SCHAUMANN BIOENERGY

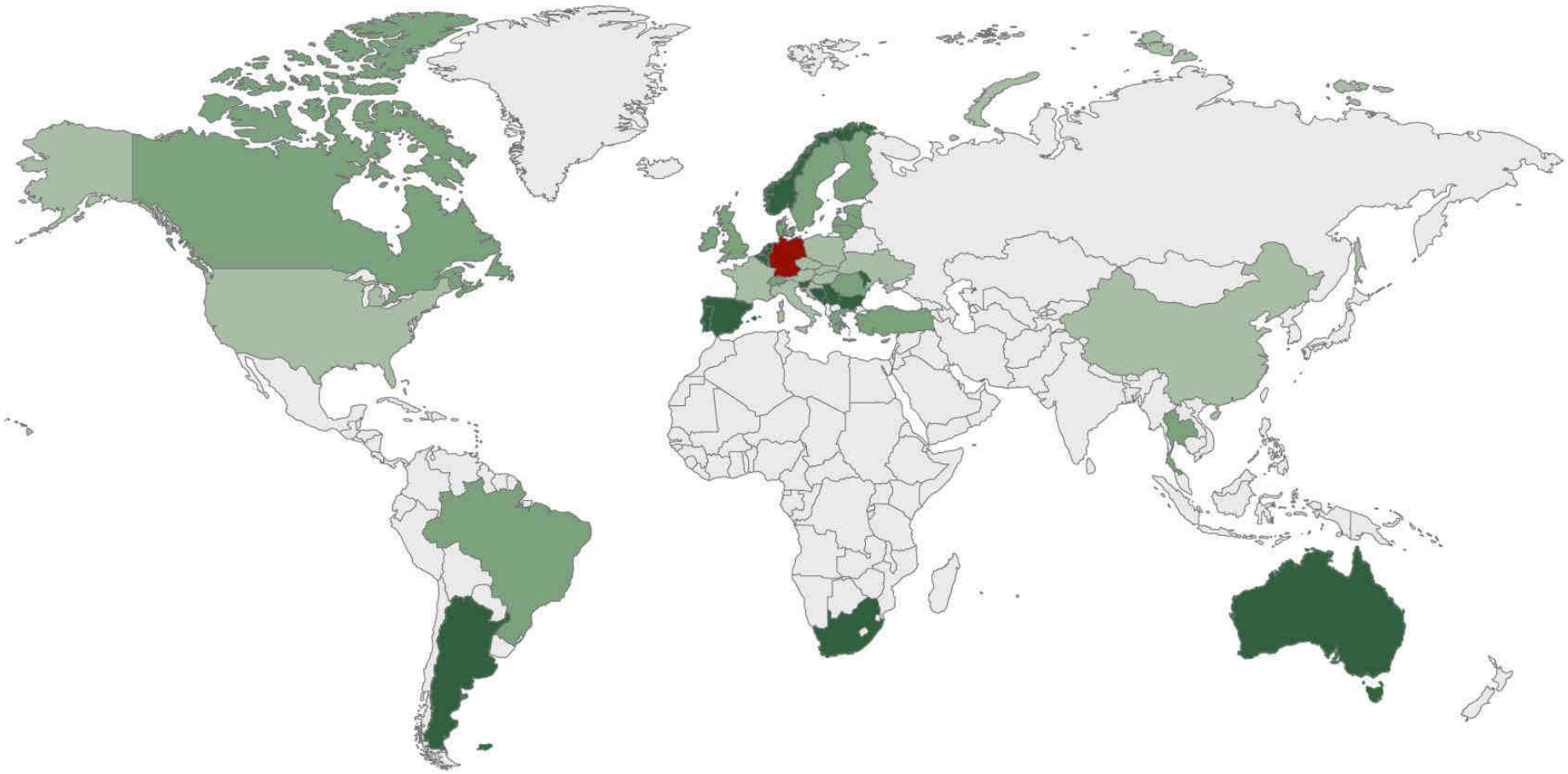
Getting the nutritional and biological health right:

N-rich feedstocks: Feed Heaven or Feed Hell?

Melanie Hecht, PhD

UK AD & World Biogas Expo, Birmingham, UK
03. July 2019

Consultants in AD: worldwide



Direct Support Locations Distribution Partners

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in the UK & Ireland working in partnership with

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Hülsenberg Estate, Germany

ARABLE LAND:	2,000 acres
LIVESTOCK:	diary cattle, pigs, sheep, poultry
BIOGAS:	1: 725 kW (maize, WCS, grass, slurry, manure)
	2: 75 kW (slurry)
RESEARCH:	ISF: AD & AH-specialized analytics
TRAINING:	auditorium, seats 100, catering facility

Typical biological process disruptions in AD

Acidification

Overfeeding

Trace element deficiency

Inhibition of methanogens (e.g. mycotoxins)

Temperature changes

Low gas yields

Poor feedstock quality

Inhibition (e.g. NH_3)

Gas leakages

TE deficiency

Disruption of hydrolysis

Engineering issues

Floating layers

Sedimentation

Dead Zones

Foaming

Maintenance/ repairs

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N-rich feedstocks: Feed Heaven or Feed Hell?

- **Risk feedstocks:** grass, cereals, poultry manure / litter, meat & dairy: rendering facility material, protein-rich food wastes (e.g. cheese), stillage from bioethanol production, …




N-rich feedstocks:
Feed Heaven or Feed Hell?

1. **AMMONIA / NH_3 toxicity:** process inhibition & failure
2. **HYDROGEN SULPHIDE / H_2S & O_2 injection:** corrosion (steel, engine, concrete, timber)
3. **STRUVITE formation:** magnesium-ammonium-phosphate (MAP) blocks pipes & pumps





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Ammonia inhibition (NH_3)

- **Ammonia (NH_3)** is produced during degradation of N-rich feedstocks (**proteins, uric acid**)

- **Ammonia** is required for **cell growth** but is a **CYTOTOXIN** and **inhibits** bacteria and archaea involved in biogas production

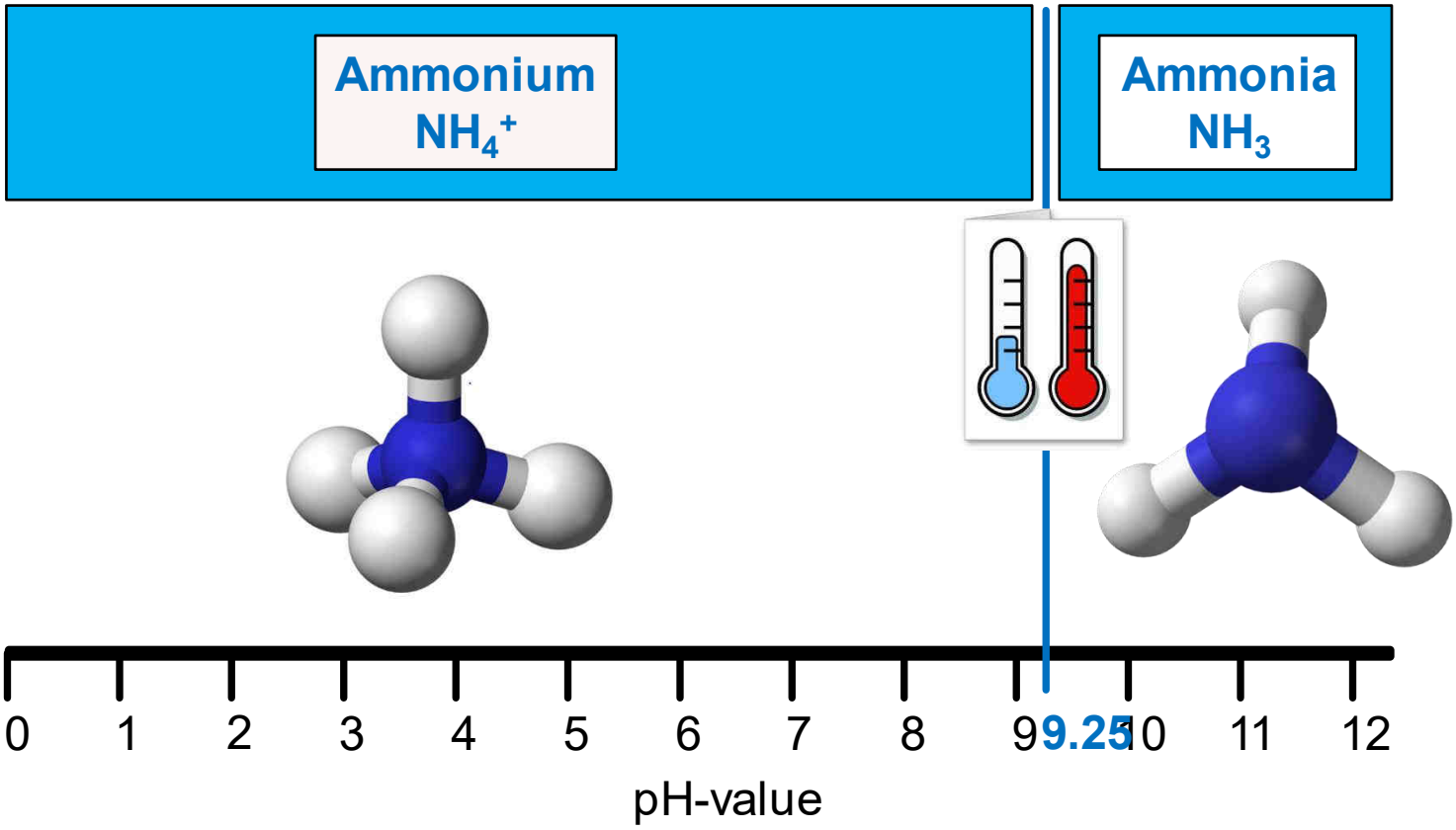



Ammonia Inhibition (NH_3)

Digester analysis

BASIS						DM/oDM		GC							
pH *	EC * [mS/cm]	VOA * [g HAc_{eq}/l]	TAC * [g $CaCO_3$/l]	VOA/ TAC	NH4+-N * [g/l]	DM * [g/kg]	oDM * [g/kg]	AA * [g/l]	PA * [g/l]	BA * [g/l]	iBA * [g/l]	VA * [g/l]	iVA * [g/l]	CA * [g/l]	HAc-EQ [g HAc_{eq}/l]
EN 12176	EN 27888	NT	NT		ISE	EN 12880	EN 12879	GHM	GHM	GHM	GHM	GHM	GHM	GHM	
8,0	64,1	10,5	20,5	0,51	5,41	58,9	35,5	3,93	3,58	0,05	0,11	0,03	0,42	< 0,03	7,20

Ammonium converts into toxic Ammonia



Conversion of Ammonium into toxic Ammonia is temperature- and pH-dependent

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Ammonia (NH_3) - Ammonium (NH_4^+) Calculator

Temperature	45 [°C]
pH-value	8
Ammonium	5,41 [g/l]
Ammonia	**0,998 [g/l]**

Ammonia Inhibition (NH_3)

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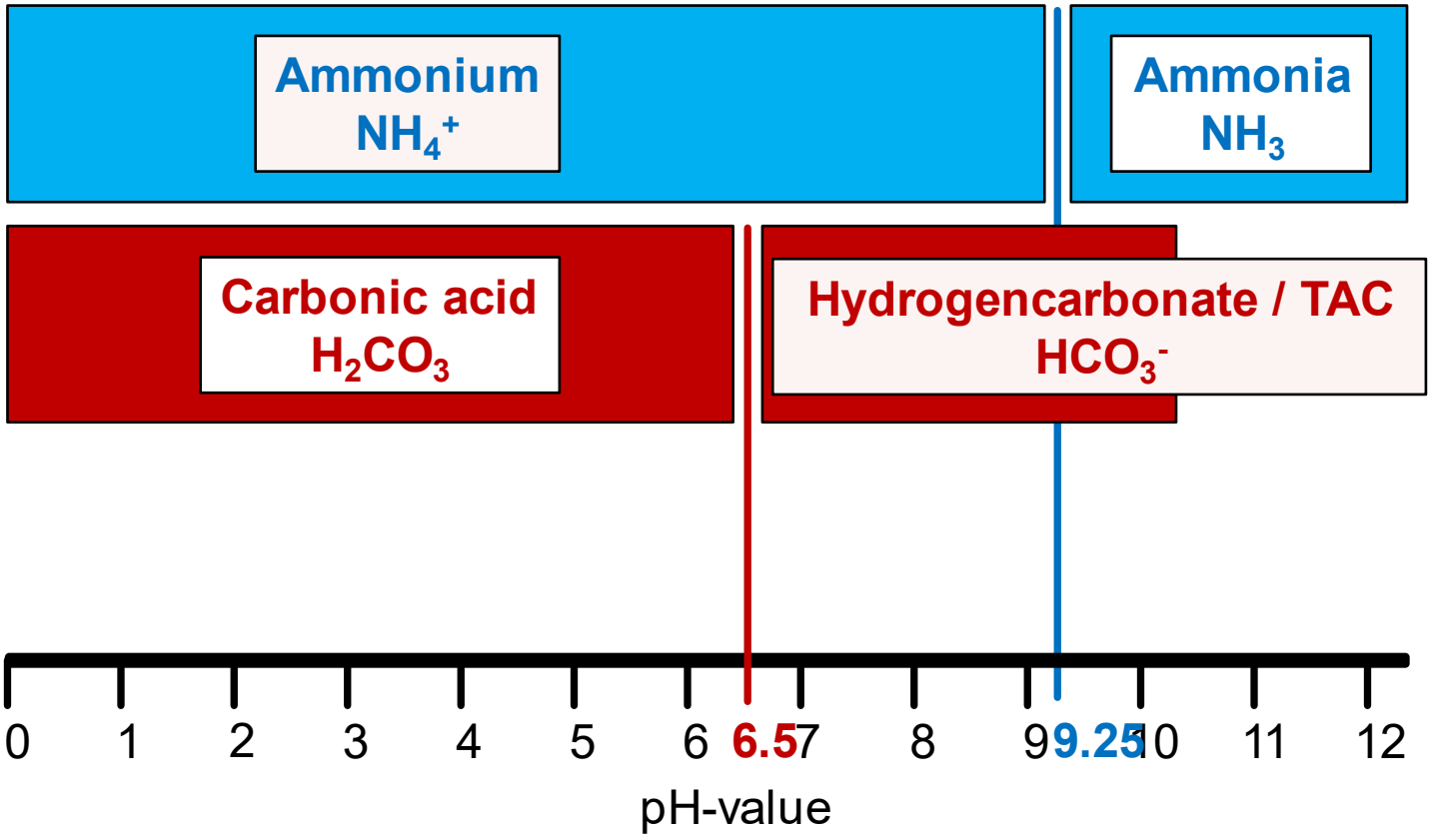
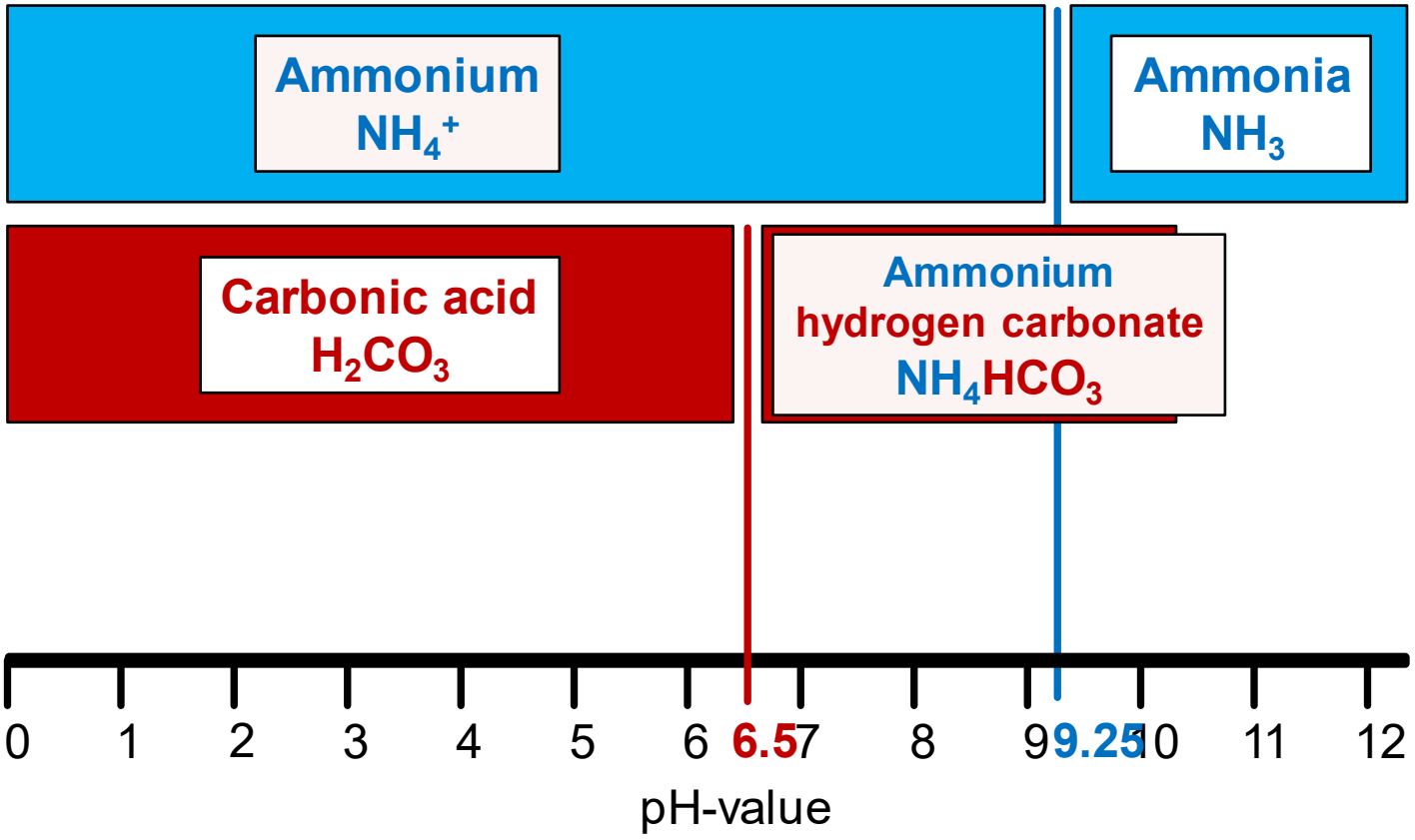
8,2		7,96	22,0												
8,2		8,05	20,4												
8,3		6,40	21,2												
8,2		5,55	21,6												
8,2		5,17	19,5												
8,1		4,15	19,4												
7,9		4,27	17,8												

The Hydrogencarbonate buffer is the TAC



The TAC increases with ammonium



Ammonia Inhibition (NH_3)

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Ammonia Inhibition (NH_3):

Digester analysis

BASIS						DM/oDM		GC						
pH *	EC *	VOA *	TAC *	VOA/	NH4+-N *	DM *	oDM *	AA *	PA *	BA *	iBA *	VA *	iVA *	CA *	HAc-EQ
	[mS/cm]	[g HAc_{eq}/l]	[g $CaCO_3$/l]	TAC	[g/l]	[g/kg]	[g/kg]	[g/l]	[g/l]	[g/l]	[g/l]	[g/l]	[g/l]	[g/l]	[g HAc_{eq}/l]
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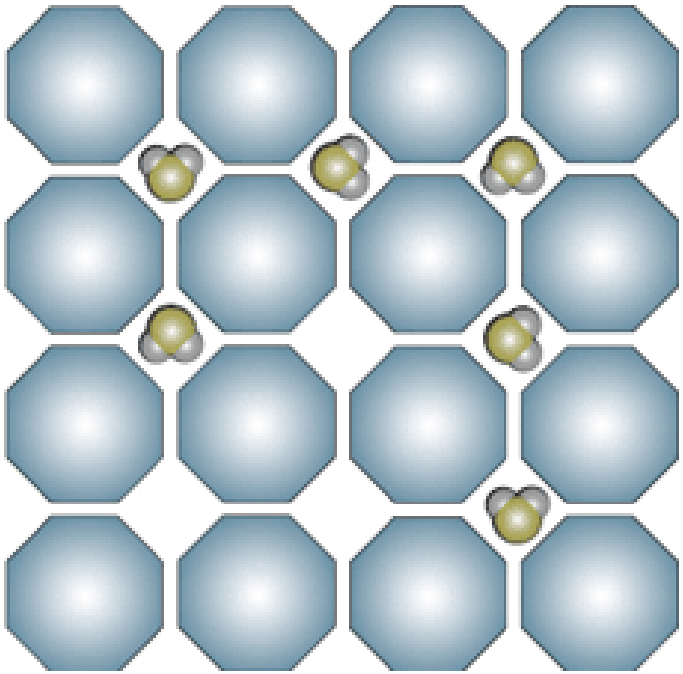
Secondary environmental effect: enhances microbial inhibition (high TAC ⟺ high pH)

Direct toxic effect: microbial inhibition (acid build-up)

Ammonium Binding Additive

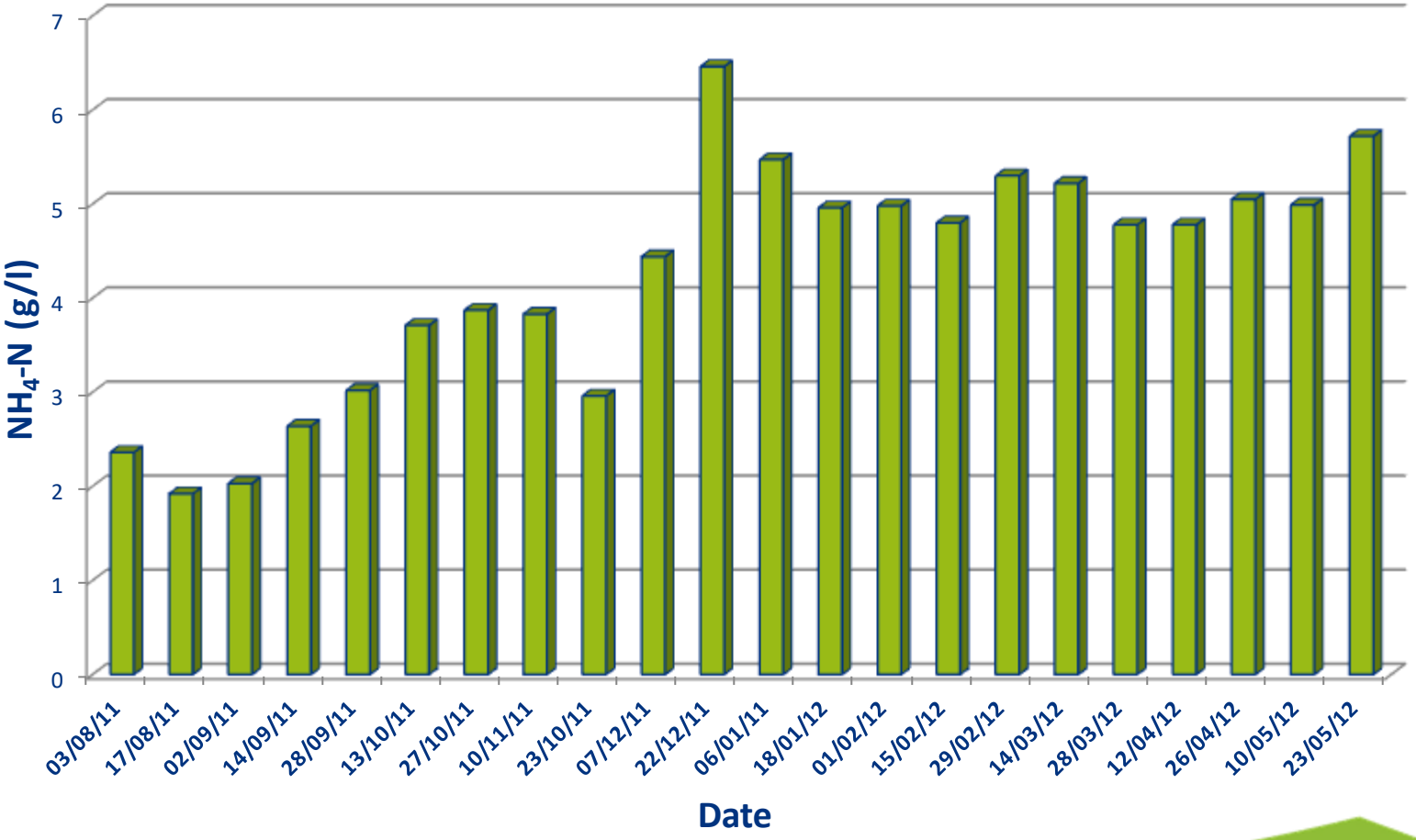
Case Study



- **Commissioned August 2011**
- **1x Primary Digester**
- **~1400m3 working volume**
- **250kW Capacity**
- **Processing:**
  - Poultry Manure
  - Maize Silage
  - Grass Silage
- **Mesophilic**

Ammonium Binding Additive

Case Study



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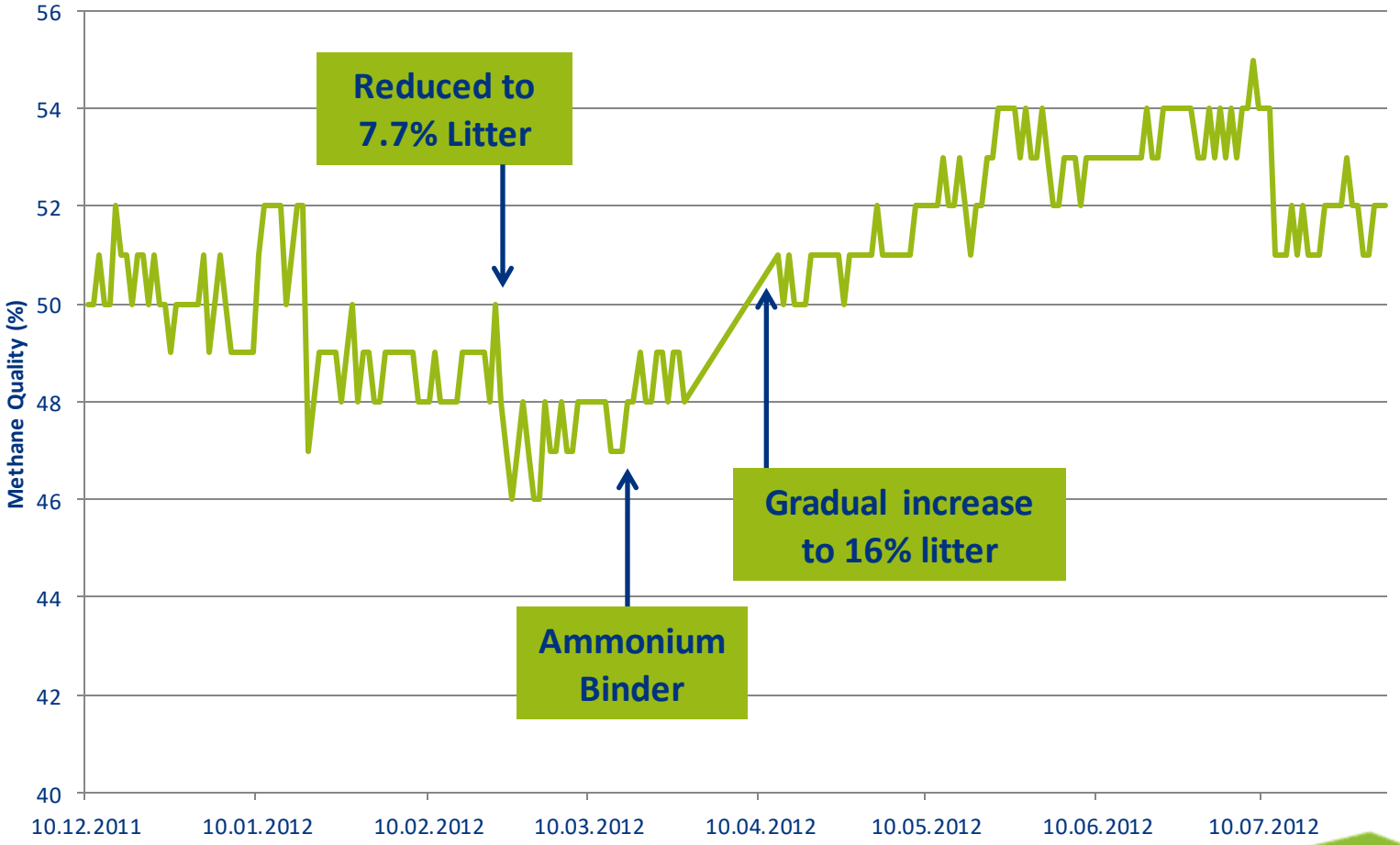
Ammonium Binding Additive

Case Study



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NH_3-inhibition: Countermeasures

- **If an option: Decrease of N-Input**
- **If an option: Temperature decrease** to lower mesophilic range (39 – 40°C)
- **Please don‘t: pH-decrease** with acid Risk of **FOAMING** ⟺ high **TAC**!
- **Last resort: Dilution** (water, digestate, slurry) ⟺ phase-separation
- **Best bet: Ammonium binder** BC.ATOX Ncon : **long or short term**
- **Best bet: Reseeding** with NH_3-adapted digester material




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H_2S-induced corrosion due to O_2 injection:
concrete, steel, timber

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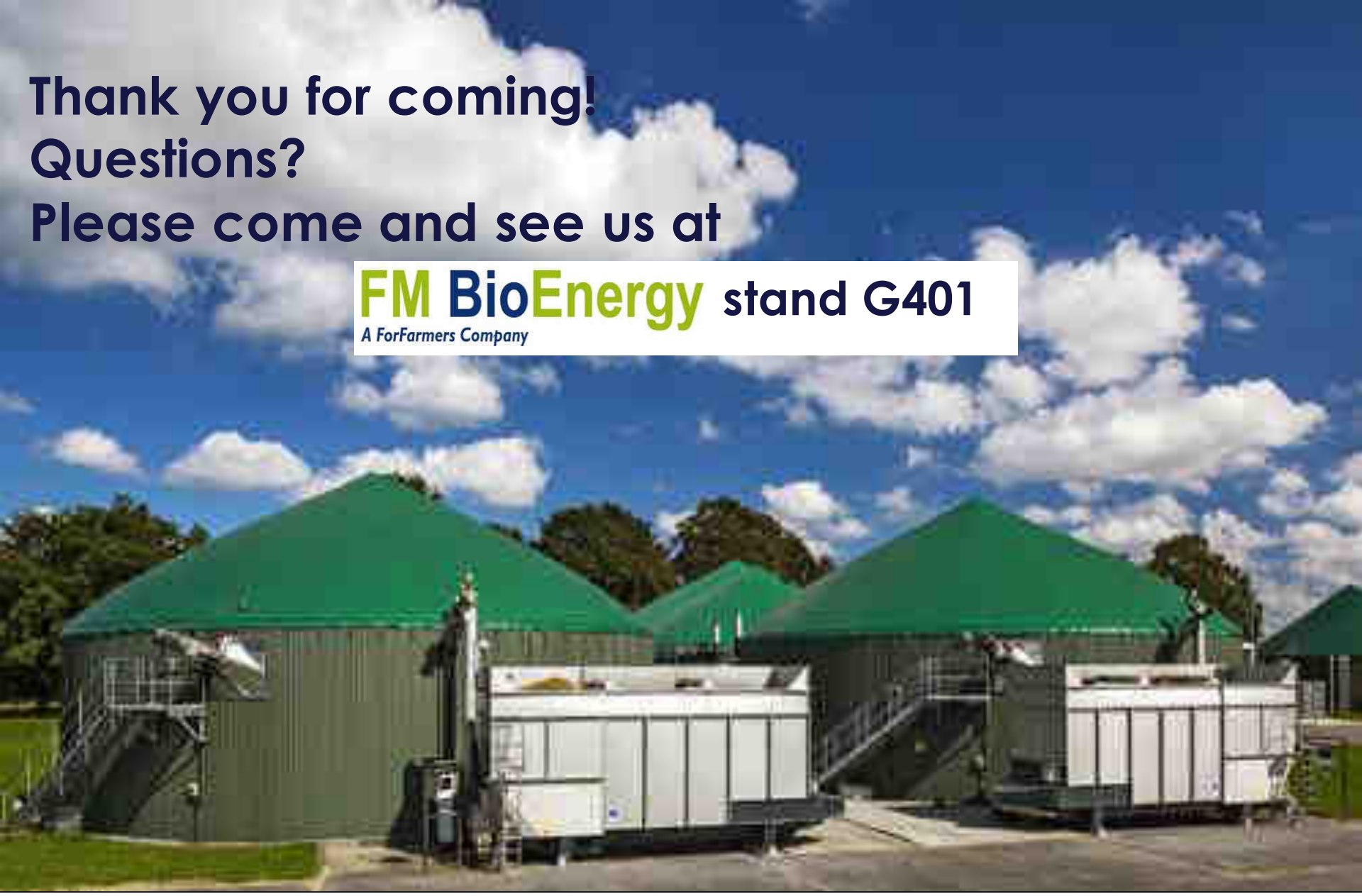
Struvite formation: pipes, pumps

$(NH_4)Mg[PO_4] \cdot 6H_2O$
Magnesium-Ammonium-Phosphate
(MAP)


Thank you for coming!
Questions?
Please come and see us at
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stand G401