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Integrated biogas production for nutrients recirculation: a large-scale demonstration project.

Francesco Ometto, PhD, Project Manager
Jörgen Ejlertsson, Professor, R&D Director

IBBA, Poznan
August 23rd 2017

Facts about Scandinavia Biogas

Founded in December 2005

Head office in Stockholm

R&D in Linköping

~50 employees

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Business idea of Scandinavian Biogas

- **The overall business idea** of Scandinavian Biogas is to operate and optimize industrial scale biogas plants to profitably produce and sell biogas.
  - **This is achieved** through a *build-own-operate* business model where Scandinavian Biogas fully controls plant design, operation and plant process optimization.
  - **Revenues** from the *sale of biogas* and other output from the biogas production as well as from *gate-fees* for accepting waste products.
- **Engineering and Operation services**, for clients who prefers full plant ownership.

Current operational units

Projects running	Client / Partner	Substrate	Production GWh/y (est.)	
Bromma	Stockholm Vatten: SE	Sewage sludge, EOM	25 – (28)	Well functioning plant with proven technology.
Henriksdal	Stockholm Vatten: SE	Sewage sludge, EOM	115 – (180)	Well functioning plant with proven technology. Extended 2015-16 with 3rd up-grading line and EOM dosing
Södertörn	SRV: Stockholm,SE	Food waste	70 – (85)	Launched in Aug 2015. Top of the line process solutions with off-the-shelf hardware. HOLD concept based
Ulsan	City of Ulsan: Kr	Sludge and food waste	65 (65)	Well functioning plant. Appointed to be the best food waste based biogas plant in Korea.
Trondheim	Skogn: Trondheim, NO	Kat2 salmon, slaughter waste, paper mill sludge	(125)	Under construction. Project have CSTR for Kat2 salmon silage and ECSB for process water. Liquefied methane for sale. HOLD concept based



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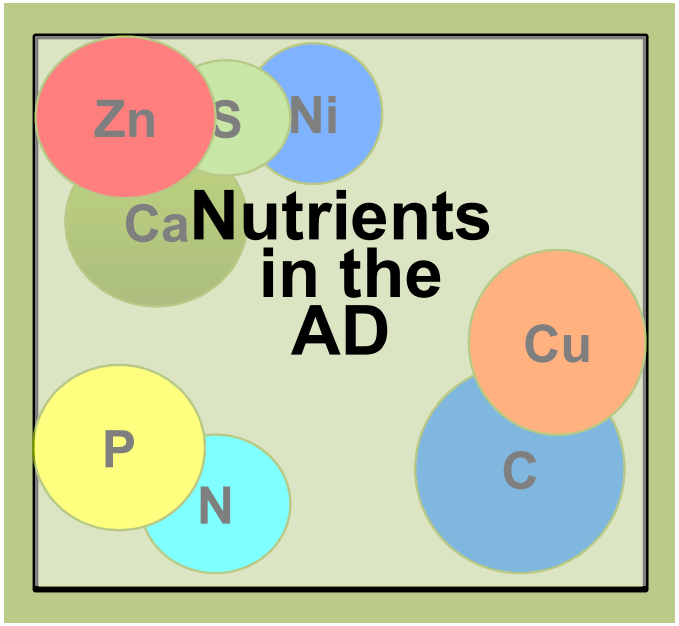
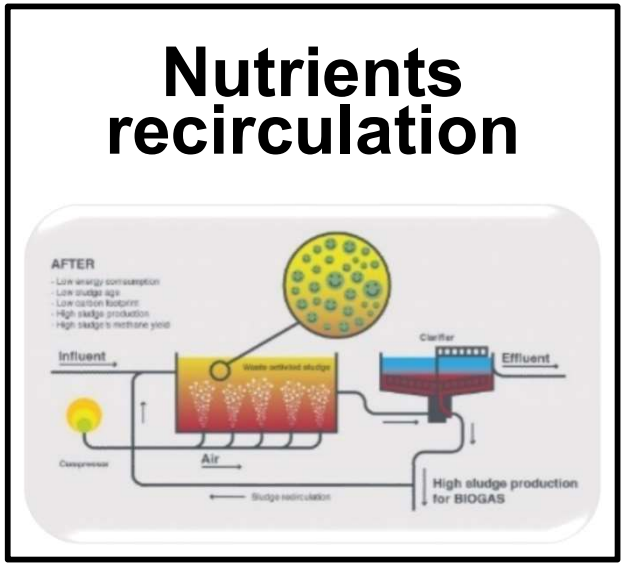
Content





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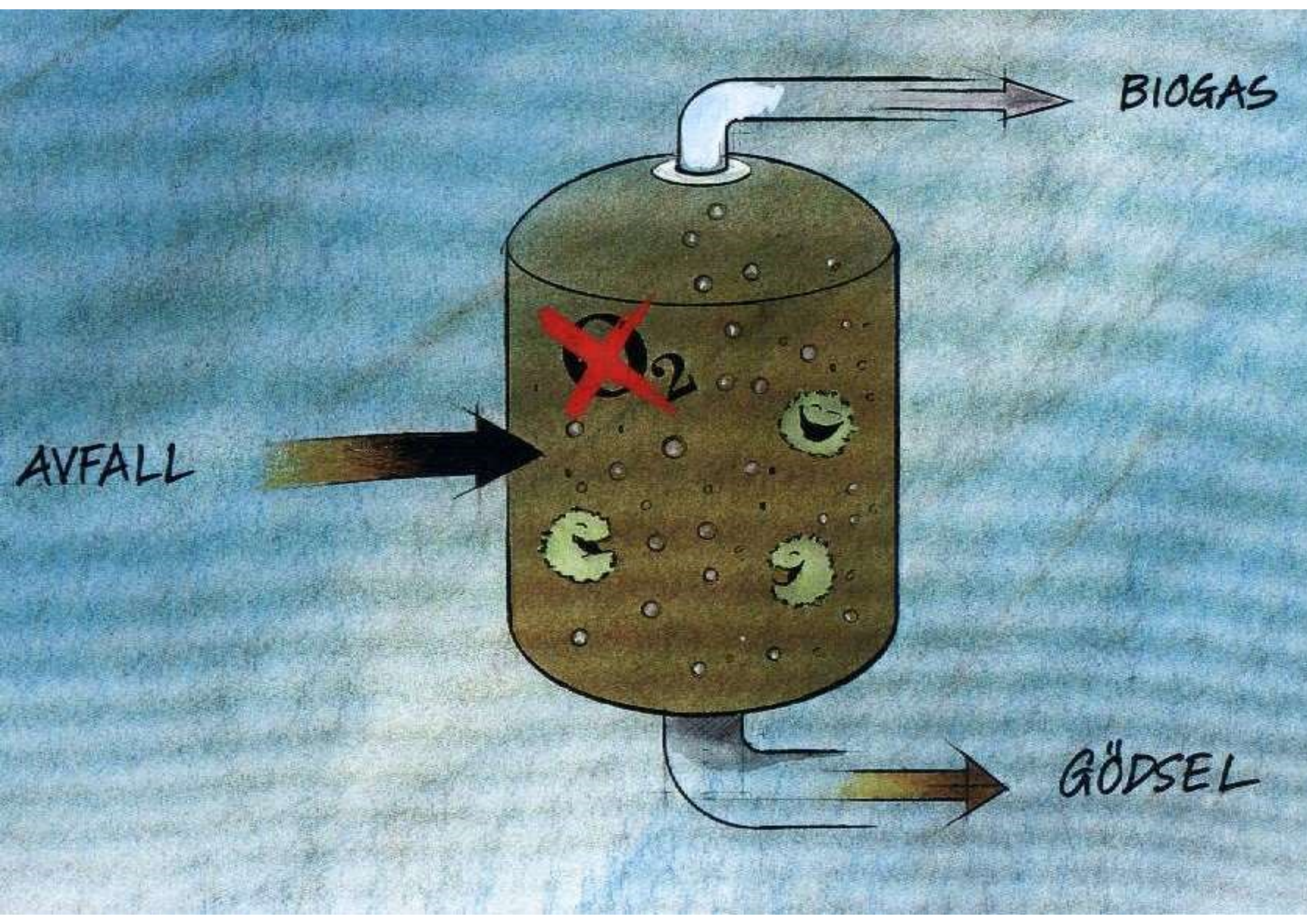
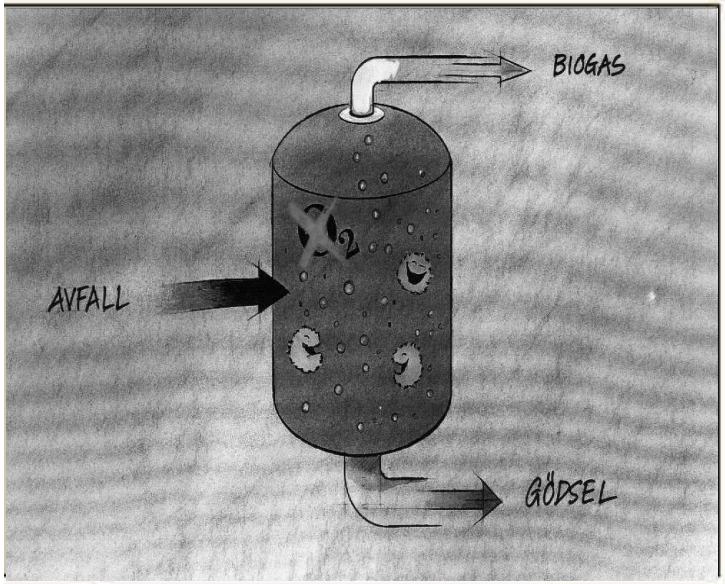

BIOGAS
AVFALL
O_2
GÖDSEL

Breaking news!

THE
SUN SHINE In Poznan

CELEBRITY NEWS AND GOSSIP — WORLD EXCLUSIVES

THE ANAEROBIC DIGESTION: IT'S A BIOLOGICAL PROCESS!



Million of bacteria generate methane from waste - is this possible in 2017?

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NYPD: "We are on RED ALERT for alien invasion" (Pag. 5)

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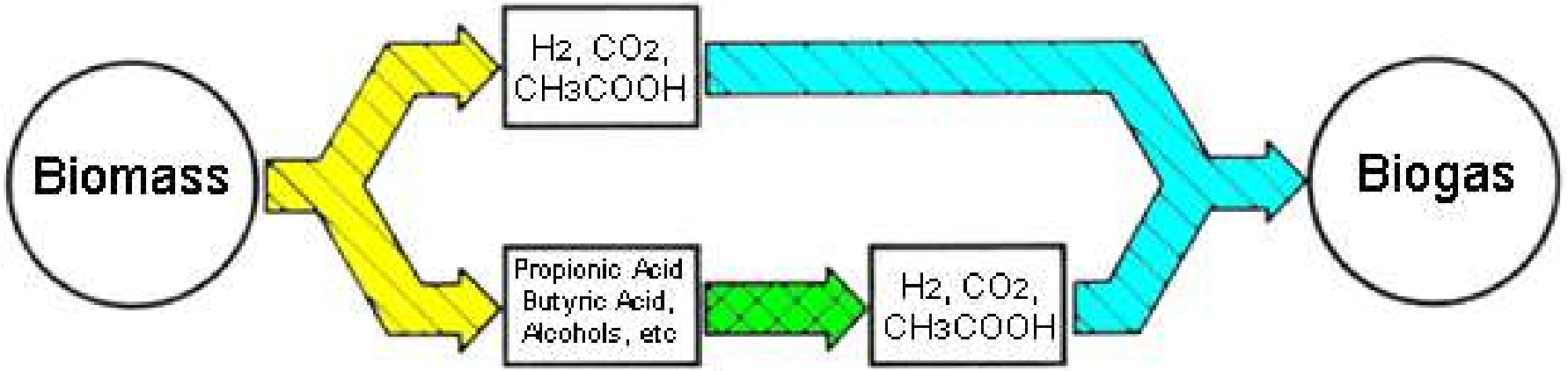
The AD process



Acidogenic bacteria

Acetogenic bacteria

Methanogenic bacteria

http://www.wtert.eu/global/images/doki/Anerobic_Decomposition_Bacterias.PNG

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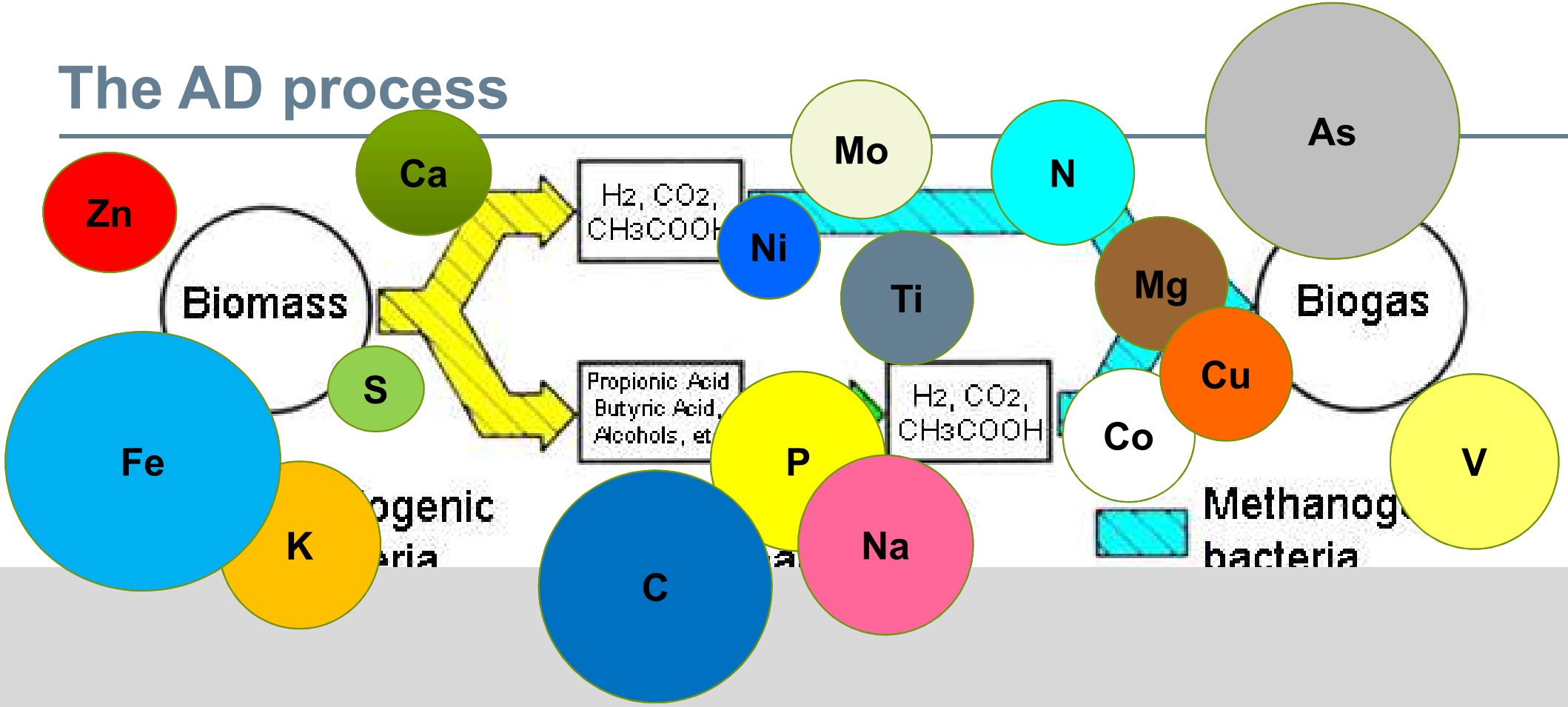
The AD process



The AD process requires "nutrients" to secure microbial growth for efficient biomass degradation and methane production.

Nutrients could make the difference!

Courtesy of Tekniksa Verken, Linköping.

Courtesy of Tekniksa Verken, Linköping.

N and P in the AD process

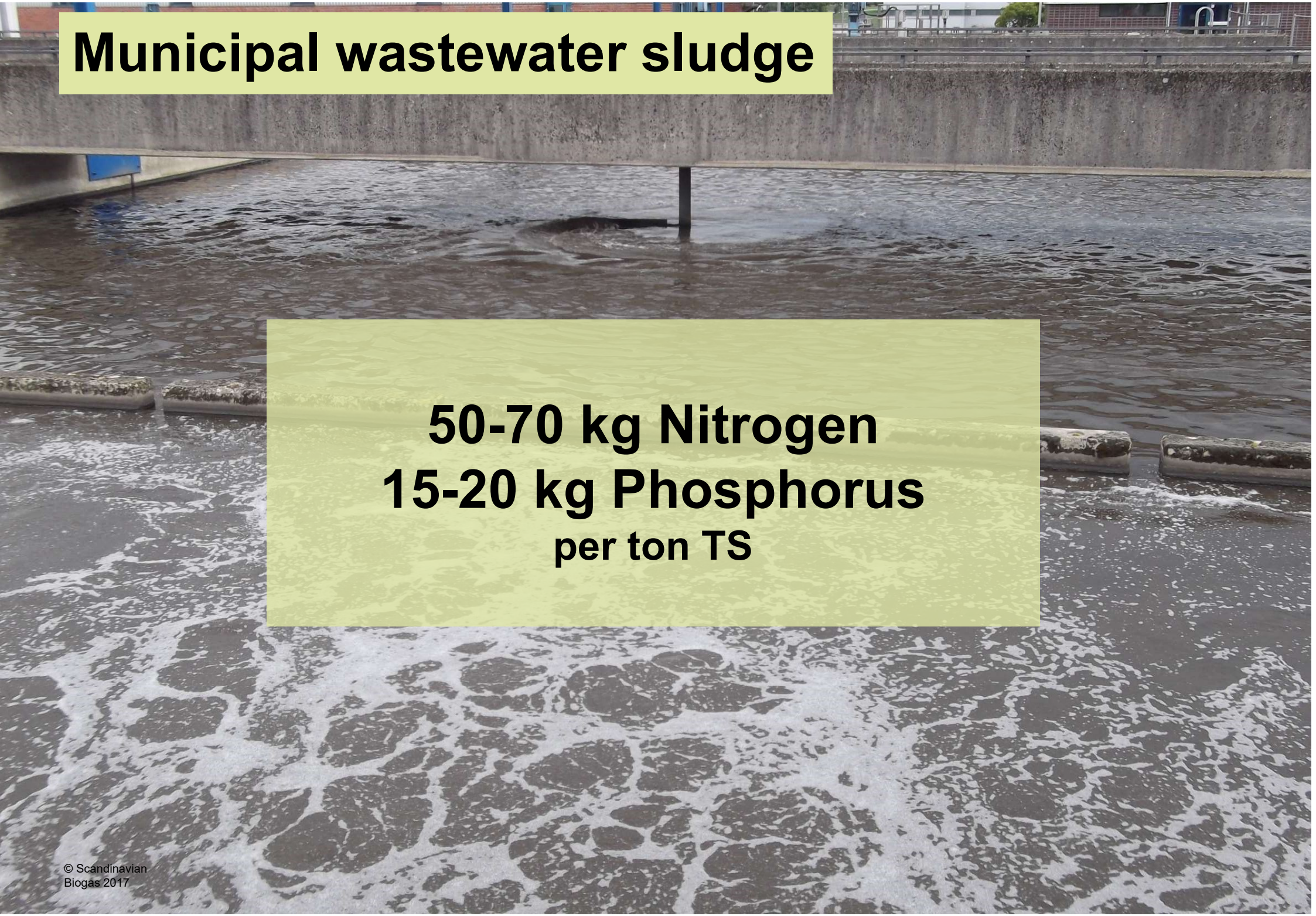
N

- N enters the digester mainly in two forms: ammonium or organic N.
- Organic N is converted to ammonium during protein degradation.
- The microorganisms in the digester requires some **N to secure microbial growth.**
- Excess of nitrogen is common (accumulation).
- Total N into the digester will equal the total N leaving the digester.

P

- The microorganisms in the digester requires some **P to secure microbial growth.**
- Some P can be converted to ortho P (a soluble form) in the digester.
- Total P into the digester will equal the total P leaving the digester .

Municipal wastewater sludge

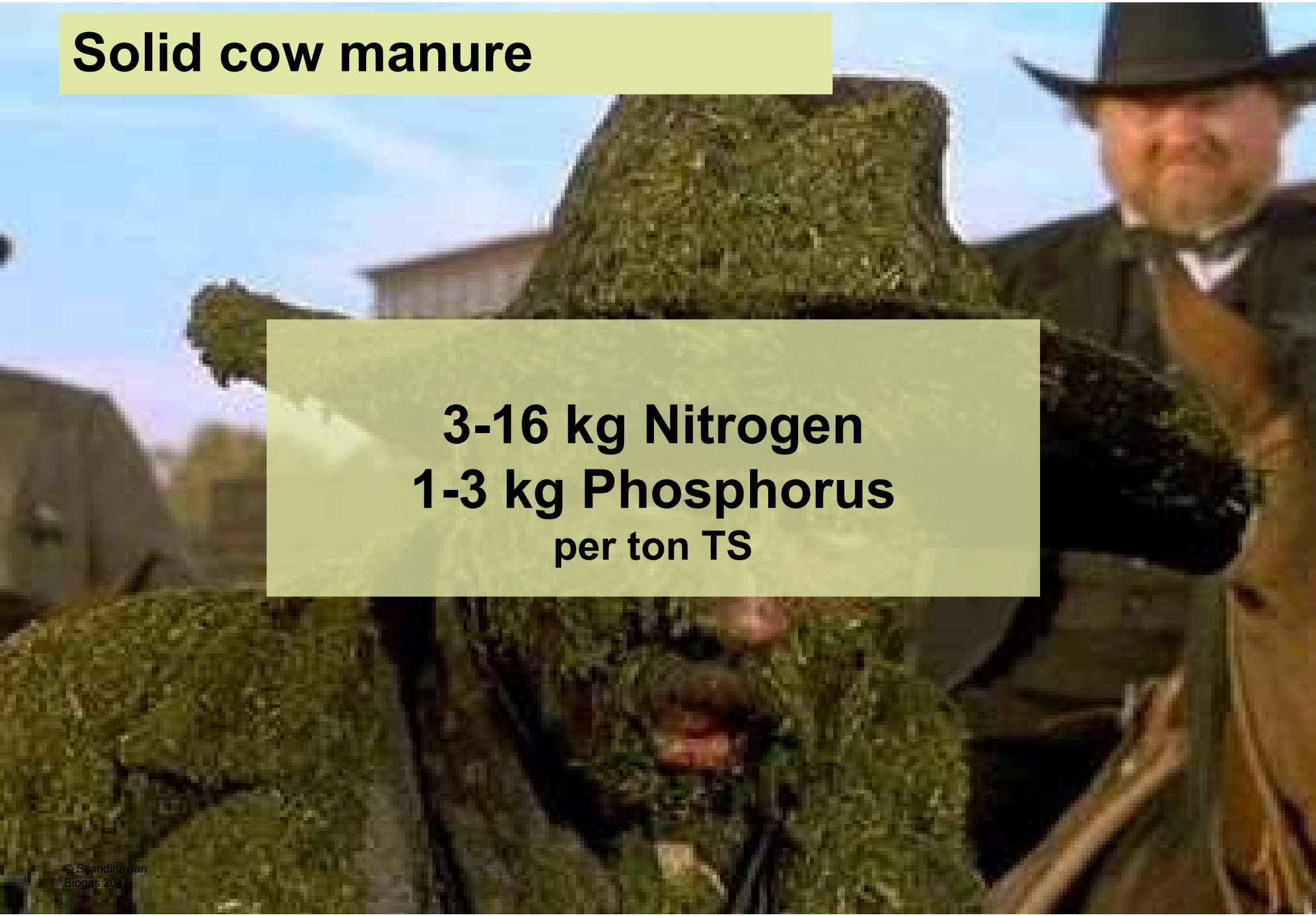


50-70 kg Nitrogen
15-20 kg Phosphorus
per ton TS

Municipal food waste

20-50 kg Nitrogen
3-8 kg Phosphorus
per ton TS

Solid cow manure



3-16 kg Nitrogen
1-3 kg Phosphorus
per ton TS

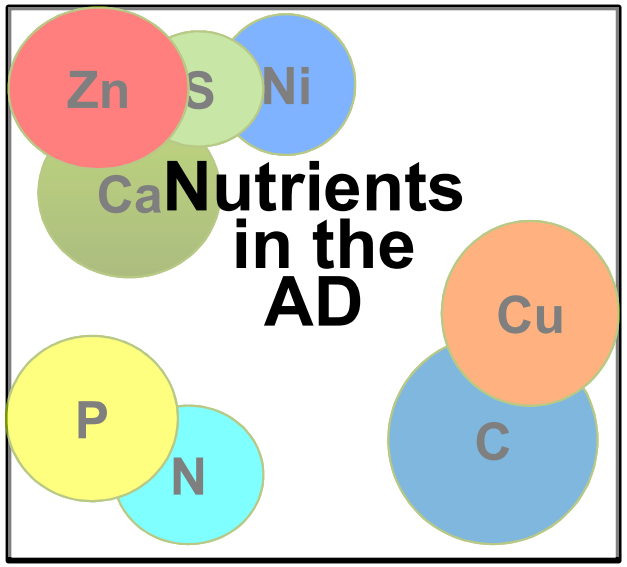
Fish waste

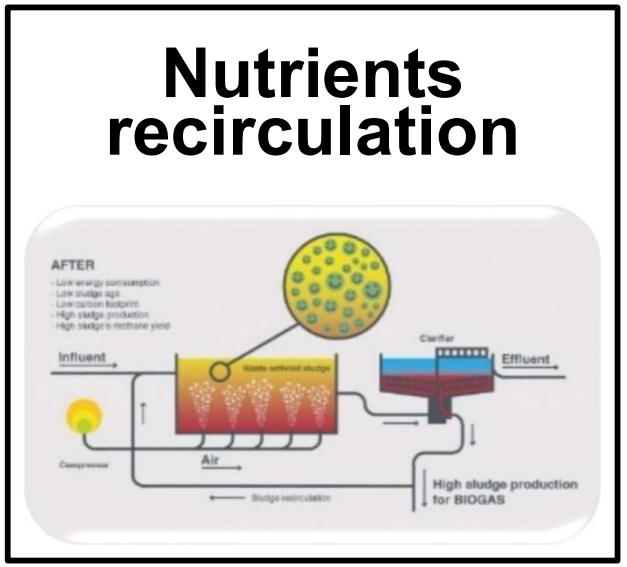
60-70 kg Nitrogen
9-12 kg Phosphorus
per ton TS

Take home message

- Nutrients/elements are fundamental for the AD process.
- Lack of individual elements could lead to process failure and major disruption of infrastructure and equipment.
- N and P are fundamental for the microbial growth (building new biomass), however they are often (BUT NOT ALWAYS) in excess.

Content





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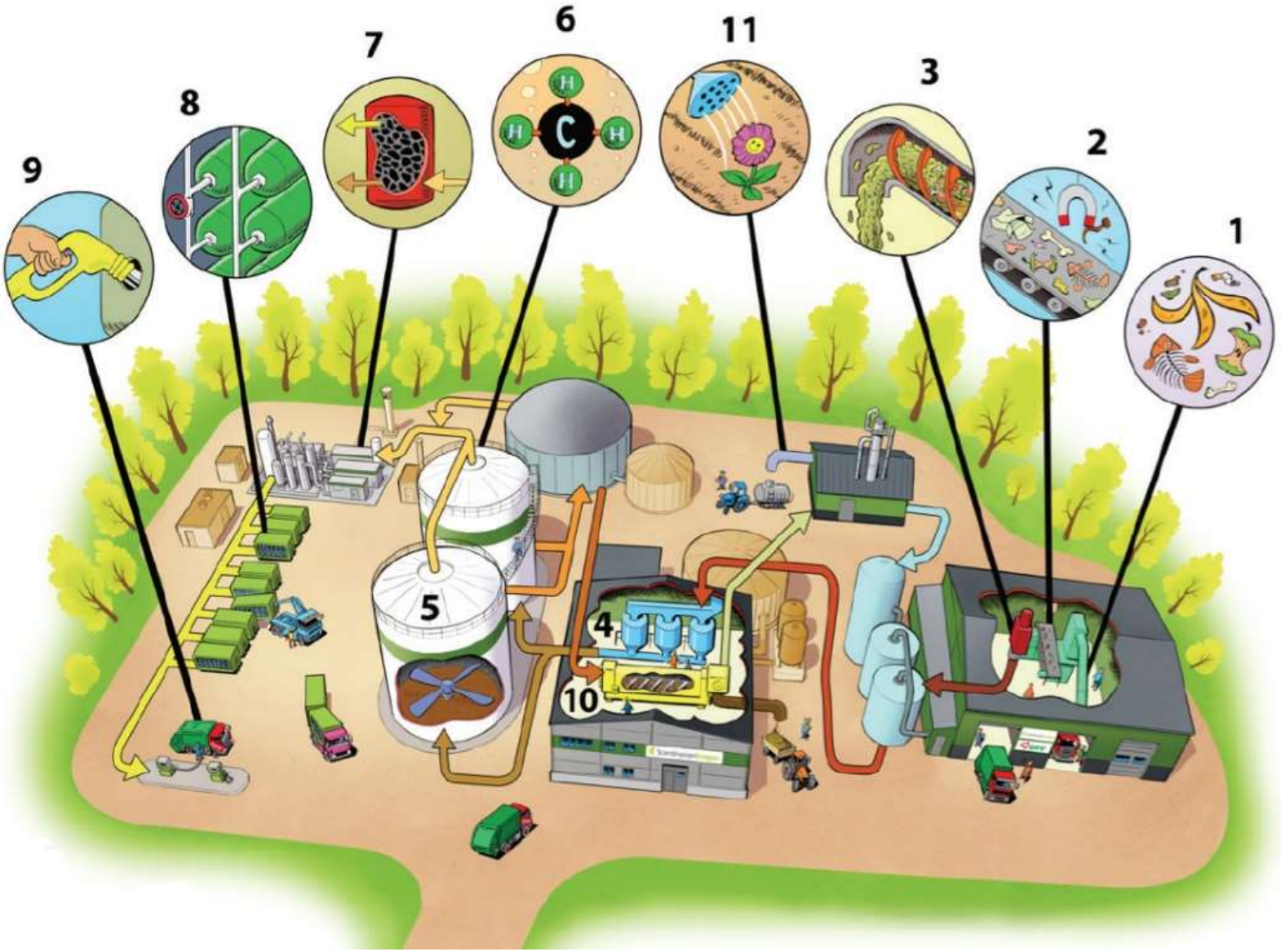
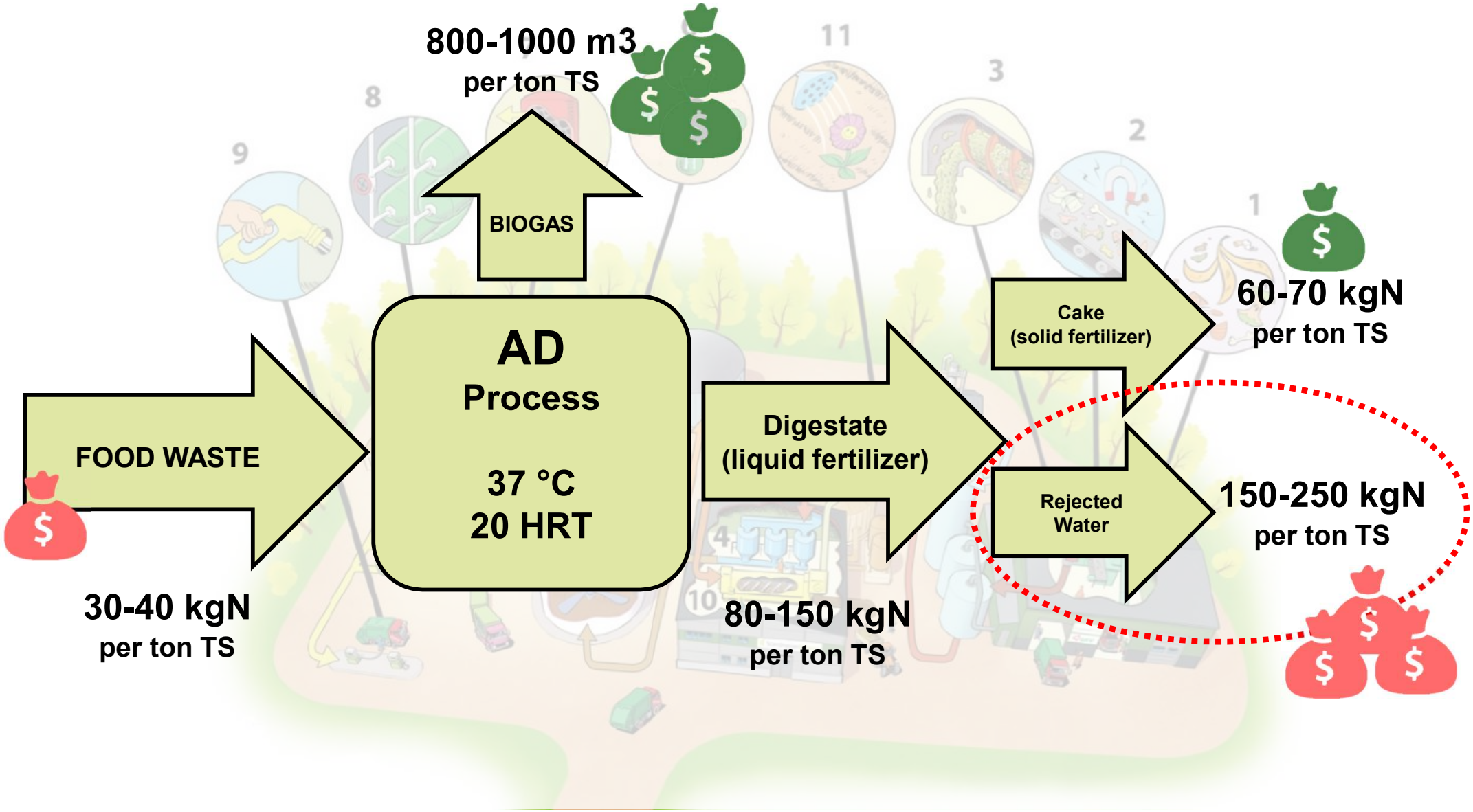


Food waste for AD: conventional process



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Observations (from experience at SBSö)

- Nutrients “disposal” is expensive.
- Digestate for fertilizer provide an income but it requires local demand.
- Concentrated nutrients requires a market.

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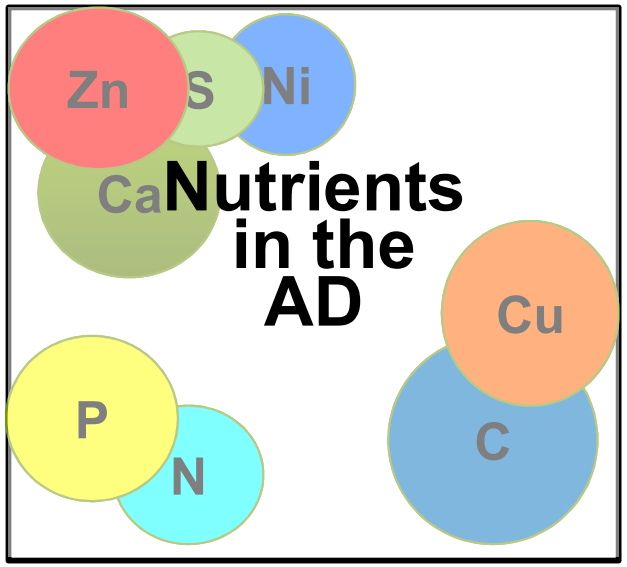

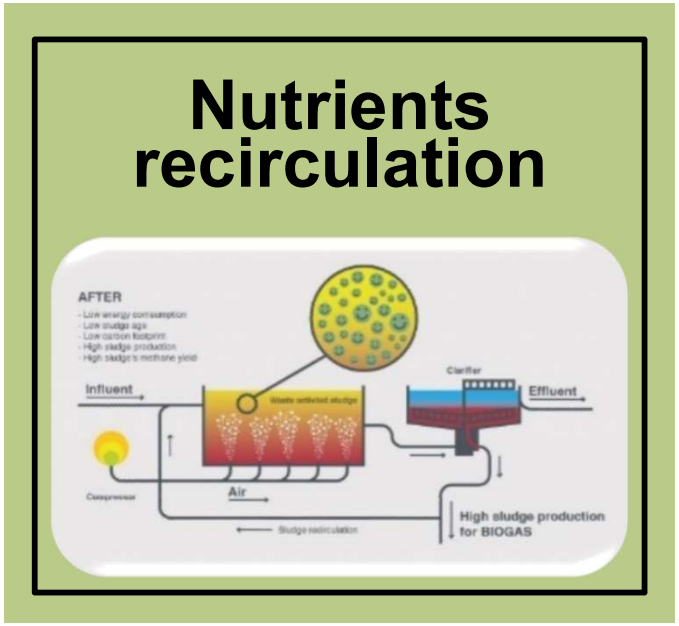

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Alternative

WHERE AND HOW DO WASTE NUTRIENTS BECOME A RESOURCE?

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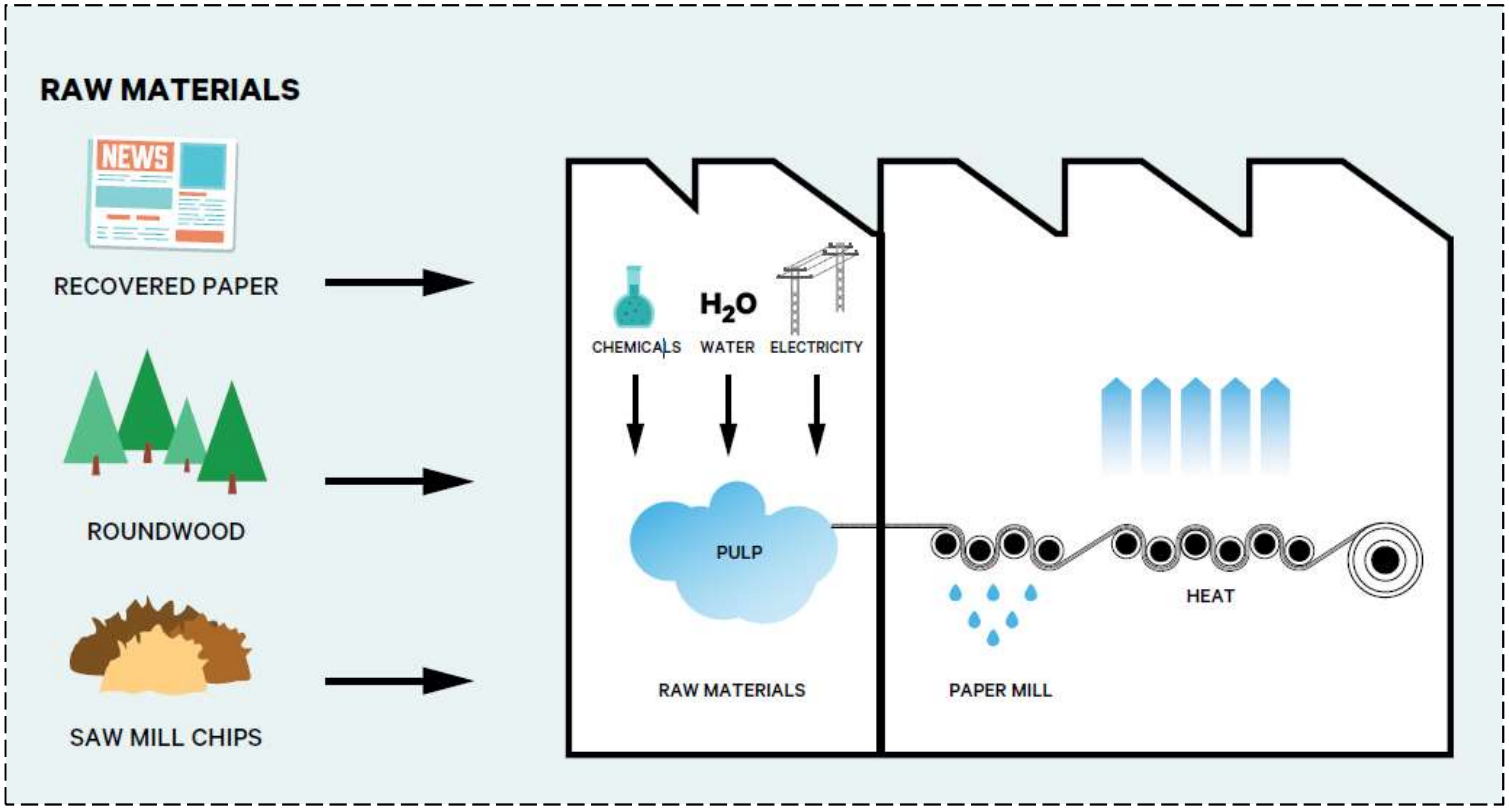
The pulp/paper production process



FINAL PRODUCTS

PROCESS WASTEWATER (enriched in C – low in N and P)

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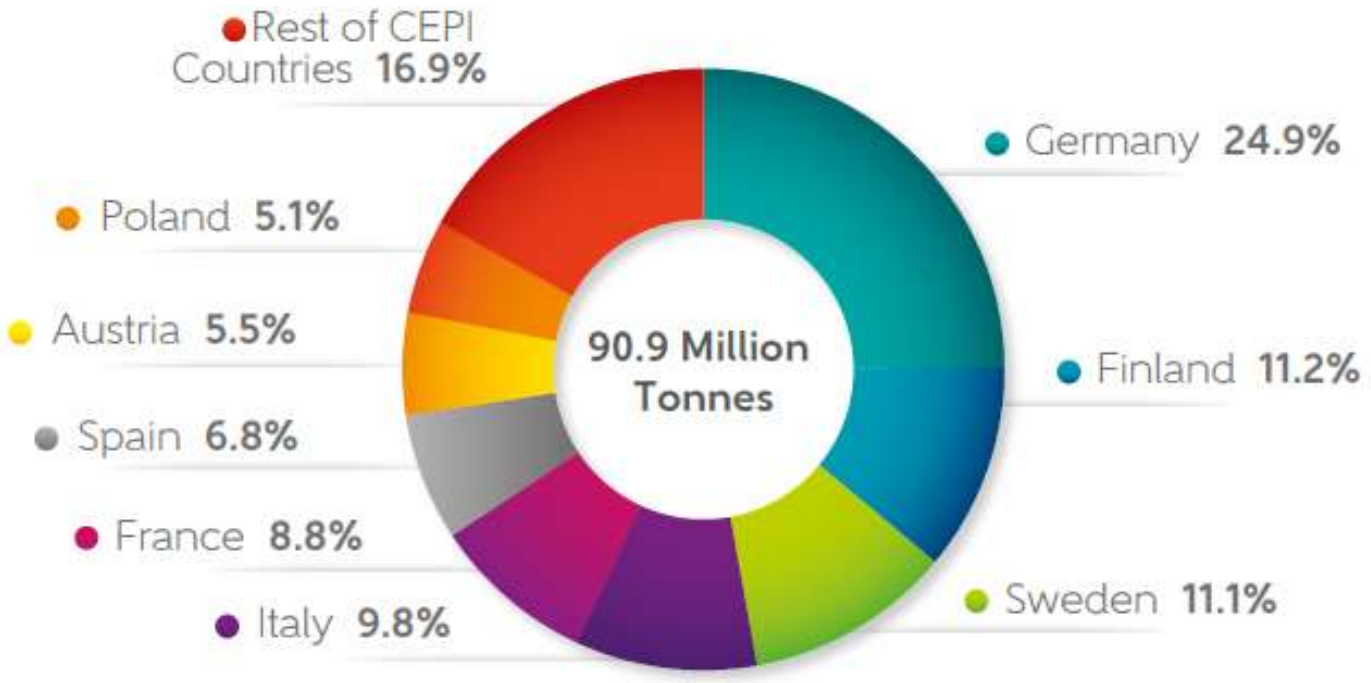
Pulp and Paper Industry (PPI) in Europe

903 active mills

81 000 Million Euro turnover

15 m^3 wastewater per ton product



Paper and Board production

(data from CEPI, June 2017)

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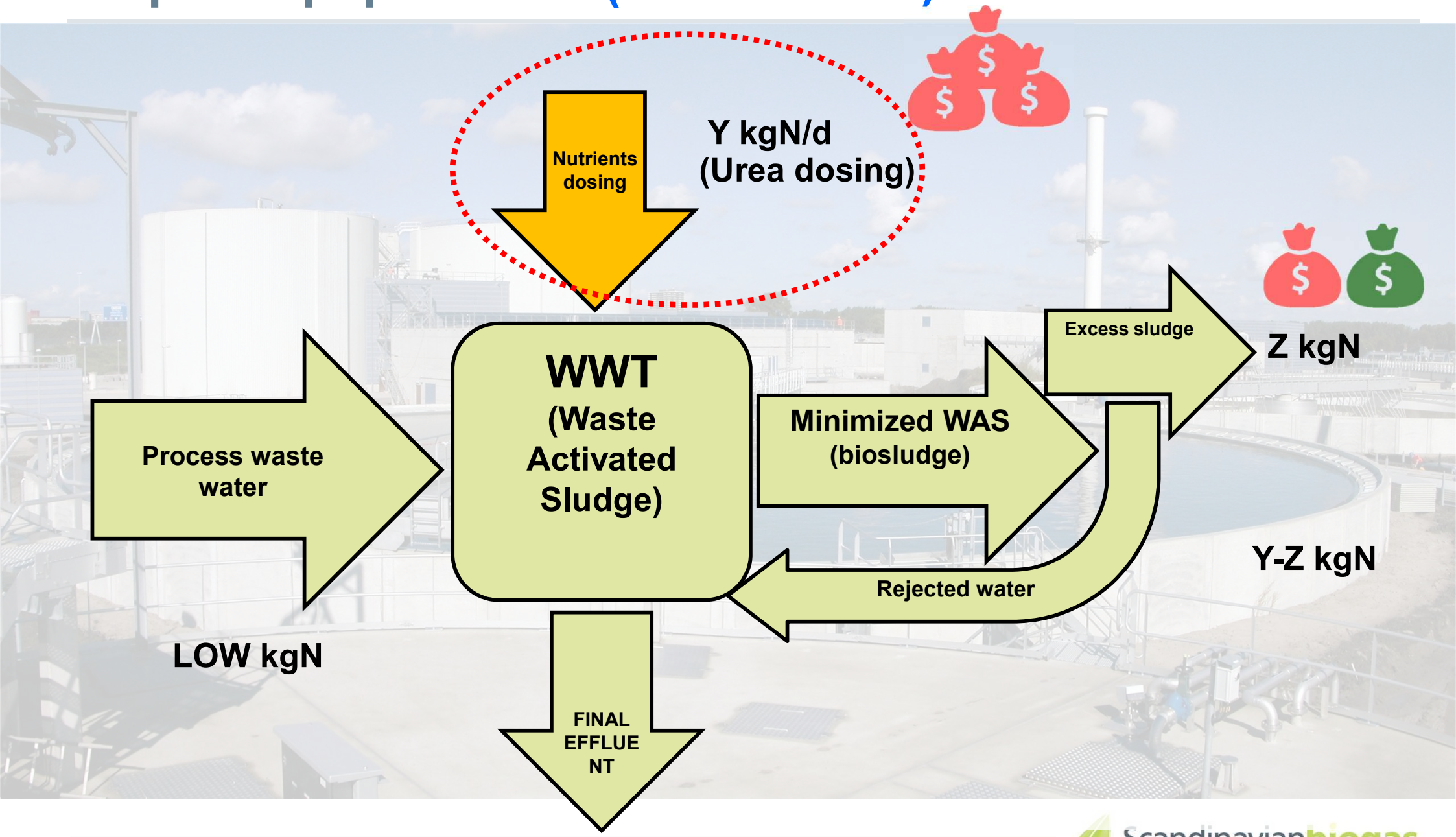
Pulp and paper WWT (PROCESS 1)



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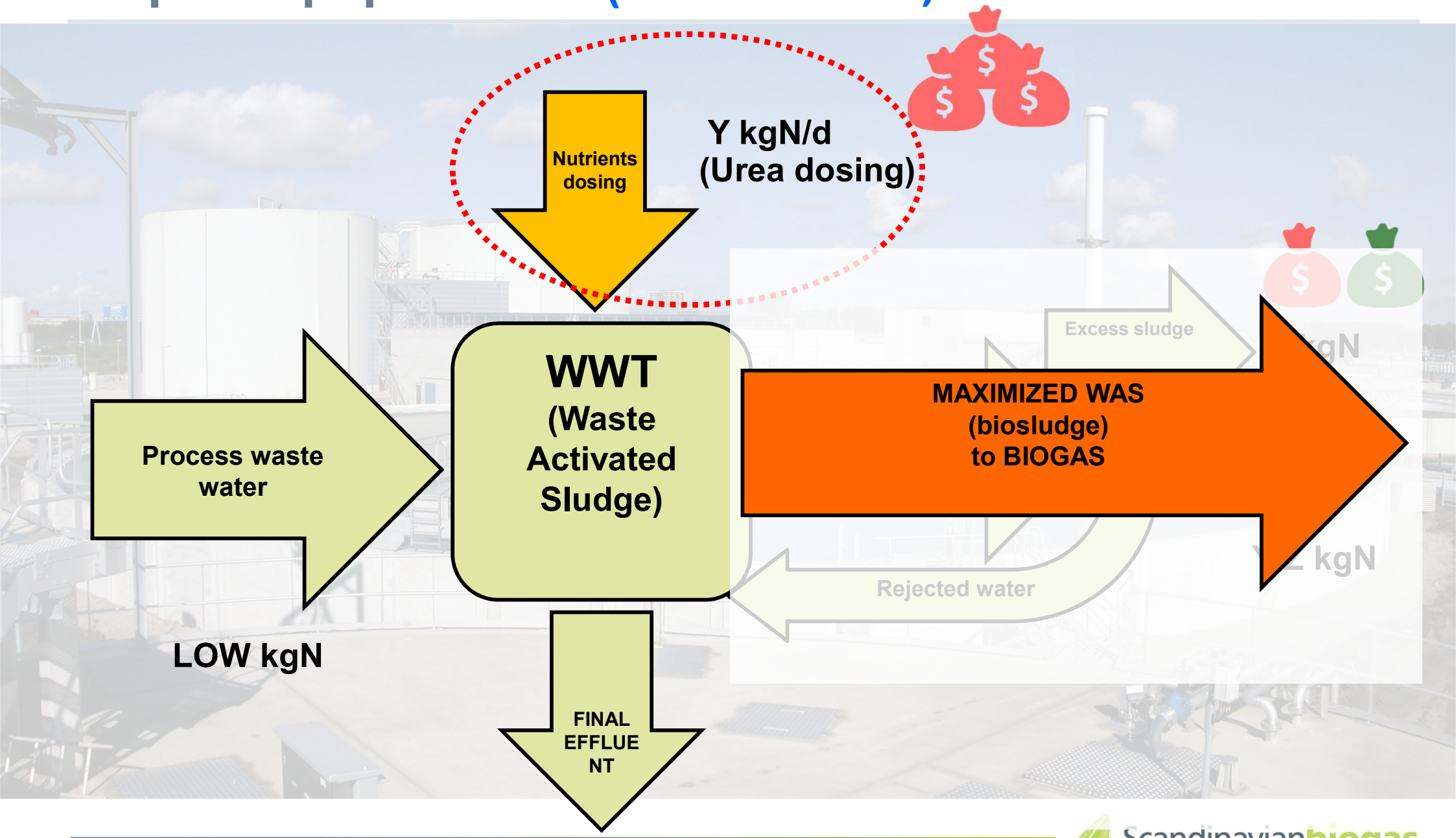
Pulp and paper WWT (PROCESS 1)



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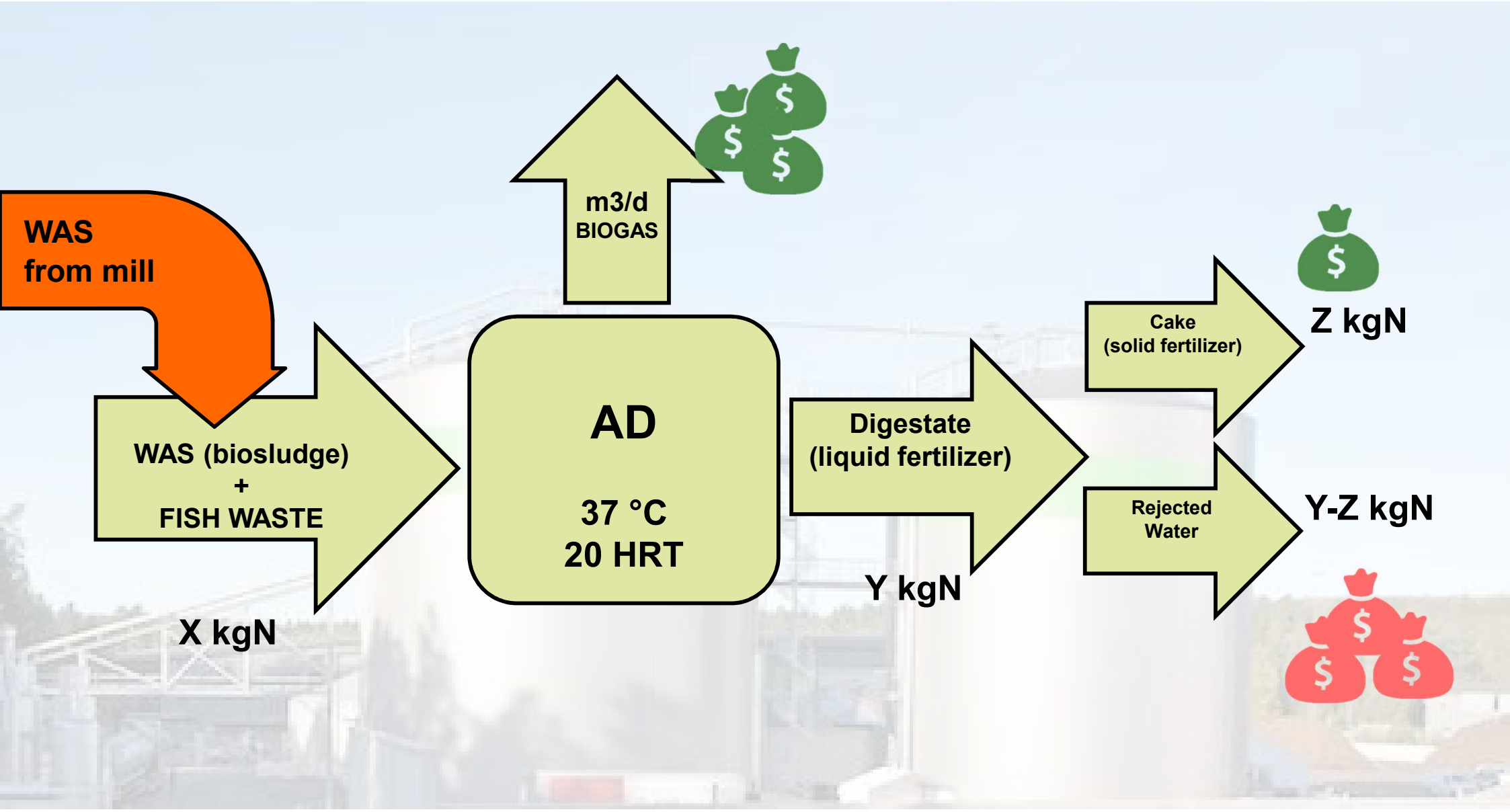
AD plant treating WWS + Fish (PROCESS 2)



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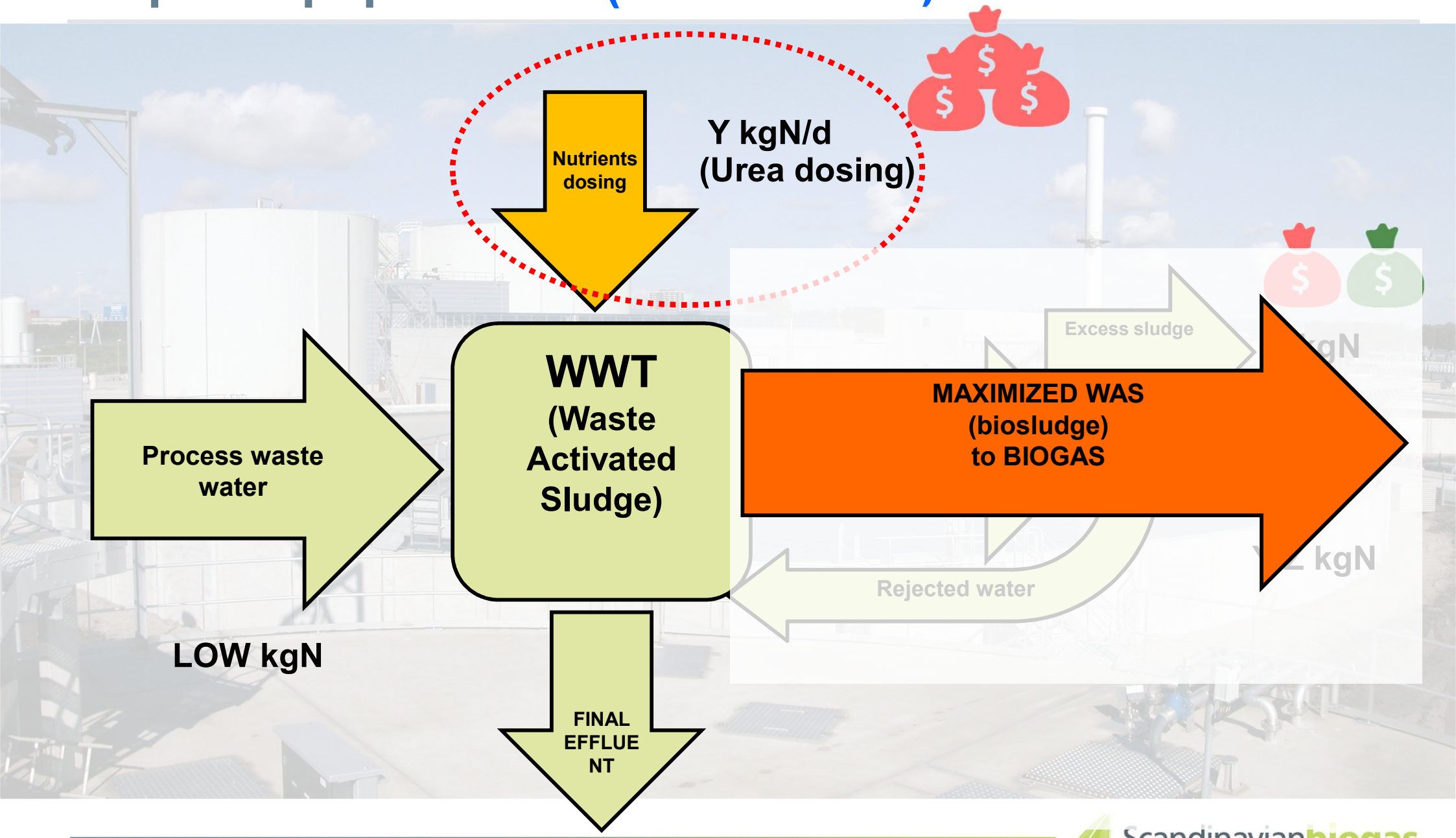
Pulp and paper WWT (PROCESS 1)



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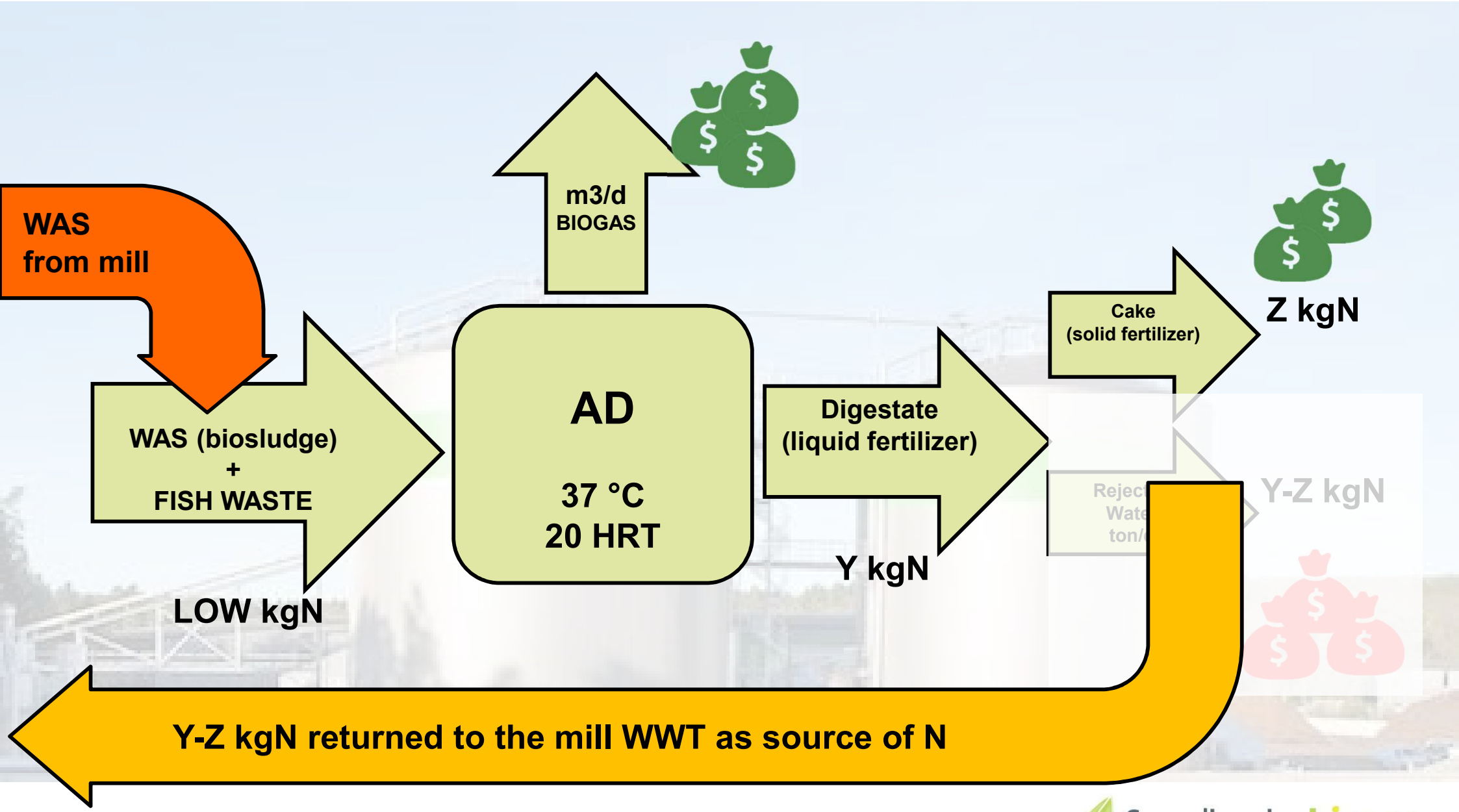
AD plant treating WWS + Fish (PROCESS 2)



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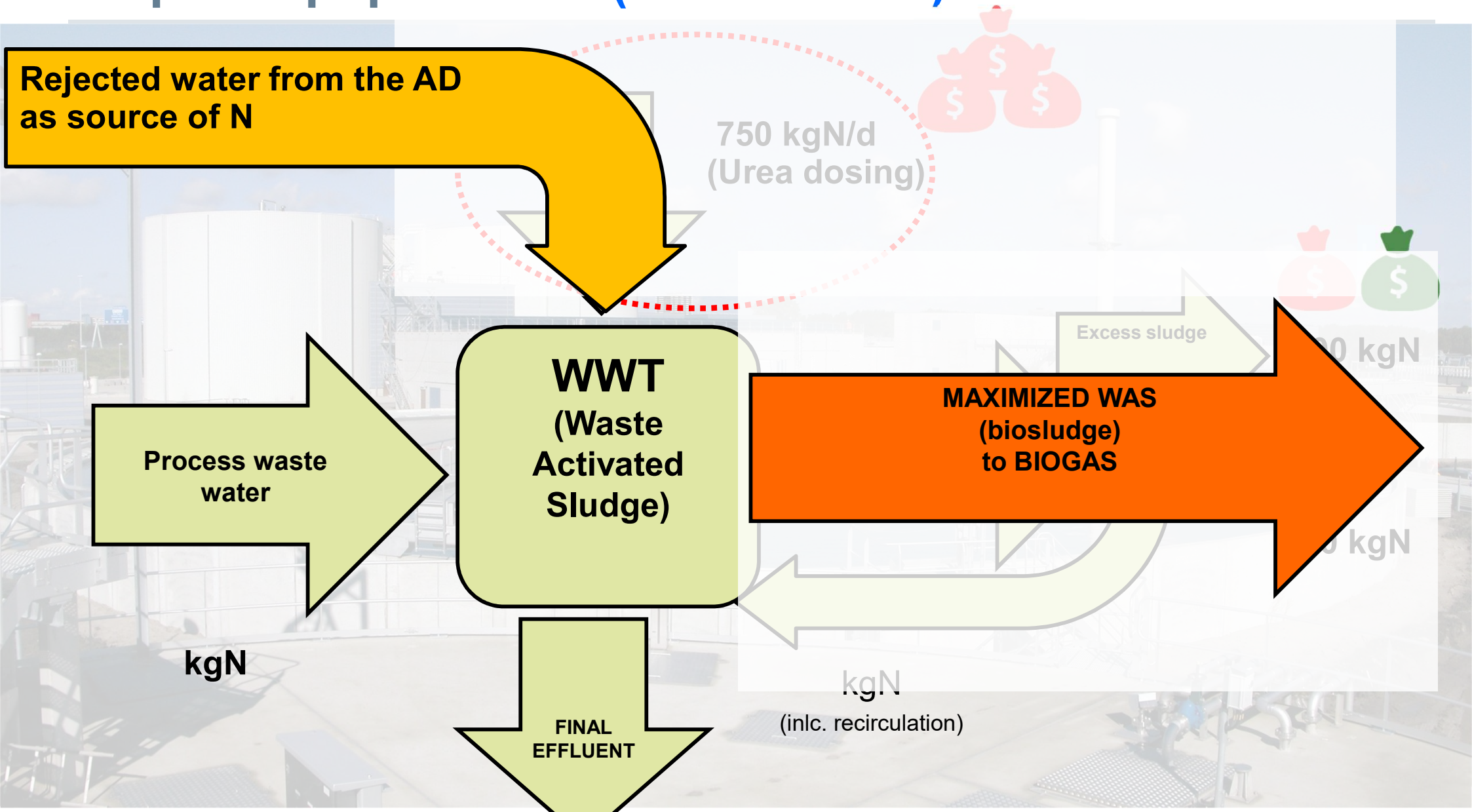
Pulp and paper WWT (PROCESS 1)



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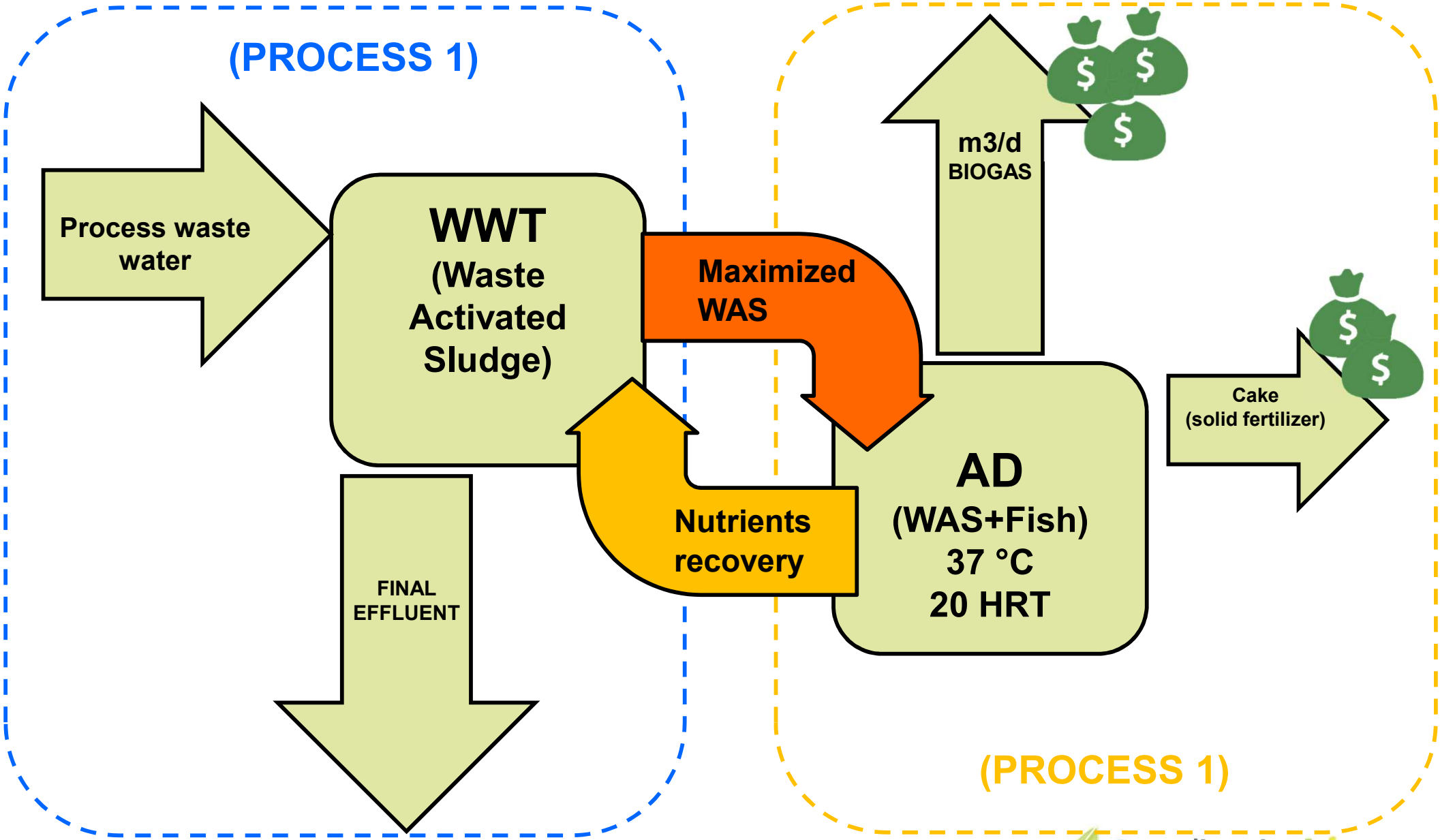
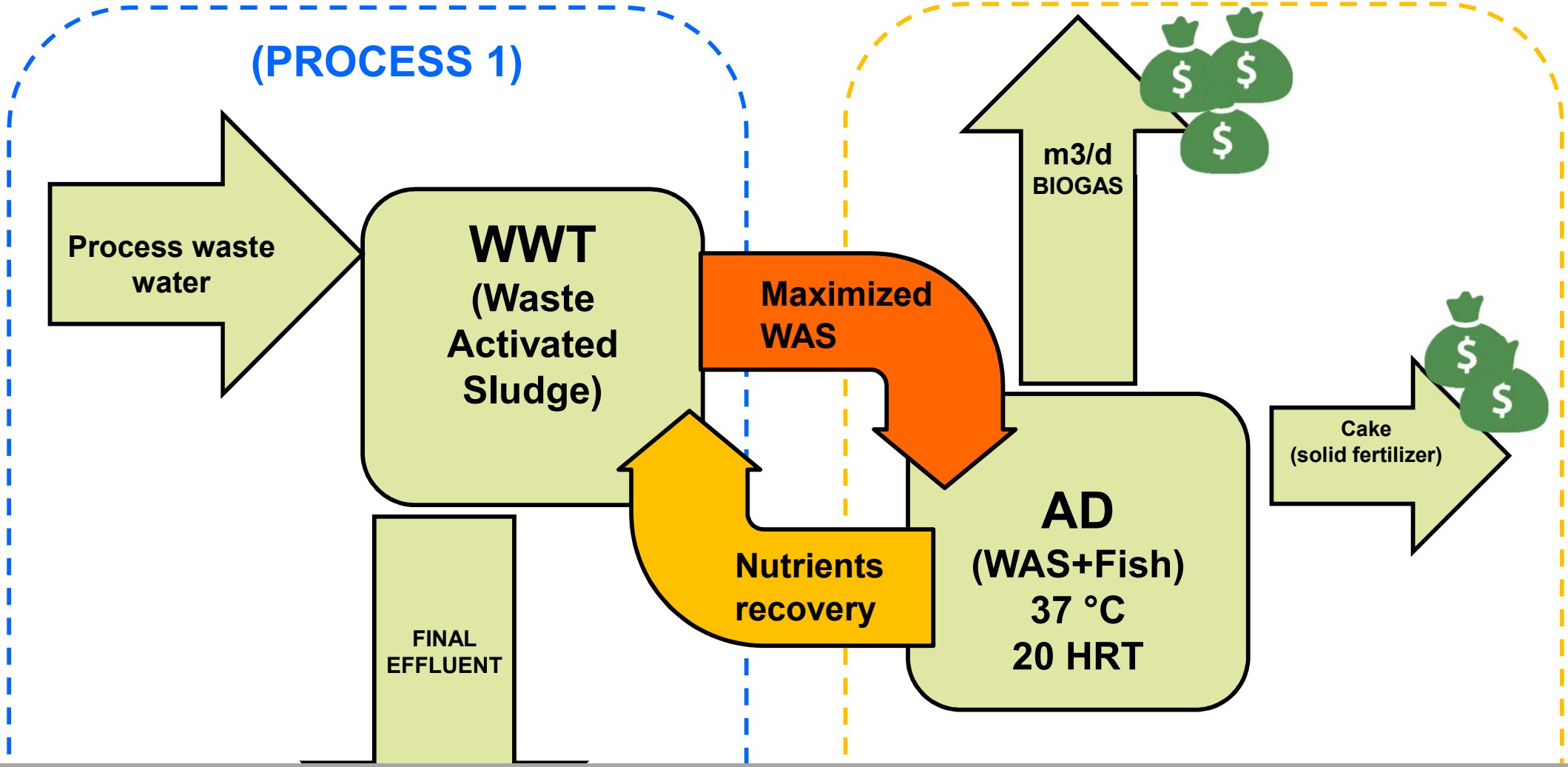
Integrated process (WWT+AD)

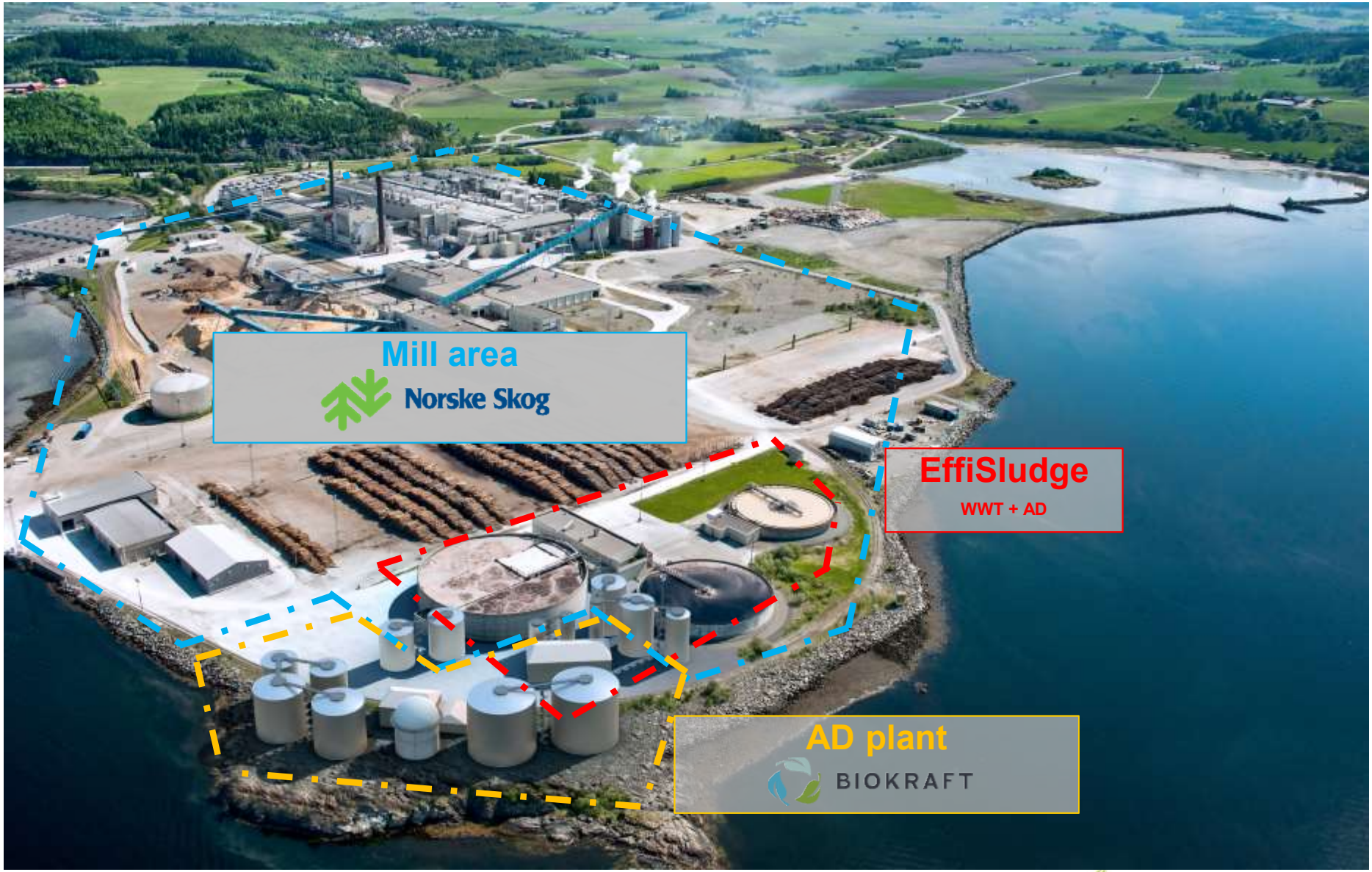


Integrated process (WWT+AD)



INDUSTRIAL SYMBIOSIS

The Skogn case (Norway)



Demonstration project (ongoing)

EffiSludge 4 Life

For a sustainable and energy efficient pulp and paper industry

2015-2019

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BIOKRAFT

Norske Skog

BIOKRAFT

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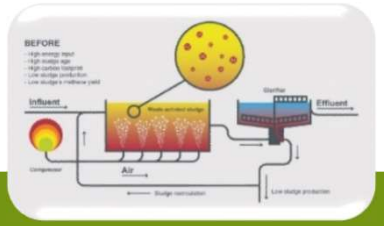
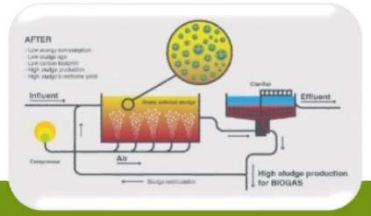
Expected impact on WWT

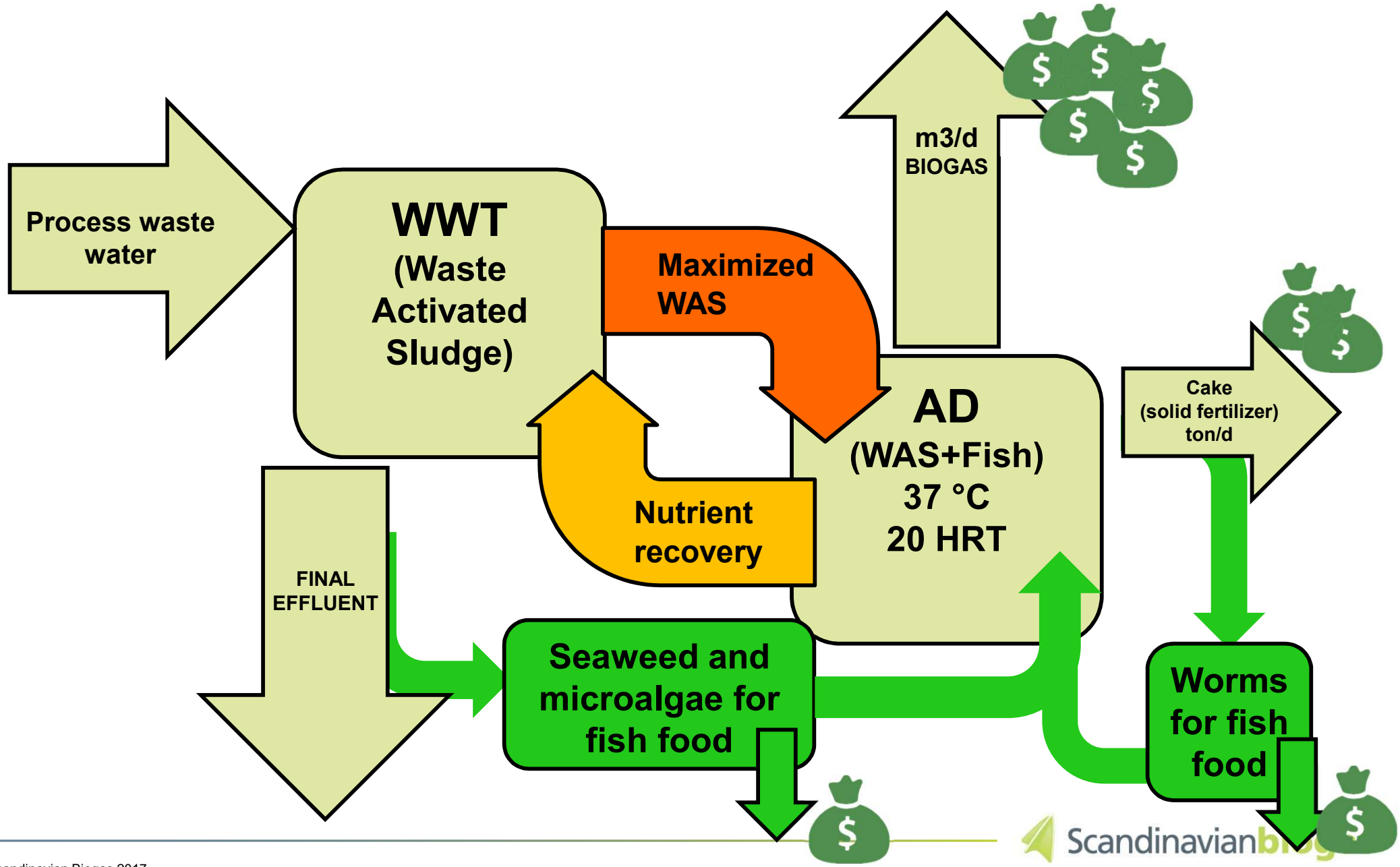




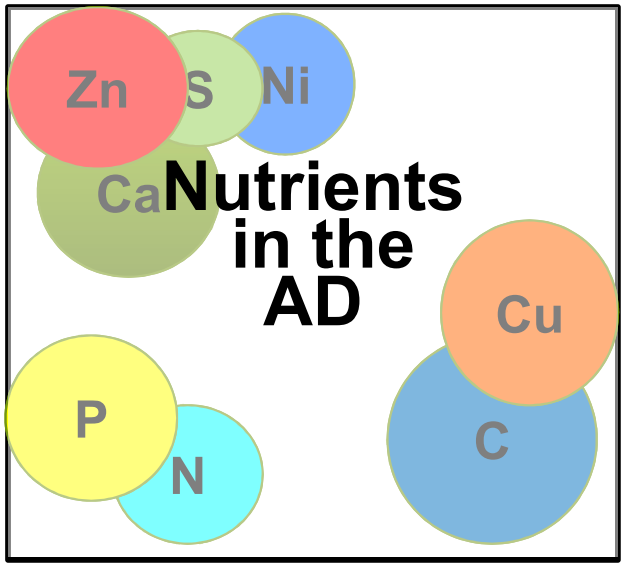
PARAMETERS	TODAY VALUES	EXPECTED VALUES (2019)
Sludge age (d)	**18**	**<10**
Energy demand (MWh/d)	**25**	**<15**
WAS production (kg SS/kgCODred)	**0.22**	**0.35-0.45**
BMP value (Nm3/ton VS)	**100**	**160**
Nutrient recirculation	**NO (external addition)**	**YES (from AD rejected water)**
Carbon footprint (kgCO2eq/ton newsprint)	**15**	**8**

The COMPLETE project

The Research Council of Norway

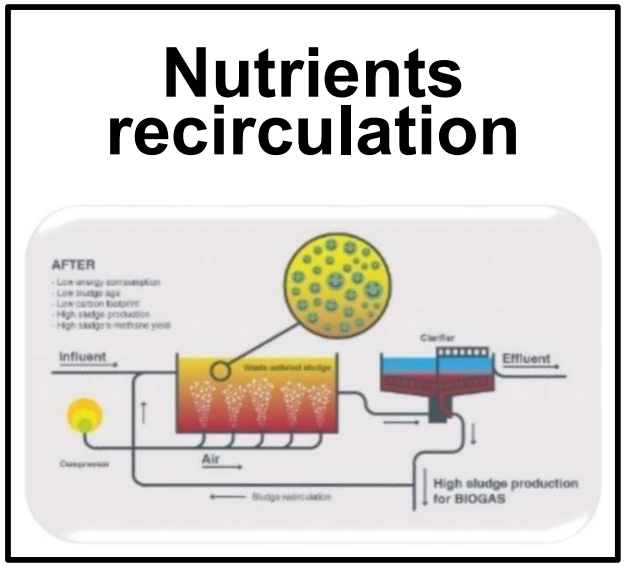


Summary



- Nutrients are essential. N and P are often in excess (only partially utilized for microbial growth).
- N and P introduced equal N and P in the output.

- Conventional AD practice leave the N issue to the downstream processes.
- High costs impacts the feasibility/profitability of the AD plant.



- Smart thinking to support industrial symbiosis.
- Green economy helps to identify optimal realities when “dream” comes true.

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Thanks for listening!

http://scandinavianbiogas.com/effisludge/

https://twitter.com/EffiSludge

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