Interreg North-West Europe WOW!

EUROPEAN UNION

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Report on the use of WOW-AC in Pilot-scale demonstration plant for MP-elimination from real wastewater

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NAME: Use of WOW-AC in Pilot-scale demonstration plant for MP-elimination from real wastewater

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SUBJECT: Pilot-scale results of WOW!-AC

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1. Introduction

1.1. Context

Sewage contains valuable substances that can be used as raw materials for biobased products. However, to date this potential has hardly been exploited to its full potential in North-West Europe. This results in loss of valuable materials, CO_2-emmissions and less

efficient use of natural resources. The Interreg North-West Europe project WOW! - Wider business Opportunities for raw materials from Wastewater (sewage) - aims to develop three value chains for the recovery of carbon-based elements from sewage (see figure 1):

1. **The production of biodiesel**. The sewage inflow is used to cultivate *Microthrix p.* which can accumulate lipids. The lipids are extracted, processed and transformed to biodiesel.
2. **The production of bio-oil, biochar and acetic acid**. The screening material which mainly consists of cellulose material (toilet paper) is dewatered and dried. In a thermal degradation process (pyrolysis) the dried cellulose material is converted into biochar, bio-oil and acetic acid.
3. **The production of PHA (bioplastic)**. For this the primary sludge is used. In a biological process, PHA is enriched and extracted. Then the PHA is compounded and processed to an end product.

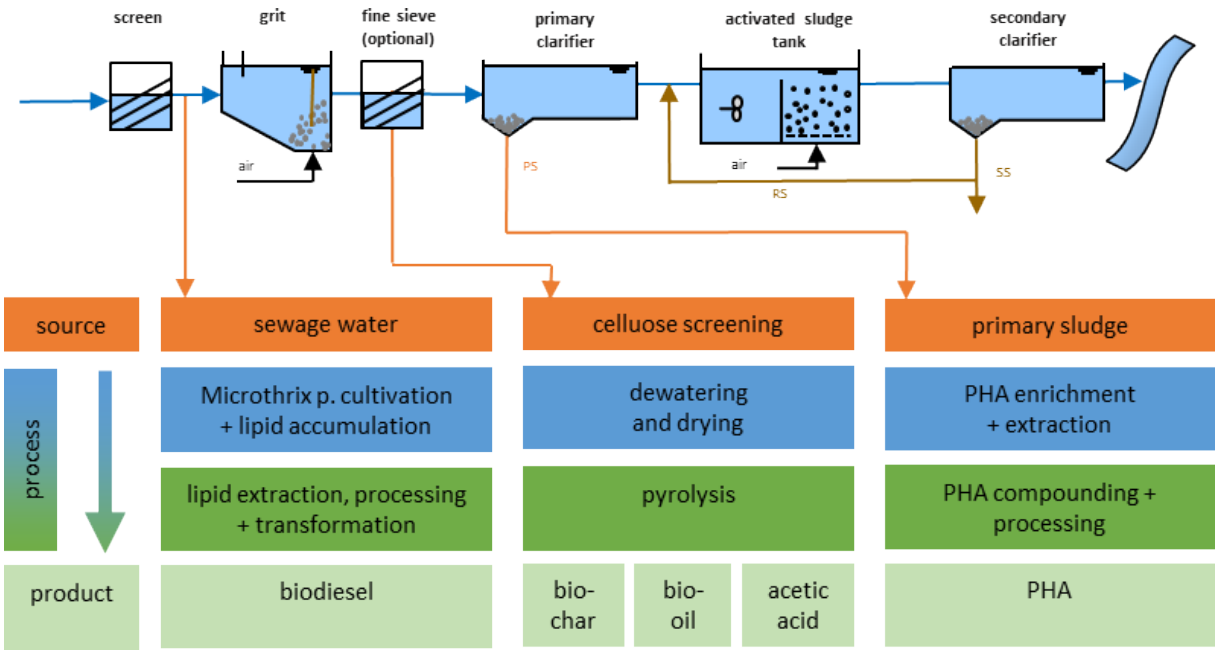


Figure 1. Recovery of carbon-based elements from sewage in WoW!

One of the main activities of the project was to demonstrate the technical feasibility of these three value chains in three pilots with a focus on optimisation of the different recovery and upcycling techniques and tailoring the products to market needs.

1.2. Motivation

- Use large WWTPs as factories to boost **territorial cohesion** and **inclusive growth** (according to the Interreg NWE program) in rural areas.
- The NWE zone is composed of rural areas with a high percentage of small and medium WWTPs discharging in sensitive rivers where **pollution mitigation** is of utmost importance to achieve the good (chemical and) ecological conditions in surface water;
- The Wow Activated Biochar from Cellulose can be applied as **admixture in Nature-based Solutions (NBS)** for pollution mitigation in NWE's rural areas

1.3. Nature Based Solutions (NBS) for micropollutants mitigation

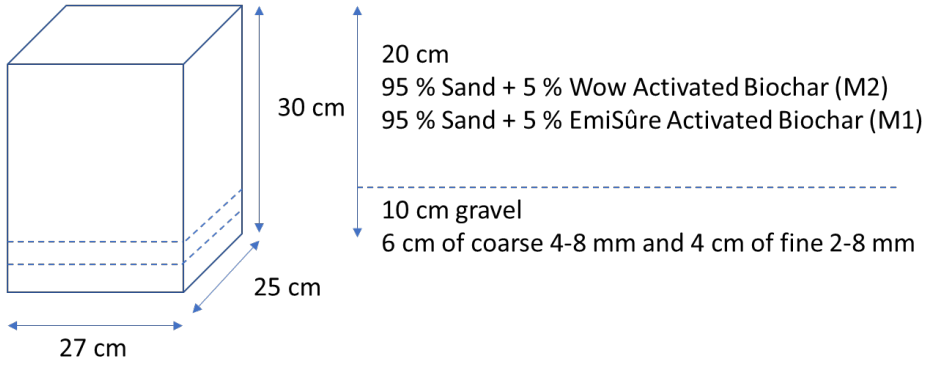
Definition

- **Nature-based Solutions** are innovative approaches that regenerate areas affected by human activities, restoring key ecological functions that improve people's quality of life (EC, 2023).
- Micropollutants pose a possible risk to aquatic system;
- Conventional WWTPs are inefficient to remove most micropollutants;
- Mandatory for all EU member states to monitor 17 compounds, among them the antibiotics azithromycin, clarithromycin and erythromycin;
- **A solution for small/medium sized WWTPs is needed.**

2. Materials and methods

2.1. Mesocosm design

It allows to conduct experiments under replicated, controlled and repeatable conditions at low cost.



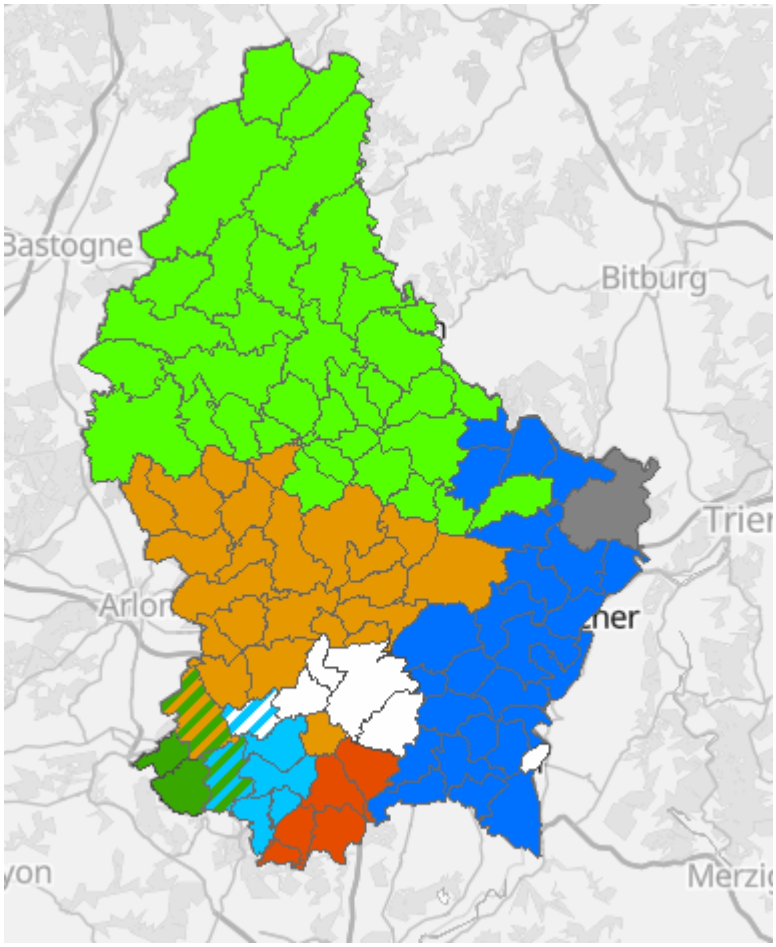
2.2. Target contaminants

Group	Class	Substance	CAS number
P - Pharmacauticals (16)	Anti-inflammatories (2)	Diclofenac	15307-86-5
		Ibuprofene	15687-27-1
	Anaesthetics (1)	Lidocaine	137-58-6
	Antibiotics (4)	Ciprofloxacin	85721-33-1
		Clarithromycin	81103-11-9
		N4-acetylsulfamethoxazole	21312-10-7
		Sulfamethoxazole	723-46-6
	Beta-blockers (2)	Atenolol	29122-68-7
		Metoprolol	51384-51-1
	Contrast media (2)	Amidotrizoic acid	117-96-4
		Iomeprol	78649-41-9
	Hormones (3)	Estradiol-beta	50-28-2
		Estrone	53-16-7
		Ethinylestradiol	57-63-6
	Lipid regulators (1)	Bezafibrate	41859-67-0
	Psychiatric drug (1)	Carbamazepine	298-46-4
H - Herbicides (5)	Herbicides (5)	Deet	134-62-3
		Diuron	330-54-1
		Flufenacet	142459-58-3
		Isoproturon	34123-59-6
		Terbutryn	886-50-0
O-Others (7)	Antimycotic (1)	Carbendazim	10605-21-7
	Corrosion inhibitor (2)	Benzotriazole	95-14-7
		Tolyltriazole	29385-43-1
	Flame retardant (1)	Tris(2-chloroisopropyl)phosphate (TCPP)	115-96-8
	Fluorosurfactants (1)	Perfluorooctanesulfonic acid (PFOS)	1763-23-1
	Stimulants (1)	Caffeine	58-08-2
	Sweeteners (1)	Sucralose	56038-13-2

2.3. WWTP Characteristics

WWTP of Beringen Mersch (70000 PE)

11373 m3/d (average 2022)



2.4. Testing plan

Scenarios	Specifications	Hydraulic Load per irrigated surface (m3/m2d)	Hydraulic Load per irrigated volume of soil (m3/m3d)	Motivation
SCENARIO 1	Batch test	0.09*	426.9	0.1 m3/m2d EmiSûre/CoMinGreat surface hydraulic Load (45 to 90 cm dept)
SCENARIO 2	Continuos test	0.023	115.74*	110 m3/m3d EmiSûre/CoMinGreat surface hydraulic Load (45 to 90 cm dept)

3. Results

3.1. Relevance of micropollutants for the WWTP

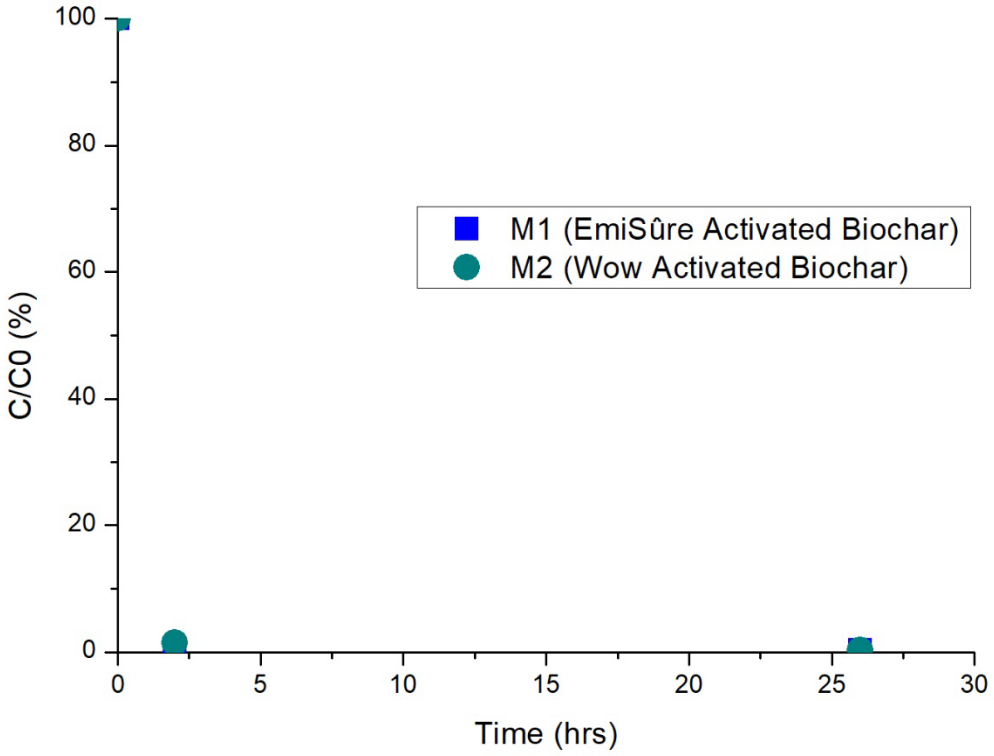
Results:

- 17 compounds out of 28 are relevant in the influent of the WWTP (>50 ng/L)

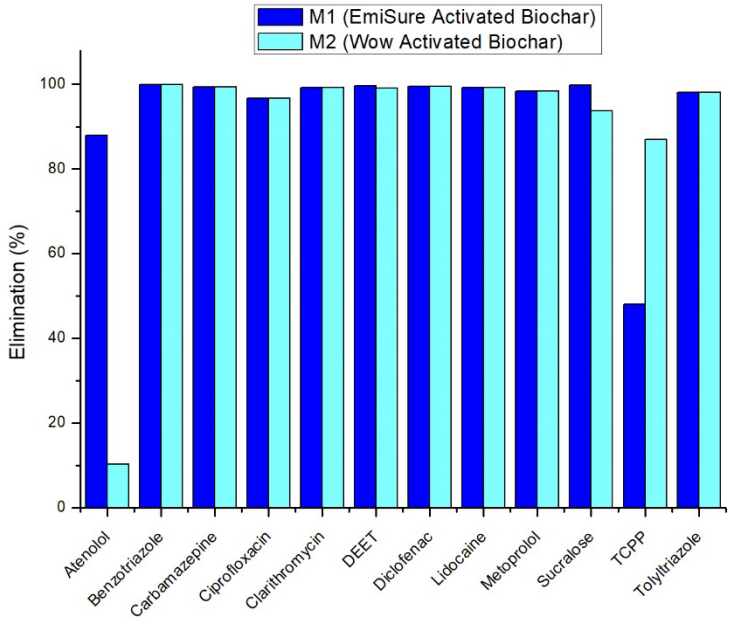
- 12 compounds out of 28 are relevant in the effluent of the WWTP (>50 ng/L)

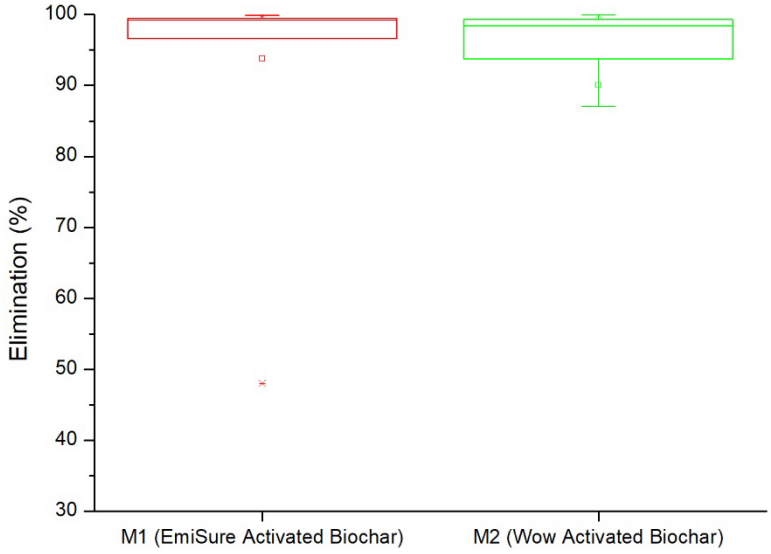
3.2. Scenario 1

Experiments



- Full elimination occurs already with the first flush, after 4 hrs from the watering (Example **Diclofenac**)

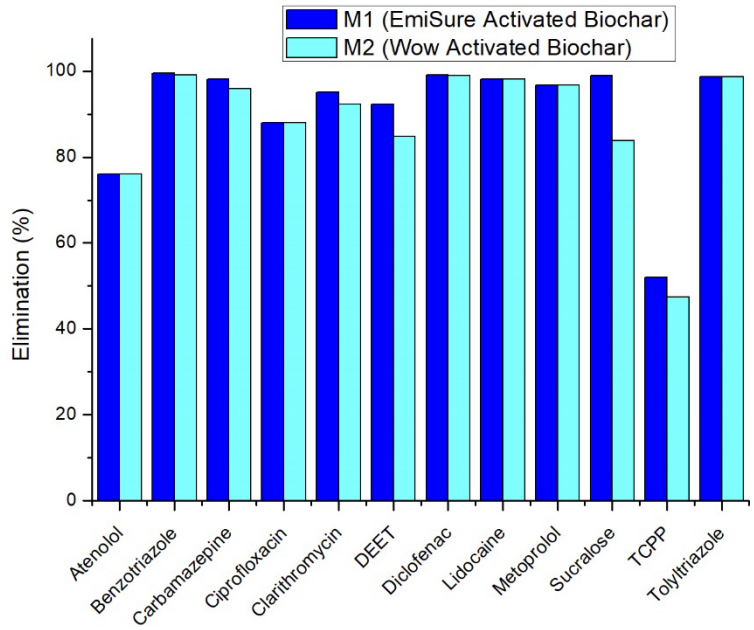


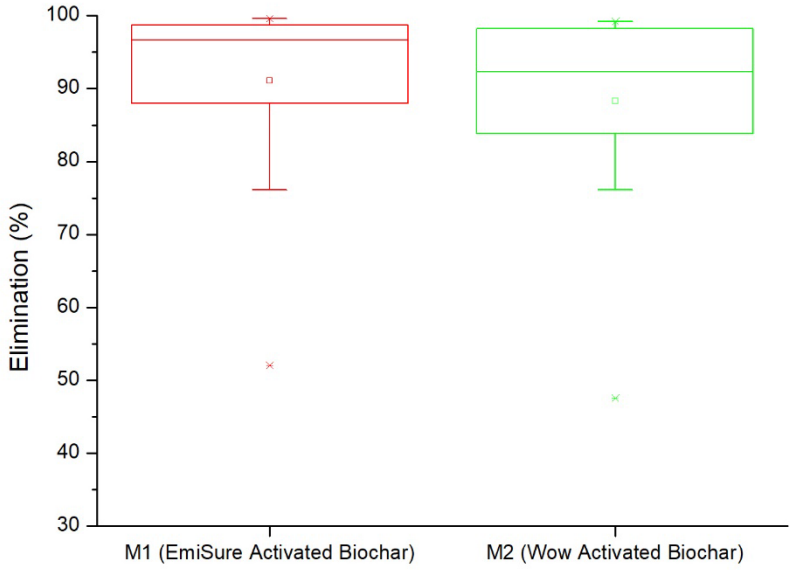


There is not a significative difference in performance between M1 (EmiSure Activated Biochar) and M2 (Wow Activated Biochar)

Average elimination (12 compounds)= 91.1% (M1) and 88.4% (M2)

3.3 Scenario 2





There is not a significative difference in performance between M1 (EmiSure Activated Biochar) and M2 (Wow Activated Biochar)

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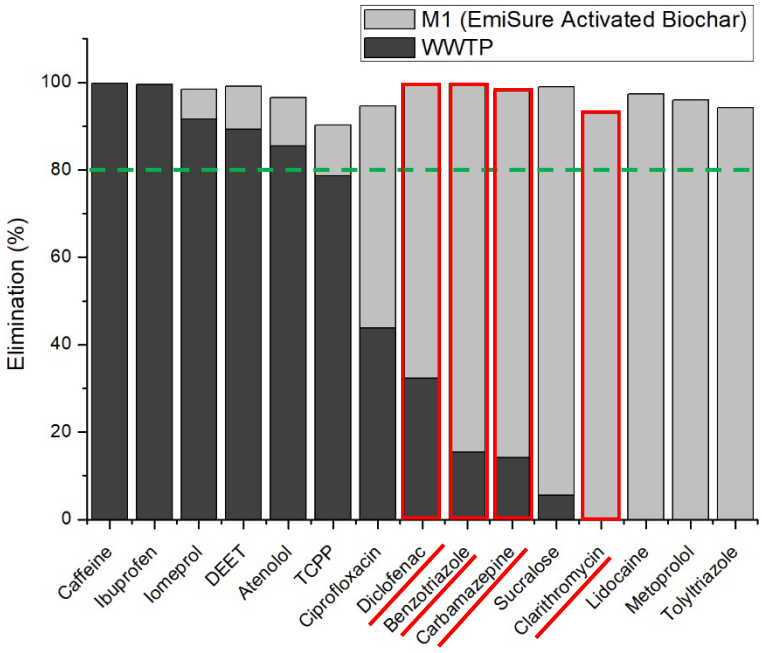
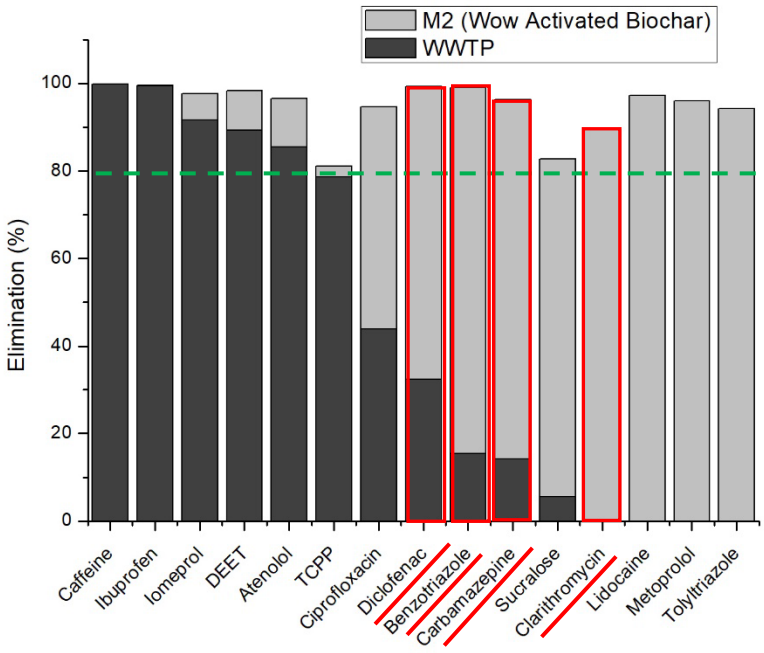
3.4 Implementing policy





Meeting the legislation restrictions with 80 % elimination for 4 mandatory compounds (Luxembourgish legislation)

4. Conclusions

- The Wow Activated Biochar from Cellulose proved to **be suitable** as admixture in CW for the removal of micropollutants (post-treatment step)
- The performance of Wow Activated Biochar from Cellulose is similar to those of previous Activated Biochar (produced from plants) with more than **80 % elimination** for most relevant micropollutants

5. References

Interreg North-West Europe
WOW!
European Regional Development Fund

Project partners

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