BIOGRACE II

Biogas – how to deal with actual multi-input into a biogas plant

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What is the problem?

- **Biogas plants are typically operating as multi-input**
- **Default values refer to single inputs.**
  (exception: manure + maize, combined but separately calculated)
- **For actual calculation:**
  - biogas yield by input is basically relevant
    (MJ Biogas/MJ feedstock)
  - Actual biogas yields never match with literature values
  - Mixed feedstocks react unpredictably resulting from specific feedstock quality, fermenting conditions and technical factors (plant design, operation mode).

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What is the problem?

- BioGrace tool input value: specific single input WET MANURE:

Anaerobic digestion		
Yield		
Biogas output	0,42	MJ_{Biogas} / $MJ_{Wet\ manure}$
Energy consumption		
Electricity EU mix LV	0,019	MJ / MJ_{Biogas}
Heat (from biogas CHP)	0,096	MJ / MJ_{Biogas}
Biogas CHP		
Biogas input per MJ heat	0,101	MJ / MJ_{Heat}

What is the problem?

- BioGrace tool input value: specific single input
  MAIZE

Anaerobic digestion		
Yield		
Biogas output	**0,60**	MJ_{Biogas} / MJ_{maize}
Energy consumption		
Electricity EU mix LV	**0,024**	MJ / MJ_{Biogas}
Heat (from biogas CHP)	**0,098**	MJ / MJ_{Biogas}
Biogas CHP		
Biogas input per MJ heat	**0,101**	MJ / MJ_{Heat}

What is the problem?

Feedstock 1 $e_{ec}1$	Feedstock 2 $e_{ec}2$	Feedstock 3 $e_{ec}3$

Biogas plant e_p

Biogas $E = e_{ec} + e_p$
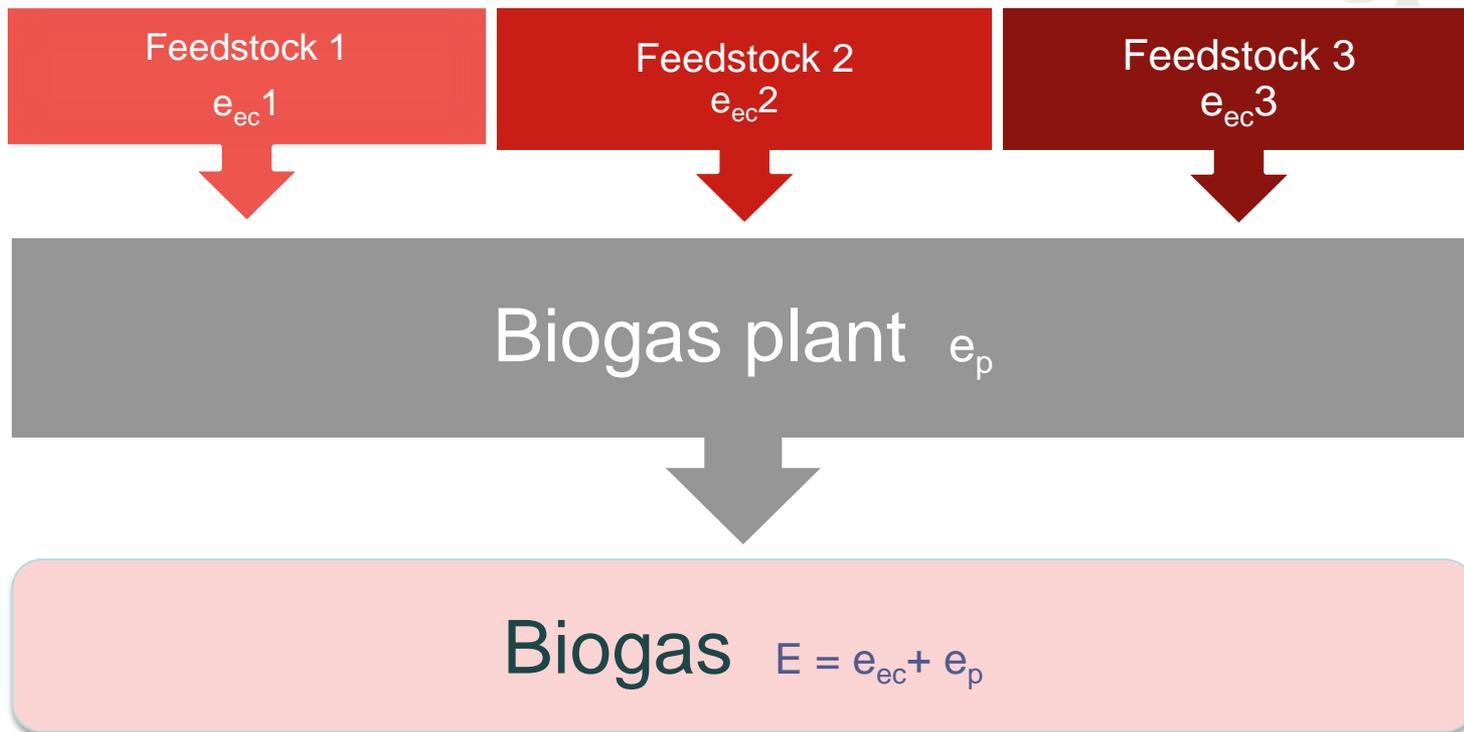
What is ruled?

Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme (2010/C 160/01):

- **2.2.3 mass balance:**
 "… When consignments with different (or no) sustainability characteristics are **mixed**, the separate sizes and sustainability characteristics of each consignment remain assigned to the mixture[8].

    [8] Thus, if the characteristics include different figures on greenhouse gas emissions they remain separate; **these figures cannot be averaged** for the purpose of showing compliance with the sustainability requirements."

What is ruled?

Feedstock 1 $e_{ec}1$	Feedstock 2 $e_{ec}2$	Feedstock 3 $e_{ec}3$

Biogas plant

$e_p \cdot AF1$ $e_p \cdot AF2$ $e_p \cdot AF3$

Biogas $E1 = e_{ec}1 + e_p \cdot AF1$	Biogas $E2 = e_{ec}2 + e_p \cdot AF2$	Biogas $E3 = e_{ec}3 + e_p \cdot AF3$

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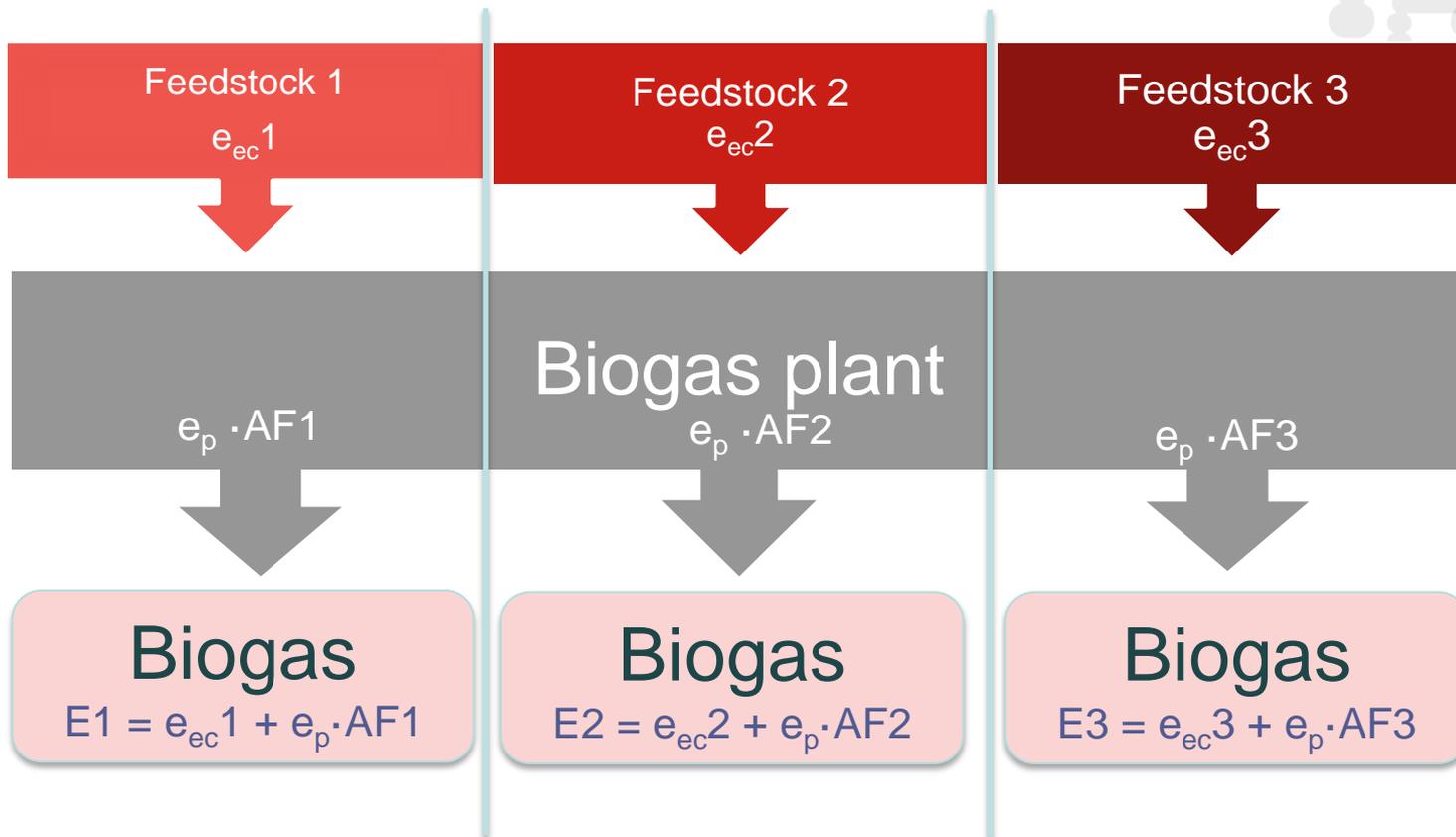
What is needed for actual calculation?

Feedstock 1
$e_{ec}1$

Biogas plant
$e_p \cdot AF1$

Biogas
$E1 = e_{ec}1 + e_p \cdot AF1$
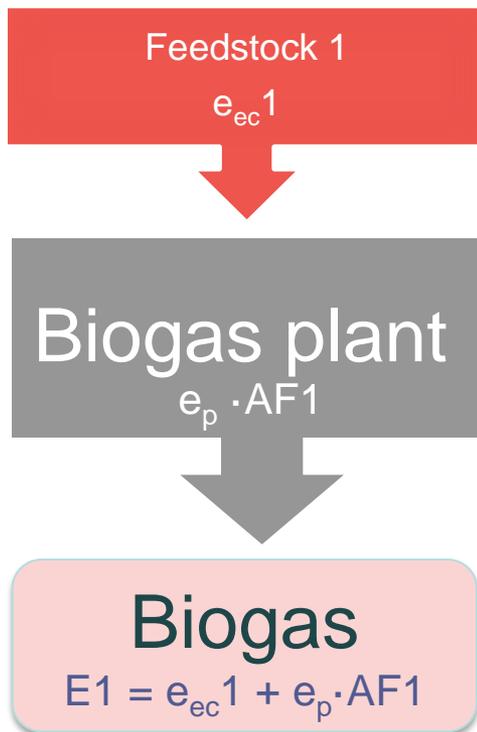
- **Operators can measure the total biogas yield related to the total input of all feedstocks.**

- **Nobody can measure which portion of biogas is actually originated from which feedstock.**

- **Standardized factors are needed to derive the portions of biogas to be separately assigned to each of the different inputs.**

Proposal for practical application

- **Take standardized factors describing biogas yield ratios by feedstock.**
  - **e.g. from KTBL 2009: "Faustzahlen Biogas"**

feedstock	Biogas Yield l/kg dry org. matter	CH4 content %	CH4 yield l/kg dry org. matter
grown biomass			
CCM	730	52	380
Futterrübensilage	700	52	364
Getreide-GPS	620	53	329
Getreidekorn	730	52	380
Grassilage	600	53	318
Grünroggensilage	600	53	318
Kartoffeln mittl. Stärkegehält	730	52	380
Klee-/Luzernesilage	530	55	292
Kleegrassilage	580	55	319
Körnermais	730	52	380
Landschaftspflegegras	300	50	150
Maissilage	650	52	338
Raps	645	55,2	356
Sonnenblumensilage	520	57	296
Sorghumsilage	610	52	317
Stroh	400	52	208
Sudangras	478	53,7	257
Topinambur	535	54	289
Weidelgras	623	53	330
Weißkohlblätter	610	55	336
Zuckerhirse	538	54	291
Zuckerrübensilage	700	52	364
manure			
Geflügelmist	500	55	275
Pferdekot	300	55	165
Rindermist	450	55	248
Rindergülle	380	55	209
Schafmist	450	55	247,5
Schweinegülle	420	60	252

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Proposal for practical application

- **Take standardized factors describing biogas yield ratios by feedstock.**
- **Apply these factors to assign the actual total biogas volume to the separate feedstock quantities.**
  - **e.g.: 40 m³ Biogas (= 1.025 MJ) generated from:**
    180 t maize, 50 t wheat whole plant, 150 t wet manure.

	Input	Input	energy value	yield factor	theoretical biogas yield	actual biogas yield	assigned biogas portion	adapted yield factor
	t (f.m)	t (d.m.)	MJ (d.m.)	MJ bg/MJ fs	MJ	MJ (m3)	MJ	MJ bg/MJ fs
Maize silage	180	57,6	1036,8	0,639	662,1		695,5	**0,671**
wheat whole plant	50	20	360	0,621	223,5		234,8	**0,652**
wet manure	150	22,5	225	0,401	90,2		94,8	**0,421**
Sum				**1621,8**		**975,9**	**1025**	**1025,0**
						(40 m3)		

Measured by operator

Applied to the BioGrace spreadsheet

Slide 11

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Proposal for practical application

- **BioGrace tool input value:**
  Actual value for specific input in input mixtures

  MAIZE

| Anaerobic digestion		
Yield		
Biogas output	**0,671**	MJ_{Biogas} / MJ_{maize}
Energy consumption		
Electricity EU mix LV	**0,024**	MJ / MJ_{Biogas}
Heat (from biogas CHP)	**0,098**	MJ / MJ_{Biogas}
Biogas CHP		
Biogas input per MJ heat	**0,101**	MJ / MJ_{Heat}

Proposal for practical application

Need to implement such an approach as a calculation rule?

→ Prevent "cherry-picking"!

Feedstock 1	Feedstock 2	Feedstock 3

Biogas plant

Biogas	Biogas	Biogas

Assigning low GHG emissions arbitrarily to this portion.

Assigning the major part of GHG emissions arbitrarily to other portion.
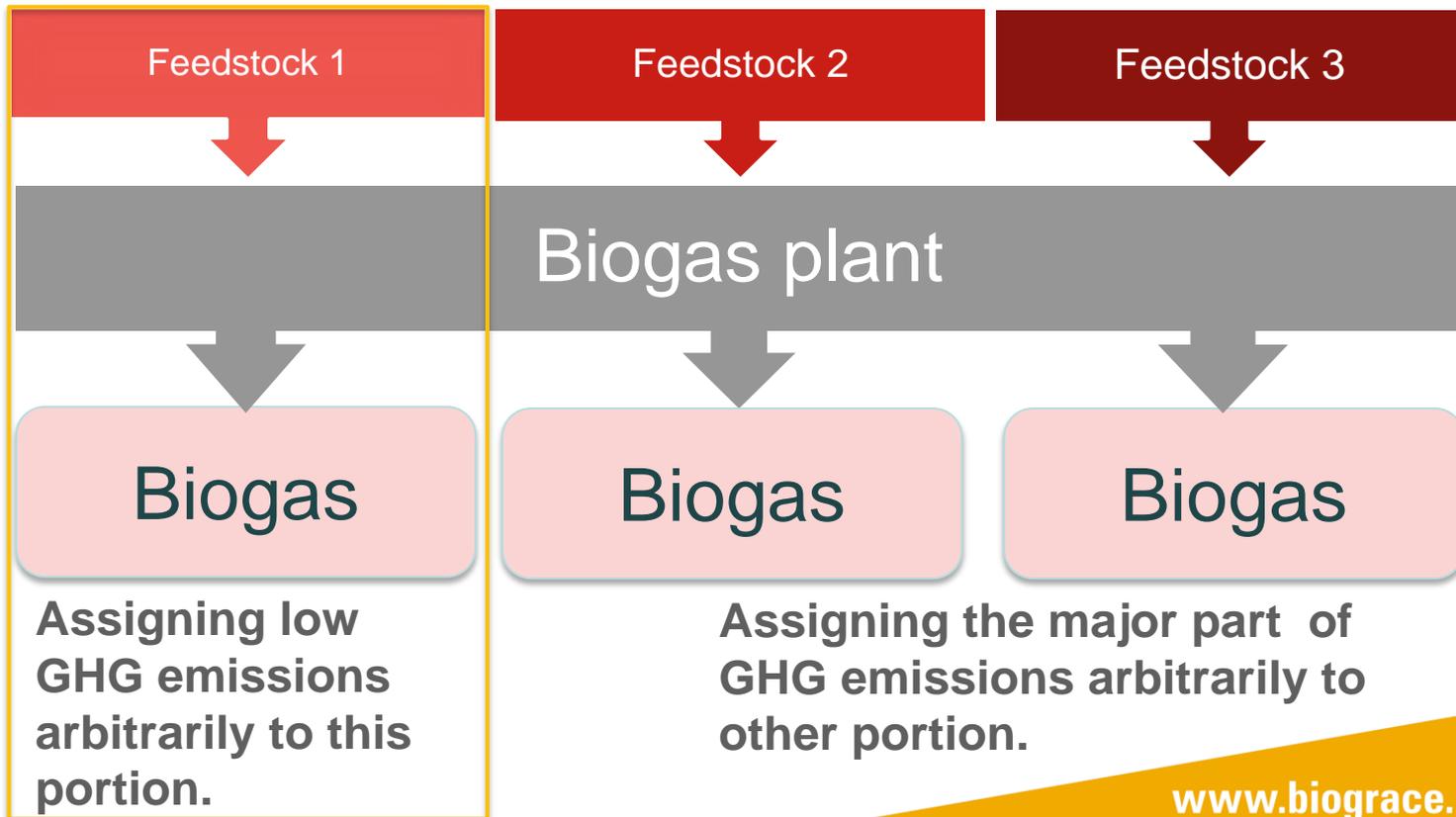
Conclusion

- **In Germany operators from biogas plants, of certification system and verifiers require a valid and recognized scheme to handle multi-input feedstocks into biogas plants.**

- **The proposed approach just clarifies the way how to assign actual feedstock input to actual biogas output
  → mass balance of process is unaffected!**

- **Data and approach should be handled as a rule similarly to the "BioGrace calculation rules" because otherwise there some space left open for "cherry-picking".**