

# DSM Bio-based Products & Services

## The role of modern biotechnology in industrial biomass processing.

*Carbohydrases - examples*

**ADEBIOTECH 2014**

**October**

**Paris, France**

*Theo Verleun - replaced by Françoise Geoffroy*

# Successful transformation 1902 - 2014

Coal Mining → (Petro)chemicals → Life Sciences & Materials Sciences



Our mission :Connect our unique competences in;  
Life Sciences and Materials Sciences,  
To create solutions to nourish, protect and improve performance  
for people today and generations to come.

# Our core value : sustainability

- Food & Feed
  - Hunger
  - Hidden hunger
- Health
  - Aging world population
  - Food safety & quality
- Climate & Energy
  - Solar, Wind
  - Bio-based fuels
  - Bio-based chemicals.

 Renewable raw materials

Facilitate the needs of a growing world population using Biotechnology (enzymes & microbes)



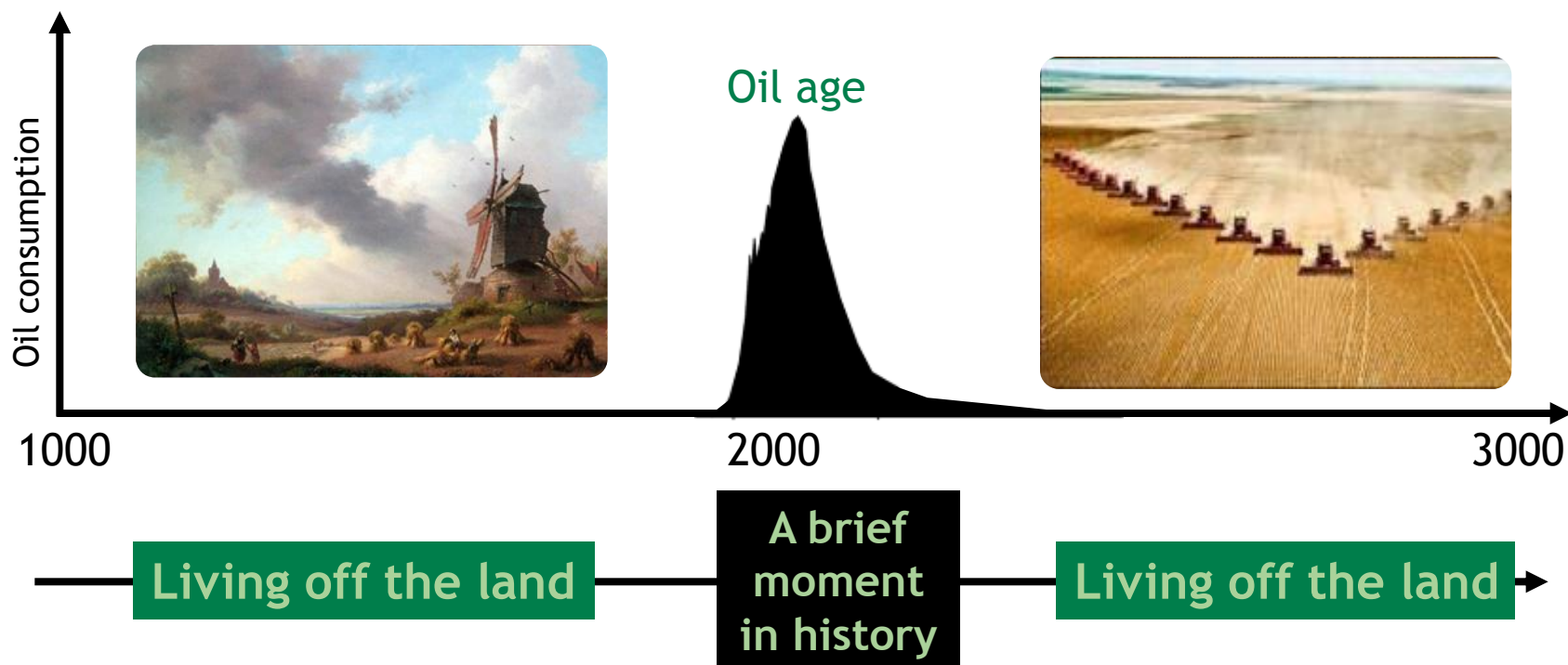
# Why focus on the Bio-based Economy



# Fact: Demand for Consumer Goods



# Fact: Energy Security



The Oil age will end, long before we run out of oil.  
And while running out, it will become much more expensive.  
Wind, Solar and Water do not yield -products-

Can Biomass be the answer?

# Will there be enough Biomass?

## Biomass Availability 2050 (EJ, ExaJoules $10^{18}$ )

- Global energy demand in 2050 is estimated at 600-1040 EJ
- Yearly biomass demand estimate in 2050: 50-250 EJ
- Conservative production capacity estimate 2050 is 200-500 EJ:
  - Reststreams forestry & agriculture: 40-170 EJ
  - Additional forestry: 60-100 EJ
  - Energy crops from land not used for agriculture (idle): 120 EJ
  - Energy crops on marginal land: 70 EJ
  - Increased agricultural yields: 140 EJ
- Alternative energy sources needed
- Abundant supply for chemicals (<5% of the consumption)

Source: Copernicus Institute, WUR, MNP en ECN; <http://www.senternovem.nl>



# Will there be enough Biomass?

## Biomass Availability 2050 (EJ, ExaJoules 10<sup>18</sup>)

- Global energy demand in 2050

- Yeast

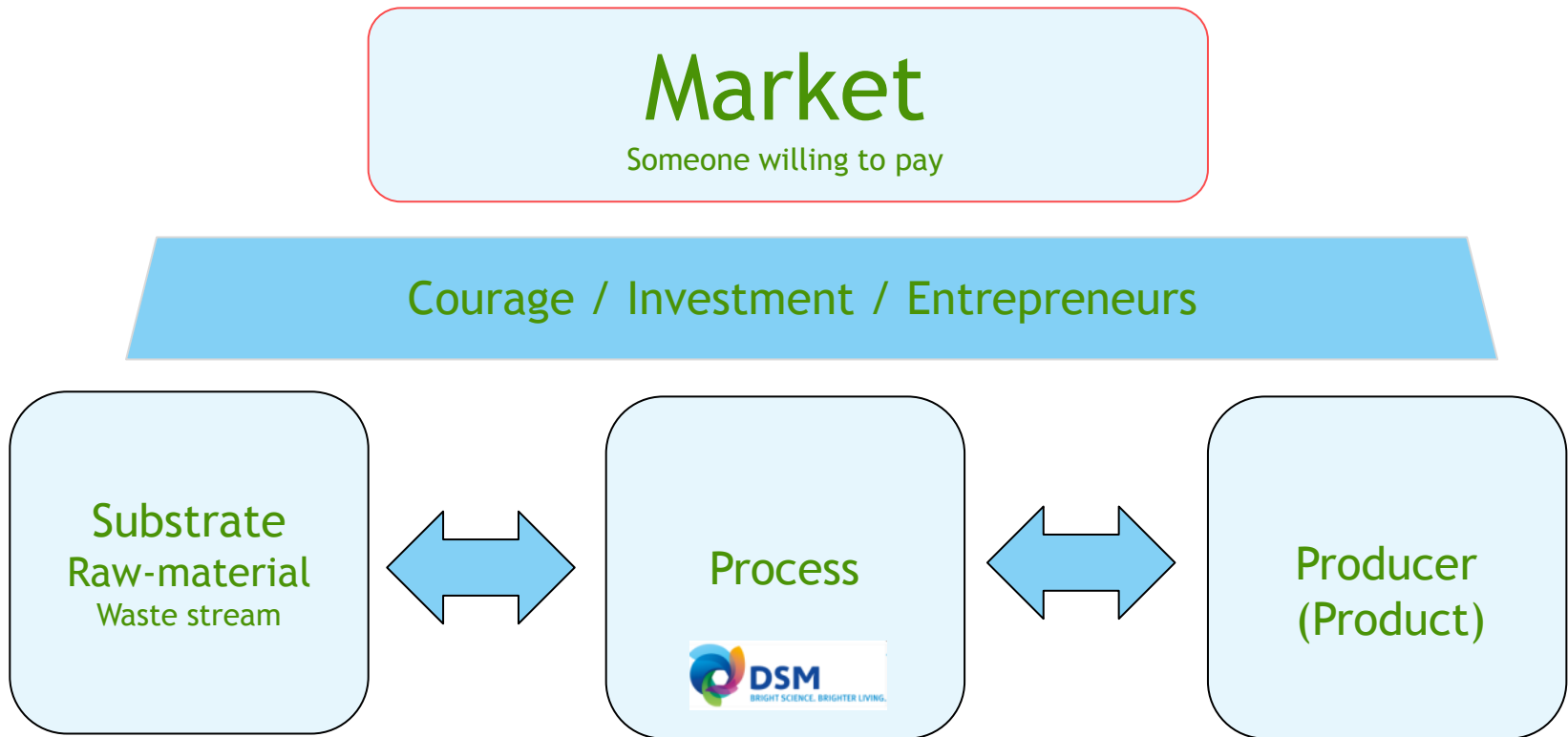
### Requirements

- Use processing waste and food left-overs efficiently.
- Across the globe further improvements and substantial changes in Agri- and Aqua-cultural efficiency.
- Innovation in Plant-science, Eco-science and Biotechnology.
- All with the Future of the Planet in mind.

Source: [www.senternovem.nl](http://www.senternovem.nl) (5% of the consumption)

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# Market demand / forces team creation



**Plenty of ideas.....**



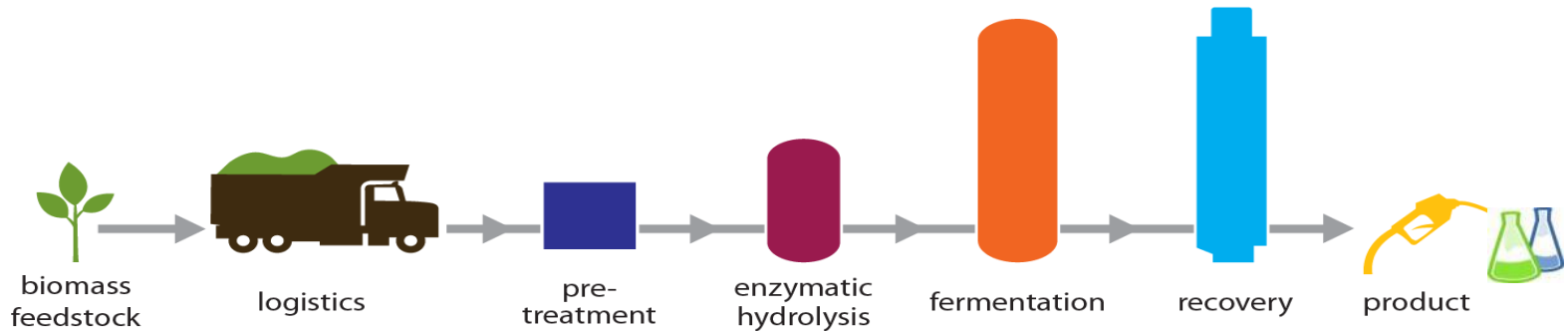
# Market demand / forces team creation

**Without a - clear - market demand  
&  
Without a dedicated team that owns  
the same vision,  
Brilliant idea's useless !!!!**

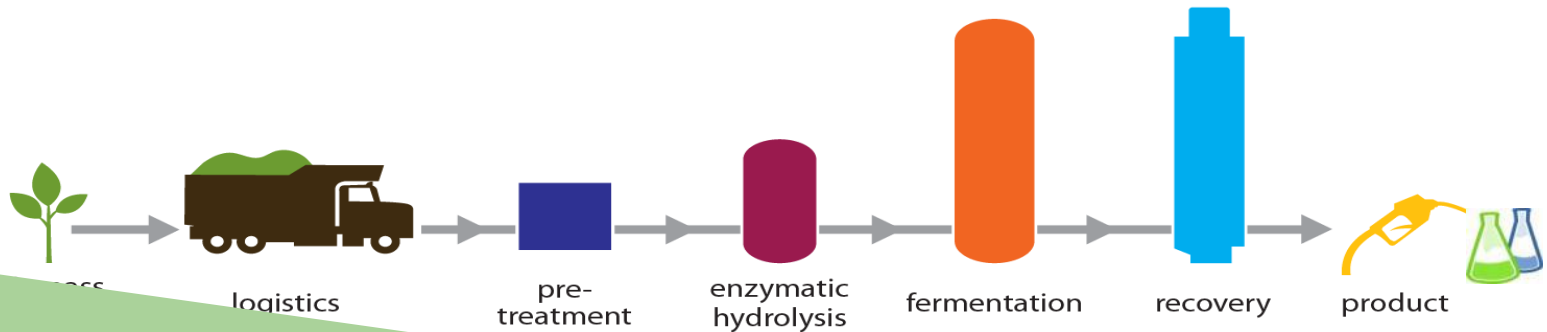


**Plenty of ideas.....**

# Emerging value chain → partnerships needed



# Emerging value chain → partnerships needed



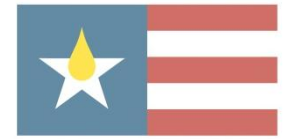
**Cooperation / partnerships;**

We need to bring the world's knowledge and science (academic and industrial) together, to be successful in constructive partnerships.

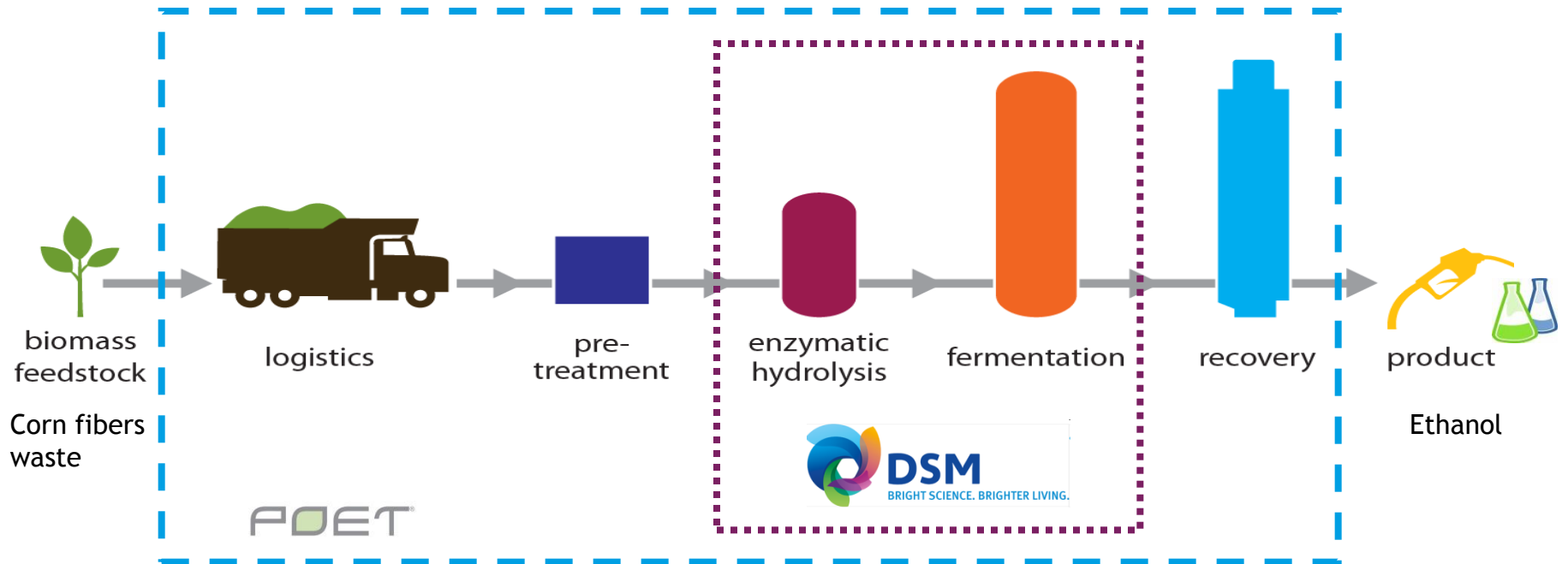


# POET-DSM Advanced Biofuels

*two innovative companies - one shared vision*

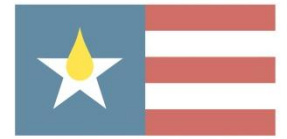


Project LIBERTY



# POET-DSM Advanced Biofuels

*two innovative companies - one shared vision*



Project LIBERTY

**Opening September 3<sup>rd</sup> in Emmetsburg, Iowa**

**Total investment; \$250 million**

**Designed to produce more than ~ 80 million liters of Ethanol from corn fibers waste.**

Replicate technology throughout POET's existing network of 27 corn ethanol plants (> 2400 million liters)

bioma  
feedsto

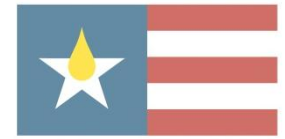
Corn fiber  
waste



Advanced Biofuels

# POET-DSM Advanced Biofuels

*two innovative companies - one shared vision*



Project LIBERTY



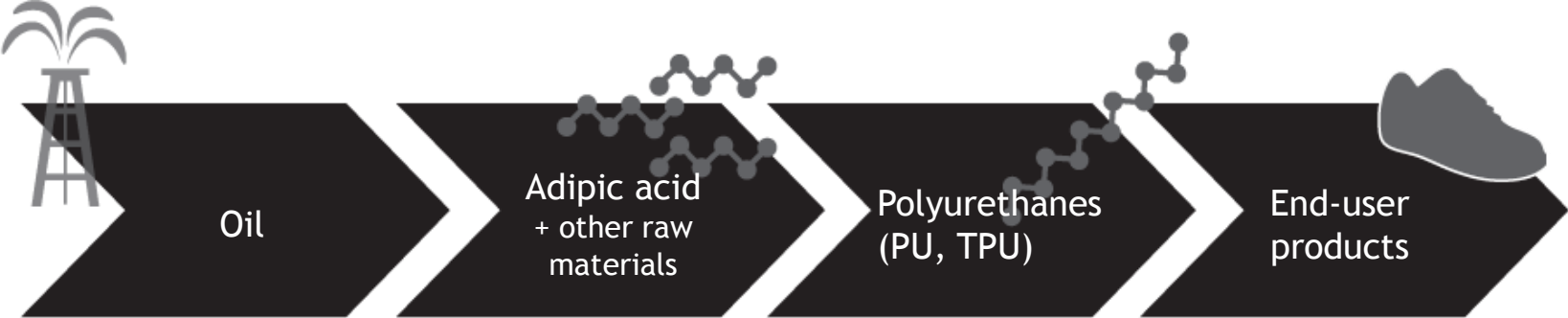
**Opening September 3<sup>rd</sup> in Emmetsburg, Iowa**

700 ton Corn-fiber/day - It is not only a scientific achievement it is also an AGRO achievement and most of all a logistics achievement.

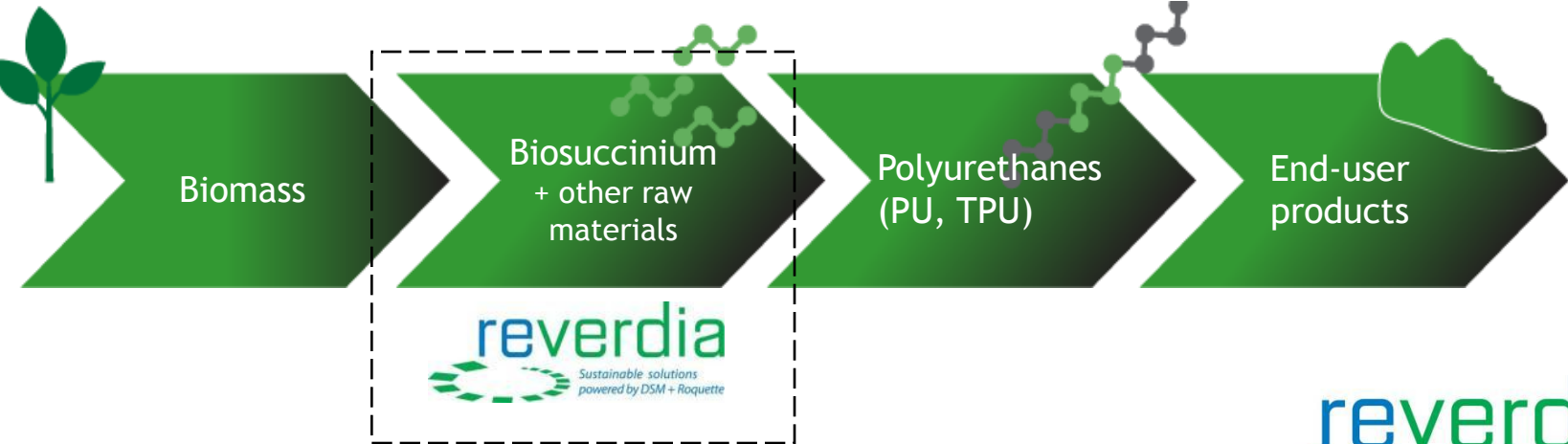


# Sustainable Polyurethanes

Current Technology: Industry based on oil to produce adipic acid



New Technology: Biosuccinium™ replaces petro-based adipic acid



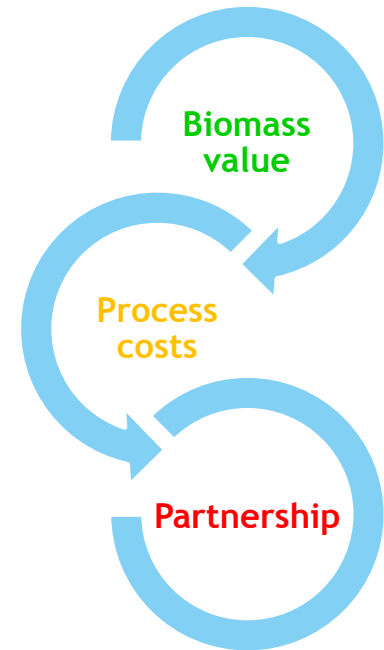
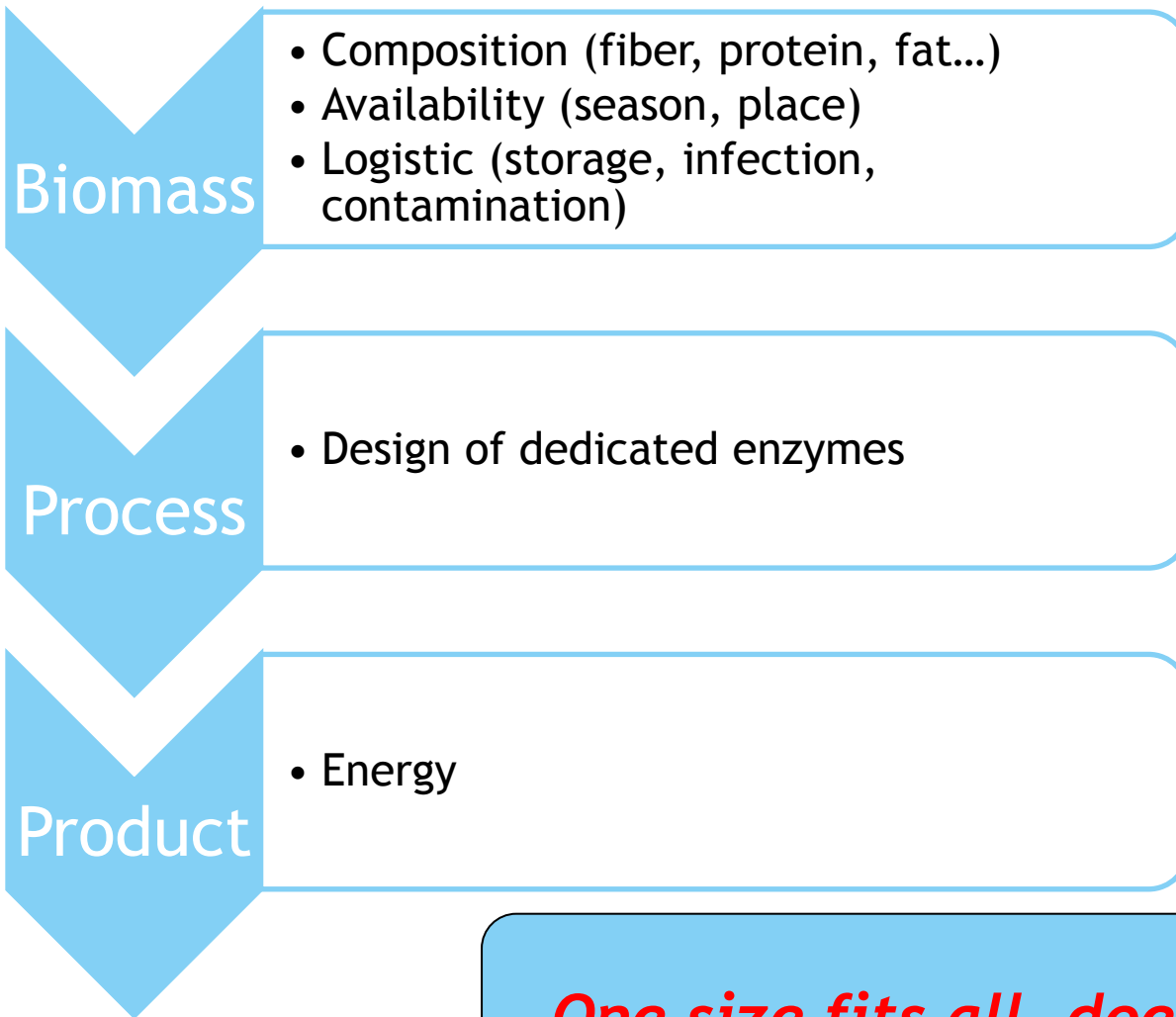
# Reverdia Commercial Plant in Italy

In operation since late 2013

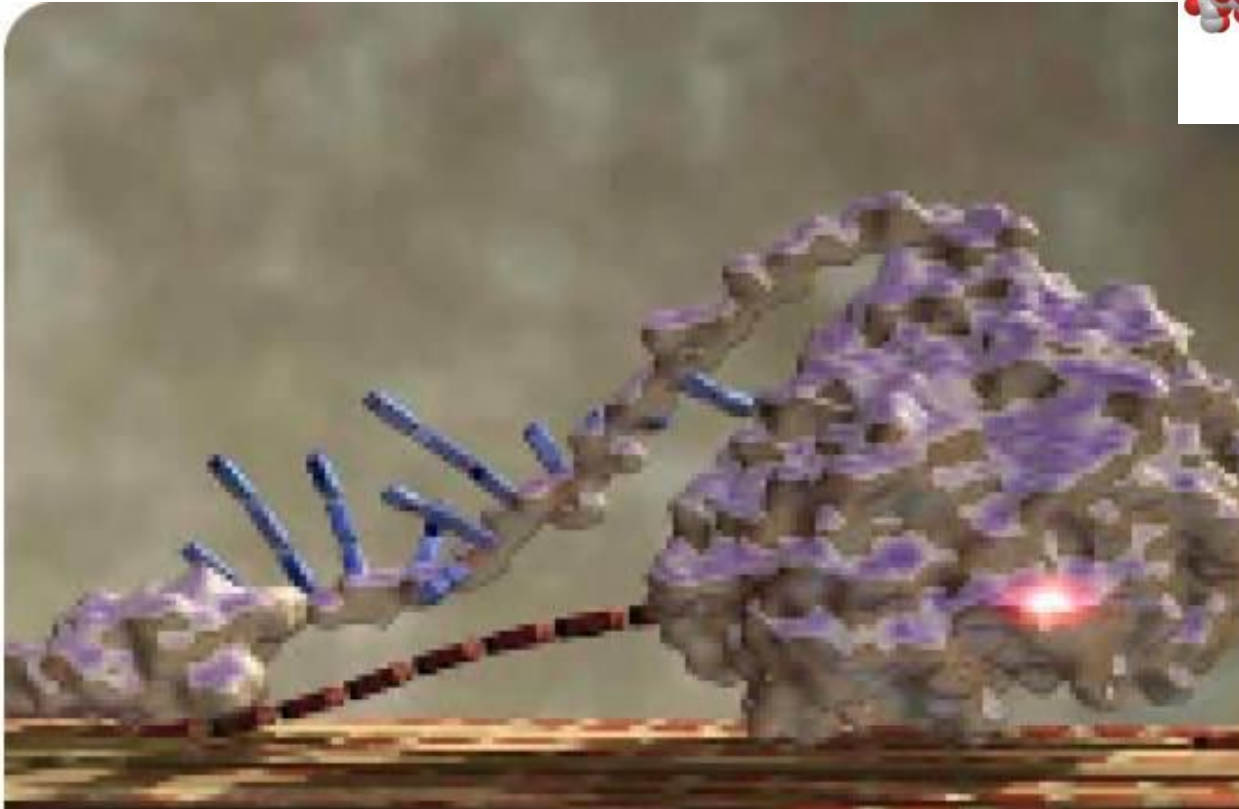
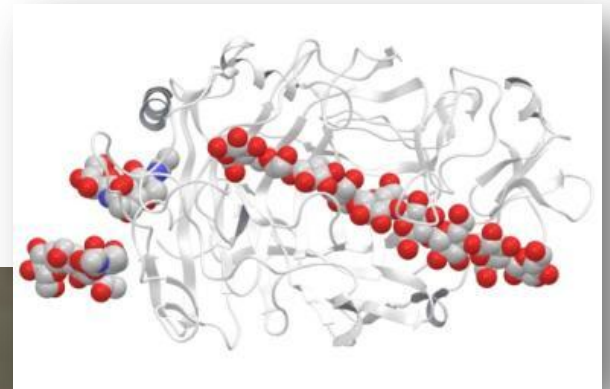


# Biomasses.....





***One size fits all, does not exist !!!***



**Can Enzymes be the answer?**

# The function of enzymes

## The properties of enzymes:

- Enzymes are biological catalysts. They accelerate a reaction without being consumed itself in the reaction
- Enzymes are proteins, composed of 100 to 1000 amino acids, folded, have an active center, usually with separate binding sites to build up a link to the substrate.
- Due to the protein structure, enzymes themselves are subjected a degradation and therefore an inactivation.



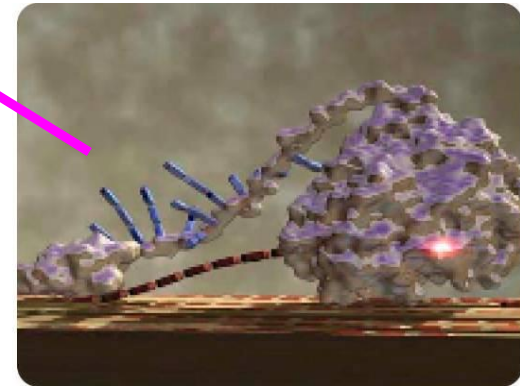
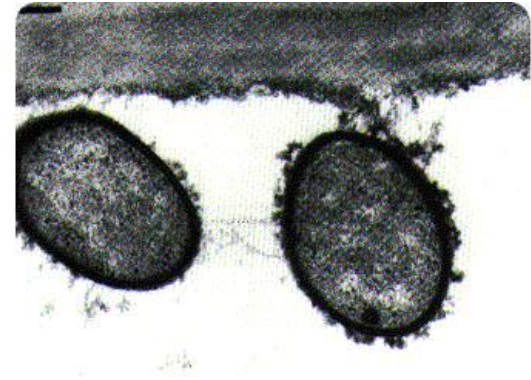
# Capabilities of enzymes

Enzymes bring a wide range of processing benefits and ensure cost savings by:

- improving processing efficiency
- reducing production time
- replacing physical and chemical treatments
- reducing energy needs
- using less raw materials



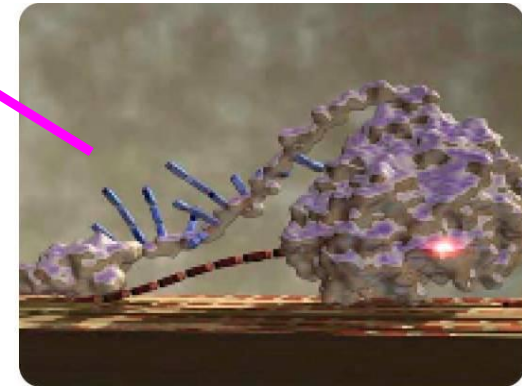
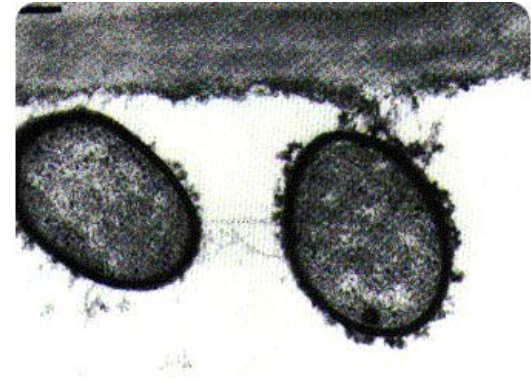
# Enzymes for better efficiency



Animated action of a (1) Cellulase on a synthetic smooth Cellulose fibre surface.  
Dieses Video wurde zur Verfügung gestellt

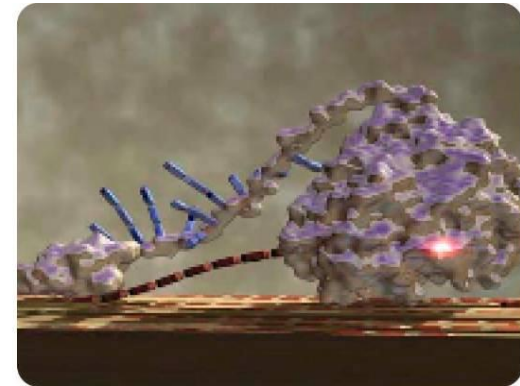
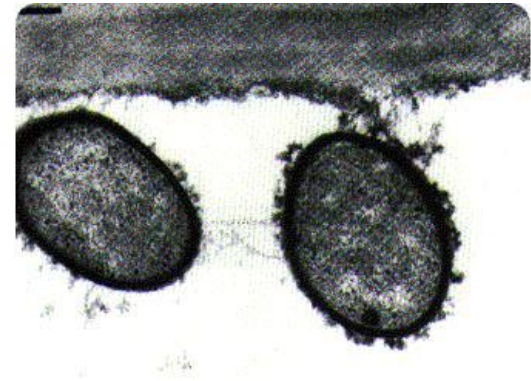
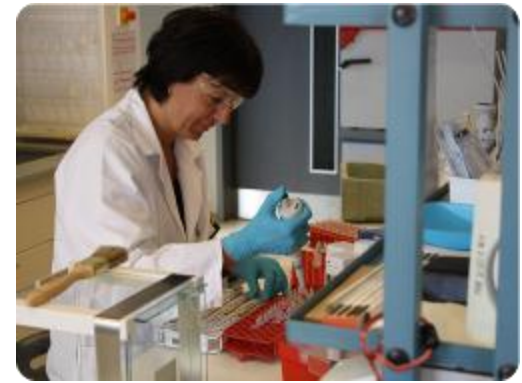


# Enzymes for better efficiency



Dreidimensional visualisation of Cellulases at work on a Cellulose fibre.  
Dieses Video wurde zur Verfügung gestellt.

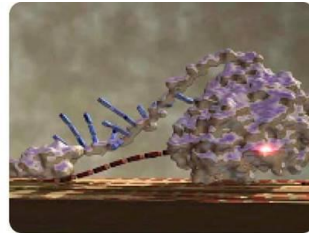
# Enzymes for better efficiency



Hydrolysis of Cartboard within 14 days. (links: Control; rechts: 100 ppm MethaPlus)

# The *Industrial Green* process

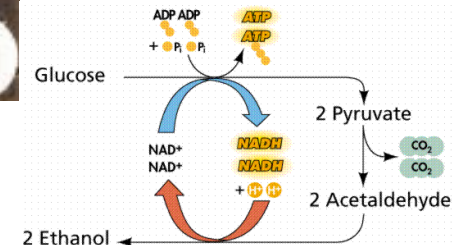
Defined biomass



Hydrolysate  
C5-C6 sugars



product



First step

Multiple enzymes, Right enzymes  
breaking up the biomass  
Conditions & time are crucial

Second step

Microbes (yeast /bacteria or alike)  
at work, consuming nutrients and  
creating products.

# Bio-Tech Facilities / Products and Processes



# DSM Biogas Products



## ✓ Axiase™ 100

Cereal based fibers / Glucans-Pentosans

## ✓ MethaPlus® L 100

Fibrous substrates / (hemi-)cellulose

Both are Carbohydrase mixes.



# Axiase™ 100 (cereal as biomass)

type of cereal	β-Glucan [g/kg DM]	Pentosan [g/kg DM]
Barley	107	66
Oat	66	58
Rye	29	87
Wheat	10	66
Triticale	12	90
Maize	12	40

from Dierick 1989; Choct&Annison 1990

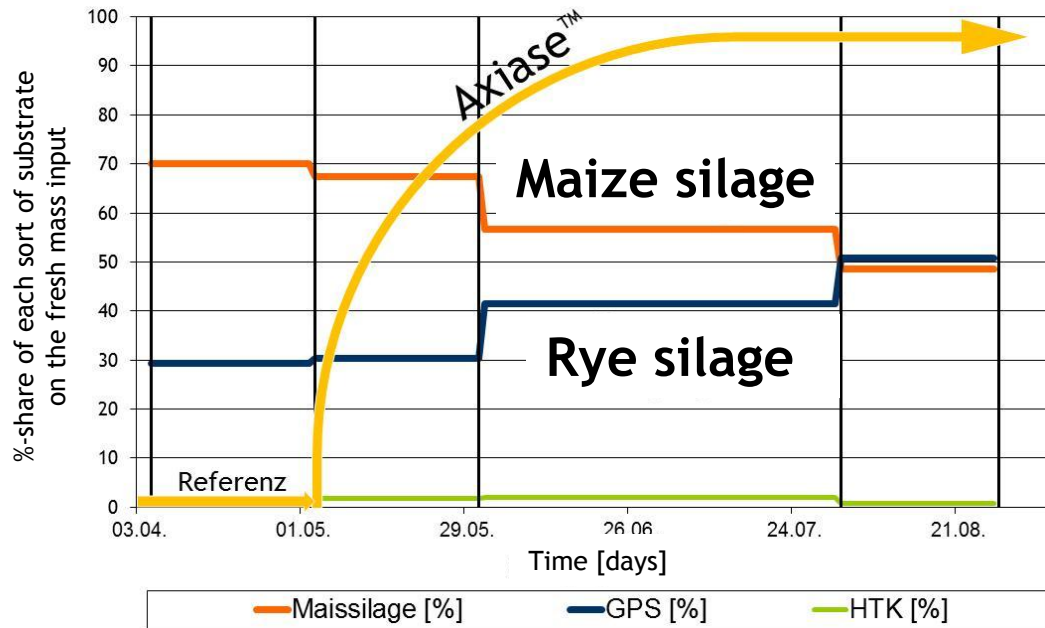
β-Glucan (soluble fraction): viscosity ↑, degassing ↓

Pentosan (soluble fraction): water retention ↑, degassing ↓



# Axiase™ 100

Fresh mass input against the time



Plant builder: MT-Energie (F, NG each 2285 m<sup>3</sup>)

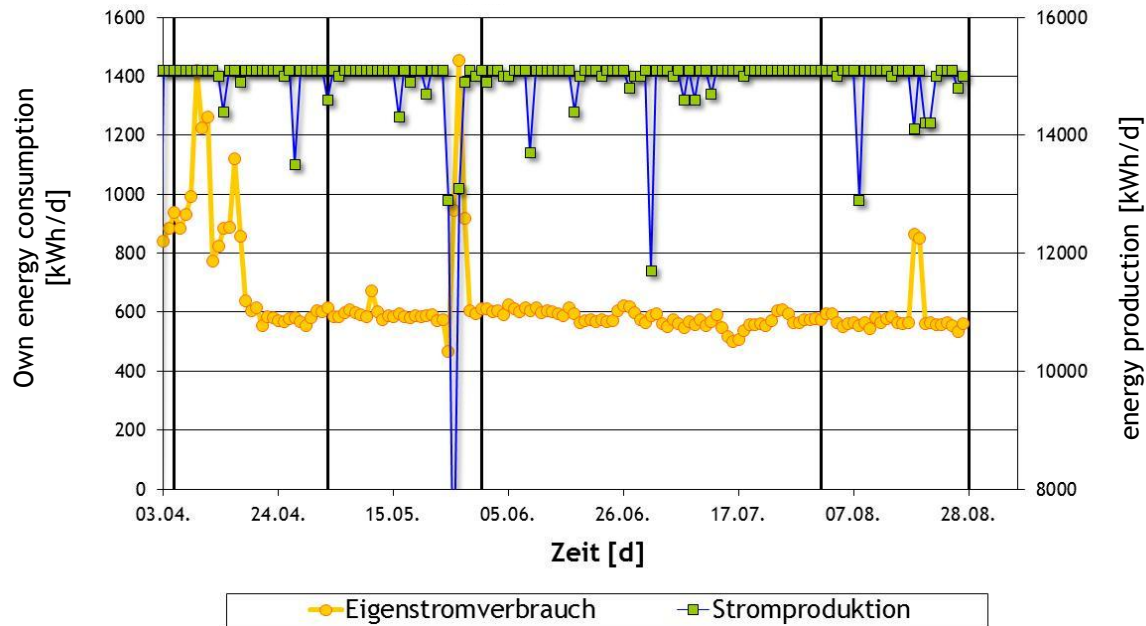
Capacity: 625 kW

Loading rate: ca. 4,5 [kg oDM/m<sup>3</sup> x d]



# Axiase™ 100

## Own energy consumption and energy production



→ Constant own energy consumption (yellow)

→ Constant energy production (green)





# Axiase™ 100

- ✓ contains complex enzymes-mix which can degrade pectins, beta-glucans, pentosans, hemicellulose and cellulose.
- ✓ *Aspergillus sp.* und *Trichoderma sp.*
- ✓ Developed together with MT-Energie for biogas co-digestion processes.
- ✓ 1 MW biogas plant -> 2 kg Axiase per day

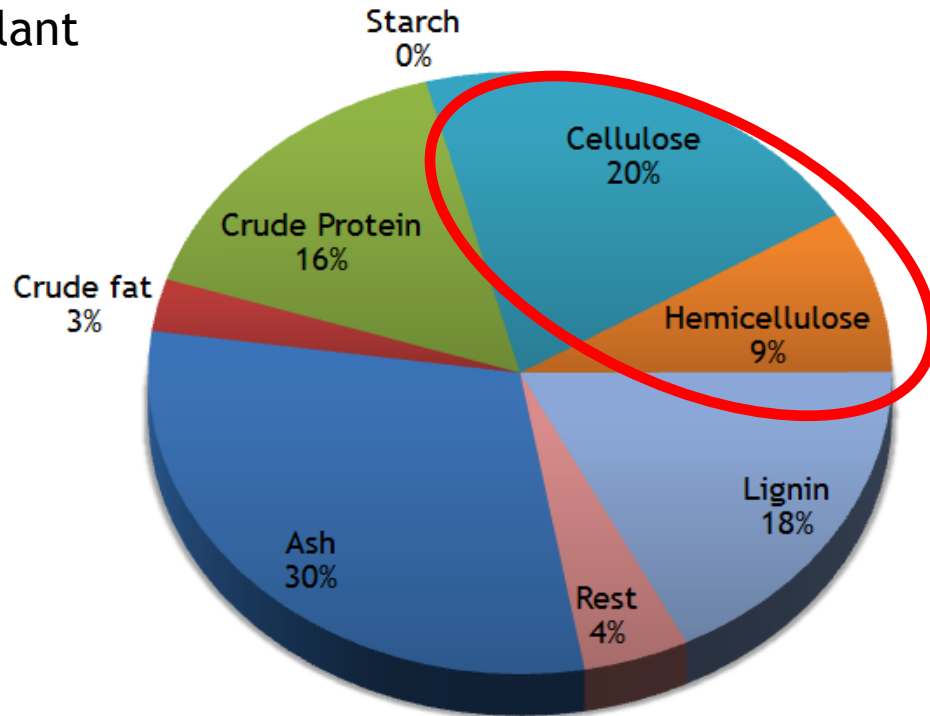
## Benefits in application:

- ✓ Maximise the proportion of triticale in the substance mix
- ✓ More flexibility in the substrate mix management.
  - risk spreading(harvest/weather)
  - breaking-up the crop rotation
- ✓ Cost benefits through higher flowability
  - better mixing
  - Less technical problems with pumps/mixers



# MethaPlus® L 100 (valorise waste stream)

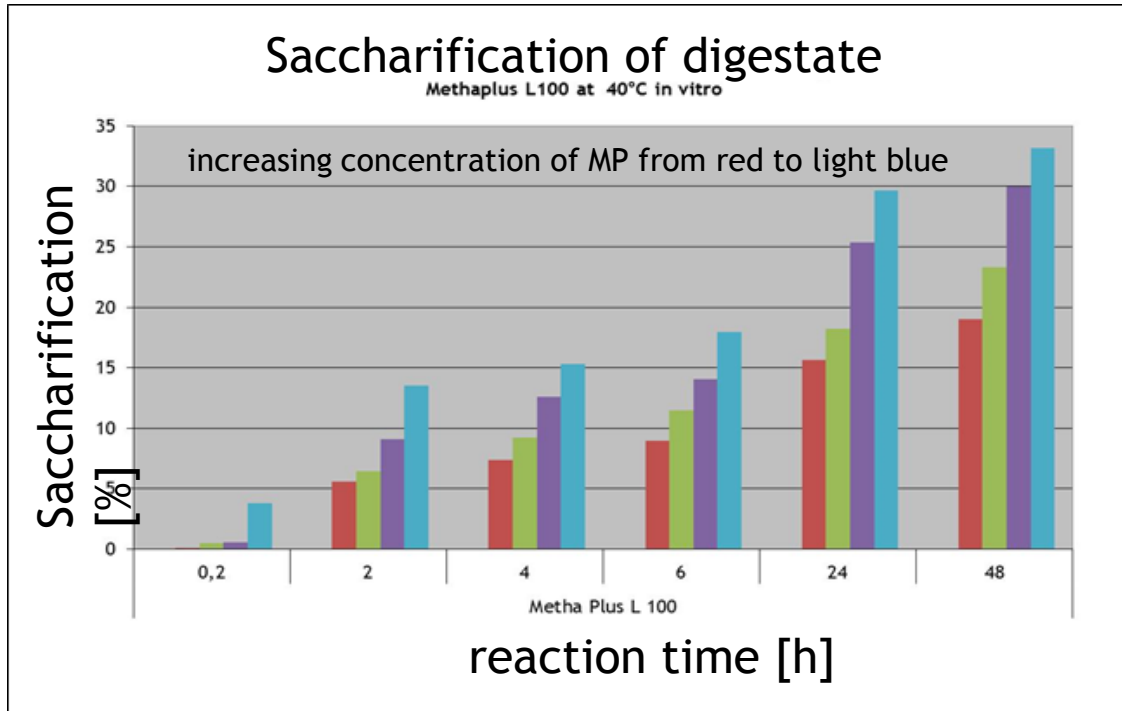
Analysis of the waste stream of a biogas plant



Approx. 50% of digestate holds biogas potential



# MethaPlus® L 100 (better efficiency)



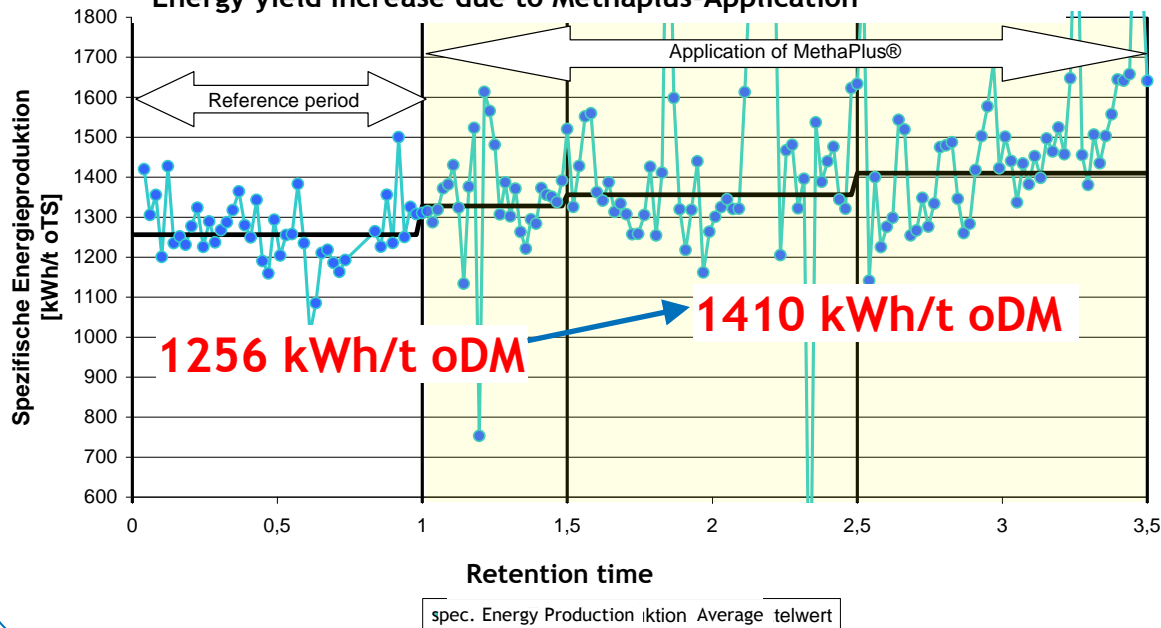
→ Very clear effect of MethaPlus with the digestate

# MethaPlus® L 100

	R1	E1	E2	E3
Spec. energy production [kWh/t oDM]	1256	1328	1356	1410
%-Differenz zu R1 [%]	0	<u>+6</u>	<u>+8</u>	<u>+12</u>

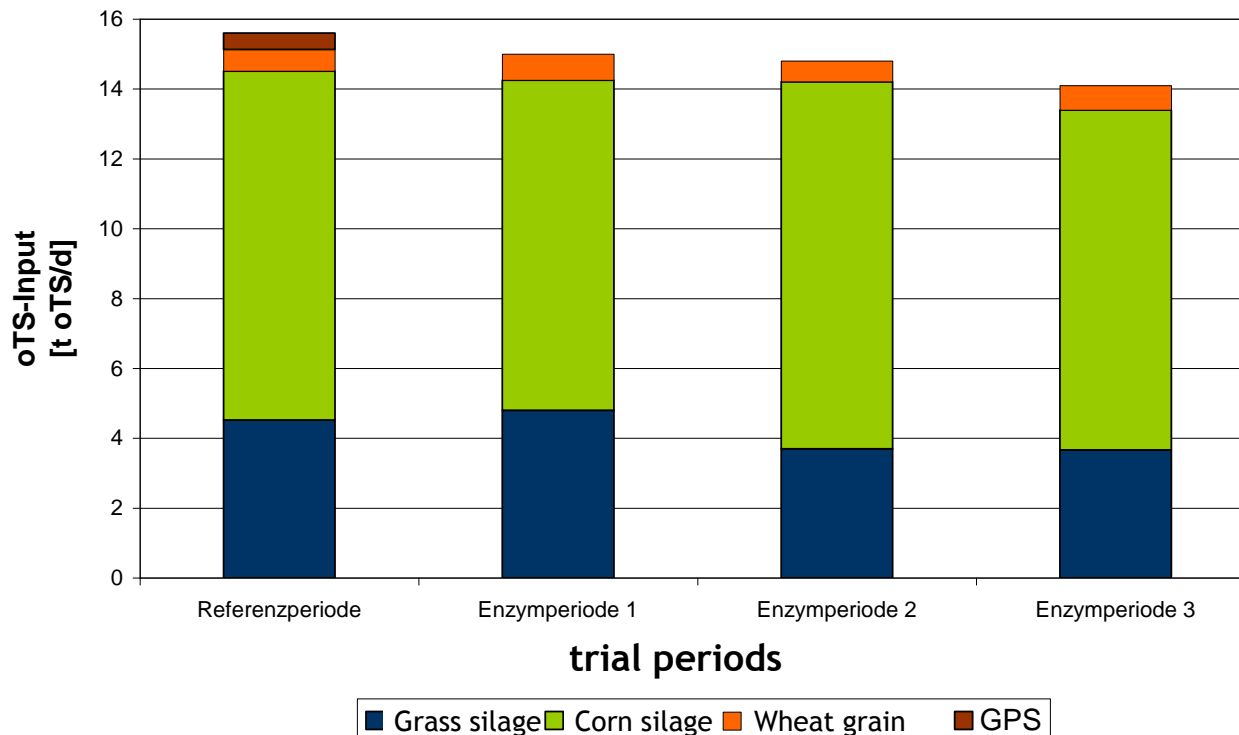
Steigerung der Energieausbeute durch die Applikation von MethaPlus

Energy yield increase due to Methaplus-Application



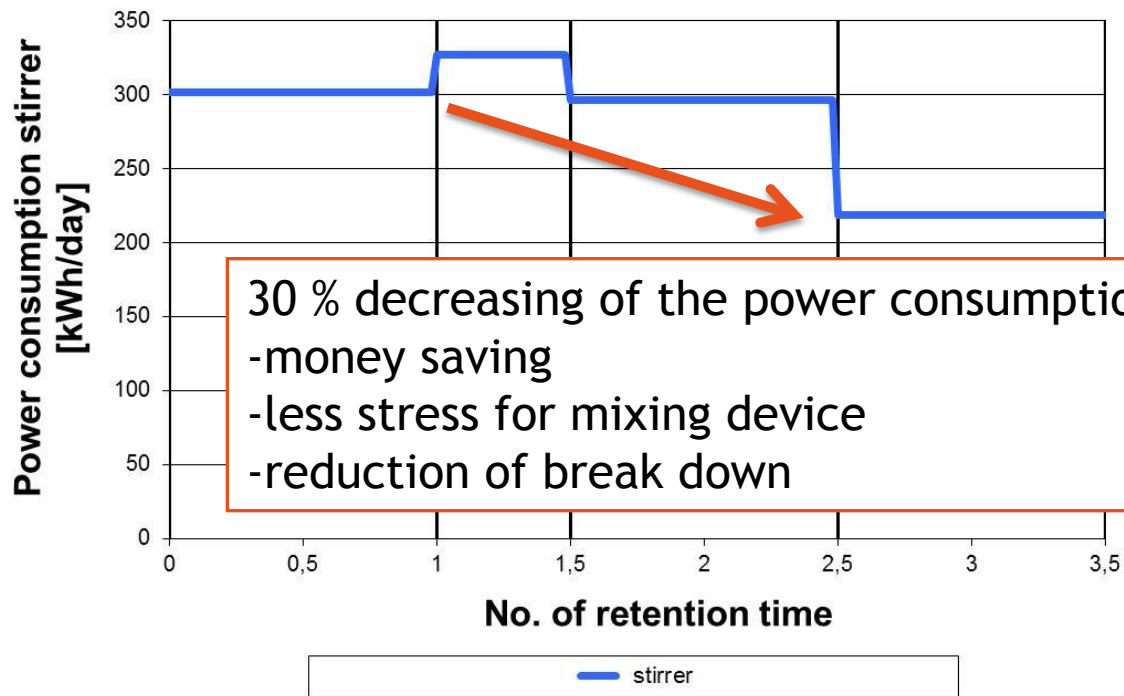
Biogas plant Trial

### Average oDM-Input in dependency of the trial periods



A way to save money is less biomass going into plant

## Viscosity reduction



# MethaPlus® L 100

- ✓ Liquid *Trichoderma* mix of ca. 30 different enzyme activities for the degradation of cellulose derived biomass.
- ✓ Dosage for 1 MW -> 2 kg / day, (0,1 kg MP/to oDM)

## Benefit in application:

- ✓ increasing the substrate degradation
- ✓ contains highly active enzymes optimized for BioGas operations
- ✓ enables the acceleration of the biogas process
- ✓ uses additional substrate shares, that remains otherwise unused in the biogas process
- ✓ decrease the viscosity of the fermenter content

More than 40 Full dataset of biogas plants and DSM enzymes



# MethaPlus® L 100

## Economic results:

- 12 % increase of spec. energy production is translated to reduction of 1,5 t oDM/d = 4,5 t corn silage\* x € 30-45/ton = 160€/day
- Enzyme costs 70 €/ day (2kg \* 35€/kg)
  - Savings in range of 25000€ - 50000/year. On a 1MW installation.

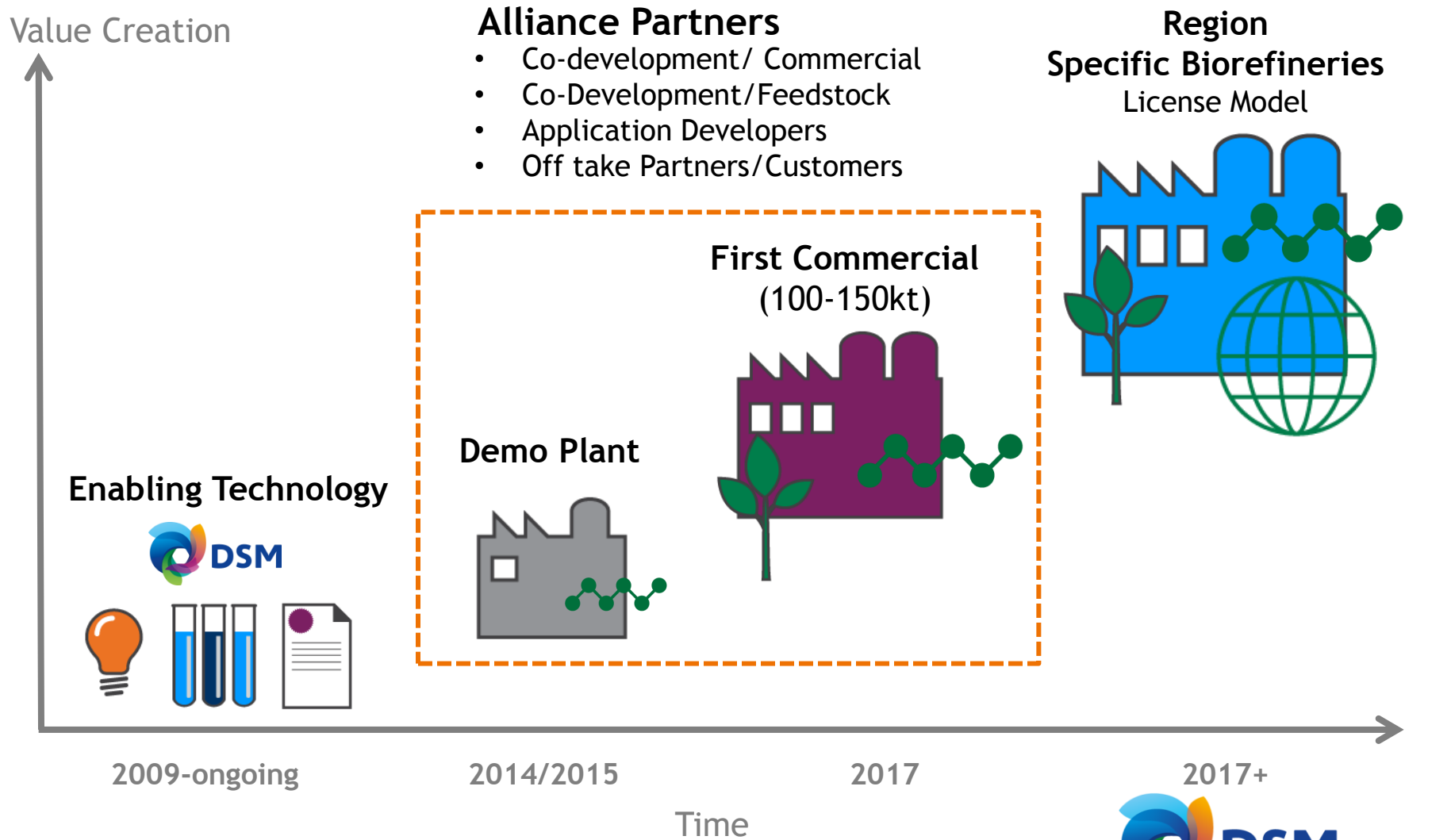
## **Additional benefits,...not quantified**

- lower digestate output(-3,4 m<sup>3</sup>/d), saving in disposal/storage costs
- Saving of cultivated land (ca. 30 ha)
- Reduced agitation energy required
- Less risks on floating layers and other blockage hick-ups.

\*Dry matter corn silage: 33 % DM, organic dry matter corn silage: 97% price range corn silage: 30-45 €/t FM



# MethaPlus<sup>®</sup> L 100/ Axiaise<sup>™</sup> 100 (future)



## Alliance Partners

- Co-development/ Commercial
- Co-Development/Feedstock
- Application Developers
- Off take Partners/Customers

## Region Specific Biorefineries License Model



## Enabling Technology



2009-ongoing

2014/2015

2017

2017+

Time

# Conclusions

- Biobased products have a clear role in (near) future.
- Cooperation throughout the value chain is a **MUST**.
- **Enzymes & microbes will play a crucial role in the required industrial processes using biomass (wastestreams) from the land.**
- The Bio-Based Economy offers huge opportunities for Science / Agriculture and (Bio-)Technology

**BRIGHT SCIENCE. BRIGHTER LIVING.™**

**Thanks for your attention**

**For Questions: [theo.verleun@dsm.com](mailto:theo.verleun@dsm.com)**