Highlights der Bioenergieforschung
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VOGELBUSCH
Biocommodities

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

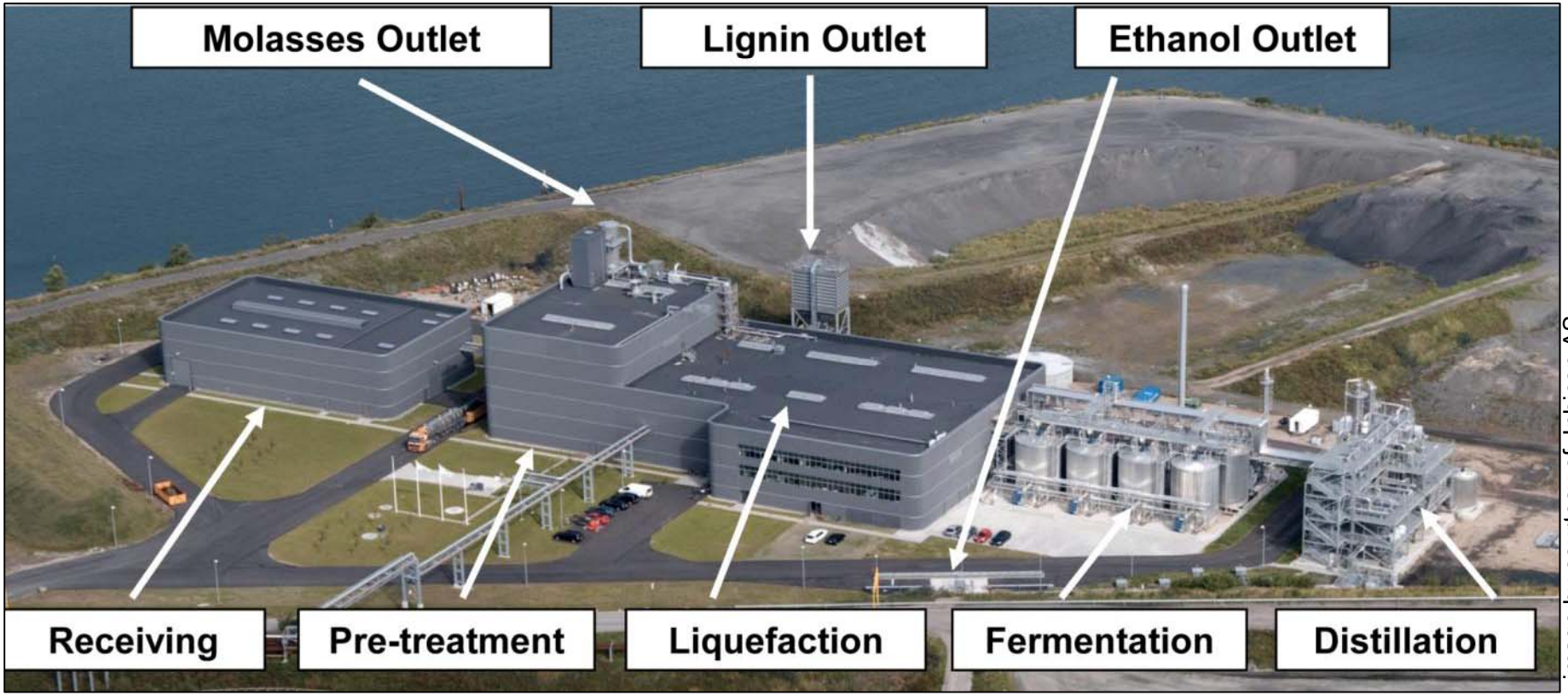


image by courtesy of Inbicon AS

EXAMPLE: Inbicon | Kalundborg | DK

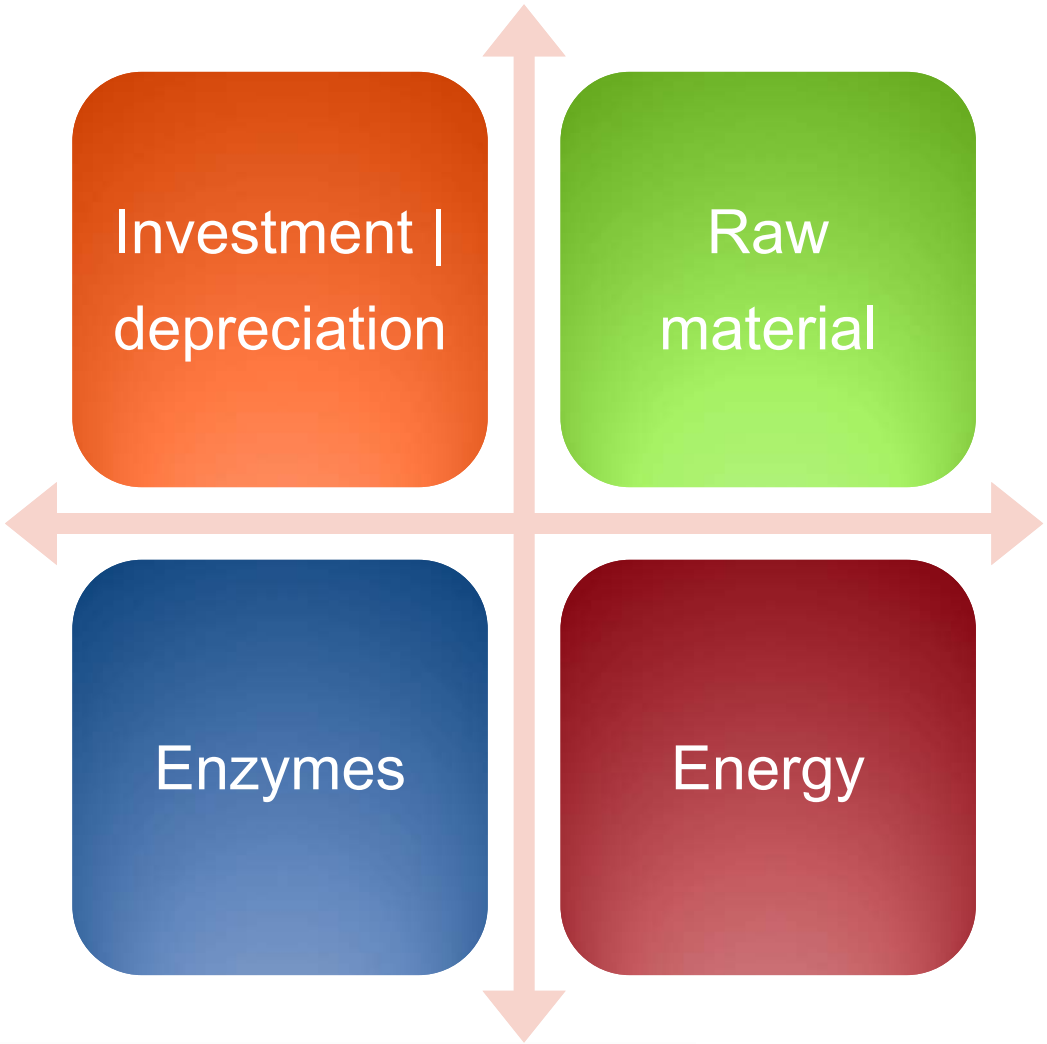
Raw material	wheat straw (4 t per hour = 30,000 t per year)
Capacity	4,300 t / 5,400 m^3 of ethanol per year
Technology	a combination of existing and new: DONG - experienced with biomass logistics from power plants (> 30 t per hour) INBICON - pilot tested mechanical/hydrothermal/ enzymatic pretreatment and C6 fermentation VOGELBUSCH - license and process design for fermentation, distillation, dehydration and evaporation
By-product	11,000 t of C5 molasses / year (feed, biogas, bioethanol)
Start-up	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 m³/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

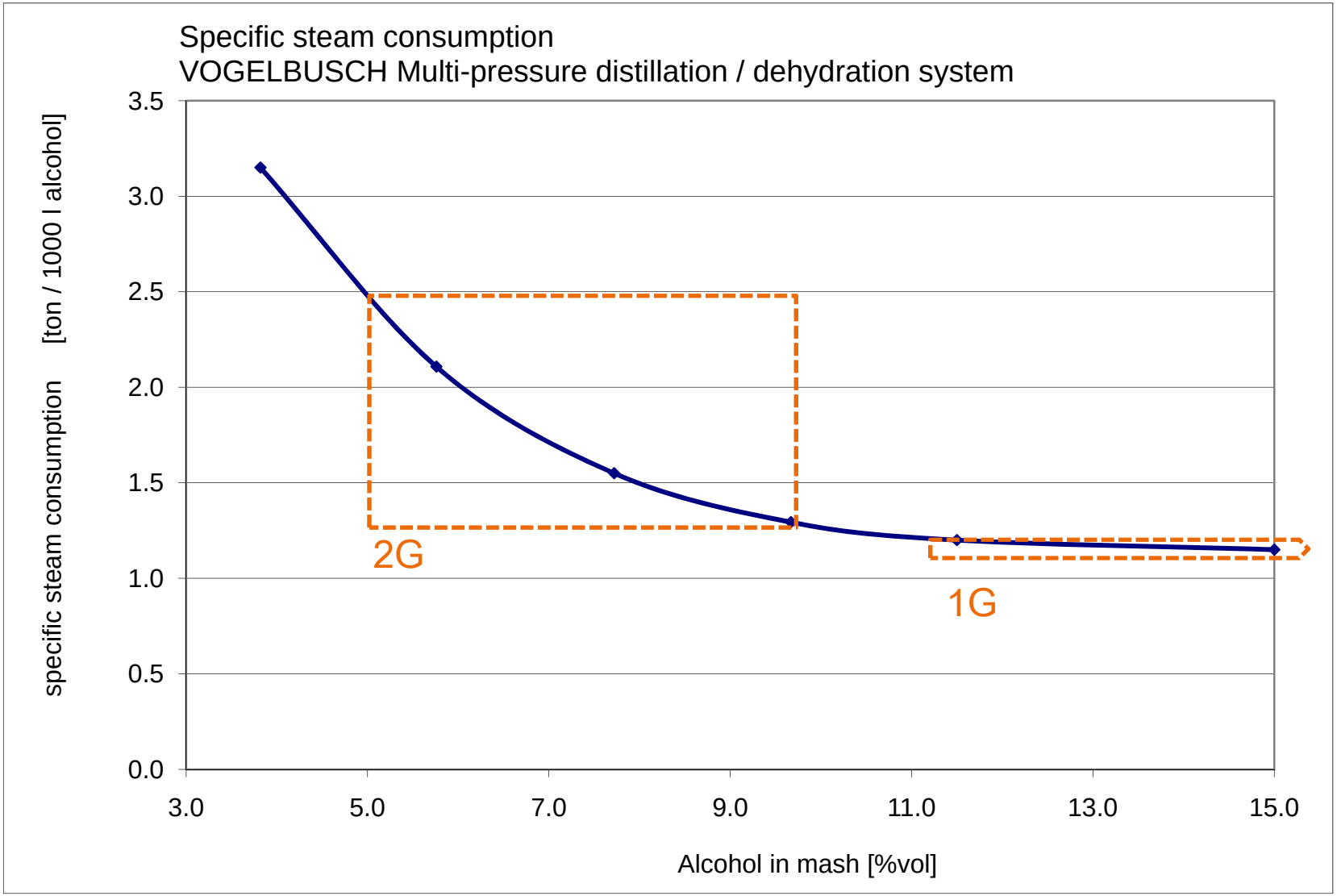
➔ reduced energy demand for distillation and stillage treatment

VB Multi-pressure distillation

➔ minimized energy costs for distillation

Energy saving plant design

| High alcohol concentration in mash reduces steam demand



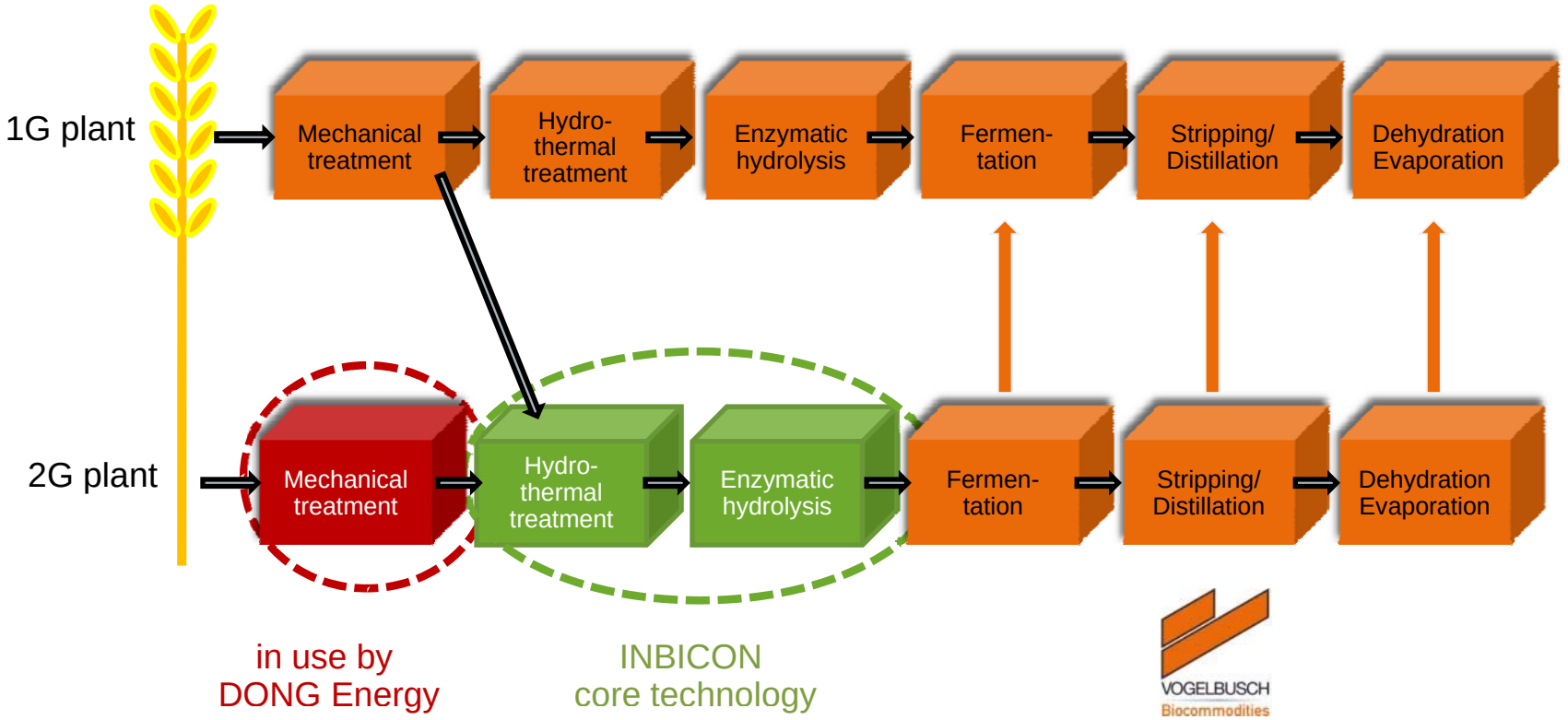
Requirements for raw materials

- 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



graph by courtesy of Inbicon AS

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 then G1 product*
- *Raw material availablity*
- *First commercial plant*