Project Demoware - Overview and Water Reuse Europe

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Innovation Demonstration for a Competitive and Innovative European Water Reuse Sector

Cranfield UNIVERSITY

IRTA INVESTIGACIÓN Y TECNOLOGÍA AGROALIMENTARIAS

AMPHOS 21 SCIENTIFIC AND STRATEGIC ENVIRONMENTAL CONSULTING

MEKOROT ISRAEL NATIONAL WATER CO.

n|w Fachhochschule Nordwestschweiz

vendée eau

IRSA CNR

ROTEC

Thames Water

Blue Biolabs

GLOBAL CAD

DOW

IWVA Kring-Lopend Water is ons Ambacht

a·r·t·i Agenzia regionale per la tecnologia e l'innovazione

ACTeon environment research & consultancy

Fiordelisi

VEOLIA ENVIRONNEMENT

KWR

Consiglio Nazionale delle Ricerche

GRUP cassa EXPERTS EN AIGUA, ENERGIA I MEDI AMBIENT

PML Innovative Particle Monitoring Technologies

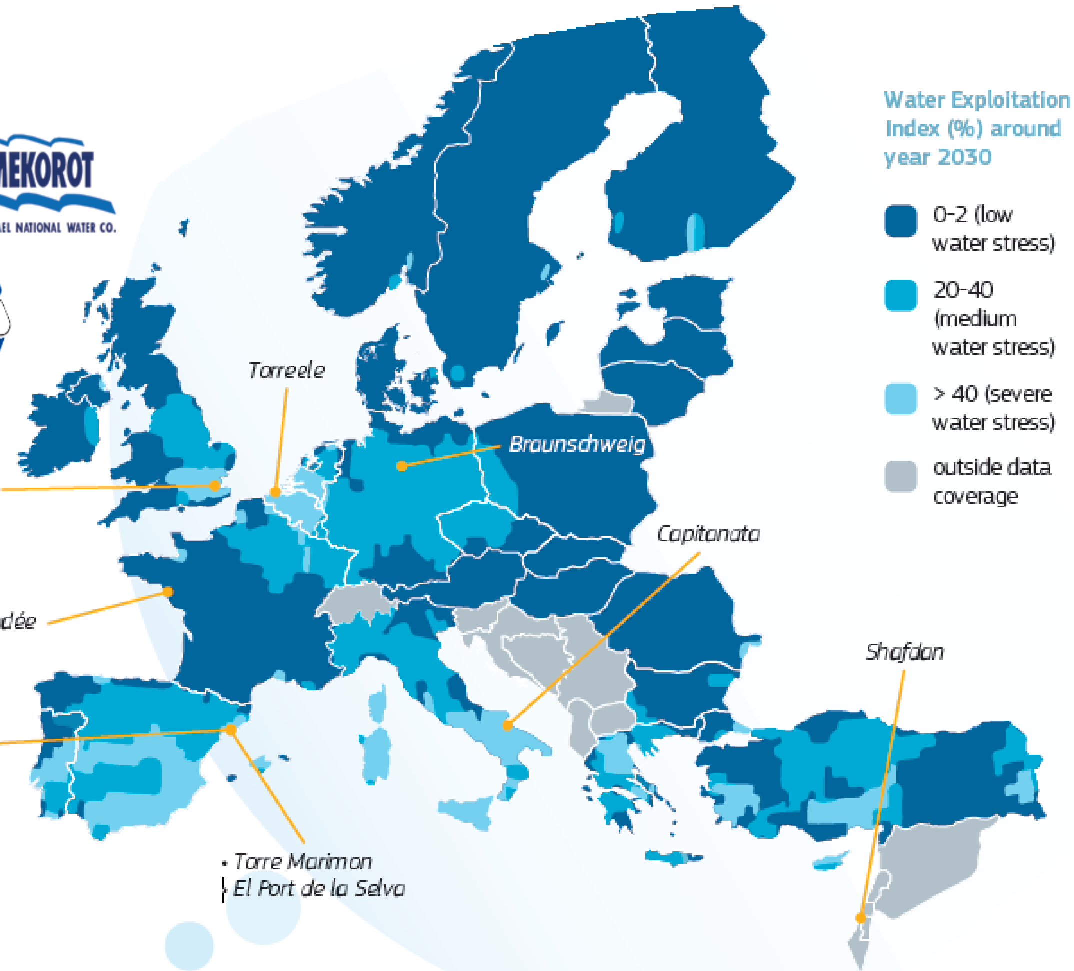
biomonitech

KOMPETENZZENTRUM Wasser Berlin

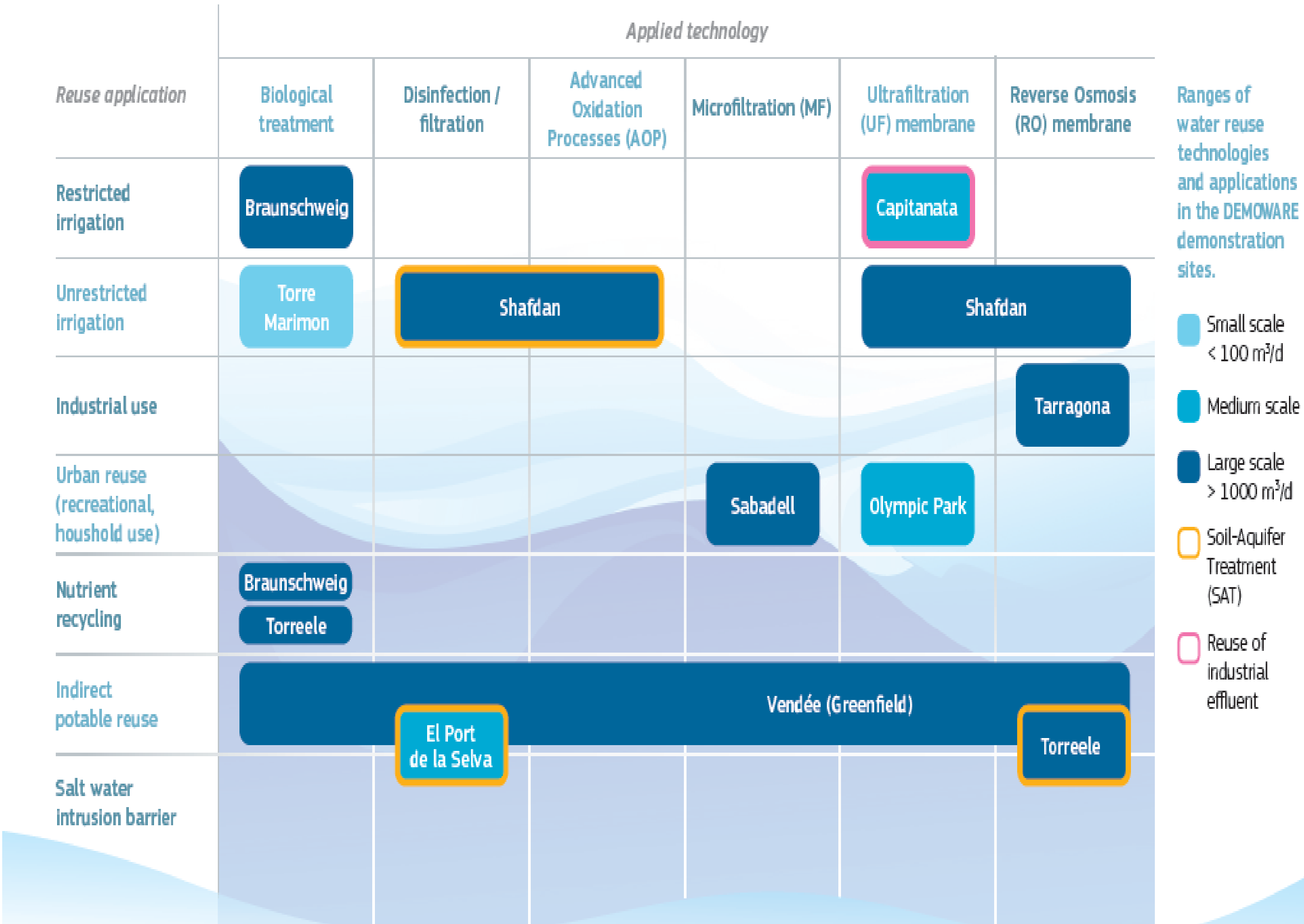
HidroQuimia

European Commission JOINT RESEARCH CENTRE The European Commission's in-house science service

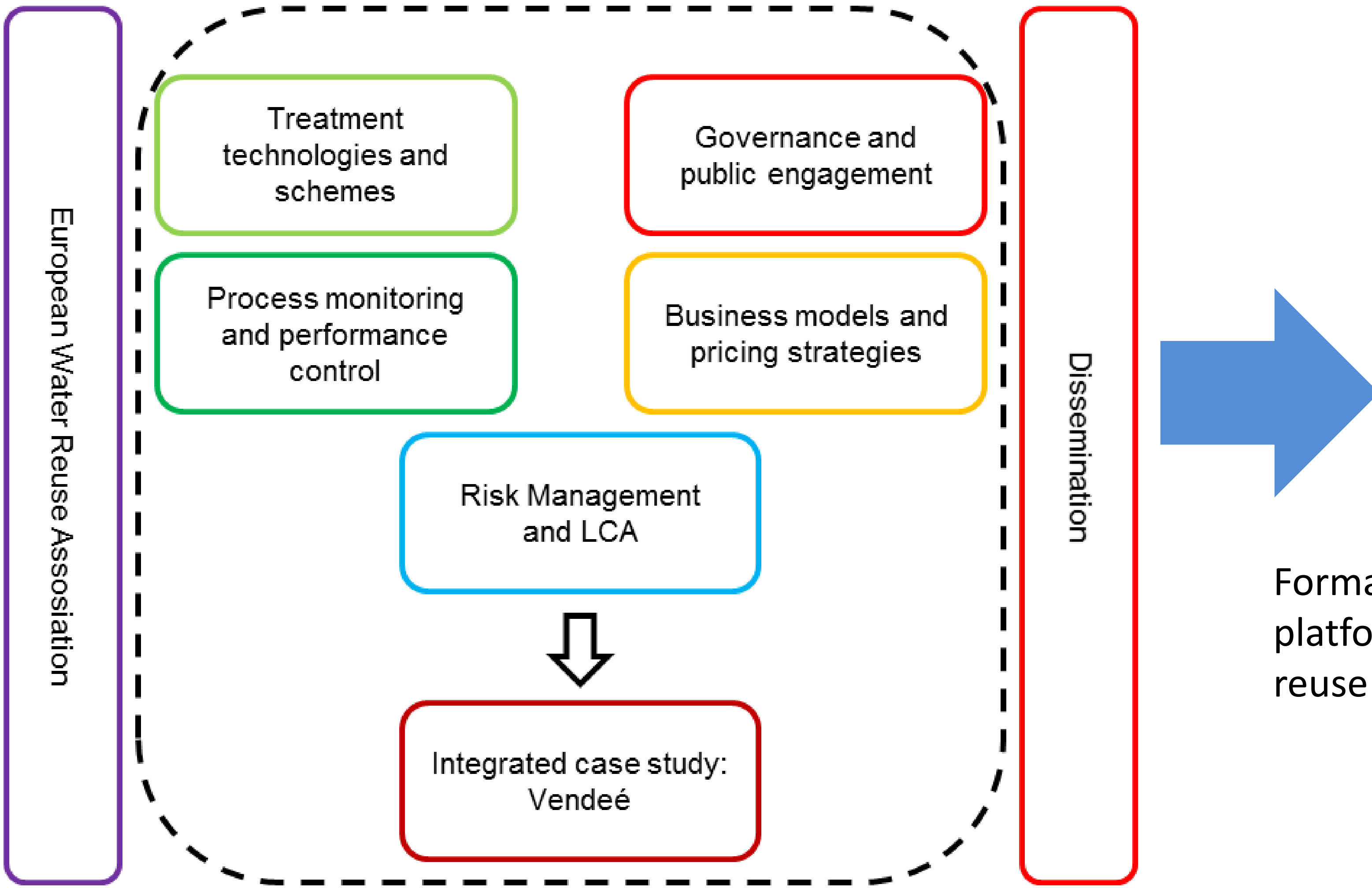
ctm CENTRE TECNOLÒGIC



Case studies



Project structure



Formation of platform for the EU reuse industry

Water Reuse Europe (WRE)

Water
Reuse
Europe

The trade association for organisations involved in the European water reuse sector.

WRE’ mission is to create a collective identity for the European **water reuse sector** and promote an innovative and dynamic **water reuse industry**.

WRE’s objectives

To facilitate knowledge exchange amongst public and private entities involved in water reuse;

To promote European expertise and services in water reuse to a global audience;

To support European companies (particularly SMEs) in their efforts to commercialise water reuse solutions;

To promote research and innovation on water reuse.

Water Reuse Europe

Official launch by the end of 2015!

Stay connected at: http://www.water-reuse.eu

For more information on WRE and membership, please contact the WRE Secretariat at:

info@wre-reuse.eu

Results from disinfection trials at WWTP Steinhof

Ulf Miehe, Johan Stüber, Ludwig Reichelt (KWB)

Christoph Siemers, Florian Grass (SE/BS)

Background and Outline

1. Motivation
   - Initial situation
   - Results from microbial risk assessment
2. Pilot trial on disinfection
   - Ambition
   - UV disinfection
   - Performic acid disinfection (PFA)
3. Cost estimation
   - UV vs. PFA

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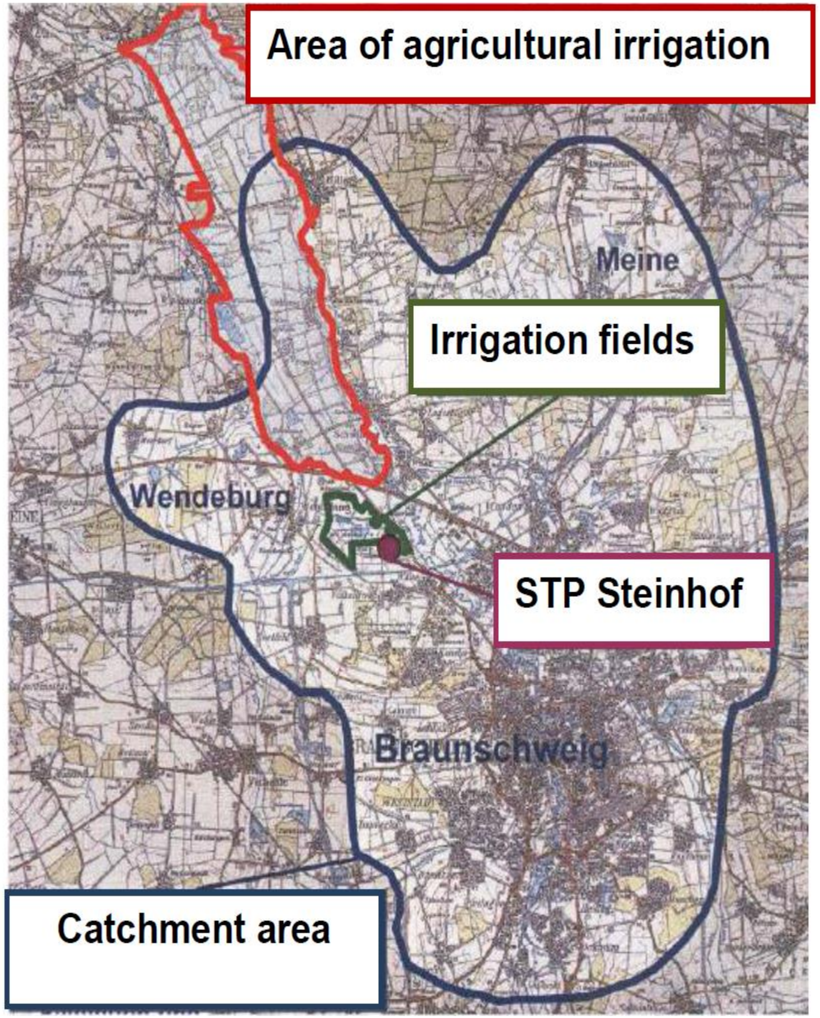
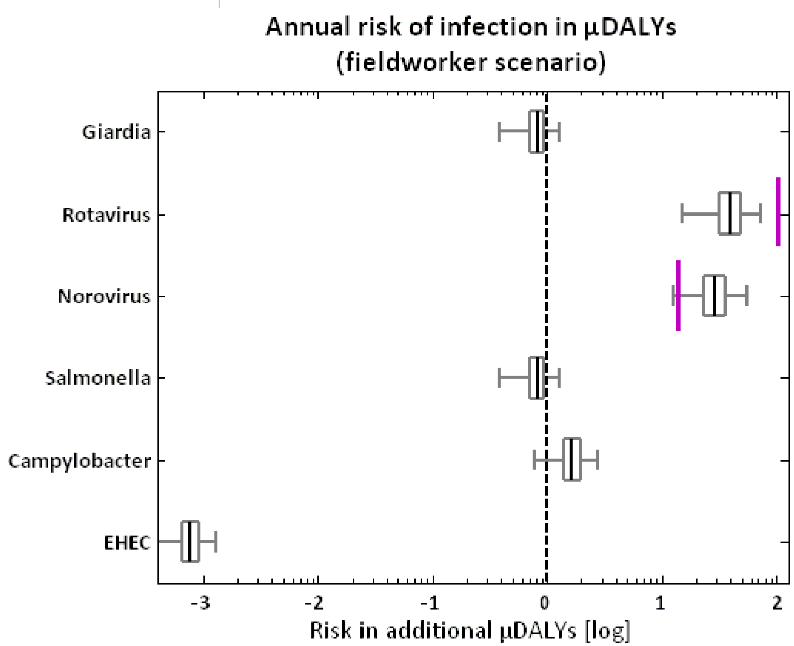
Motivation: Water reuse in Braunschweig



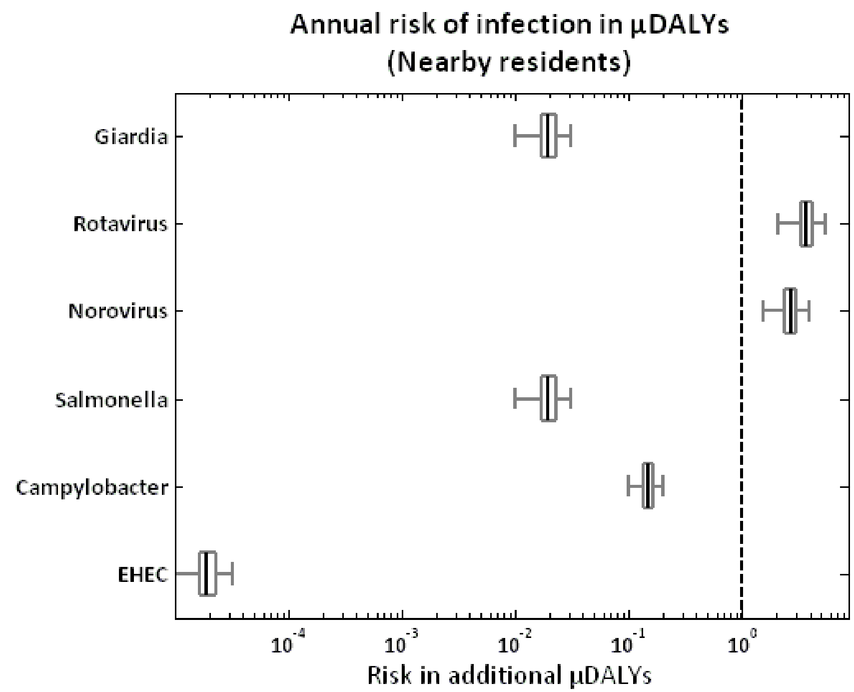
- Secondary effluent is used for irrigation via sprinkler irrigation
- Microbial parameters not regulated in legal permission
- No directly consumed crops produced
- Minimum distance to local communities regulated (60-150m)
- During summer: digested sludge is added to the irrigation water (thermophilic+mesophilic digestion → excluded in RA)

Motivation: First risk assessment based on literature data



For comparison:
Present background risk in Germany:

Rota: 110 µDALYs pppy
Noro: 14 µDALYs pppy



Calculated risk resulting from viruses exceed the tolerable level of 1µDALY (WHO):

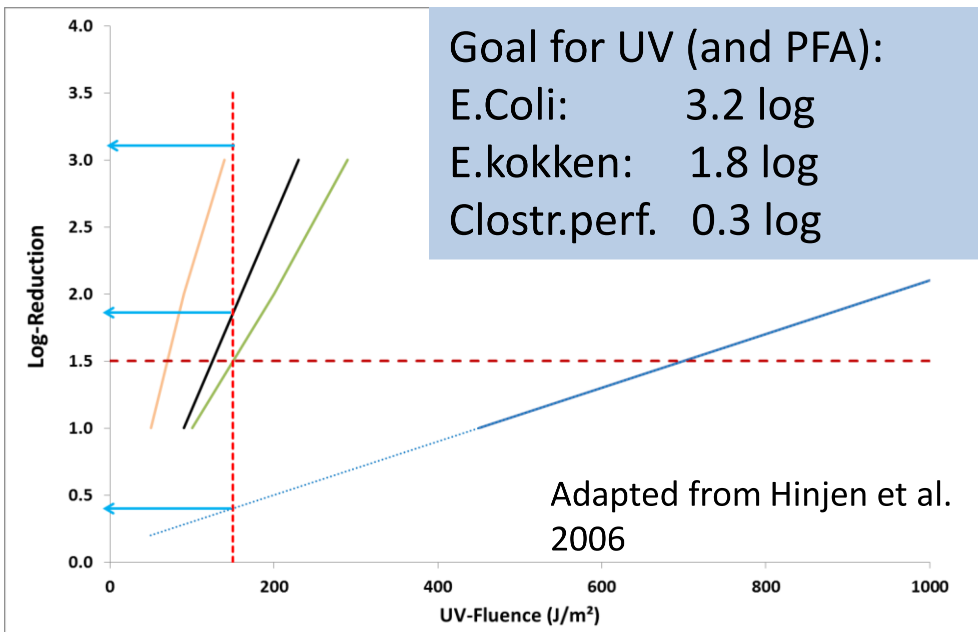
1. Need to perform QMRA study with field data on microbial parameter
2. Possible countermeasures should be assessed

Disinfection target

Parallel Approach

Indirect target: 1.5 log reduction for Rotavirus

Goal for UV (and PFA):
E.Coli: 3.2 log
E.kokken: 1.8 log
Clostr.perf. 0.3 log



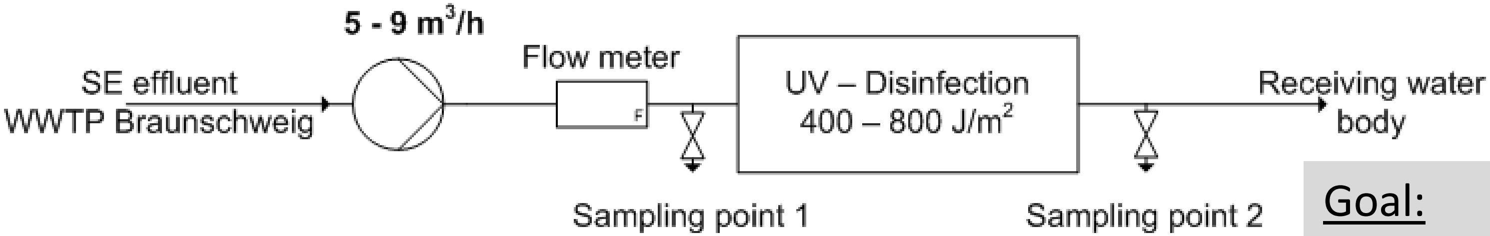
Adapted from Hinjen et al. 2006

Direct target: class 3 according to DIN19650: “Bewässerung - Hygienische Belange von Bewässerungswasser”

Intest. Enterococci	≤ 400 MPN/100 mL
Escherichia Coli	≤ 2000 MPN/100 mL

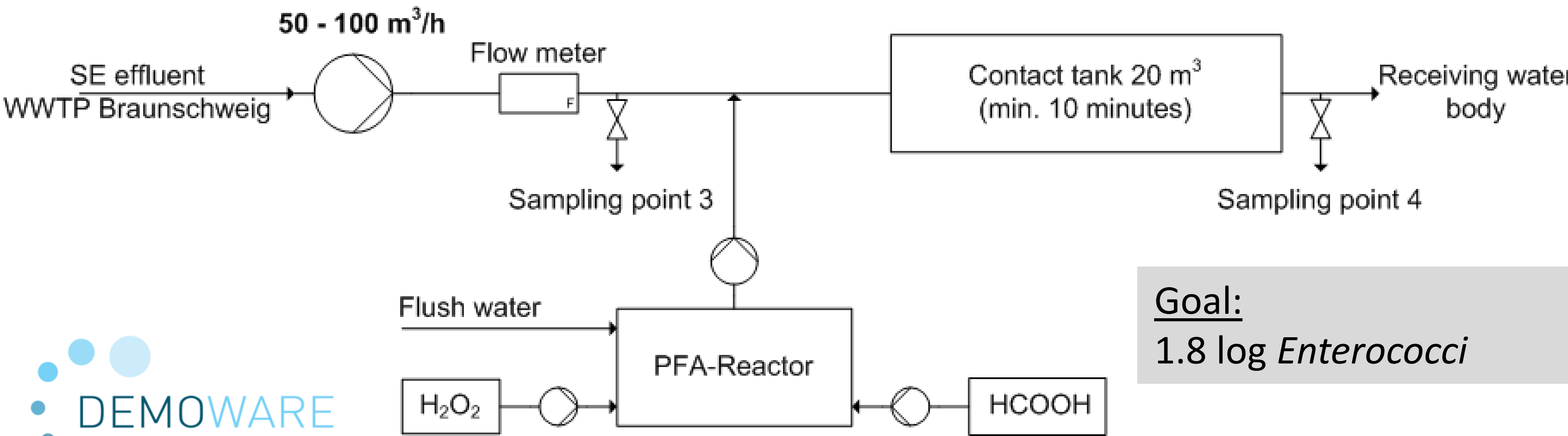
Pilot units

UV disinfection



Goal:
3.2 log *E.Coli*
1.8 log *Enterococci*
0.3 log *Clostrid. perf*.

Chemical disinfection (Performic acid)



Goal:
1.8 log *Enterococci*

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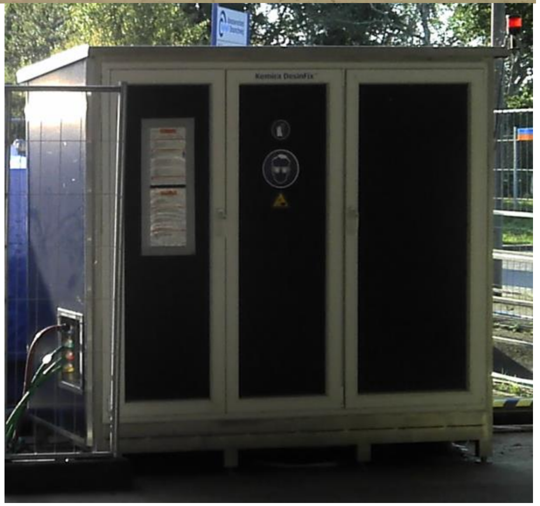
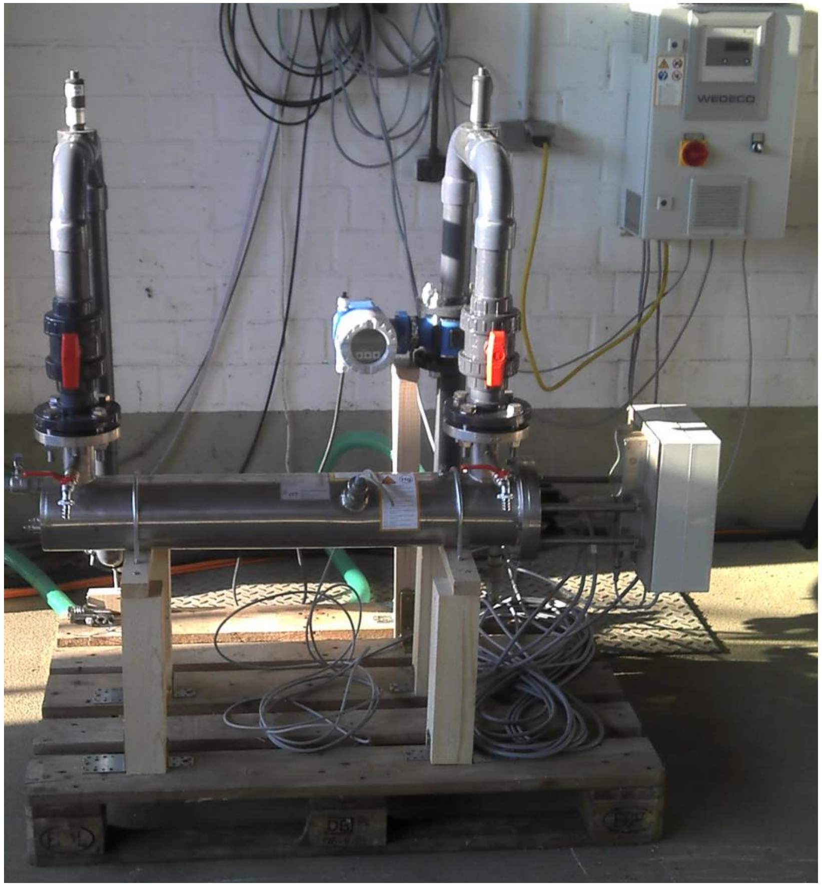
Pilot trials at WWTP Steinhof



Chemical disinfection



UV Disinfection

Trial planning + monitoring

Phase 1 (6 Weeks):
- Variation of dosing
  - low – medium – high

	low	medium	high
PFA (ppm)	1,4	2,0	2,7
UV (Wh/m^3)	27	32	44

- Goal:
  - Disinfection performance at changing water quality
  - Setting of dosing conditions for phase 2

Phase 2 (6 weeks):
- Evaluation of disinfection performance with dosing conditions defined in phase 1

Analyses

Standard parameter – WWTP Steinhof lab

Bacteria:
E.Coli, Enterokokken, Clostridium perfringens – Labor UCL

Virus:
Somat. Coliphagen – Labor BWB

Disinfection performance Phase 1

			UV [Wh/m³]				PFA[ppm]			
		Indirect Target	27	32		44	1.4		2.0	2.7
E. Coli	$\log(N_0/N)$	3.2	2.7	3.0		3.7	1.6		1.9	2.6
E. Cocci	$\log(N_0/N)$	1.8	1.8	2.1		2.7	1.5		1.8	2.4
Clostridium perfringens	$\log(N_0/N)$	0.3	0.4	0.5		0.4	0.1		0.2	0.3
Coliphages	$\log(N_0/N)$		3.2	4.0		3.6	2.6		2.4	2.5

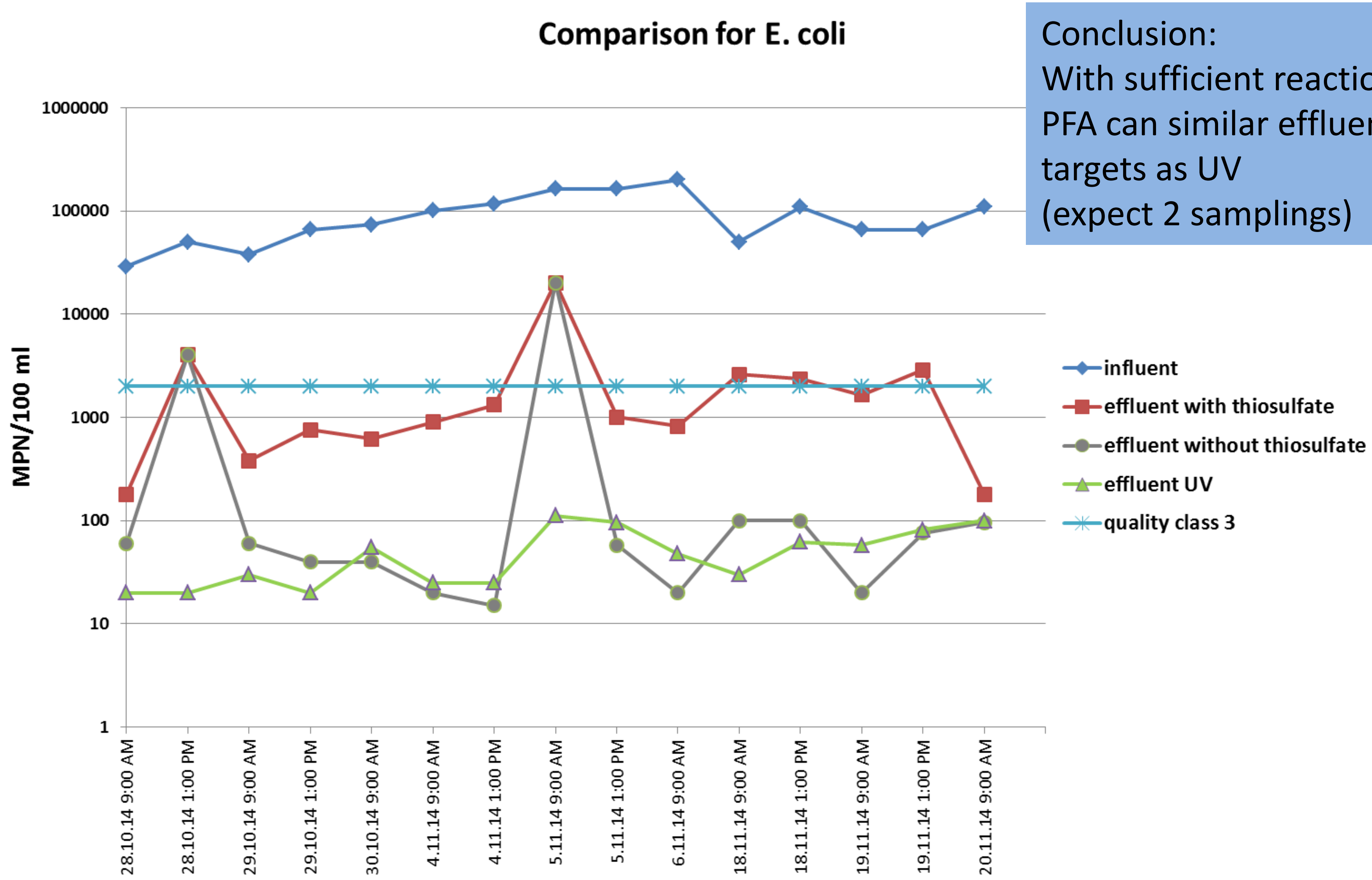
UV disinfection:

- Performance as expected → 35 Wh/m³ (~ 700 J/m²) for Phase 2

Perfomic acid:

- Performance lower as expected
- Tracer test revealed short cutting in reaction tank → minimal HRT only 3 min
- 2 ppm chosen for phase 2 (but additional samples to be taken without thiosulphate dosing during sampling (thiosulphate stops the reaction)

Stability of disinfection and effect of reaction time (Benchmark 2000 E.Coli/100 mL)



Conclusion:
With sufficient reaction time PFA can similar effluent targets as UV
(expect 2 samplings)

Disinfection performance Phase 1+2

			UV [Wh/m³]				PFA[ppm]			
		Indirect Target	27	32	35	44	1.4	2.0*	2.0	2.7
E. Coli	$\log(N_0/N)$	3.2	2.7	3.0	3.2	3.7	1.6	3*	1.9	2.6
E. Cocci	$\log(N_0/N)$	1.8	1.8	2.1	2.3	2.7	1.5	2.3*	1.8	2.4
Clostridium perfringens	$\log(N_0/N)$	0.3	0.4	0.5	0.4	0.4	0.1	0.4*	0.2	0.3
Coliphages	$\log(N_0/N)$		3.2	4.0	4.3	3.6	2.6	n.a.	2.4	2.5

* Without stopping the reaction with thiosulphate (HRT > 6-10 min)

UV disinfection:

- Performance as expected → 35 Wh/m³ (~ 700 J/m²) for Phase 2

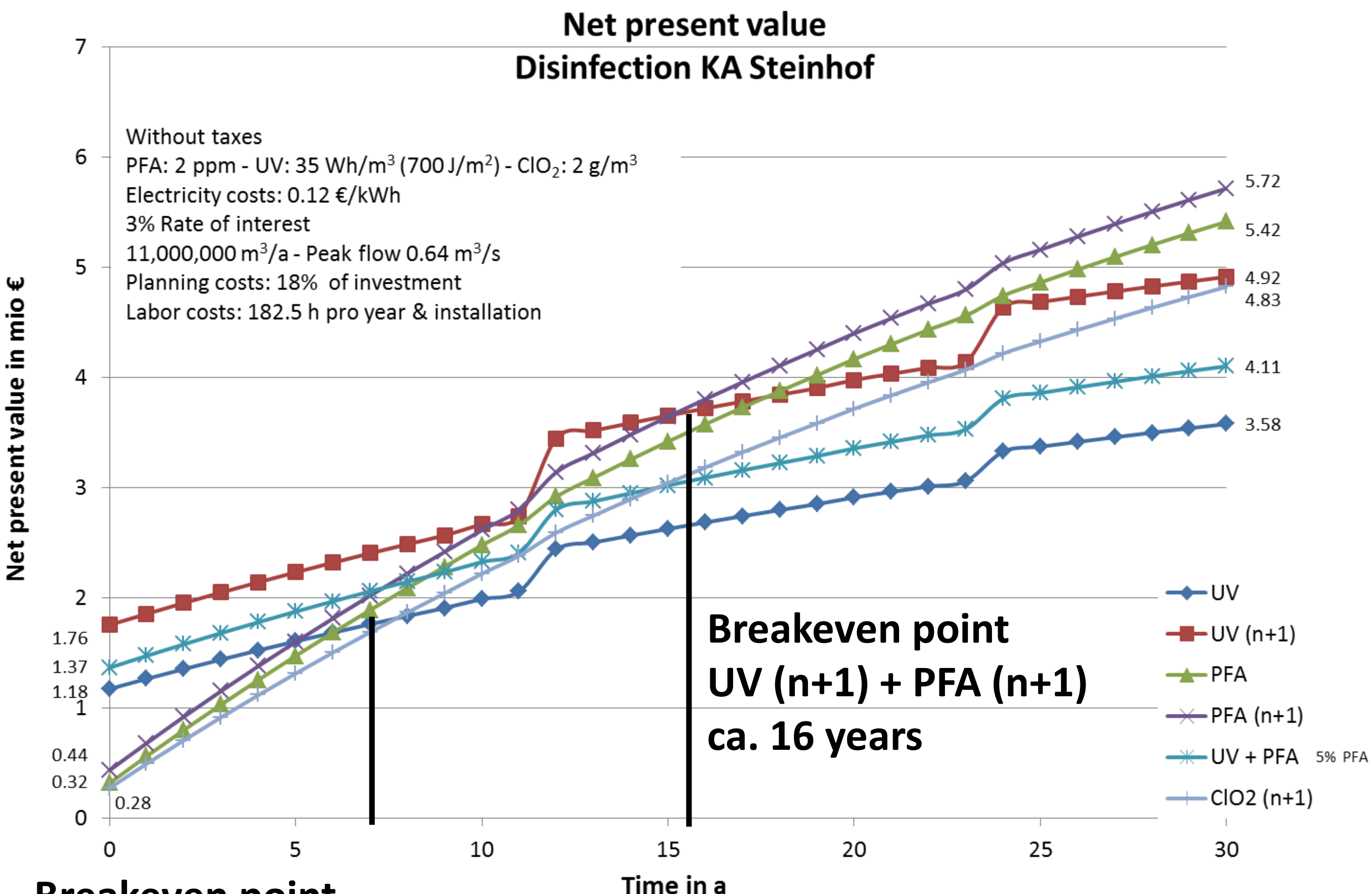
Perfomic acid:

- Performance with longer HRT (> 6-10 min) in the range of UV

Conclusion disinfection performance

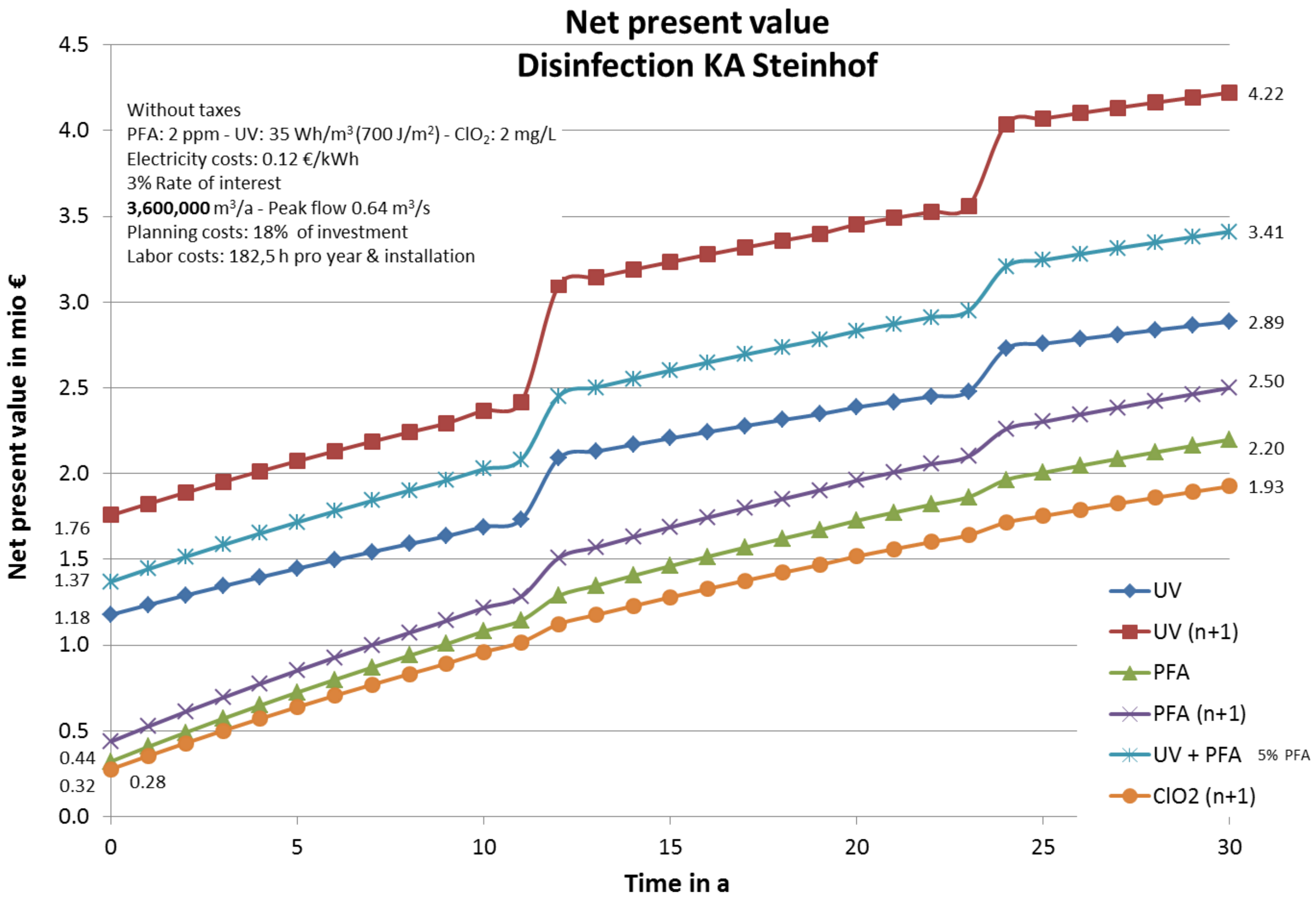
- UV:
  - Quality class 3 (DIN 19650, e.g. fruit and vegetables for preservation) achievable with 35 Wh/m³ (no filtration!)
  - Indirect goal (1,5 log for Noro-/Rotavirus) in average achieved, but not in all samples (13 out of 26 for E.Coli)
- Performic acid:
  - Quality class 3 (DIN 19650, e.g. fruit and vegetables for preservation) achievable with 2 ppm (with sufficient reaction time; minimum time 5-6 min; not average HRT!)
  - Indirect goal (1,5 log for Noro-/Rotavirus) in average achieved, but not in all samples (15 out of 23 short HRT; 13 out of 13 long HRT for Intestinal Enterococci)
  - In some cases strongly reduced disinfection performance. No hints found in water quality, but partly due to PFA dosing station: flushing of dosing pipes to prevent blocking by bubbles)

Net present value (30 a) for different scenarios (assumption current annual water flow)



Breakeven point
UV + PFA
ca. 8 years

Net present value (30 a) for different scenarios (assumption water flow = crop demand)



Comparison of design approaches

Total annual cost in ct/m³

Annual vol. (Mio m³/a)	Peak flow (m³/s)	Capacity usage (%)	UV	PFA	UV (n+1)	PFA (n+1)	UV (+PFA)
3.6	0.64	16	4.5	3.1	6.3	3.5	5.3
11 (current flow)	0.64	54	1.8	2.3	2.4	2.6	2.1

Conclusion cost calculation:

- Current flow conditions:
  - UV more on economic on long-term
  - Break-even point: 8a without redundancy, 16 a with n+1
- Demand driven flow conditions (120 mm/ha)
  - PFA more economic in all cases

- Overall conclusion:
  - The lower the capacity usage (= Average flow/Peak flow), the more favorable is chemical disinfection (OPEX driven).

www.demoware.eu

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The European Union is acknowledged for co-funding DEMOWARE within the 7th Framework Programme under grant agreement n° 619040