POWERSTEP

YOUR FLUSH, OUR ENERGY

FULL SCALE DEMONSTRATION OF ENERGY POSITIVE SEWAGE TREATMENT PLANT CONCEPTS TOWARDS MARKET PENETRATION

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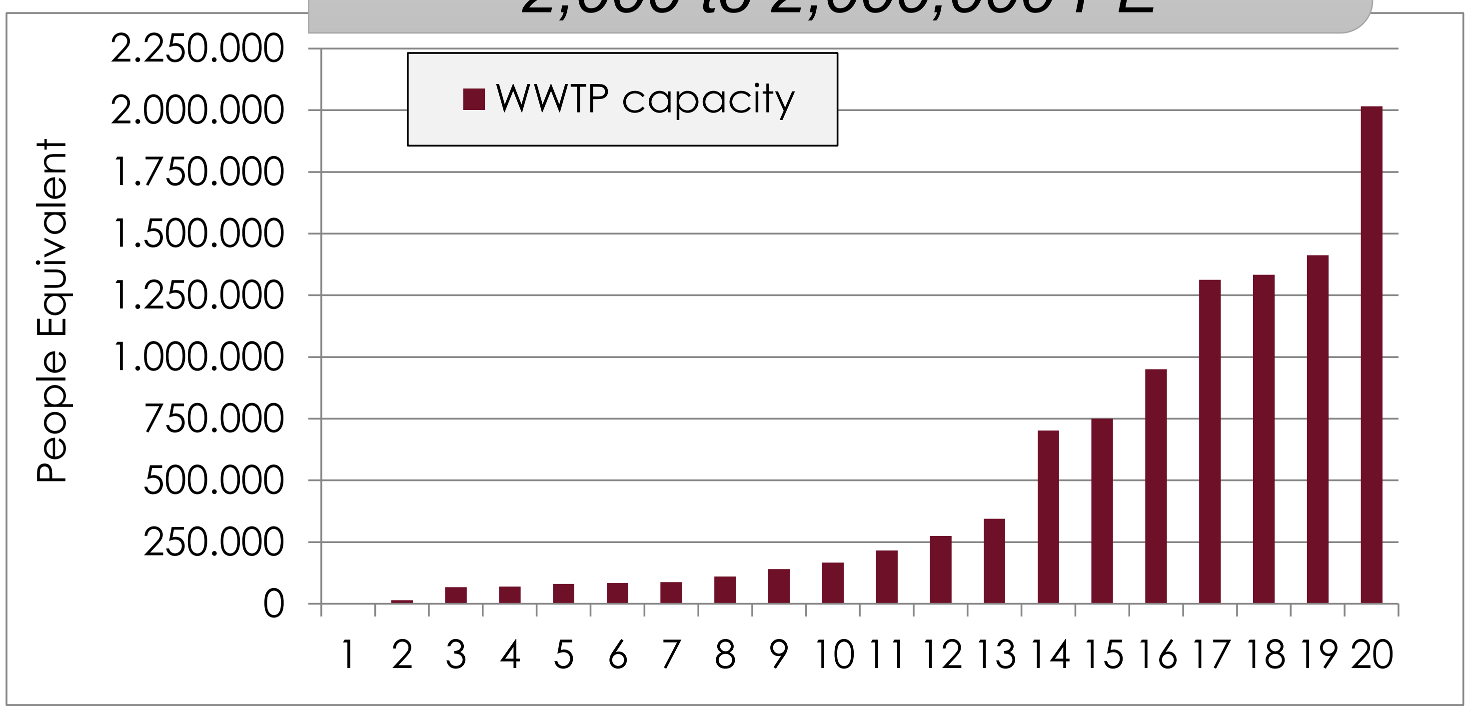
POWERSTEP technologies lead to energy-positive WWTPs

(a market validation by carrying out energy audits)

Powerstep evaluation in existing WWTP

20 WWTP out of 38 candidates

from small to big WWTP
2,000 to 2,000,000 PE



in 9 countries

from low to high loading rates
40% to 150% in average

from low to high discharge requirements
only C removal to TN 8 mg/l

from low to high electricity consumption
16 to 92 kWh/(PE ·a)

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Powerstep audit concept

1st step
- Current situation assessment

2nd step
- Optimisation through state-of-the-art measures

3rd step
- Optimisation through Powerstep concepts

Conventional energy audit

Water2Energy

Goal: assess the real potential of Powerstep concepts

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OCEAN software

Plant & equipment data

Operating data

Treatment requirements

→ OCEAN →

proven in more than 100 WWTP worldwide

Mass balances

Energy balances

Chemicals consumptions

+

- ✓Can be used with low amount or quality of data
- ✓Data consistency check
- ✓KPI calculation & comparison with benchmarks
- ✓Easy calculation of optimisation measures & impact on the whole WWTP

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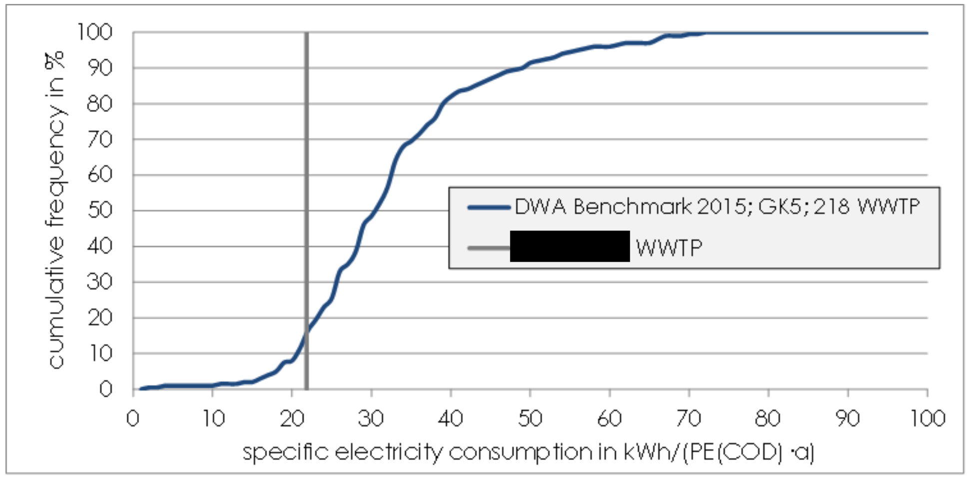
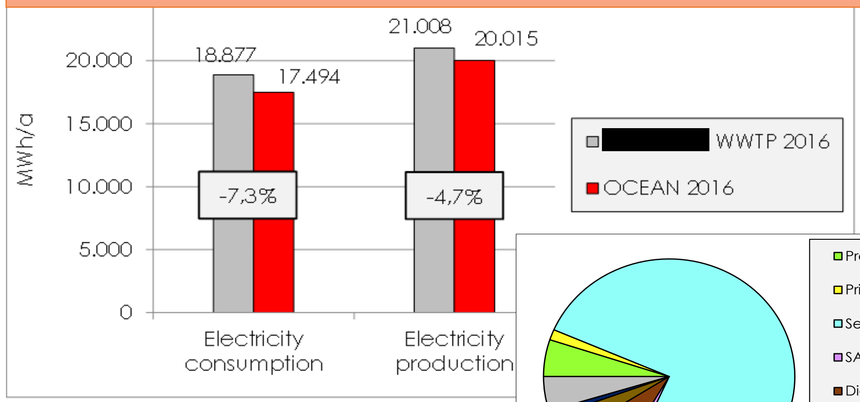
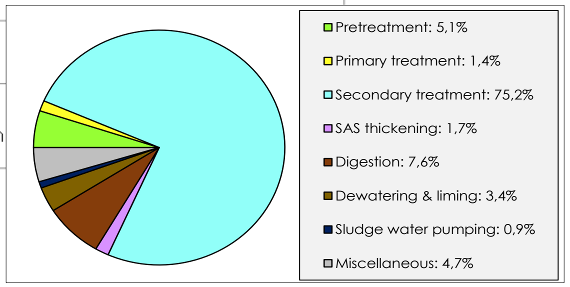
Audit deliverables

KPI comparison with benchmarks



OCEAN calibration results





Cost-benefit analysis of state-of-the-art measures

Action GI-2. Chemical enhancement of the primary settling

Technical Issues

order to improve the outlet quality (espe- ...lly phosphorus), we recommend to dose ...agulant at the inlet of the primary settling. ...this way, the phosphorus concentration at ... outlet of the primary settling could be ...duced so the phosphorus load coming ...m the by-passed settled water could be ...creased. With this action, it is possible to ...ach at the outlet of the main line lower P ...ncentrations than the discharge require-...ent. In the other hand, additional COD will ... removed and the biogas production ...uld increase. However, the implementa-...n of the Action GI-1should avoid lack of ...OD for denitrification.

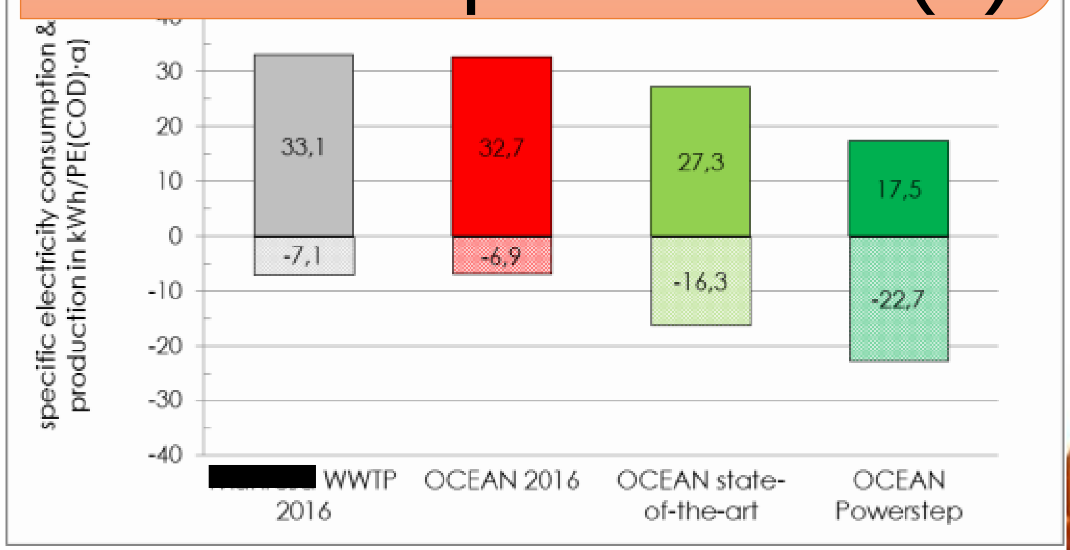
...agulant dosing in the ASP will still remain ...t the dose will considerably decrease.

Key parameters and assumptions

- Assumed FeCl3 dosing in the primary settling: 2,5 to 3 mg Fe/l
  - **Additional coagulant consumption: 1.400 t/a → 176.000 €/a**
- **Calculated P outlet concentration: approx. 0,9 mg/l** < 1 mg/l requirement
- Liquid polymer savings for SAS mechanical thickening due to lower biological sludge production:
  - 20 t/a
  - **55.000 €/a liquid polymer savings**
- **Decrease of the purchased electricity** due to the increase of electricity production: **1.940 MWh/a → 138.000 €/a**
- **Increase of sludge disposal:** 1.330 t/a → **73.000 €/a**

Cost Benefits Analysis	
Investment costs	**150.000 € for a coagulant storage and dosing station**
Improvement outlet quality	**0,9 mg/l P reached at the outlet**
Costs savings	193.000 €/a (electricity & liquid polymer)
Additional costs	249.000 €/a (coagulant & sludge disposal)
Resulting additional costs	**56.000 €/a**

Savings potentials Powerstep scenario(s)



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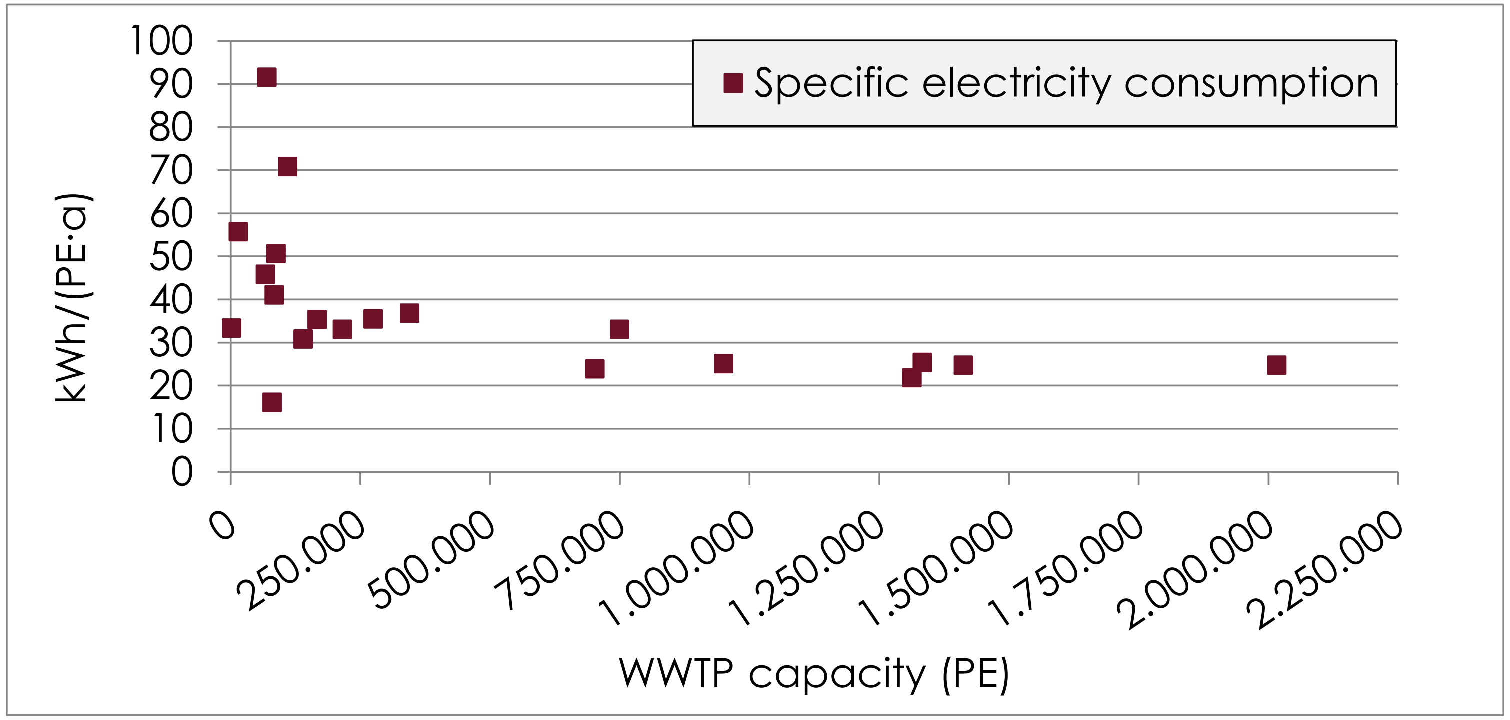
Current situation analysis – energy consumption

Electricity

Variance for plants < 100,000 PE
1. Staff skills
2. Outlet discharge requirements
3. Investment capacity



Heat

usually excess of heat production → no external consumption

Natural gas / fuel oil

Negligible except in special contexts:
- Sludge drying (w/o incineration)
- Oversized CHP

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Current situation analysis – energy production

From digestion & biogas utilisation

15 WWTP
- Start from 60,000 / 170,000 PE
- depends on electricity & sludge disposal price levels

CHP — commonly used

GAS INJECTION — Northern Europe

From sludge incineration

Heat export in 2 WWTP

Energy self-sufficiency is not a dream!

electricity self-sufficiency in 2 plants

Positive energy balance in another plant

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Proposed state-of-the-art measures

no CAPEX → high CAPEX

Optimisation of operating conditions

- *Decrease sludge age*
- *Decrease O_2 set point*
- *Optimise recirculation rates*
- *Optimise sludge water quality*

…

Optimisation of control system

- *Aeration monitoring*
- *Recirculation rates*

…

Equipment renewal

- *Aeration system (air diffusers + blowers or surface aerators)*
- *Mixing system of activated sludge tanks*
- *Pumps*

…

Implementation of additional processes

- *Modification process configuration*
- *Digestion + biogas utilisation*

…

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Proposed Powerstep concepts

WWTP < 50,000 PE

Chemically enhanced microfiltration → Activated sludge process

WWTP > 50,000 PE

Chemical enhancement of existing 1^{ary} settling

Chemically enhanced microfiltration

→ Mainstream Anammox
1-stage IFAS process

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Example with a 215,000 PE WWTP

- Underloaded (50% in average)
- not compliant for TN 11,7 > 10 mg/l requirement
- 33 kWh/(PE·a) electricity consumption > 65% of WWTP in DWA benchmark
- Only 20% electricity self-sufficiency

State-of-the-art measures:

1. *Optimisation of digestion temperature*
2. *Optimisation of SAS thickening*
3. *Optimisation of nitrogen removal*
4. *Implementation of more efficient air diffusers*
5. *Implementation of more efficient blowers*
6. *Implementation of more efficient CHP*

2. Replace existing flotation by gravity belt thickening

Cost Benefits Analysis	
Investment Cost	150.000 €
Energy savings	413 MWh/a electricity
Polymer additional consumption	6,1 t/a
Sludge disposal savings	110 t/a
Consumable costs savings	32.600 €/a

3. Implement aeration sequencing in nitrification tanks & increase MLSS recirculation rate

Cost Benefits Analysis	
Investment Cost	0 €
Improvement outlet quality	8,9 mg/l TN instead of 11,7 mg/l → compliance
Electricity additional consumption	154 MWh/a
Additional costs	16.900 €/a

5. Replace rotary lobe blowers by turbo & screw blowers

Cost Benefits Analysis	
Investment Cost	150.000 €
Electricity savings	185 MWh/a
Costs savings	20.400 €/a

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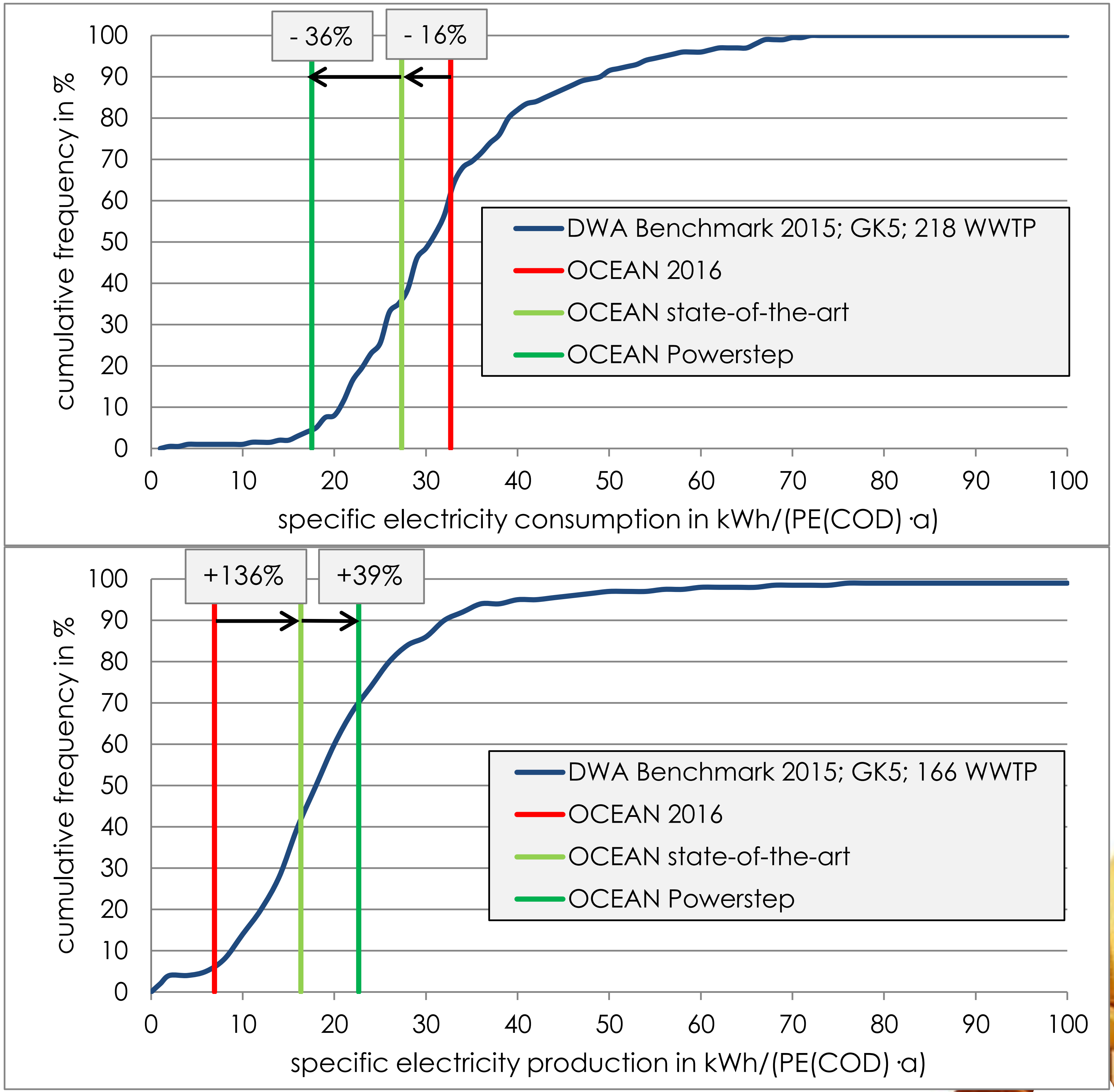
Example with a 215,000 PE WWTP

Powerstep reduces electricity consumption…
- Smaller volumes
- No MLSS recirculation
- Lower RAS rate

… and increases the production
- More sludge
- Higher methane potential



Potential to reach electricity self-sufficiency
1. Reach 60% through state-of-the-art measures
2. Reach 130% through Powerstep measures

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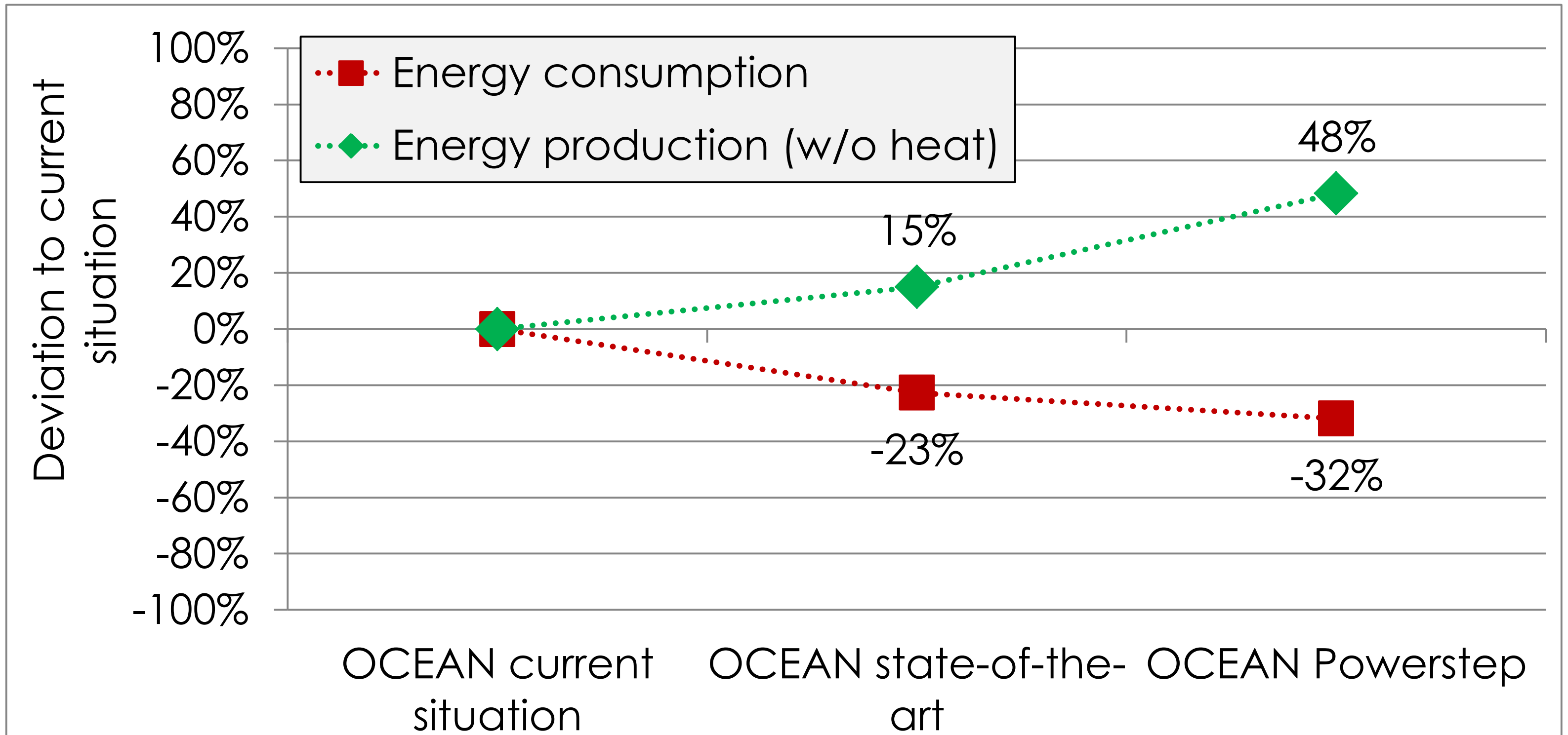
Cumulative results so far*…



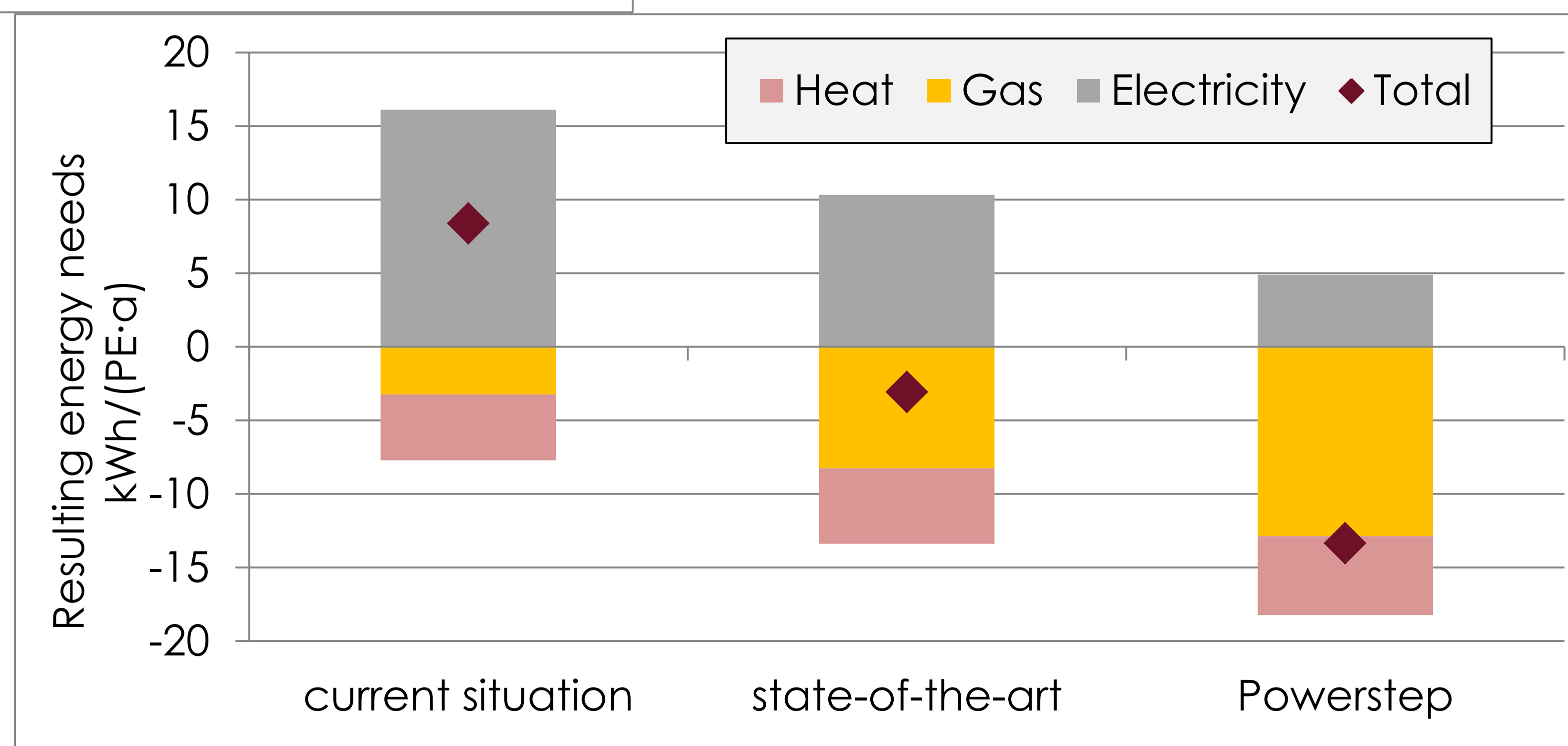
<u>State-of-the-art measures</u>:

- High energy savings
- Energy production at medium WWTP

<u>Powerstep concepts</u>:

- Limited energy savings…
- … but high potential to increase energy production

Powerstep concepts lead to extend energy self-sufficiency to more WWTP *(from 3 to 7 WWTP out of 11)*



** Results based on 11 completed audits*

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Take home messages

Energy self-sufficiency is a reality…
… but only in some plants with favourable conditions

First challenge should be to apply state-of-the-art technologies & train operators in WWTP < 100,000 PE

Powerstep concepts significantly increase energy production & enable new levels of energy-efficiency at WWTPs

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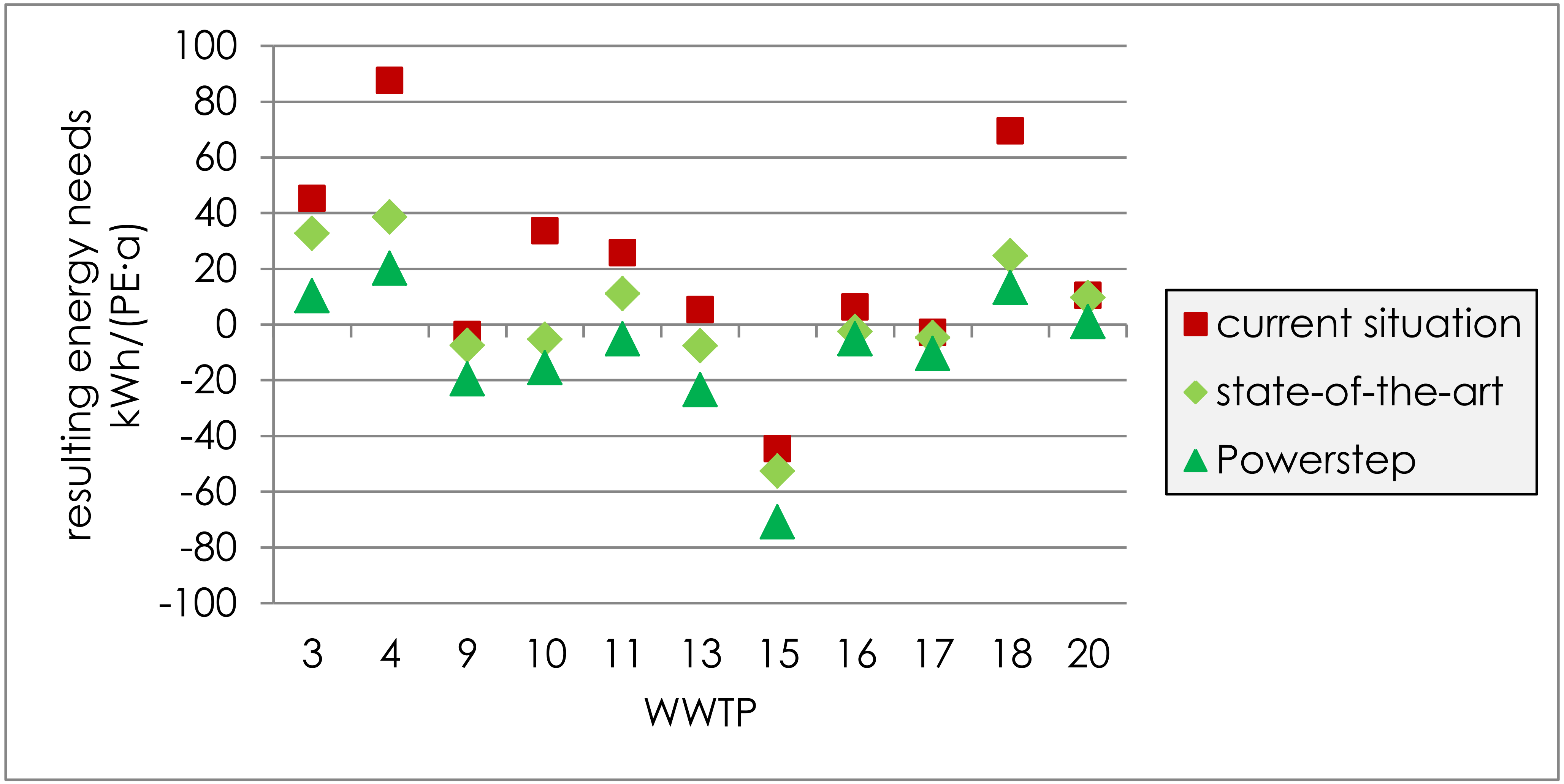
Back-up slide – Energy balances



4 & 10: implementation of a digestion
15: heat and biogas selling
10,13: biomethane selling
18: digestion but no utilised as it shoul be because biogas treatment is missing

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