Manure and sewage sludge:
Nutrient recycling and energy efficiency with improved technology

Kompetenzzentrum Niedersachsen · Netzwerk Nachwachsende Rohstoffe und Bioökonomie e.V. 3N

WORKSHOP

Connect North Netherland and Northwest Germany in circular transition

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Same problem and same task for North Netherland and North West Germany

1. **Problem**: Too many nutrients (phosphorus and nitrogen) in the environment

2. **Task**: Increase production of CO_2-neutral electricity and heat

3. **Task** (in Germany): Adhere to the new “sewage sludge regulation” (Klärschlamm Verordnung): phosphorus recovery from sewage sludge

Improved technology:

Hydro-Thermal-Carbonization (HTC)

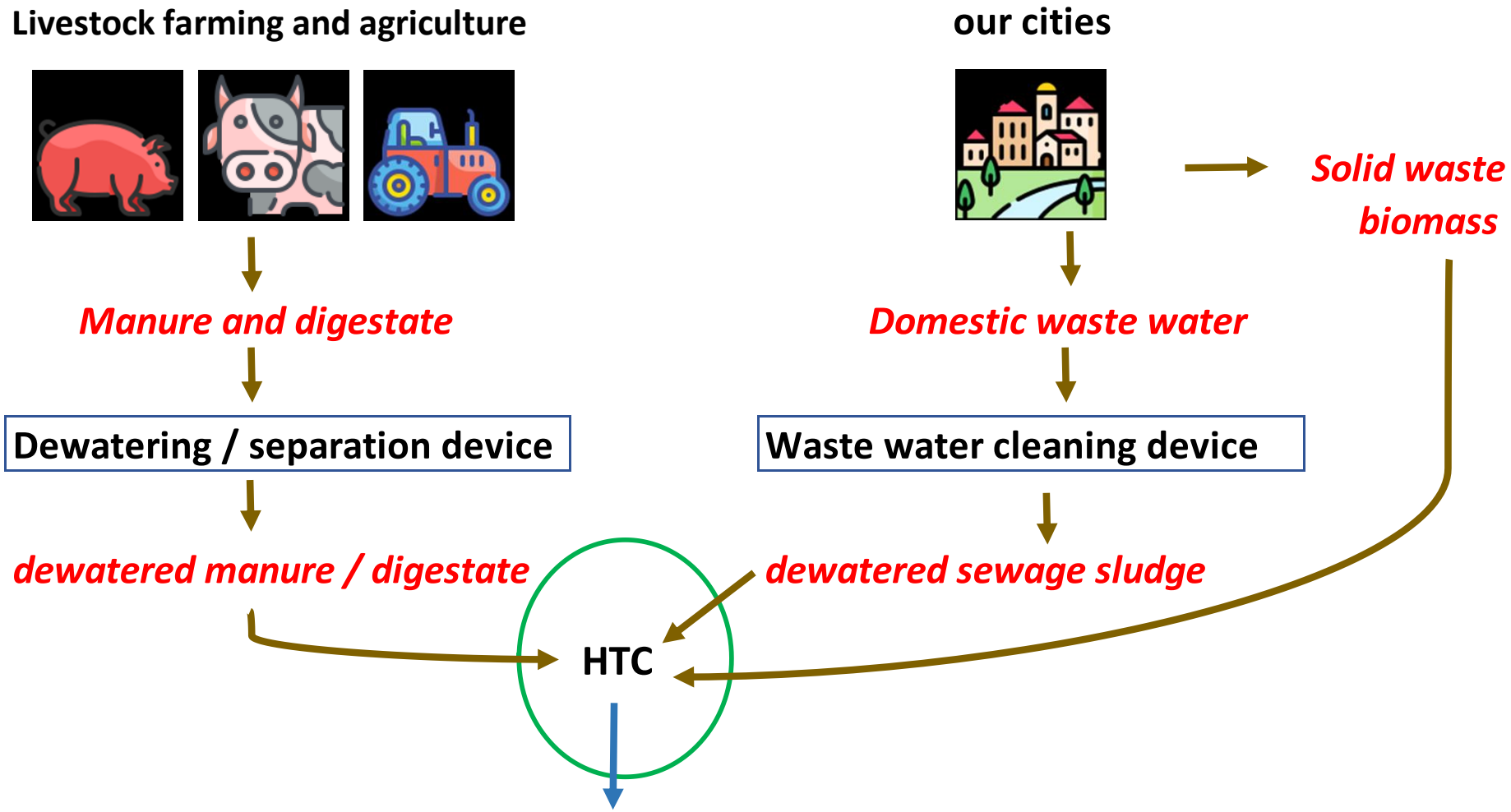
- Converts wet biomass into dried biocoal
- Technically imitates the natural coal formation which takes place in nature over long geological time periodes (50.000 to 50 million years)
- was investigated by Nobel price laureat Friedrich Bergius and first described in 1913
- Technology: thermo-chemical reaction in aqueous solution: at around 170 °C, 20 - 25 bar, 2 – 4 hours
  -> works like a steam cooker
  -> see video how it works:
  https://www.youtube.com/watch?v=c1efkfyuhn4&ab_channel=TerraNovaEnergy

HTC technology can help to solve the problem and to accomplish the tasks

1. Use manure, digestate, sewage sludge and compost (contaminated with plastic and therefore difficult to sell) as feedstock for the recovery of phosphorus and nitrogen

2. Conversion of wet biomass (which cannot be efficiently used as a fuel because of high water content) into a CO_2-neutral biocoal

Waste biomass conversion to biocoal and recovered nutrients



www.flaticon.com/de/kostenlose-icons

Mass flow chart: Nutrient recycling and biocoal production with Hydro-Thermal-Carbonisation (HTC): City with 350.000 inhabitants

Input: original substance from waste water cleaning device

23.000 t/year **sewage sludge** (25% dry matter)

HTC

Output 1: **4.800** t/year HTC-biocoal with **14 mio.** kWh/year energy content (equals: 1,4 mio. m³/year natural gas)

Output 2: **600** t/year carbon concentrate for production of CO_2-neutral graphite

-> to be used for production of batteries for electric vehicles

Output 3: **1.300** t/y Ammonium sulfate fertilizer $(NH_4)_2SO_4$

3.900 t/y Calcium-phosphate fertilizer

alternative: feedstock for the production of lithium-iron-phosphate ($LiFePO_4$) batteries for electric vehicles

Biocoal potential from sewage sludge in NL and NRW

		sewage sludge @25% dry matter	potential biocoal production @90% dry matter	calorific value	natural gas equivalent	lignite equivalent
		mio. tons/year	mio. tons/year	mio. kWh/a	mio. m³/year	mio. t / year
The Netherlands		1,3	0,27	775	77	0,27
North Rine Westphalia		1,5	0,31	894	89	0,31

calorific values values:	MJ/kg	kWh/kg
biocoal @ 90% dry matter	10,3	2,86
lignite @ 50% dry matter	10,3	2,86
natural gas		10 kWh/m³

good for 7.750 flats with consumption of 10.000 kWh/year

Case study: sewage sludge conversion for city (350.000 inhabitants)

Investment costs:	**5**	**mio. Euro for one HTC-module**						
input:	23.000	t/year sewage sludge @ 25% dry matter						
output:	4.800	t/year HTC-coal @ 90% dry matter		+ recovered nutrients + carbon concentrate for graphite production				
produced calorific value	14	mio. kWh/year (as HTC-biocoal)						
CO_2 emission reduction	2.760	t CO_2/year	(compared to natural gas,	based on	0,201	kg CO_2/kWh natural gas)		

Return of invest (ROI)	**mio. Euro/year**							
operating costs	-1,1	including depreciation						
saved disposal costs	1,5	reduction of sewage sludge @ 25% dry m			(based on 80 Euro/t for		18.200	t/year)
produced economic value	1,1	compared to natural gas		0,08	Euro/kWh gas price			
saved carbon costs	0,2			83,59	Euro/t CO2; average carbon price 2023			
income fertilizer / conc. carbon sales	?	Euro/year						
cost for process water drain	?	for	18.200	m^3 water/year, depending on local conditions				
net profit	**1,7**							
Return of invest (ROI)	**+ / - 3**	**years**						

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