

Sustainable materials and energy from sewage sludge

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ECN acts as a bridge between science and corporate innovation



Mission

We develop knowledge and technologies that enable a transition to a sustainable energy system



Not-for-profit research institute

Founded in **1955**

5 Commercial licensing deals / year

500 Employees

+/-20 patents a year

€ 80 M annual turnover



Petten Energy Research Campus



~275
employees



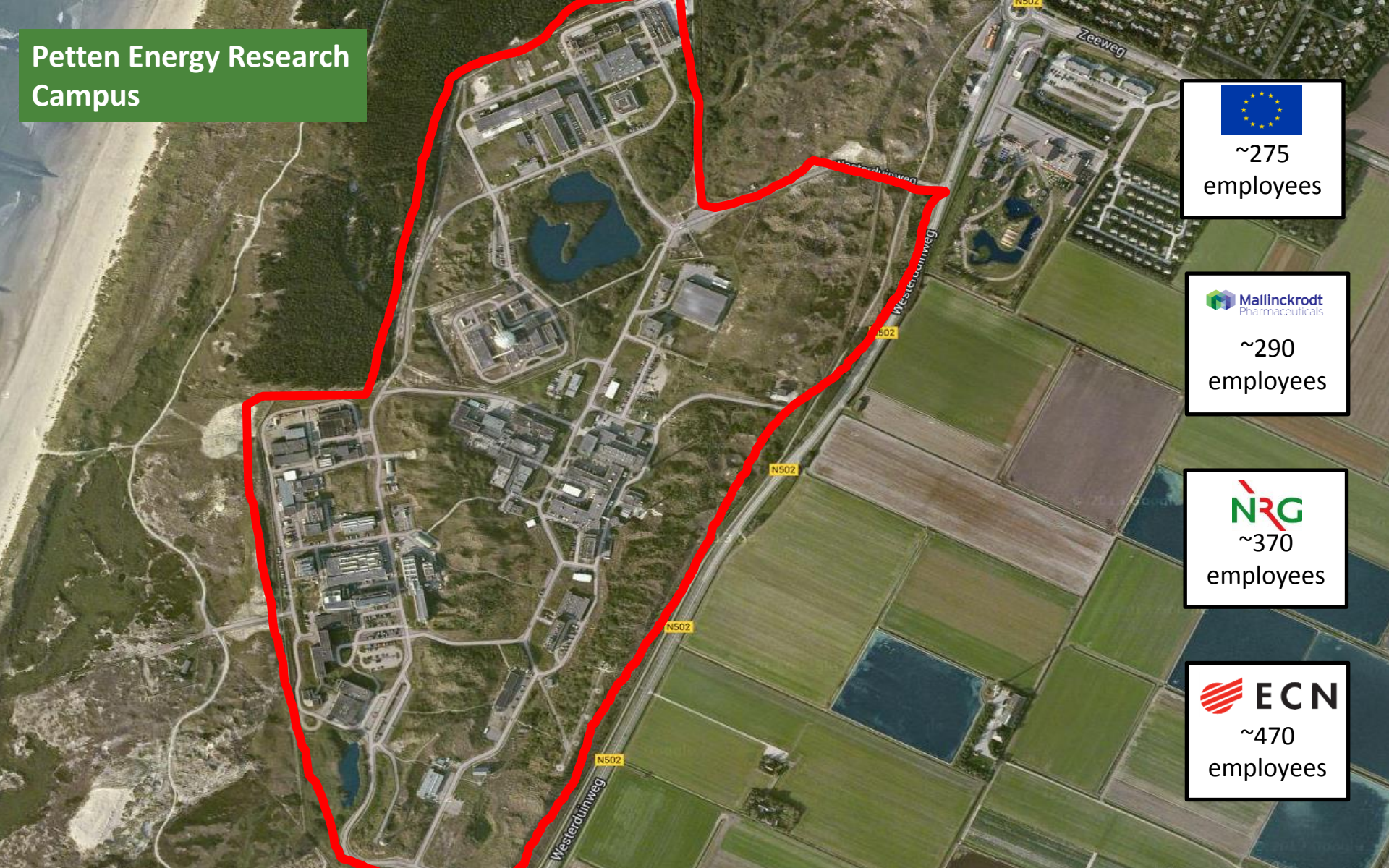
~290
employees



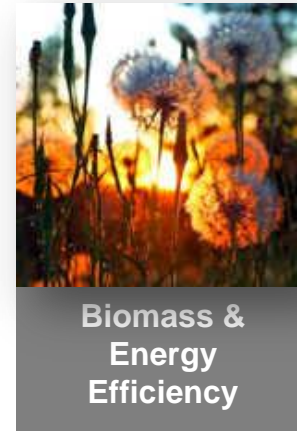
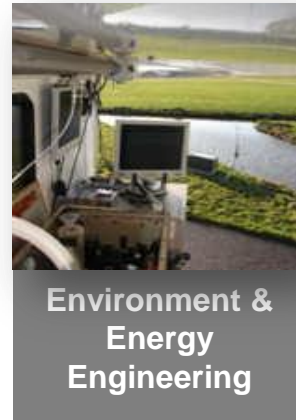
~370
employees



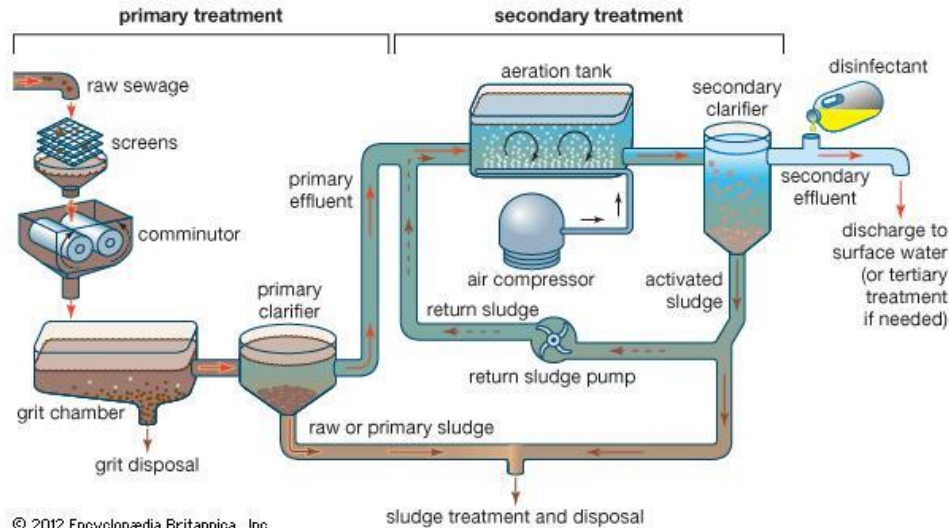
~470
employees



ECN Units



What is sewage sludge?



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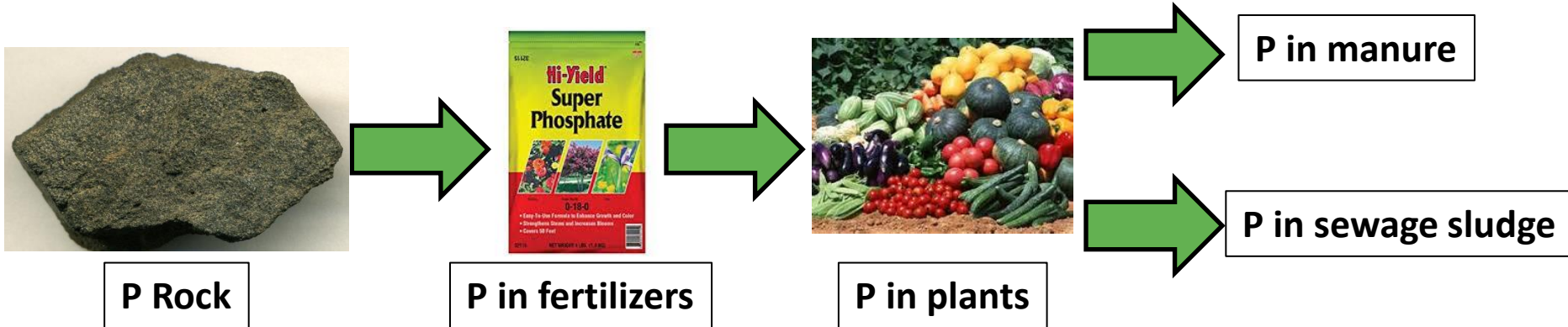
- By-product of sewage treatment
- It can be
 - digested
 - landfilled
 - incinerated
 - applied on agricultural land
- In The Netherlands 356 WWTPs produce 1.5 Mton/year sewage sludge

Legislation changes cause increase in amount of sludge

- Legislation and Codes of Practice restrict disposal
-> avoid soil & water pollution
- ADAS Safe Sludge Matrix (restriction on the type of sewage sludge to land) -> ensure food safety
- Sludge (Use in Agriculture) Regulations 1989 -> ensure food safety
- Sewage Sludge Directive 86/278/EEC
-> encouragement of reuse of sewage sludge
- Urban Waste Water Treatment Directive 91/271/EEC
-> avoid health risks
- EU Landfill Directive 1999/31/EC -> avoid methane emissions

Why is phosphorus (P) important?

- Sewage sludge and manure contain large amounts of phosphorus

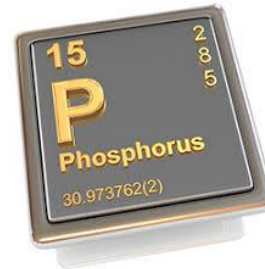


Sewage sludge - The challenges

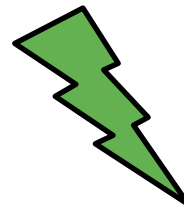
- Reduce the amount of sludge that is produced



- Recover nutrients (phosphorus)



- Maximise energy production



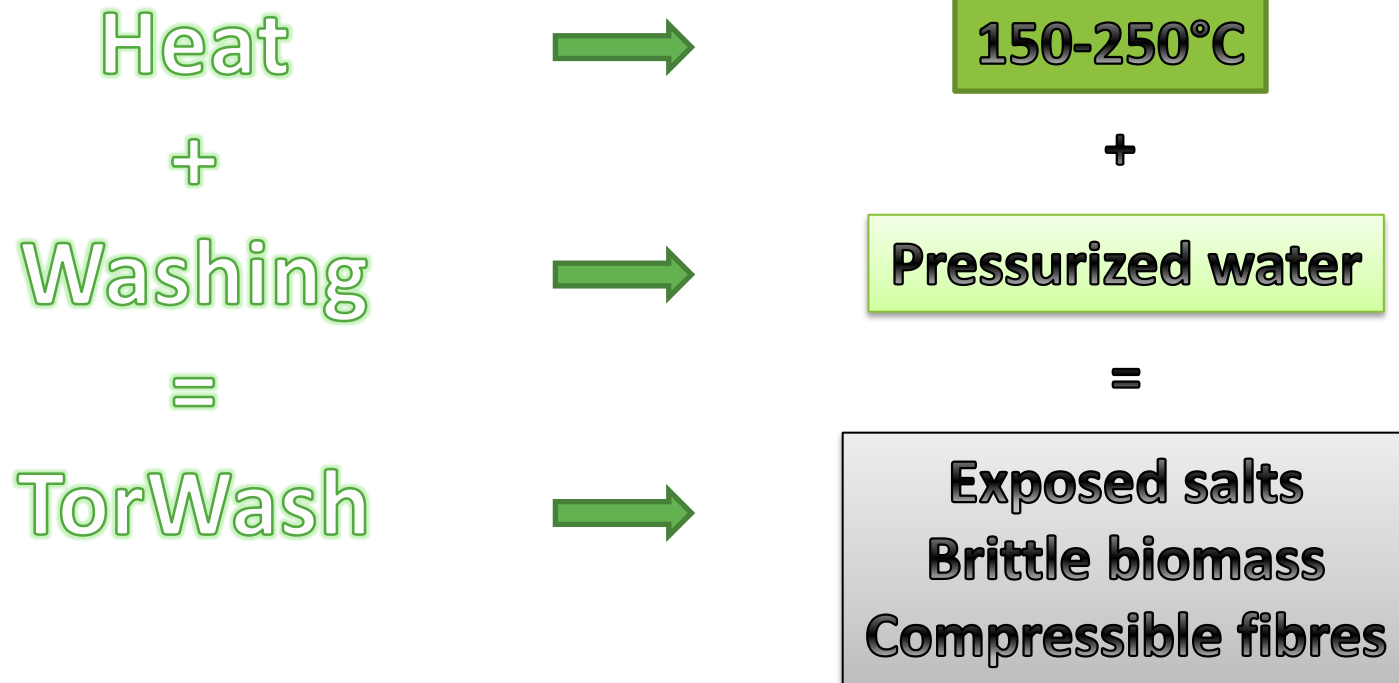
Water Authority Zuiderzeeland

- Population: 400.000
- Largest city: Almere
- 5 sewage treatment plants
 - with digestion
 - without digestion
- 56,000 ton/year sewage sludge
- “Sewage is not a waste stream but a source for sustainable energy, materials and clean water”

**ENERGIE EN
Grondstoffen
FABRIEK**



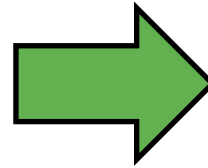
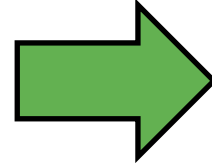
What is TORWASH[®]?



TORWASH[®] = Wet torrefaction + Washing



Sewage Sludge



Liquid Effluent



Solid Biofuel

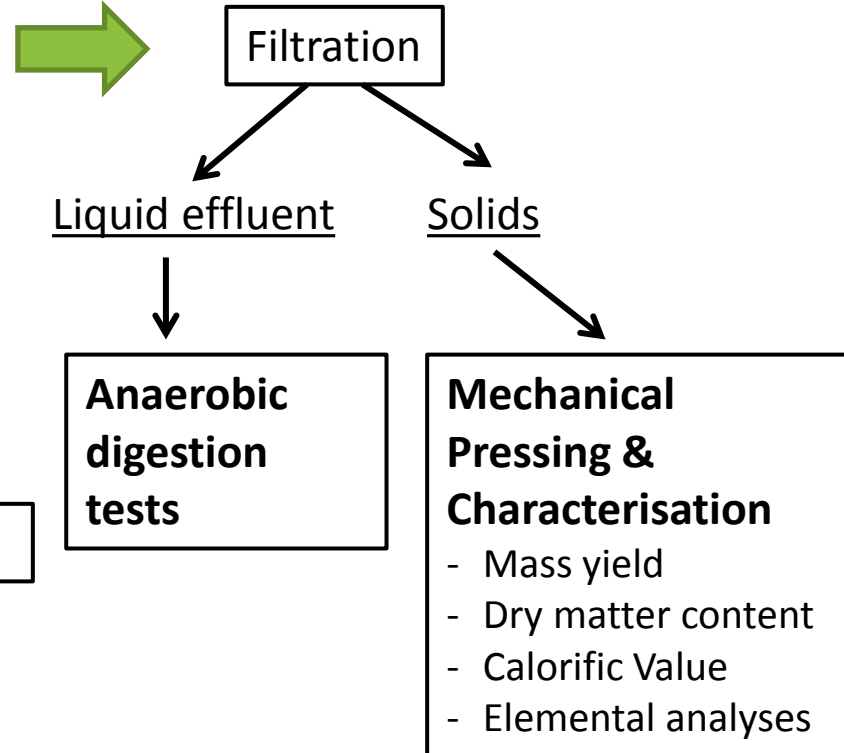
Experimental approach



Sewage
Sludge

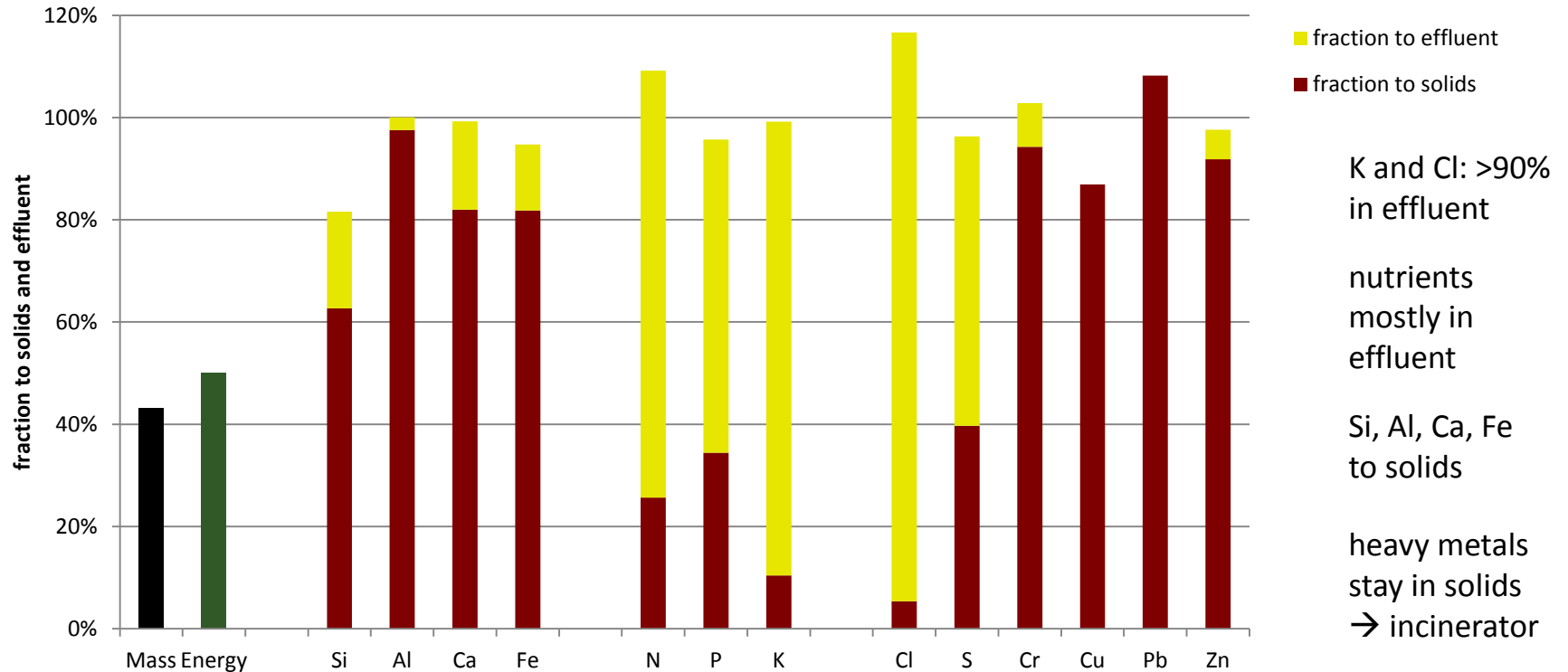


20-L autoclave vessel



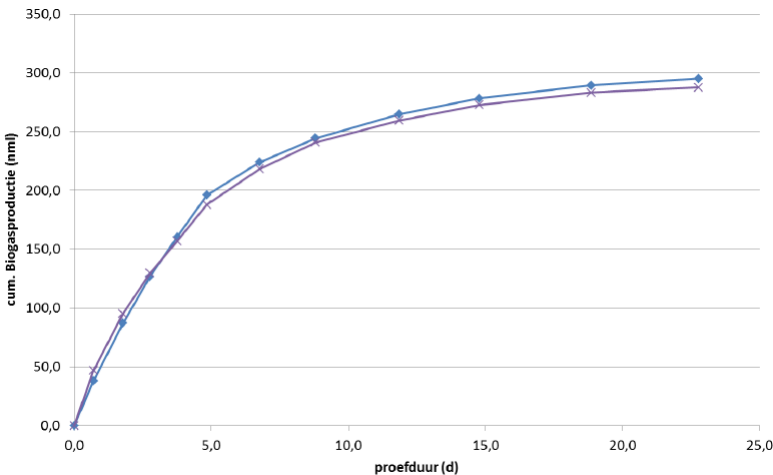
TORWASH[®] of Almere sludge

Distribution of elements



* Mass and Energy in solid product

TORWASH[®] effluent digestion tests

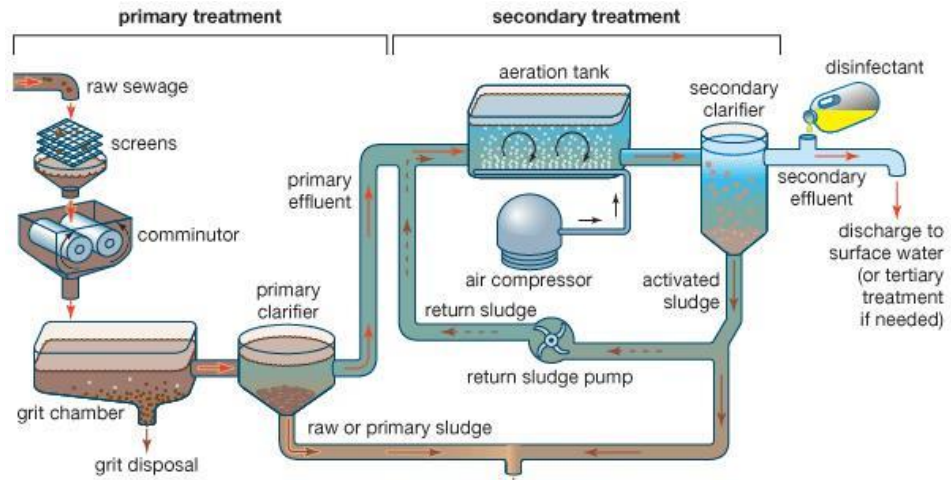


- Batch tests at OPURE
 - 18-25 days
 - Filtered effluent after TORWASH[®]

- Measurements
 - COD measurements before and after
 - biogas production
 - methane content → methane production

- For TORWASH[®] assessment purposes, digestibility is defined as the COD conversion

Sewage sludge – current situation



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sludge treatment and disposal



Sewage sludge

8-12 wt% dry matter

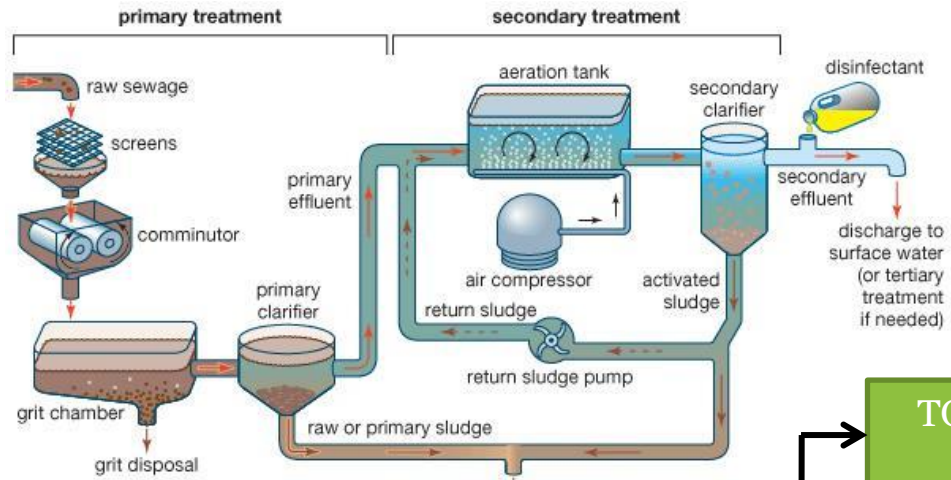
Dewatering step (e.g. press)

20-25 wt% dry matter

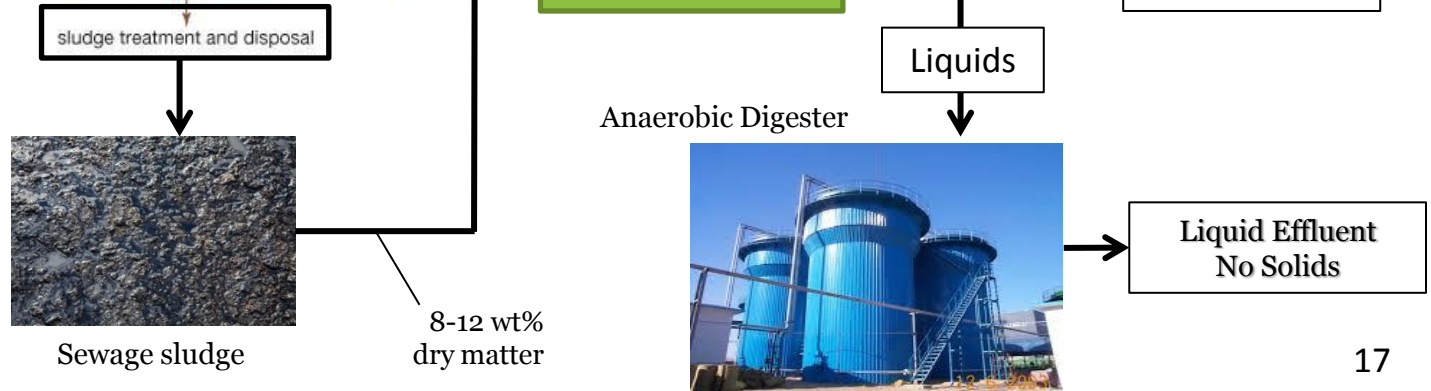


incinerator

TORWASH[®] → Digestion



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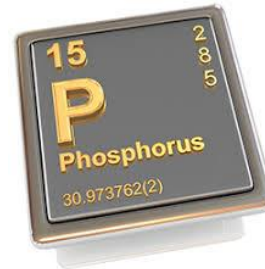


Back to the challenges

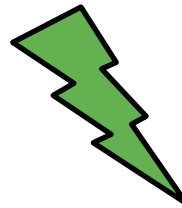
- Reduce the amount of sludge that is produced



- Recover nutrients (phosphorus)



- Maximise energy production



The TORWASH[®] promise

Almere as an example



	Dry matter	Volume [ton]	Disposal costs*
Centrifuge	8%	56 000	
Existing Press	21%	21 000	M€ 1.3
Best Press	24%	19 000	M€ 1.1
TORWASH[®]	65%	3 100	M€ 0.2

* € 60 per ton “as received” in all cases

- Amounts of sludge reduced from 21 to 3 kton/year
- Potential savings on disposal costs € 1.1 million/year

How about P recovery and energy production?- The Almere case

- From TORWASH® effluent:
 - Recovery of 80 kg/y of phosphorus -> 183 kg/y of phosphate
 - 0.3 MWe by combustion of produced biogas
- From TORWASH® presscakes/pellets
 - 0.4 MWe by combustion
- 800-900 ton/y CO₂ reduction potential

TKI-BBEG EnCore

EnCore

(Efficiente Cascadering en Opwerking Rioolslib voor Energie-neutrale bedrijfsvoering)

- Pilot scale TORWASH® + anaerobic digestion (40 kg/h)
- Proof-of-feasibility
- Quantification P recovery
- Quantification energy production

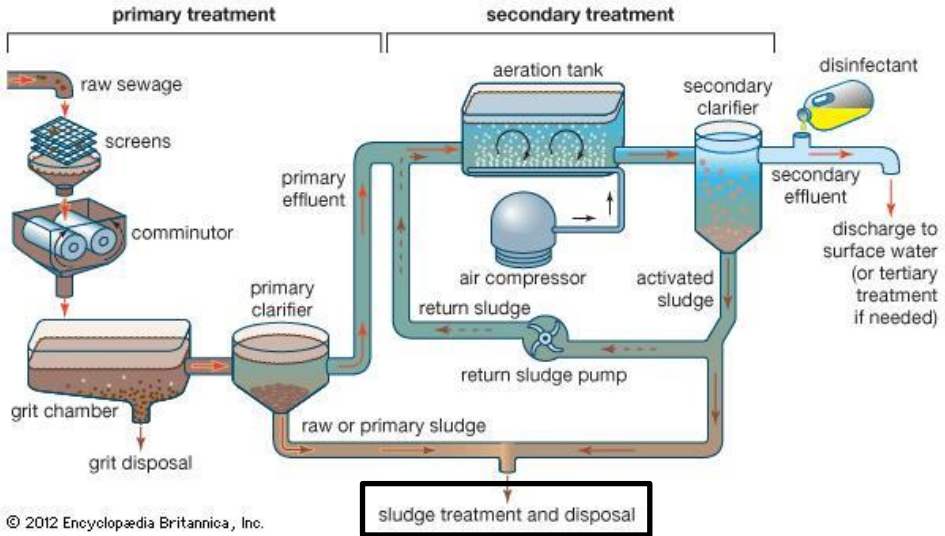


Digestion → TORWASH®

incinerator



To power & electricity



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sludge treatment and disposal



Sewage sludge

8-12 wt% dry matter



Anaerobic Digester

>60 wt% dry matter

Liquids recycling

TORWASH®
Reactor

Slurry digested sewage sludge

Filter

Liquid Effluent
No Solids

Dewatered cake

Press

10 wt% dry matter

Thank you for your attention!



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