Sustainable **E**lectrochemical **R**eduction of contaminants of emerging concern and **P**athogens in WWTP effluent for **I**rrigation of **C**rops

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Objectives

a) Investigate and minimise the spread of CECs and antibiotic resistant bacteria (ARB) and antibiotic resistance genes (ARG) with a focus on additional water sources for food production
b) Developing an innovative treatment technology

Approach

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).

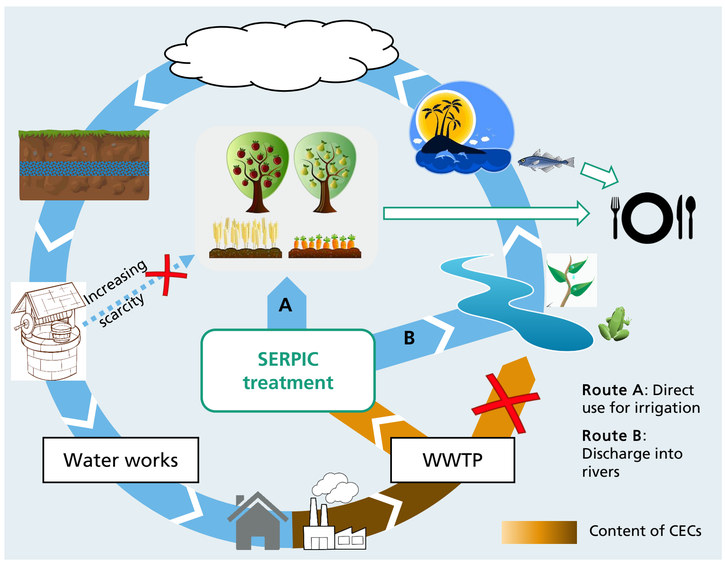

Figure 1: SERPIC water cycle.

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**, see **figure 1**). 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.

Methodology

A review investigation of CECs spread and transformation will be performed at four regional showcases in Italy, Spain, Portugal and South Africa.

Subsequently, the boundary parameters for the prototype test will be defined concerning WWTP effluent composition, irrigation method, crop selection and solar irradiance. A set of representative pollutants relevant in the four showcase regions will be selected. Six target CECs will be chosen:

- One from the group of ARBs
- One from the group of ARGs
- Four other chemical compounds.

Treatment technologies

The treatment solution of SERPIC (see **figure 2**) is based on membrane nanofiltration, splitting the water flow into a permeate with negligible amounts of CECs while preserving the nutrients for **Route A**, and a concentrate that contains the rejected pollutants for **Route B**. The oxidant chlorine-dioxide will be added to the stream of Route A to receive a residual disinfection so that microbials will be avoided until the water reaches the field. Powerful oxidants (peroxosulfate and chlorine dioxide) will be produced electrochemically, activated by deep UV, to minimise the CEC content in the stream of route B. Initially persulfate will be the target species for the membrane photoreactor and ClO2 will be used only in case persulfate does not operate properly.

Transfer

Concepts will be developed to transfer the results of the treatment technology to other regions, especially in low- and middle-income countries.

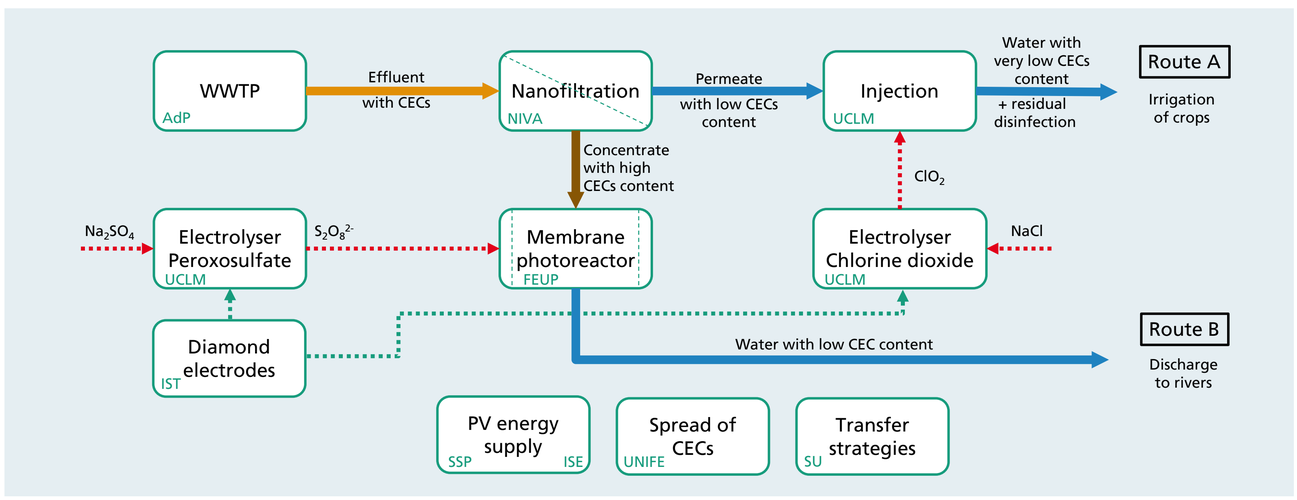

Figure 2: SERPIC process chain.

Prototype field test

To validate the effectiveness of the multi-barrier treatment technology, a prototype plant will be set-up on-site in Ciudad Real, Spain and evaluated for irrigation in long-term field tests with the help of agricultural test pots. We will sample the irrigation water as well as the vertical pollutant profiles in the soil and the grown vegetables.

The prototype will use **regenerative, sustainable energy**: The necessary electrical power will be generated by photovoltaic modules.

Outcomes and expected impact

- Concepts and technology for the valorisation of constantly available alternative water sources by reuse of wastewater effluent for safe use in agricultural irrigation
- Review investigation of CECs spread and transformation at four regional showcases in Europe and in Africa
- Identification of the six representative pollutants relevant in the four showcase regions
- Technology to reduce CECs from WWTP effluent by membrane filtration and light driven electro-chemical processes
- Results about breakdown and transformation of CECs in the product water
- A prototype treatment plant at TRL5, powered by photovoltaics
- Results about irrigation with the treated water via long-term agricultural growth tests
- Strengthening the competitiveness and growth of companies by developing an innovative product and process
- Contribution to economic growth as well as safeguarding and creating jobs, especially in low- and middle-income countries and regions like South Africa by adequate transfer concepts.
- Contribution to fulfil the EU goal of efficient water resources management and maximisation of water reuse for irrigation.

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