EU Interreg IV B project

noPILLS

The activities of a water board
on the topic of pharmaceutical substances in water

Dr. Emanuel Grün – COO of Emschergenossenschaft and Lippeverband

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The activities of a water board on the topic of pharmaceuticals in waters

Our association area

Catchment area of the rivers Emscher and Lippe

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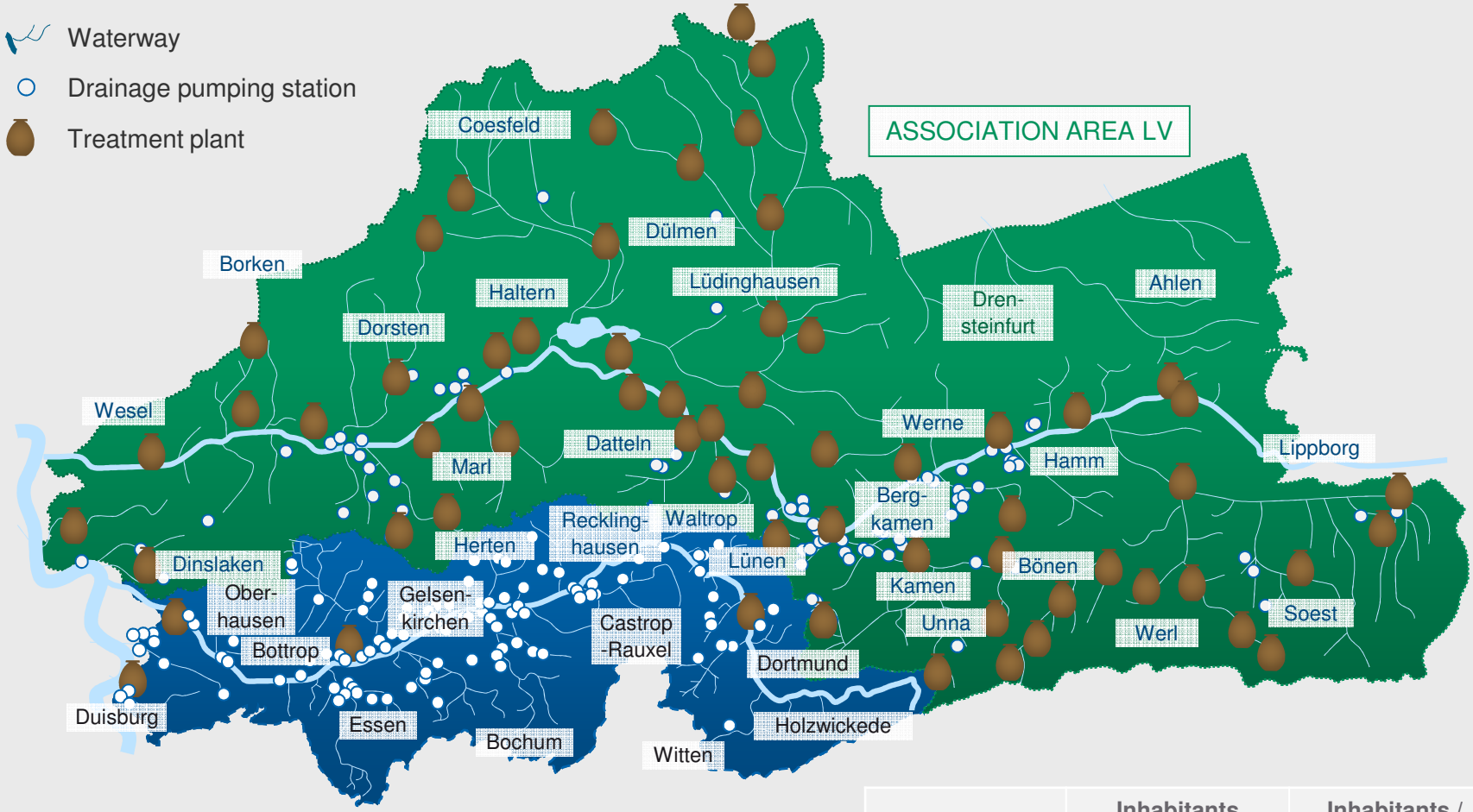

ASSOCIATION AREA EG

	Area (km²)	Inhabitants (mill.)	Inhabitants / km²
Lippeverband	3,280	1.4	427
Emschergenossenschaft	865	2.4	2,775

Water management - key figures

2014 (incl. urban drainage of the city Hamm)

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Watercourses	738	km
Wastewater sewers	1.238	km
Pumping stations	304	
Polder areas	842	km^2
Wastewater Treatment Plants	62	
Design capacity	7,4	mill. inhabitants
Annual wastewater disposal	0,8	billion m^3/a
Rainwater treatment facilities	383	
Flood detention basins	56	
Detention capacity	4,9	Mio. m^3
Dykes	193	km

Economic key figures

Emschergenossenschaft and Lippeverband 2013

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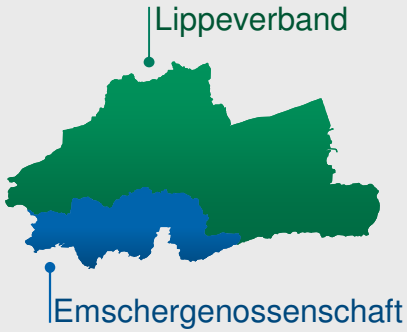
Turnover	414	million EUR
Investments	364	million EUR
Total balance	4.0	billion EUR
Fixed assets	3.7	billion EUR
Operative cash flow	70	million EUR
Organisation	non profit	
Employees	1,603	



State-of-the-Art UWWTP in Germany

with tertiary treatment (and effluent polishing)

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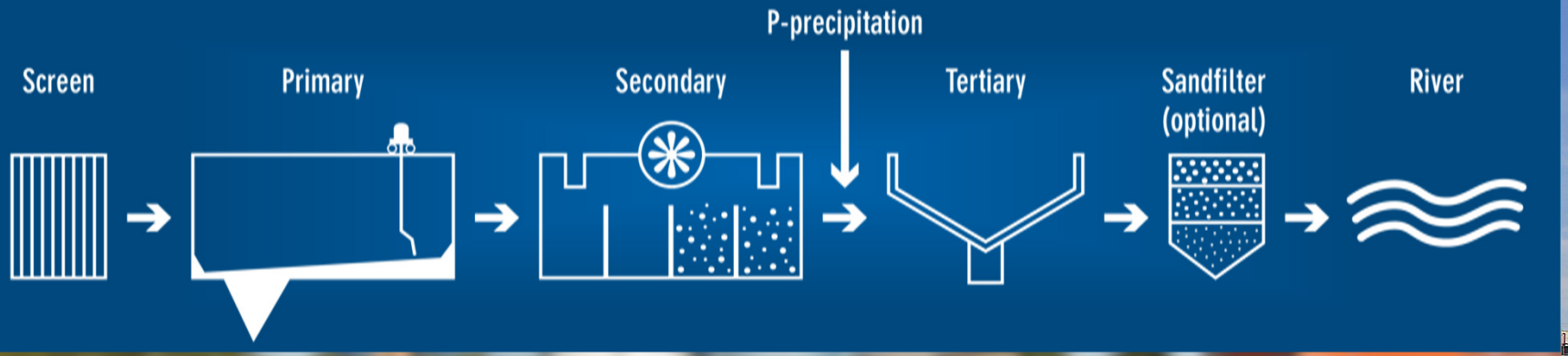


Approx. 10,000 UWWTPs in Germany

98% with tertiary treatment

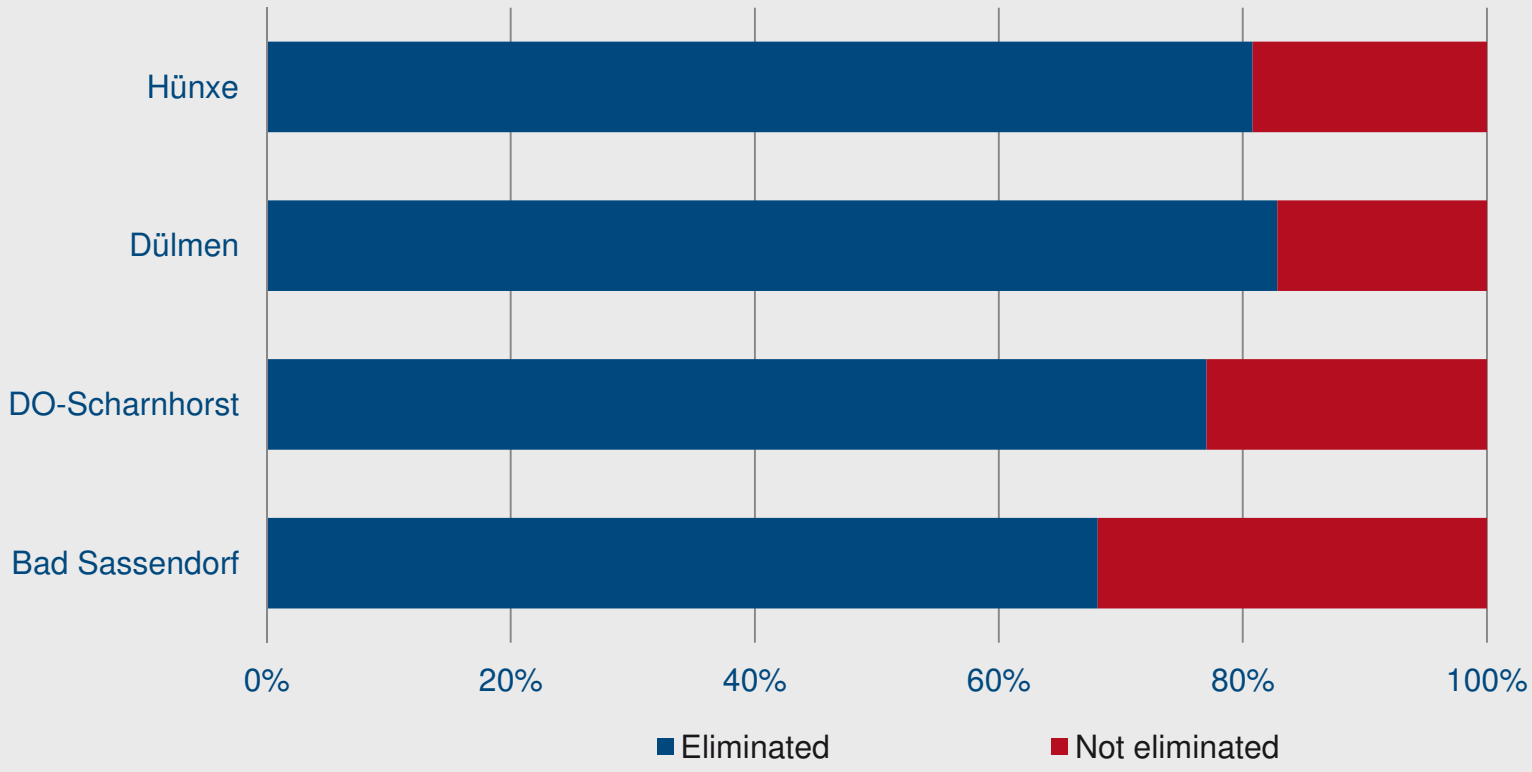
10 billion m³ wastewater per year

Total investment of 1,5 billion EUR (in 2010) for wastewater disposal

Source: BMU 2011; DWA 2009

Elimination of micropollutants in State-of-the-Art UWWTP

Mass balance of 79 micropollutants at four wwtps incl. pharmaceuticals and x-ray contrast media



Effluent concentration of single substances < 2 µg/L

Elimination of some APIs in State-of-the-Art UWWTP

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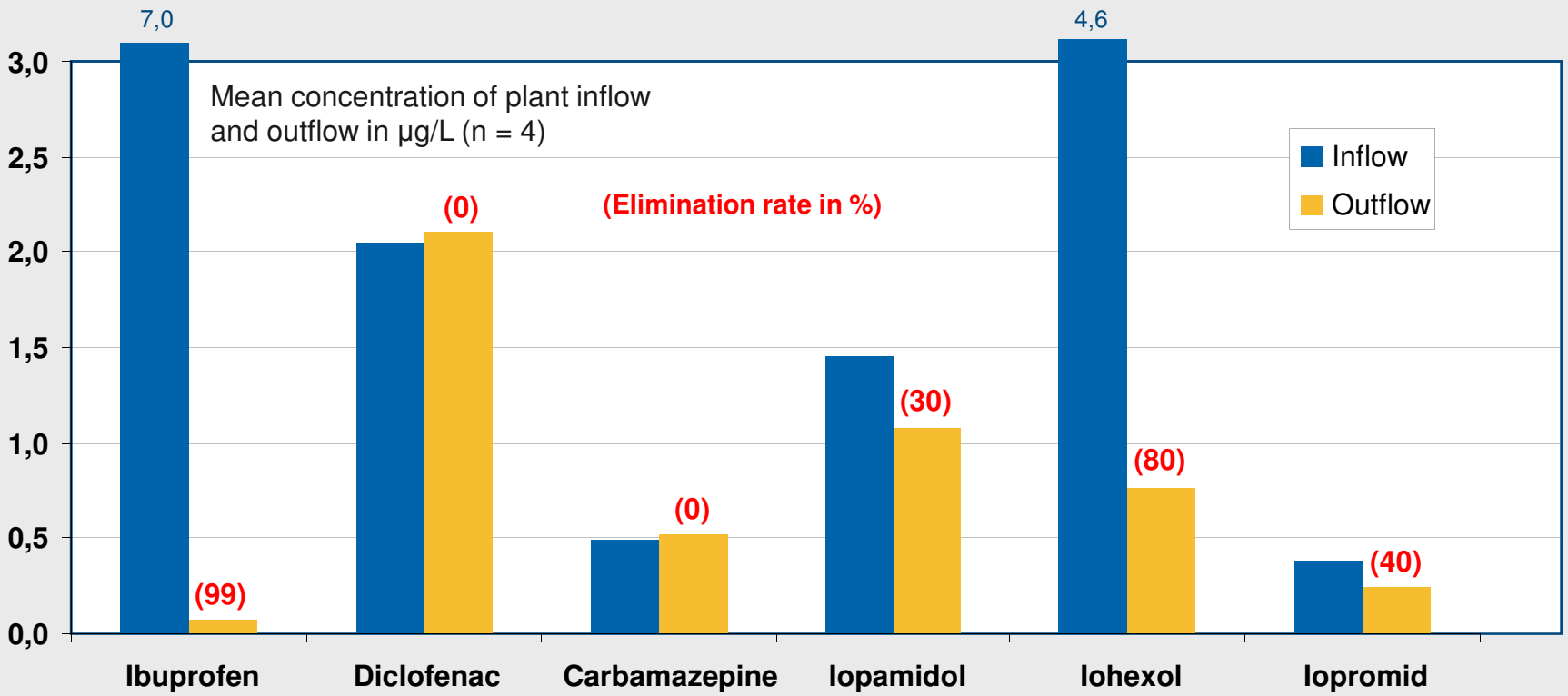

Conventional wastewater treatment plants are
eliminating some pharmaceuticals
but are not able to eliminate all pharmaceutical residues efficiently

Advanced treatment methods

Technologies for the elimination of micropollutants in wastewater

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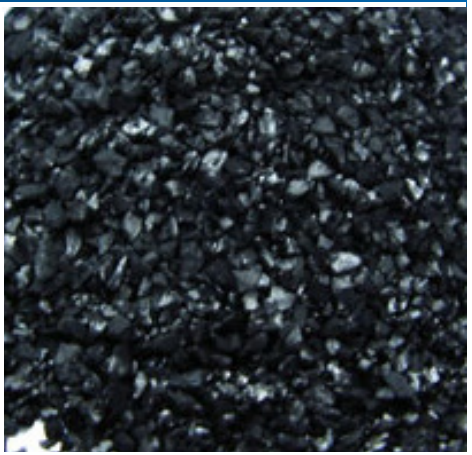

Membrane filtration (Nano, RO)

Oxidation processes

Adsorption on activated carbon

There is still a lack of long-term experiences in operating and monitoring advanced wastewater treatment technologies in "real life”

Some options to reduce pharmaceuticals in waters

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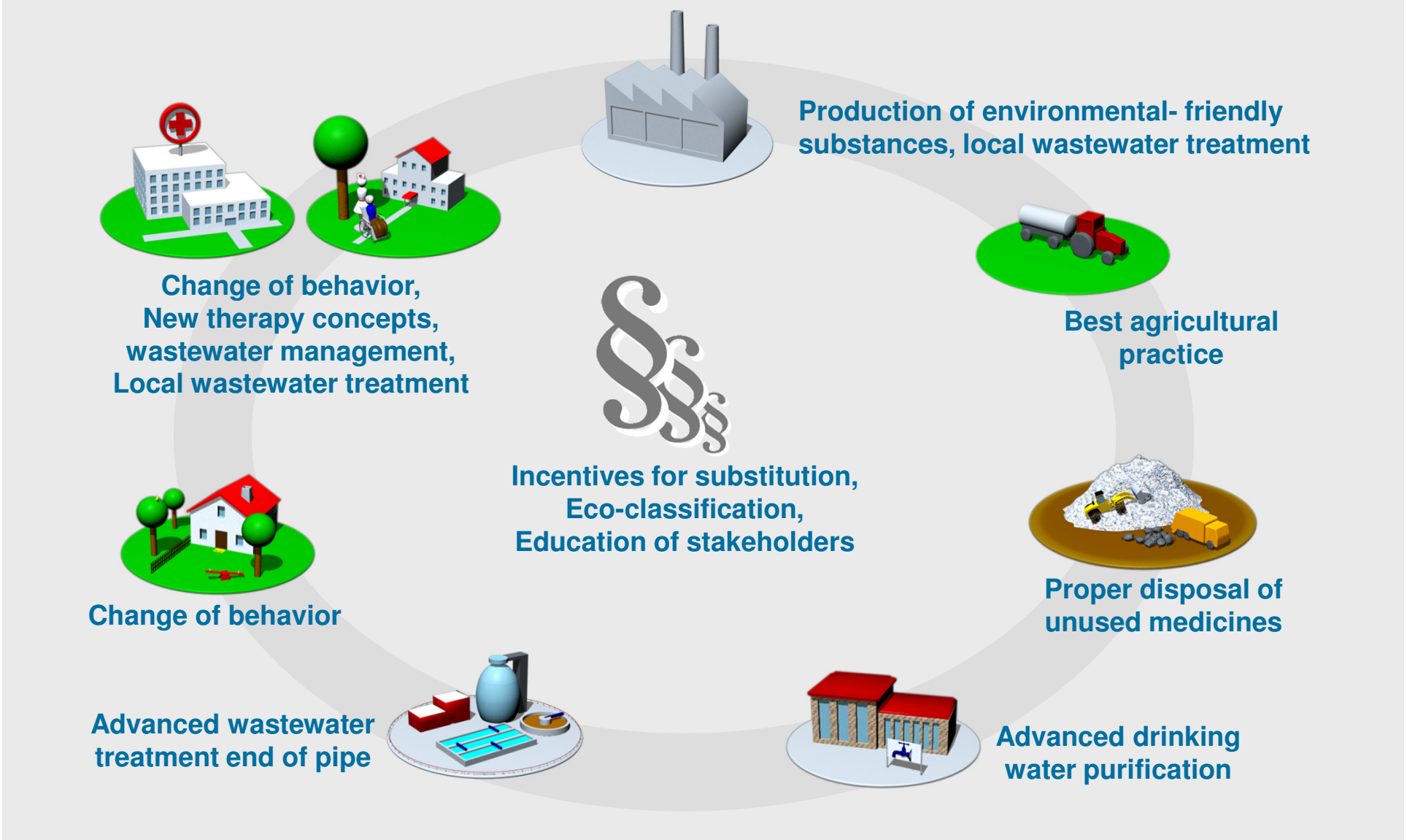

Requirements for advanced treatment technologies

for the elimination micropollutants in municipal sewage treatment plants

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- A broad range of micropollutants should be largely eliminated by the technology
- No problematic by-products should be produced
- Operation of technology should be possible with existing staff
- Technology should lead to a reasonable use of resources (materials, energy, costs)

Our advanced treatment facilities for the elimination micropollutants

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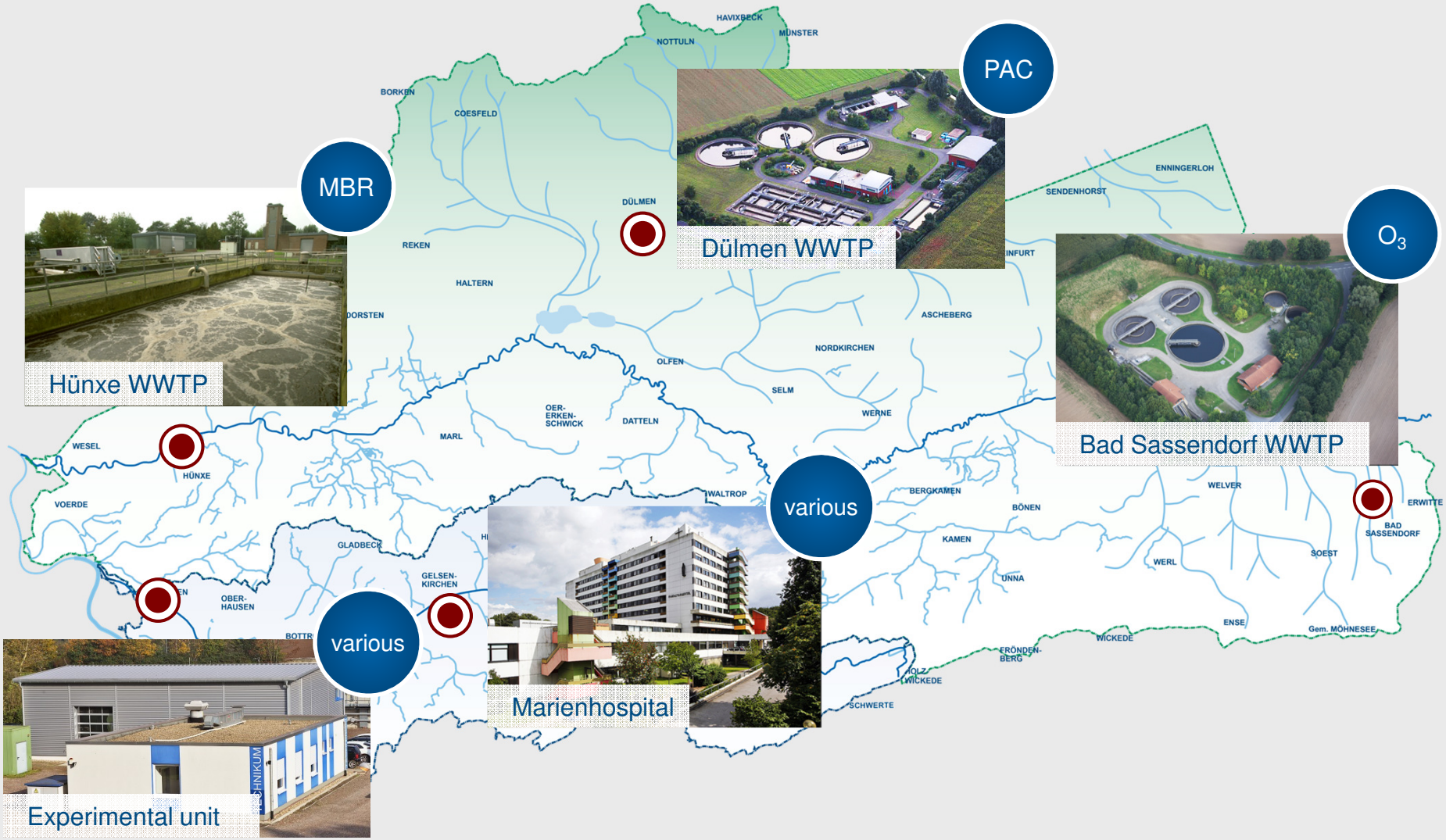
Investigations on technologies for the elimination of micropollutants at large-scale



WWTP Hünxe

Membrane bioreactor and conventional treatment

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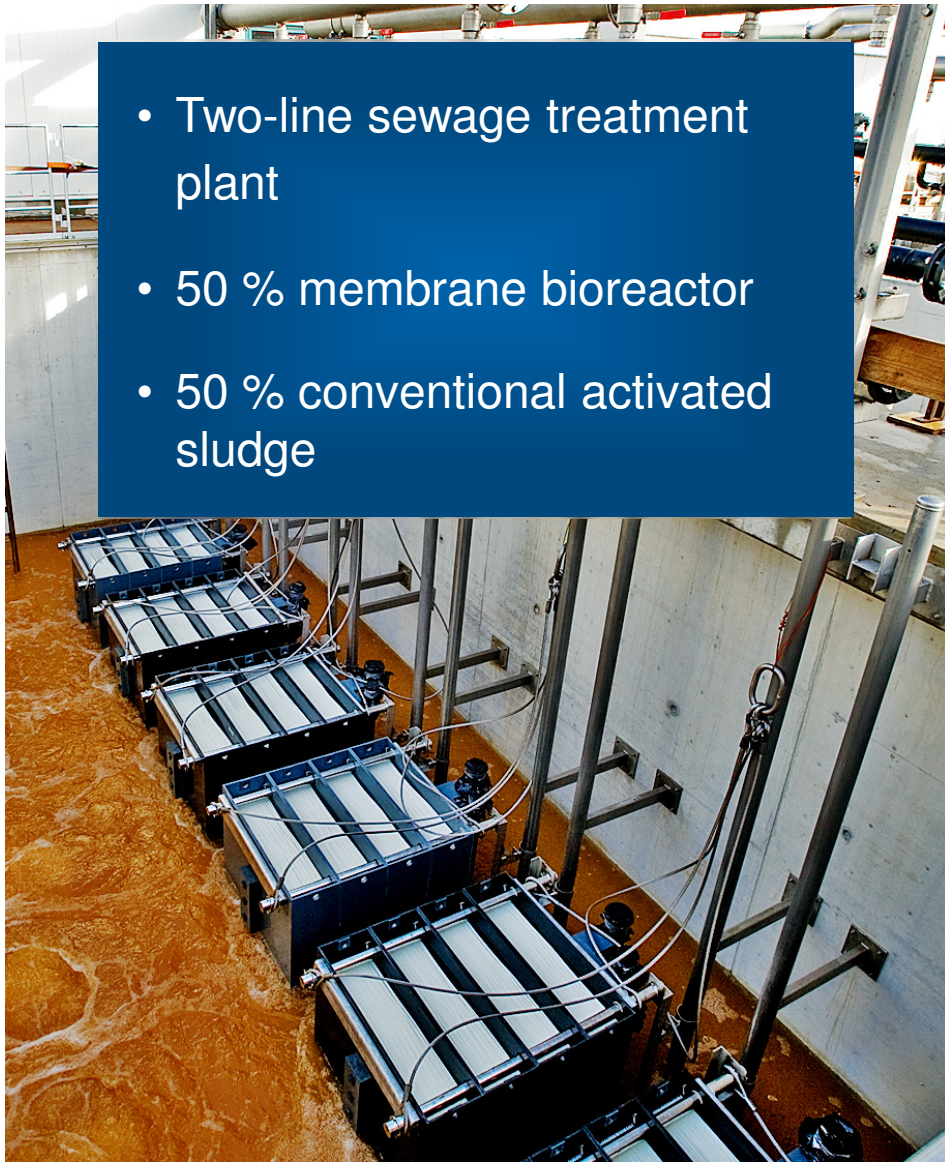
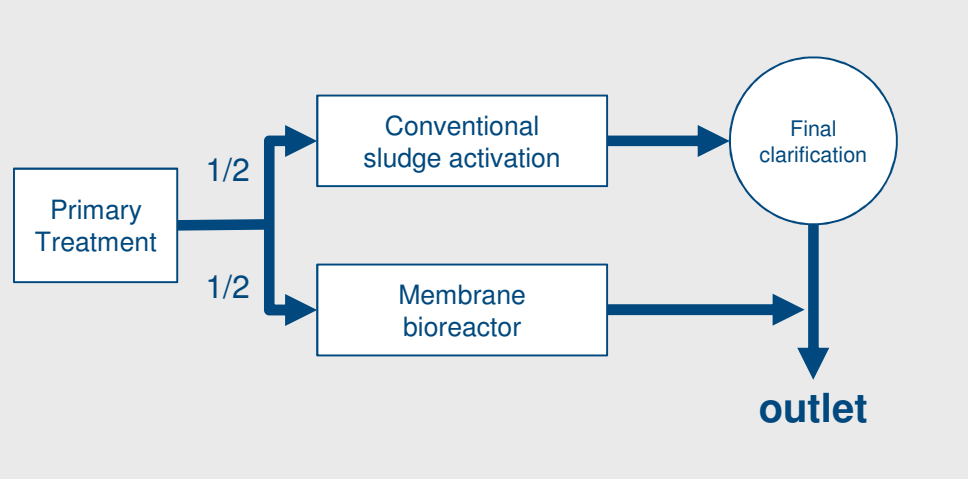
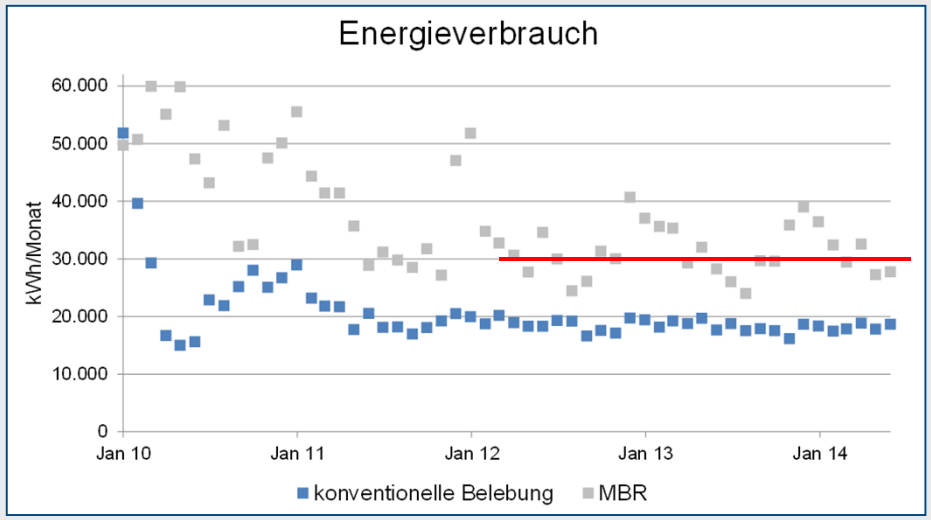


- Two-line sewage treatment plant
- 50 % membrane bioreactor
- 50 % conventional activated sludge

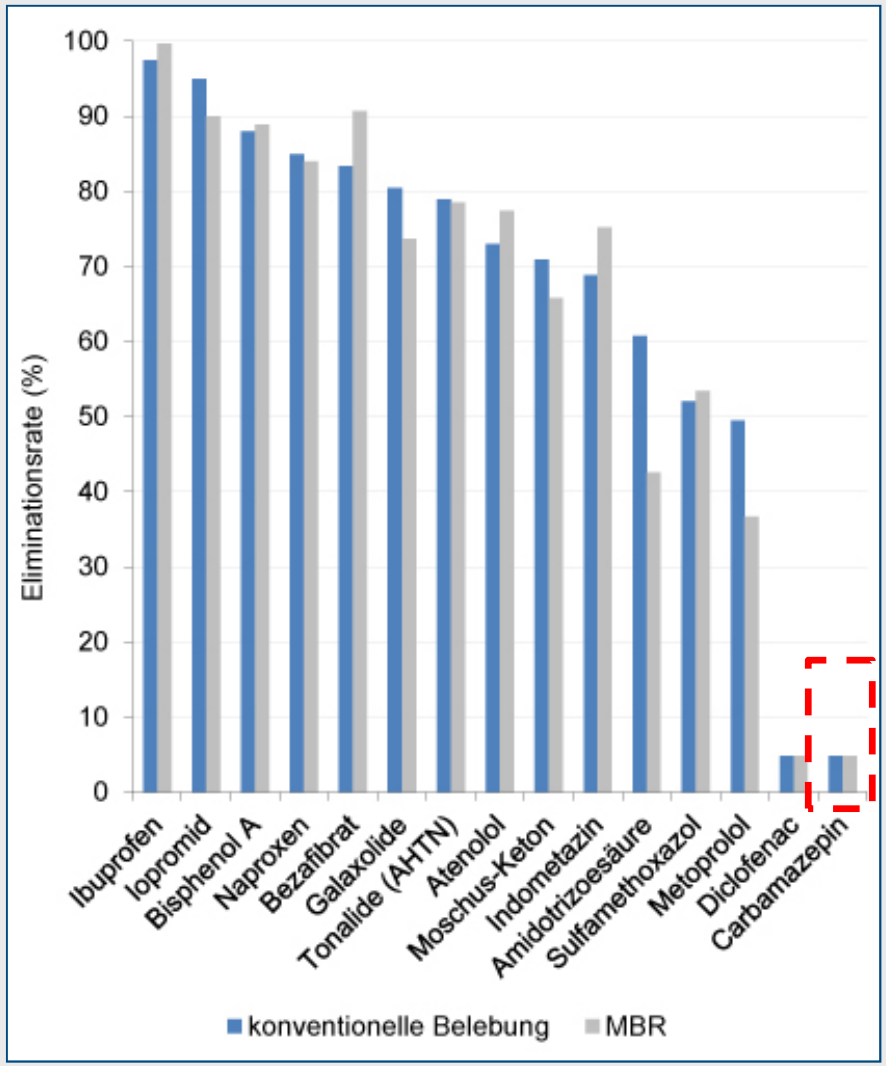


WWTP Hünxe

Energy consumption and elimination of micropollutants



- Energy consumption MBR + 50 %
- Sludge amount MBR - 10 %
- Sludge age MBR >> conventional
- no significant differences regarding the elimination of micropollutants



New technologies are technical challenges for the staff

Membrane bioreactor at WWTP Hünxe

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„Our comparatively young membrane bioreactor is a technical challenge.

The whole staff is thrilled with the good treatment efficiency (reg. organics and nutrients).“

Martin Reitbauer
foreman of the WWTP

Bad Sassendorf WWTP

Full-scale ozonation facility

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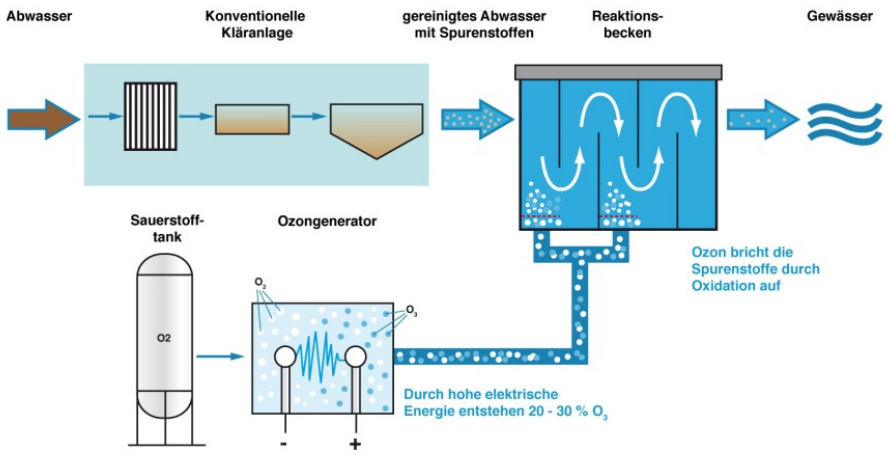
Bad Sassendorf

- 12,000 Inhabitants
- 6 hospitals (1,200 beds)
- Maximum average age in NRW



Bad Sassendorf WWTP

Full-scale ozonation facility

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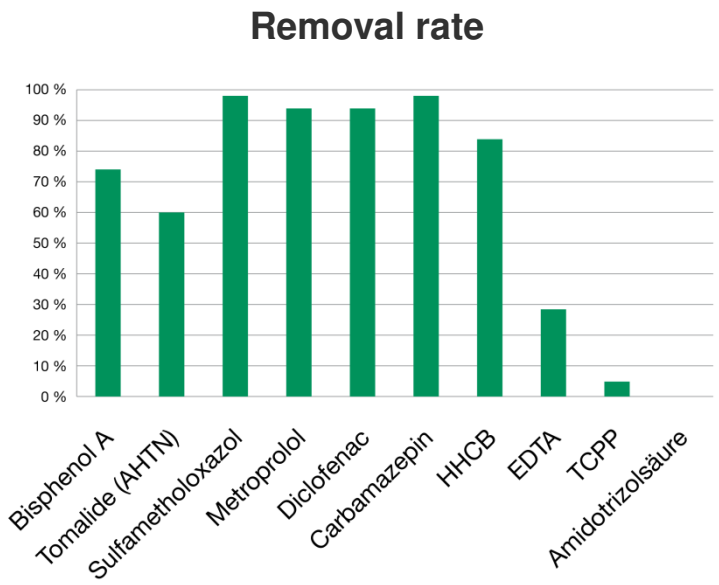
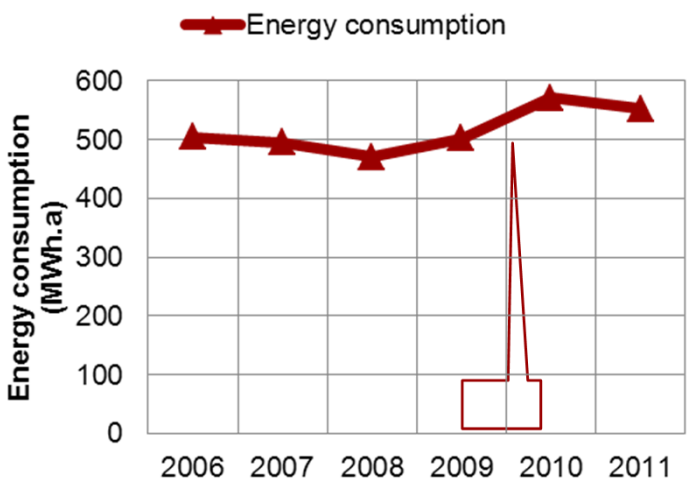
Operation since November 2009

- With ozone dose of 2 mgO_3L:
  > 90 % transformation of fast reacting substances like Diclofenac and Carbamazepine
- With ozone dose of 5 mgO_3/L:
  90 % transformation of moderate reacting substances like Metoprolol
- Less than 20 % transformation of slow reacting substances like Diatrizoate
- Increase of energy consumption between 15 and 50 %





Operation of full-scale ozonation

What indicative parameters for the process control?

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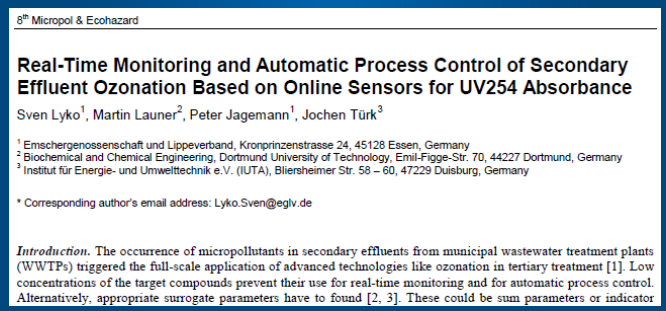
- Target-oriented process control using sum parameters or indirect surrogates?
- Demand oriented process control using online sensors
- Load-proportional ozone dosing
- Simple constant ozone dosing?



8th Micropol & Ecohazard

Real-Time Monitoring and Automatic Process Control of Secondary Effluent Ozonation Based on Online Sensors for UV254 Absorbance

Sven Lyko[1], Martin Launer[2], Peter Jagemann[1], Jochen Türk[3]

[1] Emschergenossenschaft und Lippeverband, Kronprinzenstrasse 24, 45128 Essen, Germany
[2] Biochemical and Chemical Engineering, Dortmund University of Technology, Emil-Figge-Str. 70, 44227 Dortmund, Germany
[3] Institut für Energie- und Umwelttechnik e.V. (IUTA), Bliersheimer Str. 58 – 60, 47229 Duisburg, Germany

* Corresponding author's email address: Lyko.Sven@eglv.de

Introduction. The occurrence of micropollutants in secondary effluents from municipal wastewater treatment plants (WWTPs) triggered the full-scale application of advanced technologies like ozonation in tertiary treatment [1]. Low concentrations of the target compounds prevent their use for real-time monitoring and for automatic process control. Alternatively, appropriate surrogate parameters have to found [2, 3]. These could be sum parameters or indicator

New technologies are technical challenges for the staff

Full-scale ozonation at WWTP Bad Sassendorf

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„Meanwhile the facility is running smoothly with less effort than previously expected.

The measurement technology needs special attention.

Due to ozone as hazardous substance health and safety measures are very important, too.“

Heinz Dieter Marschewski
foreman of the WWTP

Powdered activated carbon

Dülmen WWTP – start of operation 20. May 2015

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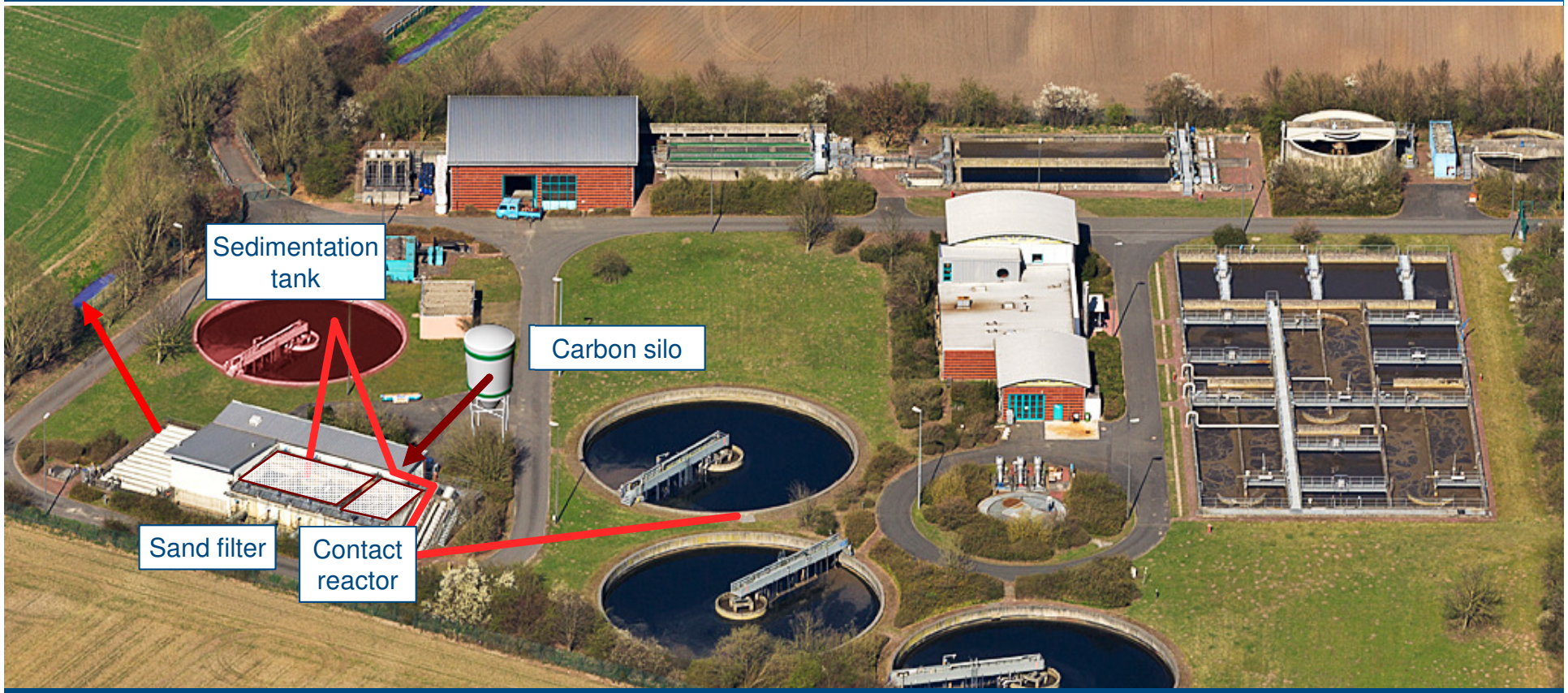

- 55,000 population equivalents
- Investment 3.8 mill. Euro
- construction start May 2014
- reactor volume for activated coal 360 m³
- sedimentation tank 1.440 m³
- Partly use of existing sand filter as contact reactor

Good status after the elimination of micropollutants at the WWTP?

Monitoring the effects of the advanced wastewater treatment

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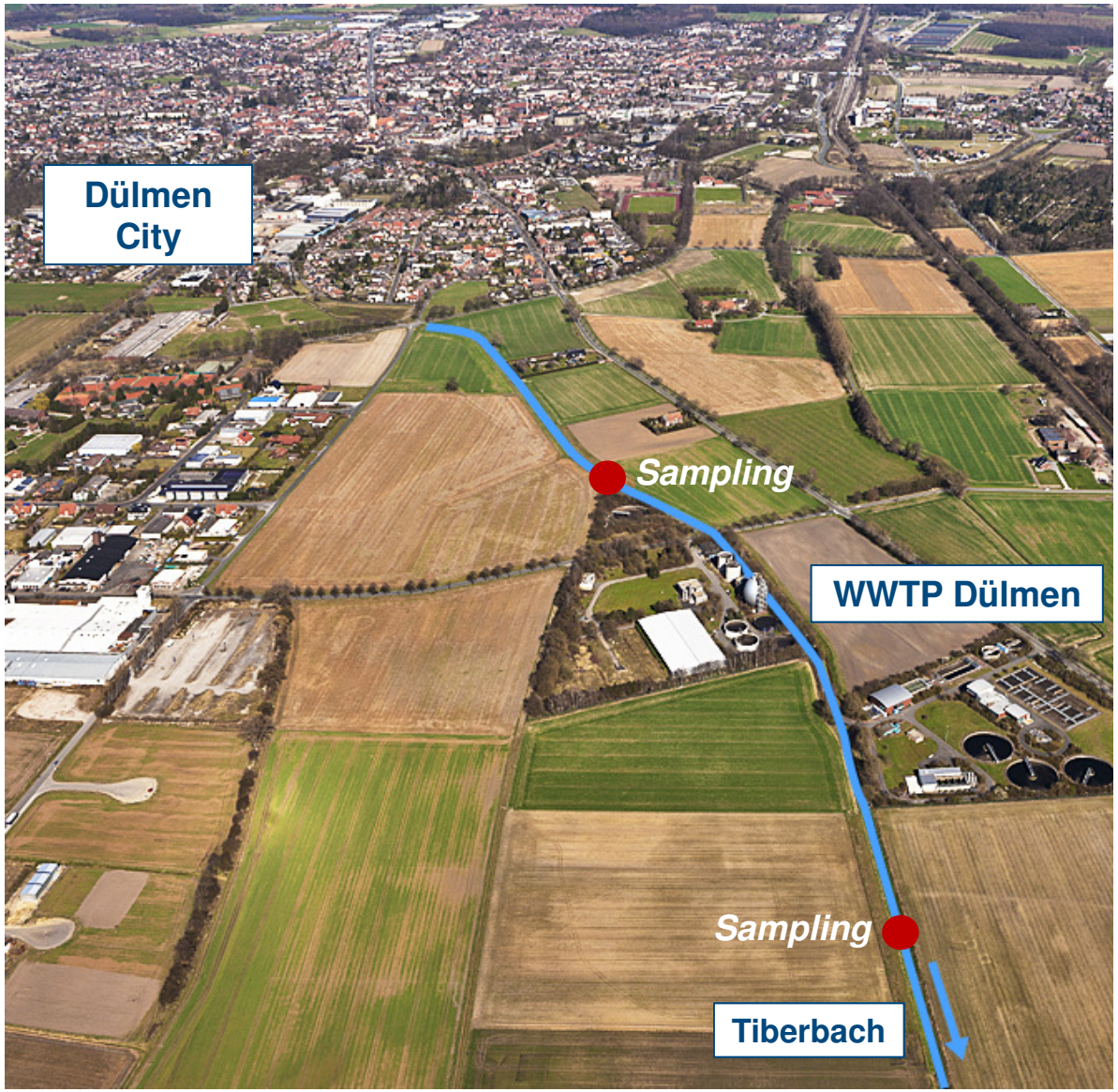
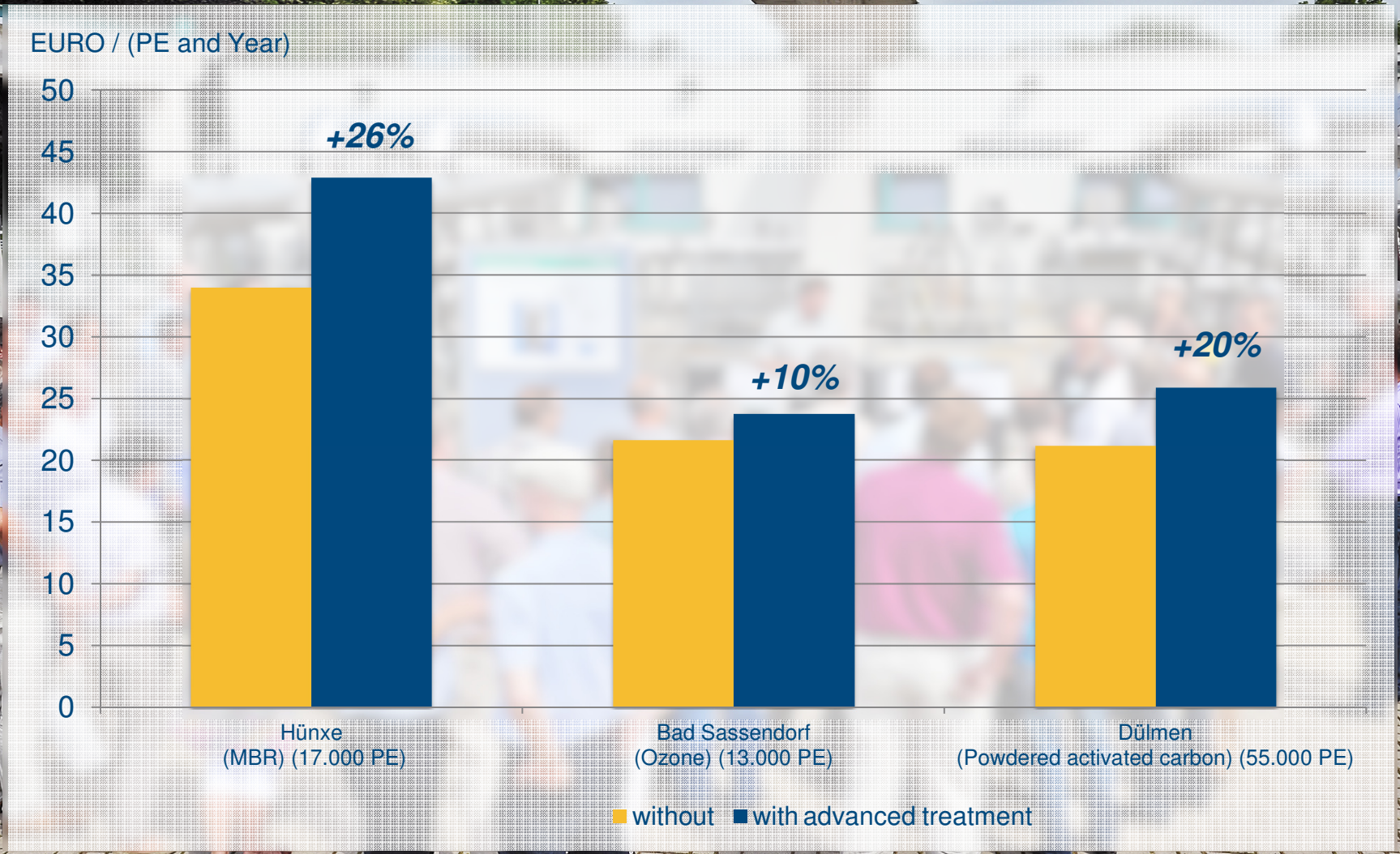


- Sampling campaigns before and after micropollutants elimination in the WWTP
- Monitoring of the chemical and ecological status of the river according WFD
- River sediment analysis
- Analysis of stress markers in aquatic organisms

Operational costs

Costs increase due to additional technologies for the elimination of micropollutants



A new topic

Microplastics in water und wastewater

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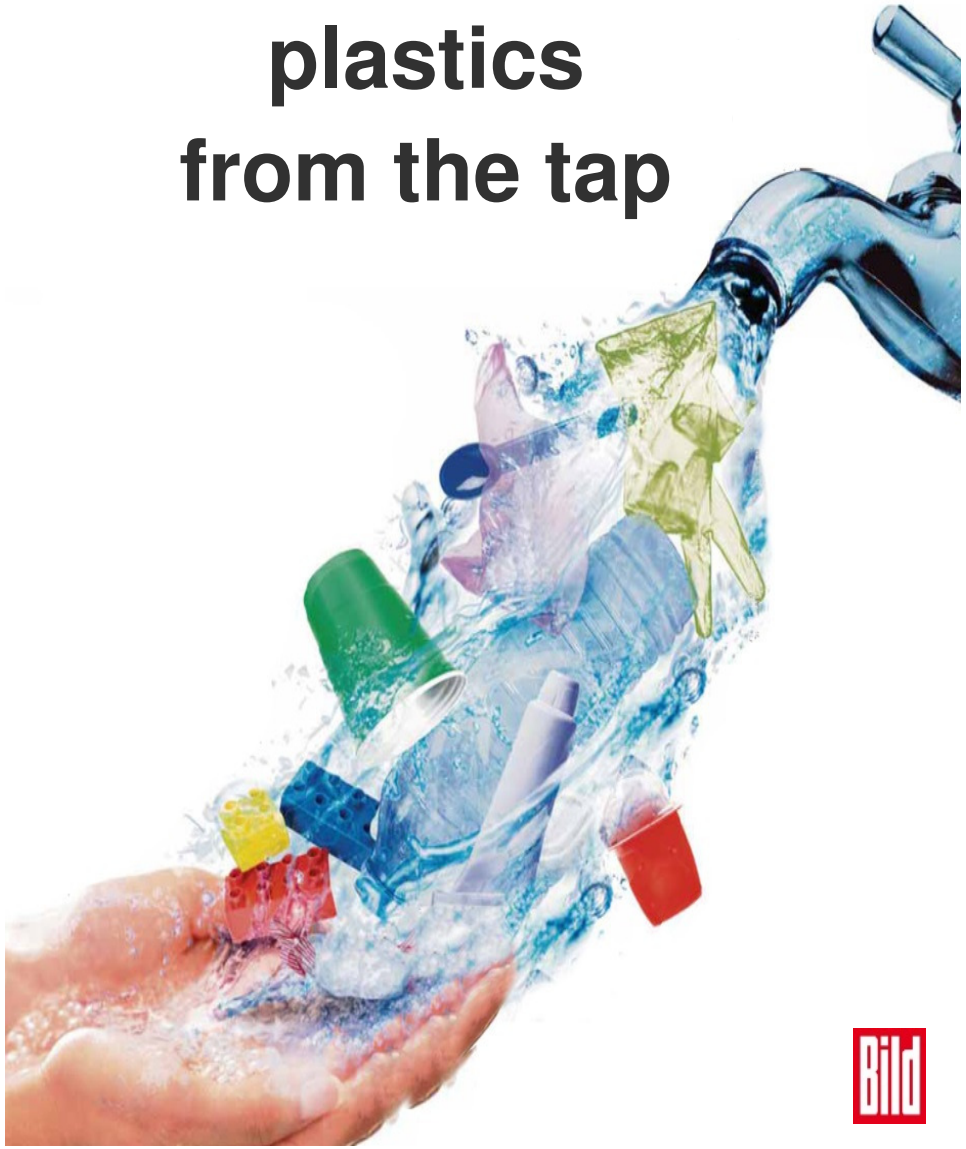

- Microplastic detected in wastewater and in freshwater ecosystems
- Relevance of pathways to environmental compartments unknown

Sustainable approach: producers should abandon the use of these microplastics in products

Experimental unit

for technical and economic improvements

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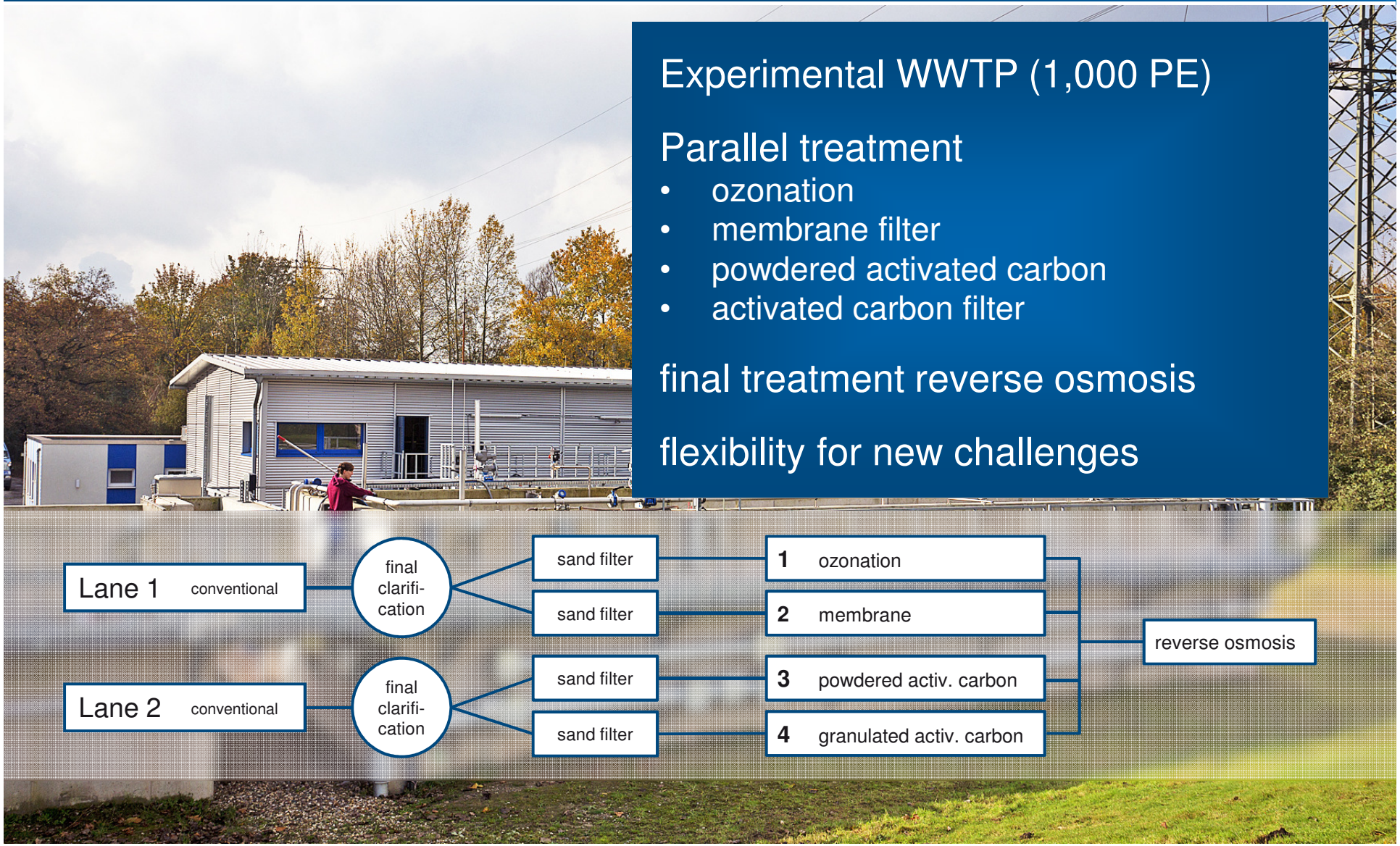

Experimental WWTP (1,000 PE)

Parallel treatment

- ozonation
- membrane filter
- powdered activated carbon
- activated carbon filter

final treatment reverse osmosis

flexibility for new challenges

Implementation of WFD in Germany

Is the elimination of micropollutants required to achieve good status?

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- Chemical status of surface waters: mainly good, but some deficits regarding e.g. mercury, PAHs, pesticides
- Ecological status of surface waters: mainly good, but some deficits regarding e.g. heavy metals, pesticides
- Detection of non-regulated micropollutants (no EQS, e.g. pharmaceuticals) in surface waters – impact on the ecological status?
- Measures regarding micropollutants in the draft River Basin Management Plan and Program of Measures of the federal state of North Rhine Westphalia:
  - Monitoring of sewage treatment effluents
  - Feasibility studies for the implementation of micropollutants elimination technologies at sewage treatment plants
  - Implementation of micropollutants elimination technologies at sewage treatment plants

Mitigation options

The whole life cycle of micropollutants should be considered

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Production → **Usage** → **Disposal**

- Wastewater is one of several pathways sources of micropollutants into waters – Wastewater treatment plants are not the source of the problem but could play a role for mitigation.
- End-of-pipe strategy at wastewater treatment plants excludes several pathways.
- Implementation of advanced wastewater treatment should be based on a broad social acceptance and legal requirements.
- The polluter-pays principle should be considered adequately.
- Stakeholder engagement and public awareness raising is required for sustainable source control measures!

Thank you for your attention!

Acknowledgements:

Investments of the ozonation plant in Bad Sassendorf, the membrane bioreactor in Hünxe, the activated carbon facility in Dülmen and the experimental unit were co-financed by the ministry of environment of North-Rhine Westfalia

Investments of the activated carbon facility in Dülmen were co-financed in the framework of the EU INTERREG IV B project noPILLS