POZNAN UNIVERSITY OF TECHNOLOGY

Resource recovery at the WWTP

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„Only those who will risk going too far can possibly find out how far one can go.”

T.S. Eliot

Changing attitude to wastewater treatment process

1. **Previously**
   - Clean sewage
   - Fulfilling law requirements

2. **Nowadays**
   - Pro-environmental technologies
   - Improvement of economic balance at the WWTP

How to improve economic balance at WWTP?

1. Limitation of energy consumption

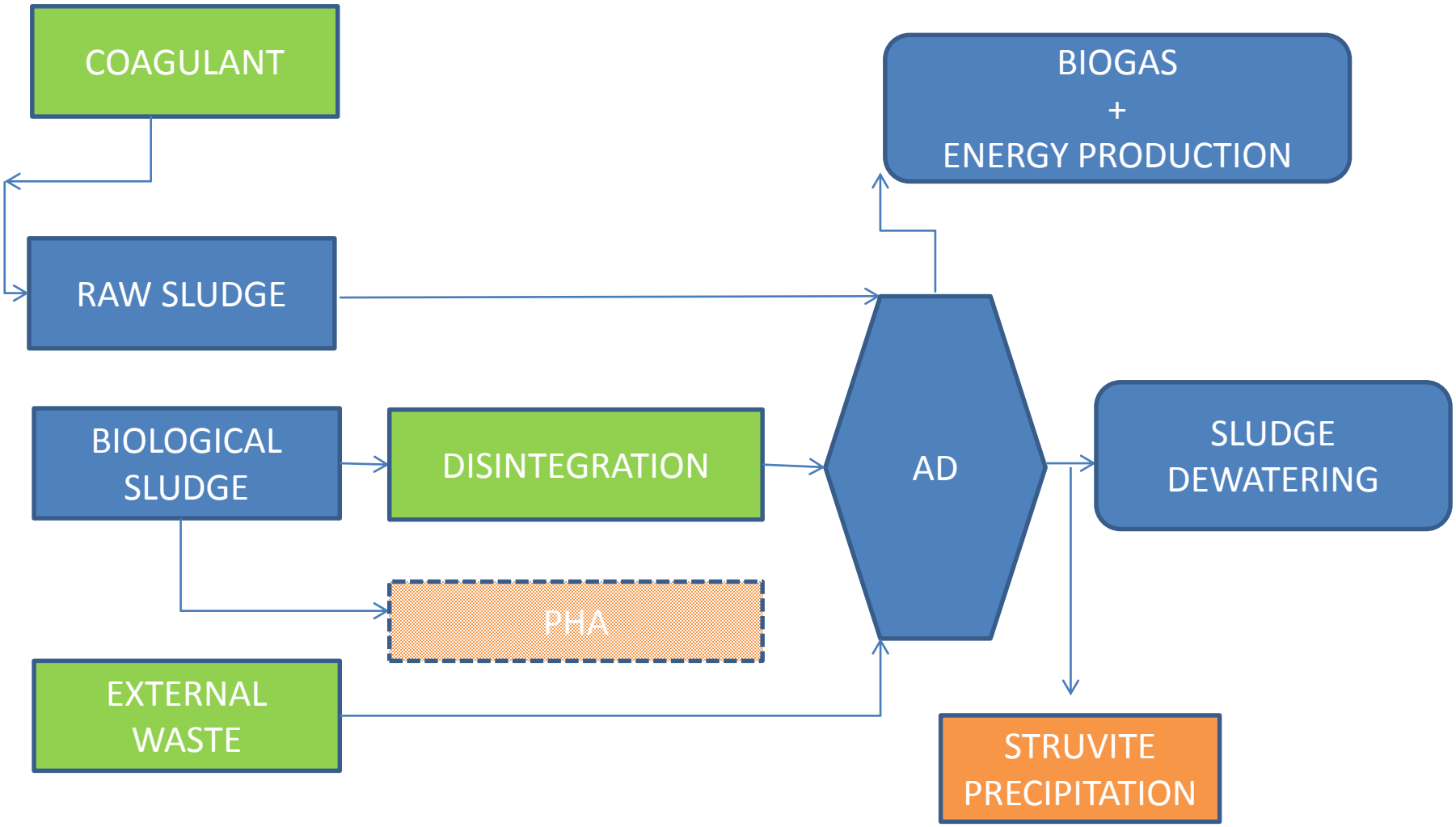
- Better electric efficiency of equipment
- Advanced steering system (e.g. STAR)
- New technologies (e.g. Anammox)

2. Maximizing of energy recovery

- Sludge fermentation
- Waste fermentation

3. Resources recovery (C, N, P, metals)

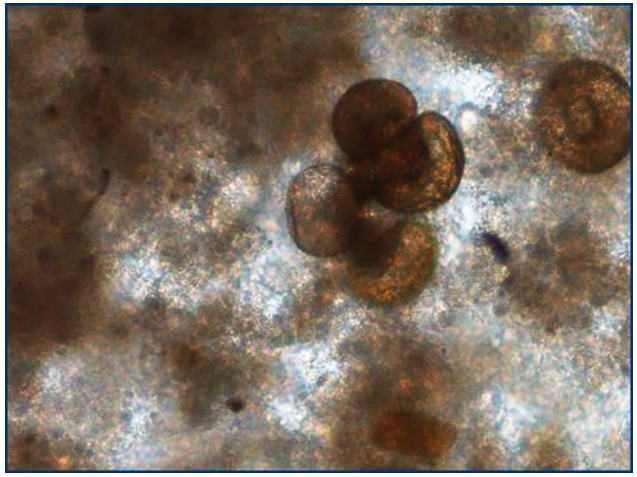
Scheme


COAGULANT
BIOGAS
+
ENERGY PRODUCTION
RAW SLUDGE
BIOLOGICAL
SLUDGE
DISINTEGRATION
AD
SLUDGE
DEWATERING
PHA
EXTERNAL
WASTE
STRUVITE
PRECIPITATION

Sludge disintegration (1)

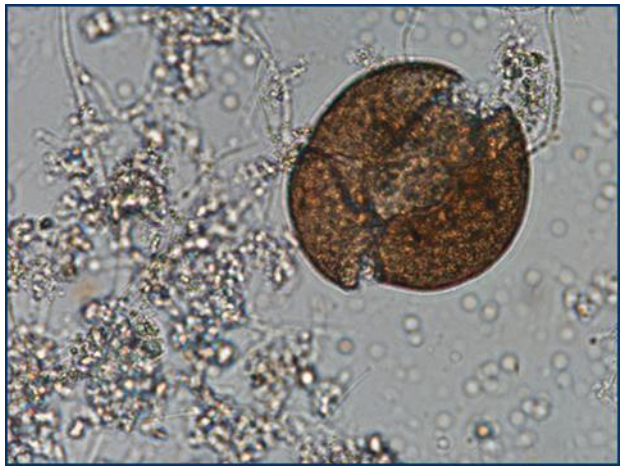
The aim:

- Pretreatment of biological / excess sludge
- Flocks and cells lysis and organic matter release
- Increase of biogas production



Technology methods:

- Mechanical methods (ultrasonic, hydrodynamic etc.)
- Chemical methods (alkaline, acidic etc.)
- Thermal methods (low or high temperature)
- Mixed methods



Effectiveness:

5%-30% of higher biogas production

Sludge disintegration (2)

Example: Implementation mixed disintegration in WWTP 1 mln PE

Date:

Biological sludge production 22 000 kg VS/d

Pretreatment: NaOH 30% + 60°C 1h

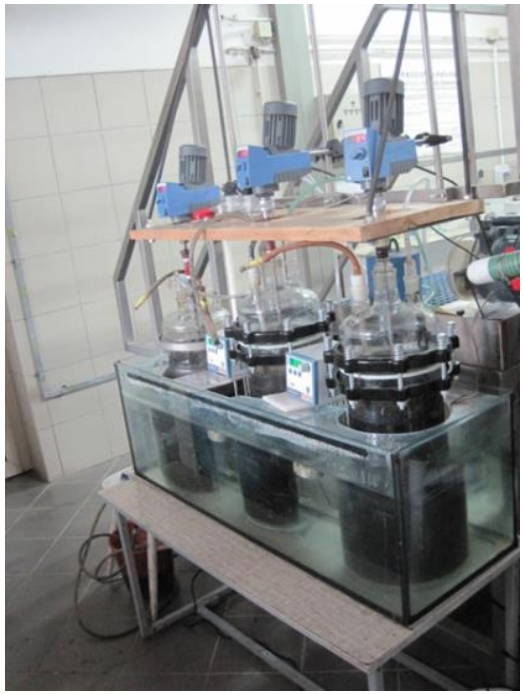
Results:

Biogas enhancement: 25%

Covering energy demand: 8-10%

Expected economic benefit:

Savings	ca. 800 000 PLN/a
Expenses	ca. 350 000 PLN/a
	(+) 450 000 PLN/a



Coagulants (1)

The aim:

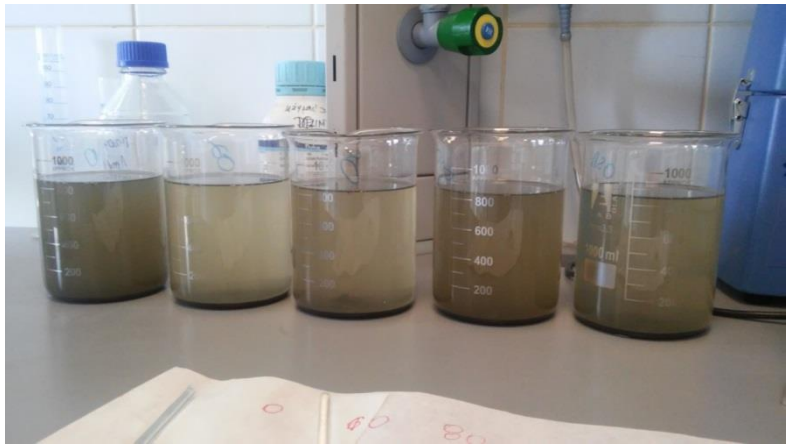
- increase of biogas production
- reduce of energy consumption

Methods:

- Inorganic coagulants (PIX)
- Organic coagulants

Advantages:

- Increase of suspended solid reduction
- More effective organic carbon distribution
- Higher biogas production
- Better dewatering sludge parameters
- Lower oxygen consumption



PIX:
< H2S in biogas
< struvite problems

organic coagulants:
> Possibility to phosphorus recovery

Coagulants (2)

Example: Implementation coagulant dosage in WWTP 1 mln PE

Date:
PIX 60g/m^3
Qs 110 000 m^3/d
Energy Consumption = 24 mln kWh/a
Bio Part = 12 mln kWh/a

Parameters	Lack of PIX	PIX 60g/m3	Reduction
	[mg/l]	[mg/l]	[%]
COD	613	413	32
BOD	284	188	33
SS	142	91	36
Ptot	9,58	6,09	36
Ntot	59,7	55,2	7,5

Results:
Extra biogas production: ?
Oxygen savings: 25-30% (theoretical calculation according to ATV directions)
Reduction in energy demand: 12,5%

Expected economic benefit:
Savings (oxygen) ca. 1 100 000 PLN/a

Expenses (PIX) ca. 1 000 000 PLN/a

(+) 100 000 PLN/a

RISK of denitrification stability!!!

Waste co-digestion (1)

The aim:

- Increase of biogas production
- decrease the electricity supply from non-renewable resources.

Technology methods:

- Waste pretreatment: fragmentation, dilution, heating
- Waste dosage to existed fermentation chamber

Effectiveness:

- Higher biogas production depending on kind of waste and reserve („free space”) in AD

Waste co-digestion (2)

Example: Co-digestion of sludge from poultry industry in WWTP 1 mln PE

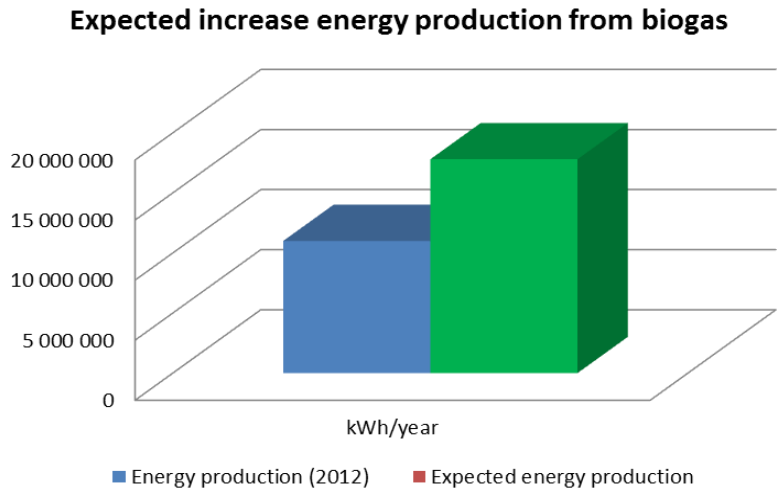
Data for calculation:

Extra organic load 8 500 kgVS/d

SBP 1,0 m^3/kgVS

Unit energy production 2,2 kWh/m^3

SBP – specyfic biogas production from waste



Results:

- 60% higher energy production
- covering energy demand (+) 30%

Energy recovery – summary

Parameter	Unit	Value
Energy consumption	kWh/year	24 000 000
Energy production	kWh/year	11 000 000
Covering energy demand	%	**46**
Extra energy production: waste	kWh/year	6 800 000
Extra energy production: disintegration	kWh/year	1 700 000
Energy savings: coagulants	kWh/year	3 000 000
Expected covering energy demand	%	**93**

Controlled struvite precipitation (1)

The aim: Phosphorus recovery

Technology methods:

- From sewage
- From sludge after fermentation

Advantages:

- P and N load decrease
- P reduction efficiency 80-95%
- N reduction efficiency 10-15%
- Lower flocculant dosage ca. 10%
- Higher dry mass after sludge dewatering (2-4%)
- Fertilizer production and disposal - $MgNH_4PO_4*6H_2O$

Biopolymers – PHA production (1)

The aim:

Reuse of organic matter from the sludge

Technology scheme/ three-step process:

Use of the sludge stream in combination with mixed microbial cultures

- Prefermentation and VFA production
- Enrichment – to select microorganism with high PHA storing capacity
- PHA accumulation

Effectiveness:

30-60%PHA in dry mass of sludge

Biopolymers - PHA production (2)

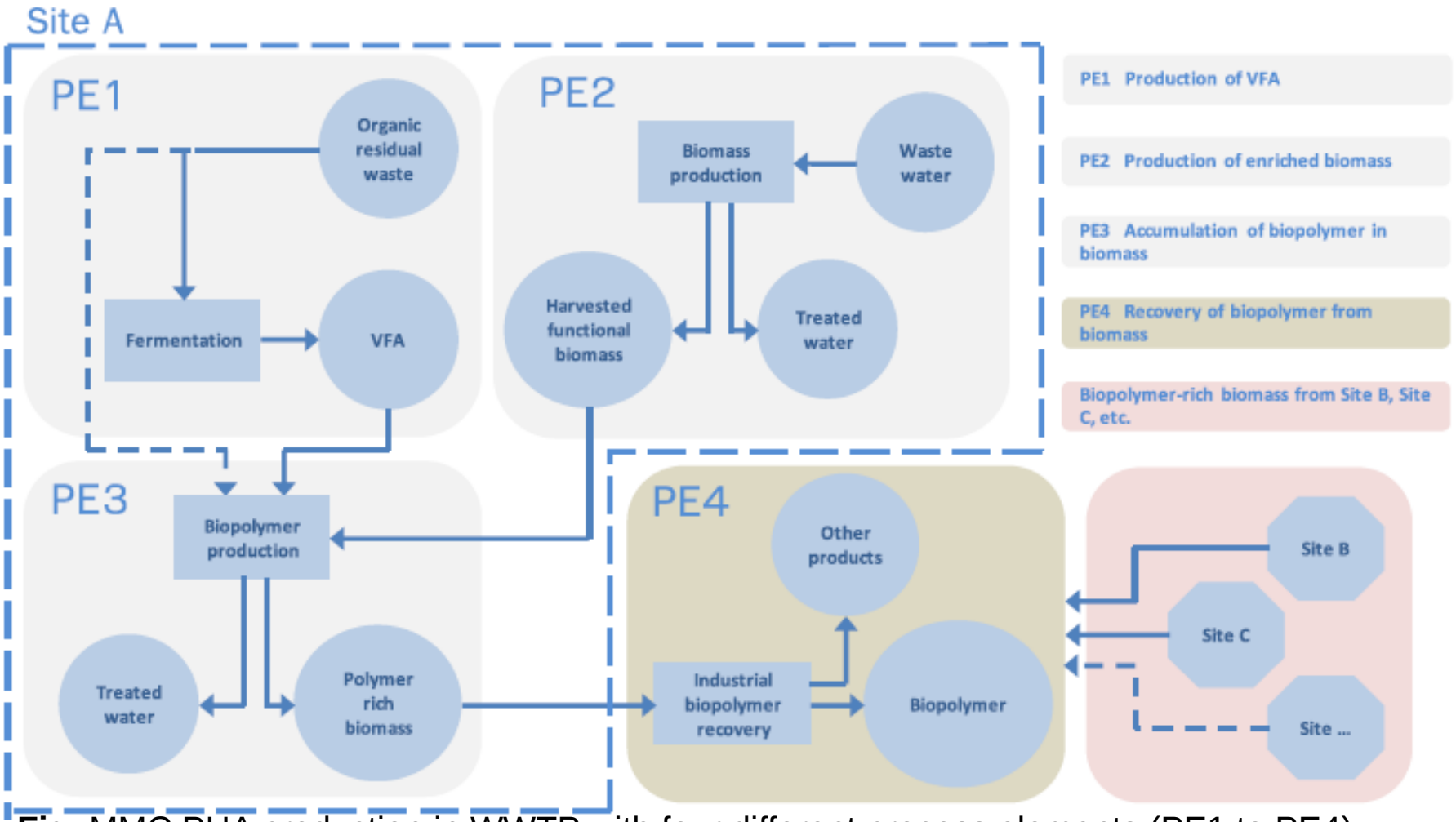


Fig. MMC PHA production in WWTP with four different process elements (PE1 to PE4)
F.Morgan-Sagastume, 2016

Conclusions

1. Nowadays the priority become the integrated view on the WWTP operation in terms of technology and economics.
2. New technologies give wide opportunity in energy and materials recovery to save naturals resources.
3. **We should look for effectiveness and economically reasonable methods feasible in technical scale.**

Thank you for your attention

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