

**VOGELBUSCH**  
**Biocommodities**

Highlights der Bioenergieforschung  
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# **Is 2G Bioethanol Commercialized Yet?**

## **Technical issues and challenges of second generation demonstration plants**

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# VOGELBUSCH Biocommodities GmbH

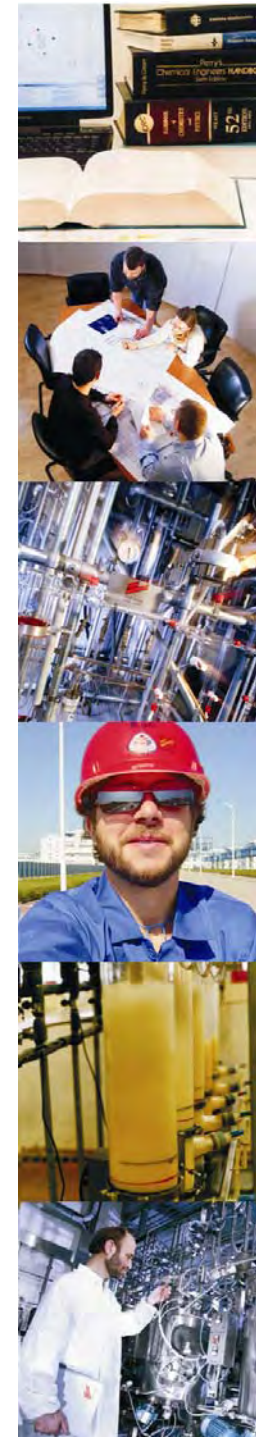
| We make biotechnology work

Complementing client's 2G process with proven first generation bioethanol technology

- ▶ Process design for pilot and demonstration plants
- ▶ Assist in developing fermentation and separation strategies
- ▶ Equipment supply for separation, distillation and dehydration
- ▶ Examples
  - ▶ demo plant of IOGEN | CD
  - ▶ demo plant of INBICON | DK
  - ▶ pilot plant ABENGOA BIOENERGY | US
  - ▶ demo plant of MITSUI/SIME DARBY | MY

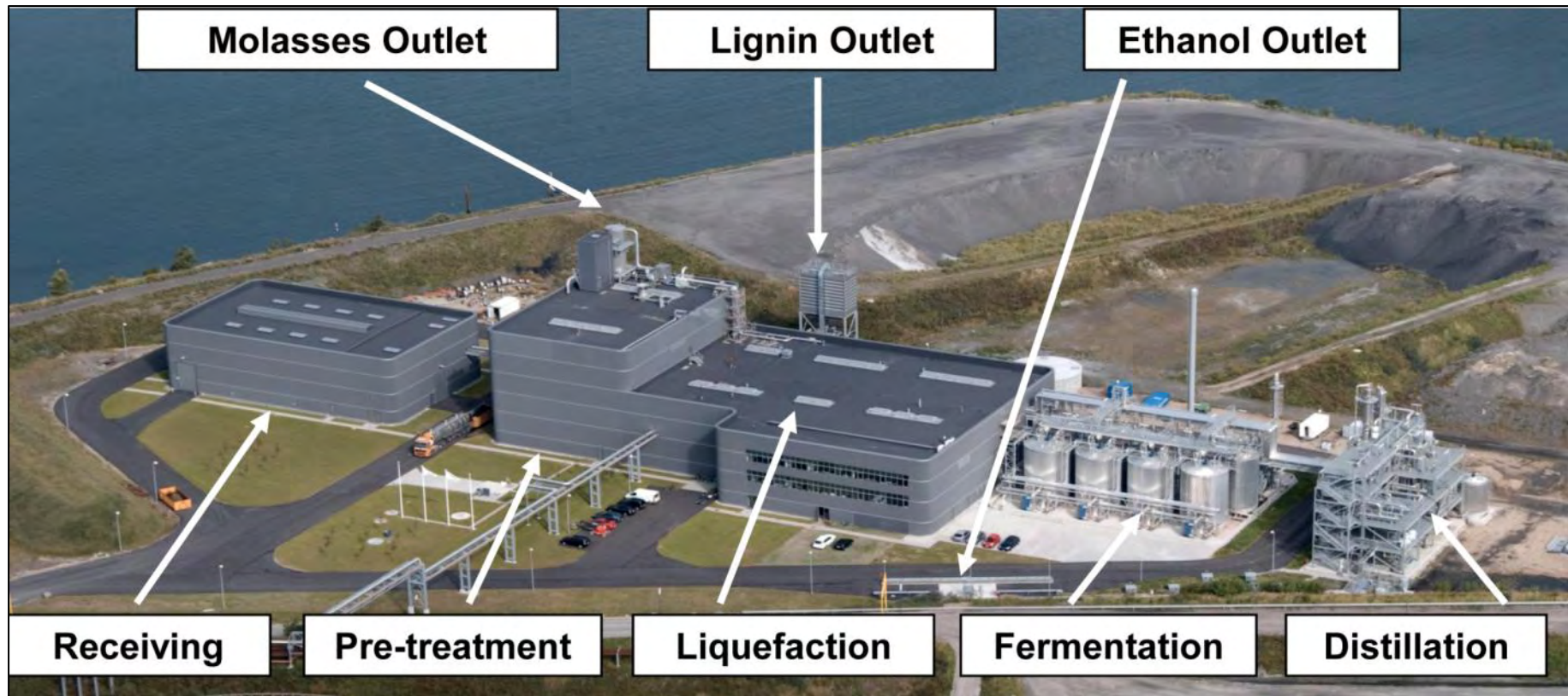


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# EXAMPLE: Inbicon | Kalundborg | DK

| 2G demonstration plant



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## EXAMPLE: Inbicon | Kalundborg | DK

<b>Raw material</b>	wheat straw (4 t per hour = 30,000 t per year)
<b>Capacity</b>	4,300 t / 5,400 m <sup>3</sup> of ethanol per year
<b>Technology</b>	a combination of existing and new: DONG - experienced with biomass logistics from power plants (> 30 t per hour) INBICON - pilot tested mechanical/hydrothermal/enzymatic pretreatment and C6 fermentation VOGELBUSCH - license and process design for fermentation, distillation, dehydration and evaporation
<b>By-product</b>	11,000 t of C5 molasses / year (feed, biogas, bioethanol)
<b>Start-up</b>	2010

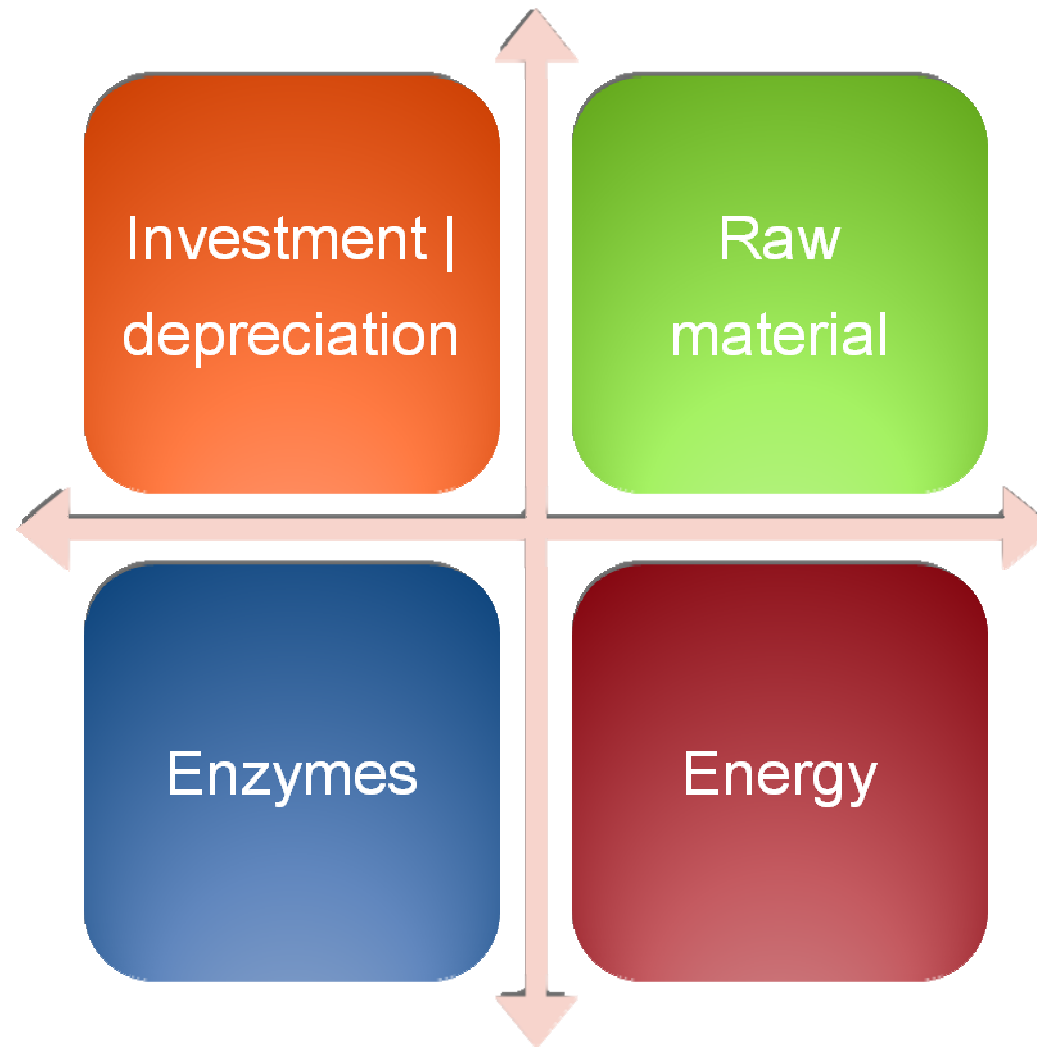
## Comparison G1 vs G2 plant

	G1 plant	G2 plant (estimates)
Raw material	wheat	wheat straw
Yield (l alcohol / t raw material)	390	180
Fermentation time (hours)	60 – 80	120 – 150
Alcohol content (%vol in mash)	11 – 16	5.0 – 10
Steam consumption (t / 1000 l alc)		
Liquefaction	0.4	2.0 – 4.0
Distillation/Dehydration	1.2	1.7
Estimated investment 75,000 m <sup>3</sup> /y plant (Mio €)	60 – 80	180 – 220



# Commercial viability: Cost drivers in production

| Issues and challenges



## Cutting process energy consumption

| Saving costs AND improving greenhouse gas balance!

Incineration of lignin and/or biogas

→ self-contained steam supply possible

Thermal integration = internal use of latent heat of waste streams (dryer)

→ utmost energy efficiency

Increase alcohol content in mash

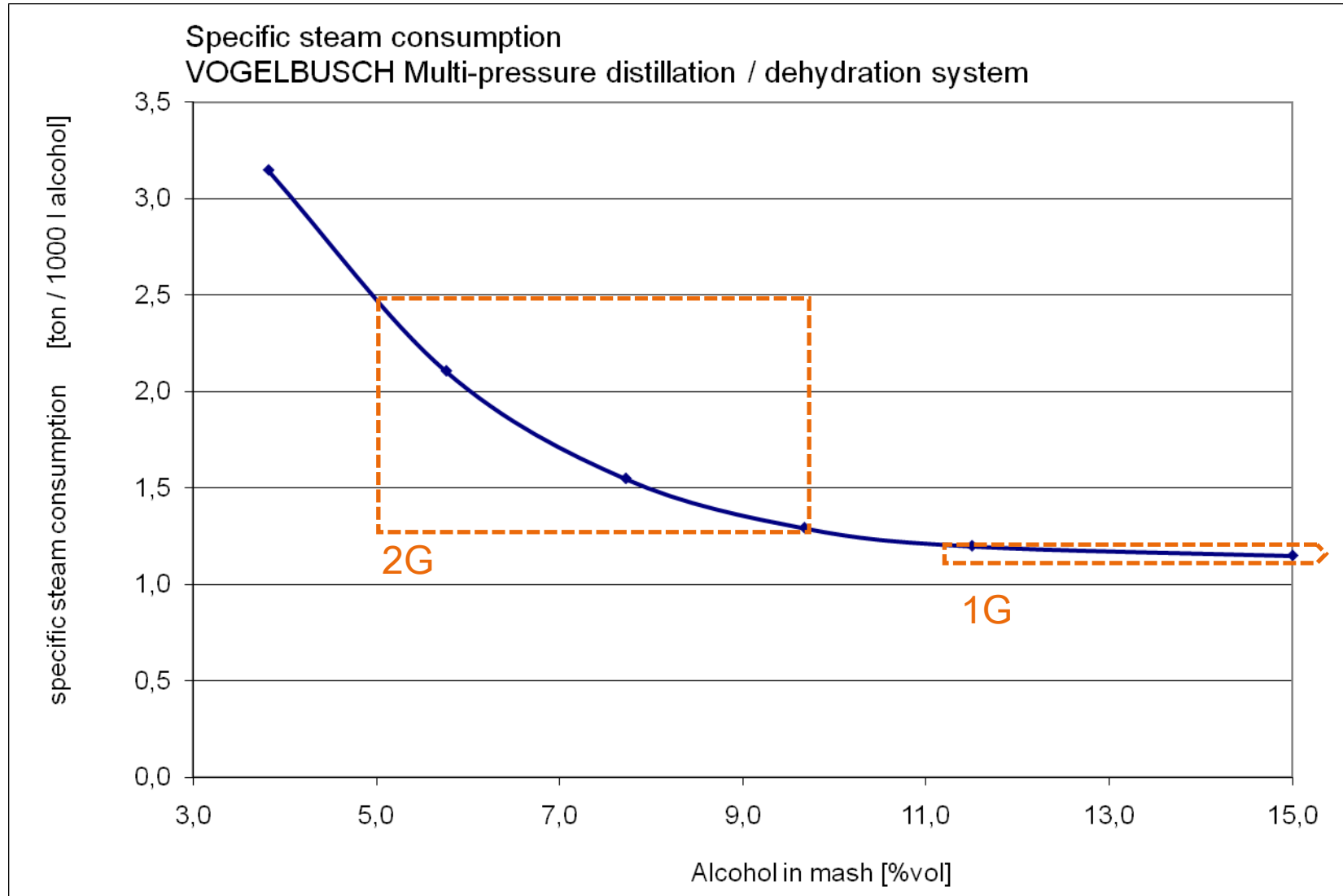
→ reduced energy demand for distillation and stillage treatment

VB Multi-pressure distillation

→ minimized energy costs for distillation

# Energy saving plant design

| High alcohol concentration in mash reduces steam demand





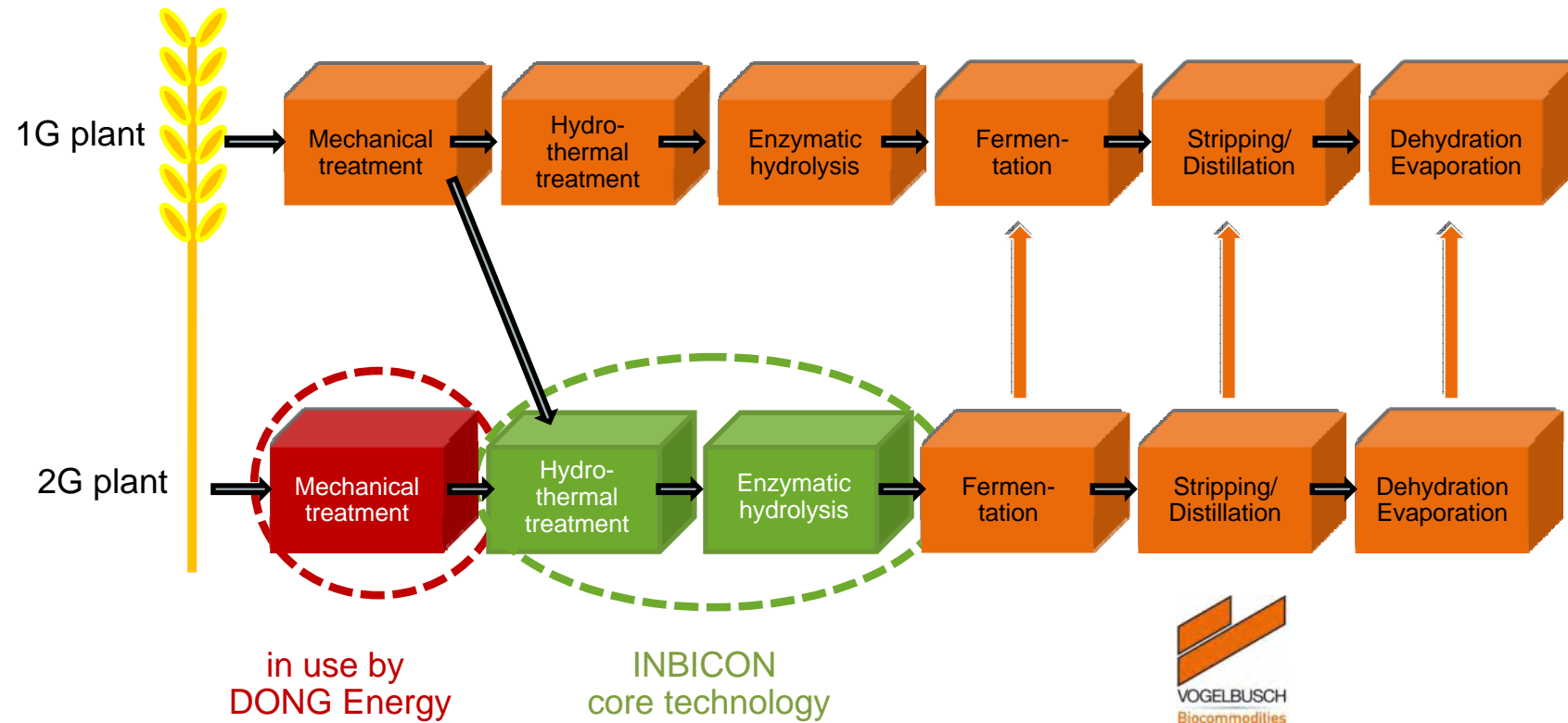
## Requirements for raw materials

- ▶ Availability
- ▶ Short transport distance
- ▶ High density / content of fermentable sugars
- ▶ Low price  
(e. g. € 90 / ton wheat straw is equivalent to € 195 / ton wheat)

### Alternatives to straw

- ▶ Bagasse
- ▶ Corn cobs
- ▶ EFB (empty fruit bunches from palm oil production)
- ▶ ...

# Future concept for plant integration



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# Revamping of G1 plants for G2 feedstock?

| Expensive and difficult

## RETROFIT AND LICENSE COSTS

- ▶ Raw material storage and liquefaction need proprietary process

## TECHNICAL HURDLES

- ▶ Fermentation performance reduced to appx. 30 %
  - ▶ Lower alcohol content and
  - ▶ Increased fermentation time of G2 substrate
- ▶ Specific properties of G2 media to be considered
  - ▶ Viscosity of mash
  - ▶ High content of suspended solids

## The bottom line

### Achieved

- *Stable, proven process*
- *Plant in industrial design available*
- *Industrial product quality requirements*

### Unresolved

- *High investment costs compared to G1 plants*
- *Still higher production costs than G1 product*
- *Raw material availability*
- *First commercial plant*

# ARBEITSGEMEINSCHAFT

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ÖRWZ — Österreichischer  
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Steyrermühl Papierfabrik  
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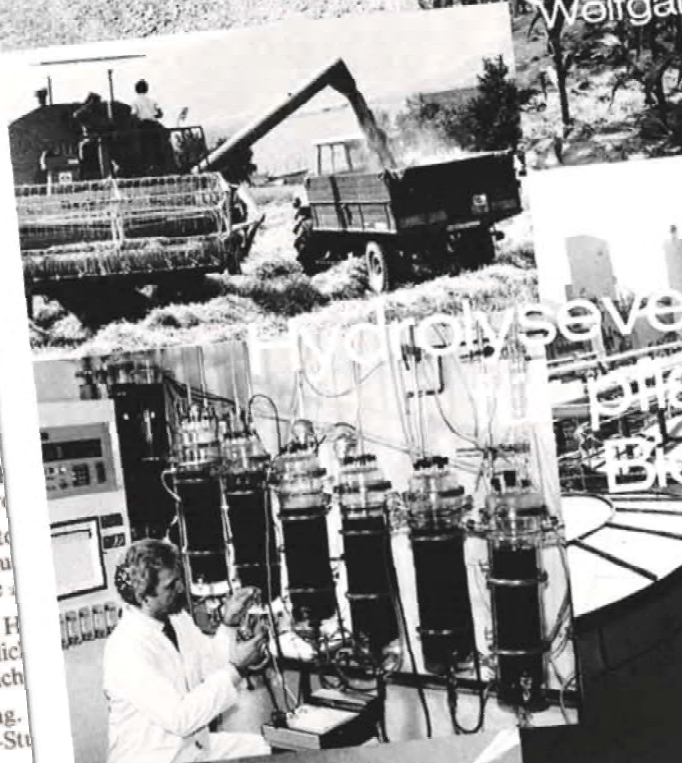
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## Hydrolyseverfahren für pflanzliche Biomasse

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