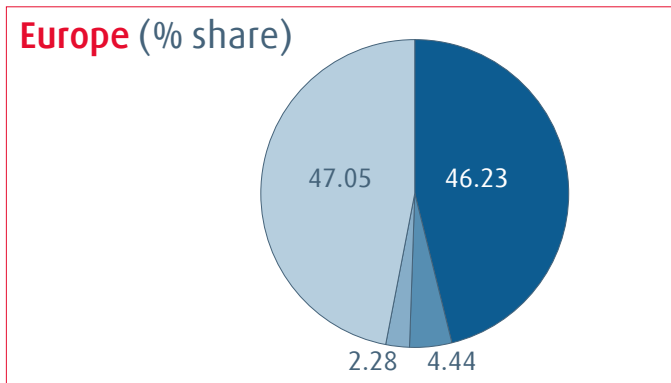


- scale of annual production:  $\approx 1.8$  bn t
  - direct consumption as food & feed
  - **industrial starch platform:  $\approx 60$  mio t\***
    - processed food & food ingredients & feed
    - paper & corrugating
    - chemicals & pharmaceuticals

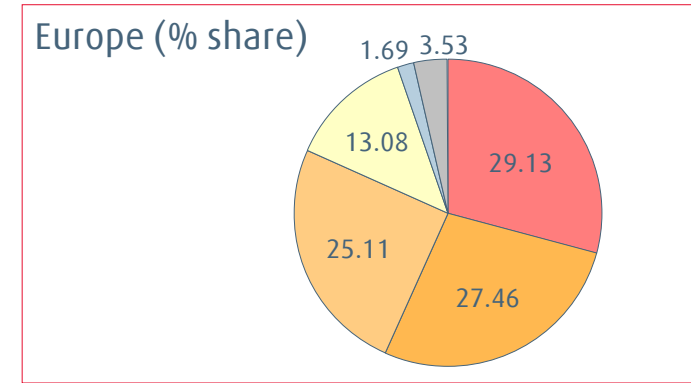
\*Source: Starch – A Global Strategic Business Report, Global Industry Analysts Inc., March 2008

# Industrial starch platform – Market analysis

## Product groups

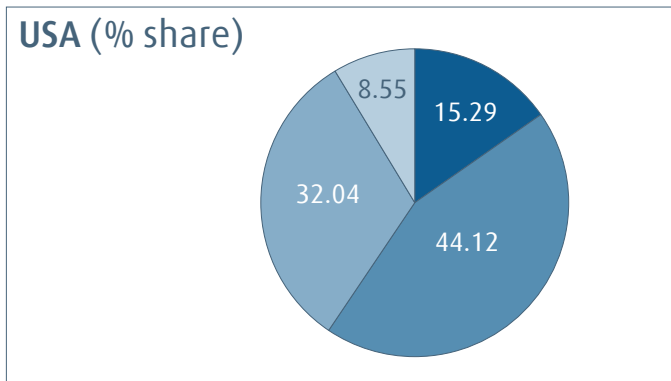


## Consumption by end use markets

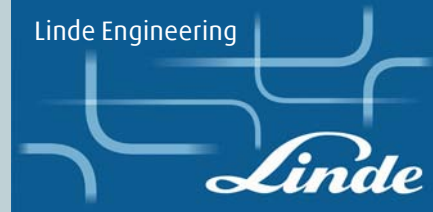


- Native & modified starch
- Ethanol
- Isoglucose/HFCS
- Other syrup based starches

- Corrugating and paper making
- Confectionary and drinks
- Processed food
- Pharmaceuticals and chemicals
- Feed
- Others

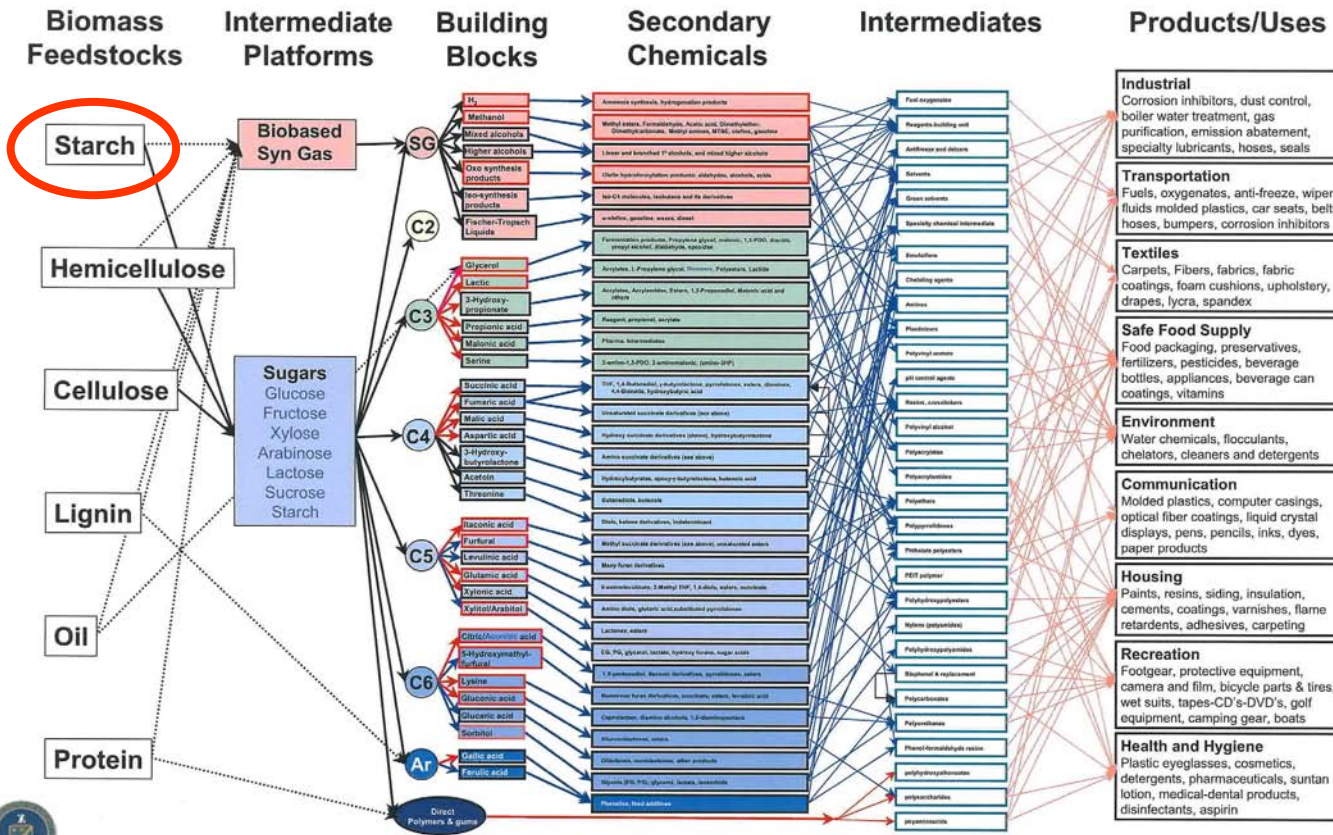


Source: Starch – A Global Strategic Business Report, Global Industry Analysts Inc., March 2008



# Industrial starch platform – FUTURE

## STARCH as renewable raw material for chemical production



# Case study „Zeitz“ – a first generation biorefinery

Linde Engineering

*Linde*

# Project „Zeitz“ – Facts & figures

## Type of plant:

- Plant for production of modified wheat starch and gluten
- Capacity: 120 000 t/a wheat (10 000 t gluten, 60 000 t modified starch, 30 000 t feed)

## Investor/client:

- FRP CS GmbH (Food Retail & Production CS GmbH)

## Investment:

- > 50 Mio EUR
- supported by the European Regional Development Fund (ERDF)

## Location:



# Project „Zeitz“ – Fast-track schedule

## Contract signing

December 12, 2007



## Groundbreaking ceremony

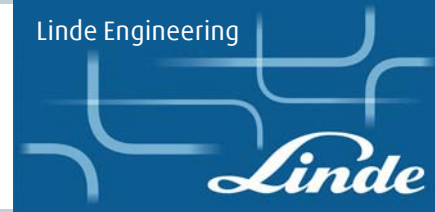
on February 1st, 2008



## Start-up

planned for August 2009

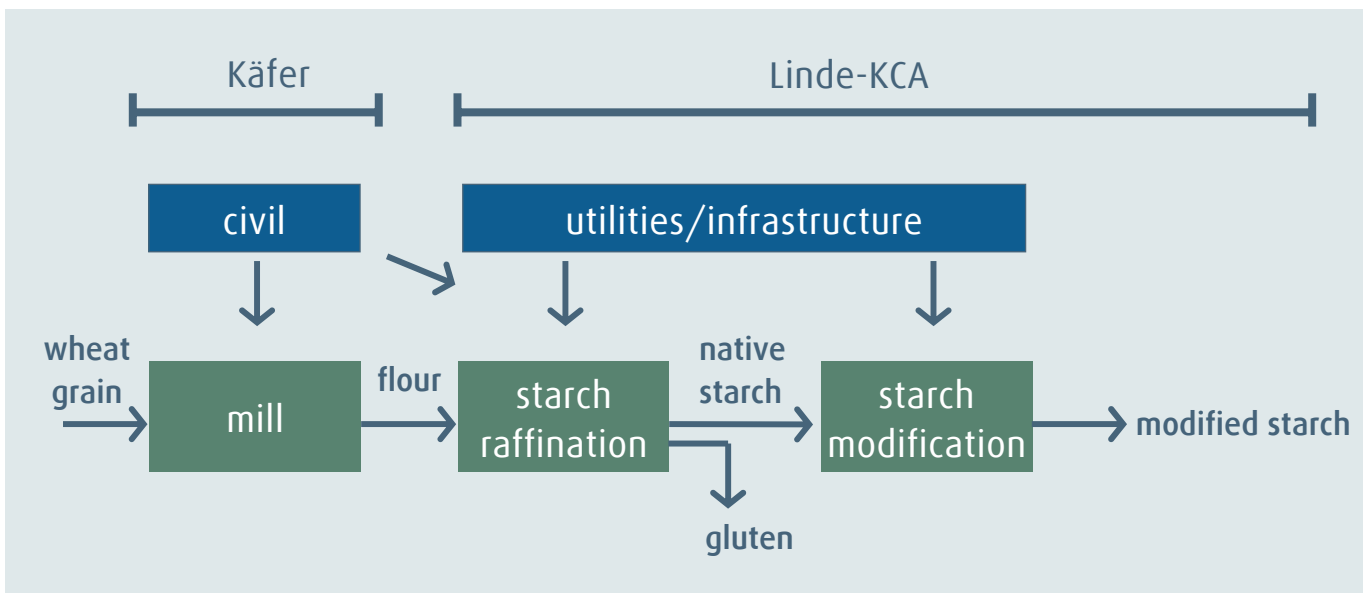




## Contractor

ASK (All Starch Consortium), consisting of

- Linde-KCA-Dresden GmbH (technology/EPC, consortium lead)
- Kaefer Construction GmbH, Bremerhaven (building & mill/EPC)



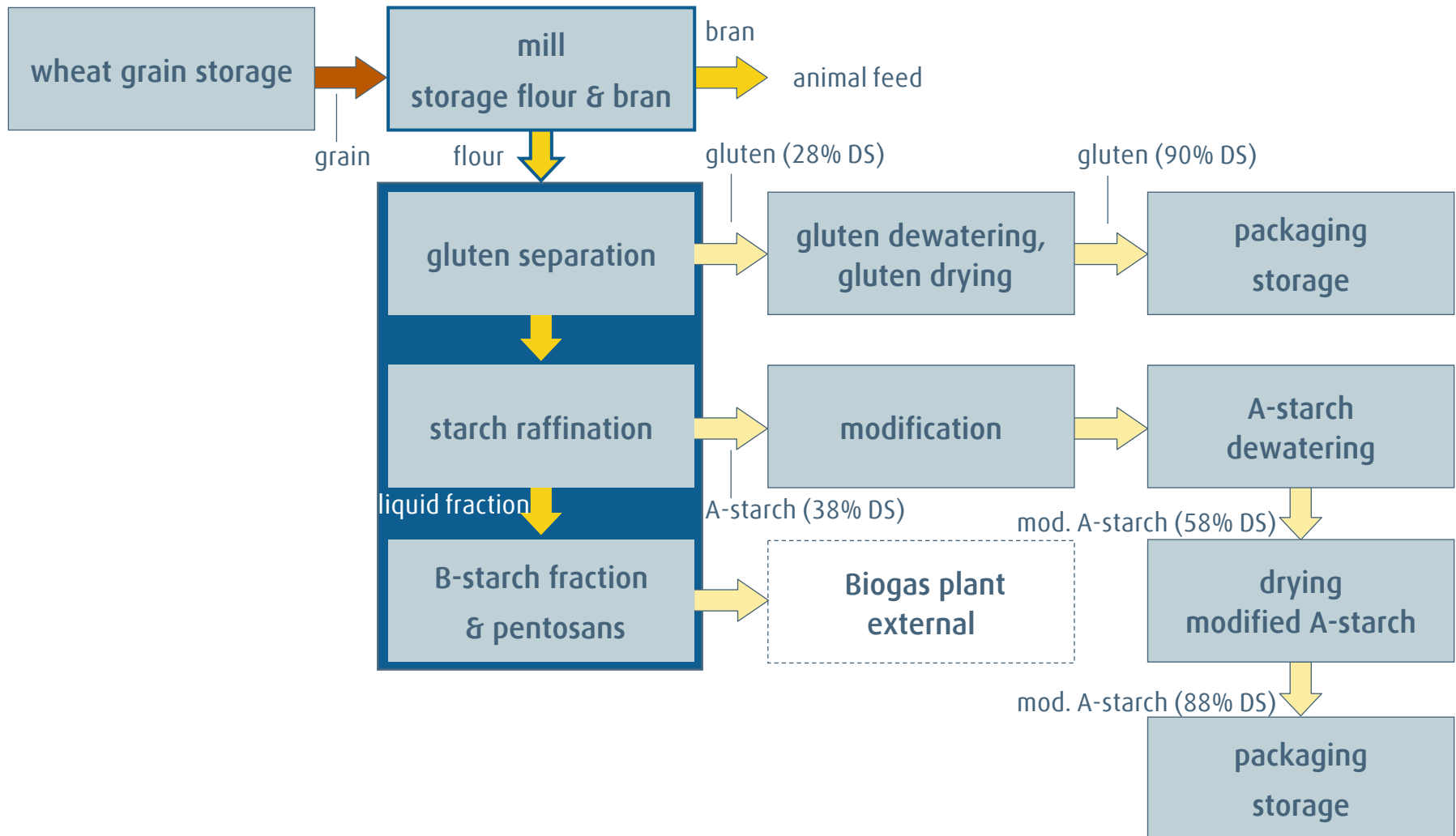
Legend:

Linde-KCA/Käfer

vendors



# Project „ZeitZ“ – Process technology

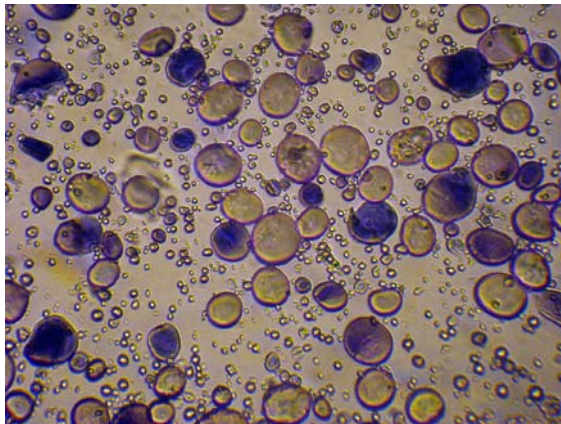


# Key-equipment – starch raffination

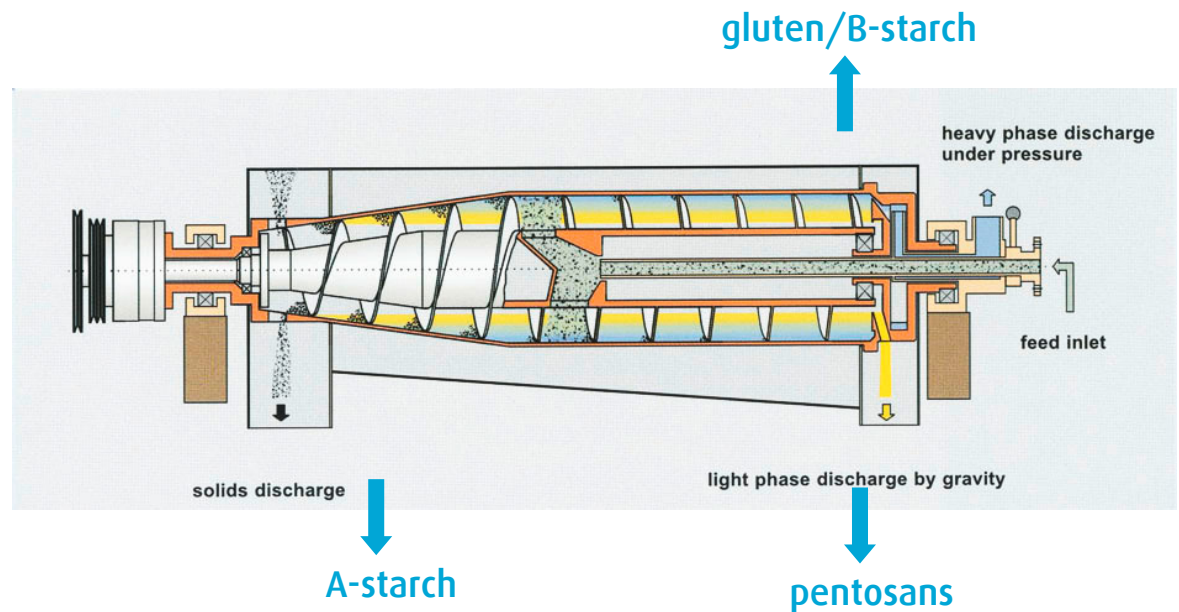
## TRICANTER® Technology

Flottweg GmbH & Co. KGaA

- efficient separation of wheat flour into 3 distinct phases
- continuous process



wheat starch granules



# Key-equipment – Airstream drying for A-starch & gluten

## Flash Dryer/Ring Dryer

- highly specialised vendors, e.g. Anhydro & GEA Barr Rosin
- basic principle:
  - pneumatic system
  - material to be dried is dispersed and conveyed in a hot air stream
  - with selective internal recirculation of semi-dried solids in Ring Dryers

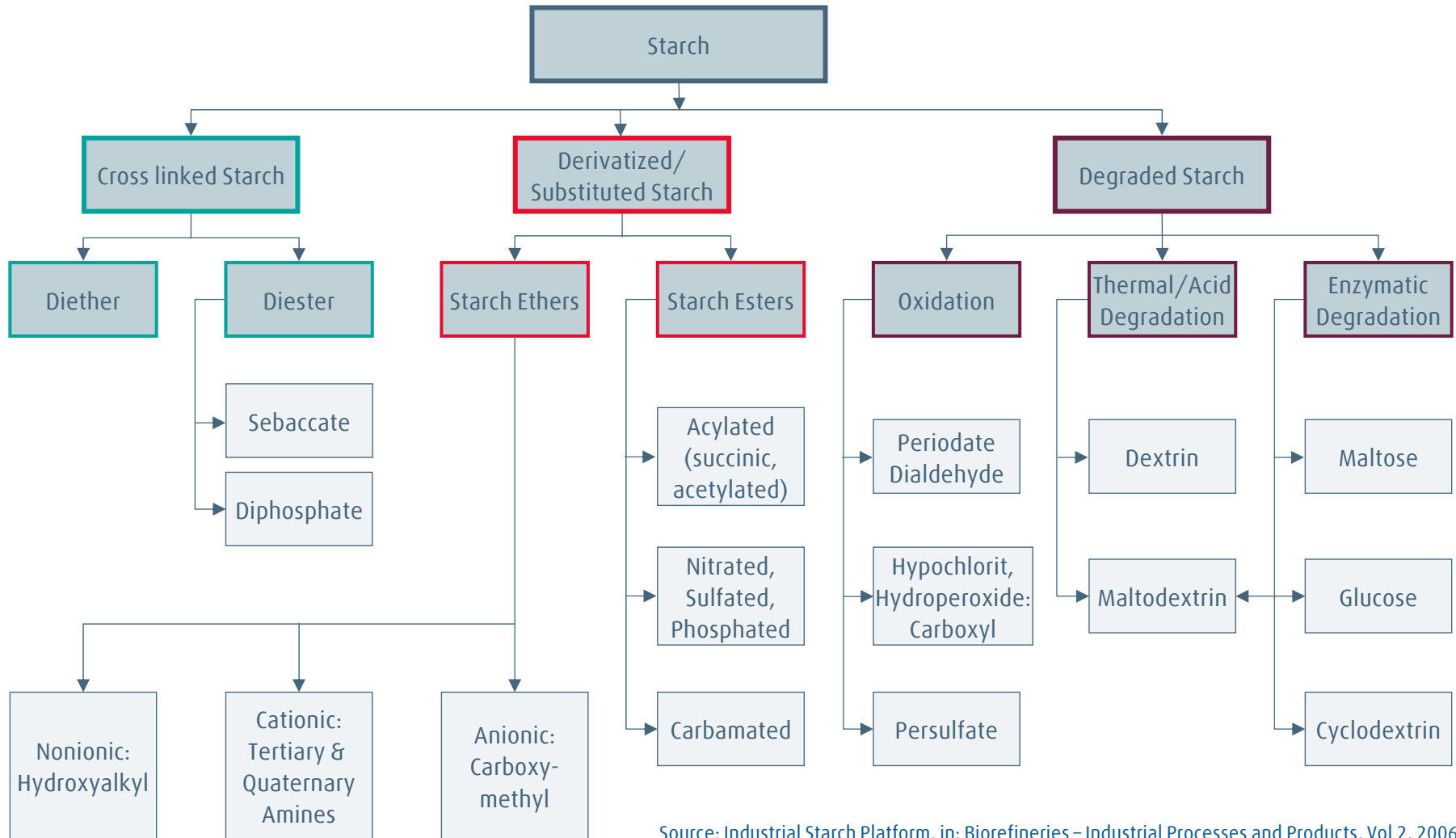
A-starch  
dryer



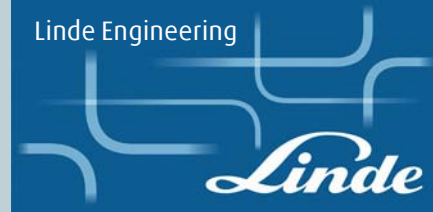
gluten  
dryer

Source: GEA Barr Rosin / examples taken from similar plant

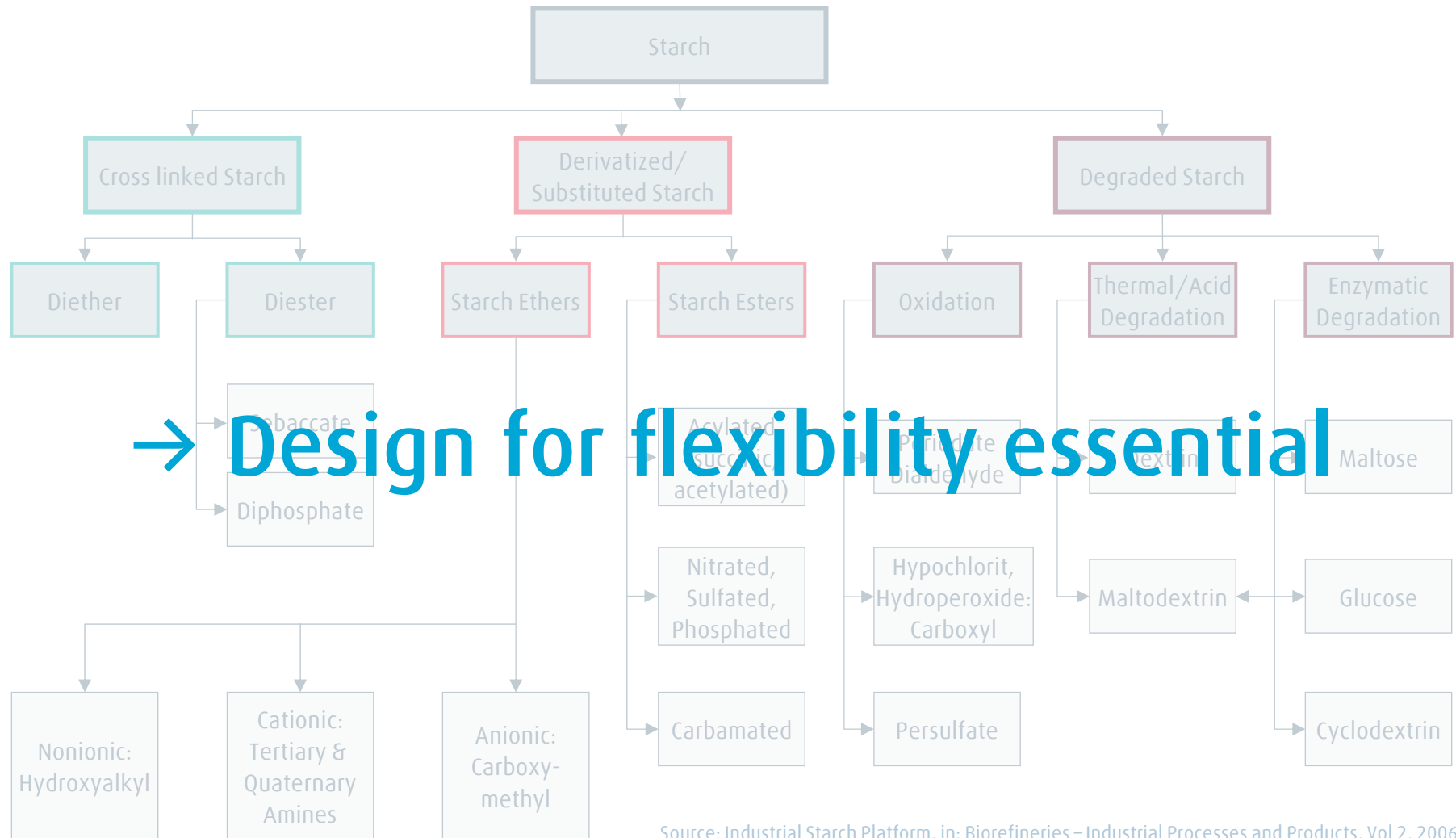
# Starch modification – textbook overview of different types



Source: Industrial Starch Platform, in: Biorefineries – Industrial Processes and Products, Vol 2, 2006

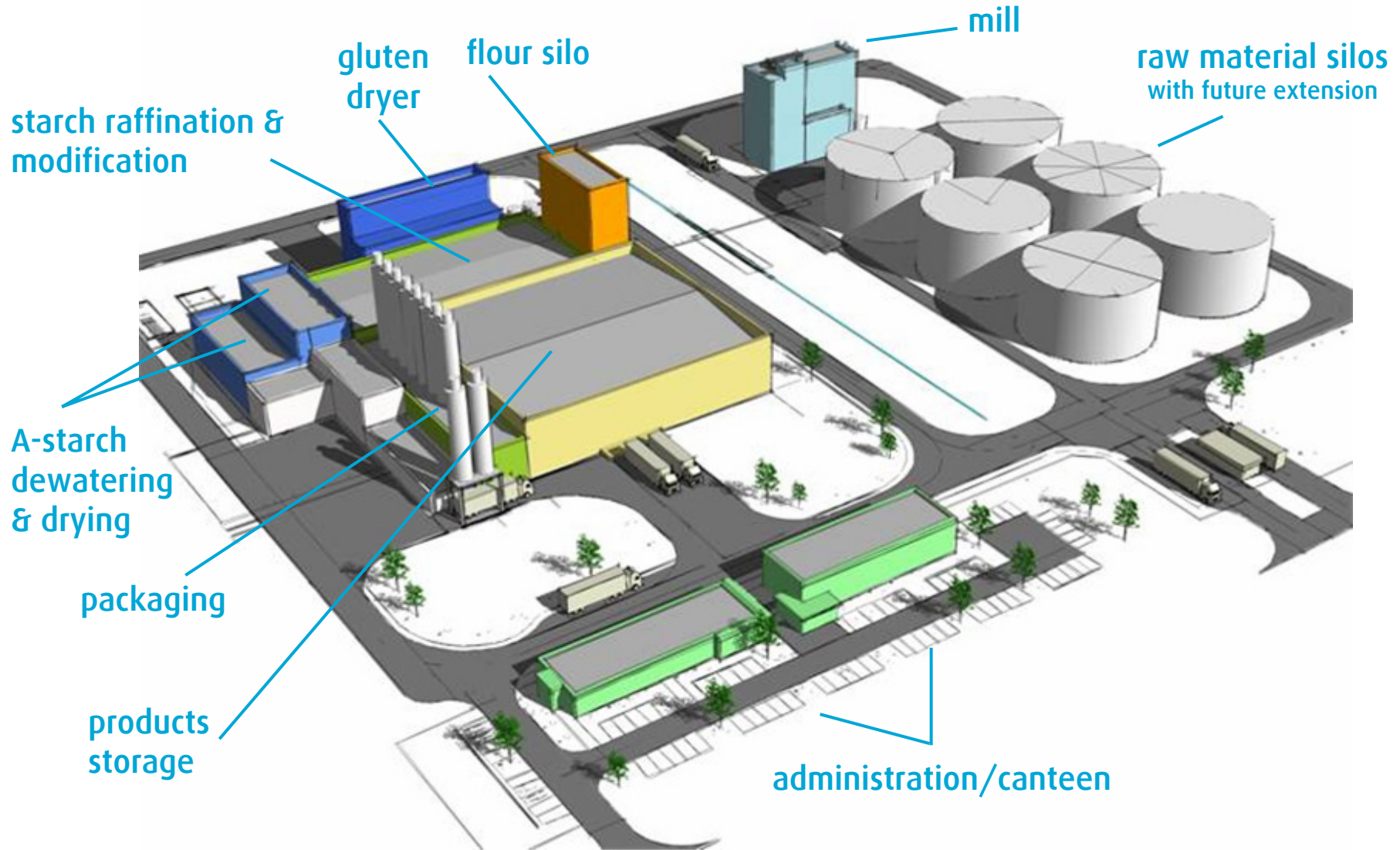


# Starch modification – textbook overview of different types

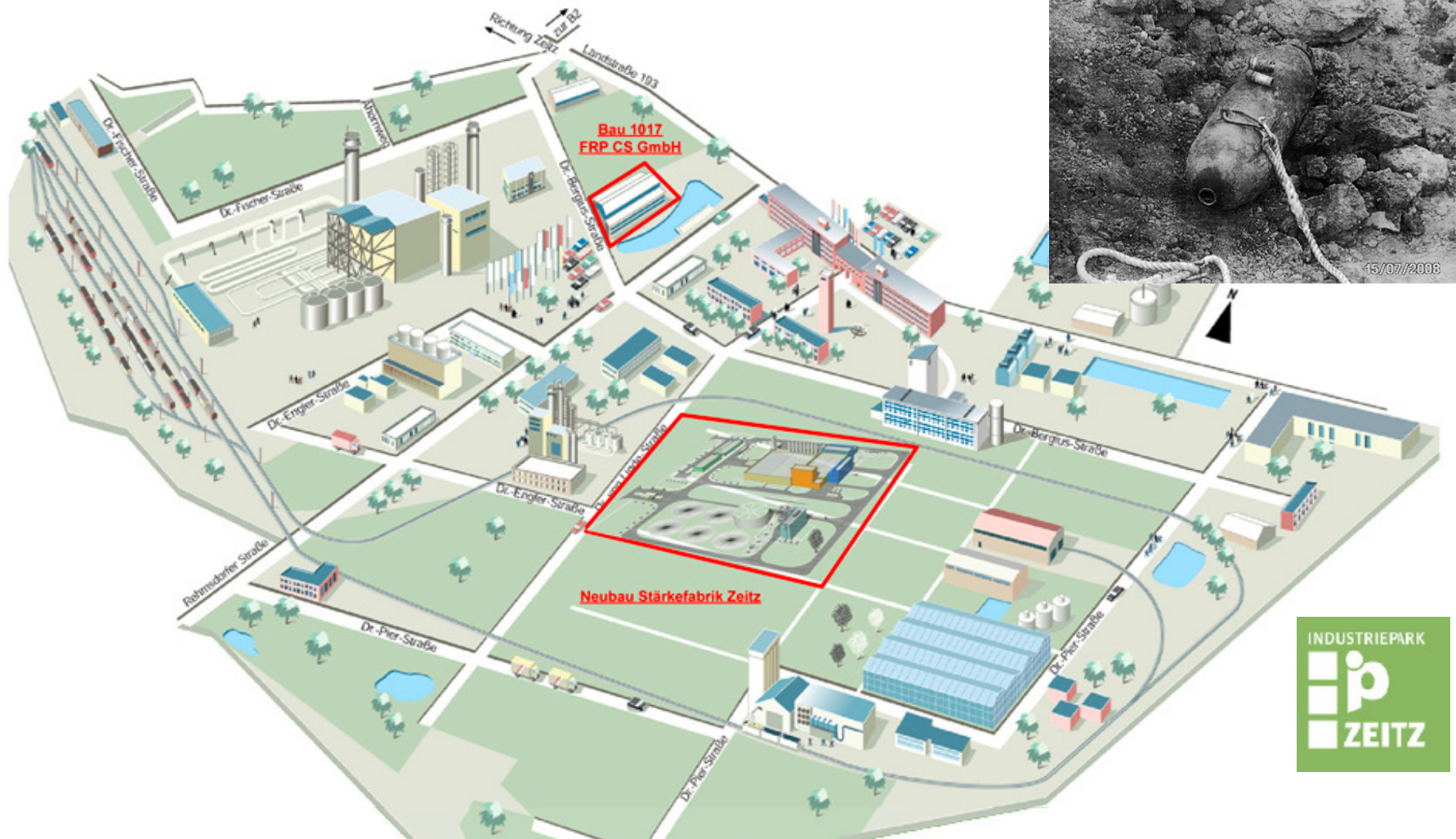


Source: Industrial Starch Platform, in: Biorefineries – Industrial Processes and Products, Vol 2, 2006

# Project „Zeitz“ – 3D model



# Project „Zeitz“– Integration into established infrastructure



# Project „Zeitz“ – Picture from the site





- **Future trend** - from „1G reality“ such as „Zeitz“ to 2G biorefineries
  - from established mature technology with easy-to-process food raw materials and well-known products
  - to emerging technologies under development with difficult-to-process LCB raw materials and either well-known or new products
  
- **Linde-KCA's path forward**
  - biorefinery R&D projects
    - BMBF program „BioEnergie 2021“ (focus on „new concepts“)
    - BMU project „Grüne Bioraffinerie“ (focus „process technology“)
  - cooperation for stepwise implementation of the vision „Biorefinery Leuna“
  - for 2G Biofuel/cellulosic ethanol & butanol plants, development on-going

Thank you for your interest!

Questions?  
Cooperations?

Linde Engineering

The Linde logo is a stylized, cursive script of the word "Linde" in white, positioned in the bottom right corner of the blue rectangular area.

Dr. Karin Bronnenmeier, Linde-KCA-Dresden  
contact: [karin.bronnenmeier@linde-kca.com](mailto:karin.bronnenmeier@linde-kca.com)  
+49.(0)351.250-3364