



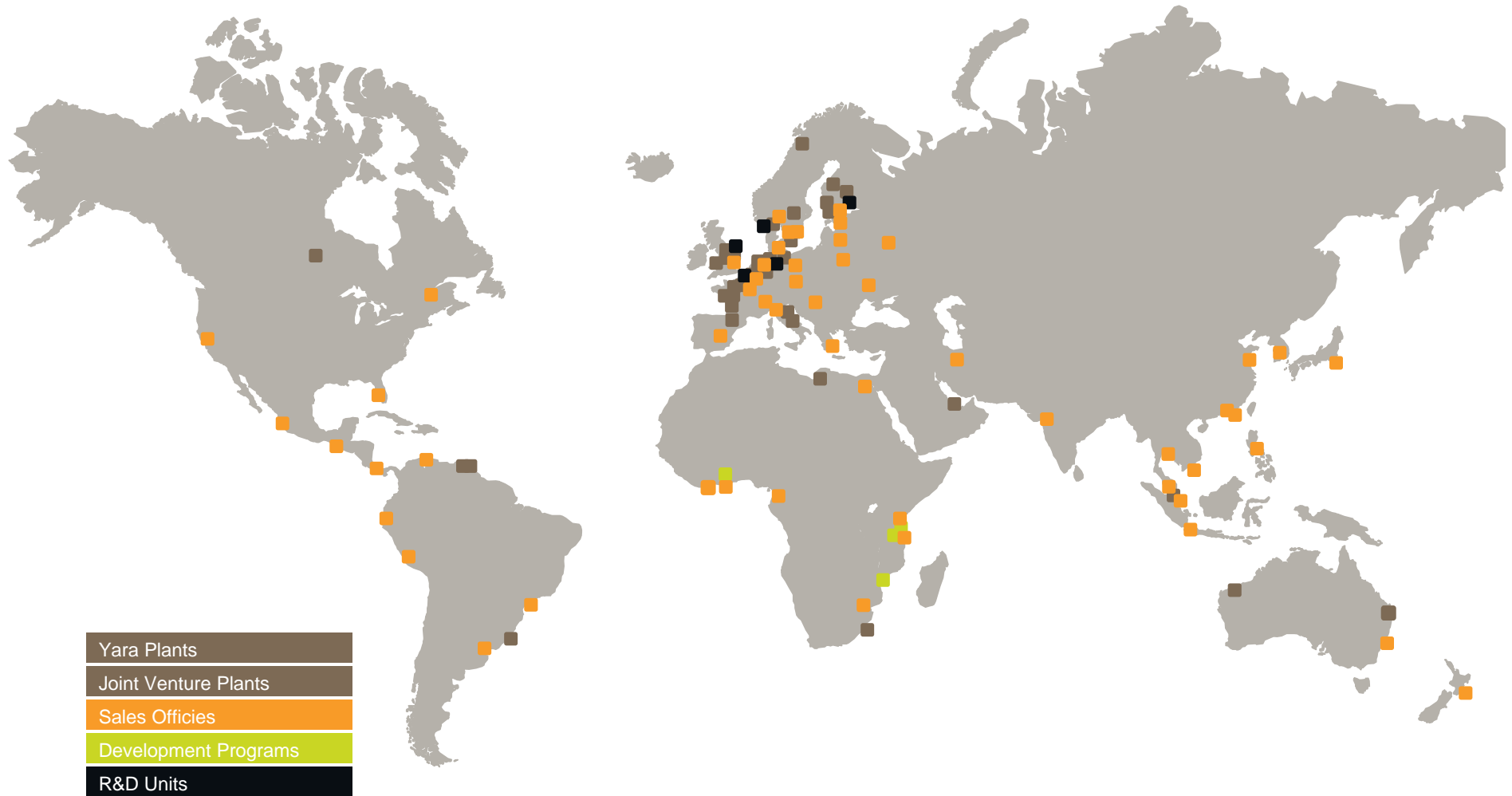
Knowledge grows

IBBA Malmö Yara's Biogas Production Optimiser

Günter Doppelbauer / Sara Ekström
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Yara – Global Player with Sales to >150 Countries



Yara – Business Unit Nitrates



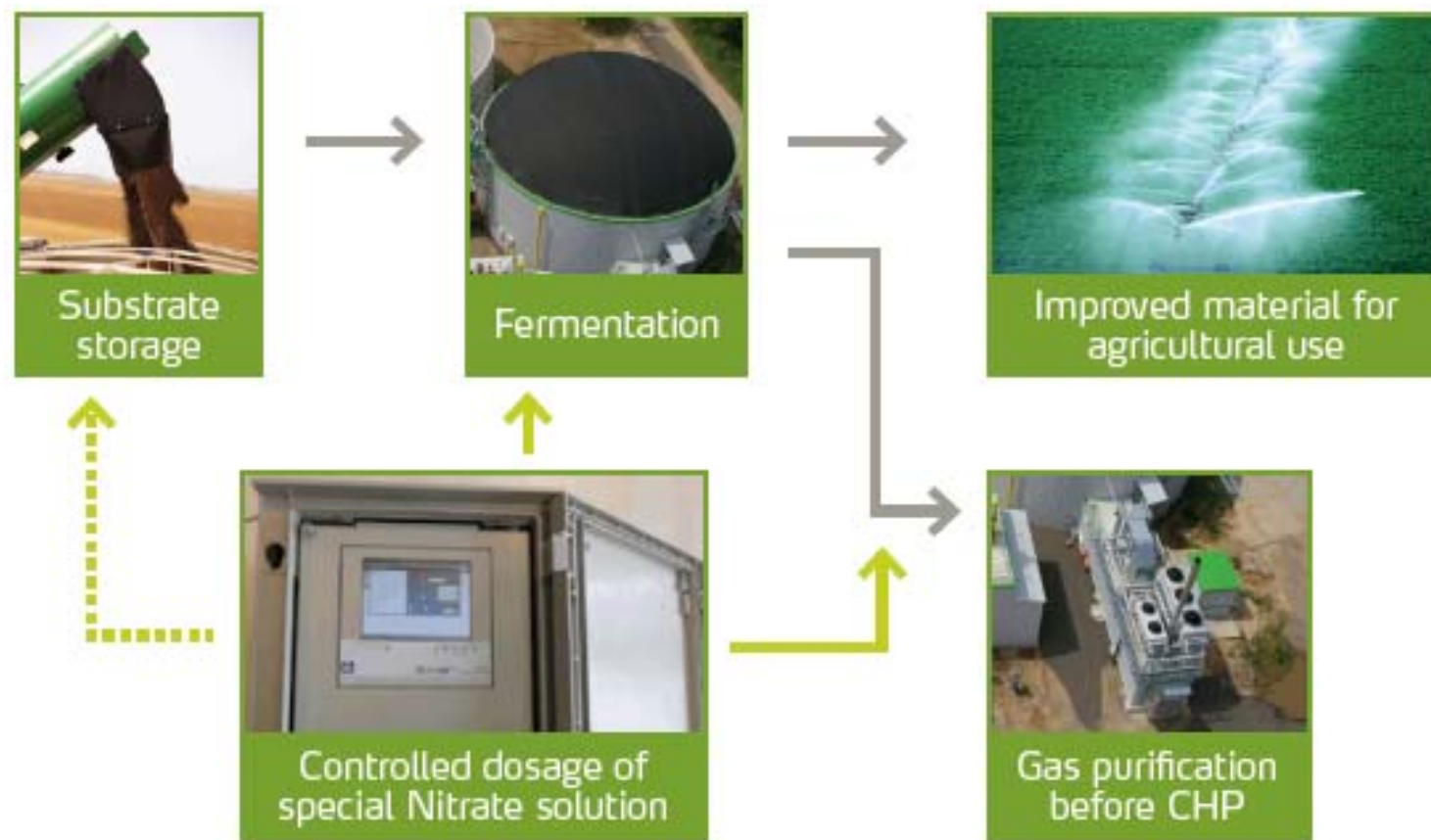
- Established Applications
 - Nutriox: Waste water / sewage treatment system for odour and corrosion control
 - NitCal: Additive for cement / concrete
 - DipCal: Coagulant for latex
 - ...
- New Developments
 - Conventional energy sector
 - Renewables:
 - **Biogas:**
Improvement of the fermentation process, higher methane yield, ...
 - Concentrated Solar Power
 - ...



Yara BPO Concept Optimization of the Anaerobic Digestion Process



Application of Nitrate-solution to enhance biogas yield and to reduce H₂S

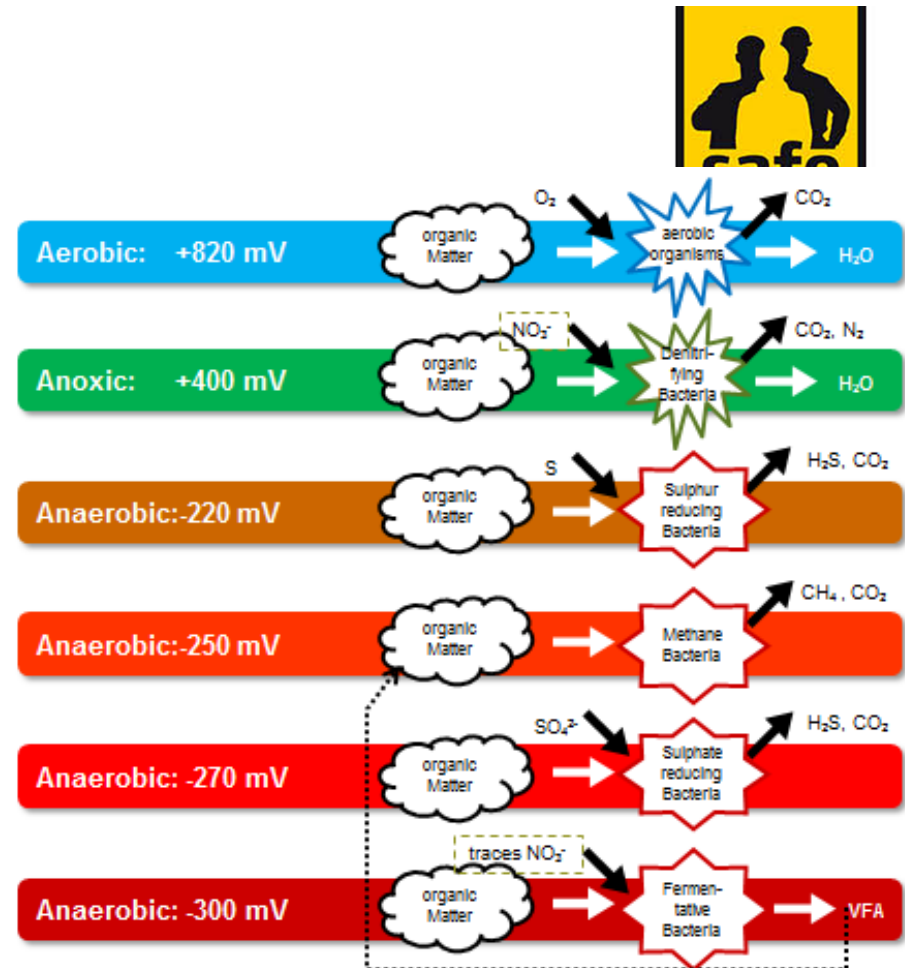


Yara BPO Concept Mechanism

- Redox-Potential shifted
 - Small-scale
 - More energy-efficient conversion of organic compounds by bacteria

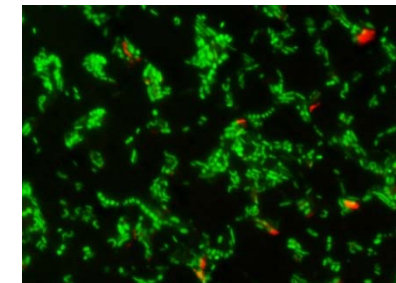
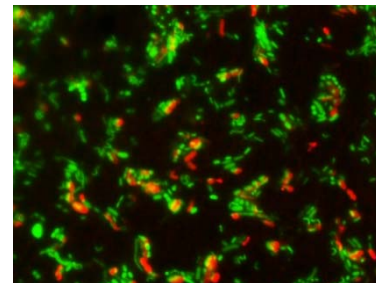
- Nutrient availability (theory)

If feasible energy sources are available, various bacteria are able to metabolize certain nutrients more completely or at all.
Genetic analyses and enzyme tests in prep.



FISH / Epi-fluorescence-technology:
Genetic method to verify different metabolic pathways by bacteria

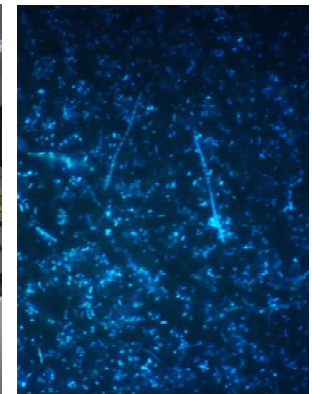
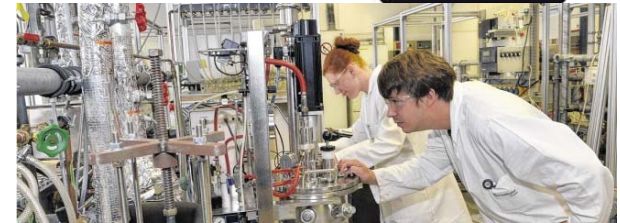
Source: FORSTER, D., Ettl, M.,
FRANKE, W. & STOECK, T. (in prep.)



Yara BPO Concept R&D Activities and Outlook



- Continued lab tests
 - Fraunhofer UMSICHT (DE, Oberhausen)
 - Batch test corn / cattle manure: +2,6 - 6,3% CH₄
 - Batch test food waste: +10,2% CH₄, -31,3% H₂S
 - Continuous tests: no negative impact
 - Fraunhofer UMSICHT (DE, Sulzbach)
 - Positive effect on thermal pressure hydrolysis
 - Kaiserslautern University (DE): Genetic verification of changed bacterial metabolism
 - 30% growth of methanogenic bacterium *Methanoculleus* sp.
 - Shift of total bacteria community towards methanogenic species
 - Verification via enzyme activity tests in prep.
- Additional applications
 - Digestate: Odour control application
 - Landfill sites: Field test
 - Digester (WWTP):
 - Successful pilot test (FiW Aachen, DE)
 - Field tests started (DE, PT); positive interim results



Yara BPO Concept Results



Biogas plants running with agricultural substrate

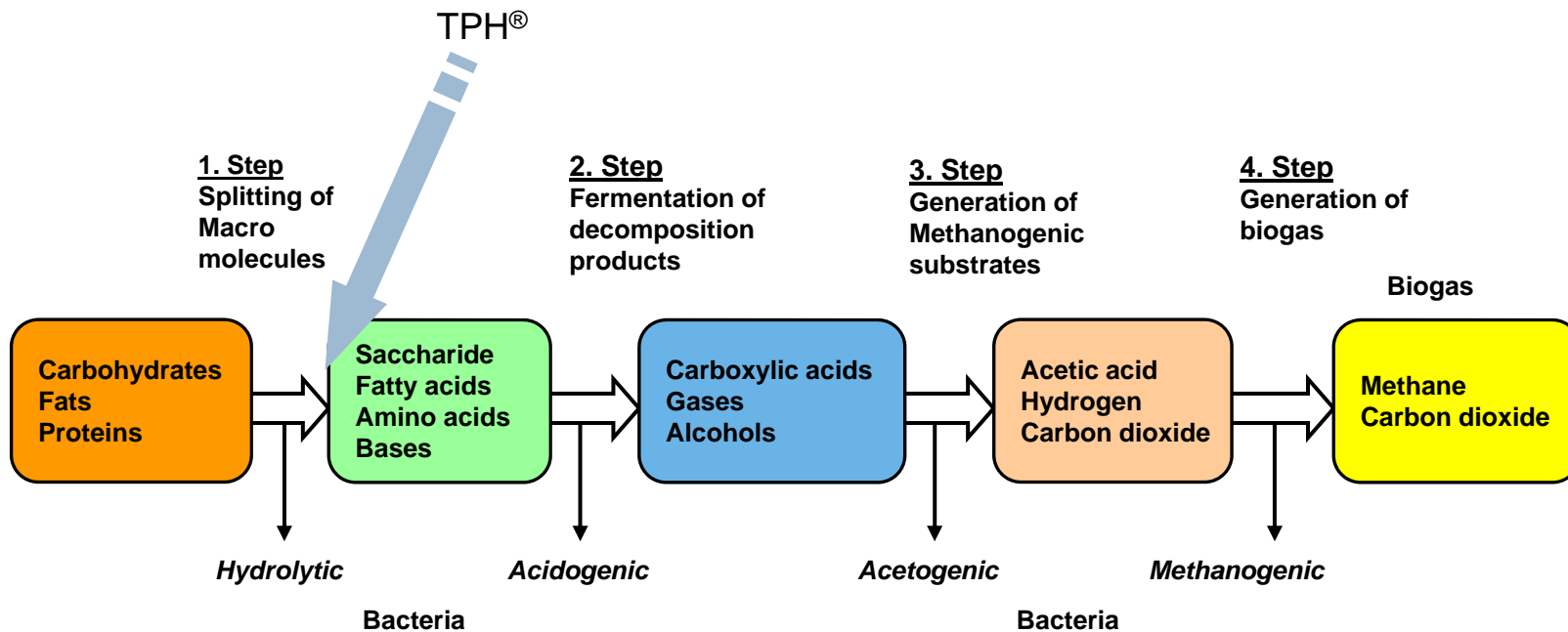
- 2.5 - 5.0% more biogas
- 1.5 - 2.0% higher methane-concentration
- around 20% lower H₂S-concentration
- 6.5 - 10% less substrate demand (in cases of limited CHP capacity)
- enhanced buffer of plant operation - especially when changing the substrate
⇒ stabilization of the fermenter reactions



Calculation example (I): 700 kW _{el} 2.8% more biogas	
Additional income	40.500 €/ a
Product costs	13.800 €/ a
Profit	26.700 €/ a

Calculation example (II): 500 kW _{el} 8% less substrate and digestate	
Saving on substrate	25.000 €/ a
Saving on digestate	2.000 €/ a
Product costs	8.000 €/ a
Profit	19.000 €/ a

Thermal Pressure Hydrolysis (TPH[®]) Basics



Hydrolysis = process limitation step for anaerobic fermentation

Thermal Pressure Hydrolysis (TPH[®]) Advantages



Conventional fermentation

- All process steps in digester
- AD residence time 25 - 40 days

Methanogenesis
Acetogenesis
Acidogenesis
Hydrolysis

BIOGAS

TPH & fermentation

- TPH = Thermal pressure hydrolysis
- T = 200°C, p = 20 bar, RT > 30 min
- AD residence time about 15 days
- Smaller reactors possible
- Sterilization guaranteed
- Higher grades of anaerobic degradation
- Safe prion inactivation

Methanogenesis
Acetogenesis
Acidogenesis

TPH

Thermal Pressure Hydrolysis (TPH[®]) Impact of TDH[®] Pre-Treatment (examples)



Wheat Bran: without TPH[®]



with TPH[®]

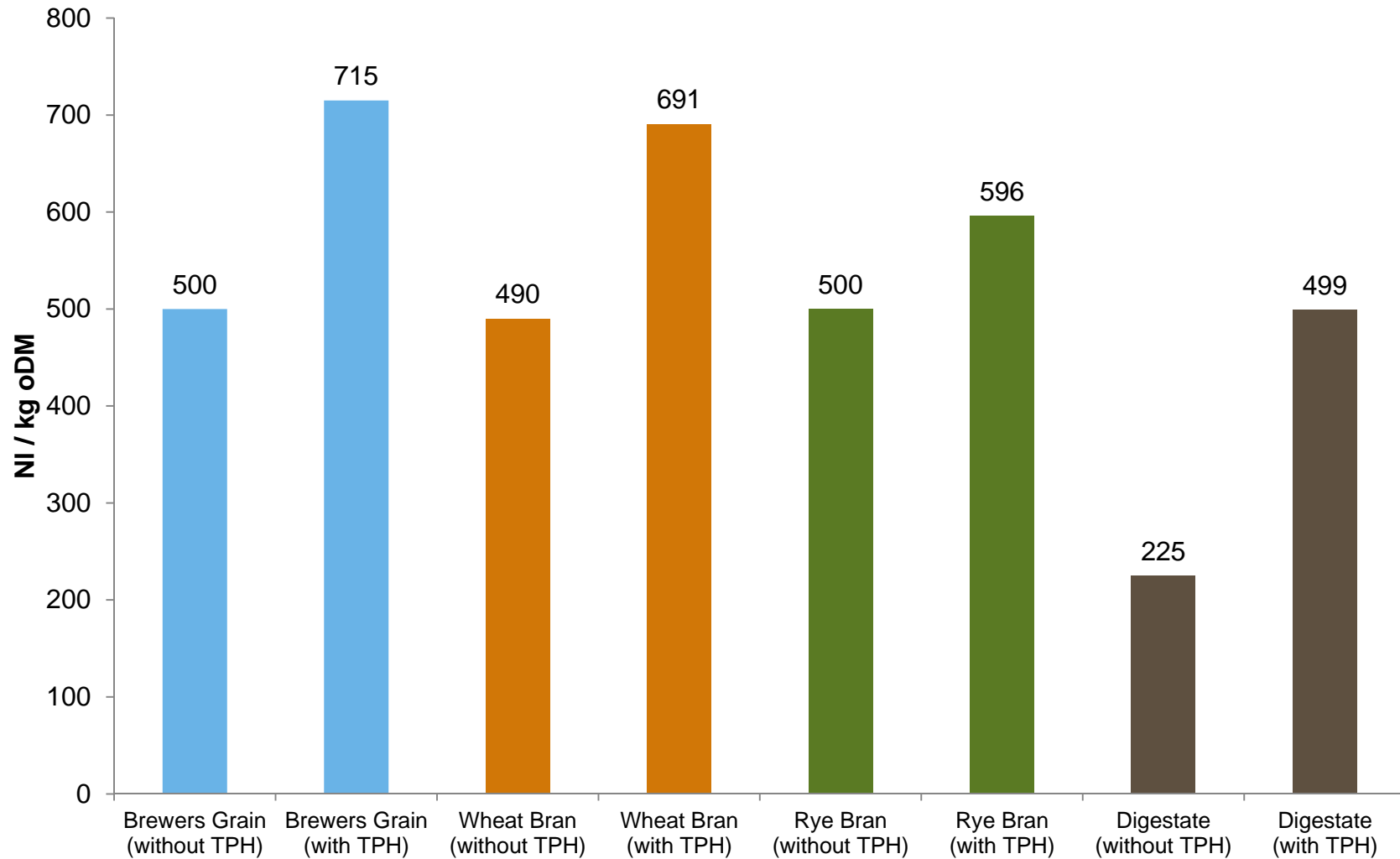


Digestate: without TPH[®]

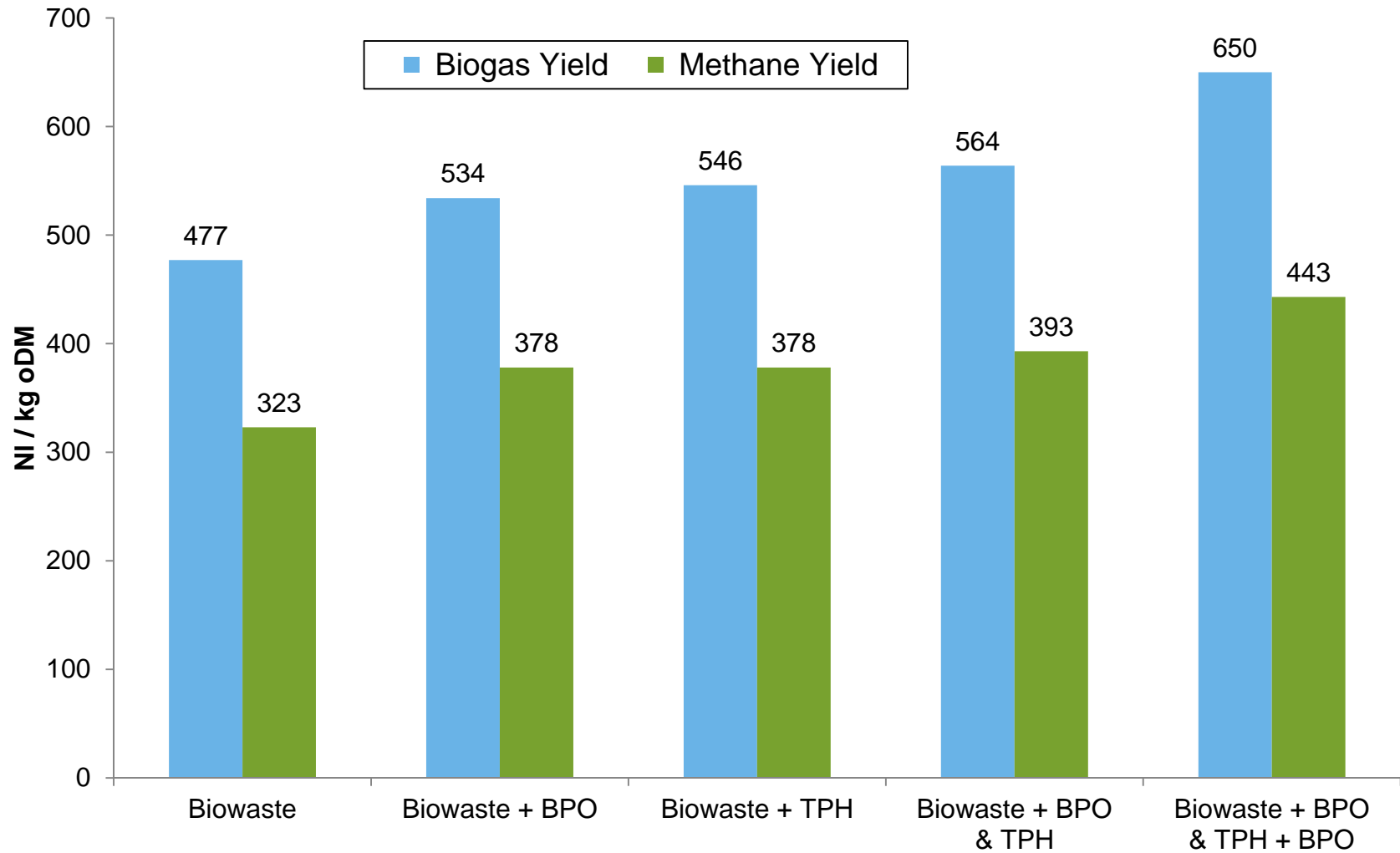


with TPH[®]

Thermal Pressure Hydrolysis (TPH[®]) Pre-Treatment of Biogenic Residues



Thermal Pressure Hydrolysis (TPH[®]) in Combination with Yara BPO (smale scale test)





Knowledge grows

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