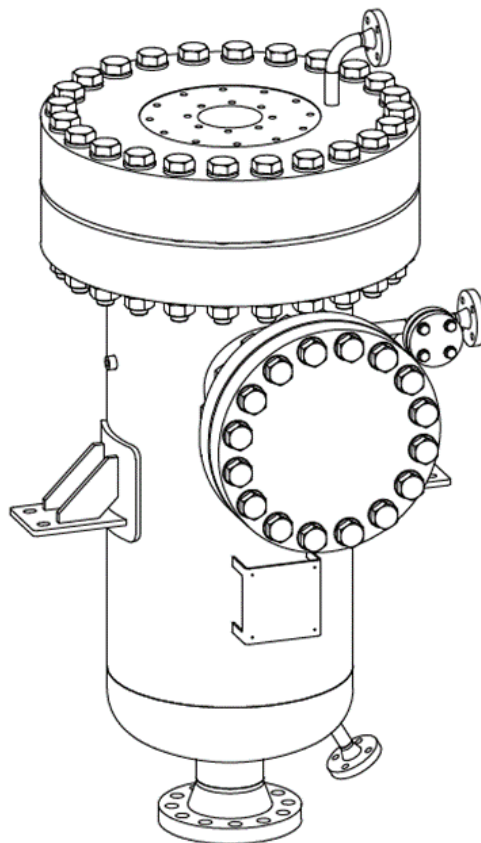


Robust and safe Diaper recycling



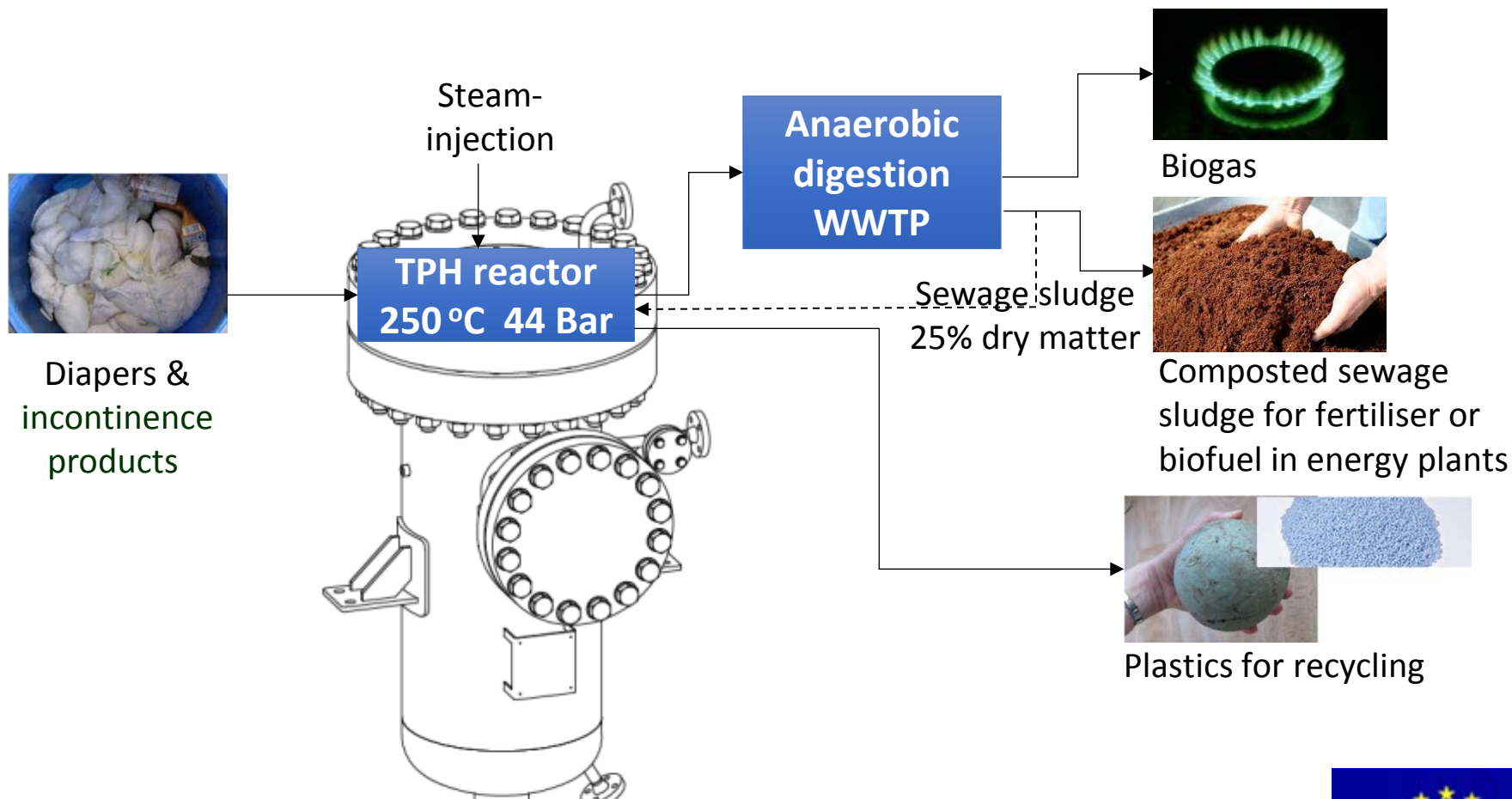
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Diaper recycling ARN/Elsinga with sewage sludge WWTP* Rivierenland



*This project is financial supported by the European Regional Development Fund,
Project Number 00057, subsidy provision Operational Programme Oost 2014-2020*

*WWTP = wastewater treatment plant



Diaper recycling ARN/Elsinga with sewage sludge WWTP* Rivierenland

Plastics approx.

6% -> Separation and recycling



Plastic pellets after extrusion

Fluff pulp

SAP

Faeces and urine with
C,N,P,S + trace elements

11%

3%

80%

} Hydrolysis & anaerobic digestion

Antibiotics

pharmaceutical products

Medicaments

and pathogens

} Decomposition/inactivation

5 of 17 'Boxall' - Pharmaceuticals selected

Decomposition Range 195-704°C

Non Steroidal Anti-Inflammatory Drugs

- Ketoprofen
- Ibuprofen
- Diclofenac
- Indomethacin



Analgesic

Ca-channel blocker: Verapamil

Beta-blocker: Atenolol

Anti-Parkinsons: Amantadine

Antidepressant: Fluoxetine

Anti-cancer: 5-fluorouracil



Hormones

- Estradiol
- Ethinyl-estradiol

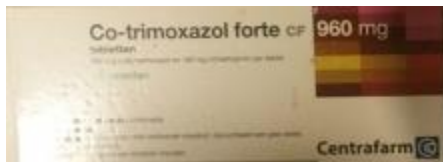


Anti-gout:

Allopurinol

Antibiotics

- Chloramphenicol
- Sulfamethoxazole



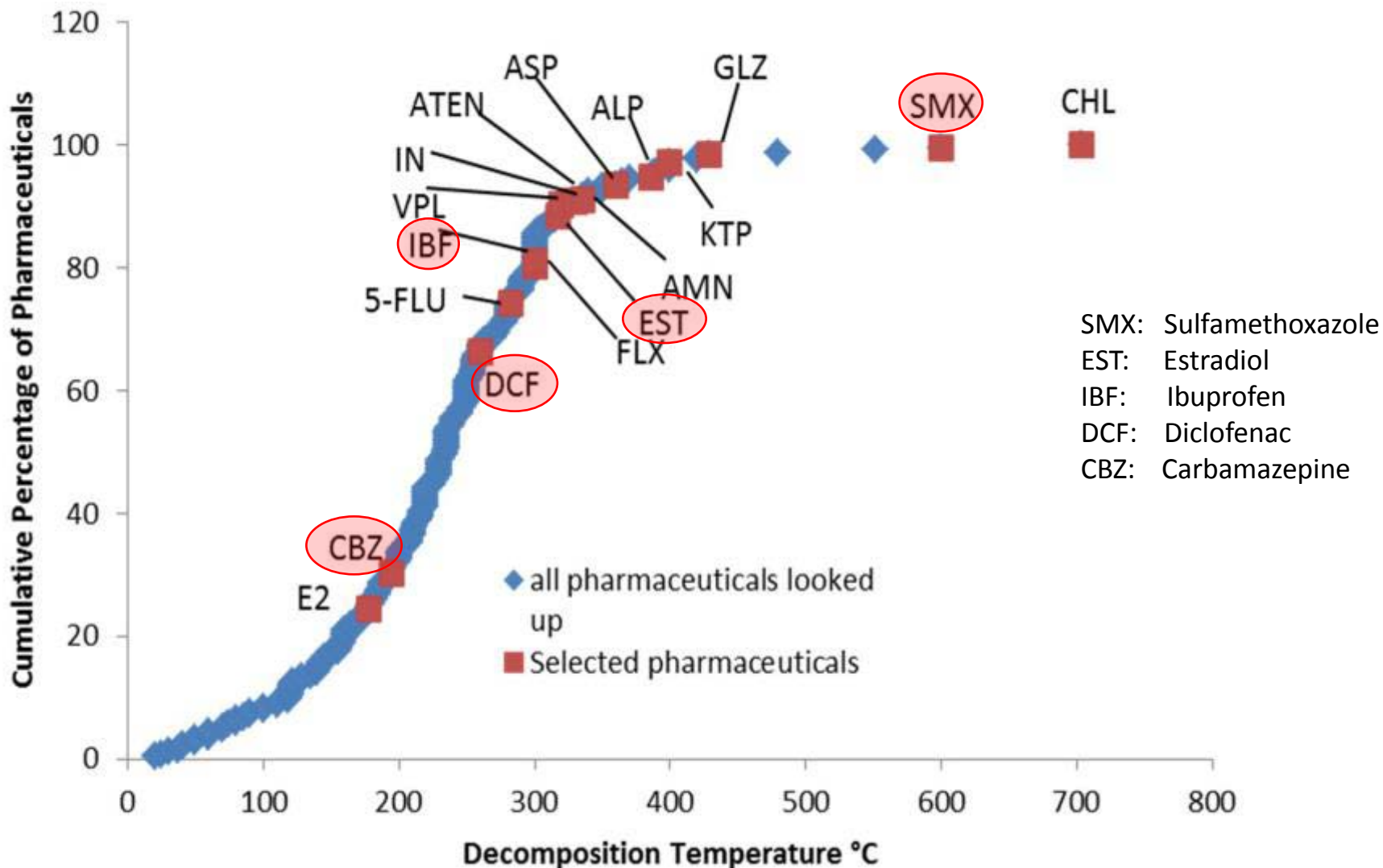
Anti-diabetes:

Gliclazide

Anti-epilepsy: Carbamazepine

Decomposition Pharmaceuticals compared to data prof. Boxall*

Stability of study compounds; 5 of 17 'Boxall' - Pharmaceuticals selected



Decomposition Pharmaceuticals in TPH reactor ARN/Elsinga with diaper/incontinence material and sewage sludge

Researched Pharmaceutical products: with high environmental hazard and which are applied in care homes** and passing through the body intact in high amounts

Compound	Degradation by TPH ARN/Elsinga***	Degradation Burkhardt*	Boxall degradation temp. (°C)
Carbamazepine	>99%	88%	Approx. 200
Diclofenac	>98%	99%	Approx. 260
Ibuprofen	>82%	96%	Approx. 300
Sulfamethoxazo	100%	82%	Approx. 600
17β estradiol	>99%	84%	Approx. 320
Average	>96%	90%	

With the TPH treatment at ARN/Elsinga, a highly effective decomposition of Pharmaceuticals is reached (average > 96%).

*Burkhardt, BTU, Biogas World, Berlijn 2014

**Perlet, T.: study in care home medicus in Cottbus, 2012, unpublished

*** Willem Elsinga, Jelle Duindam en Roy Morssinkhof (Elsinga beleidsplanning en innovatie BV)
Afbraak medicijnresten bij Thermische drukhydrolyse van luiers en inco-materialen,
published March 2017

Focus on microbiological heat resistance

Resistance level	Organism/pathogen	Temp [°C]	Time [min]	Press. [bar]
I	Pathogen streptococcus, listeriens, polio virus	61,5	30	
II	Most vegetative bacteria, yeast	80	30	
II	Mould fungus, all viruses except hepatitis-B	80	30	
III	Hepatitis-B-virus, most fungi spores	100	5-30	
IV	Bacillus-anthraxis-spores	105	5	
V	Bacillus-stearothermophilus-spores	121	15	
VI	Priones	132	60	
Lab/hospital standard		121	20	2
Lab/hospital standard		134	5	3

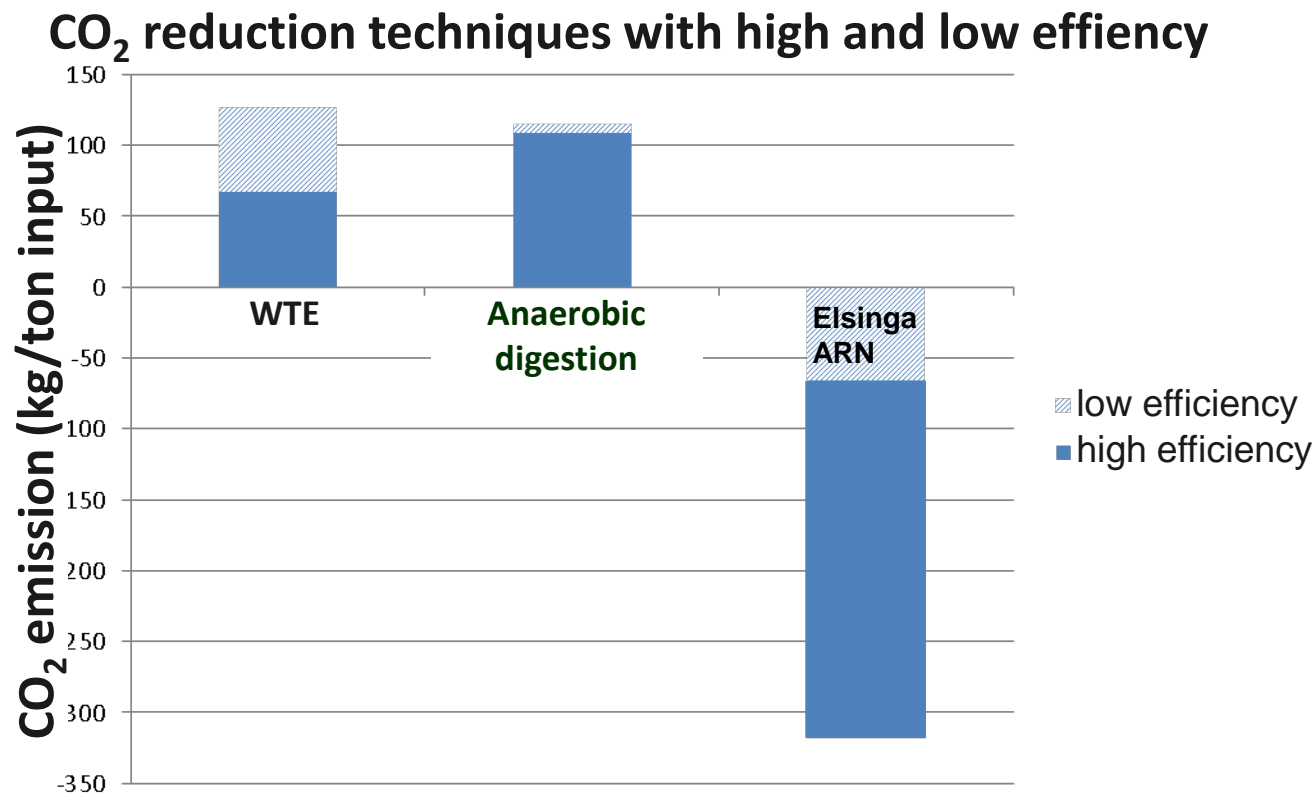
With the TPH treatment at ARN/Elsinga, a highly effective deactivation of organisms /pathogens is reached: the sludge is sterilized.

Ecotoxicity test



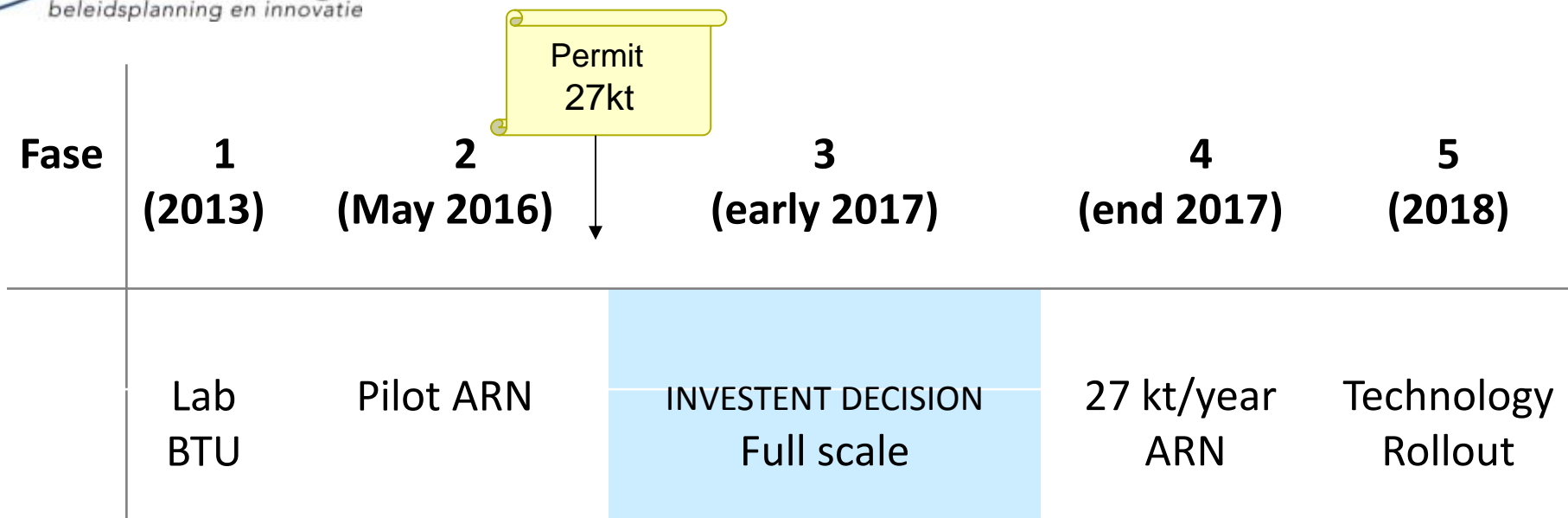
As a general conclusion it can be stated that, after anaerobic digestion and composting, the addition of 20% organic fraction of thermally treated baby diapers to Vegetable, Garden and Fruit waste did not cause a negative effect on plants and earthworms. Moreover, the addition of organic fraction of thermally treated baby diapers resulted in a higher biogas production.

Saving 150- 250 kg/ton CO₂ relative to waste-to-energy (WTE) plants or co-digestion with source separated organic municipal waste



	WTE	Anaerobic digestion	Elsinga/ARN
Low efficiency	Only power, no heat use	Batch mesophilic	No recycling of plastics
High efficiency	Use of power and heat	Continuous thermophilic	Recycling of plastics

Organisation and planning



Supply contracts:

1. Contracts with municipalities on source separated diapers.
2. Preference long-term contracts with child day care centers and elderly care facilities

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