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Interreg North-West Europe WOW!
European Regional Development Fund

WOW!

Wider business Opportunities for raw materials from Wastewater

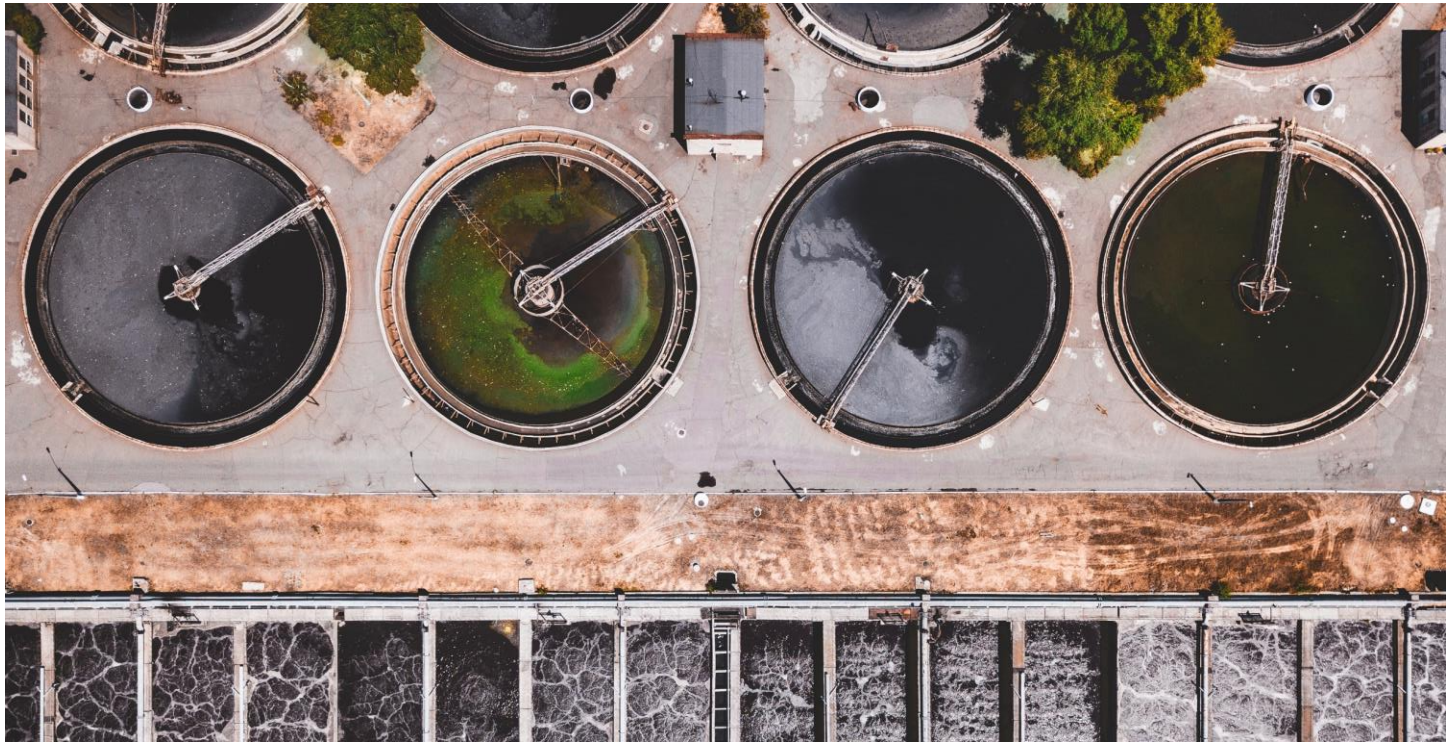
Decision Support Tool

Today

- Goal of the Decision Support Tool (DST)
- What is the DST
- Results of the DST
- What does the DST look like
- Time for questions

Goal of the DST

- Support and stimulate water authorities to realize their sustainability goals.
- Show policy makers the opportunities for recovery and reuse of carbon-based elements from wastewater.



What is the DST

- An Excel tool for water authorities that operate sewage treatment plants.
- The DST can be used to get a first impression if the influent of a sewage treatment plant is suitable for recovery and re-use of carbon-based elements.
- Looking at:

Bio-oil, biochar and acetic acid from pyrolyzed cellulose

Bioplastics by microbial PHA accumulation

Biofuel from microbial lipids accumulation

- Using a limited amount of (readily available) input parameters.

The outcome of the DST can be used to decide if the technologies are worth a closer look.

Result of the DST - outcome

The (composition of an) input stream of a sewage treatment plant indicates that:

1. implementation of technique for cellulose, PHA and/or lipids **is promising**
2. implementation of technique for cellulose, PHA and/or lipids probably **is NOT feasible**
3. **it is not yet clear** if implementation of technique for cellulose, PHA and/or lipids is feasible.
   A more detailed consideration is needed.

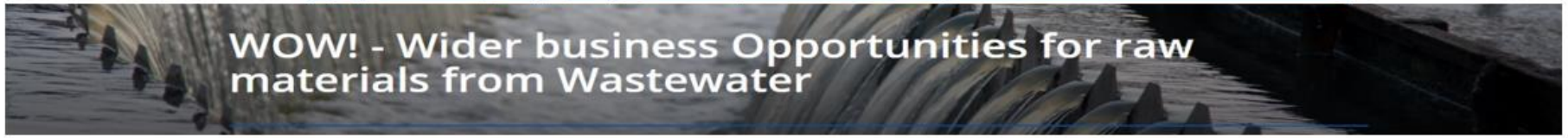
Result of the DST - information

DST provides information on:

- Effects of Wow! technologies on other sewage treatment plant processes
- Technical aspects → *based on information from pilots*
- Economic aspects → *based on information from TEA*
- Environmental & sustainability aspects → *based on information from pilots*
- Social aspects

Let's go to the Decision Support Tool

https://www.nweurope.eu/projects/project-search/wow-wider-business-opportunities-for-raw-materials-from-wastewater/



DECISION SUPPORT TOOL

The Decision Support Tool (DST) is a tool that offers organizations that operate sewage treatment plants a comprehensive decision making framework on the re-use of (carbon elements in) sewage for the production of valuable products. This tool is meant for water authorities (policy makers, sewage treatment plant operators) and factory owners to see if their sewage is suitable for:

- ***Production of the bioplastic PHA (polyhydroxyalkanoates):***

PHA is a fully degradable bioplastic that can be produced bij bacteria that are present in a sewage treatment plant (STP). First secondary sludge is used to grow bacteria with a high PHA production capacity. Next, the water fraction of primary sludge which contains volatile fatty acids (VFAs) is fed to these bacteria. The bacteria will convert the VFAs into PHA and store this PHA inside their cells. In the last step, the PHA is chemically extracted from the bacteria.

- ***Production of bio-diesel:***

The effluent from the primary treatment often contains fats and oils. These fats and oils can be converted into lipids by the bacteria species Microthrix parcivella. The lipids produced by Microthrix can be used for the production of bio-diesel. The conversion of fats and oils into lipids by Microthrix will be done in a Microthrix parvicella Selecting Reactor (MPSR). The effluent from the primary treatment will be fed to this MPSR.

- ***Production of oil, (bio)char and acetic acid from cellulose:***

The influent of a sewage treatment plant often contains cellulose (toilet paper). This cellulose can be used for the production of oil, (bio)char and acetic acid. In a first step, special cellulose screens will filter the influent of the STP. The filtered fraction will mainly consist of cellulose, some other organics and a fraction of sand. After dewatering, the harvested cellulosic screenings are dried, pelletised and fed to a pyrolysis process. During the pyrolysis process, carbon chains are disintegrated into different fractions: oil, (bio)char and acetic acid. The oil can be used as (bio)fuel, the (bio)char can be used to remove medicines from sewage water and the acetic acid can possibly be used in the production of the bioplastic PHA.

DST – input tab

- Name + location STP
- Primary treatment (YES/NO)
- % sewage from households (<25%, 25-50%, >50%)
- Amount of Population Equivalents (PE)
- COD and/or BOD (mg/l)

DECISION SUPPORT TOOL - DATA INPUT

INSTRUCTION

* In this tab 'input' you can fill in data from up to 50 sewage treatment plants. Information can be filled in in the cells coloured and
* **A)** First you have to choose which method is used to calculate the population equivalent for the sewage treatment plants that you are testing. There is an option menu for this (**row 11**).
* **B)** gives the standard value for the BOD/COD-ratio that will be used in the calculation if no BOD and/or COD concentration is filled in in column G and/or H. In this case, a standard BOD/COD-ratio of 0,5 will be used in the Decision Support Tool. This value is based on average BOD/COD ratios in the influent of sewage treatment plants in Europe. The standard BOD/COD ratio can be changed in this cell if you have information about the actual BOD/COD ratios of the influent at your sewage treatment plants.
* In Column A and B you can put in information about the name a the sewage treatment plant and the location (city, region)
* In column D, E, F, G and H you have to fill in specific information about (the influent of) the sewage treatment plant. Column D and F have an option menu. Additional information can be found in the cells with a red triangle if you move your cursor over the cell.

A) Which method do you use for calculation of Population Equivalents?

B) Standard value for BOD/COD-ratio *(only used if BOD and/or COD concentration is NOT known)* 0,5

	Name Sewage Treatment Plant	Location	Primary treatment	Percentage sewage from households	Amount of Population Equivalents	BOD	COD
			yes/no	*%*	*PE*	*mg/l*	*mg/l*
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
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15							

DST – overall results

- Overall results for each technique per STP

	Name Sewage Treatment Plant	Location	PHA (bioplastics)	Bio-diesel (from lipids)	Oil - Char - Acetic Acid (from cellulose)
1	ALFRETON (STW)	Belper			
2	ARMTHORPE (STW)	Scunthorpe			
3	ASHBOURNE (STW)	Swadlincote			
4	ASLOCKTON (STW)	Newark			
5	ATHERSTONE (STW)	Nuneaton			
6	BAKEWELL - PICKORY CORNER (STW)	Buxton			
7	BALDERTON (STW)	Newark			
8	BARNHURST (STW)	Wolverhampton			
9	BARROW & QUORN (STW)	Loughborough			
10	BARSTON (STW)	South Birmingham			
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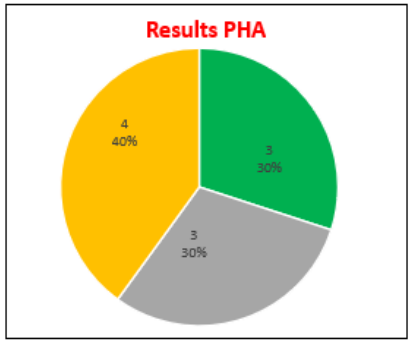

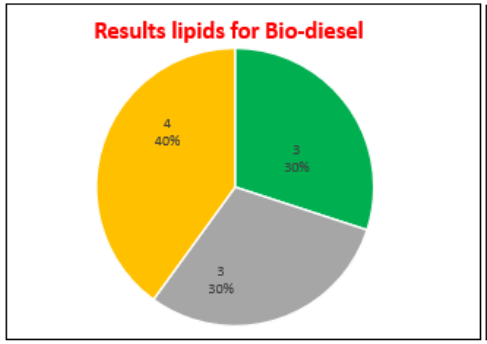

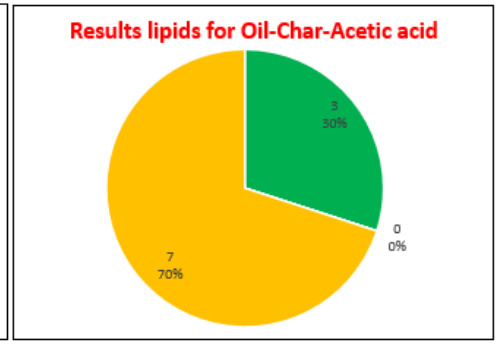

	Input of information indicates that the input stream of the sew age treatment plant is promising for this technique
	Based on the given input it is not yet clear if the input stream of the sew age treatment plant is suitable for this technique. A more detailed consideration is needed.
	The composition of the input stream of the sew age treatment plant indicates that implementation of this technique at this sew age treatment plant only is probably NOT feasible. *(NOTE: other aspects such as combined implementation of the technique at several STPs or desire to reduce organic load of STP could make technique feasible, see factsheet*
	Not all necessary input parameters are filled in in the 'Input' tab. The result cannot be determined.

	PHA	Bio-	Oil - Char-Acetic
Promising	3	4	3
Not yet clear	3	3	0
Not suitable	4	3	7
Total	10	10	10

DST – technique specific results

- Results for one technique (in this case PHA)
- Result for each relevant parameter

	Name Sewage Treatment Plant	Location	Primary treatment	Percentage sewage from households	Amount of Population Equivalents	BOD/COD	COD	OVERALL
			yes/no	%	PE	--	mg/l	
1	ALFRETON (STW)	Belper	Yes		80000	0,44		
2	ARMTHORPE (STW)	Scunthorpe	Yes		15232	0,30		
3	ASHBOURNE (STW)	Swadlincote	Yes		21982	0,44		
4	ASLOCKTON (STW)	Newark	Yes		125000	0,44		
5	ATHERSTONE (STW)	Nuneaton	Yes		16298	0,22		
6	BAKEWELL - PICKORY CORNER (STW)	Buxton	Yes		11396	0,44		
7	BALDERTON (STW)	Newark	Yes		10690	0,44		
8	BARNHURST (STW)	Wolverhampton	Yes		1622556	0,44		
9	BARROW & QUORN (STW)	Loughborough	Yes		12748	0,44		
10	BARSTON (STW)	South Birmingham	Yes		62210	0,44		
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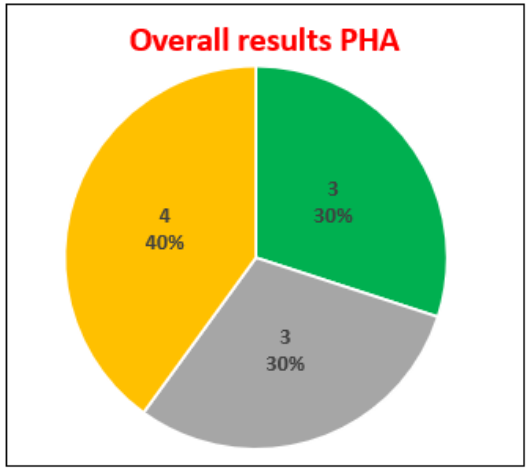

DST – technique specific factsheet

PYROLYSIS OF CELLULOSE TO PRODUCE OIL, (BIO)CHAR AND ACETIC ACID

Possible effects on other processes of sewage treatment plant

Nutrient and/or organic carbon removal	
Aerobic secondary treatment	
Anammox	
Nereda	
Coagulation / flocculation	
Energy production	
Anaerobic digestion of primary & secondary sludge to methane	
Heat or electricity from cellulose	
Gasification of sewage sludge to syngas	
Nutrient recovery	
Struvite from waste water (Anphos,)	
Phosphorus from sewage sludge (EuPhore, TetraPhos, PULSE, Struvia, RecoPhos, Airprex, Pearl)	
Phosphorus from sewage water (FiltraPHOS)	
Other recovery processes	
Lemna growth (eg. to feed or protein)	
(micro) Algae growth (eg. to feed or protein)	
PHA production	
Lipid production for bio-oil	
Kaumera (biopolymer from Nereda process)	
Direct use of sludge as fertilizer (ROUTES)	

- implementation of pyrolysis of cellulose has no impact on this process
- implementation of pyrolysis of cellulose POSSIBLY has an effect on this process
- implementation of pyrolysis of cellulose has an effect on this process

DST – technique specific factsheet

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Additional information on technique

Technical aspects of pyrolysis	
Dimensions	- Building for pilot of sives and pyrolysis: 10 x 30 m - Activation Biochar is done off site
Status of technique	Pilot scale (up to 500 m3/h of input stream for sieves)
Electricity use	- Sieves: 40 W/m3 influent - Activation biochar: data will be added when results Wow project are available
Chemical use	- Propane (for pyrolysis: 3 kg/hour durng pyrolysis - Nitrogen (for pyrolysis)
Maintenance	- Sieves require normal maintenance - Pyrolysis: maintenance by experts needed
Time of operation	- Sieves: continuous - Pyrolysis plant: batch (hours?)
Complexity of operation	Data will be added when results Wow project are available

Economic aspects of pyrolysis	
CAPEX	223 €/tonDM/yr (including chemical char activation) Scale (183 – 1004 tonDM/yr) –> 325 – 170 €/tonDM/yr
OPEX	386 €/tonDM/yr (including chemical char activation) Scale (183 – 1004 tonDM/yr) –> 420 – 365 €/tonDM/yr
Main influencing parameters	Product prices and plant scale
Possible applications of product(s)	Char for combustion; Activated char for purification; Pure acetic acid for medical use, food additive and impure as chemical reagent; Bio-oil as renewable feedstock for chemicals and fuel
Prices of products	Char – 1.4 €/kg; Activated char – 2-4 €/kg; Acetic acid – 0.3 - 0.8 €/kg depending on purity; Bio-oil – 0.5 €/kg (Market prices)
Impact on existing configuration STP	- See 'Possible effects on other processes of sewage treatment plant' - Less processing of sieved material - Less energy is needed for aeration because due to removal of cellulose less COD/BOD is present in secondary treatment process
Employment	- Sieves: < 0,5 fte - Pyrolysis: data will be added when results Wow project are

Environmental & sustainability aspects of pyrolysis	
Odour	- Sieves: fully covered and the ventilation air is treated in biofilters. Also the whole building is ventilated and treated. So no relevant odour emissions from the sieves. - Pyrolysis installation: completely closed. The exhaust fumes (flue gas) come out of the burners but will not cause odour
Noise	Limited because all activities are performed within buildings
Visual	Sieves and Pyrolysis installation will be in a concealed building
Emissions / residue stream	Pyrolysis: flue gas. This flue gas will be cleaned.
Reduction/avoided CO_2 emissions	The calculation of the reduction of the CO2 emissions is very complicated. It depends how far you look: do we also look at the GER values of the products (compared to de GER values of the fossile alternatives)?
Reduction of pollutants	Removal of cellulose. This leads to up to 40% COD removal from input stream

Social aspects of of pyrolysis	
Health & Safety	- Sieves: comparable to other equipment at a sewage treatment plant. - Pyrolysis: operates with high temperature and gasses. ATEX applies!
Acceptability	- No specific attention points
Legal aspects	- Currently there is no end of waste status for (bio)oil from pyrolysis of cellulose - Acetic acid and biochar: data will be added when results Wow project are available

Q&A

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