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Minimizing the CO_2 footprint

Ressource-efficient production of 1G and 2G bioethanol

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Experience in bioethanol plant design

First generation

Premier supplier of 1G process engineering packages for the fuel ethanol industry since the 70ies (Brazil, USA, China, Europe)

- Total annual capacity of 5 million tons

Second generation

Complementing client's 2G process with proven 1G bioethanol technology

- Examples
  Iogen, Canada | Inbicon, Denmark | Abengoa Bioenergy, USA (pilot) | Mitsui/Sime Darby, Malaysia | Ineos Bio, USA

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EU Renewable Energy Directive COM(2008)19

Framework conditions for bioethanol production in the EU

Greenhouse gas (GHG) **emission reduction** compared to fossil fuels

- 35 %	• starting 2013 (plants in operation in 2008)
- 50 %	• after 2017
- 60 %	• for new production plants

Mandatory minimum target 10% biofuels by 2020

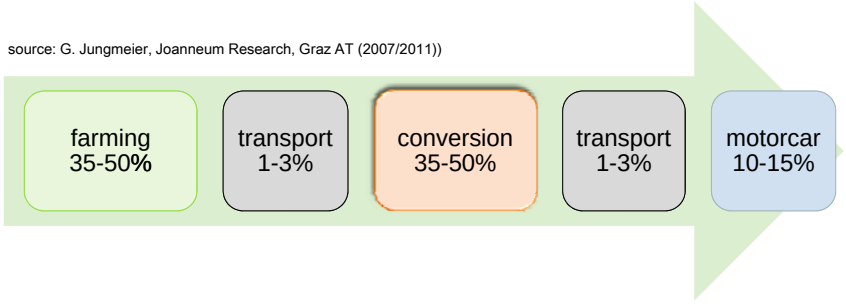
2G	• YET: cellulose / lignocellulose count twice!

Life cycle analysis of GHG emissions

First generation ethanol

Range of share of each sector
(out of total 100% greenhouse gas emissions)

source: G. Jungmeier, Joanneum Research, Graz AT (2007/2011))



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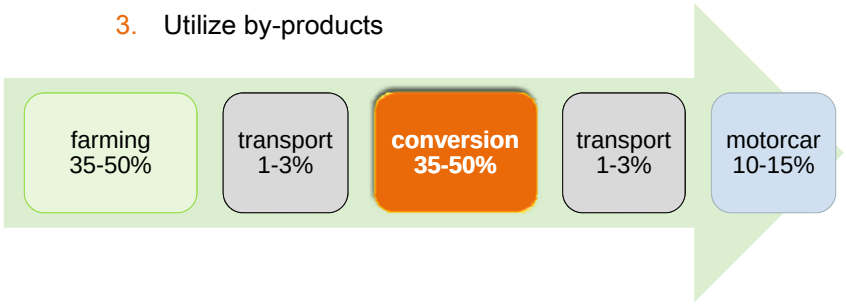
Sustainable biofuels and efficient production

Improving GHG balance in conversion

1. Cut process energy consumption
2. Choose renewable energy source
3. Utilize by-products



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Sustainable biofuels and efficient production

Improving GHG balance in conversion

1. **Cut process energy consumption**
   - process design
   - thermal integration
2. **Choose renewable energy source**
   - primary biomass
   - residues from process
3. **Utilize by-products**
   - DDGS: substitute soy production (animal feed)
   - vinasses: substitute animal feed or fertilizer production
   - C5 residues: biogas, feedstock for advanced fermentations
   - thermal use of by product

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Comparison 1G vs 2G plant

75,000 m³/y plant		1G	2G 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
Viscosity	cP	30 – 50	200 - 400
Steam consumption	t /1000 l alc		
Liquefaction		0.30[VB] – 0.4	2.0 – 4.0
Distillation/Dehydration		1.25[VB] – 2.0	1.7[VB] – 2.5
Share of total energy used downstream	%	80 - 90	40 – 60

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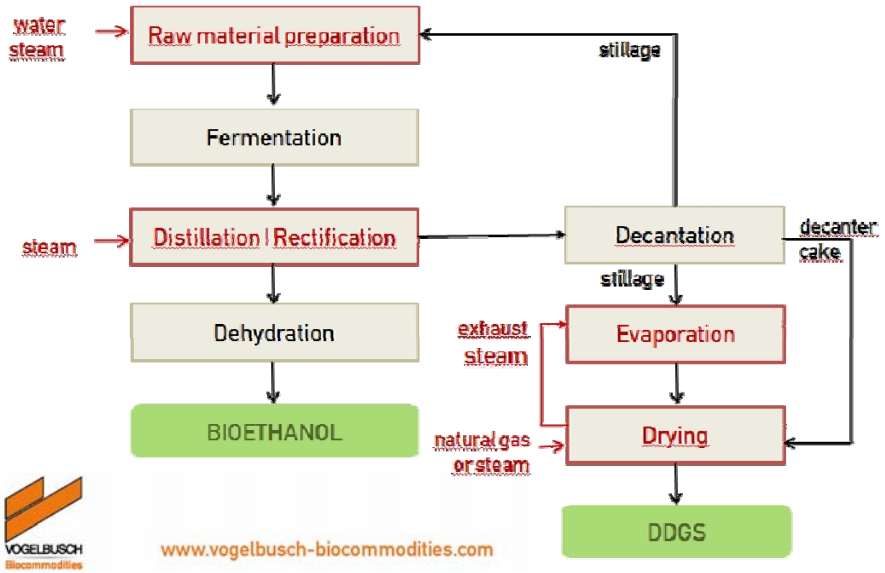
Ethanol process diagram

- processes with high energy consumption



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Special downstream processing solutions

| For first & second generation bioethanol

GIVEN CONTEXT
Cutting process energy consumption improves the carbon footprint.

Technological measures to improve energy efficiency:

1. **Stillage recycle**
   ➔ reduce water consumption and evaporation capacity
2. **VB Multipressure distillation**
   ➔ reduce energy demand for distillation
3. **VB Zero steam evaporator heated by dryer's vapor**
   ➔ reduce energy demand for stillage treatment

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Vogelbusch Multi-pressure distillation I

| For first and second generation bioethanol

3 pressure stages for threefold usage of life steam	‣ vacuum ‣ atmospheric ‣ overpressure
Distillation in split mash columns	‣ vacuum ‣ atmospheric
Rectification in split rectifiers	‣ atmospheric ‣ overpressure
Hydrous alcohol vapors fed directly to molecular sieve unit	

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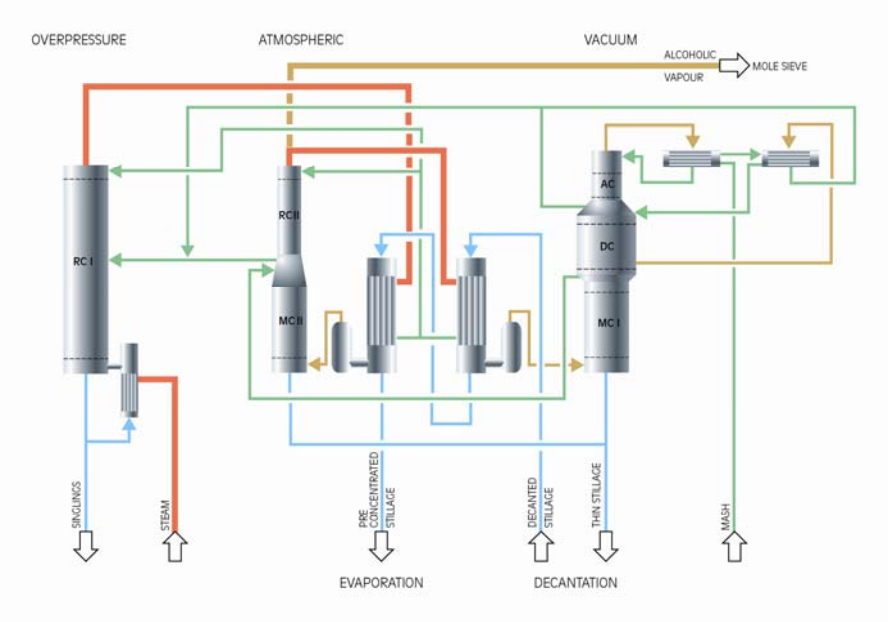
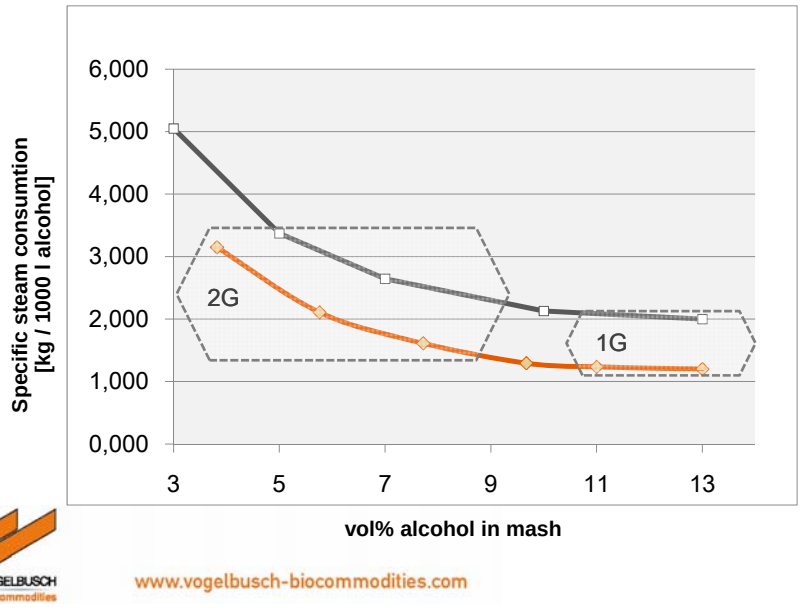
Vogelbusch Multi-pressure distillation II



Vogelbusch Multipressure distillation III

| Influence of alcohol content in mash on steam demand



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Vogelbusch zero steam evaporator

For first and second generation bioethanol

- DDGS dryer is the biggest single steam consumer in a 1G plant
- State-of-the art indirect heated dryers produce vapors with a wet bulb temperature of 90 – 98 °C
- Depending on wet bulb temperature, 50 – 80 % of total dryer's vapors can be utilized as heating source in evaporators
- 1G Plants: multi-effect evaporators are heated completely by dryer's vapors without any additional live steam
- 2G Plants: heated by lignin dryer's unit

Thermal integration pays off!!

| Impact on total energy consumption of a 1G plant

	Conventional Plant	VB Thermally Integrated Plant
Upstream	400	300
Distillation / Dehydration	2,000	1,250
Evaporation	1,800	0
Dryer	2,400	2,400
TOTAL	**6,600**	**3,950**

in kg life steam per 1000 l alcohol

Annual steam saving for a 200,000 tpa corn/wheat based alcohol plant:

> 600,000 tons of life steam per year

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The bottom line

How to meet EU regulations

- Cutting process energy consumption in conversion improves the carbon footprint

Competitive advantage

- Saving energy = saving costs!

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Thank you for your attention.

For questions please contact
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