ECN
Your energy. Our passion.

Sustainable materials and energy from sewage sludge

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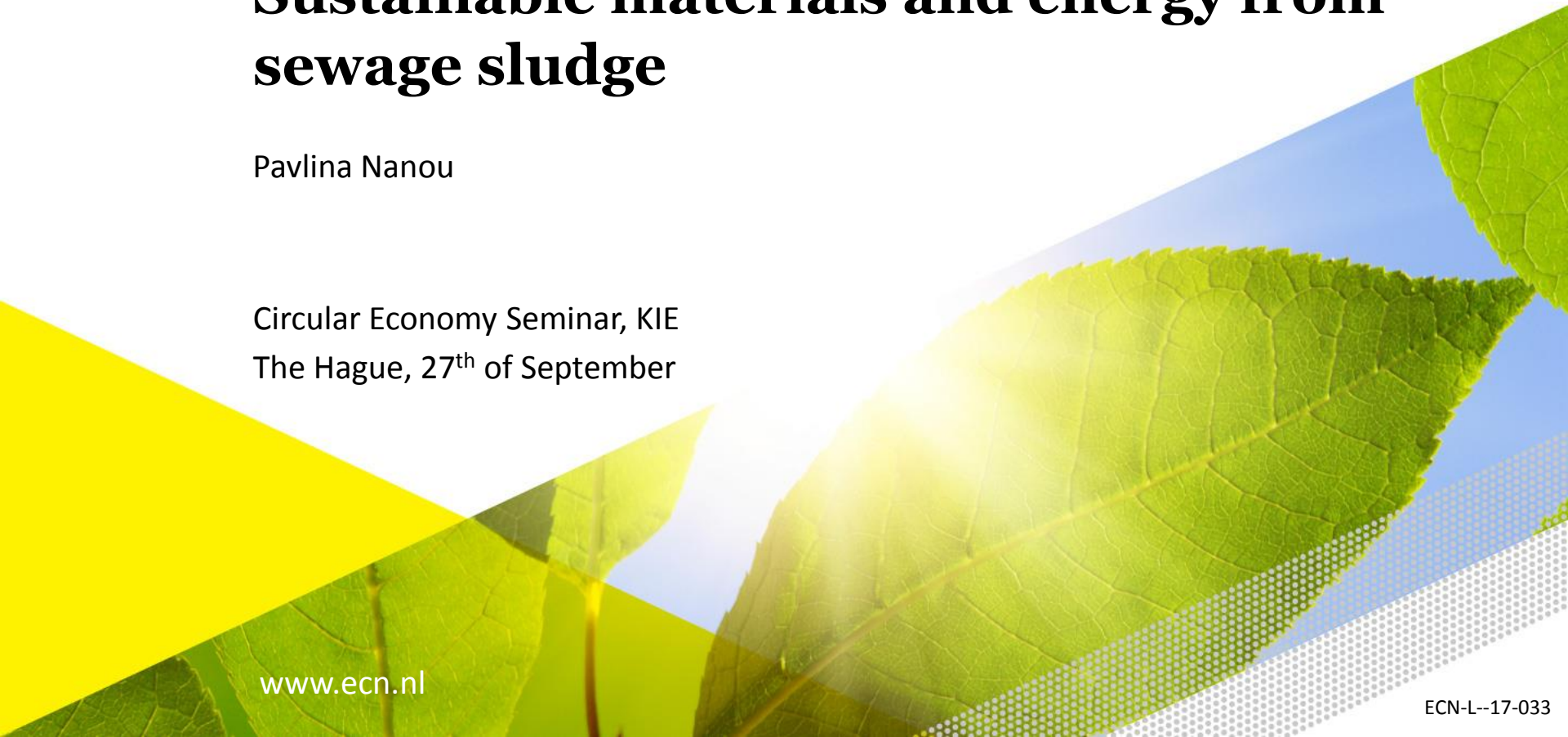
Circular Economy Seminar, KIE
The Hague, 27th of September



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ECN-L--17-033

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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
Zeeweg
Westerduinweg
N502
~275 employees
Mallinckrodt Pharmaceuticals
~290 employees
NRG
~370 employees
ECN
~470 employees

ECN Units

Policy Studies

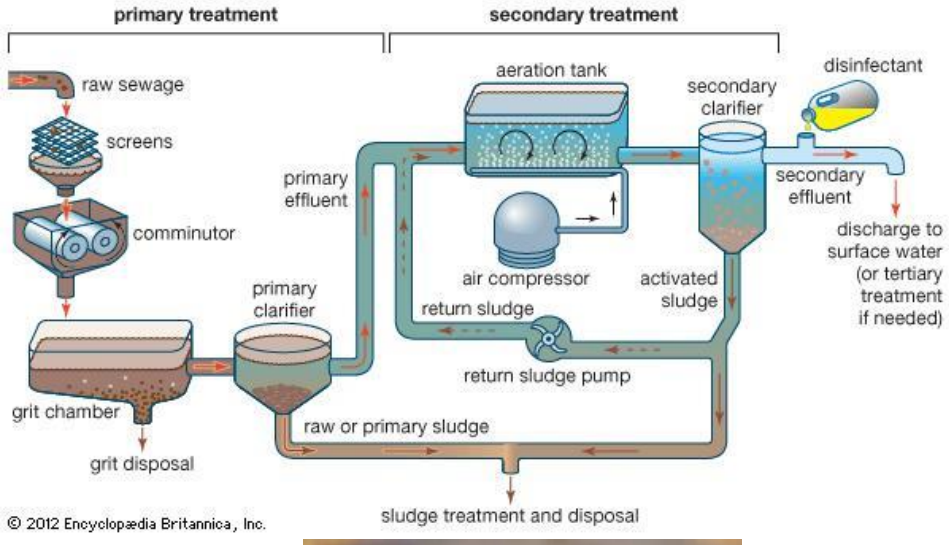
Environment & Energy Engineering

Biomass & Energy Efficiency

Solar Energy

Wind Energy

What is sewage sludge?



- 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

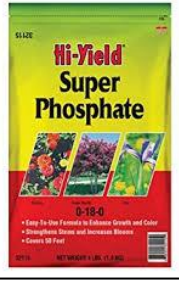
Legislation changes cause increase in amount of sludge

- 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**

P Rock



P in fertilizers

P in plants

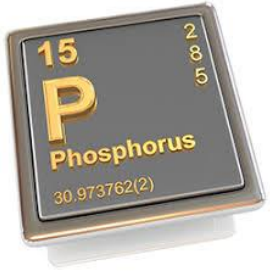
P in manure

P in sewage sludge

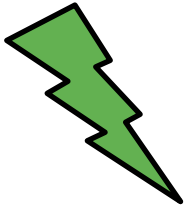
Sewage sludge - The challenges

- **Reduce the amount of sludge that is produced**

- **Recover nutrients (phosphorus)**



- **Maximise energy production**

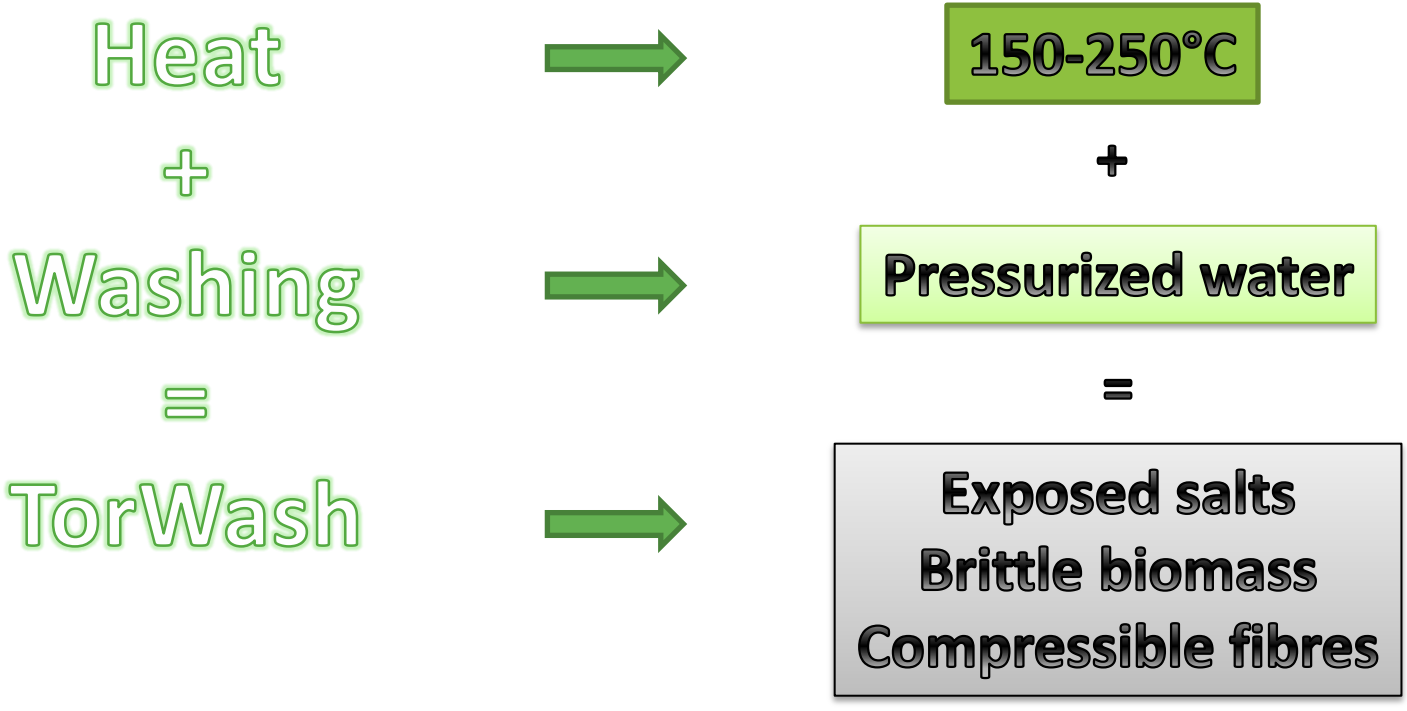


Water Authority Zuiderzeeland

- 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

Filtration

Liquid effluent

Solids

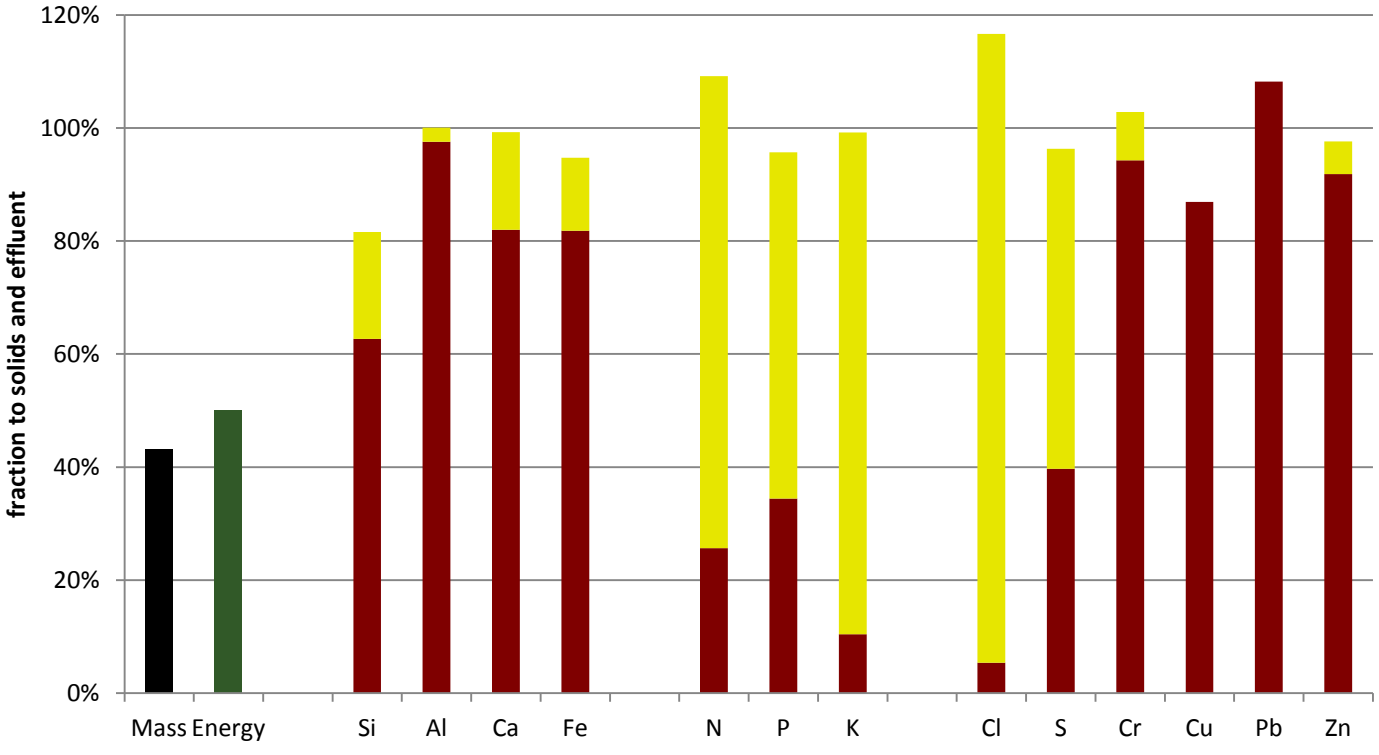
Anaerobic digestion tests

Mechanical Pressing & Characterisation

- Mass yield
- Dry matter content
- Calorific Value
- Elemental analyses

TORWASH® of Almere sludge

Distribution of elements



K and Cl: >90% in effluent

nutrients mostly in effluent

Si, Al, Ca, Fe to solids

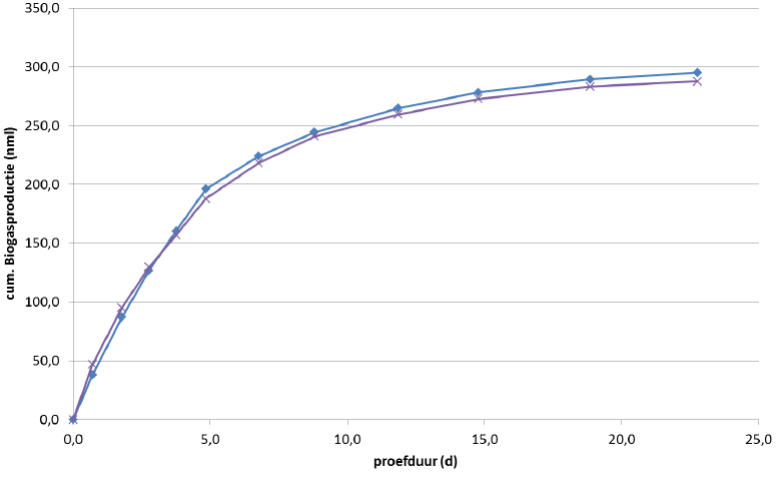
heavy metals stay in solids → incinerator

* Mass and Energy in solid product

TORWASH® effluent digestion tests

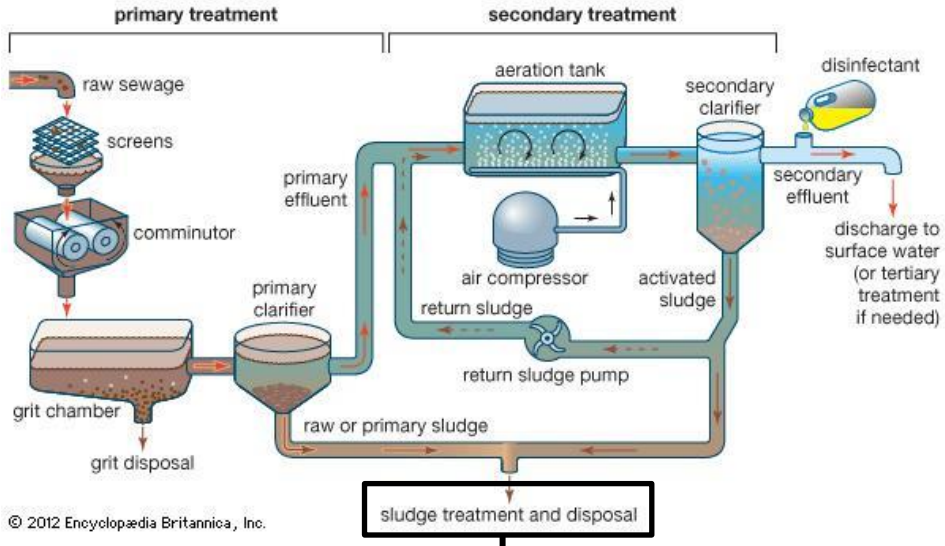
Foto 1. Glas reactor

Foto 2. Broedstoven ruimte



- 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



incinerator

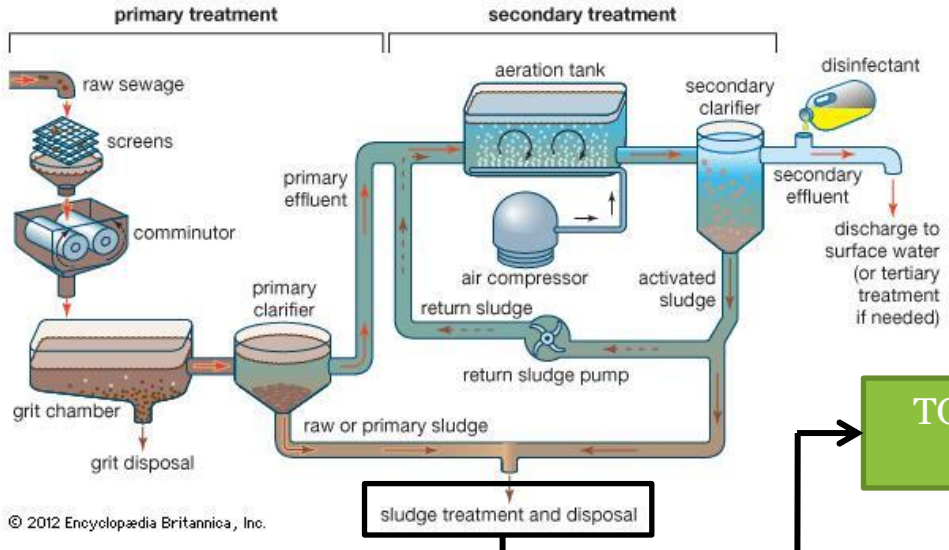
Sewage sludge

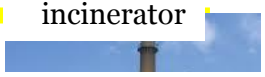
8-12 wt% dry matter

Dewatering step (e.g. press)

20-25 wt% dry matter

TORWASH® → Digestion





incinerator

To power & electricity

>60 wt% dry matter

TORWASH® Reactor

Press

Dewatered cake

Liquids

Anaerobic Digester

Liquid Effluent No Solids

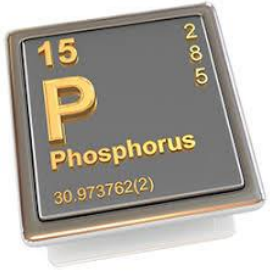
Sewage sludge

8-12 wt% dry matter

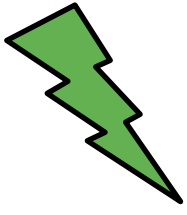
Back to the challenges

- **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 CO_2 reduction potential**

TKI-BBEG EnCore

EnCore

(**E**fficie**n**te **C**ascadering en **O**pwerking **R**ioolslib voor **E**nergie-neutrale bedrijfsvoering)

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

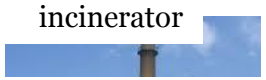
ECN Your energy. Our passion

WATERSCHAP ZUIDERZEELAND

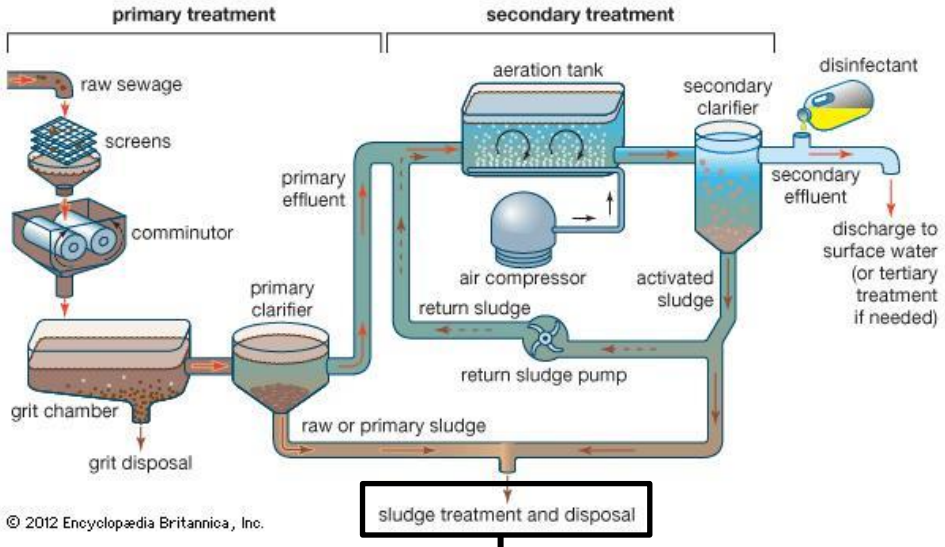
PAQUES

stowa

Digestion → TORWASH®



To power & electricity



>60 wt% dry matter

Dewatered cake

Press

Liquids recycling

TORWASH® Reactor

10 wt% dry matter

Slurry digested sewage sludge

Filter

Liquid Effluent No Solids

Sewage sludge

8-12 wt% dry matter

Thank you for your attention!

TOPSECTOR ENERGIE
Empowering the new economy

Ministerie van Economische Zaken

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