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D7.1: Selection toolbox design and development strategy; description of selection toolbox functionalities

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Deliverable Review and Approval

The individuals listed below are not directly involved in the preparation of this deliverable and will review the present document.

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Deliverable Development and Review Process

 			-
	Key Event	Deadline	Done by
1	Submission of Draft Deliverable to reviewers	01/08/2019	27/08/2019
2	Initial Review and Comments obtained	15/08/2019	05/09/2019
3	Uploading and submission of Final Deliverable on Participant Portal	30/08/2019	26/09/2019

Executive summary

This document describes the main characteristics of Project Ô's Technology Selection Toolbox. A general overview of the conceptual design and the software architecture is presented in order to provide the reader a clear understanding of the scope of the tool. One of the main strengths of the tool is how it integrates different types of data and technologies, which allows to carry out water treatment simulations and data analysis. The platform can be connected to a database of water treatment technologies to provide information about the available technologies and equipment for certain networks/locations.

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1 Introduction

Project Ô, and specifically Work Package 7, has the aim of assessing the economic and operational sustainability of water circular use, within specific water regulatory conditions, and how it interfaces with a circular economy business model, more business driven and where water is one of the resources to be shared. The main outcome of WP7 is a set of tools to facilitate user engagement and to underpin collaborative business opportunities between different stakeholders along the value chain.

A key output of WP7 is the Design of a Technology Selection Toolbox for water treatment technologies. It is meant to be a single dynamic online platform which will be used by water treatment facilities and water system managers for the identification of the best technology solution and/or system of solutions to treat a specific water stream. It will also empower small communities and SMEs to implement virtuous practices for on-site circular use (or re-use) of water. The toolbox will provide technical, economic, environmental and regulatory information reported in a graphical way that enables the comparison between alternatives and facilitates their final decision.

Accessed from the project website, it is composed of a set of modules displaying fact sheets consisting of charts, tables and other information gathered. Ultimately, the selection toolbox will be one of the key components conforming the Users Collaborative Platform to be developed in Project Ô as part of the same work package (WP7).

This deliverable presents the first functional version of the Technology Selection Toolbox, which builds upon the current state-of-the-art technologies for Used water treatments and foresees the integration of the innovative technologies in Project Ô portfolio. The toolbox will evolve towards a more technology-oriented tool along with the development of the project and will rely on the technical and economic information that is being developed by consortium partners. This first functional version is coded in VBA (Visual Basic for Applications) and includes a simple user interface, which would be transferred to a web-based tool once integrated in the Users Collaborative Platform in task T7.2.

2 Basic structure and content of the toolbox

The toolbox consists of 8 main elements:

- 1. **Input block**. The "SUMMARY AND INSTRUCTIONS" tab works as the tool's input block, where the users are meant to introduce their specific water type to be treated and water quality data, such as water source, flow to site, solids particle size, Biochemical Oxygen Demand (BOD5), Total Suspended Solids (TSS), Total Phosphorous (TP), metals, among others.
- 2. **Instructions**. The tool offers a set of instructions in the "COMPANY" tab, outlining a step by step guide on how to use the tool for obtaining optimal results. Moreover, in the data input tab, the tool also presents warnings when the selected information is incorrect and/or wrongly placed e.g. combination of treatment and source type not compatible.
- 3. **Catalogue**. Under the tab "Data", the selection toolbox gathers a variety of technologies for every treatment stage and water process type. For each technology, the removal rate of the different Key Performance Indicators (KPI)¹ are stated, which is a crucial aspect for calculating the overall output KPI content depending on the technology selection and input data. The result of this calculation will be compared against the regulations limit values to evaluate their legal compliance.
- 4. Process selection. Based on the input data, the tool will automatically select the suitable water treatment process stages, which will be displayed on the left-hand side of the tab "SUMMARY AND INSTRUCTIONS". The selection will be graphically illustrated in the form of a Process Flow Diagram in the tab "PFD".
- 5. **Technical and economic data**. A more detail information of the process and technology selection is shown under the tab "process data" for the technical aspects, and the tab "Economic data" for the CAPEX and OPEX.
- 6. **Regulatory data**. The legal limit values of the considered KPIs are stated in the tab "Permits", both for Used water and Clean water. The data will then be used for comparison purposes of the treatment selected, to assess if the output aligns with the current legal requirements; if it does not then a different or additional set of water treatment technologies should be selected. The tool allows to add on technologies or modify the selection made to look for a better solution so that the output water parameters are within the regulatory limits.
- 7. Interface. The performance results of the different technology selections are shown in form of infographics in the tab "Graphs". It is featured in a user-friendly approach that enables the comparison between alternatives and facilitates their final decision. The charts present the water treatment performance of the different train of technologies chosen in each selection, comparing the KPIs against the limit values set by the regulations.
- 8. **Back end**. All the codes and formulas to run the toolbox are stored in the back-end side of the engine, protected under password.

¹ KPIs defined in the Annex

3 Technical content

The aim of this work is to develop an easy to use tool which can assist in the selection of appropriate technologies and processes required for water treatment. Below, a step-by-step user guide is presented for facilitating the optimal use of the tool.

1. Within the 'SUMMARY & INSTRUCTIONS' tab, complete column J (light blue cells) of the input sheet with the relevant information. If the data to entered is for used water, the clean water cells should be empty as shown in the figure below and vice versa.



Figure 1: summary sheet to input data of only Used water contents.

Only cells in blue are to be filled and updated. Data in white cells are calculated and should not be manually updated.

2. The '**Process Data'** tabs provide the unit data for the Clean/Used water treatment. Input the required data in the Summary table and the stream table (light blue cells). For Used water selection please use Process Data 1 to 5 to input data. For water option use Process data 6 to 11 to input the relevant data.

INPUT DATA														
		USE PHASE			TRANSPORT PHASE				SOURCE	NOTES				
VARIABLE	DESCRIPTION	QUANTITY	UNITS	COMMENTS	DISTANCE (km)	LOAD CAPACITY (t)	ACTUAL LOAD (t)	EMPTY RETURN?	DATA TYPE	Please specify the material input of your				
Screen Type	(Coarse, Fine)	Coarse								manufacturing process(es) defining any ancillary material used (e.g. lubricants,				
Openings size	Screen size	0.2	mm							packaging etc.) Please use the unit system				
Flow in	Flow in	120000	m³/d							data for full year and for the entire factory,				
Flow in Velocity	Should be betweer and 1.2 m/s	0.3	m/s							without specifying the particular product(s) or production line(s). from different				
Settling Velocity (For Grit)		0.02	mm/s							production lines				
Cross Section Area		4.63	m²											
Width		1.756820922	m	Assuming Depth = 1.5*Width										
Depth		2.635231383	m											
Detention Time		134.719482	8											
Volume		12.20	m³							NOTES				
										Please define the output product(s) of your manufacturing activities per				
				OUTPU	T DATA					year coming from different				
VARIARI E	OUTPUT MATERIAL	OUANTITY	UNITS	COMMENTS	TSS OUTPUT	_			SOURCE	production lines				
Flow Out	Elow out	120000	owin s	COMINIENTS	295.03	Data in	blue cells		DATA TYPE					
Flow Out Velocity	100 000	0.3	m/s		200.00			5 I	DAIATIFE					
Solids Removed	Solids out	0	m³/h			need to	o be identii	ied						
							- 1							
							」 ◀	7						
								~						
-					FOR EXERGY USE ONL	Y								
SUMM	ARY													
# MAIN FEEDS	1													
OTHER INPUTS	-													
OTHER OUTPUTS	1													
# PRODUCTS	1													
<u> </u>					Chart	Area e) Axis Major Gridlines								
STREAM #	1	2	3											
COMPOSITION	Flow in	Solids out	Flow out											
RECTULED?														
RECICLED TO #	RECYCLED TO #													
				ENERGY	DATA									
	PURCHASED ENE	RGY DATA								NOTES				
MACHINERY	ENERGY SOURCE	OUA								Please specify the energy input of				
MARCHINERT	ENERGY SOONCE	Pro	cess data	tabs 🗖						your manufacturing process(es)				
COMPANY INFO	SUMMARY & INSTRU				Proce	ss Data 1 Process Data	2 Process Data 3	Process Data 4 P	rocess Data 5	Process Data 6 . (+) :				
										The Display Settings				
L0										con orspialy securitys m (I)				

Figure 2: Process data sheet to input data streams number and names.

3. On the 'SUMMARY & INSTRUCTIONS' tab, click on 'Select the Process' button to display suggested technology / process needed; shown in column D (orange cells).

Summary Selected Processes List Total Jumber of Processes: 6 Site Name Select the Process Site Name Select the Process Source Type Domestic and Industrial waste Source Type Domestic and Industrial waste Source Type Domestic and Industrial waste Size Type Small Select the Process Data 3 Activated Carbon Adsoper Process Data 3 Process Data 3 Process Data 4 Process Data 5 A Scondary Clarifier Through flow to site Table Matterwater Input Data Value Under State 2 Process Data 5 Process Data 5 Pro	
Selected Processes List INPUT SHEET PFD Overvit Total Jumber of Processes: 6 Site Name Select the Process Index Site Name Vest Select the Process Clear PFD Sheet Clear PFD Sheet Process Data 1 Git Score 1 yee Denestic and Industrial wate Select the Process Button Select the Process Button Process Data 2 Croular PS1 NA To clear Button Adsorper Select the Process Button Process Data 3 Scoreal yee Small Value To clear Button Value To clear Button Process Data 3 Scoreal yee Small Value To clear Button To clear Button Process Data 5 Scoreal yee Small Value To clear Button To clear Button Process Data 5 Scoreal yee Small Value To clear Button To clear Button Versite 2 Storeal Value Storeal Yee Small To clear Button To clear Button Versite 2 Storeal Value Storeal Value To clear Button To clear Button To clear Button Versite 2 Storeal Value Storeal Value To	
Step Description Site Name Site Name Treatment Type Variewater Index Site Name Process Data 1 Git Process Data 1 Git Process Data 1 Git Process Data 2 Circular PST Process Data 3 Activated Carbon Adsorper Process Data 4 ASP Process Data 5 Secondary Clarifier Process Data 5 Activated Carbon Adsorper Process Data 5 Accounted Carbon	v
Site Name Index Index Index Set Name: Process Name: Ver Process Name: Domestic and Industrial waste Process Name: Domestic and Industrial waste Process Name: Domestic and Industrial waste Process Name: Process Name: Process Name: Domestic and Industrial waste Process Name: Domestic and Industrial waste Process Name: Process Name: Process Name: Domestic and Industrial waste Process Name: Select the Process Name: N/A Select the Process Butt Process Name: Select the Process Name: N/A Develal Wastewater Input Data Value Through flow to site Size Type Size Type Smail Develal Wastewater Input Data Value Through flow to site 120000 m3/d Index Size Type Smail Develal Wastewater Input Data Value Value Value <td< td=""><td></td></td<>	
Treatment Type Wastewater Index Index Process Name: Process Data 1 Git Domestic and Industrial vaste Process Data 2 Circular PST Domestic and Industrial vaste Process Data 3 Activated Carbon Adsorper Small Process Data 5 Socondary Clarifier Mastewater light to site 120000 m3/d Process Data 5 Socondary Clarifier Process Data 5 Activated Carbon Adsorper Mastewater light to site 120000 m3/d Process Data 5 Socondary Clarifier Het ISS 23500 mg/l Process Data 5 Activated Carbon Adsorper Het ISS 23500 mg/l	t new PFD
Index Select tide Process Data 1 Gir Process Data 2 Circular PST Process Data 3 Acrivated Cabon Adsorper Process Data 5 Secondary Clarifier Process Data 5 Activated Cabon Adsorper Process Data 5 Secondary Clarifier Process Data 5 Activated Cabon Adsorper	
Index Source Type Domestic and Industrial waste Process Data 1 Git 2 Process Data 2 Circular PST NA Process Data 3 Activated Carbon Adsorper NA Process Data 4 ASP Small Process Data 5 Secondary Clarifier Through flow to site 120000 m3/d Process Data 5 Activated Carbon Adsorper Through flow to site 120000 m3/d Process Data 5 Activated Carbon Adsorper Through flow to site 120000 m3/d Inlet BOD 11et BOD 330 mgfl Intel SD Intel TS 255.03 mgl 255.03 mgl	
Process Data 1 Gift Process Data 2 Process Data 2 Circular PST Process Data 3 Acrivated Carbon Adsorper Process Data 4 ASP Process Data 5 Secondary Clarifier Process Data 5 Acrivated Carbon Adsorper Process Data 4 ASP Process Data 5 Secondary Clarifier Process Data 5 Acrivated Carbon Adsorper Hele ISDs 2300 mg/l Hele ISDs 255.03 mg/l	
Process Data 1 Grit Process Data 2 Circular PST Process Data 3 Acrivated Carbon Adsorper Process Data 4 ASP Process Data 5 Secondary Clarifier Process Data 5 Acrivated Carbon Adsorper Process Data 5 Secondary Clarifier Process Data 5 Acrivated Carbon Adsorper Value Value	
Process Data 1 Grit Through flow to site Tot Process Data 2 Circular PGT Size Type Small Process Data 3 Activated Carbon Adsorper Overall Wastewater Input Data Value Process Data 3 Sp Through flow to site 12000 m3/d Process Data 5 Secondary Clarifier Inlet BCDs 330 mg/l Process Data 7 Activated Carbon Adsorper Inlet BCDs 330 mg/l	
Process Data 2 Circular PST Size Type Small Process Button Process Data 3 Acrivated Carbon Adsorper Overall Wastewater Input Data Value Process Data 5 Socondary Clarifier Through flow to site 120000 m3/d Process Data 5 Socondary Clarifier Intel BOD_6 330 mg/l Process Data 5 Activated Carbon Adsorper Value Value	
Process Data 3 Activated Carbon Adsorper Dverall Wastewater Input Data Value Oran Process Data 4 ASP Through flow to site 120000 m3/d Process Data 5 Secondary Clarifier Inlet BODy Process Data 5 Activated Carbon Adsorper Inlet BODy Process Data 5 Activated Carbon Adsorper Inlet BODy Process Data 5 Activated Carbon Adsorper Inlet TSS Process Data 7 Through flow to site 12000 m3/d	
Process Data 4 ASP Through flow to site 120000 m3/d Process Data 5 Secondary Clarifier Inlet 800 g 330 mg/l Process Data 5 Antwated Carbon Adsorper Inlet 75 235,03 mg/l Process Data 7 Antwated Carbon Adsorper Inlet 75 235,03 mg/l	
Process Data 5 Secondary Clarifier Inlet BOD; 330 mg/l Process Data 5 Activated Carbon Adsorper Inlet TS 255,03 mg/l Process Data 7 Inlet TS 255,03 mg/l	
Process Data 6 Activated Carbon Adsorper / Inlet TSS 295,03 mg/l	
Process Data 7	
riocess data / inter int	
Process Data 8 Inlet Fe 10 mg/l	
Process Data 9 Inlet Ammonia 37.28 mg/l	
Access Data 10	
Process Data 11 Results of suggested process and	
Proceedings 11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
Process Data 34 Process Data 35 Process Data 3	

Figure 3: Suggested processes and technologies results

4. To reset the PFD in the 'PFD' tab (which will display the resultant information as a diagram), on the 'SUMMARY & INSTRUCTIONS' tab, click on the 'Clear PDF Sheet' button, this will clear the old PDF. Then click the 'Create new PFD' button to start a new PFD.

		Summary								
Sele	ected Processes List			INPUT SHEET		PFD Overview				
Total Number of Processes:	6	St Clear ₅ clicke	PFD sheet b	Clear PFD Sheet	Creat new PFD					
Index	Process Name:	Sc new Sc Scenario Number Please choose de (For Fish Tanks on	Senaio Number 2 Please choose desalination type (For Fish Tanks only) NA							
Process Data 1	Grit	Through flow to sit	e	120000	m3/d					
Process Data 2	Circular PST	Size Type	Small							
Process Data 3	Activated Carbon Adsorper	Overall Wastew	ater Input Data	Value	Unit					
Process Data 4	ASP	Through flow to sit	e	120000	m3/d					
Process Data 5	Secondary Clarifier	Inlet BOD ₅		330	mg/l					
Process Data 6	Activated Carbon Adsorper	Inlet TSS		295.03	mg/l					
Process Data 7		Inlet TP		22.87	mg/l					

Figure 4: Process block diagram drawings procedure.

5. Once new information has been added and the user has clicked on 'Select the Process' button', return to the 'PFD' tab to build the diagram. Build by selecting the buttons to the right of the diagram window and under the 'Please click buttons below to draw PFD' column. For each process, design parameters and results will be presented based on the input data.



Figure 5: Process block diagram drawings results

6. Column K in the **'SUMMARY & INSTRUCTIONS'** tab displays auto-warnings for incorrect inputs, correct by following the warning(s) instructions. Ensure all warnings are cleared before clicking on the **'Select the Process'** button as errors could occur.



Figure 6: A warning massage example

7. Update data in sheets 'Permits', 'Data' and 'Economic Data' as shown in the following figures.

Wastewater			Wastewater		
KPI	Permit	Unit	КРІ	Permit	Unit
Biological Oxygen			Chloridae		
Demand (BOD5)	25	mg/l	Chionaes	250	mg/l
Chemical Oxygen					
Demand (COD)	125	mg/l	Sulphates	250	mg/l
Total Suspended					
Solids (TSS)	25	mg/l	Calcium	100	mg/l
Total Phosphorus (TP)	1	mg/l	Magnesium	50	mg/l
Ammonia	4	mg/l	Sodium	150	mg/l
Iron	4	mg/l	Potassium	12	mg/l
тос	30	mg/l	Aluminium	0.2	mg/l
			Nitrates	50	mg/l
			Nitrites	0.1	mg/l
			Ammonia	0.5	mg/l
			Iron	200	μg/l
			Manganese	50	μg/l
			Copper	100	μg/l
			Zinc	100	μg/l
			Total Phosphorus (TP)	5	mg/l
			Total Suspended		
			Solids (TSS)	0	μg/l
			Nickel	50	μg/l
			Lead	50	μg/l
			E. coli	10	UFC/
					100 ml

Figure 7: All data in Permits sheet can be checked and updated

	-			-			
Tech		Prices k€/U	Init	Ope	erating Cos	t k€/yr	
	Micro	Mini	Small	Micro	Mini	Small	
Membrane Distillation Unit MD	50	100	500	3.27	2.69	0.73	
Solar Photo Fenton	35	336	1785	1.54	0.66	0.23	
Photo-Catalytic Reactor	50	480	2550	2.28	1.81	0.73	
HiNaPEF Disinfection	22	110	204	2.03	1.34	0.27	
Activated Carbon Adsorper	85	660	1570	3.27	1.87	0.57	
CDI Desalination	102	770	1710	2.4	2.13	0.33	
Microwave enhanced catalytic degradation	175	847	1880	2.23	1.49	0.42	
ASP Denitrification Reactor	27	30	33	2.23	1.4	0.52	
Algea Separator	25	100	200	2.03	1.2	0.32	
Advanced control unit							
Nanofiltration Secondary Clarifier	80	50	325	3.5	1.03	0.28	
· · ·	-			-			
Screenings	1	2	3	4	5	6	
Grit	1	2	3	4	5	6	
Flotation	1	2	3	4	5	6	
Mixing	1	2	3	4	5	6	
Rectangular PST	3	5	10	1.6	1	0.6	
Circular PST	13	50	79	3.5	2	1.2	
Percolating Filter	27	30	33	2.23	1.4	0.52	
ASP Oxidation Ditch							
ASP Plug Flow							
ASP Complete Mix							
Granular Media Filter	1	2	3	4	5	6	
Ultrafiltration (UF)	80	145	325	1.21	1.03	0.28	
Microfiltration (MF)	80	145	325	1.21	1.03	0.28	
Reverse Osmosis (RO)	80	145	325	1.21	1.03	0.28	
Electrodialysis (ED)							

Figure 8: All data in Economic Data sheet can be checked and updated

In **'Data'** sheet (See figure 9), the removal percent shown in column F can be updated. This value is used to estimate the KPI value remining at the output flow of each technology. Therefore, data in columns O to AL must also be updated.

1	C Delete O	Did Data	Reset Se	lection	E Selection 1		Selection 2	Selection 3	 	Selection 4	Selection 5	5	Se	lection	on bւ	utton	s	0	Р						
1	Water Process Type	Treatmen	it stage	15	Technology Details				Selecte d? Yes/No	References TO			AL CAPIT	AL	Op	perating Co	ost	TSS	B0D5						
1				Ma	um items to select	is 16							<u> </u>			kl/yr		mg/l	mg/l						
			_	Sorooping	No of Sele	cted Items:	6 Removes larg particuls (> TSS removal: 25%	6mm).	Yes	https://blog.oraneengin-	eering.net/screen	Micro	Mini 2	Small 3	Micro	Mini	Small	221.27	247.5						
-	This	button		ocieering		<u> </u>	BOD removal 25% Removes grits (>1.5 and <	6 mm).		wastewater-screens https://www.hydro-int.co	omlenlarit-		-	-		-	Ň	221.21	241.5						
-	must	t be		Grit Channe Gravity Fl	els 💙		TSS removal: 40%		No	removal-0		1	2	3	4	5		221.27	247.5						
	clicke to de	clicked first to delete delete delete			fore ectior	ves grits (< 0.5 mm) emoval: 70% i removal: 50%	L	No	As an example: 2 can be removed		25% c I by So	of TSS creen	ing		5	6	221.27	247.5							
		Flow Equipment							No									221.27	247.5						
-	any d	סומ		Organic Eq	ualiser				No									221.27	247.5						
-	data			Circular tan	er dec		TSS Bemoval: 60%		No			13	50	79	35	2	12	221.27	247.5						
	uata		ment	Rectangula	artanks		BOD5 Removal: 50%		Yes	https://www.ebsbiowizar	rd.com/primary-	3	5	10	1.6	1	0.6	110.64	123.75						
				Square Tar	nks		P Removal: 10%		No	clarifier-operation-op rr								110.64	123.75						
				Trickling Filt	ters		BOD5 Removal: 80% Ammonia Removal: 85% Total P Removal: 55%		Yes	https://nptel.ac.in/cours cture%2028.htm 2. https://pdfs.semanticscl ee1e1d98469fe177ed05 f.pdf	ses/105104102/Le holar.org/87c3/e 557399cd768bffd	27	30	33	2.23	1.4	0.52	110.64	24.75						
_				Biological N	Mixed Treatment		BODS Removal: 80% Ammonia Removal: 88% Total P Removal: 79% COD removal: 85%		No	https://pdfs.semanticsc cb02e4c304d1d2f756b 6.pdf	holar.org/c72d/6f 79dbe93c7f4ba8	27	30	33	2.23	1.4	0.52	110.64	24.75						
	₩astewater	Secondary	Treatment	Oxidation D	Ditch		BOD5 Removal: 96% Ammonia Removal: 94% Total P Removal: 54% COD removal: 92%	% 94% %	BODS Removal: 36% Ammonia Removal: 34% Total P Removal: 54% COD removal: 32%		D5 Removal: 96% nonia Removal: 94% al P Removal: 54% D removal: 92%		i. https://www3.epa.gov/n ion_ditch.pdf 2. https://www.ncbi.nlm.nik 624387	pdes/pubs/oxidat n.gov/pubmed/22	0	0	0	0	0	0	110.64	24.75			
_				Plug Flow			BOD5 Removal: 96% Ammonia Removal: 95% Total P Removal: 55% BOD5 Damoval: 95%		BOD5 Removal: 96% Ammonia Removal: 95% Total P Removal: 55%		BDD5 Removal: 96% Ammonia Removal: 95% Total P Removal: 55%		BODS Removal: 96% Ammonia Removal: 95% Total P Removal: 55%		No	1. https://pdfs.semanticsol ef7b13083c0bf3d99824 73.pdf	holar.org/a422/0 4ecbf187d972e4							110.64	24.75
				Complete №	1ix		BOD5 Removal: 95% Ammonia Removal: 80% Tatal B Removal: 25%		No	1. https://www3.epa.gov/n	pdes/pubs/apartl							110.64	rt Area µe) A 24.75						
Н				Contact Sta	ablization		rotari memoval 207		No	ag.pu								110.64	24.75						
				Sequencin	g Batch Reactor				No									110.64	24.75						
				Final Settlin	ng Tank		TSS Removal: 90%		No									110.64	24.75						
		Tertary Treatment Adsorption (Activated Carbon) AA			BDD5 Removal: 80% TSS Removal: 95% Total P Removal: 90% Iron Removal: 90%		BDD5 Removal: 80% TS5 Removal: 95% Total P Removal: 90% Iron Removal: 90%		8005 Removal: 80% TSS Removal: 95% Total P Removal: 90% ron Removal: 90%		No	1. https://www.researchga /8673139_Application_c a_Filtration_in_Wastewa _and_Reuse	ite.net/publication of_Granular_Medi ater_Reclamation	70	550	1200	2.7	1.5	0.4	110.64	24.75				
				Adsorption	(Activated Carbon)	AA	Pharmaceutical Product COD removal: 53% Ammonia Removal: 88%	s Removal: 80%	Yes	https://www.wateraction ents/177327/558166/Ad tivated+carbon.pdf/772 7af2-082afba76978	plan.com/docum lsorption+with+ac d7b4f=0140=fc8b	85	660	1570	3.27	1.87	0.57	110.64	24.75						
				Photocatalytic Reactor o	biodegradable/toxic organic removal effecien TOC removal: 99.6%	cy: 90%	Yes			50	480	2550	2.28	1.81	0.73	110.64	24.75								
1				Chemical tr	eatment				No									110.64	24.75						
	ļ			Air stripping	1				No					10.00				110.64	24.75						
1				Solar photo	o-Fenton		J		Yes			35	336	1785	1.54	0.66	0.23	110.64	24.75						
0	COMPANY IN	IFO SUM	1MARY & I	NSTRUCTI	ONS PFD	Data	Selection Table	Graphs	Permis	Economic Data	Process	Data 1	Proce	ss Data	2 Pr	rocess D	ata 3	Proce	ss Data 4						

Figure 9: Data sheet to select relevant process

Data in columns J to N are linked to in the 'Economic Data' sheet and must not be manually updated.

The old data must be cleared by clicking '**Delete Old Data**' button before selection. This is done only once, at the beginning of the selection process. After that, the '**Reset Selection**' button must be clicked to reset column G for the new selection. If the other selections are required the button must be clicked before each selection button (Selection 2, 3, 4 or 5) are clicked.

The technology can be selected by choosing **'Yes'** in column G. This will be highlighted in green once selected. The KPI values will be updated automatically.

To help the technology selection process, the cost per unit of KPI removal is shown in the "**CPI**" tab or Cost Performance Index. This value gives a good reference of how well a technology treats the water pollutants compared to its price. The CPI values are calculated for each technology individually and for the selected train of technologies as a whole.

Cost Perform	ance Index	(CPI)	Small			
Water Process Type	Treatment stage	Technology	KPI	Removal (mg/L)	Cost (€)	CPI (€/(ml/L removal)
	_	Screening	TSS BOD	73.8 82.5	3000	40.7 36.4
	Pre-	Grit Channels	TSS	88.5	3000	33.9
	treatment	Gravity Flotation/Vacuum	TSS	92.9	3000	32.3
		Flotation/Electro	BOD	59.4	3000	50.5
1			TSS	79.7		991.7
		Circular tanks	BOD	44.6	79000	1773.3
	Primary		P	2.3		34543.1
	Treatment		TSS	26.6		376.6
		Rectangular tanks	BOD	22.3	10000	448.9
1		_	Р	2.1		4858.4
1			BOD5	17.8		1851.9
1		Trickling Filters	Ammonia	31.7	33000	1041.4
1	Secondary Treatment	_	P	10.2		3238.9
1			BOD5	3.6		9259.3
1		Distantial Mined Transfer and	Ammonia	4.9	22000	0.0
1		Biological Mixed Treatment	Р	6.6	33000	0.0
			COD	255.0		0.0
Wastewater			BOD5	0.4		6734.0
1		Construitor and die filterations	TSS	25.2	2000	118.9
1		Granular media filtration	P	1.6	3000	1904.1
1			Iron	9.0		333.3
	Torton	Adsorption (Activated Carbon) AA	Pharmaceutical Products	50.0	1570000	31400.0
	Treatment		COD	23.9		65828.1
	rreatment		Ammonia	0.6		2658695.3
		Photocatalytic Reactor	biodegradable/ toxic organic removal TOC	60.0 73.4	2550000	42500.0
1		Chemical treatment				
► COM	IPANY INFO	SUMMARY & INSTRUCT	IONS PFD	Data CPI	Select	ion Table Gra

Figure 10: Cost Performance Index table for individual technologies

		KPI Removal								CPI (cost/removal					
	TSS	BOD5	Ammonia	Total Phosphor ous	COD	тос	Iron	Cost (€)	TSS	BOD5	Ammonia	Total Phosphor ous	COD	тос	
S1	184	305	37	14	159	295	0	3,401,000	18444	11142	92901	249933	21390	11530	
S2	229	326	36	7	159	295	0	3,371,000	14743	10331	92647	453533	21201	11429	
S3	242	326	36	7	159	295	0	3,440,000	14219	10543	94544	462817	21635	11663	
S4	242	328	37	13	289	368	0	5,990,000	24760	18275	161841	446954	20747	16259	
S5	295	330	37	23	298	368	9	13,374,000	45386	40527	358745	585410	44833	36302	

Figure 11: Cost Performance Index table for train of technologies

8. Each selection will be automatically inserted in individual tables in **'Selection Table'** sheet as shown in the figure below. These tables will also present all the relevant KPI for each technology.

Selection 1									
Technology	TOTAL CAPITAL	Operating Cost	TSS	BOD5	Ammonia	Total Phosphorou s	COD	тос	Iron
	k€	k€/yr	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Screening	3.00	6.00	221.273	247.5	37.28	22.87	300	368.7	10
Rectangular tanks	10.00	0.60	110.636	123.75	37.28	20.583	300	368.7	10
Trickling Filters	33.00	0.52	110.636	24.75	5.592	9.26235	300	368.7	10
Adsorption (Activated Carbo	1570.00	0.57	110.636	24.75	0.67104	9.26235	141	73.74	10
Solar photo-Fenton	1785.00	0.23	110.636	24.75	0.67104	9.26235	141	73.74	10
Overall	3401	7.92	110.636	24.75	0.67104	9.26235	141	73.74	10
Selection 2									
Scietaria						Total			
Technology	TOTAL CAPITAL	Operating Cost	TSS	BOD5	Ammonia	Phosphorou s	COD	тос	Iron
	k€	k€/yr	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Screening	3	6	221.273	247.5	37.28	22.87	300	368.7	10
Grit Channels	3	6	132.764	148.5	37.28	22.87	300	368.7	10
Rectangular tanks	10	0.6	66.3818	74.25	37.28	20.583	300	368.7	10
Complete Mix			66.3818	3.7125	7.456	15.43725	300	368.7	10
Adsorption (Activated Carbo	1570	0.57	66.3818	3.7125	0.89472	15.43725	141	73.74	10
Solar photo-Fenton	1785	0.23	66.3818	3.7125	0.89472	15.43725	141	73.74	10
Overall	3371	13.4	66.3818	3.7125	0.89472	15.43725	141	73.74	10
Selection 3									
Selections						Total			
Technology	TOTAL CAPITAL	Operating Cost	TSS	BOD5	Ammonia	Phosphorou s	COD	тос	Iron
	k€	k€/yr	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Screening	3	6	221.273	247.5	37.28	22.87	300	368.7	10
Grit Channels	3	6	132.764	148.5	37.28	22.87	300	368.7	10
Circular tanks	79	1.2	53.1054	74.25	37.28	20.583	300	368.7	10
Complete Mix			53.1054	3.7125	7.456	15.43725	300	368.7	10
Adsorption (Activated Carbo	1570	0.57	53.1054	3.7125	0.89472	15.43725	141	73.74	10
Solar photo-Fenton	1785	0.23	53.1054	3.7125	0.89472	15.43725	141	73.74	10
COMPANY INFO	SUMMA	RY & INSTE	RUCTION	IS PF	D Data	Selectio	on Table	Grap	hs Pei

Figure 10: Selection Table sheet shown the results of the selection process.

The result of the performance of each selected process and technology will be presented in **'Graphs'** sheet for comparison of the performance of each selection. This sheet contains a table of the overall performance of the integrated selected technologies for each selected option. These values are then plotted in graphs of each KPI for each selection. This will help to decide the most cost-efficient technology for the most optimised and effective removal process.

The table in this sheet is automatically updated and must not be changed manually.



Figure 11A: Final selection options performance results sheet (A).



Figure 11B: Final selection options performance results sheet (B).

4 Conclusions

As the H2020 instruments, and specifically projects with high TRL such us Project Ô, aim to deliver tools and technologies closer to market, higher attention needs to be paid to the business opportunities and the plan to capture value through the innovations proposed. The Toolbox presented herein is built with that purpose: a tool for the water sector and its key stakeholders to find new or optimal ways of treating water streams, thus, creating new business opportunities with reusable water and resources.

This deliverable describes the main functionalities of the Technology Selection Toolbox and can be used as a user guide offering some guidance to use the outputs obtained with the tool properly.

The Technology Selection Toolbox developed in Project Ô is a decision support tool to help selecting the most suitable water treatment technology for specific water streams. It considers precise information input provided by the user regarding the water characteristics. Additionally, the tool gathers and estimates some other parameters automatically (e.g. process diagram and output KPIs content).

The designed decision support tool integrates different technologies and packages that allows it to be easily extended to consider additional analysis and information. The tool's catalogue gathers the water treatment technology specifications supplied by the tech providers in the project. The information that the Toolbox generates to support decision making relies mainly on the quality of the information on the database. The flexible architecture of the tool allows it to consider additional information in the database without intensive changes on the software. Moreover, a service model business can be generated around the tool by customizing the database for specific technology providers.

Additional developments, analysis and useful information can be generated from the tool's use history, which can serve for generating business rules or developing policies. Data mining and bigdata approaches could be applied on the database that the tool builds, based on the profiles' inputs so that trends and insights can be drawn with respect to variables such as user needs, technology adoption.

It is worth to remember that the tool is just a frame for the user to insert their data. The quality of the data inputted by the user is directly linked to the quality of the outputs generated by the tool: the hypothesis considered to reach the outputs needs as careful consideration as the outputs obtained.

5 Next steps

The Technology Selection Toolbox is ultimately meant to be a web-based platform, with added features such as databases for helping the users filling the forms and for collecting the information generated. The current version of the tool focuses on the treatment process selection depending on the input water source and type, with a high-level comparison of the different water treatment technologies performance and cost.

As the project develops, and specially the demonstration activities involving the technologies testing in a real environment, the tool will be updated with more accurate and realistic data. Furthermore, the new version of the platform will address more in detail the specifications and different variables affecting the technology selection, therefore, shifting towards a more tech-oriented approach for achieving optimal results. The web-based version of the tool will also include a user-friendly interface to facilitate the technology comparison and the decision making, for example with respect to the application of the water after treatment. Several captures are shown below representing how the Toolbox will potentially be presented.



Figure 1 – Technology selection toolbox landing page

PROJ	ECT Ô	Home	Simulate	About Project	Admin	Login
	exen.	123		AND CA	29	1
	Select Water Treatment type					
	Wastewater			*		
	Select source type					
	Domestic and Industrial waste			×		
	Through flow to site (m^3/d)					
	120000					
Prev					Ne	xt



PROJECT Ô			Simulate	About Project	Admin	Login
	194600 A	25	U7.	ninda.	26	1
	Physical Properties Solids Inlet Size					
	Medium (from 0.15 to 1.5 mm)			×		
	Solid Specific Gravity					
	1.9					
	Water Specific Gravity					
\frown	1					
Prev	Gravity constant (m/s ²)				Ne	xt
	9.8					
	Viscosity					
	0.001002					

Figure 3 – Physical properties of water to be treated

PR	DJECT Ô	Home	Simulate	About Project	Admin	Login
E Car		A	0R	SUN.	(în)	þġ
Prev	KPI Values Inlet BOD (mg/l)s 350 Inlet TSS (mg/l) 295.03 Inlet TP (mg/l) 22.87 Inlet Fe (mg/l) 10 Inlet Ammonia (mg/l) 37.28 Inlet COD (mg/l) 300 Inlet Turbidity (NTU) 20 Inlet Alkalinity (mg/l) 150 Inlet TOC (mg/l)				Fini	ish
	368.7 polyphenols (mg/l) 1.3			\$		

Figure 4 – KPI values of the water to be treated



Economic Performance:





Wastewater Performance:



Figure 5 - Economic and performance values of the different selections

6 Annex

The Key Performance Indicators considered for the treatment technologies performance analysis are listed below. These parameters are based on the information displayed in Project \hat{O} 's Deliverable 6.1 – Key Performance Indicators, specifically the ones concerning technological and operational aspects, as well as, economic values. For the purpose of not overloading the software tool, the most relevant KPIs have been considered.

Technological and Operational KPIs

Total Suspended Solids	Biological Oxygen	Total Organic Carbon	Chemical Oxygen	
(TSS)	Demand (BOD₅)	(TOC)	Demand (COD)	
Ammonia	Iron	Sodium	Zinc	
Sulphates	Chlorides	Potassium	Nickel	
Total Phosphorous	Magnesium	Aluminium	Lead	
Copper	Calcium	Manganese	E. coli	

Economic KPIs

CAPEX OPEX

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