Coastal Biogas

Roskilde University, November 13, 2019

Digestate regulations and management in Denmark

Bruno Sander Nielsen

Danish Biogas Association





Danish Biogas Association

Members:

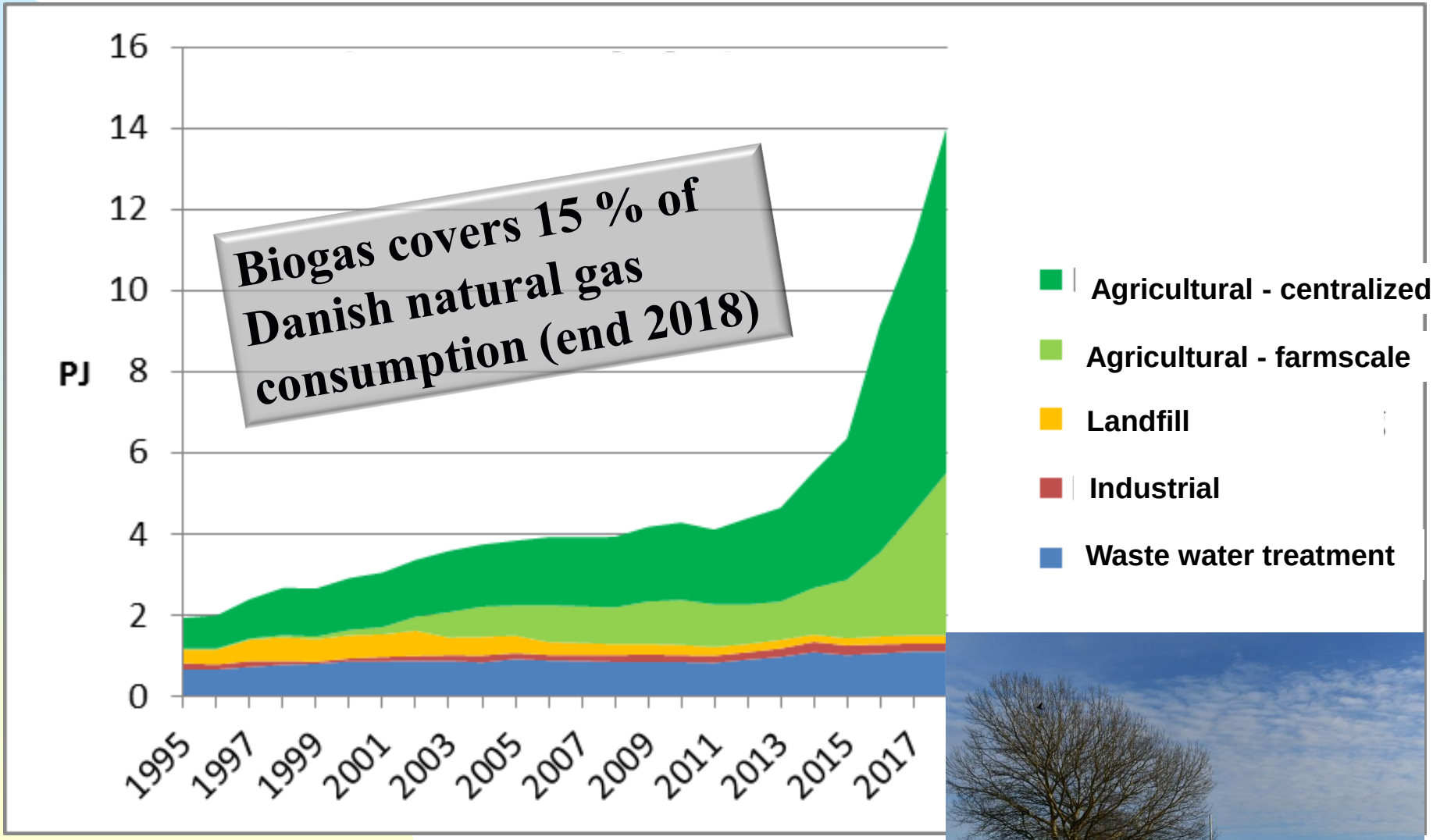
Biogas plants, turn-key and equipment suppliers, consultants, energy -, waste – and agricultural sectors, biomass suppliers, pretreatment plants, municipalities etcetera. (*all stakeholders in the biogas sector*)

Mission

Promote economic and environmental sustainable production and use of biogas and strengthening the political priority here of

- Lobby and communication
- Networking and knowledge sharing
- Co-operation with authorities
- International co-operation and eksport

Biogas production 1995-2018



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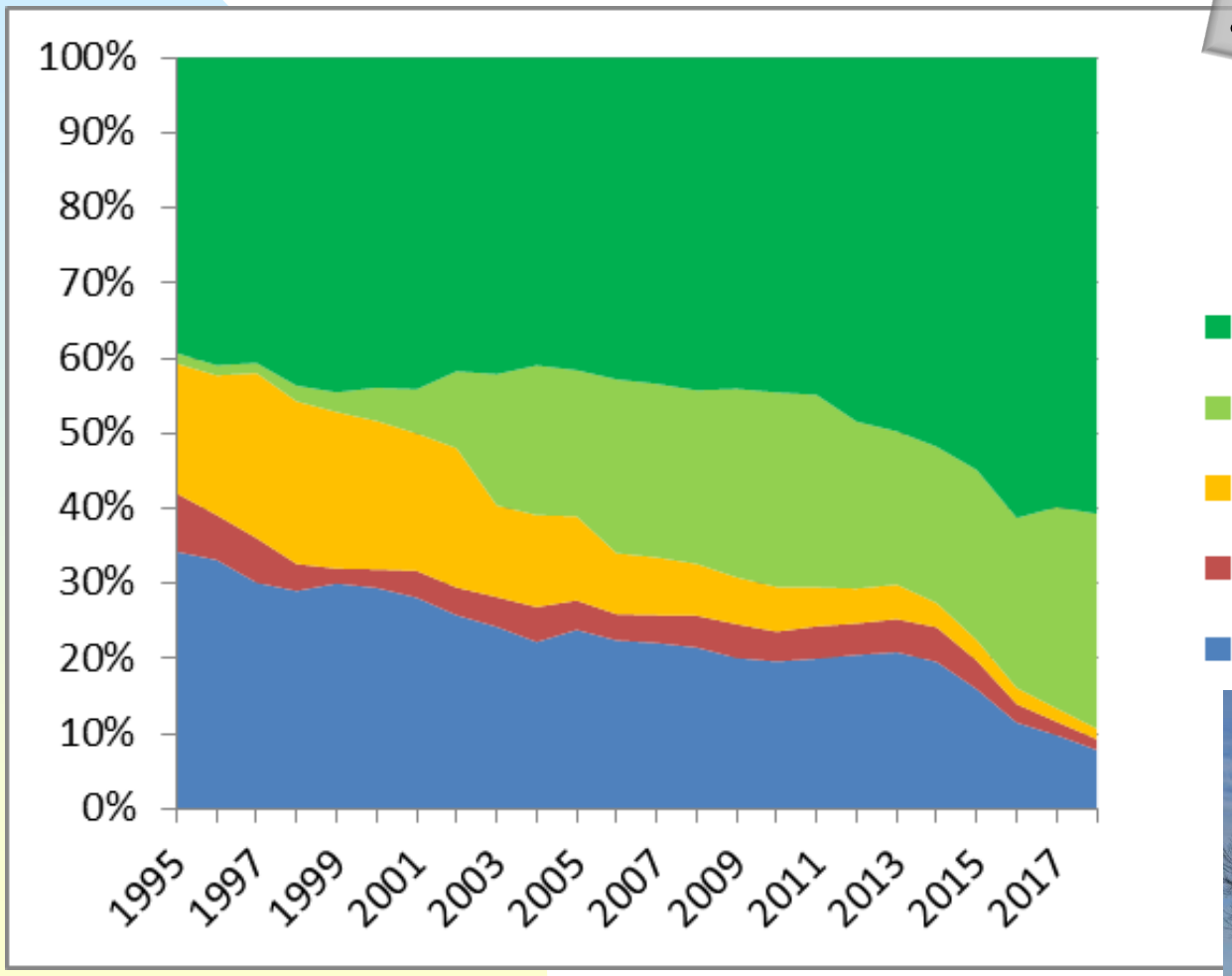
2018 extrapolated

Relative biogas production

Danish biogas is agricultural based



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2018 extrapolated

Biogas in Denmark

Livestock manure
Liquid slurry/Deep litter
Organic catch crops

Organic residues
Agriculture, households, industry, servicesector

Better environment

Reduced GHG emissions

Improved fertilizer & recirculation
Recirculation; N, P , K and carbon
Nutrient supply (organic)

Renewable energy
Stabilising energy system
Supplementing wind power

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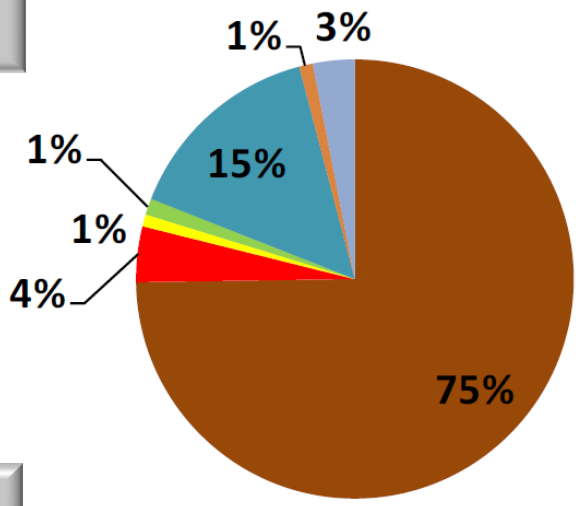
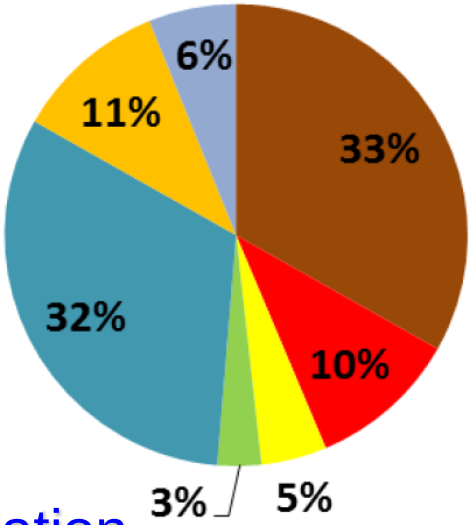
Feedstock and gas origin

Feedstock



Origin of biogas



- Livestock manure
- Energy crops
- Straw
- Other crop residues
- Industrial residues
- Glycerine
- Food waste

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2017/18 (preliminary)

Digestate regulation since 80'ies

Regulated as livestock manure

- If waste is less than 25 per cent
- Nitrate directive (170 / 230 kg N per hectare)
- Fertilizer accounts on farm with minimum utilisation of N
- **Until 2017:**
  - N-regulation:10 per cent below economic optimum
  - Value of digestate
    - Higher yield through
      - improved utilisation
- **From 2017**
  - Also P regulation

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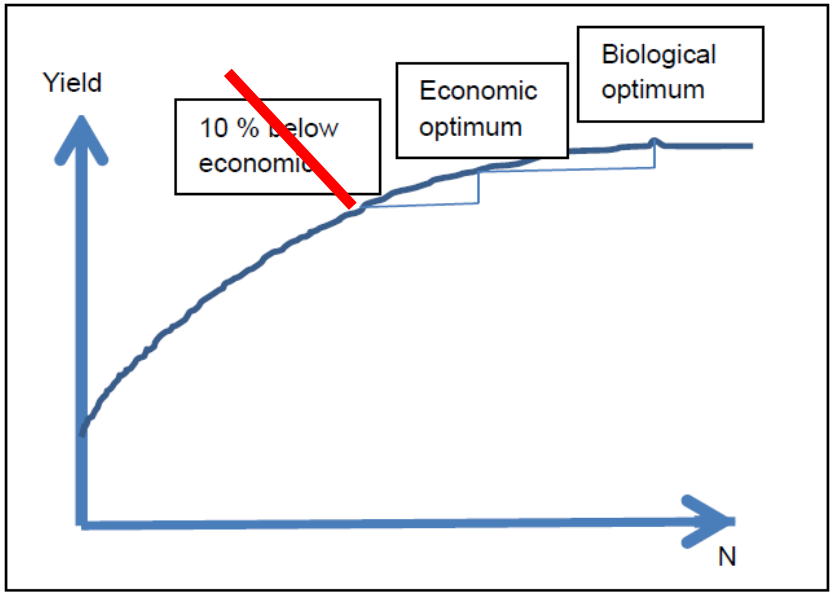
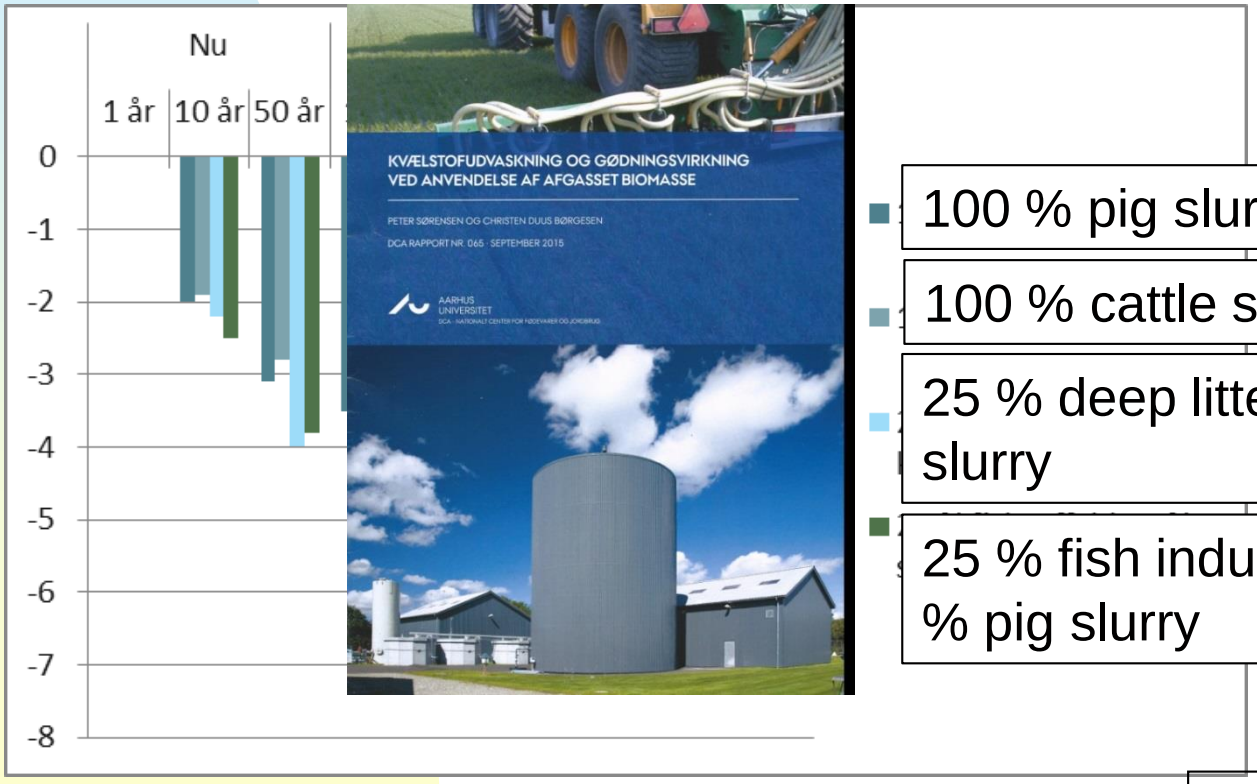


Improved fertilizer and environment

- Anaerobic digestion of livestock manure in biogas plants
  - improves the value as fertilizer: 5-8 kg more N available per LU*
  - Reduces leaching of nitrate with 2 – 4 kg per LU*

*** Livestock unit**
1 LU: 100 kg of N

Nitrate leaching kg N/LU*



From: Aarhus University 2015

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Double phosphorous challenge

- **The phosphorous challenge is double**
  - In the short term – adaption to the new national P regulation
    - for farmers and biogas plants
  - In the long term – P is a highly critical ressource
    - recirculation and reuse is a prerequisite for the future food supply
- **Biogas plants is digesting manure and residues etcetera**
  - which makes it feasible to digest livestock manure and hence the possibility of solutions for P, climate change aquatic environment
  - But this also increases the P challenge in livestock intensive areas

Are biogas plants part of the solution or part of the problem?

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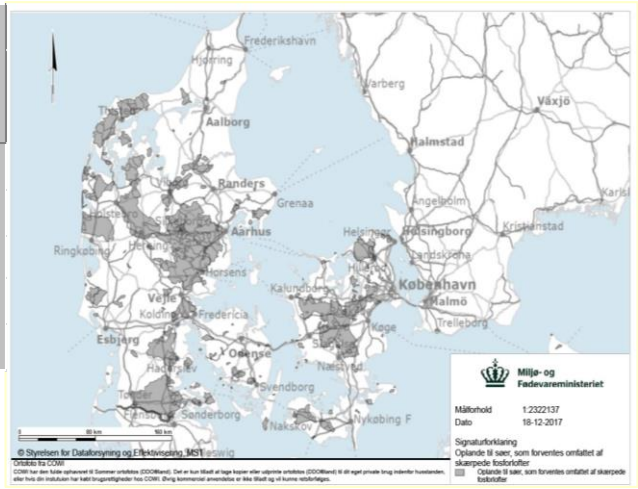
New phosphorous regulation

Regulation of not only N but also P leads to new challenges

New challenges for farmers

- **On their own farm**
  - Especially for poultry and pigs
  - Especially in areas with reduced P access (ceiling)
- **When different types of livestock manure is**
  - Mixed in biogas plants
  - Which leads to shift in P ceiling for the farmer

Phosphorous cealing, kg P per hectare	General	Areas with stricter phosphorous cealings
Cattle, normal 170 kg N per hectare	30	30
Cattle, exeptions 230 kg N per hectare	35	35
Pigs, poultry, fur, horses, sheeps, goats	35	30
Waste	30	30
Chemical fertilizers	30	30



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Livestock manure in Denmark

Manure (1.000 tonnes)	Liquid slurry	Deep litter	Solid manure	Urine	Total	%
Cattle	17.895	2.922	209	236	21.262	50
Pigs	19.385	142	11	38	19.576	46
Poultry	5	238	64	0	307	1
Fur	1.270	183	0	0	1.453	3
Horses	0	217	0	0	217	1
Total	38.555	3.702	284	274	44.341	
Per cent	90	9	1	1		

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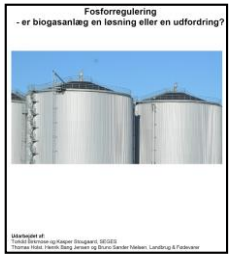
2016/17



Phosphorous in livestock manure

Phosphorous Tonnes	Liquid slurry	Deep litter	Solid manure	Urine	Total	%
Cattle	13.008	3.791	327	36	17.162	**39**
Pigs	20.359	361	53	18	20.791	**47**
Poultry	8	2.345	470	0	2.823	**6**
Fur	2.634	572	0	0	3.206	**7**
Horses	0	360	0	0	360	**1**
Total	36.009	7.429	850	54	44.342	
Per cent	**81**	**17**	**2**	**0**		

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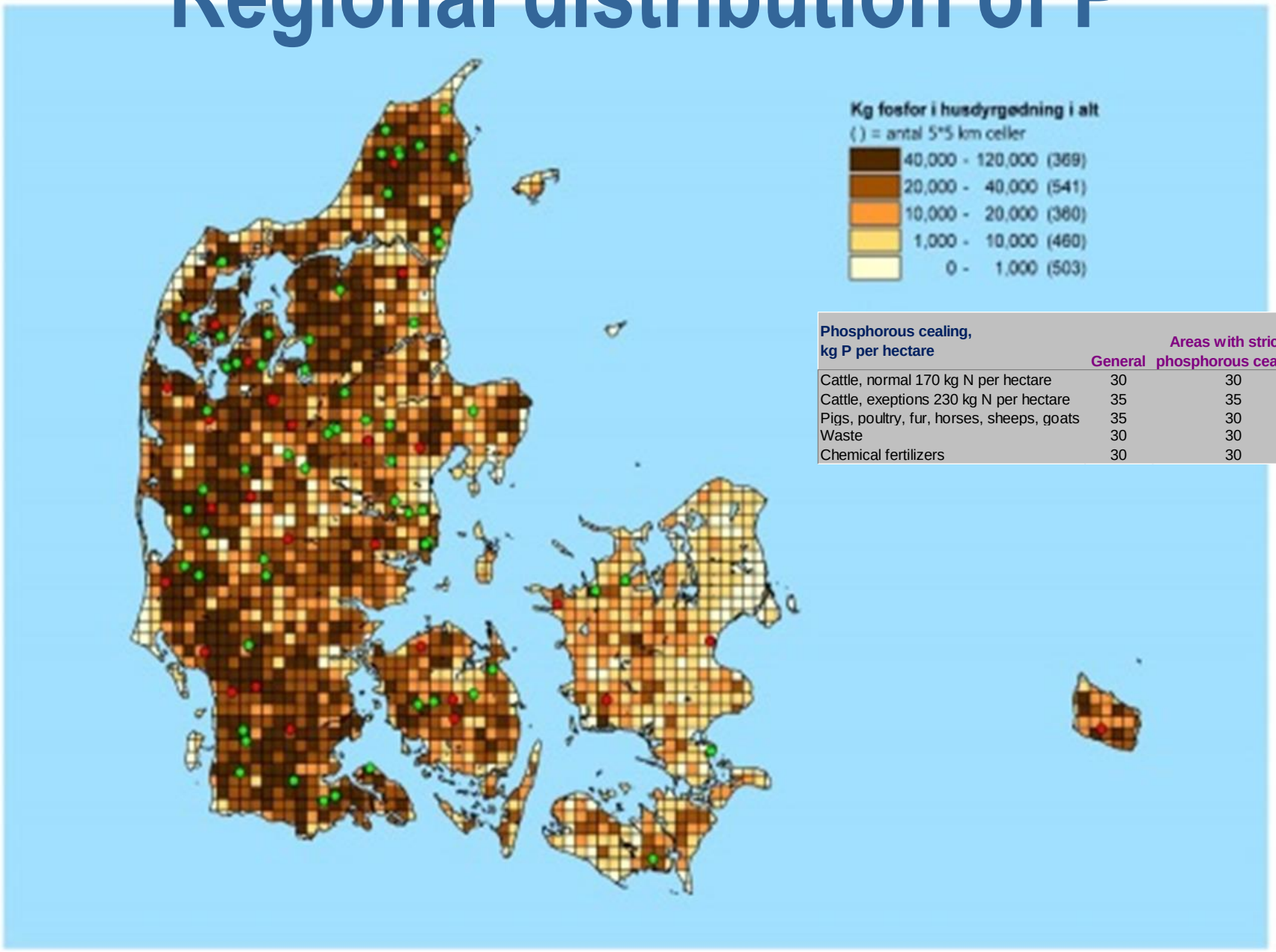
2016/17

Regional distribution of P



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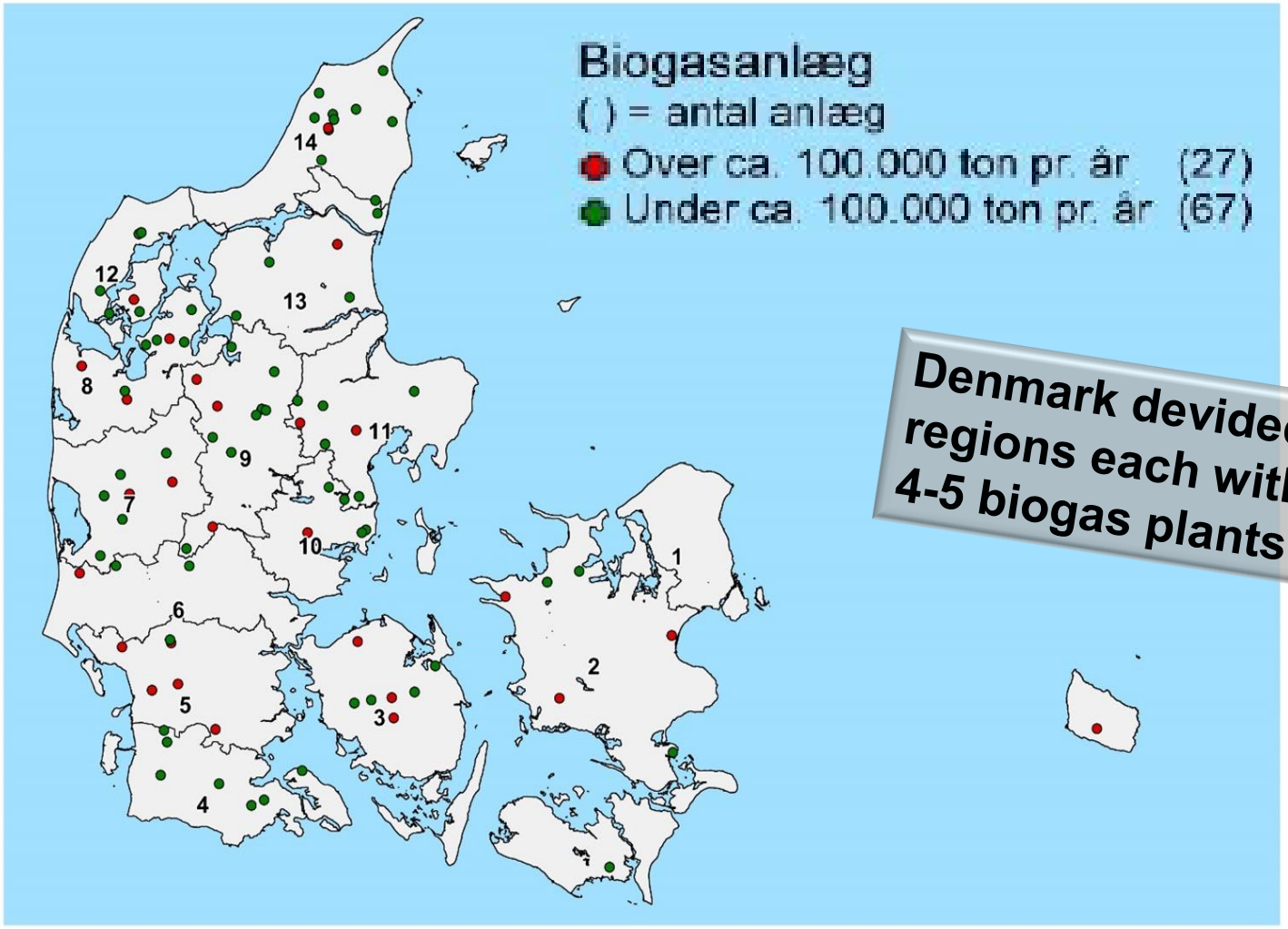
Waste	30	30
Chemical fertilizers	30	30

Where are the biogas plants?



Denmark devided into 14 regions each with minimum 4-5 biogas plants

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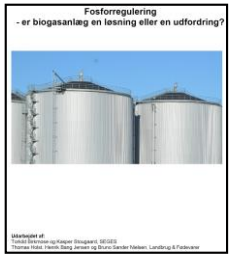

Origin of P in biogas plants

	Type	Origin	Ton per yr.	Kg P per ton	Total kg P
Livestock manure	Manure	Agriculture	5.328.936		5.027.306
Energy crops	Energy Crops	Agriculture	316.855		247.475
Animal biproducts	Industrial waste	Agriculture	207.301	3	621.902
Organic waste (enterprises)	Industrial waste	Industry	76.233	1	76.233
Sludge (animal origin)	Industrial waste	Agriculture	284.626	3	853.879
Sludge and waste water (pure)	Industrial waste	Industry	309.606	0,2	61.921
Source separated household waste	Households	Cities	86.604	0,6	51.962
Glycerine	Industrial waste	Industry	72.599	0	0
Other organic fertilizers	Industrial waste	Agriculture	156.337	1	156.337
Other organic fertilizers	Industrial waste	Industry	102.188	1	102.188
Total			6.990.503		7.199.203

2016/17

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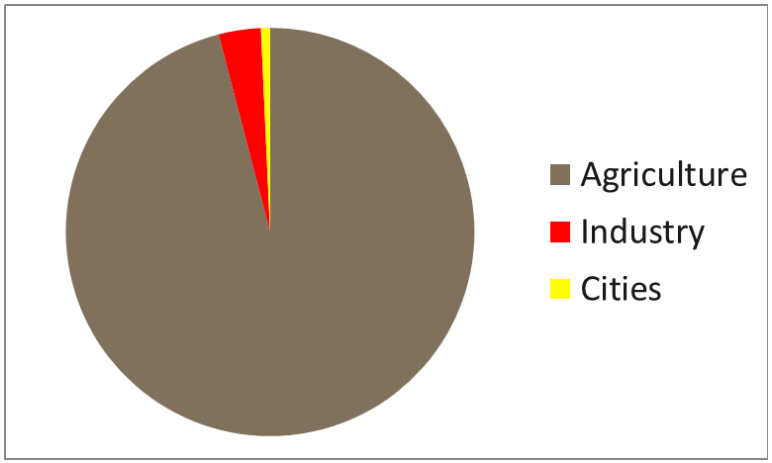

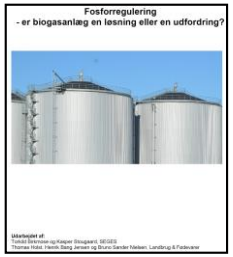

Origin of P in biogas plants

Phosphorous (tonnes)	Agriculture	Industry	Cities	Total	%
Livestock manure	5.027	0	0	5.027	**69**
Industrial waste	1.641	260	0	1.901	**26**
Energy crops	196	0	0	196	**3**
Crop residues	46	0	6	52	**1**
Household waste	0	0	52	52	**1**
Seavage sludge	0	0	36	36	**1**
Total	6.910	260	94	7.264	
Per cent	**95**	**4**	**1**		

2016/17

And more than 20,000 tonnes of P in chemical fertilizer

To compare: 1,700 tonnes of P is used as start fertilizer for maize

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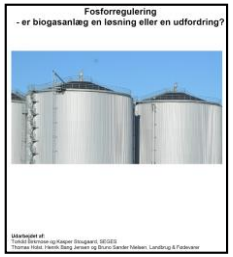
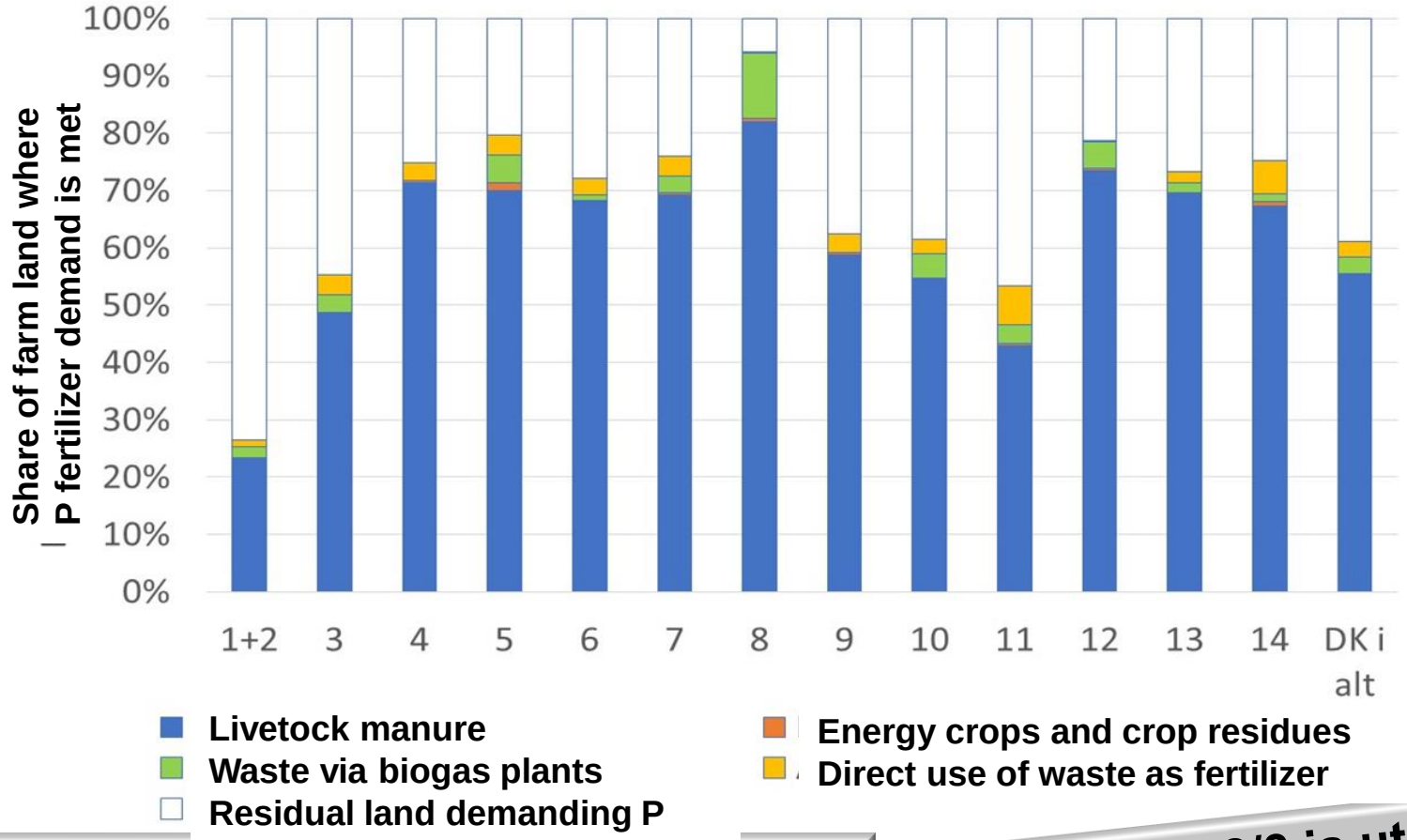
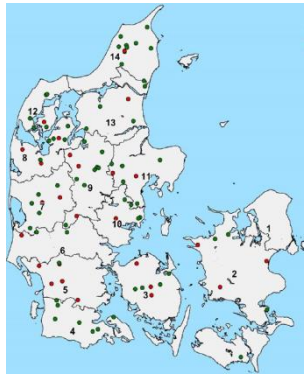


How much of the land is utilised?

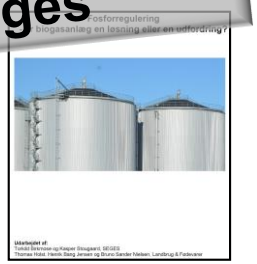




1+2 Sjælland, Lolland-Falster, Bo
3 Fyn
4 Langs den tyske grænse
5 Kolding, Ribe
6 Vejle, Varde
7 Ringkøbing, Herning
8 Lemvig, Holstebro
9 Silkeborg, Viborg
10 Skanderborg, Horsens
11 Aarhus, Randers, Djursland
12 Mors, Thisted
13 Himmerland, Ålborg
14 Vendsyssel

Separation may be necessary to change the N/P-ratio in digestate or export P out of local area

Nationally only 2/3 is utilised – but regionalle there are challenges



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Economy for a crop producer

How to convince crop farmers about the value in fibre fraction?

DKK per hectare	Winter wheat	Spring barley
Without fibre fraction		
Purchase chemical fertilizer	1892	1448
Application of chemical fertilizer	200	100
Total costs	**2.092**	**1.548**
With fibre fraction		
Purchase of chemical fertilizer	1457	969
Application of chemical fertilizer	200	100
Purchase, storage and transportation (fibres)	0	0
Appllication of fiber fraction	150	150
Increased soil disturbance	0	0
Total costs	**1.807**	**1.219**
Cost savings with fiber fractions	285	329
Valure of phosphorous in years 2 and 3	288	334
Value of nitrogen in subsequent crops	30	30
Total value	**603**	**693**

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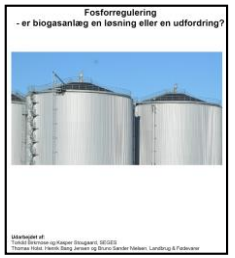
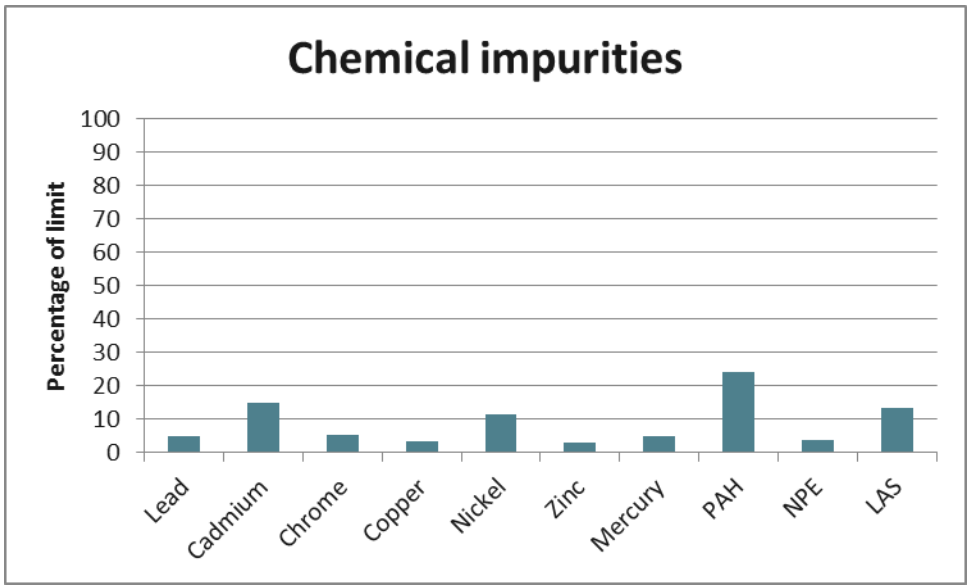


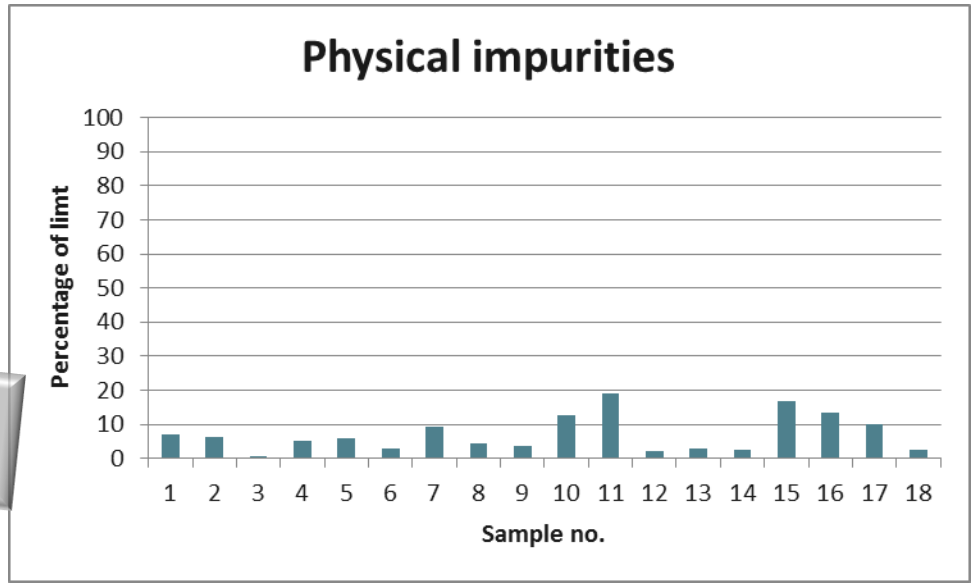
Quality standards for waste input

mg/kg	Threshold
Lead	120
Cadmium	1
Chrome	100
Copper	1.000
Nickel	30
Zinc	4.000
Mercury	1
PAH	3
NPE	20
LAS	1.300

Physical	Threshold
Glass, metal, etcetera	0.5 % (DM)
Plastic	0.15 % (DM)
	1 cm^2/% DM

Point of control: Entry of biogas plant





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Conclusion

- **Biogas plants are the major tool**
  - in the circular economy to recirculate and reuse nutrients
  - to optimize livestock manure (fertilizer, environment, climate)
  - to meet challenges in N and P regulations
- **The digestate is regulated as livestock manure**
  - Until 2017 a way for farmers to get access to enough N
  - Since 2017 new P challenges for farmers and biogas plants
  - Quality requirements for waste input (chemical/physical)

In 2020 we digest 20 % of livestock manure in biogas plants which produce 20 PJ biogas which equals 20 % of Danish gas consumption

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Thanks for your attention!

Questions?

Remember
Økonomiseminaret
December 3 in Vingsted

bsn@biogas.dk
www.biogasbranchen.dk

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