LCA results on a low emission farming concept in highly integrated pig and poultry production

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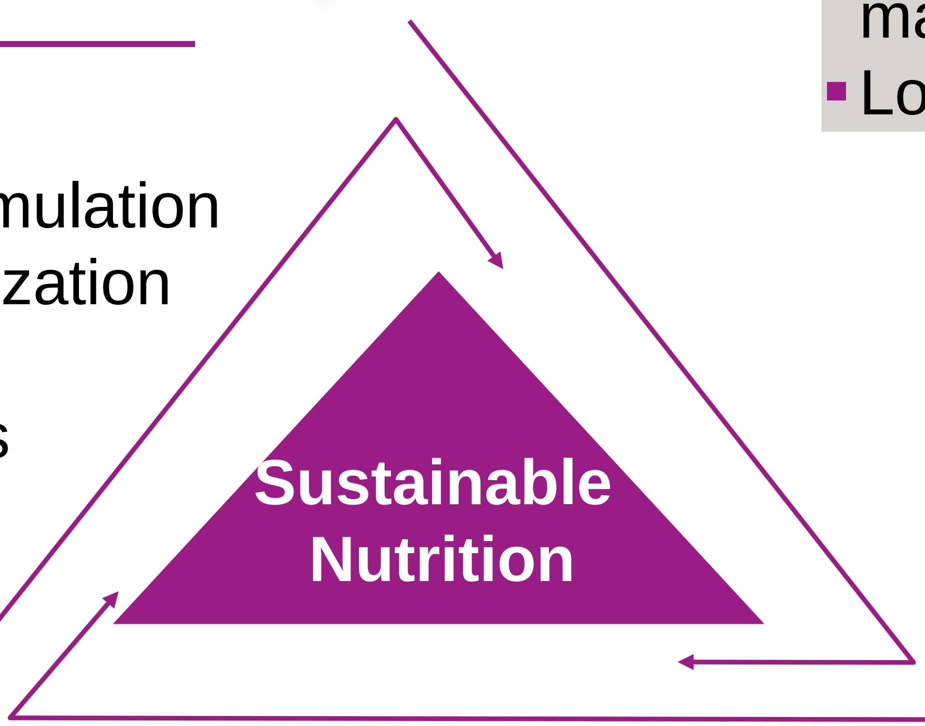
Future sustainability of food value chain depends on three dimensions of innovation

- **Ecological Footprint**
- **Low Emission**

Ecology

- Modern nutrition concepts (SID, NE)
- Improved livestock and manure management
- Low protein diets



- Least cost feed formulation
- Feed/protein optimization
- Nutrient utilization
- Efficient ingredients

Efficiency

- **Population growth**
- **Affordable protein**

- Animal welfare
- Gut health solution concepts
- Save and healthy food chain
- Performance and nutritional additives

Food Quality and Safety

- **End-consumer needs**
- **Food ethics**

Environmental Impact Categories most relevant and critical for livestock

- Climate change
  - Global Warming Potential
- Energy and resource efficiency
  - Primary Energy Demand
- Air, Soil and Water Quality
  - Excretion of excess nitrogen and phosphorus leading to eutrophication
  - Ammonia emissions largely responsible for acidification (fish mortality, forest decline, biodiversity)
- Land use, Land use change
- Water footprint
- Biodiversity

Low Emission Farm – a concept to lower the environmental footprint of animal farms

Basic idea:

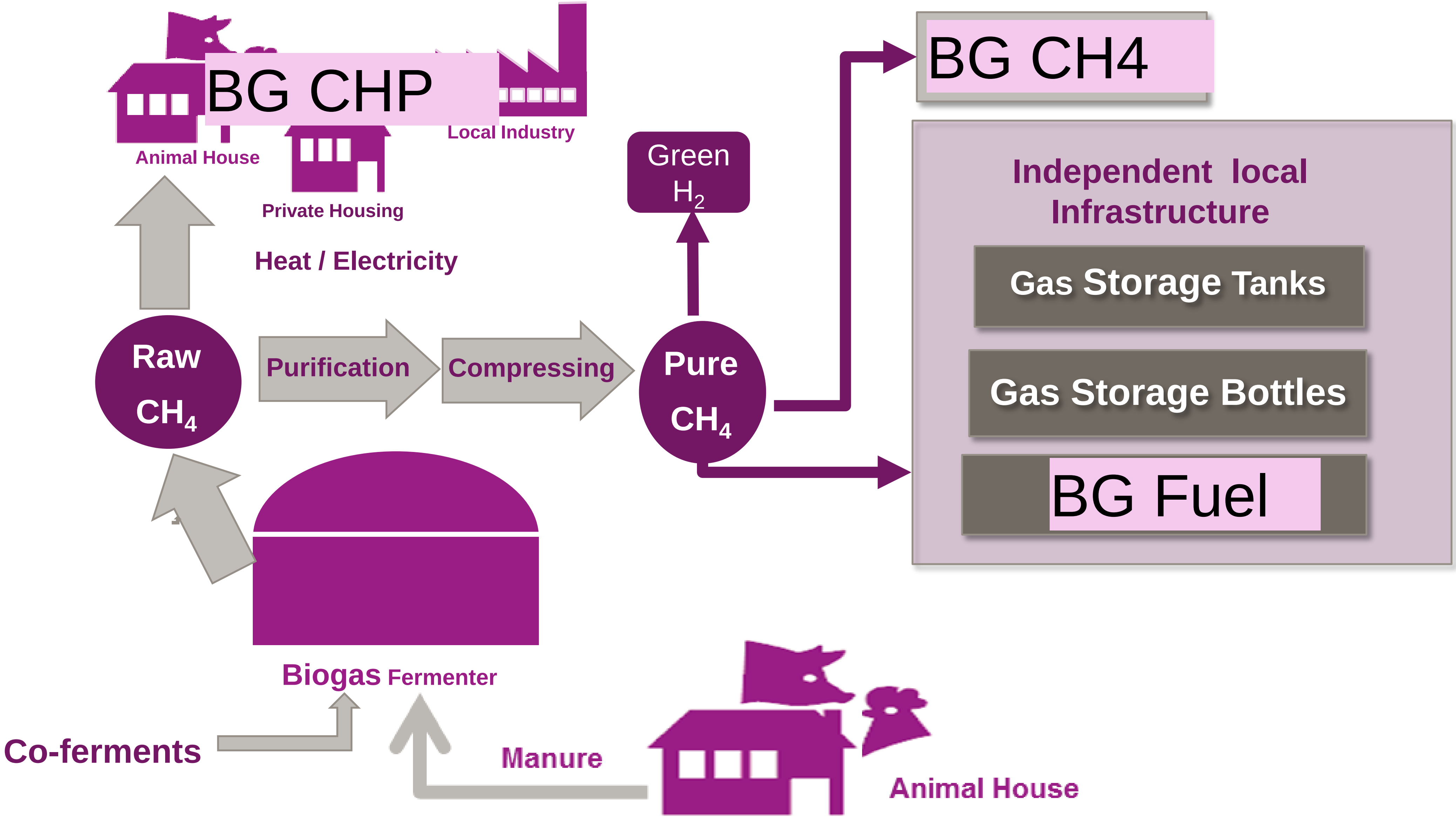
Combination of

- **NUTRIENT** management
- **EMISSION** and **WASTE** management
- Recycling of energy and increased energy efficiency
- Closed Nutrient Cycle
- Additional use of further processed as P / N – fertilizer on farm level
- Additional business opportunities

Low protein and low phosphor diets – the nutrition part of LEF

- High protein diets are imbalanced in the amino acid profile
- Supplementing feed amino acids (AA) restore the imbalance and leads to crude protein (CP) reduction
- CP reduction lowers nitrogen content in excreted manure (~ 10% by 1% lower CP)
- CP reduction lowers water consumption of animals and thus manure volume (~ 3-5% by 1% lower CP)
- Phytase reduces phosphorus excretion by up to 60% and saves finite mineral phosphate sources

The LEF Concept – combining state of the art management of nutrients, emissions and energy and creating new business opportunities



1 t of average pig feed calculated according to the composition of diets (gestation, lactation, pre-starter, starter, growing, finishing) (see SFIS-report IFIF 2015)

Composition in kg/t	A1 AA / -Ph	A2 +AA / -Ph
Wheat	344.39	381.51
Corn	145.60	143.47
Barley	213.82	288.10
Wheat bran	11.03	21.98
Rapeseed meal	3.26	54.35
Soybean meal	232.29	67.13
Rapeseed oil	6.93	2.99
Extruded soybean grain	8.72	0.16
Lysine	0.00	4.04
Threonine	0.00	1.44
Methionine	0.00	0.42
Tryptophane	0.00	0.22
Phytase	0.00	0.00
Mono-calcium phosphate	6.94	7.01
Salt	4.00	4.00
Calcium carbonate	15.61	15.78
Vitamin premix	5.00	5.00
Dried whey	2.41	2.41

Nutritional information for 1 ton of average pig feed, calculated according to the composition of diets (gestation, lactation, pre-starter starter, growing, finishing) (see SFIS-report IFIF 2015)

Content	Unit	A1 -AA/-Ph	A2 +AA/-Ph
FCR (fattening)	kg/kg	2.75	2.75
Crude protein	kg/t	180.8	138.4
Total P	kg/t	5.39	5.40
DE	kcal/kg	3255	3147
ME	kcal/kg	3107	3026
NE	kcal/kg	2298	2298
Digestible lysine (SID)	kg/t	7.83	7.80
Digestible P (Apparent)	kg/t	2.48	2.48

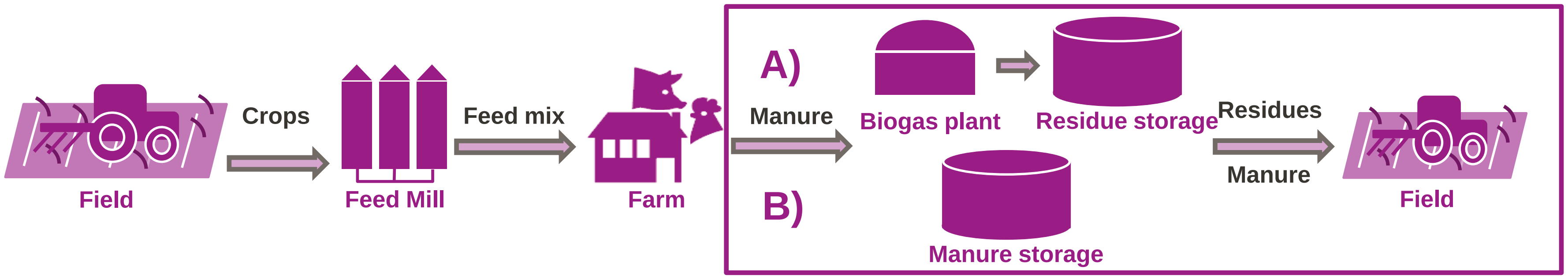
1 ton of average feed for broilers, calculated according to the composition of diets (pre-starter, starter, finisher) (see SFIS-report IFIF 2015)

Composition in kg/t	A1 -AA/-Ph	A2 +AA/-Ph
Wheat	0.00	453.95
Maize	392.23	242.01
Wheat bran	27.63	0.00
Rapeseed meal	77.07	17.79
Soybean meal	448.75	223.26
Rapeseel oil	20.00	20.00
Lysine	0.00	2.65
Threonine	0.00	0.69
Methionine	0.00	1.93
Phytase	0.00	0.00
Mono-calcium phosphate	10.64	11.03
Salt	3.76	3.61
Sodium bicarbonate	0.00	0.40
Calcium carbonate	14.93	17.70
Vitamin Premix	5.00	5.00

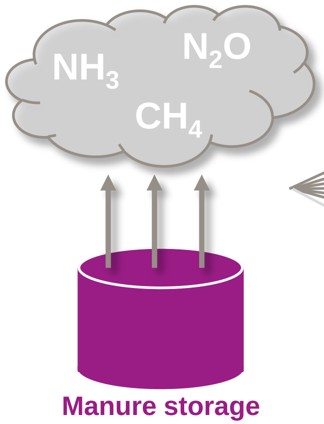
Nutritional information for 1 ton of average broiler feed, calculated according to the composition of diets (pre-starter, starter, finisher) (see SFIS-report IFIF 2015)

Content	Unit	A1 -AA/-Ph	A2 +AA/-Ph
FCR	kg/kg	2.01	1.85
Crude protein	kg/t	265.12	178.55
Total P	kg/t	7.29	6.10
ME	kcal/kg	2831	3082
Digestible lysine	kg/t	13.37	9.70
Digestible methionine	kg/t	3.74	4.38
Digestible methionine + Cysteine	kg/t	7.62	7.27
Digestible threonine	kg/t	9.19	6.30
Digestible tryptophane	kg/t	2.81	1.85

Cradle to gate LCA including manure effects using GaBi data sets



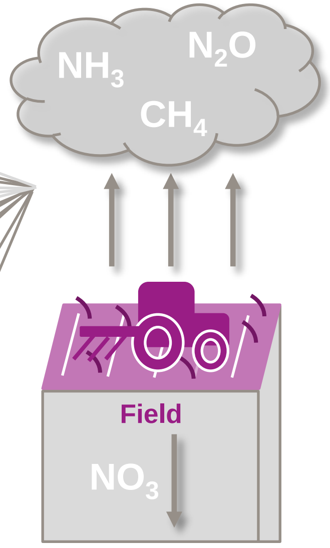
Emissions from storage



Influencing factors

- Time of storage
- Temperature
- Climate zone
- Covered/uncovered MMS
- Natural crust cover
- Liquid/solid storage / mixing regime
- Rainfall, weather
- Soil type
- Crops / plants on field
- Residue composition
- Application technology/spreading
- Saisonal point of manure application

Emissions from field application

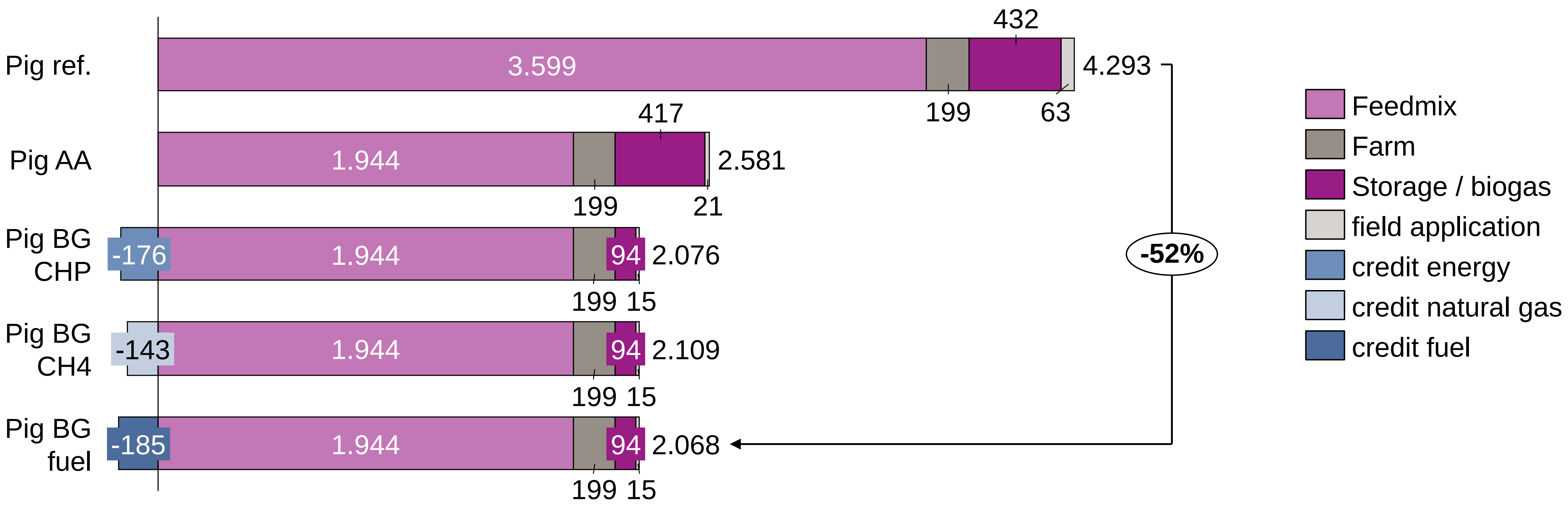


1st approach: use IPCC data for emissions

------ = direct influencing factor
------ = indirect or uncertain influencing factor

GWP reduction potential by using amino acids and different biogas options: Pigs

GWP (100) excl. biogenic carbon [kg CO_2e/1.000 kg live weight] incl. dLUC emissions



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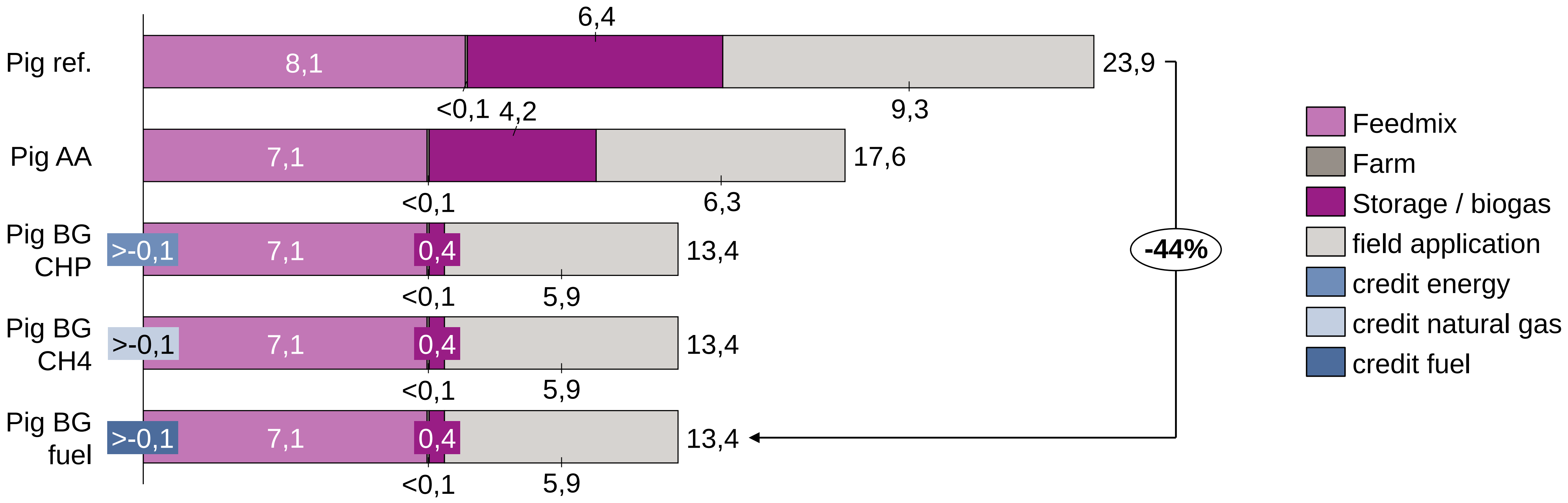
Eutrophication reduction potential by using amino acids and different biogas options: Pigs

EP [kg PO_4e/1.000 kg live weight]



GWP reduction potential by using amino acids and different biogas options: Broilers

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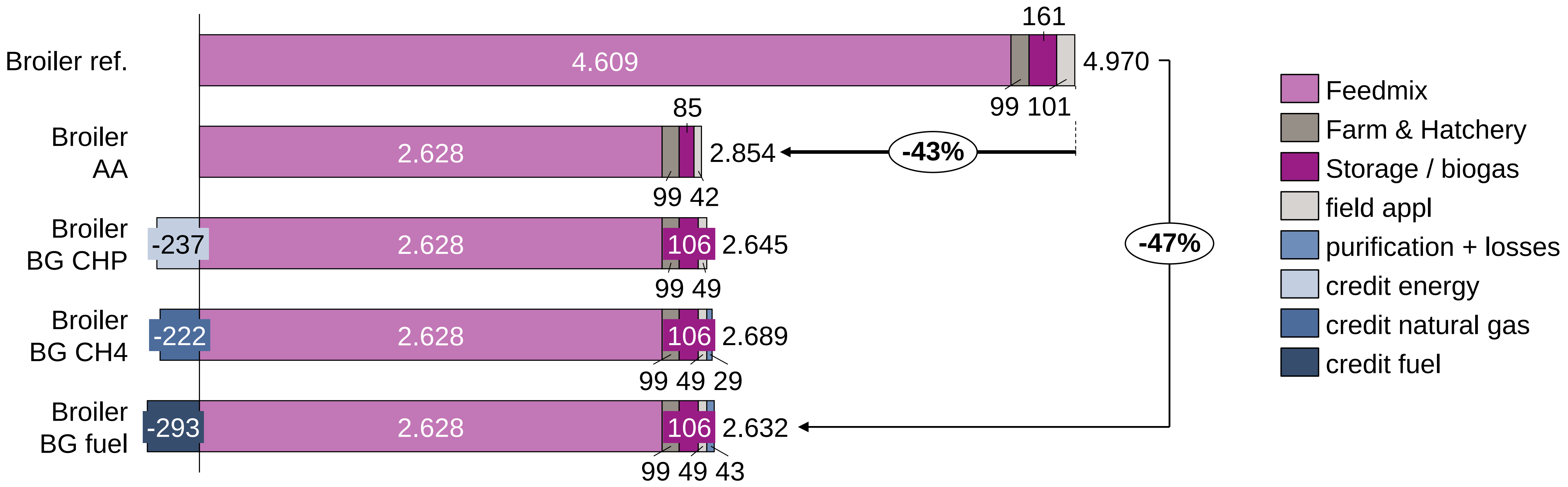

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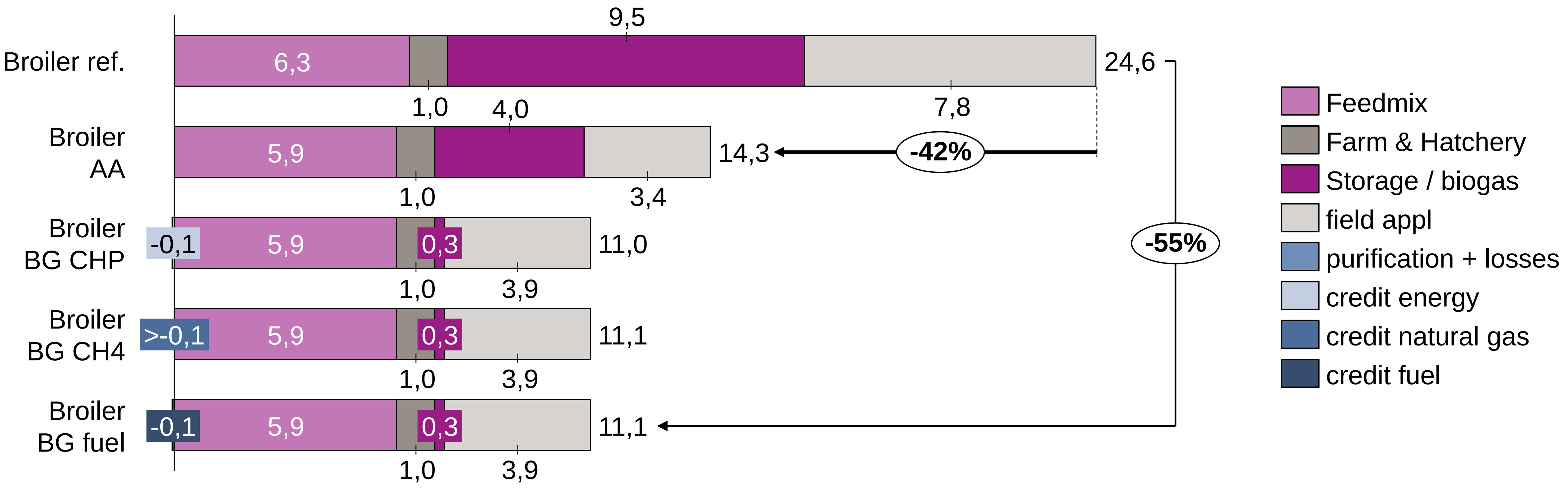

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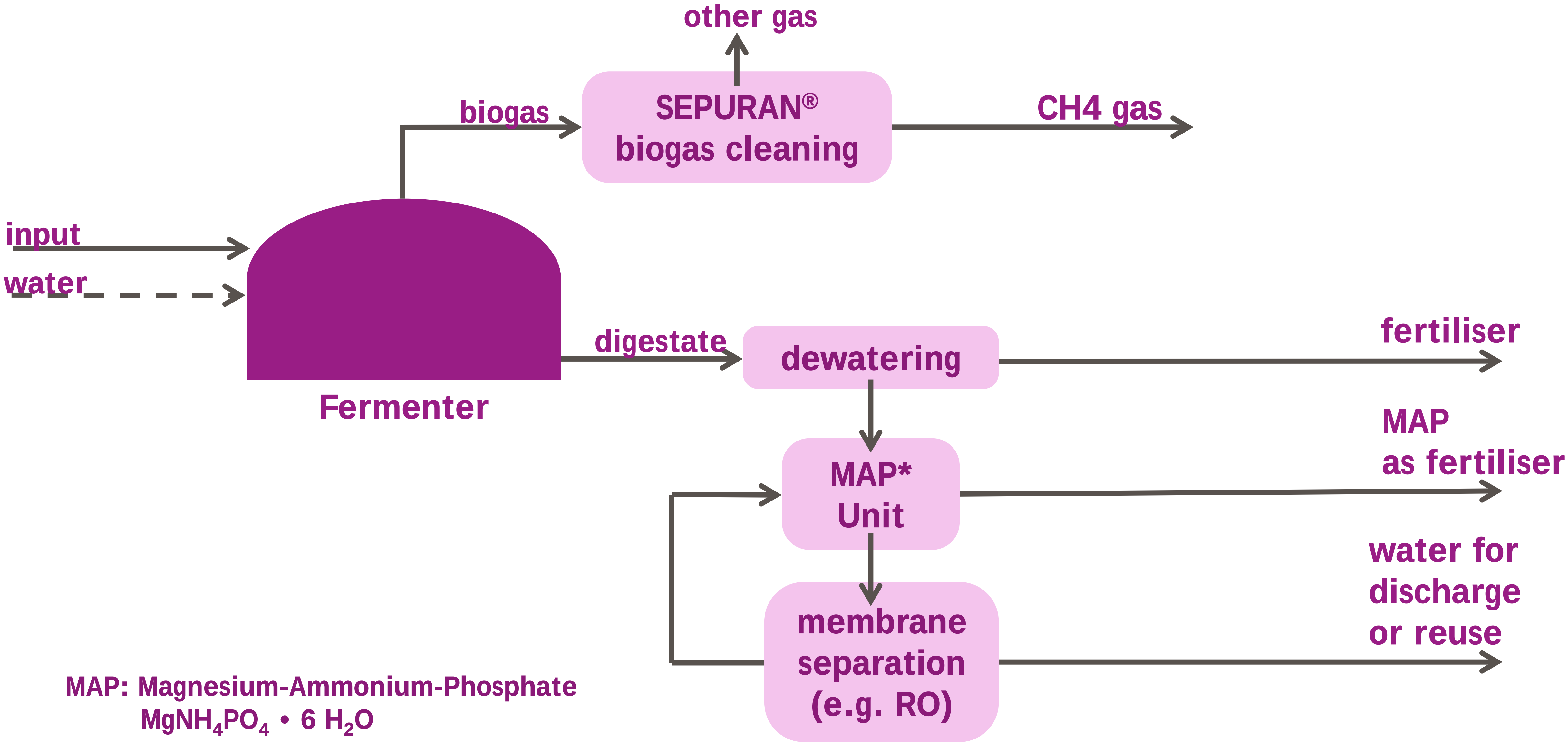
Acidification reduction potential by using amino acids and different biogas options

AP [kg SO_2e/1.000 kg live weight]

	Broiler	Pigs
Reference (AA-)	65.3	50.1
AA+	31.7 (-51.5%)	34.3 (-31.5%)
BG CHP	15.3 (-76.3%)	16.3 (-67.5%)
BG CH4	16.3 (75.0%)	17.0 (-66.1%)
BG Fuel	16.2 (-75.2%)	16.9 (-66.3%)

Further treatment of fermentation rest leads to a more flexible and more ecological organic fertilizer management



MAP: Magnesium-Ammonium-Phosphate
$MgNH_4PO_4 \cdot 6\ H_2O$

Conclusion and outlook

- Agriculture is responsible for about 20% of global GHG emissions, ¾ of that for lifestock
- Globally GHG emissions are dominated by ruminants; significant N and P emissions from poultry and swine
- Manure management practice and temperature have a dominant influence on GHG formation during manure storage → cover for storage tanks necessary
- Diets with amino acids have a significant reduction potential for N emissions and related acidification and eutrophication potentials; GHG reduction‘s significance is strongly connected with LUC and Soy from South America
- Several measures can help to reduce impacts on every production stage; e.g. farming and fertilizer use and application, feeding strategies/low protein diets; manure management to recover energy and avoid emissions from storage
- Biogas can significantly reduce emissions from manure storage and offset farm emissions by credits for electicity/heat, natural gas or even diesel replacement
- Lowering feed protein content further using more AA and digestate treatment offer further emission reduction potential.