

## Deliverable Report

### D4.1 Exploitation Plan 1<sup>st</sup> version

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2	17.1.2024	Approved by Coordinator

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## 1 Introduction to the project SERPIC

The project *Sustainable Electrochemical Reduction of contaminants of emerging concern and Pathogens in WWTP effluent for Irrigation of Crops – SERPIC* will develop an integral technology, based on a multi-barrier approach, to treat the effluents of wastewater treatment plants (WWTPs) to maximise the reduction of contaminants of emerging concern (CECs). The eight partners of the SERPIC consortium are funded by the European Commission and by six national funding agencies from Norway, Germany, Italy, Spain, Portugal and South Africa. The official starting date of the SERPIC project is 1. September 2021. The project has a duration of 36 months and will end 31. August 2024.

The overall aim of the SERPIC project is to investigate and minimise the spread of CECs and antimicrobial resistant bacteria/antibiotic resistance genes (ARB/ARG) within the water cycle from households and industries to WWTPs effluents, and afterwards via irrigation into the food chain, into soil and groundwater and into river basins, estuaries, coastal areas, and oceans with a focus on additional water sources for food production.

A membrane nanofiltration (NF) technology will be applied to reduce CECs in its permeate stream by at least 90 % while retaining the nutrients. A residual disinfection using chlorine dioxide produced electrochemically will be added to the stream used for crops irrigation (Route A). The CECs in the polluted concentrate (retentate) stream will be reduced by at least 80 % by light driven electro-chemical oxidation. When discharged into the aquatic system (route B), it will contribute to the quality improvement of the surface water body.

A prototype treatment plant will be set-up and evaluated for irrigation in long-term tests with the help of agricultural test pots. A review investigation of CECs spread will be performed at four regional showcases in Europe and Africa. It will include a detailed assessment of the individual situation and surrounding condition. Transfer concepts will be developed to transfer the results of the treatment technology to other regions, especially in low- and middle-income countries.

## 2 Report summary

This report describes the exploitation activities that are planned at the time of the creation of this document, as well as the connected dissemination activities. The horizon of activities goes beyond the project duration until TRL 9 when the SERPIC technology will be eventually applied in real application. It contains a timeline graph and a detailed description of the dissemination and exploitation activities.

## 3 Deliverable description as stated in the Project Description

The exploitation plan, developed in task **T4.4**, will be concluded in this deliverable as preliminary version. It will be published on the project website to enable contacts by additional stakeholders.

## 4 Introduction

*Departing from the project description, the consortium decided to put this deliverable confidential because it presents a preliminary status. The final exploitation plan (D4.2) will be published.*

The work package 4 has two objectives: To achieve the adoption of the project results by other parties and stakeholders, the WP has the objective to ensure that the results will reach the relevant academic, economical and societal communities. The second objective is to ensure that the expected impacts to society and environment will be finally achieved. The main action to fulfil these objectives is the development of an **exploitation plan** to prepare the **use** of the project

**results.** It shall cover not only the project duration but also the period afterwards with a timescale until the water treatment technology reaches market introduction (TRL9). The exploitation plan is strongly linked to the dissemination activities in task **T4.3**.

Due to the importance of the exploitation of the results for a successful future application, a step-wise strategy is followed to develop the exploitation plan: This preliminary version is forming deliverable **D4.1** and will be presented to the Stakeholder Board for discussion and feedback. The agreement of the stakeholders about the general strategy of the exploitation plan forms milestone **M4.1**. Input from the Stakeholder Board will be considered for further development of the plan. The final version will be reported in a public version as **D4.2** in the final project month.

The exploitation plan has a view to audiences beyond the consortium, addressing three groups: **academic, economical and societal communities**. Because each group has different interests and needs, separate sets of dedicated dissemination activities are planned to inform all three groups thoroughly about the results of the project. Thereby, other organisations like enterprises or R&D performers can uptake the results and further develop the technology to higher technology readiness level for their specific application. Furthermore, the consortium identifies interesting parties for joint follow-up activities. Scientific and educational communities are important for further research on the technology and to transfer the scientific results to other application areas. The stakeholder group from business comprises wastewater treatment plant provider, manufacturer of water treatment technology and corresponding components, and end-users like farmers, farmer associations and water providers. It is important to communicate also with the general public to inform them about new solutions for CEC-free plants and food, and to provide accountability about the use of public money. Both European, African and national channels are considered, also in national languages.

An important point in planning follow-up activities of the consortium is to **look for funds**, like research programs, for a potential subsequent R&D project.

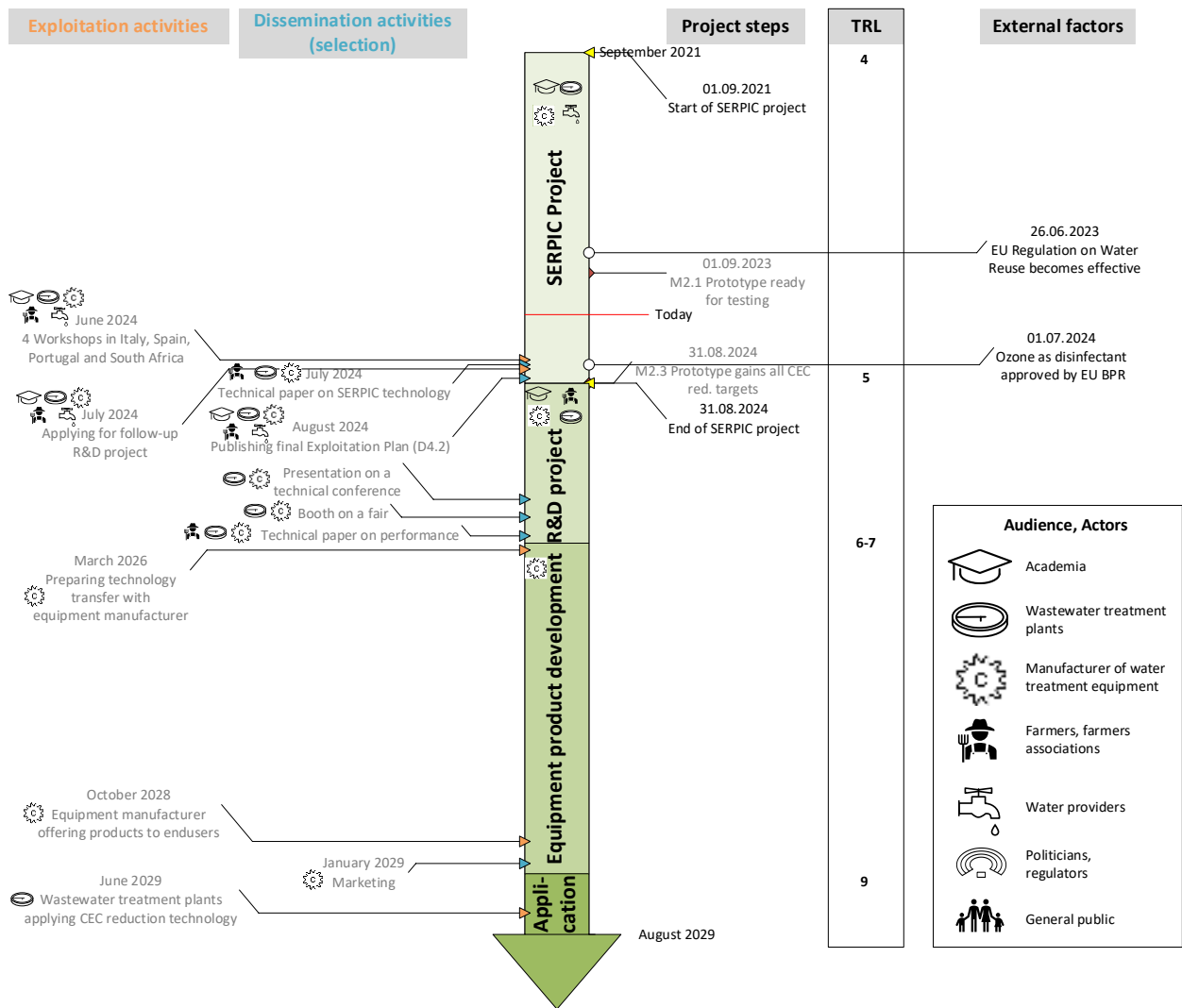
## 5 Results

### 5.1 Exploitation and dissemination timeline

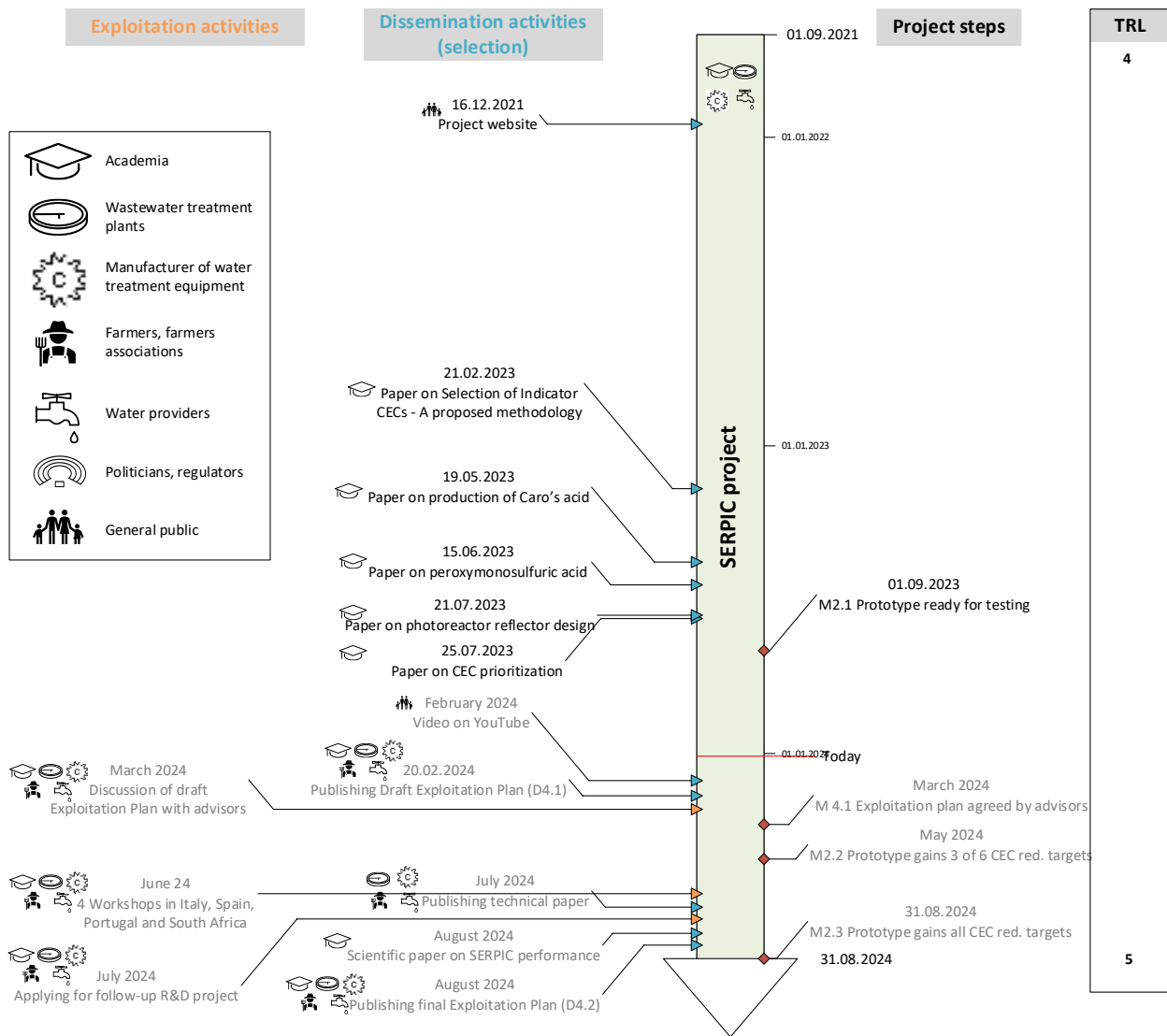
To reach organisations and people outside the consortium, they must know about the project and the interim results. Thus, a dissemination action is the prerequisite for each exploitation action. Therefore, exploitation and dissemination activities have been linked temporally. The timeline is shown in **Figure 1** and **Figure 2**. The figures show the most important activities that have already been implemented as well as the planned activities. **Figure 1** shows in an overview the timeline until the potential implementation of the SERPIC technology (TRL 9) in approximately five years after project end (2029). **Figure 2** shows the timeline only of the project duration in a detailed way. The increase of technology readiness level (TRL) is shown parallel to the timeline.

For each activity, the relevant stakeholder groups are assigned by symbols. Here, the group of economical communities is further separated into sub-groups, because these sub-groups need different dissemination approaches:

- a) wastewater treatment plants,
- b) manufacturer of water treatment equipment,
- c) farmers and farmer associations, and
- d) water providers.



**Figure 1:** Timeline of dissemination and exploitation activities, overview until estimated implementation of the SERPIC technology at TRL 9, including important external regulation factors; implemented activities in black font, planned activities in grey font; BPR: Biocidal Products Regulation of the European Commission.



**Figure 2:** Timeline of dissemination and exploitation activities, details within the project duration; implemented activities in black font, planned activities in grey font.

## 5.2 List and description of dissemination and exploitation activities

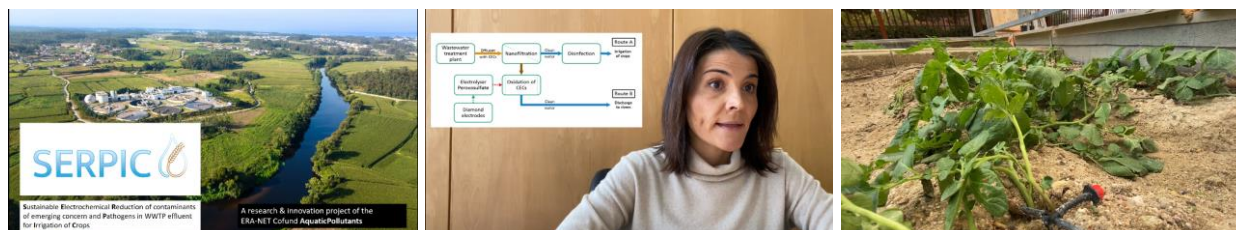
The planned dissemination and exploitation activities until the end of the project are listed in **Table 1** and further described in detail below.

**Table 1:** List of planned dissemination and exploitation activities.

Dissemination	Exploitation	Activity	Date	Details
1		Project video on YouTube	February 2024	
1		Elaborating Draft Exploitation Plan	February 2024	(confidential deliverable D4.1)
1		Presentation for stakeholders	February 2024	PowerPoint, in different national languages
	1	Workshop in Portugal	28.02.2024	Internal workshop of AdP
	1	Discussion of Draft Exploitation Plan with selected members of Stakeholder Board	March 2024	In all six countries of the consortium
	1	Workshop in Spain	June 2024	Integrated in workshop of Network of Electrochemical Engineers, Bilbao
		Applying for follow-up R&D project	July 2024	Focus on Route B; additional equipment manufacturer
	1	Workshop in Italy	2024	(tbd)
	1	Workshop in South Africa	2024	(tbd)
1		Technical paper on SERPIC technology	July 2024	in the six languages of the countries
1		Scientific paper on SERPIC performance	August 2024	Jointly with all partners
1		Final Exploitation plan on project website	August 2024	(public deliverable D4.2)

### Project video on YouTube

This video intends to inform the general public. It has an app. length of six minutes and consists of statements of consortium members complemented with graphical schemes of the process chain. It also shows the SERPIC prototype plant and the irrigation of crops with the treated wastewater effluent. It is produced by IST and will be published in February 2024 on YouTube.



**Figure 3:** Screenshots of the SERPIC project video.

### Elaborating Draft Exploitation Plan

This task consists of the elaborating of this document with the input of all consortium partners. It will be finished in February 2024.

## **Presentation for stakeholders**

To discuss the interim results with the Stakeholder Board, a short presentation will be prepared in February 2024 that will be used by all consortium members. It will be translated into the national languages, if necessary.

## **Workshop in Portugal**

This will be the first of the series of four national workshops to be implemented in the four target regions Italy, Spain, Portugal and South Africa. All workshops will be integrated into other events to address a larger audience compared to a separate workshop only for the SERPIC results. The Portuguese workshop will be organised by AdP and UP and will be integrated into an event of project partner company Águas de Portugal, opened to the stakeholders of SERPIC project. This event will take place in Santarém at 28.2.2024.

## **Discussion of Draft Exploitation Plan with selected members of Stakeholder Board**

This document will be presented to selected members of the Stakeholder Board, together with the presentation described above. The feedback of the SB members will be considered for the further development of the exploitation plan until the final version (D4.1, to be finalised in August 2024).

## **Workshop in Spain**

The Spanish workshop will be integrated in a workshop of the Network of Electrochemical Engineers. This event will take place in Bilbao in June 2024.

## **Applying for follow-up R&D project**

As shown in the timeline, the consortium is convinced that another research & development project is necessary to increase the technology readiness level before industry can take-up the results and develop products from it. The consortium is actively looking for calls for proposals that fit to the topic and the involved countries like Horizon Europe, ERA-NETs or WATER4ALL. If necessary, additional partners will be searched to complement the necessary competences, e.g. for CEC analytics, horticulture or hardware equipment (e.g. membrane manufacturer).

## **Workshop in Italy**

The Italian workshop is not yet selected.

## **Workshop in South Africa**

The South African workshop is not yet selected.

## **Technical paper on SERPIC technology**

The consortium agreed to publish technical papers of the SERPIC technology at the end of the project to inform water treatment equipment manufacturer about the project results. The idea is to create versions of the paper with identical content in the different national languages Norway, German, Italian, Spanish, Portuguese and English. Then, relevant journals will be selected in each country to reach relevant development engineers from equipment manufacturers, like *Filtration & Separation* (English) or *Vann* (Norway). The papers will be written in a non-scientific manner and focus on the technological process chain, the main parameters of the prototype plant, the control concept and on the results of the life-cycle analysis.

### Scientific paper on SERPIC performance

At the end of the project, a summarizing scientific paper is planned to inform the research community about the SERPIC results. The paper will focus on the CEC degradation performance and the fate of CECs in soil and plants. It will be a joint publication with co-authors from all consortium partners.

### Final Exploitation Plan on project website

At the end of the project, the Exploitation Plan will be finalised considering the input from the SB members and the preparation of follow-up activities. It will be published on the SERPIC project website and advertised via the AquaticPollutants TransNet project and other channels.

## 6 Publications and other dissemination activities

The following **Table 2** lists all dissemination activities that have been implemented until 31.12.2023.

**Table 2:** List of implemented dissemination activities.

Publishing name	Title of contribution	Publishing date
<b>Conferences, oral presentations</b>		
XVI Young Science Symposium, Ciudad Real, Spain	Persulfates electrogeneration using BDD anodes and 3D-printed reactors	23.06.2023
10th IWA Membrane Technology Conference & Exhibition for Water and Wastewater Treatment and Reuse, St. Louis, USA	Effectiveness of membrane filtration for removal of cell free antibiotic resistance genes from water and wastewater	26.07.2023
<b>Conferences, poster presentations</b>		
One Health in the 21st Century 2021, Oslo, Norway	SERPIC	03.11.2021
3rd Water JPI Conference, Mülheim/Ruhr, Germany	SERPIC	17.11.2021
XLII Meeting of the specialized group of electrochemistry of the RSEQ, Santander, Spain	Generación electroquímica de persulfatos utilizando ánodos de BDD en un reactor electroquímico adaptado mediante impresión 3D	06.07.2022
6th conference on the Environmental Dimension of Antibiotic Resistance (EDAR6), Gothenburg, Sweden	Removal of cell free antibiotic resistance genes from water by membrane filtration and from membrane concentrate by 265 nm UV-LED	27.09.2022



<b>Publishing name</b>	<b>Title of contribution</b>	<b>Publishing date</b>
X Jornadas Doctotales de la UCLM, Albacete, Spain	Reduction of CECs and ARB/ARG in wastewater from WWTP using electrochemically generated persulfate	25.11.2022
EA3G conference on ozone and advanced oxidation, Toulouse, France	Electrochemical production of persulfate with boron-doped diamond electrodes	28.11.2022
IOA World Congress 2023, Milan, Italy	Disinfection via electrogenerated ozone for wastewater reuse	04.07.2023
1 <sup>st</sup> Clausthal Conference on Circular Economy, Clausthal-Zellerfeld, Germany	Sustainable Electrochemical Reduction of contaminants of emerging concern and Pathogens in WWTP effluent for Irrigation of Crops	24.11.2023
<b>Scientific journal papers</b>		
<a href="#">Science of the total environment</a>	Selection of Indicator Contaminants of Emerging Concern when reusing reclaimed water for irrigation - A proposed methodology	21.02.2023
<a href="#">Separation and Purification Technology</a>	Optimization of the electrolytic production of Caro's acid. Towards industrial production using diamond electrodes	19.05.2023
<a href="#">J. of Water Process Engineering</a>	Outstanding productions of peroxymonosulfuric acid combining tailored electrode coating and 3-D printing	15.06.2023
<a href="#">Journal of Environmental Chemical Engineering</a>	Reflector design for the optimization of photoactivated processes in tubular reactors for water treatment	21.07.2023
<a href="#">Science of the total environment</a>	Quantitative and qualitative approaches for CEC prioritization when reusing reclaimed water for irrigation needs – A critical review	25.07.2023
<b>Contributions to monographs</b>		
<a href="#">Funded Projects Booklet Joint Transnational Call 2020</a>	SERPIC	29.09.2021
<b>Newsletters</b>		
<a href="#">AquaticPollutants e-newsletter, AquaticPollutants Newsletter #1</a>	Selected target CECs steer the technological process chain development	28.04.2022
Nuova Ferrara, Local newspaper	Anche Unife studia possibili soluzioni: "La tecnologia aiuta a trovare rimedi"	20.06.2022

<b>Publishing name</b>	<b>Title of contribution</b>	<b>Publishing date</b>
Resto del carlino, Local newspaper	Studio internazionale dell'Università: Progetto per usare acqua reflua ripulita grazie all'energia solare	20.06.2022
Estense.com, Local newspaper	Unife nel progetto internazionale per fronteggiare la scarsità d'acqua in agricoltura	20.06.2022
<b>Websites</b>		
<a href="#">AquaticPollutants</a>	SERPIC	06.10.2021
<a href="#">JPI AMR - SERPIC</a>	SERPIC	06.10.2021
<a href="#">AdP (Águas de Portugal)</a>	SERPIC	01.12.2021
<a href="#">SERPIC project website</a>	SERPIC	16.12.2021
<a href="#">UNIFE news</a>	Crisi idrica   Unife partecipa a SERPIC, progetto europeo per il riciclo dell'acqua in agricoltura	20.06.2022
<a href="#">UNIFE Dep of Engineering</a>	H2020-SERPIC: progetto europeo che vuole fornire una soluzione contro la siccità e la crisi idrica	20.06.2022
<a href="#">AquaticPollutants</a>	SERPIC project develops a methodology how to select indicator CECs	21.07.2023
<a href="#">YouTube</a> , channel of JPI Oceans	ERA-Net Cofund AquaticPollutants - Communication Activities SERPIC	7.8.2023
<b>Workshops</b>		
AquaticPollutants Kick-off, (online meeting)	SERPIC	30.09.2021
WS Final do projeto REUSE, Beja, Portugal	Projetos LIFE PHOENIX   SERPIC	14.12.2021