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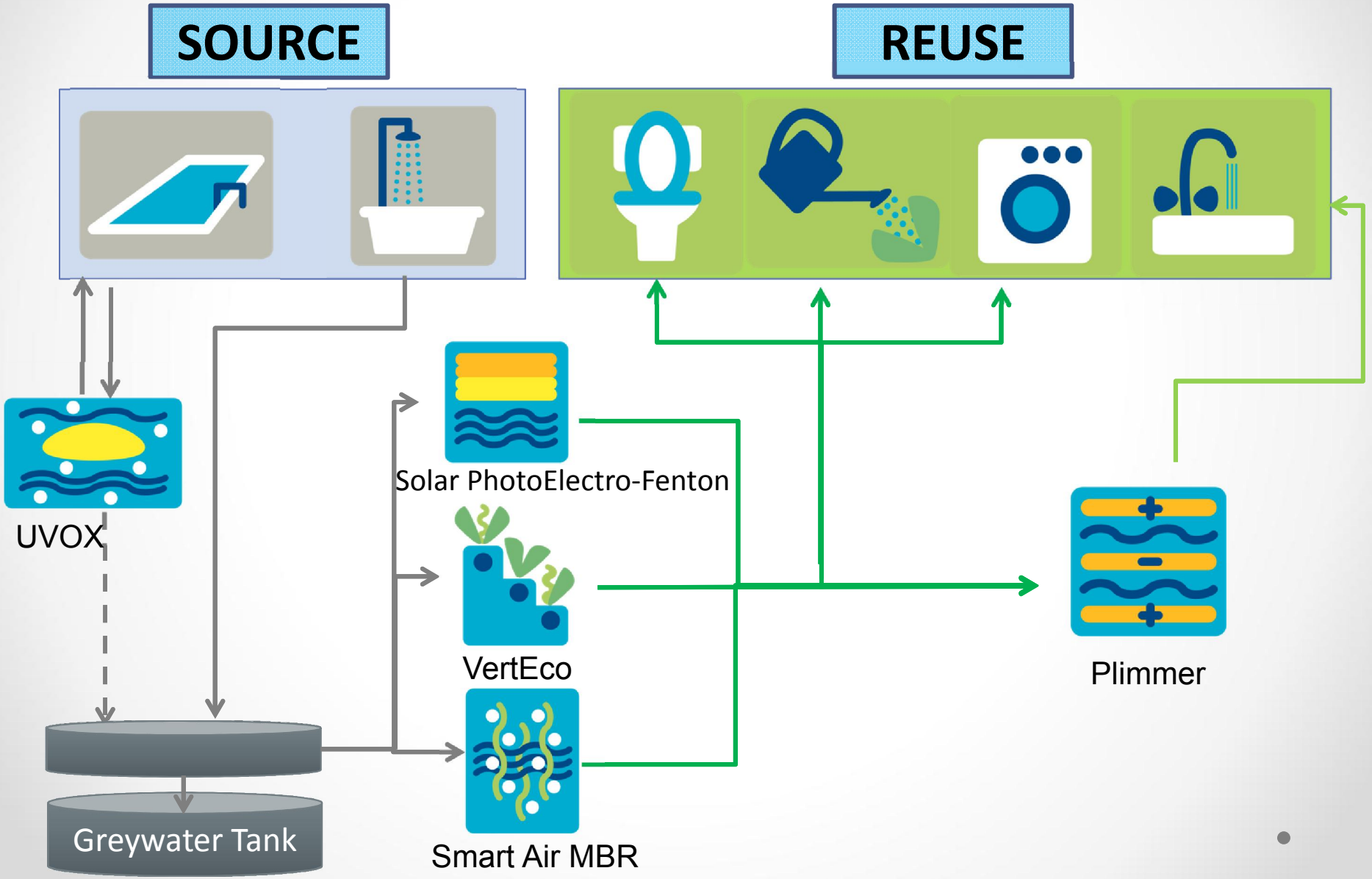
Greywater – ROADMAP



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demEAUmed technological solutions

UVOX : UV (advanced) Oxidation

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UVOX® redox

Barbara Berson MBA

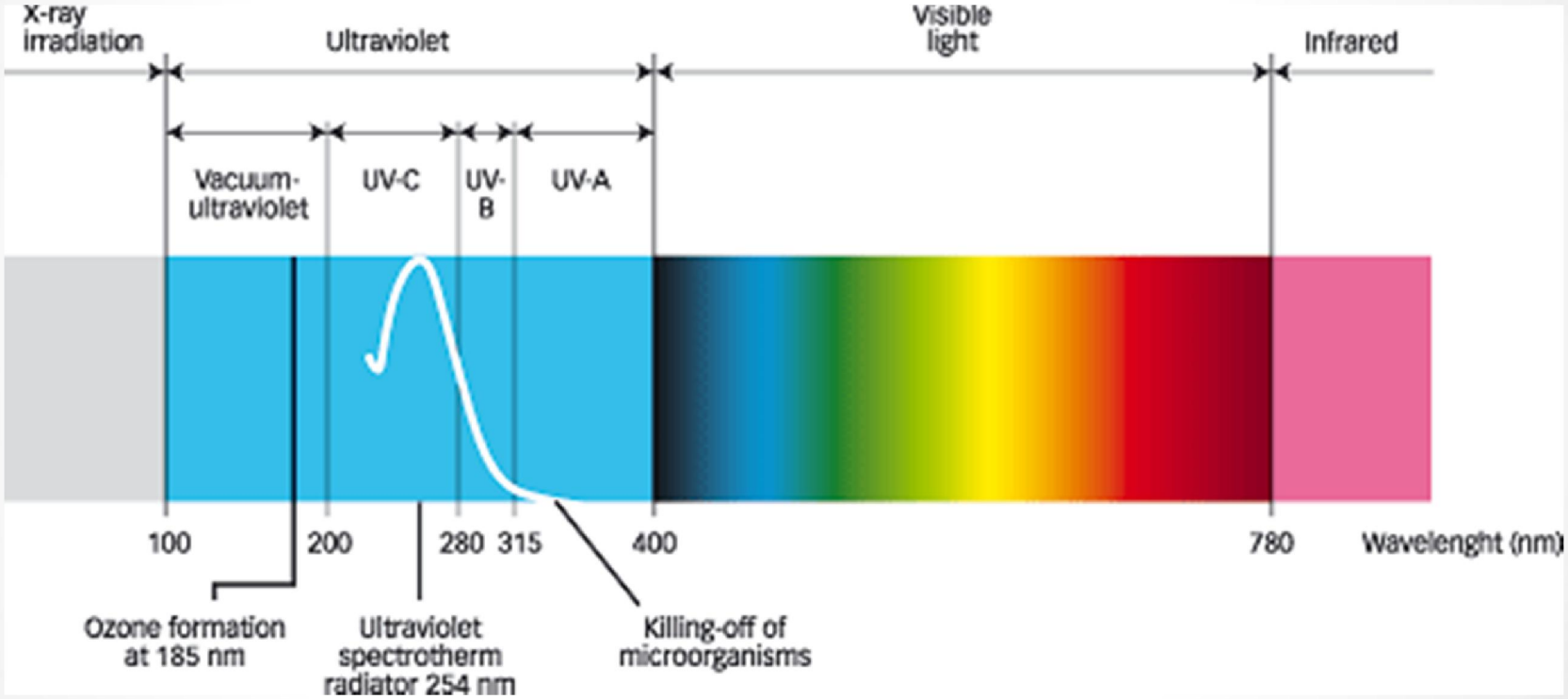
demEAUmed final conference
Barcelona, Spain
18th May 2017

Outline

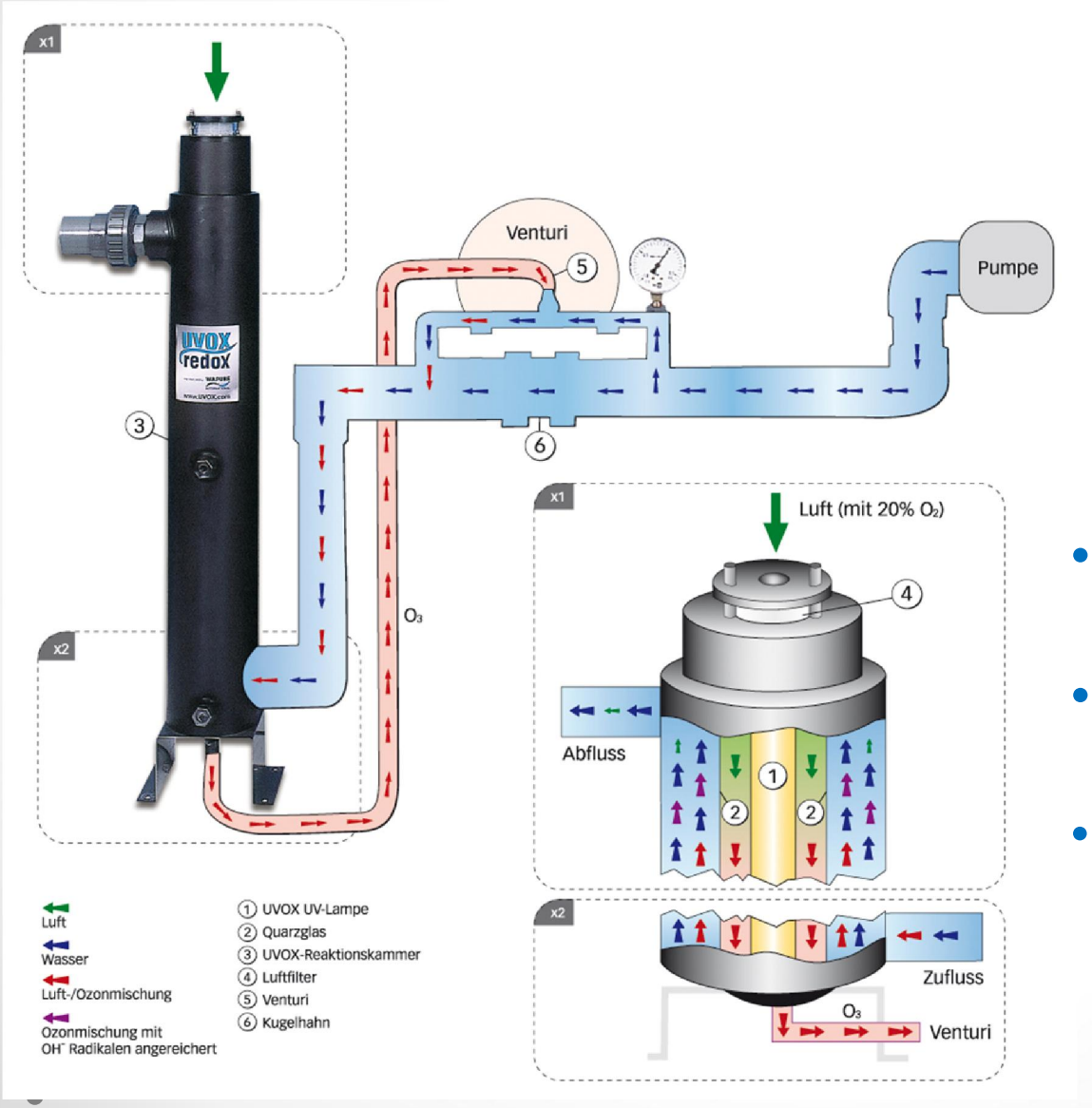
1. **UVOX: The sun as a role model**
2. **The UVOX Triple Process with one single UV lamp:**
   - Ozone
   - UV Disinfection
   - advanced oxidation process (AOP)
3. **UVOX in the swimming pool:**
   - Operational parameters
   - Summary of the test results
   - Further research & development
   - Competitive edge for public swimming pools
4. **Other areas of application.**

Go and check the poster for more details!

1. UVOX : The sun as a role model



1. The UVOX: the triple purification



- Ozone
- UV Disinfection
- Advanced Oxidation

UVOX -2000
operational parameters:

UVOX 2000	Factsheet
Full Scale :	20 -70 m^3/h
Pool seize:	60 – 210 m^3
Air Ozone flow:	4 – 16 l/min
Energy consumption:	
UVOX Lamps:	4 x 180 Watt /h
Booster pump:	depending on
	operating
	pressure
Carbon Footprint:	

Summary of the Testresults:

- **The killing rate of Exherichia Coli (E-Coli):**

The complete removal / inactivation of the Exherichia Coli (E. Coli) was achieved already by a very low UV-Dose of 7 mJ/cm².

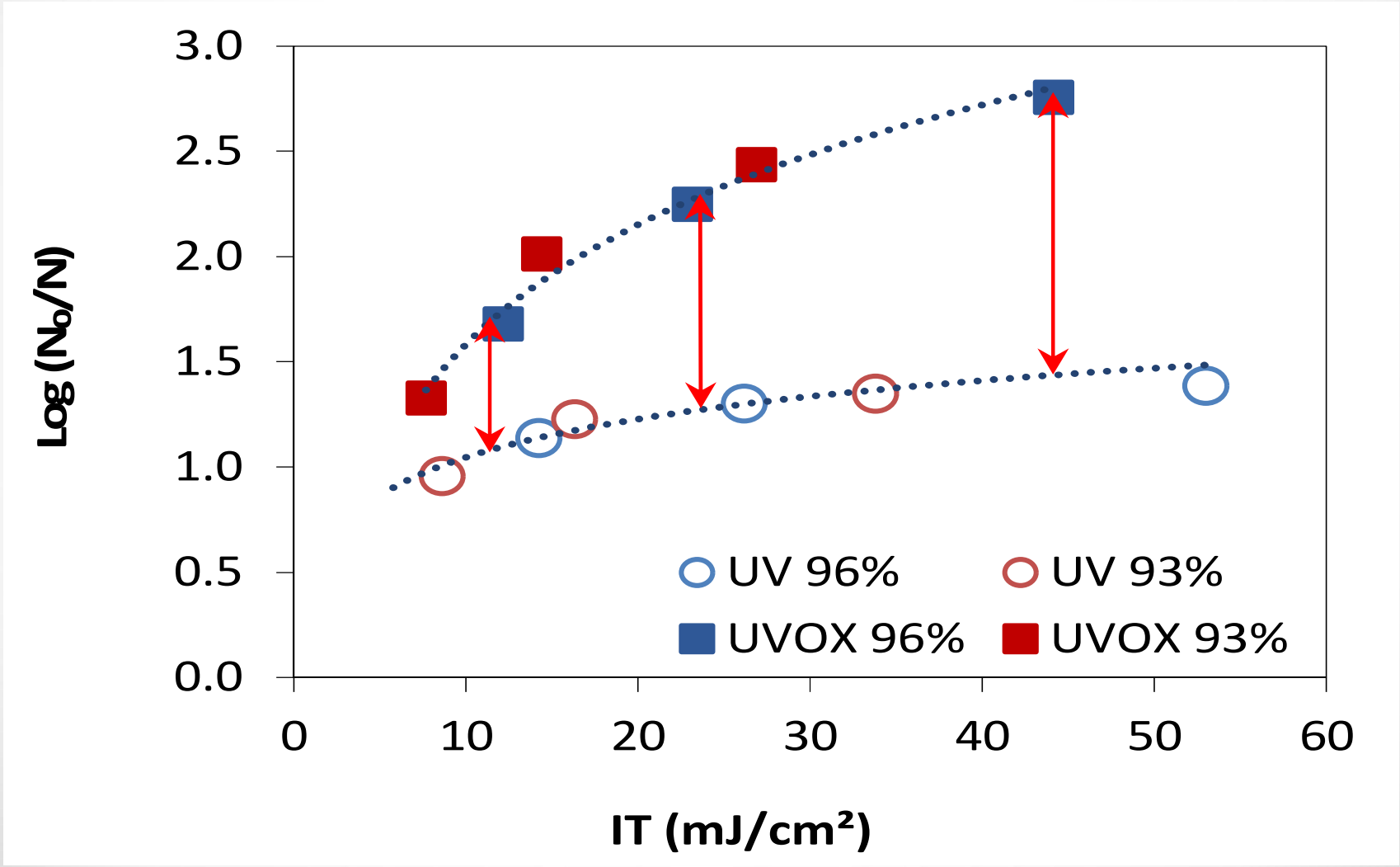
A removal of > Log 5

- **The killing rate of B. Subtilis spores:**

A removal of Log 1,6 of the B. Subtilis was already achieved by the UV-Dose of 12,5 mJ/cm² at T =93%.
A water flow of 59 m³ / h was effectively treated.

A highly effective inactivation of

B. Subtilis as result of the A.O.P.:



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Summary of the test results on

DBP´s using water recirculation:

The UVOX 2000 with an UV Intensity of < 9 mJ/cm² and a flow capacity of 59 m³ per hour:

- reduced rapidly the **combined Chlorine** levels.
- **no additional DBPs** (THMs, HAAs, HANs and Bromate) were formed.
- **Cloroform** and **DCAA** were reduced after 3 times of recirculation.

- *In case* the Body Fluid Analog (micro pollutants) was treated by UVOX *before* chlorination, *the formation of BDPs was reduced significantly.*

Competitive edge of UVOX:

Advantages:

- Triple water treatment:
  - ✓ Ozone
  - ✓ UV-Disinfection
  - ✓ Advanced oxidation
- Chemical free way of water purification
- A green technology
- Absolutely safe and easy to maintain
- No dangerous by-products
- A low carbon foodprint

Competitive Edge of UVOX:

Costs & savings:

- **Low capital / investment costs**
- **Low operation costs**
  A main stream of 59 m³ pool water can be treated effectively with only 2.22 kW/h energy consumption.
- **Additional savings on water, chemicals and energy.**
- **Early Return-on-Investement in approximately 2.8 years.**

Other application areas:






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Thank you very much for your attention!

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demEAUmed technological solutions

vertECO: Vertical Ecosystem

• • •

Heinz Gattringer, alchemia-nova GmbH

demEAUmed final conference
Barcelona, Spain
18th May 2017

alchemia nova
institute for innovative phytochemistry
closed loop processes

Radtke Biotechnik

demEAUmed

Company Background

- Consultancy and R&D services
- Research driven SME
- National and European research projects
- Sustainable management and use of natural resources
- Circular-economy technologies
- Nature based solutions
- spin-off „blue carex phytotechnologies GmbH“ for commercialization of technologies

alchemia nova
institute for innovative phytochemistry & closed loop processes

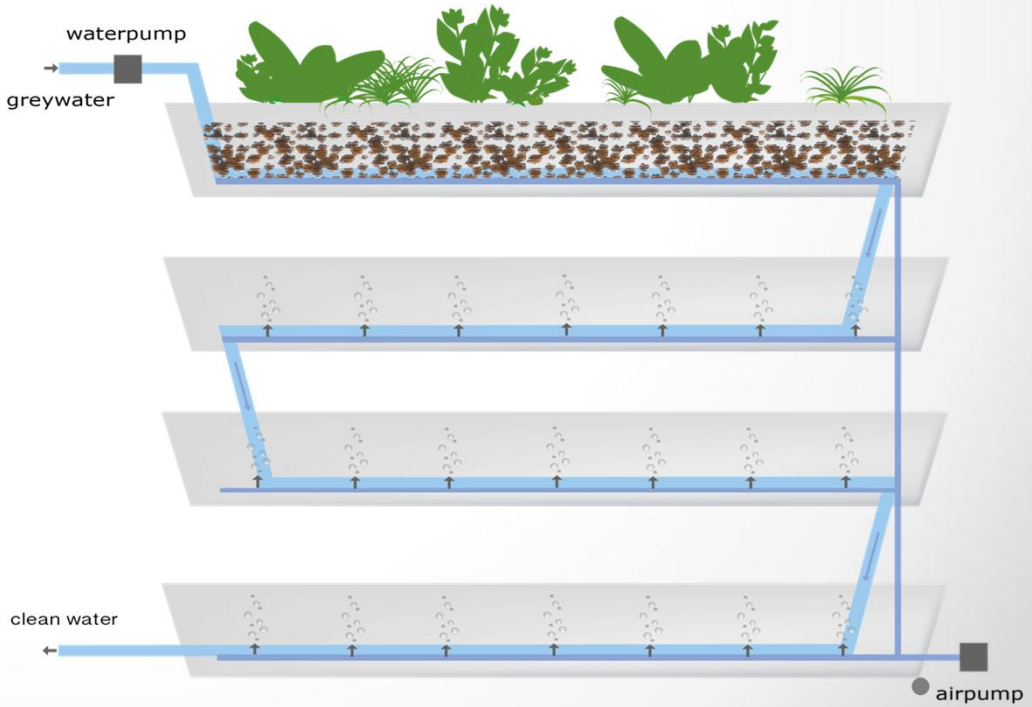
blue carex
phytotechnologies

vertECO: basic principles

Constructed Vertical Ecosystem: compact constructed wetland in vertically cascading stages with high metabolic activity

microorganisms and plant synergy provide pollution removal

Innovation: vertical setup → integration unto walls, even indoors
integration of ecosystem services into buildings



Target pollutants:
organic matter (biodegradable)
NPK-nutrients
micropollutants

Treatment line(s): greywater

Austrian Patent AT 516363
achieved within demEAUmed project

vertECO @ Hotel SAMBA

TRL from 5 → 8 during demEAUmed 2014-2017

vertECO

Operational Parameters

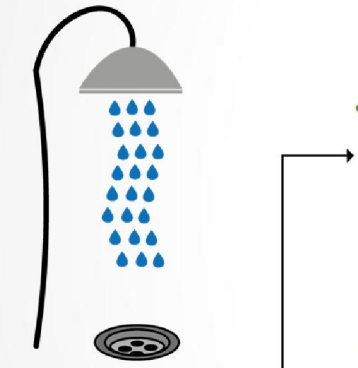
Parameter	
installation area (wall space)	≈ 4 m^2/m^3-water per day
static weight load	≈ 1.500 kg/m^3-water per day
light requirements	> 800 lux
energy requirements	< 2 kWh/m^3-water
maintenance	gardening

vertECO: Resume of results

Selected Parameters

greywater:

COD: 208,5 mgO_2/l
BOD5: 96,2 mg O_2/l
turbidity: 67,5 NTU

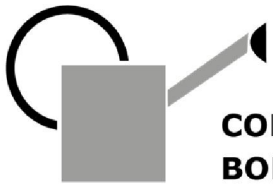


water after vertECO treatment:

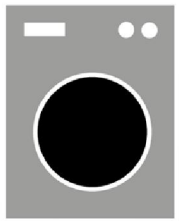
COD: 16,6 mgO_2/l
BOD5: 4,4 mg O_2/l
turbidity: 1,6 NTU

Legal limits according to **91/271/EC**

COD: 125 mgO_2/l
BOD5: 25 mg O_2/l
turbidity: 2 NTU



COD: 125 mgO_2/l
BOD5: 25 mg O_2/l
turbidity: 2 NTU



COD: 125 mgO_2/l
BOD5: 25 mg O_2/l

analytics by ICRA - data from: 2015-2017

vertECO: Market Application

Where can it be applied?

- greywater effluents
- swimming ponds

Who may be interested?

- high water costs
  periodic water scarcity
- irrigation of recreational areas e.g. golf course
- guests value sustainability efforts
- companies committed to sustainability

VertECO: Multiple Benefits

- significant water savings
- energy efficient water treatment
- nature based solution
- aesthetic / design potential
- microclimatic effects
- clear sustainability message

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Thank you for your attention

alchemia nova
institute for innovative phytochemistry & closed loop processes

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blue carex
phytotechnologies

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This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No. 619116

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demEAUmed technological solutions

Electrochemical treatments:

ECEF & SPEF

Ignacio Montero Castro

LEITAT
managing technologies

demEAUmed final conference
Barcelona, Spain
18th May 2017

Outline

1. ECEF basic principles
2. ECEF resume of results
3. Application into the tourism and water market
4. SPEF basic principles
5. SPEF resume of results
6. Application into the tourism and water market

Go and check the poster for more details!

Electrocoagulation-Electroflotation

Basic principles

ECEF: Electrochemical primary treatment for destabilizing and absorbing water pollutants.

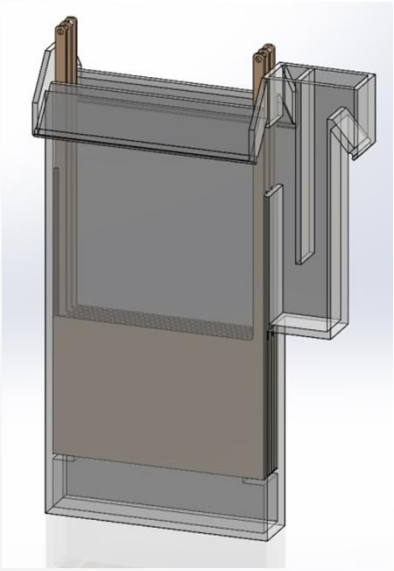
Innovation: Electroflotation (EF) process derived from hydrogen and oxygen gas generation and coagula dragging.

Target pollutants:
oils and fats, suspended solids, organic matter and microbiological charge.

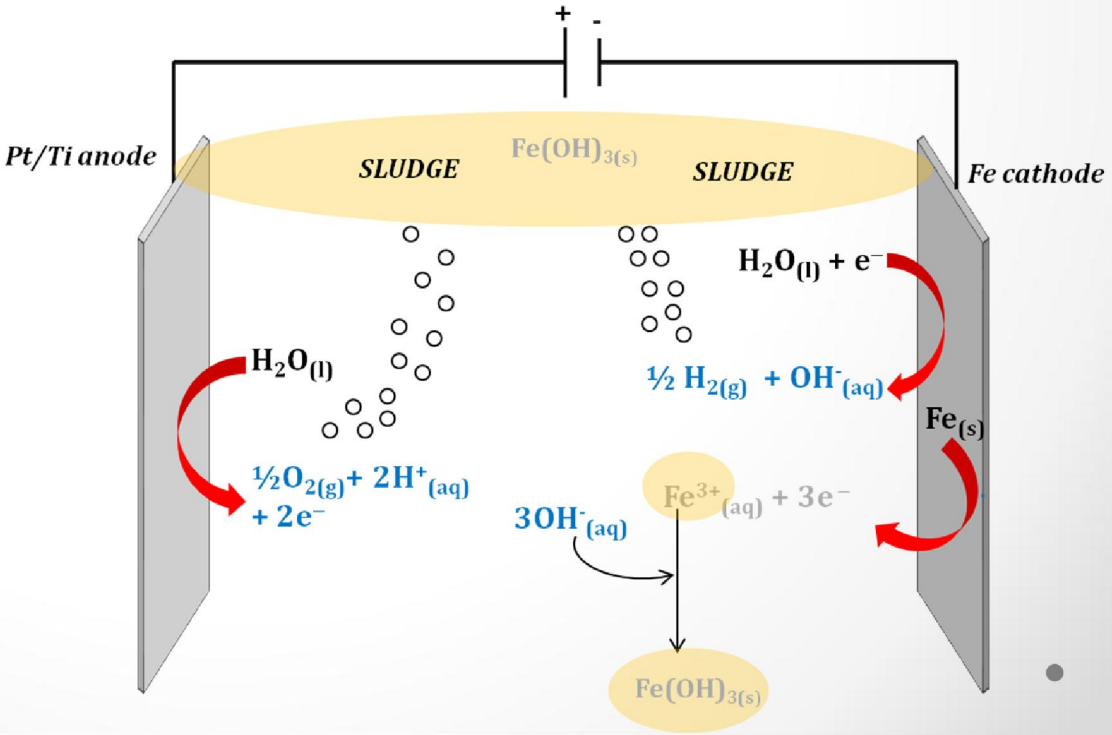
Treatment line:
Wastewater

Electrocoagulation-Electroflotation
Operational parameters

Parameter	
Anode & Cathode	Fe & Pd/Ti
Input flow	20 - 60 L/h (Continous)
Current intensity	15 A

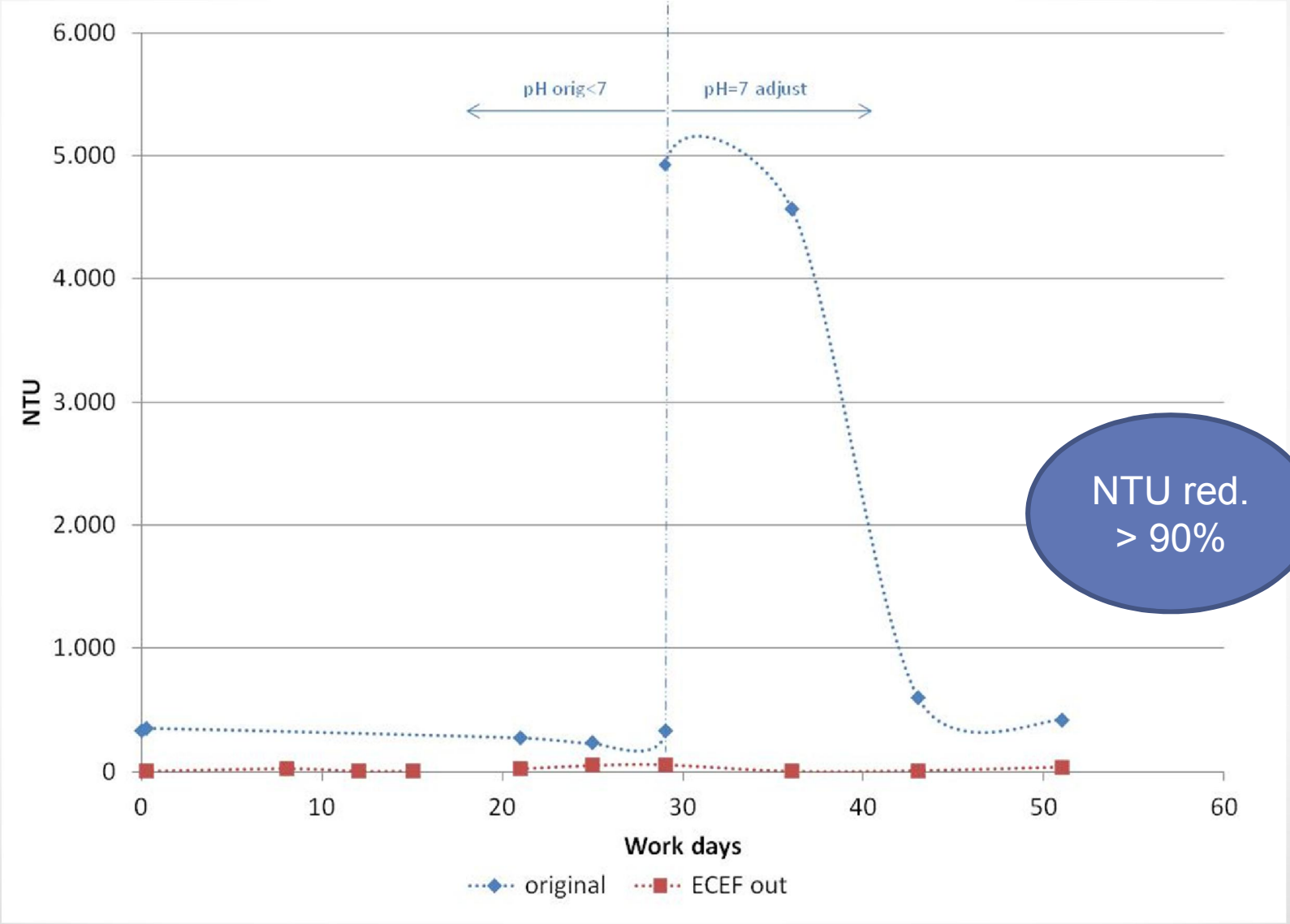


ECEF cell- Leitat Design



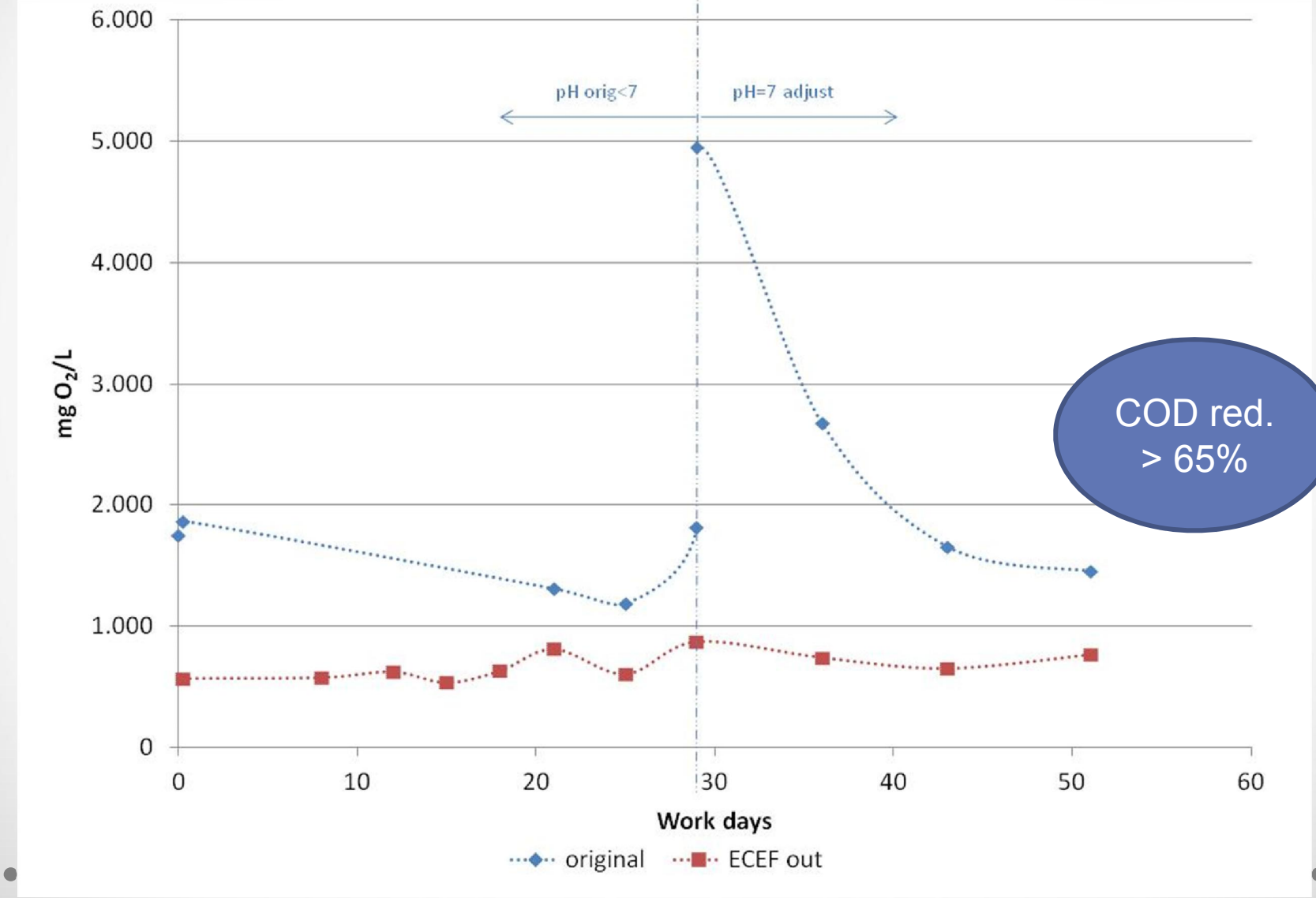
ECEF - Resume of results

NTU Reduction



ECEF - Resume of results

COD Reduction



Application into the market

Is it market-competitive?

- Estimated OPEX: **0,26€/m³**
- Easy sludge disposal
- No need for coagulant additions

Who may be interested?

- Users who want to **reduce maintenance management**
- Wastewater treatment lines with **spatial restraints**
- Facilities with high solids, oils/fats content in ww

Solar Photoelectro-Fenton
Basic principles

SPEF: Advanced electrochemical oxidation process for removing hazardous organic contaminants.

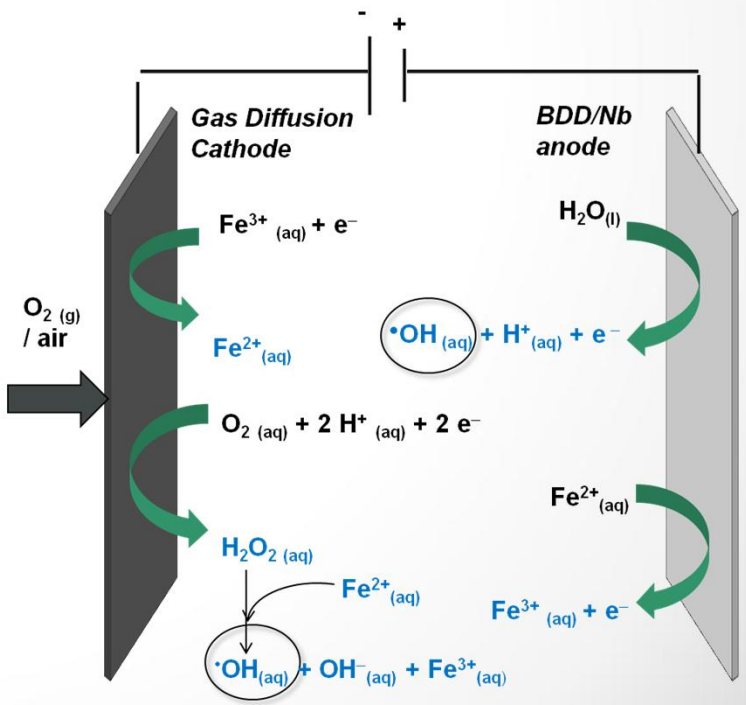
Innovation: Combination of electrogeneration of H_2O_2, Fenton reaction and solar treatment for catalyst recovery.

Target pollutants: organic matter, organic micropollutants and microbiological charge.

Treatment line: Greywater

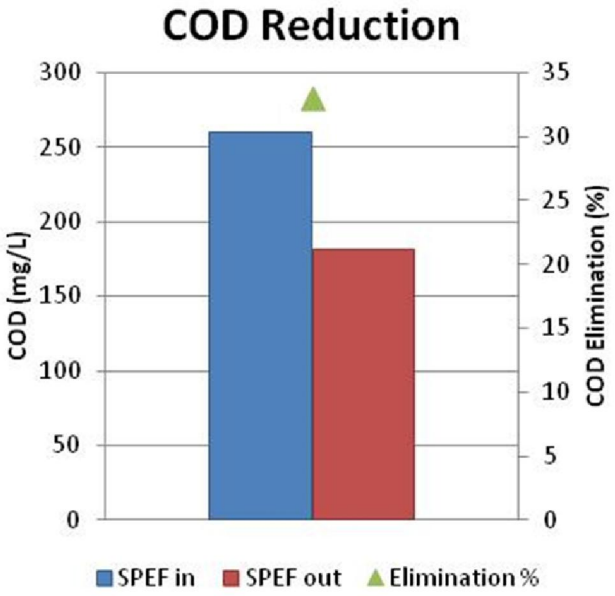
Solar Photoelectro-Fenton Operational parameters

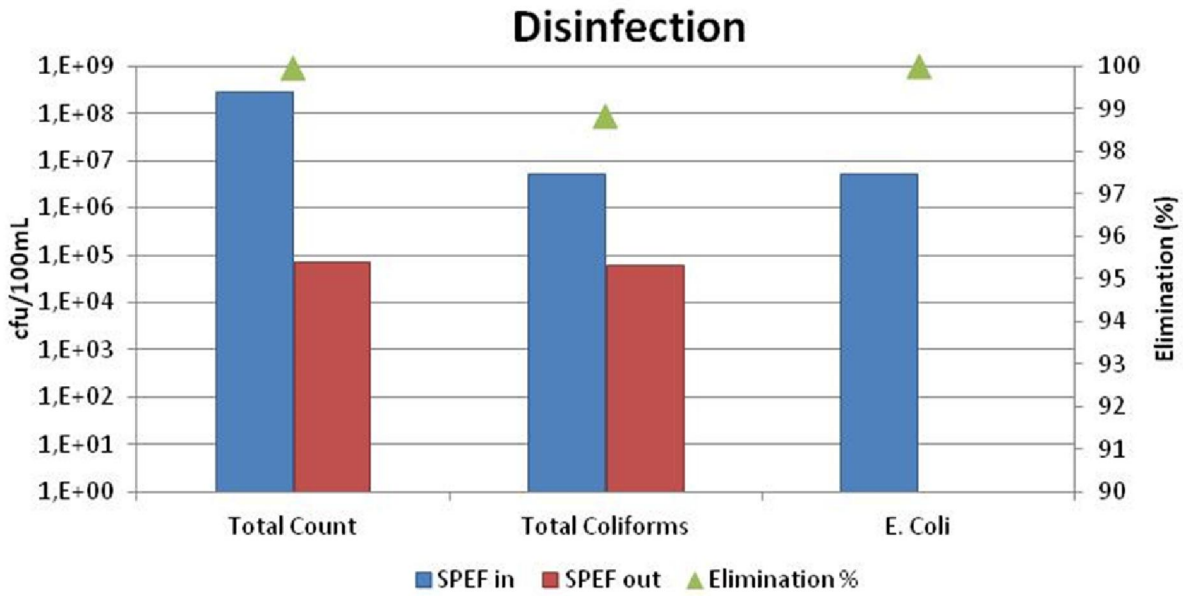
Parameter	Value
Anode & Cathode	BDD & GDC
Input flow	20 L/h
Retention time	30 min
Input pH	3
Air flow	2 L/h
Parabolic collector volume	4 L
Current intensity	10 A



SPEF - Resume of results

COD Reduction & Disinfection





SPEF - Resume of results

Micropollutants Abatement

I (A)	Estrone mg/L	Estradiol mg/L	Bisphenol A mg/L	Carbamazepine mg/L	Diclofenac mg/L	Ibuprofen mg/L	Metoprolol mg/L	Sulfamethoxazole mg/L
TEST 1								
SPEF in	0,73	2,61	2,16	3,53	3,58	3,60	2,56	1,80
2,5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
10	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
TEST 2								
SPEF in	4,92	3,94	5,14	4,17	0,00	9,27	3,15	1,70
2,5	0,00	0,00	0,90	0,00	0,00	0,00	0,20	0,00
5	0,00	0,17	0,80	0,00	0,00	0,00	0,11	0,00
10	0,00	0,00	0,75	0,00	0,00	0,00	0,00	0,00

Application into the market

Is it market-competitive?

- Estimated OPEX: **1,85€/m³**
- Efficient treatment for recalcitrant organic pollutants

Who may be interested?

- Facilities with **micropollutants polluted streams**
- Firms looking for **innovative refining solutions**
- Companies desiring to **further develop** the technology

Thank you for your attention

For further information:

www.demEAUmed.eu

Leitat Technological Center

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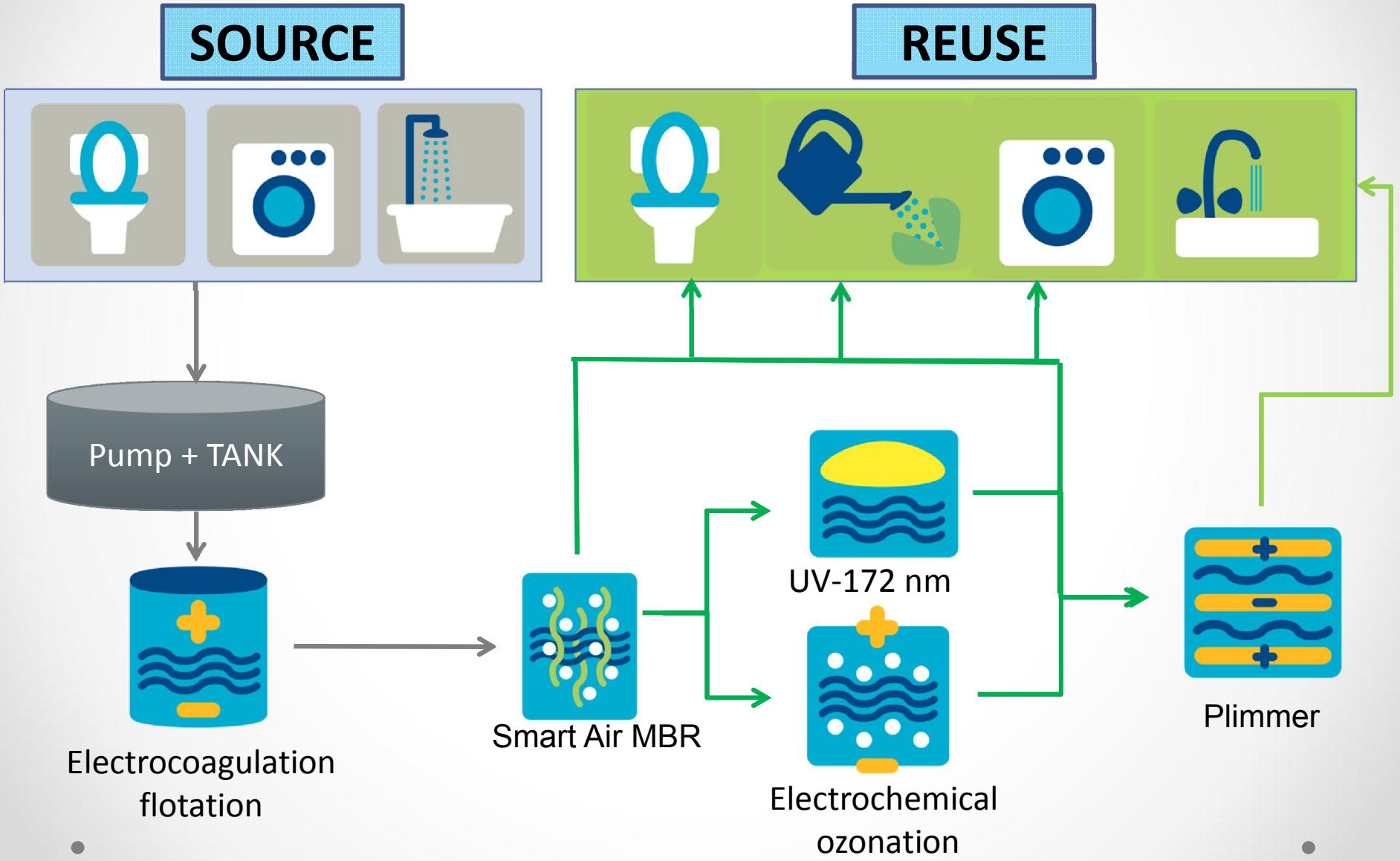
Wastewater – ROADMAP



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demEAUmed technological solutions
172nm UV

Walter Nadrag

demEAUmed final conference
Barcelona, Spain
18th May 2017

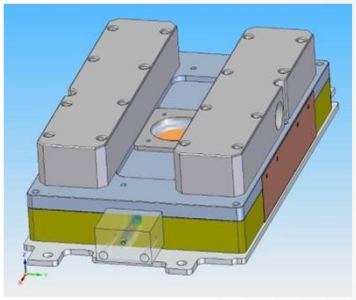
Outline

1. The technology
1. Resume of results
1. Application into the tourism and water market

Go and check the poster for more details!

The existing technology

Basic principles



172nmUV: This photo reactors irradiates UV-Light with a wavelength of 172nm.
These high energetic photons efficiently split water into reactive radicals e.g. hydroxyl radicals.
The following treatment is known as AOP (Advanced oxydation process). In AOP processes any complex and persistent organic molecules are going to be degraded.

Innovation: The photoreactor used by Sico is able to produce much more UV-Power than other known lamps in this spectral area. This fact enables the 172nmUV system to be used in commercial scale.

Target pollutants: persistent organic pollutants, , pharmaceuticals, some heavy metals,

Treatment line(s): industrial/specified wastewater

The technology
Operational parameters

Parameter	
Operation, prototype	batch operation integrated 180l tank
Batch run duration	variable (20mins default)
flow	2-20 L/h *(2 lamp setup)*
Influent req.	pre filtered (1µm)
Temperature range	5 - 45°C

Resume of results V9 (Tertiary treatment step!)

Go and check the poster for more details!

	TOC	COD	TN	$N\text{-}NO_3$
Unit	mgC/L	mgO2/L	mgN/L	mg/L
in	8,32	40,8	1,02	0,47
out	1,97	15 (<LOD)	0,87	0,50
Removal	76 %	> 63%	15 %	No removal

Resume of results V29 (standard run - no optimization)

	Ibuprofene	COD
Unit	mg/L	mg/L
in	26,6	94
out	5,7	69
Removal	78 %	16 %

Application into the market

Where can it be applied? The existing 172nmUV prototype can be used best in environments where the wastewater volume is low and where the components of the wastewater are mostly known.

Is it market-competitive?

Yes, absolutely. It is the most powerful UV plasma AOP reactor known to us. The size and the power brings UV induced AOP into commercial
scale.

Who may be interested?

Wastewater treatment companies, industrial partners (biotech, pharma, etc.) with problematic wastewater substances

Thank you for your attention

For further information:

www.sico.at

office@sico.at

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No. 619116

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Electrochemical Ozonation

Christiane Chaumette

Fraunhofer IGB

demEAUmed final conference
Barcelona, Spain
18th May 2017

Outline

1. The technology
2. Resume of results
3. Application into the tourism and water market

Go and check the poster for more details!

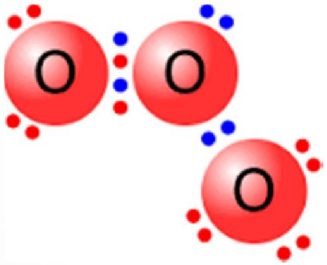
Outline

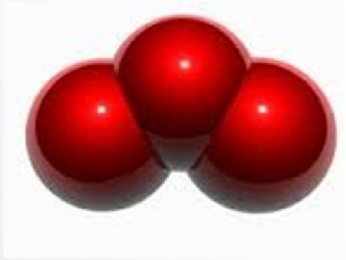
1. **The technology**
2. Resume of results
3. Application into the tourism and water market

Go and check the poster for more details!

Ozone produced by boron doped diamond electrodes

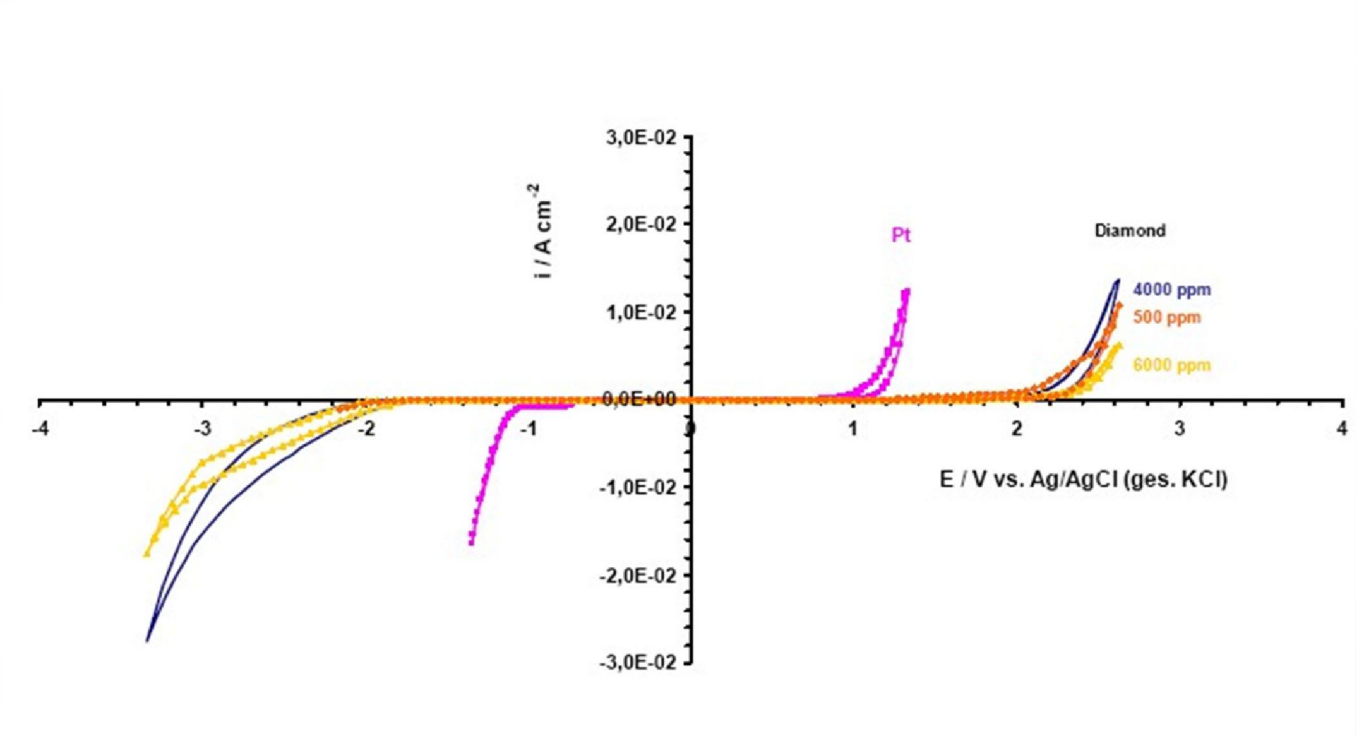
- Oxygen derived ozone is a standard in drinking water treatment and a growing technology in wastewater treatment.





Voltametry BDD electrodes

- Ozone can also be generated from water by electrolysis with special electrode surfaces.



Advantages of Electrochemical Ozonation

- No oxygen feed needed
- Automatic operation
- Chemical free process – no need to add hydrogen peroxide, ozone or catalysts
- Adjustable treatment capacity
- Adjustable treatment intensity (saving energy)
- Disinfection of the treated water as a side-effect
- Independent of UV-absorbance of the feed water

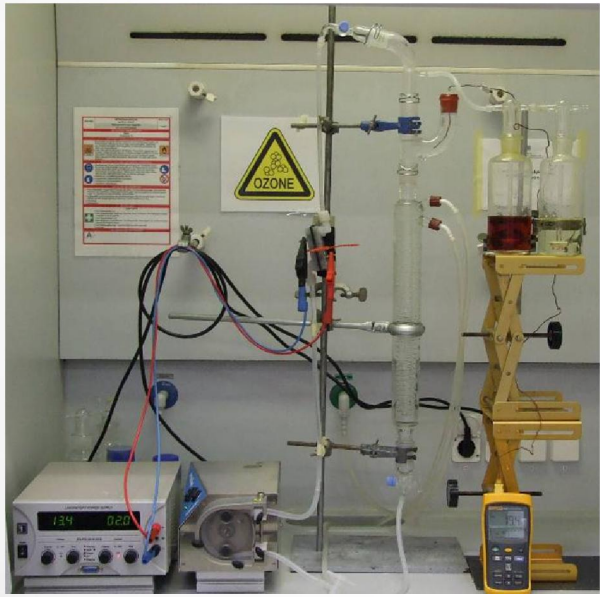
Outline

1. The technology
2. **Resume of results**
3. Application into the tourism and water market

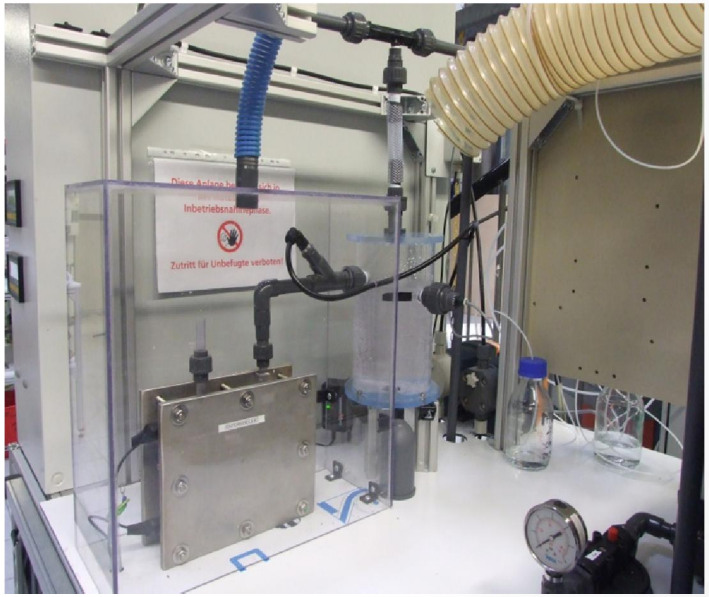
Go and check the poster for more details!

First Apparatus for electrochem. Ozonation

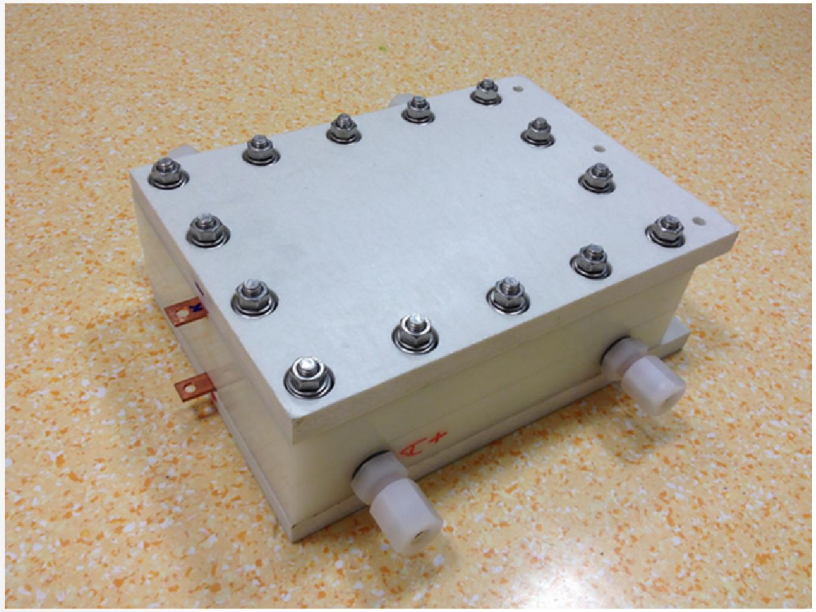
Laboratory Set-up
2 l

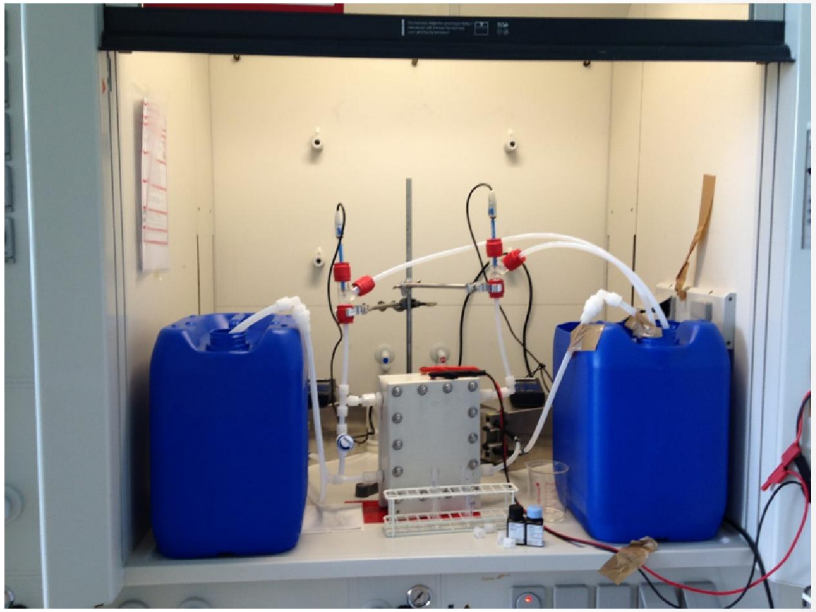


Demonstrator
10 l

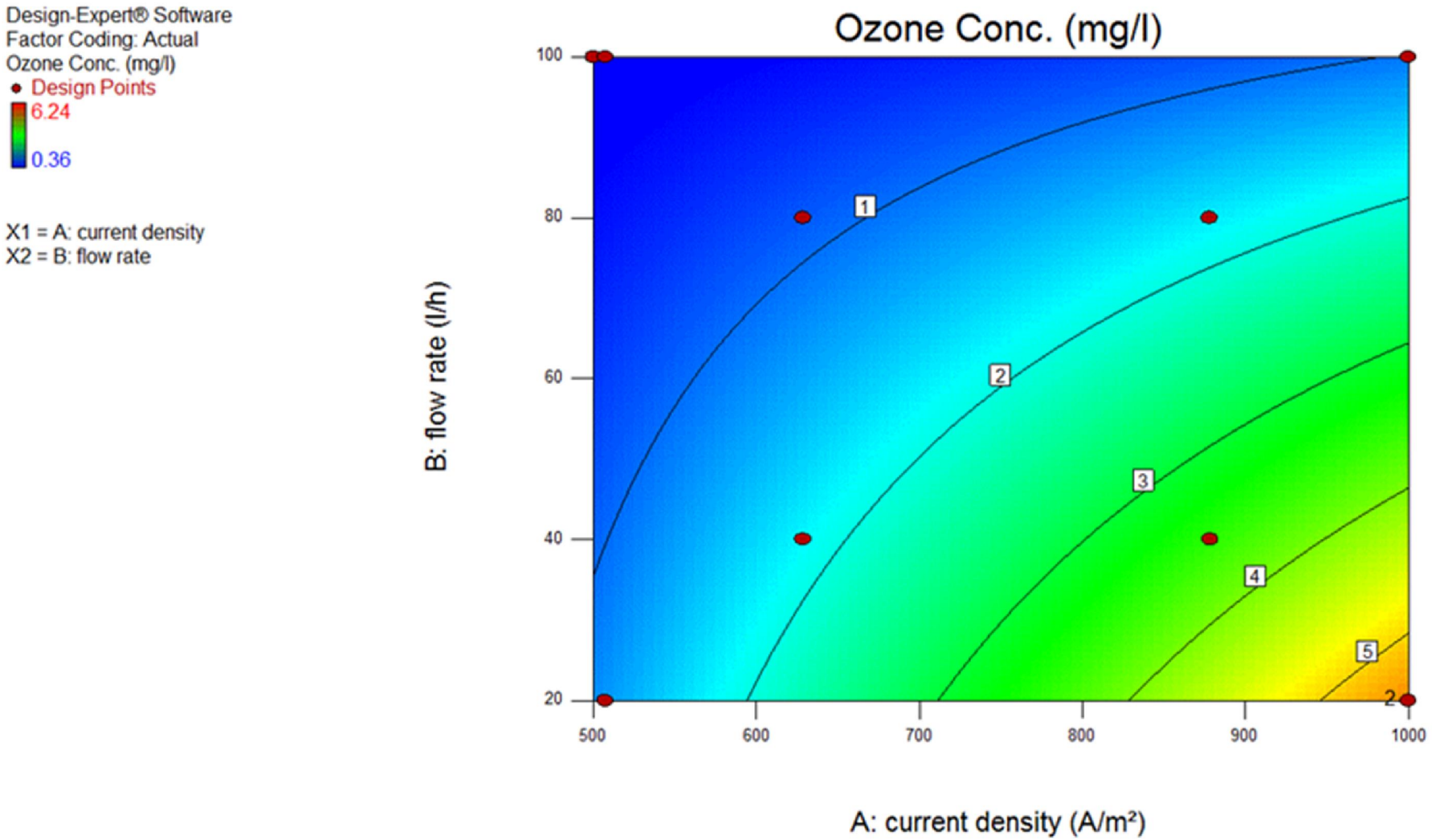


Direct Ozonation in a Thin Channel EUT Ozone Cell

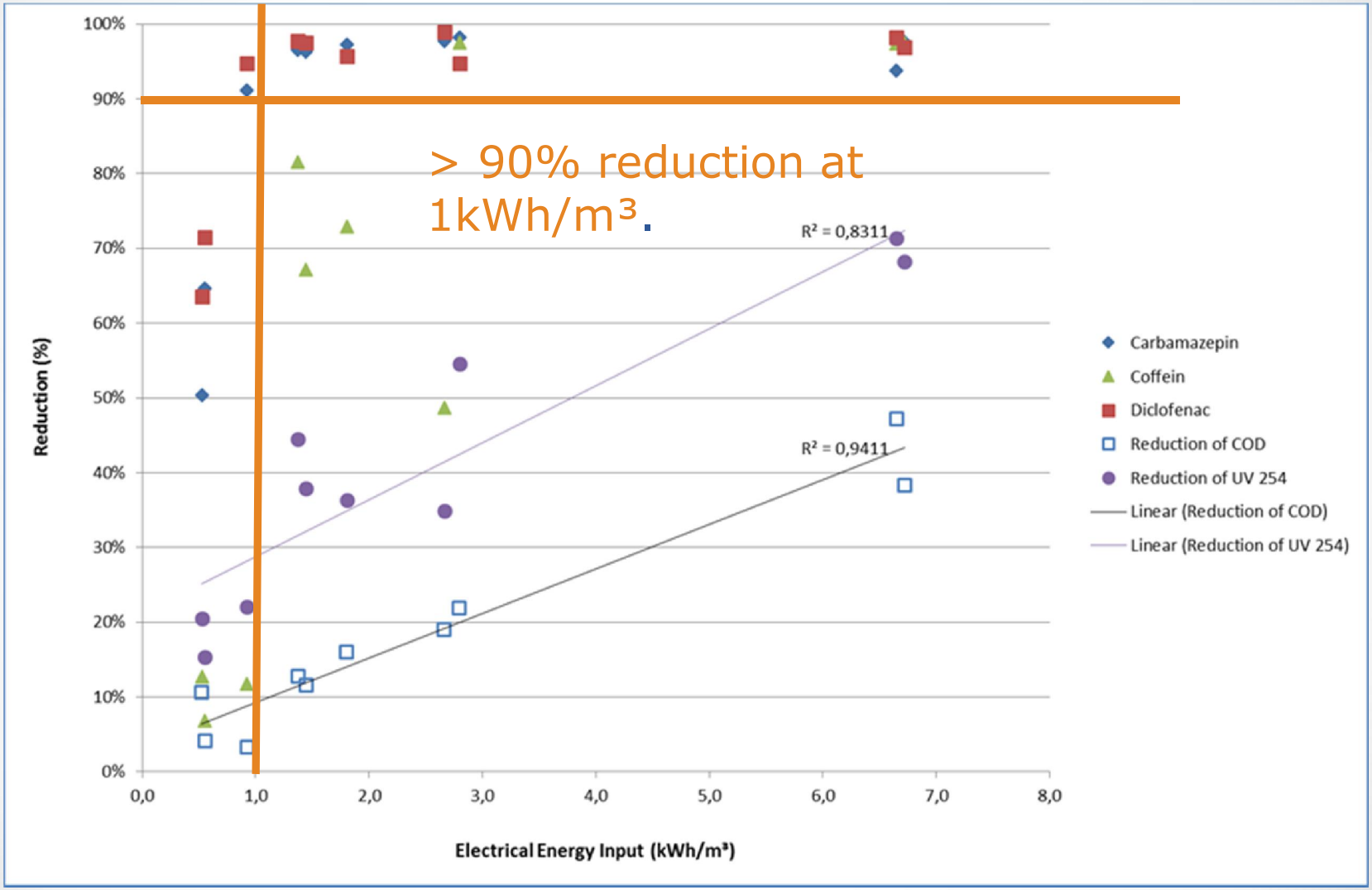




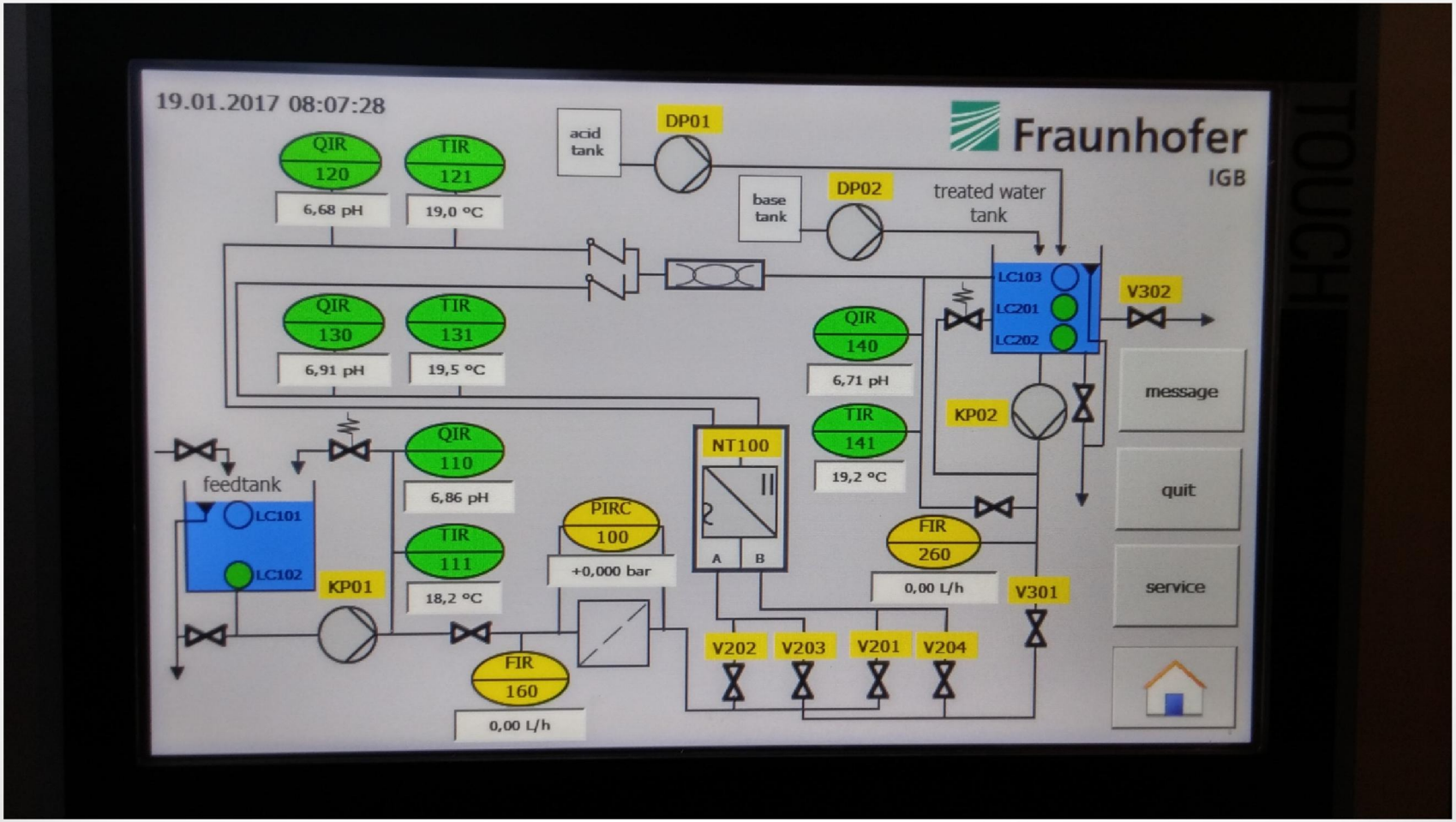
Thin Channel EUT Cell: Continuous Treatment



Thin Channel EUT Cell: Continuous Treatment



Automated Electro-Ozonation (EO)Unit



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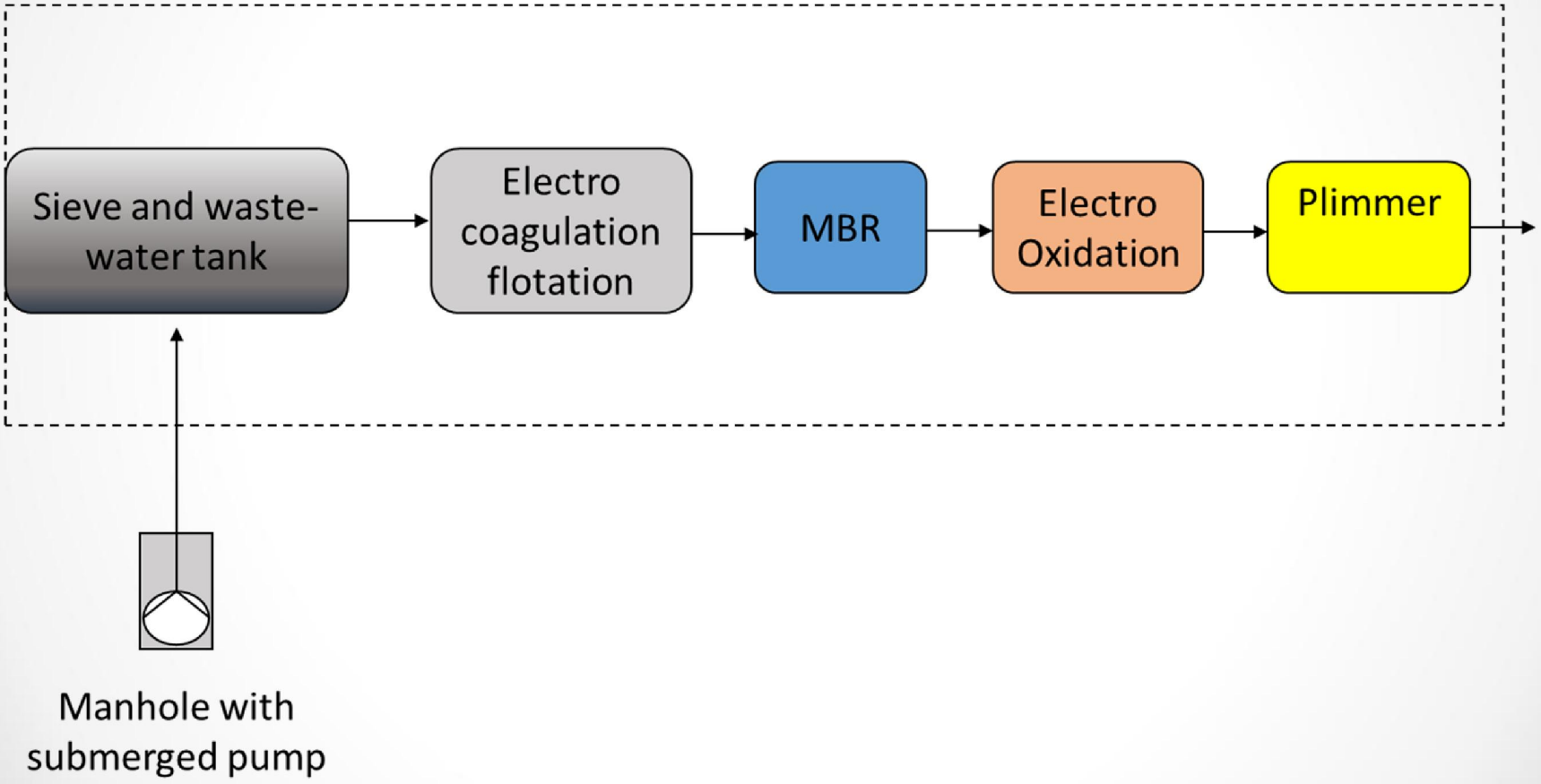
Automated Electro-Ozonation (EO)Unit

Wastewater treatment line



Outline

1. The technology
2. Resume of results
3. **Application** into the tourism and water market

Go and check the poster for more details!

Application

- The technology holds potential as polishing treatment for small to medium scale installations in view of achieving drinking water quality of the treated water.
- It removes emergent and priority pollutants even at trace levels and disinfects the water.
- The technology is in use today to remove organic substances from ultra-pure water and to directly treat recalcitrant or toxic industrial effluents.

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Contact Information

Fraunhofer IGB

Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB

https://www.igb.fraunhofer.de/en/research/competences/physical-process-technology/process-and-wastewater-purification.html

christiane.chaumette@igb.fraunhofer.de

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Thank you for your attention

Fraunhofer IGB

For further information:

www.demEAUmed.eu

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demEAUmed

Funded under the Water and Innovation Action of the
7th Framework programme of RTD-D of the European Union

demEAUmed technological solutions

Plimmer

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IDROPAN-DELL'ORTO
DEPURATORI S.R.L

Tullio Servida

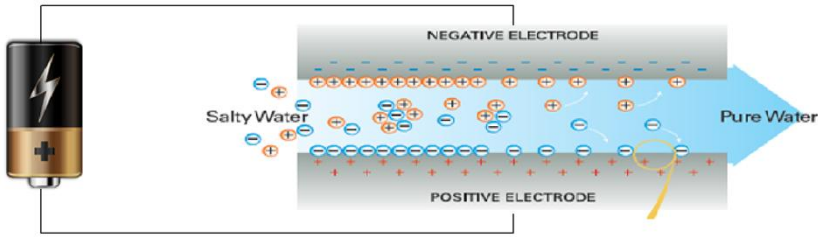
demEAUmed final conference
Barcelona, Spain
18th May 2017

Q: Plimmer CDI what is this?

- Is a technology for water desalination
- Alternate to RO technology with lot more advantages
- Can be used for drinking water to improve quality
- Glass/Dish washers
- Boiler rooms to reduce fuel usage (10%)
- Can be used for grey/waste water reuse in combination with other techs
- Nutrients removal/recovery

Q:How it works?

Plimmer CDI: Capacitive deionization is a technology able to remove salts and nutrients from a water stream using a low DC voltage (1,5V)



Salts are removed during a period of about 1 minute and after this are discharged in a small residual volume that is about 20% of the feed water and cycle restart

Q: Why should I install Plimmer CDI?

- Removes the widest spectrum of inorganic contaminants
- Lowest water wastage expecially compared to RO
- In drinking water applications some minerals can be retained while contaminants are removed
- Selectivity in ions removal contaminants removed better than healty salts
- For water reuse applications nutrients like NO3 NH4 P can be removed
- Possible nutrients reuse
- Increase water quality

One technology

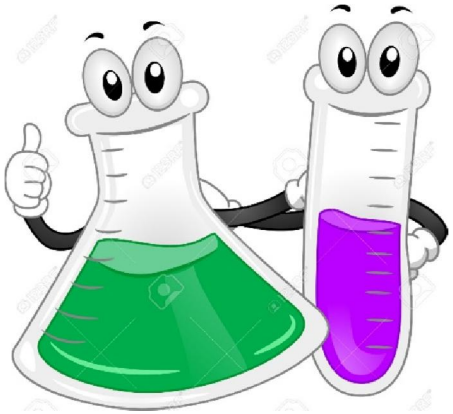
multiple salts removed

SALTS	METALS	OTHERS
• Total Dissolved Solids • Total Hardness • Calcium Carbonate • Magnesium Carbonate • Sodium Chloride • Phosphates • Sulphates • Chlorides • Nitrates • Fluoride ...	• Chrome • Iron • Arsenic • Nickel • Copper • Zinc • Cadmium • Mercury • Manganese • Lead • Vanadium	• Ammonia • Chromium 6 ...

Q: How much water will I recover for reuse?

CDI: High water recovery → 80%

80%



20%

Competing tech's (RO): Low water recovery → 50% in best conditions

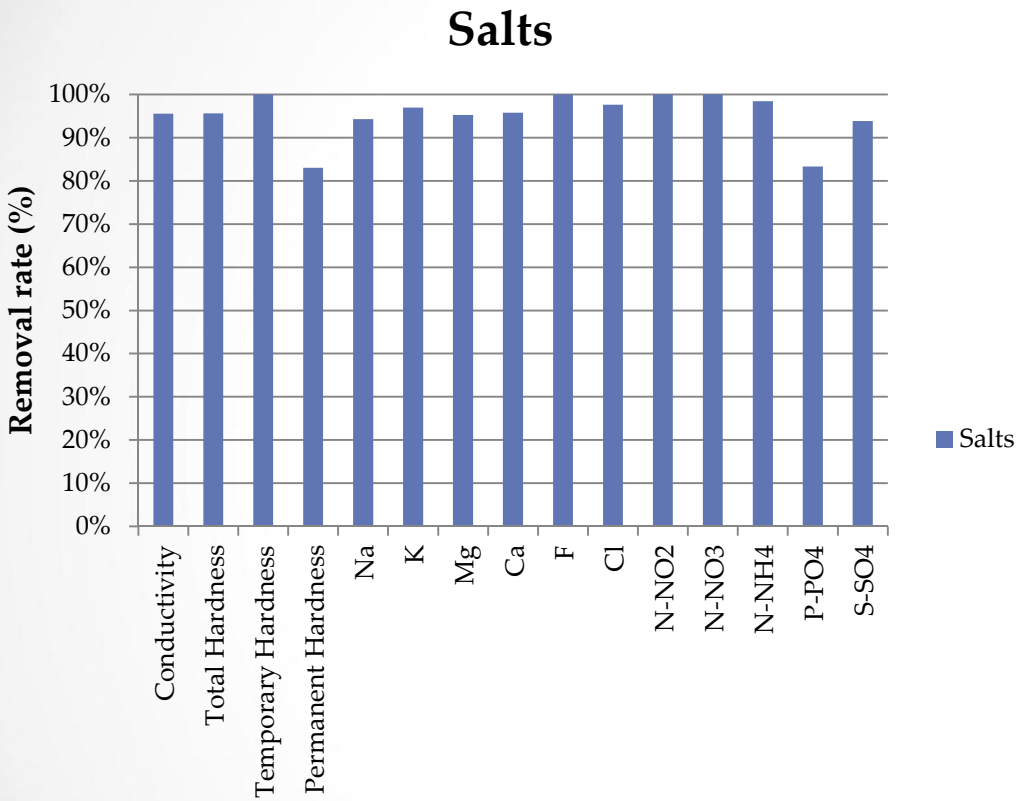
50%

50%

Q: Will be more expensive than RO?

- Plimmer CDI is optimally priced for:
  - Drinking water
  - Glass/Dish washers
  - Boiler rooms
- Plimmer CDI in water reuse will become a low OPEX technology
- Plimmer CDI lower OPEX will lead to a much lower «cost of ownership»
- Plimmer CDI can become a strategical choice for Hotel/Resort in water scarce environments

Water reuse: one example of quality



- Grey water reuse
- Pretreatment technology was «Green Wall»
- Water quality is superior
- More advanced use than just toilet flushing
- Possible use is «Contact water»
- Example cloth washing
- Water quality similar to waterworks or better

Go and check the poster for more details!

Thank you for your attention

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demEAUmed technological solutions

Smart Air MBR

Ignasi Rodriguez-Roda
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demEAUmed final conference
Barcelona, Spain
18th May 2017

Outline

1. The technology
2. Objectives
3. The pilot plant
4. Resume of results
5. Application into the tourism and water market

Go and check the poster for more details!

1. The technology

MBR: Combination of a conventional activated sludge bioreactor and a membrane filtration system (MF/UF)

- Very high effluent quality
- Compact
- Automated

WATER REUSE

DECENTRALIZED SYSTEMS

- High energy consumption

1. The technology

MBR: Combination of a conventional activated sludge bioreactor and a membrane filtration system (MF/UF)

Innovation: **air-scour control** system based on permeability trend. Previous results demonstrate energy savings (up to 22%) in **municipal wastewater treatment**, minimizing fouling and keeping or improving nutrient removal efficiencies

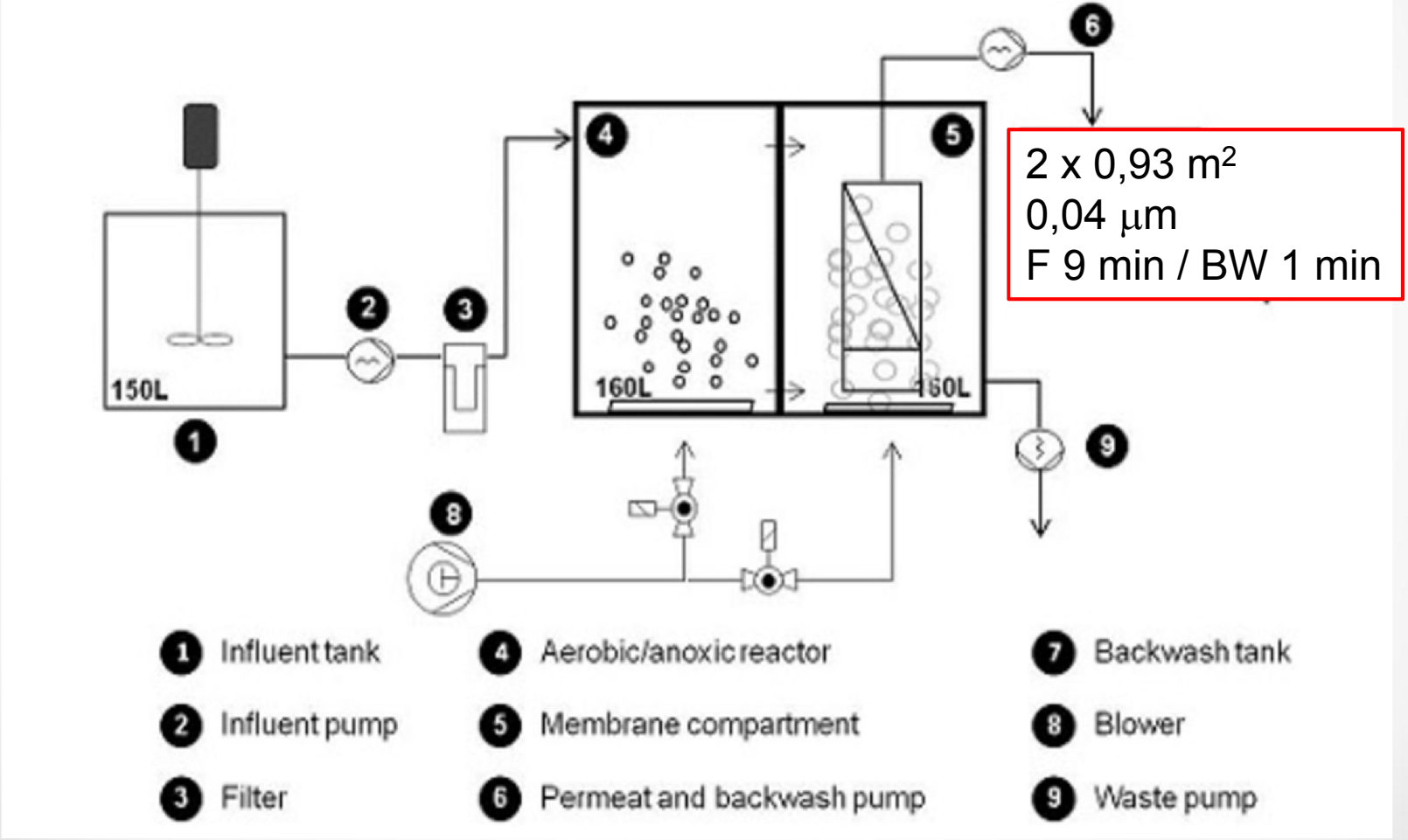
Ferrero *et al.*
ES2333837 Spanish Patent, 2010

2. Objectives

- Validate/demonstrate smartAir MBR at the hotel
- Removal efficiencies (fouling, cost)
  - organic matter
  - nutrients
  - microbial indicators
  - micropollutants (14 PhACs & 13 EDCs)
- Grey water? Black water? Water from other uses?
- Single/integrated system

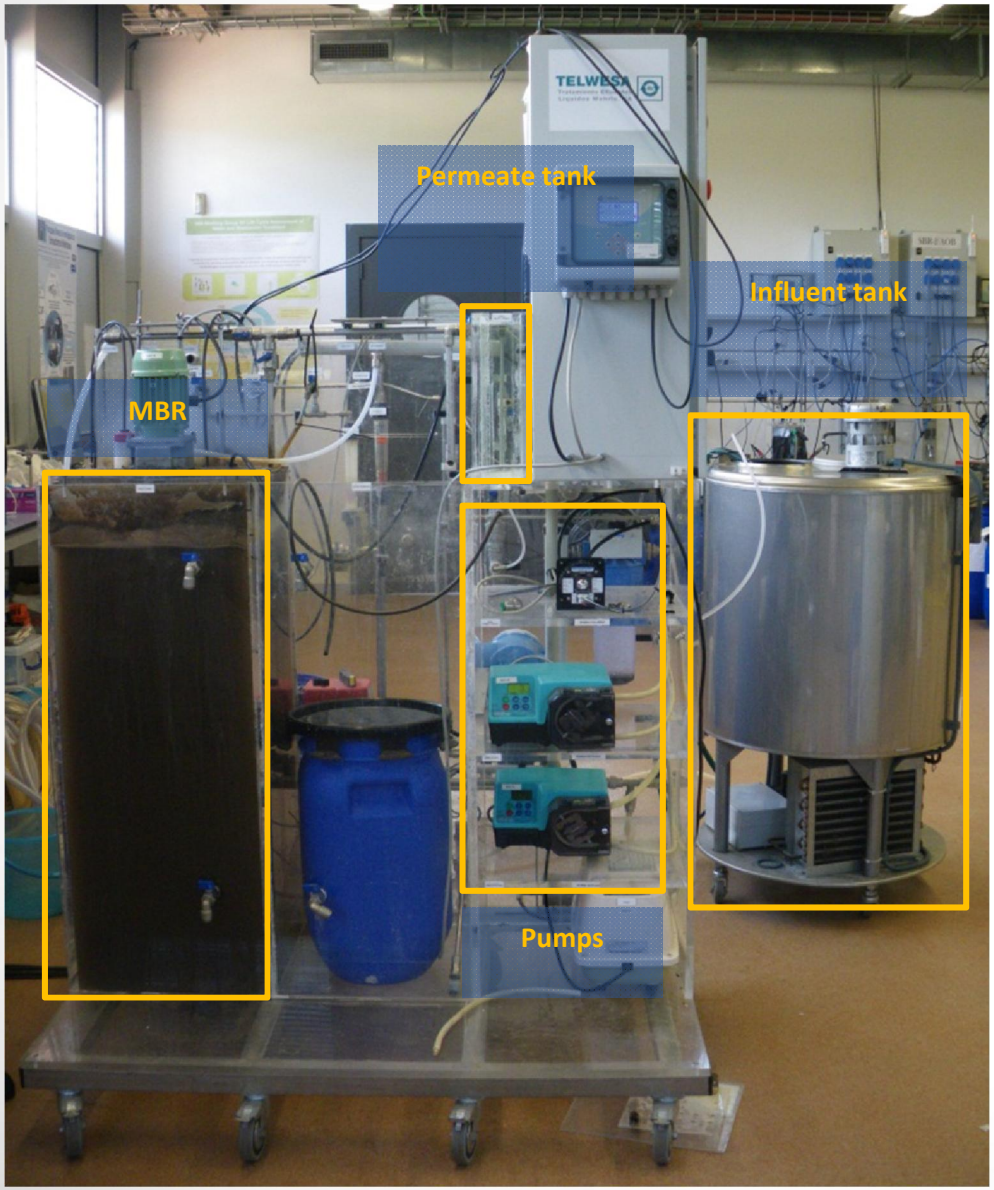
3. The pilot plant

SCADA (Supervisory Control And Data Acquisition)
TMP, pH, temperature, dissolved oxygen, flows, pumps...
SmartAir MBR



2 x 0,93 m^2
0,04 μm
F 9 min / BW 1 min

3. The pilot plant



In the lab (ICRA)

Synthetic water
Shower and laundry
14 months

- 20-30- 40 L/h
- 10-15-20 LMH
- HRT 4-8 h
- SRT 20-22 d
- Air scour 3,5 m^3/h

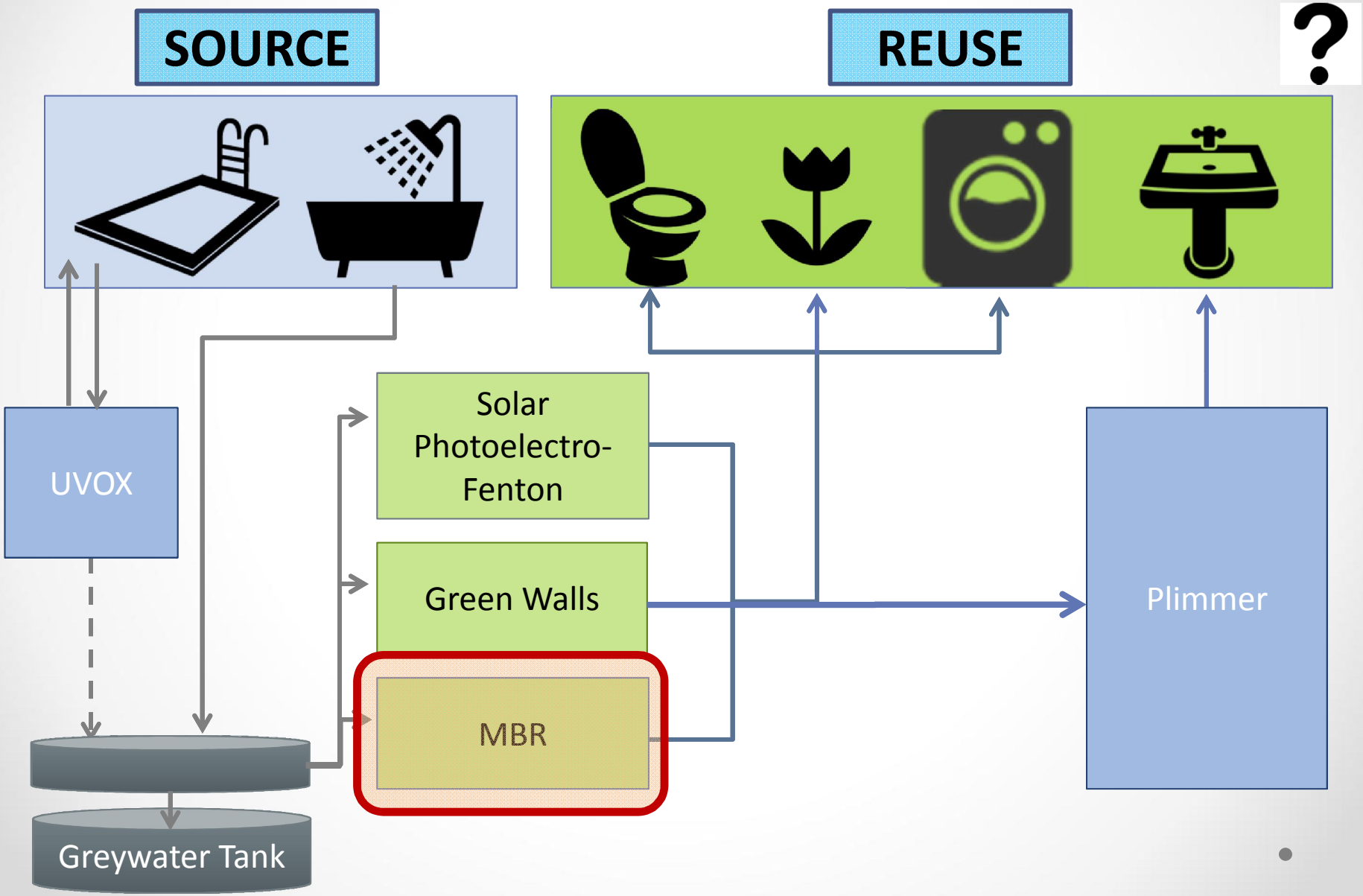
3. The pilot plant

In the demo site (Samba)

Real water from the hotel:
Grey water (shower, 8 months)
Wastewater (2 months)

- 20-30- 40 L/h
- 10-15-20 LMH
- HRT 4-8 h
- SRT 20-22 d
- Air scour 2 - 3,5 m^3/h

Greywater – ROADMAP



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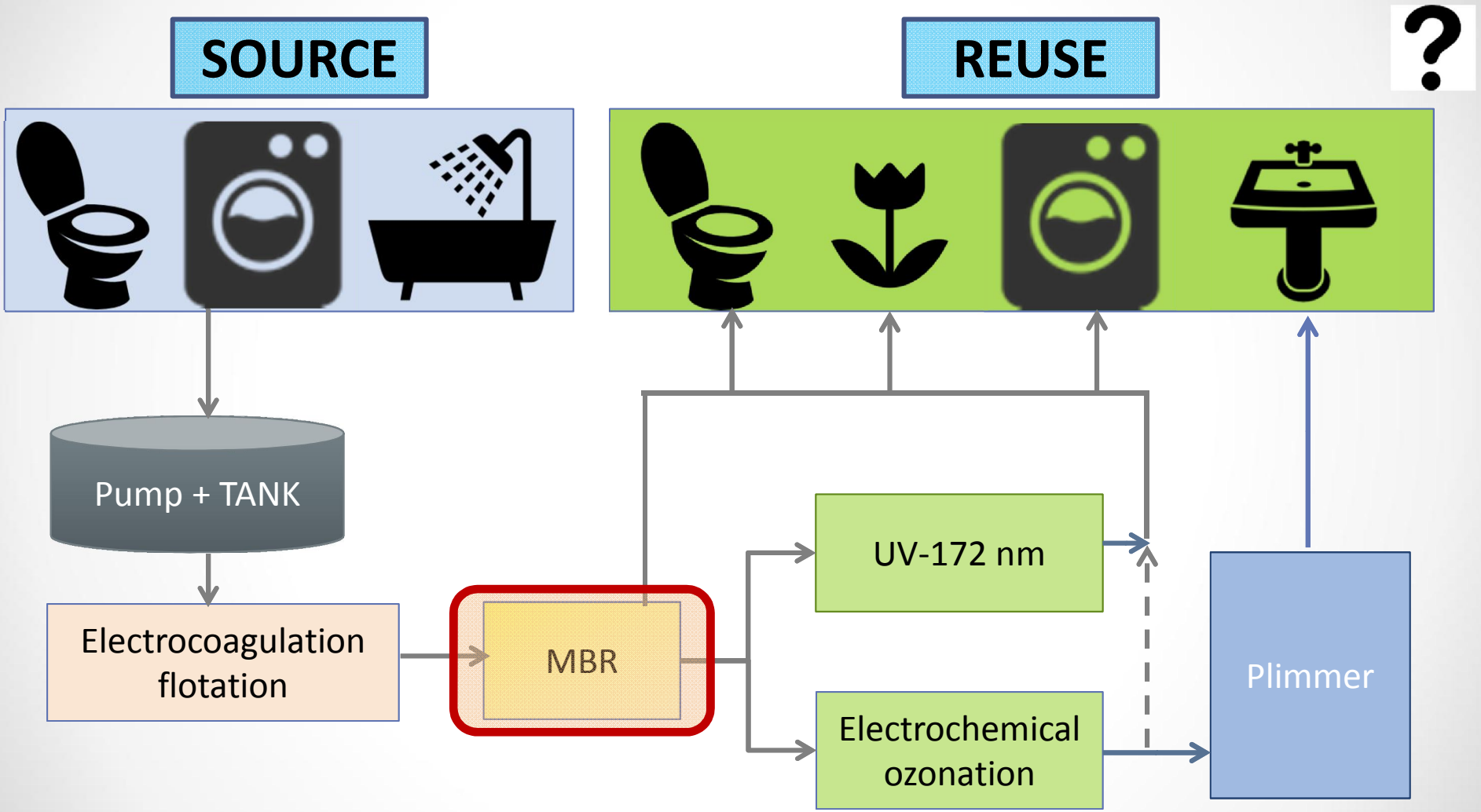
Wastewater – ROADMAP



4. Resume of results

GREY WATER (Samba Hotel)

~ 90% removal of COD
~ 95% removal of BOD5

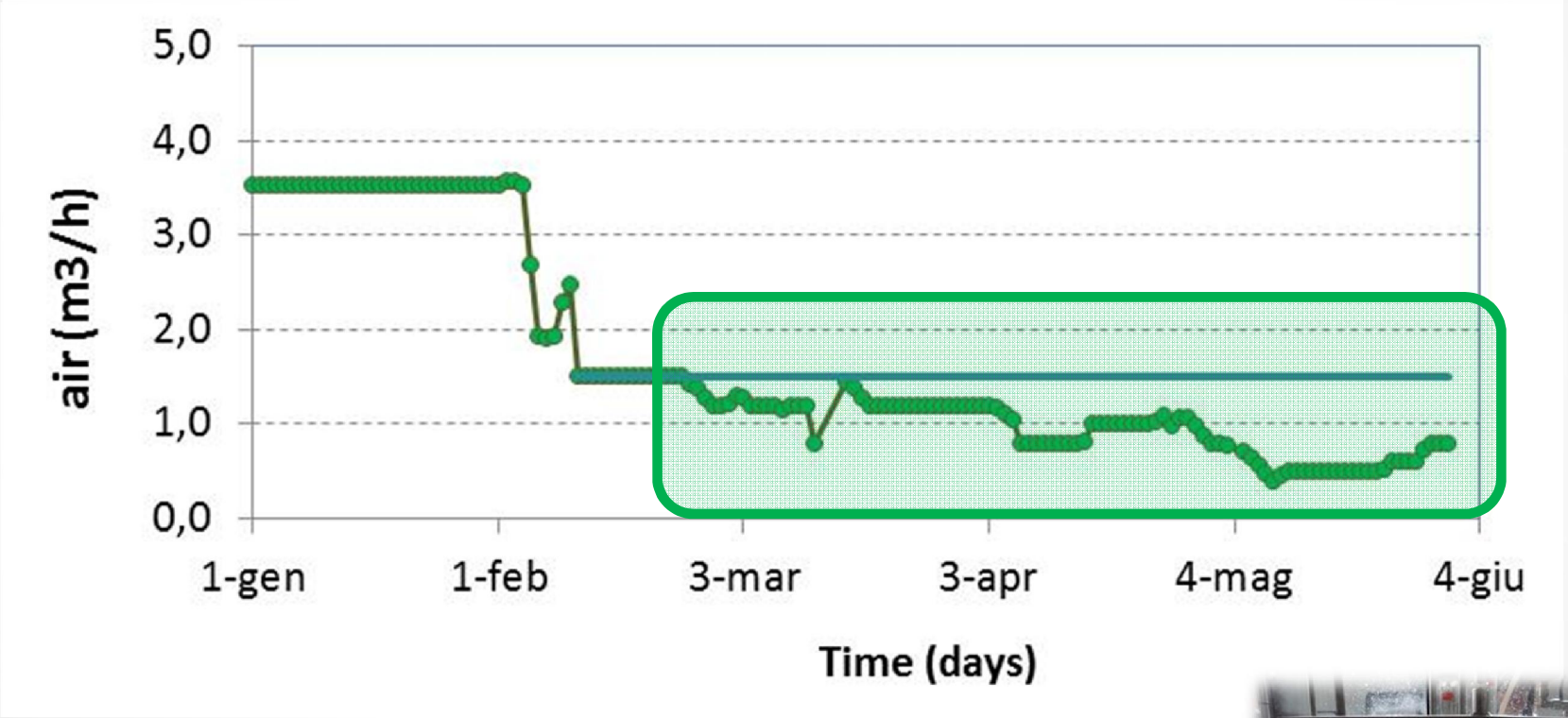
~ 89% removal of TKN and NH4+ (nitrification)
≤ 5 mg/L NO_3^-
No removal of P

Pathogen removal between 3 and 5 logs

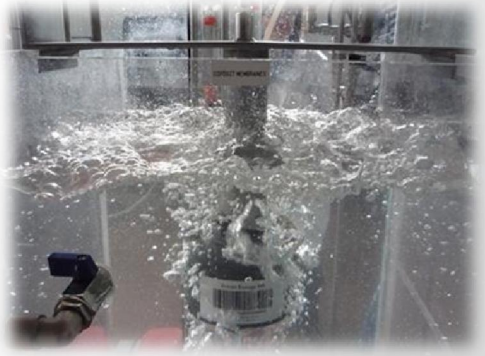
High (but variable) removal of micropollutants

4. Resume of results

Smart Air MBR
Air-scour Control System



~ 35,2% or air saving
~ SAD reduced from 0,75 to 0,27-0,45
• same fouling
• same removal efficiency



5. Application into the (tourism) market

Where can it be applied?

- greywater effluents (shower and laundry)
- wastewater (or black) effluents (domestic and industrial)

Who may be interested?

- water scarcity (Mediterranean area)
- high water quality required
- high water cost
- irrigation of recreational areas
- toilet flushing
- Decentralized areas

New €Directive

Thank you for your attention

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