LIFE Project Number

LIFE15 ENV/ES/000598

Final Report

Covering the project activities from 01/09/2016[1] to 31/12/2019

Reporting Date[2]

31/12/2019

LIFE EMPORE

Development of an efficient and sustainable methodology for EMerging POllutants REmoval in WWTPs

Project Data

Project location:	Spain – Comunidad Valenciana
Project start date:	01/09/2016
Project end date:	31/12/2019
Total budget:	1,783,824€
EU contribution:	1,030,407€
(%) of eligible costs:	57.76%

Data Beneficiary

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[1] Project start date
[2] Include the reporting date as foreseen in part C2 of Annex II of the Grant Agreement

1 Table of contents

Instructions:

Please refer to the General Conditions annexed to your grant agreement for the contractual requirements concerning a Mid-term/Final Report.

Both Mid-term and Final Reports shall report on progress from the project start-date.

Please follow the reporting instructions concerning your technical report, deliverables and financial report that are described in the document "Guidance on how to report on your LIFE 2014-2020 project", available on the LIFE website at: http://ec.europa.eu/environment/life/toolkit/pmtools/life2014_2020/documents/how_to_report_on_your_lifeproject.pdf. Please check if you have the latest version of the guidance as it is regularly updated. Additional guidance concerning deliverables, including the layman's report and after-LIFE plan, are given at the end of this reporting template.

Regarding the length of your report, try to adhere to the suggested number of pages while providing all the required information as described in the guidance per section within this template.

2 List of key-words and abbreviations

WWTP – Waste Water Treatment Plant
BWWTP – Benidorm's Waste Water Treatment Plant
EP – Emerging Pollutants
AIDIMME - Instituto Tecnológico Metalmecánico, Mueble, Madera, Embalaje Y Afines (AIMME in the Proposal)
LTL – Laboratorios Tecnológicos de Levante
UA – Universidad de Alicante
p.e - Population equivalent, is a unit of measurement of biodegradable organic pollution representing the average load of such pollution produced per person per day. It is specified in the Directive as 91/271/CEE, 60 g BOD5 (biochemical oxygen demand in five days) per day.

3 Executive Summary

3.1 General progress

This final report covers the entire period of the project, from 01/09/2016 to 31/12/2019. During this period, the project needed and extension of 5 months, but it has been executed according to the work plan.

Action A1 was carried out by UNESCO-IHE. As a result, an Evaluation of the situation on priority and EP in Europe has been obtained, with the collaboration of the following partners of the project: UA, AIDIMME and LTL

Having obtained the Benidorm's WWTP, henceforth BWWTP, access permissions (**Action A2**), the Annual Analytical Campaign of the influent and effluent of BWWTP (**Action B1**) started in November 2016 and finished in December 2017. This campaign, developed entirely by LTL, has lasted for a year, with an integrated sampling of weekly frequency.

A total number 108 of samples were taken (54 from influent and 54 from effluent, respectively) and a BWWTP Database was created gathering all the analytical results and was monthly distributed among the partners of the project.

The design of the pilot plant, **Action B2**, started in January 2017, 4 months earlier than initially planned to ensure the equipment delivery on time for the pilot construction, and finished in June 2018 (six months later than foreseen due to the complexity of the demonstrator and the technologies involved). Also, the action could not be considered as finished until the last changes of the installation and set-up were updated in the design plans (flow diagrams, control systems). It had been coordinated by AIDIMME with the collaboration of UA, CONSOMAR and LTL.

The demo plant implementation and set up, **Action B3**, started in October 2017, two months later that it was scheduled, and finished in June 2018, six months later that it was scheduled as a result of some delays in the purchases and delivers such the container and main pumps. Other problems were related to the acquisition and installation of the unit's control elements and their integration in the PLC by means of the SCADA, which took more time that it was planned.

All in all, **Action B4** started at the end of June 2018 and it lasted 14 months, until July 2019, an important amount of data was generated for the rest of actions of the project. With data gathered in Action B4, **Action B5** identified and selected the best elimination methodology for each emergent pollutant of the project. This information has been compiled into a deliverable that we believe will be a corner stone for the elimination of emergent pollutants in WWTP. Within **Action B6**, the transferability of EMPORE methodology has been studied in 4 locations in Europe. Also, a DSS for the transferability and implementation of the technology has been developed. **Action B7** has studied the economic viability of the EMPORE methodology and present different options to Water Management Entities to capitalise the investment. Also, a LCA has been performed and will serve as a base line for future developments to compare with. **Action B8**, has performed a legal analysis of the situation.

Actions C1 and C2, started in March 2017 as initially planned, lasted until the end of the project in order to perform the suitable environmental key performance indicators, and socio-economic impact monitoring. Within these actions a new water quality index has been developed to assess the quality of water taking into account the emergent pollutants.

Regarding **Action D1** (Dissemination and transferability of project results), LIFE EMPORE has participated in more than 70 events. Although all the Dissemination and Communication events are fully explained in Part 6, the most remarkable are the following:

- In November 2016, EPSAR organized a *Technical Work Day*, where EMPRE project were introduced. This month, Daniel Prats, from Universidad de Alicante, is interviewed about EMPORE project.

- In May 2017, LIFE-EMPORE project joined to the celebration of the *25th anniversary of LIFE Programme*.
- In March 2018, EMPORE participates in the congress "*Primer seminario internacional sobre contaminantes emergentes-First International Congress about emerging contaminants; Colombia*". Oral presentation: "LIFE EMPORE (LIFE15 ENV/ES/000598). Programe publicated in UNIVERSIA.
- In April 2018, a Seminar of EMPORE project was organized in Delft, At the IHE's facilities.
- In May 2018, EMPORE participates in the "*XIV Congreso Nacional de Comunidades de Regantes-XIV Irrigation Communities' National Congress*" held in Torrevieja (Alicante, Spain).
- In June 2018, EMPORE participates in the *Regional LIFE Infoday*.
- In June 2018, EMPORE attends the Water JPI Conference 2018 "*Emerging pollutants in freshwater ecosystems*" in Helsinki (Finland) with an oral communication.
- In June 2018, EMPORE participates in "*META Leon Conference 2018"* with an oral communication. Publicized in META Leon 2018 website.
- EMPORE attended the 12th International Congress of the Spanish Association of Desalination and Reuse (AEDyR) the 23th of October 2018 in Toledo, Spain.
- EMPORE presentation on the Working Day called "Climate Change and Sustainable Food" the 12th of November 2018 in Valencia, Spain.
- EMPORE visited ECOFIRA 2018, an international fair celebrated during 6, 7 and 8th of November of 2018.
- EMPORE attended "WATER KNOWLEDGE EUROPE" event, celebrated in Brussels the 28th and 29th of November and organised by WssTP (Water Supply and Sanitation Technology Platform).
- LIFE EMPORE Project attended the technical conference 'Treatment and elimination of pollutants, emerging from effluents by urban treatment plants', organized by EPSAR on February 12th, 2019.
- On February 28th, 2019, students from the Higher Polytechnic School of the University of Alicante (EPS Alicante) visited EMPORE pilot plant.
- EMPORE project participated in the National Water congress held on February 2019 in Orihuela (Alicante, Spain) organized by the University of Alicante.
- EMPORE project participated in the AQUARES interregional project workshop held on March in Milan Last 27th and 28th of March, 2019.
- On May 8th took place the 10th International Congress organized by the Wessex Institute of the United Kingdom and the University of Alicante. The conference was celebrated in Alicante and counted with the participation of the LIFE EMPORE Project.
- EMPORE PROJECT was at the first convention on micro contaminants in water at the Santiago de Compostela University during the13th y 14th of June, 2019.
- EMPORE Project participated in the 'XIII International Research Conference on Wastewater Treatment and Treatment Plants' held on last 12th of December in Rome, (Italy).
- Final Infoday took placed the 16th of December 2019.

All the events mentioned above were properly published at the EMPORE and beneficiaries' websites.

Furthermore, the following dissemination and communication material has been produced:

- Notice board 1, with the general information of the project. Six units, one per partner.
- Notice board 2, located at the prototype's location, describing the pilot plant.
- Brochures.

- Power point presentation.
- A panel (poster).
- Merchandising: notebooks and pens.
- Roll-up.
- Demo-film.
- Layman`s Report.

Finally, some networking activities have been carried out (**Action D2**), as is fully explained in Part 6 of this Report.

Within the activities carried out in **Action E1** (Project management and operation), the Consortium Grant Agreement was signed, and the Project Management Guidelines were worked out. Both documents were handed in to all the partners of the project before December 2016. Four face to face coordination meetings (Action E1) have been organized in this period:

- The LIFE-EMPORE Project kick-off meeting in LTL's facilities in Paterna (Valencia, Spain) in September 2016
- The 1st and 2nd Consortium Meetings both held in LTL's facilities in Paterna (Valencia, Spain) in March and September 2017, respectively.
- The 3rd Consortium Meeting, which took place in IHE's facilities in Delft (The Netherlands).
- The 4th and 5th Consortium Meetings both held in LTL's facilities in Paterna (Valencia, Spain) in October 2018 and April 2019, respectively.

Furthermore, LTL attended the LIFE Projects Call 2015 kick-off meeting that took place in Brussels, Belgium, in October 2016.

In addition to this, on 25/05/2017, 19/06/2018, 16/01/2019 and 29/01/2020, EMPORE received the monitoring visits of NEEMO EMT on behalf of the European Commission. The 16/01/2019 EMPORE also received the visit of the European Commission's Project Officer.

3.2 Identified deviations, problems and corrective actions taken

Action B1. Annual Analytical Campaign: As expected, analytical results are displaying the enormous variability in the concentration of EPs in wastewaters, as well as the seasonal variability which characterizes Benidorm. Some pollutants, fundamentally priority compounds, have not yet been detected, which could be due to the fact that these could have not been consumed or used during this period of time, but could appear in future samples. In order to ensure the objective of the action, the range of EP has been widened and additional compounds have been added to the previous list, more compounds are being analysed without extra financial consequences for the project. Main conclusions of **Action A1 (Evaluation of the situation on priority and emerging pollutants in Europe)** have been taken into account in the Initial Report, especially those regarding the physical-chemical parameters that could predict the behaviour of the selected pollutants. For this reason, staff of UNESCO-IHE and LTL have been coordinated and have collaborated actively during action B1.

Action B2. As mentioned in section 3.1, action B.2 started four months before and finished six months later than foreseen (06/2018) together with action B3. Among the difficulties that were faced, final treatment capacity was higher than foreseen; the container limitations also involved a higher difficulty in the design since it was required to optimize the equipment distribution in the available space. Tank capacities and reaction units had to be reconsidered, auxiliary equipment was modified, compressors, recirculation pumps were shared for cleaning and backwashing of filtration units. These changes implied modification of valves (2-way and 3-way valves) and restructuring of the plant design. Finally, all the previous diagrams had to be replaced by the final designs.

Action B3. **Demo plant implementation and set up:** finished four months later that it was scheduled as a result of some delays in the purchases and delivers such the container and main pumps. Other problems were related to the acquisition and installation of the unit's control elements and their integration in the PLC by means of the SCADA, which took more time that it was planned. All in all, **Action B4 Demonstration in Benidorm WWTP**, started at the end of July 2018 and is due to last 12 months, until June 2019 and will included the increased list of pollutants targeted by the project. To have enough time for the data treatment, and finish the actions Actions B5 to B8, an extension until the end of December 2019 was requested and approved. During the Action B4, several problems aroused with the electrooxidation equipment and automation.

Action D1. Dissemination and transferability of project results: For practical reasons, LTL has assumed the External Assistance to hire the website of the project instead of EPSAR, who in exchange will assume the cost of "Noticeboards (8) printing".

Despite the pilot plant was envisaged to be transferred to other European locations with presence of emergent pollutants at the end of the project and during the After LIFE, the corrosive environment of the emplacement and the corrosive nature of some of the reagents used in the operation of the pilot plant has caused that parts of the structure of the pilot plant has been corroded. Due to this corrosion, we analysed the structure of the pilot plant within **Action E2**, and as a conclusion the pilot plant will not be able to survive the transfer to another location.

4 Introduction

Environmental problem addressed (background)

Emerging Pollutants (EPs) are becoming an increasing risk due to their permanent discharge and the incapability of WWTP to remove them. There are several sources for these chemicals such as pesticides, plastic additives, pharmaceutical products and others and their effect on environment and human health are mostly unknown. Furthermore, there is no regulation for the moment.

Conventional WWTP are not designed for the treatment of this kind of substances so these compounds reach aquatic media affecting wildlife and being introduced in the food chain with the bioaccumulation linked problem. Also, unplanned or incidental use of treated WW for drinking purposes is relatively common. Usually environmental buffers are used such as rivers, dams, lakes and other aquatic media since there are natural systems that further purify water, dilution also reduces the concentration and thus, negative effect in environment.

The absence of baseline information about the state of play of pollution was also a driving force to develop this project.

Outline the hypothesis to be demonstrated / verified by the project

EMPORE will demonstrate a methodology based on a specific treatment route from selected techniques able to remove EPs from sewage treatment plants. The variety of EPs don't allow a single and common treatment, so the project aims at demonstrating the hypothesis of the integration of a range of techniques that are versatile and scalable due to their compatibility with conventional WWTP. The following hypothesis will be demonstrated:

- The selected technologies can treat and remove at low concentrations
- The developed pilot plant is flexible and spatially optimized
- Synergy between technology of selective removal of species level trace and EP concentration and electrochemical technologies.
- The treating system will be cost-effective. Systematic approaches to optimize energy consumption and resources in WW infrastructure are being applied.

Description of the technical / methodological solution

Four technologies are being used in the methodology: filtration/adsorption by columns, filtration by membrane, electrochemical processes and advanced oxidation.

Both types of filtration will reduce solids, organic matter and certain EPs.

Expected results and environmental benefits

The project will contribute to the prioritization of the list of emerging contaminants (Directive 200/60/EP) since a list of the most relevant ones according to a thorough bibliography review was defined to be measured in the WWTP before and after its treatment.

Expected long term results

To demonstrate that the selected combination of technologies is able to reduce:

- the concentration below Directive 2013/39/UE threshold of the following priority ECs: chlorpyrifos, trifluralin, Di(2-ethylhexyl)phthalate (DEHP) and 4-t-octylphenol,
- the concentration in a 95% of their original concentration of the following ECs included in the watch list of DIRECTIVE 2013/39/UE: diclofenac, 17-a-ethinylestradiol and 17-b-estradiol and the concentration of the following pharmaceutical pollutants in 95% of their original concentration: carbamazepine, ibuprofen, fluoxetine and chloramphenicol and estrone.
- To evaluate the occurrence of ECs in Europe.

- To design, construct and set-up a mobile DEMO plant able to reduce the listed ECs.
- To characterize the ECs and their yearly variability for the Benidorm WWTP, henceforth BWWTP.
- To analyze the feasibility of the technologies for the ECs removal.
- To assess the environmental state before and after treatment in BWWTP according to different organoleptic, physical and chemical parameters.
- To assess the socio-economic impact of the implementation of the demonstration plant for EC removal in the local economy and also in other European regions with similar pollution problems.
- To transfer the project results to other identified Europe places with a similar situation regarding ECs.
- To disseminate between stakeholders the benefits of using EMPORE technologies for the reduction of ECs presence in European WWTPs.

5 Administrative part

5.1 Description of Project Management

LTL has carried out an effective project management, established the communication between the EMT and EASME. Since the visits of NEEMO EMT in May 2017, June 2018, January 2019 and January 2020, all the recommendations listed in the meeting concerning the administrative part (invoices, timesheets and other economic justifications) have been checked.

LTL as the coordinating beneficiary is responsible for coordinating actions and modifying the Workplan as necessary so that the actions objectives are achieved and for the financial management of the project, including the administration and distribution of the grant, consulting with the EC any financial queries, and being responsible for the contracted obligations. The updated workplan is provided as follows:

	Project schedule And Budget	2016				2017												2018	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Num.	Action Title	sept	oct	nov	dic	ene	feb	mar	abr	may	jun	jul	ago	sept	oct	nov	dic	ene	feb
A.1	Evaluation of the situation on prioritary and emerging pollutants in Europe																		
A.2	Administrative procedures for access permission on demonstration WWTPs																		
B.1	Characterization of water samples for the WWTPs																		
B.2	Pilot plant design for pollutants removal																		
B.3	Demo plant implementation and set up																		
B.4	Demonstration in Benidorm WWTP																		
B.5	Definition of the methodology for pollutants removal in WWTPs																		
B.6	Transferibility of the methodology for contaminats removal																		
B.7	Economic feasibility analysis																		
B.8	Legal feasibility analysis																		
C.1	Effectiveness of the project actions: monitoring of the impact of ECs removal																		
C.2	Monitoring the socio-economic impact of emergent pollutants removal																		
D.1	Dissemination and transferibility of the project results																		
D.2	Networking with other LIFE and/or non-LIFE projects																		
E.1	Project management and operation																		
E.2	After LIFE Plan																		

Furthermore, as foreseen in the Proposal, LTL counts with external assistance for this action that advice with the financial management of the project in order to assure the fulfilment of the EU requests; supports with the preparation of the project's cost statements and in the production of the compulsory financial reports; Collect the financial documents required by EU or external audits to justify the project's costs; support with the production and delivery of financial the information that may be required by the external monitoring team, auditors and the EU.

Internal reports are produced every 6 months, allowing the coordinator to ensure a proper follow up of both the technical implementation and costs incurred, since financial reporting and supporting documentation is required to all partners.

Besides a continuous contact among partners, Consortium Meetings are celebrated every 6 months. At these meetings, the achieved progress per action is presented, issues are discussed and the financial status of the project is as well exposed.

These meetings celebrated up to the closure of this report, including external visits to LIFE EMPORE, are listed below:

1. On **27th of September of 2016 took place the kick-off meeting of LIFE EMPORE** Project, in the LTL facilities, as coordinator, located in Parque Tecnológico of Paterna (Valencia, Spain). As a result, the main objectives of the project and its scope were established, as well as the work plan for the following three years and general financial justification guidelines. Representatives of all associated beneficiaries, EPSAR, AIDIMME, UA, CONSOMAR and UNESCO-IHE, attended the meeting.
2. On **12th of October of 2016, took place the kick-off meeting of LIFE Projects, Call 2015**, in Brussels (Belgium). The Project Manager and Technical Manager of the project attended the meeting.
3. On **8th March 2017, the first Follow-up Consortium Meeting** of the project took place in LTL facilities. During the meeting the completed and current actions of the project were reviewed, as well as the future activities scheduled for the following six months.
4. On **May 25th** the project received the **first mission of Maria Rodríguez, the External LIFE Monitoring Team of NEEMO-IDOM**, at LTL facilities. During the event, the updated financial and technical information of the project was reviewed as well as the main results gained for the moment.
5. On **27th of September of 2017, the second Follow-up Consortium Meeting** of the project took place in LTL facilities. During the meeting the completed and current actions of the project were reviewed, as well as the future activities scheduled for the following six months.
6. On **9th of March of 2018, Technical project meeting** in LTL installations, to confirm date of transfer of the pilot plant to Benidorm and planning of tasks of the B4 action.
7. On **24-26 th april of 2018 (Delf) third project follow-up meeting**

8. On **19th June 2018 the project received the second mission of Maria Rodríguez, the External LIFE Monitoring Team of NEEMO-IDOM**, at Benidorm WWTP, where the demonstration is being carried out. During the meeting, the updated financial and technical information of the project was reviewed as well as the main results obtained so far, including the pilot plant (demonstrator). The first samples from the demonstrator were taken.
9. On **16th January 2019** the project received the visit from the Project Officer, at Benidorm WWTP. During the meeting an update of the technical status of the project has been shown. Also, a possible extension of the project has been discussed with her.
10. On **29th January 2019** the LIFE-EMPORE Consortium presented an amendment for the extension of the project.
11. On 29th of January of 2020, EMPORE received the last mission of Maria Rodríguez, the External LIFE Monitoring Team of NEEMO-IDOM, at LTL facilities. During the event, the updated financial and technical information of the project was reviewed as well as the main results gained.

No changes in the project's management procedure and organization chart have been introduced. The Management Board, as foreseen, is formed by: Raquel González (Project Manager and Chairwoman, LTL), Héctor García (UNESCO-IHE), Daniel Prats (UA), Manuel Sánchez (AIDIMME), José María Santos (EPSAR) and Javier Andreu Burguet (CONSOMAR). Please note that AIMME (as presented in the Proposal as short name) is currently being referred as AIDIMME.
Due to the strong interest and commitment of the whole Consortium, members of the MB have been accompanied and assisted by their Technical Managers to all the celebrated meetings.

5.2 Communication with the EASME

LIFE EMPORE has received different communications from EASME. The following communications has been received from EASME:

- **LIFE15 ENV/ES/000598 - LIFE EMPORE - First monitoring visit**
- **LIFE15 ENV/ES/000598 LIFE EMPORE - Progress Report**
- **LIFE Programme Key Performance Indicators (2015 – 2016 projects)**
- **LIFE15 ENV/ES/000598 - LIFE EMPORE - Second monitoring visit**
- **LIFE15 ENV/ES/000598 - LIFE EMPORE - Mid-term Report**
- **LIFE15 ENV/ES/000598 - LIFE EMPORE - Joint monitoring visit**

A detailed answer to each issue in the Mid-term Report and in the Joint monitoring visit can be found in Annex 9.4

5.3 Communication with the Monitoring Team.

During the last monitoring visit to the project, the External Monitoring Team requested in advance different documents. All the documents were delivered to the EMT.

5.4 Changes due to amendments to the Grant Agreement.

The Grant Agreement has suffered two amendments.

The first amendment was done by the EASME and entered into force on 05 October 2018. The modification was related to the definition of conditions for natural persons, submission of VAT certificate and threshold for submission of the certificate on the financial statements

The second amendment was requested by the Consortium and consisted in an extension of the project duration. And extension of 4 months of the project was needed to ensure the complete achievement of the project objectives, from 31st August 2019 to 31st December 2019. During execution of action B.2, Pilot plant design for Pollutants removal, the constraint of developing a mobile demo plant caused that the action lasted ten months instead of the five envisaged at the proposition phase. Also, the complex system to be implemented during the execution of action B.3, Demo plant implementation and set up, caused an additional delay of 4 months. Despite buffer times were envisaged, and action B.2 started four months earlier, the delay in both actions overpassed those buffer times, causing that the demo plant began operating in June 2018, instead of January 2018. The extension requested was approved by the EASME

6 Technical part

6.1 Progress per Action

Action A1. Evaluation of the situation on priority and emerging pollutants in Europe

Beneficiary responsible		Status
UNESCO		Completed
Time schedule per Annex I	Starting date	End
6 months	09/2016	02/2017
Real time schedule	Starting date	End
6 months	09/2016	02/2017

- **Objectives:** This action aims at describing the current situation of EP in Europe focusing in two main groups: industrial/agricultural pollutants and pharmaceutical products.
- **Progress:**

UNESCO-IHE has carried out a deep study on the characterization of EP in Europe, gathering a great deal of data and valuable information, presented in “Deliverable A1.01. European Emerging Pollutant Characterization” (Already submitted in the Progress Report). This report compiles several studies related to the presence of EP in water courses including reviewing their sources, their path into the environment, the different classes of EP, their occurrence in WWTP and in natural water bodies, and their effects on ecosystems. Further, environmental risk assessment methodologies are compiled which allow the identification of such EPs which exhibit the greatest risk and which should be prioritized in terms of implementing research and monitoring programs. The report concludes with a compilation of several studies describing the effects of different wastewater treatment processes and technologies on the removal of EP,

which will help guide de project and give a new approach, more specific than the initially foreseen.
In collaboration with UNESCO-IHE, UA and AIDIMME carried out a bibliography and references review concerning the presence of priority and EP in Spain and the Valencian Community, which brought specific knowledge on EP presence in Benidorm and allow, in case of contingencies in the sampling, proposal of EP species to be introduced in the analysis campaign. LTL has as well contributed with its expertise in WWTP and in water characterization, providing the methodology for the analysis of EP and priority pollutants.
The main conclusions of Action A1 have been taken into account in the Initial Report of Action B1, especially those regarding the physical-chemical parameters that could predict the behaviour of the selected pollutants. For this reason, the staffs of UNESCO-IHE and LTL have been coordinated and have collaborated actively during action B1 and A1.
As the selected pharmaceutical substances have low coefficient of adsorption, the sorption to the biomass or to suspended solids is marginal. From the kinetic biodegradation coefficient (kbiol) it can be concluded that diclofenac and carbamazepine are persistent compounds, as opposed to estradiol and estrone which are highly biodegradable. The remaining compounds have kbiol between 0.1 and 10 L/(gSS d), which implies quite good biodegradability. If we focus on the water-octanol partition coefficient (Kow), the compounds ethinylestradiol, fluoxetine, and partially diclofenac are highly lipophilic, which makes them potentially assimilated by the biomass. On the other hand, carbamazepine, chloramphenicol, and under certain circumstances ibuprofen and diclofenac have hydrophilic behavior, not showing affinity for lipids.
The selected emerging contaminants can be detected in affluent and effluents of conventional wastewater treatment plants. The following table shows the average concentrations in the affluent and effluents of conventional wastewater treatment plants, and their average removal percentage of the compounds selected as indicators:

Class by use	Name of substance	Average concentration raw influent (µg/L)	Average concentration effluent (µg/L)	Average Percentage removal efficiencies in WWTP with CAS (%)
Analgesic/anti-inflamatories	Diclofenac	1	0,8	29
	Ibuprofen	37	3,6	87
Antibiotics	Chloramphenicol	1	0,05	95
Psychiatric drugs	Carbamazepine	1,2	1,04	18
	Fluoxetine	0,54	0,24	56
Hormones	Estradiol	0,25	0,01	80
	Estrone	0,08	0,03	76
	Ethinylestradiol	0,02	0,003	78

The main removal mechanisms in the biological reactor are biodegradation and sorption. Both processes have different incidence on the percentage of removal being biodegradation the most important process. Diclofenac exhibits a wide dispersion of removal efficiencies varying between 0% and 90%. Ibuprofen exhibited higher concentration after the biological treatment; ibuprofen can be regenerated from its derivatives trough hydrolysis. Carbamezapine is the most persistent compound, and in some cases an increase in concentration has been registered in the effluent compared to the affluent, due to compound release. In addition, the hormones present high removal rates between 76% and 80%, although cases of negative removal due to estradiol oxidation into estrone and partial deconjugation of other estrogens found in the water were also registered. An analysis of the environmental risks at the undiluted effluent of a conventional wastewater treatment plant shows that the compounds fluoxetine, ibuprofen, and the three hormones estradiol, Estone and Ethinylestradiol exhibit a high risk (RQ>1). The remaining compounds display a low risk with RQ less than 0.1. In studies of environmental risks conducted at four European basins including Elbe, Scheldt, Danube and Llobregat, over 500 emerging contaminants, it was concluded that diclofenac, ibuprofen, and carbamazepin were detected in the environment; however, their PNEC must be studied in more depth. Ethinylestradiol, estradiol, estrone were rarely observed. In addition, their PNEC are estimations, so the exposure levels generated in the bodies of water and the effect on the biota need more studies. From the European mapping elaborated it can be observed that diclofenac, ibuprofen, and carbamazepine are the most searched compounds (they were searched in 9 out of the 18 countries) and that chloramphenicol, ethinylestradiol and fluoxetine are the less searched (they were searched in 9, 8 and 6 countries, respectively). These last three compounds were also the less frequently detected Regarding the presence of EM in Spain, a group of only 20 compounds was responsible for 83% of the total load of pollutants in the effluents of the WWTPs studied in Madrid, Cantabria, Barcelona and Almería. In Comunidad Valenciana (Valencia), among the substances found, it is worth highlighting the presence of: hypertension regulators such as valsartan and irbesartan; antibiotics such as clindamycin, lincomycin and ofloxacin; 4-methylaminoantipyrine and 4-ethylamino-antipyrine, metamizole metabolites; benzoylecgonine, cocaine metabolite; the antidepressant venlafaxine; and the antiepileptic carbamazepine.

- **Problems encountered and deviations:** Although around 50 references have been consulted on the information obtained, there is little information from the Administration, which might be due to the fact that most of these compounds are currently without regulation.
- **Schedule:** The action has been carried out by UNESCO according to the initial timetable.
- **Deliverables:** A1.01. European Emerging Pollutant Characterization (Already submitted in the Progress Report)

Action A2. Administrative procedures for access permission on demonstration WWTPs

Beneficiary responsible		Status
EPSAR		Completed
Time schedule per Annex I	Starting date	End
2 months	09/2016	10/2016
Real time schedule	Starting date	End
2 months	09/2016	10/2016

- **Objective:** The aim of this Action is to obtain the official access permission to Benidorm WWTP, the location for the demonstration phase within the implementation actions.
- **Progress**

Task A2.1. Ask written authorization for official access permission to BWWTP.
Following the applicable administrative procedures, EPSAR sent on 20th September 2016 a request to Benidorm City Hall to obtain an authorization as official access permission to the WWTP of Benidorm. As foreseen, the authorization was smoothly obtained and received by EPSAR on the 16th October 2016 that made it available to LTL.

Task A2.2. Authorization distribution among partners.
LTL distributed the access permission authorisation to the rest of the partners.

- **Problems encountered and deviations:** No problems neither deviation encountered.
- **Schedule:** Authorisation was obtained and distributed in due time according to the schedule.
- **Deliverables:** A2. Official access permission to Benidorm WWTP (Already submitted in the Progress Report)

Action B1. Characterization of water samples for the WWTPs

Beneficiary responsible		Status
LTL		Completed
Time schedule per Annex I	Starting date	End
12 months	11/2016	11/2017
Real time schedule	Starting date	End
12 months and one week	11/2016	12/2017

- **Objectives:** The main objective of this action is to quantify the pre-selected EP by carrying out an intensive analytical campaign during one year, so that data will allow assessing its variability.

- To quantify the pre-selected pollutants and their variability
- To define the pollutants for designing properly the demonstrator in Action B2 and B3.
- To define the pollutants for the demonstration test which are to be carry out in Action B.4.

- **Progress:**

Task B1.1. Analytical campaign design

Having obtained the access permissions (Action A2), the analytical campaign design was carried out by LTL. Besides detailing the design, the laboratory staff assigned to the project bought the material needed for sampling and analysing (bottles, consumables etc.). The schedule sampling calendar was designed too.

Task B1.2. Analytical campaign implementation

On 24th of November 2016 started the Analytical Campaign, which has had a total duration of 12 months and one week, from November 2016 to December 107 (the first week of December was taken the last sample to complete the 108 samples programmed in the project). Since the beginning of the campaign, an experienced technician of LTL had taken samples from the influent and effluent of BWWTP and carried them to the laboratories of LTL, where these samples were analysed. Four to five samples were monthly taken, from the inlet and the output of BWWTP, respectively. So, during the period covered by this report, a total of 108 samples have been taken (54 inlet and 54 output). In order to ensure a sufficient representativeness, the sampling has been integrated in time and it has been done by using two automatic sampling instruments (owned by LTL) that host 24 bottles and a distributor arm:

The Head of the Laboratory supervised the results and delivered the Test Report of each sample, with the results, in a pdf file. A database (called "BWWTP Database") was created to compile these results, having been constantly updated and monthly distributed among the partners. This database included the results of the selected pollutants, in the input and output of the water line of BWWTP, including the removal percentages for each one at the current situation without any of the proposed technologies.

Results indicate that, in general, for the industrial and/or agricultural pollutants, lower concentrations have been obtained and several compounds have not been detected, whereas this has not been the case for the pharmacological origin pollutants. Thus, it has been concluded that, emerging pollutants that should be priority objectives when starting the next action and designing the pilot plant should be: chlorpyrifos, trifluralin, octylphenol, isoproturon, DEHP, AMPA, glyphosate, diuron, diclofenac, 17-α-ethinylestradiol, 17-β-estradiol, erythromycin, chloramphenicol, carbamazepine, ibuprofen, fluoxetine, estrone, sulfamethoxazole, ketoprofen and estriol.

- **Problems encountered and deviations:**

As expected, the analytical results displayed the enormous variability in the concentration of EPs in wastewaters, as well as the seasonal variability which characterizes Benidorm.
Moreover, some emerging pollutants originally targeted were removed with current treatments (i.e.4-t-OctylPhenol, diphenyl etherbromide and ibuprofen). It was also observed that some emerging pollutants transform into other compounds in the process. Consequently, LTL decided to increase the list of pollutants targeted by the project in Actions B1 and B4 (after receiving the acceptation of EASME by July 2017).
Additionally, some consults to experts were done, for instance one to the Public Health Administration of Comunidad Valenciana (Valencia, Spain) and to the Pharmacologist Professor, Diego Cortés, from the Pharmacy Faculty (University of Valencia).
In conclusion, the list of pollutants to be analysed during the project is the following:

1. Priority compounds: chlorpyrifos, trifluralin, octylphenol, DEHP, isoproturonand **diuron**.
2. “List watch” emerging compounds: diclofenac, 17-α-ethinylestradiol, 17-β-estradiol and **erythromycin**.
3. Not regulated emerging compounds: chloramphenicol, carbamazepine, ibuprofen, fluoxetine, estrone, **AMPA**, **glyphosate**, **sulfamethoxazole**, **ketoprofen** and **estriol**.

In bold are remarked the emerging compounds added to the previous targeted pollutants

- **Schedule:** Analytical campaign was completed and no deviation on the consecution of objectives had been suffered. Water samples were collected and pollutants were analysed as foreseen.

- **Deliverables:**

- B1.01. Initial Analysis Report (Already submitted in the Progress Report) and B1.02 Final Analysis Report (section 10.2.4)

Action B2. Pilot plant design for Pollutants removal

Beneficiary responsible		Status
AIDIMME		Completed
Time schedule per Annex I	Starting date	End
5 months	05/2017	09/2017
Real time schedule	Starting date	End
10 months	01/2017	30/06/2018

- **Objectives:** The aim of this action is to design the most appropriate unit operations for the treatment of a group of priority and emerging contaminants (drugs and industrial products). The designed demo plant will allow the combination of a wide range of technologies in a real scenario; Benidorm WWTP for treatment of priority and emerging pollutants, in order to demonstrate the selected combination is the best technical solutions for the removal of contaminants mixture (B.4) and through economic feasibility analysis of the proposed methodologies (B.7).

- **Progress:**

Pilot plant design is considered of great importance since next actions depend on it, such as the correct selection of equipment, assembly and start-up of the pilot, and demonstration operations. As leader of this Action, AIDIMME evaluated the situation and became aware that technologies such as EAOPS require significant periods of time for its acquisition and manufacture. Consequently, to avoid risks of delays in the delivery of equipment and construction of the pilot, AIDIMME advanced the start of the design and contacted companies specialized in involved technologies. This early starting is tightly related to progress of A1 and B1.

Tasks performed by the participants have been the following: UA has been in charge of the pre-design of filtration; AIDIMME of the pre-design of advanced oxidation units and electrochemical processes, CONSOMAR designing the automation of the demonstrator, and LTL collaborating in the design of the recovery, storage and control units of the pilot plant. Partners have been maintaining different technical meetings for the conception of technologies in the different levels of treatment. This involves periodical work meetings in LTL facilities.

In order to do the design of the technologies, the following aspects have been taken into account:

- Average Input flow defined: 5.5 m3 / h . The actual capacity (pilot) will be conditioned by the characterization of A1, the complexity of the pollutants and therefore the number of cycles and retention times in each technology. The deviation over the design flow rate can be a maximum of 5%, which is considered insignificant.
- Recent analysis of secondary treatment effluent BWWTP
- Tertiary treatment history in other WWTPs
- Design variables based on the experience of the Consortium (UA, AIDIMME)
- Design variables based on bibliographic references

Based on the three levels of treatment, technical material has been developed for the automation design of the plant, such as:

- Tables operating instructions for design of plant automation (function tree).
- Design of drafts containing information regarding the hydraulic flow diagram with interconnection between units and process instrumentation which will be part of the Deliverable: Hydraulic flow diagrams of the pilot plant with interconnection between units and Process instrumentation.
- Technical specifications table which will be part of the Deliverable: Technical specifications of the designed technologies.

Work performed by CONSOMAR has included the study of the different demonstrator components operation in order to integrate them into the automation system; preparation of the equipment lists, and collaboration in the flow diagrams and equipment selection.

During the design, it was necessary to contact with suppliers of the different technologies selected for the pilot plant. It was carried out an action of search and maintenance of the contacts, specifically and on the second and third level technologies where UA has contacted different companies (ea. Hydrowater, Atlas Copco, Grundfos, Dow, and so on) concerning the filtration units and AIDIMME has sought suppliers of specific EAOPS technologies for the acquisition of materials from electrochemical cells. For CONSOMAR, the main challenge has been the unification of the providers and manufacturers, as well as the automation criteria of the different parts of the demonstrator.

Progress in design is resulting in additional required elements and modifications on the initial configuration are shortly described hereunder.

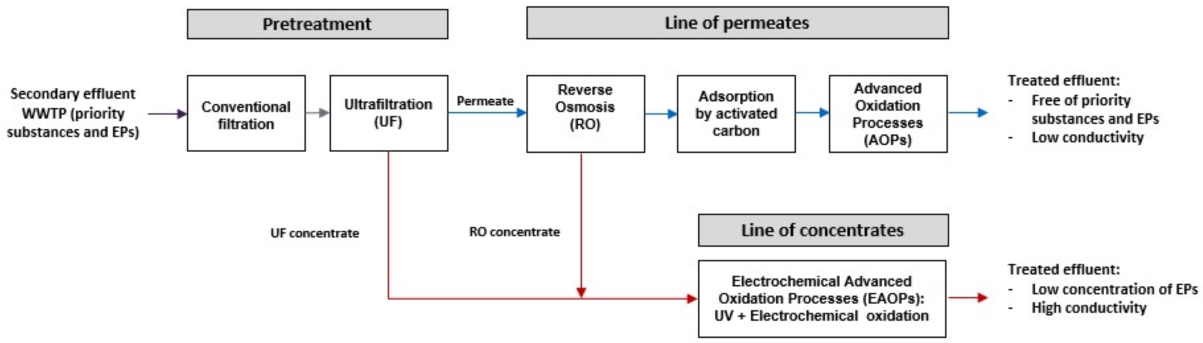


Figure 1 Treatment levels

Task B.2.1: Pretreatment design and feeding of the pilot plant.
Progress in the following activities has been done: Calculation and design of the Pre-filtration system: filtration / adsorption and Calculation and design of Filtration by ultrafiltration membranes. Activity completed at 100%.
These resulting into the following adjustments to the initial configuration:

- Replacement of the vertical pressure filter with flint-anthracite filling by a vertical pressure crystal filter.
- Acquisition of a mesh pre-filter that will ensure protection of UF membranes against solids, therefore considered important.
- Changing the activated carbon filter position, that will be placed behind the reverse osmosis, to avoid its rapid fouling due to the presence of organic matter present in the water.
- Modification of the configuration of the UF unit due to the increase in the inlet flow. Acquisition of a compressor to supply air to the backwash.
- Acquisition of an UV lamp to eliminate the microorganisms that could have passed through the UF membranes, as an extra element to protect the membranes of reverse osmosis.

Task B.2.2: Line of permeates design. Filtration system & Advanced Oxidation
Progress in the following activities has been done: Calculation and design of the Filtration unit by reverse osmosis (RO) membrane and Calculation and design of Advanced Oxidation Processes (AOPs).

- Selection of all control and safety equipment of all functional units. Activity completed 100%
- Design of drafts containing information regarding the hydraulic flow diagram with interconnection between units and process instrumentation. Activity completed at 100%.

Modifications proposed for filtration units include acquisition of a cartridge type pre-filter; RO configuration and bituminous coal filter; and for AOPS units the elimination of the Fe catalyst dosage and incorporation of separation units (decanters) in the demonstrator.

Task B.2.3: Line of concentrates design. Processes EAOPs.
Progress in the following activities has been done: Calculation and design of Electrochemical processes will be applied to concentrates from the membrane filtration operations (UF and RO). In relation to the advanced oxidation modifications proposed for the third level include elimination of Fe dosing as a catalyst reagent and therefore the reduction of Fenton technologies in combination with electrochemical reactors.
In addition, during this period UA and AIDIMME have compiled technical specifications of the selected equipment and have elaborated the Deliverable B2.02 "Technical specifications of technologies designed". The flow diagrams were updated after supervising the real connections in the plant during action B3.

▪ **Schedule:** Design of pilot plant is progressing according to schedule. Minor changes concerning deliverables order are presented in section Envisaged progress. Given the urgency with which the design tasks, study of the specific problem (Benidorm) and search for treatment and control equipment have started, the plant was designed in its entirety in 12/2017. Different modifications of the pilot plant design were required to be made from January 2018 up to June 2018 in order to properly implement the pilot plant in B3.

- **Deliverables:**

- B2.01. Hydraulic flow diagrams of the pilot plant with interconnection between units and Process instrumentation (section 10.2.3): B2.01 Deliverable was done based on EU standards EN ISO 10628-1:2015, Diagrams for the chemical and petrochemical industry part 1. Specifications of process diagrams and EN ISO 10628-2:2012. Diagrams for the chemical and petrochemical industry Part 2: graphic symbols.
- B2.02. Technical specifications of the technologies designed. (section 10.2.1)

Action B3. Demo plant implementation and set up

Beneficiary responsible		Status
LTL		Completed
Time schedule per Annex I	Starting date	End
5 months	08/2017	12/2017
Real time schedule	Starting date	End
9 months	10/2017	06/2018

- **Objectives:** The aim of this action is to install all units that were designed in the previous action. Different parts of the equipment were purchased, installed and set up. Initially all units were tested individually and afterwards the integrated system was tested in order to have the pilot plant available for the demonstration action (B4).
- **Progress:**

Task B3.1 Installation

All the prototype's units, instruments and control elements for the advanced oxidation and electroxidation processes, previously selected in action B2 have been acquired by AIDIMME. The assembly of the plant was carried out in the facilities of Manuel Romeu S.A. in Alboraya (Valencia). The process was managed by LTL.

The filtration system has been selected and purchased by UA, while the Advanced Oxidation System and the Electrochemical System has been selected and purchased by AIMME. In both cases, this task involved the selection of materials and equipment, a study budget and a supplier selection. The container where the units have been installed, as well as auxiliary materials, like pumps, agitators, filters, flow meters and sounding lines has been provided by LTL.

LTL has been in charge of the construction and the implementation of the elements mentioned above. Afterwards, CONSOMAR has provided all control systems of the pilot plant and the network analysers too. CONSOMAR has participated in the acquisition and installation of the unit's control elements and their integration in the PLC by means of the SCADA.

The system communicates with all integrated components, operating either manual or automatic mode, opening and closing valves, turning on and turning off engines reading some process parameters from the measuring instruments. The SCADA has an interface display, which allows reading every process parameter and permits to choose the technology in study and to export energy expenditure of each one.

The installation of the plant should have been completed in November 2017, but it finally lasted until March 2018 due to several incidents. The dimensions of the filtration equipment (reverse osmosis, carbon filters, glass filters) made it difficult to install in the selected container. Reception of some equipment was delayed due to snow storms in Europe (pumps, compressors,

pressure transmitters, etc.). The compressor (V-102) arrived broken in Alboraya; Atlas Copco took over the equipment and supplied a new one.
In March 2018, the plant was transported to the DWTP, where the electrical installation was carried out and the first tests with the control system were carried out.All operations done in this task were aimed to the construction of the demostrative pilot plant.

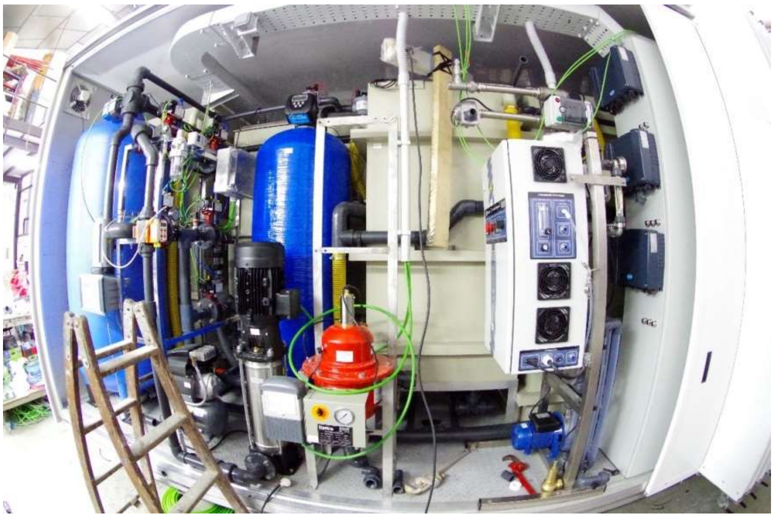
Some images of this Task B3.1 Installation are provided as follows:

CONTAINER



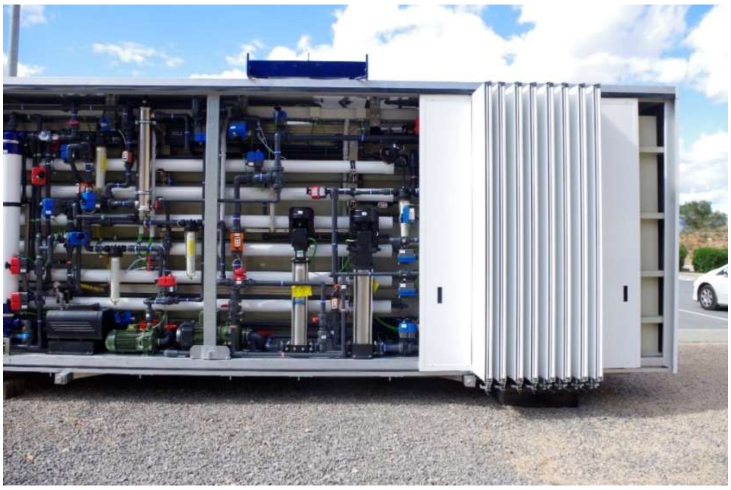
INSTALATION OF THE ELEMENTS





TRANSPORTATION TO BWWTP





To sum up, the following actions were carried out in B3.1:

- Acquisition of units, instrumentation and control elements for the prototype plant 100%
- Selection and purchase of filtration system (UA) 100%
- Selection and purchase of the Oxidation system and the electrochemical system (AIDIMME) 100%.

  Equipment purchased:
  - Electrochemical reactors, C301, C302
  - Reactor power supplies C301, C302 with instrumentation incorporated monitoring parameters I (A) and V (V), VTC301, ITC301, VTC302, ITC302

  Equipment available:
  - UV lamps, A202, A203, A301

  Selected equipment (missing purchase):
  - Reagent tank (H2O2), AB203
  - Dosing pump H2O2, AP203
  - Cartridge filter, F205
  - Safety manometers for filter F205, (PI_F205_01 and PI_F205_02)
  - Cartridge filter, F301
  - Safety manometers for filter F301 (PI_F301_01 and PI_F301_02)
- The selection and purchase involves a selection of materials and equipment, budget study and selection of suppliers.
- Construction of the demonstrator and implementation of purchased materials and equipment (LTL) 100%.
- Configuration of control and installation systems with network analyzers in the demonstrator (CONSOMAR) 100%

- Programming the automata based on the operating logic of the installed equipment (UA, AIDIMME, CONSOMAR) 100%.

Task B3.2 Pilot plant set up

In March 2018, the plant was transported to the DWTP and its commissioning started parallel to the electrical installation. During this period, AIDIMME together with UA has participated in the following tasks:

- Check the pipes according to the flow diagram.
- Installation of pressure gauges on fabric filters.
- Verification of the functioning of the equipment acquired by AIDIMME such as ozonator, fabric filter, electrochemical reactors, carbon filter, etc.
- Verification of the operation of the equipment purchased by UA such as crystal filter, mesh filter, membranes, carbon filter, etc.
- Check of the valves installed in the plant (identification of the type of valve and flow direction).
- Repair, under LTL supervision, of several pipelines.
- Hydraulic tests in manual mode to test the different technologies according to the explanations in the manuals (ozonator, f. carbon).
- Verification of the different SCADA screens.
- Verification of plant automation.

Plant automation is complex and not yet complete. The logic has been reviewed by AIDIMME, UA and CONSOMAR with the programmers to make sure they understand all the processes described. AIDIMME, together with CONSOMAR, UA and LTL, has revised on numerous occasions the programming downloaded in the SCADA by the programmers.

During this period, UA has written up the following operational protocols: a) prefiltration and ultrafiltration; b) reverse osmosis and carbon activated filter (F-203). AIDIMME has written up AOPs and EAOPs protocols. These documents have been included in the deliverable B3 " Treatment protocols comprising operational indicators". LTL has elaborated a table with all the equipment maintenance operations and it has also been included in the deliverable. The protocols also include information about the registers described in action B4.

LTL has elaborated the deliverable B3 "Manual of the pilot plant" with the collaboration of all participants. UA asked its suppliers for the manuals of the equipment purchased for inclusion in the general manual of the plant

- **Schedule:**

The demo plant implementation and set up, Action B3, started in October 2017, two months later that it was scheduled, and finished in June 2018, six months later that it was scheduled as a result of some delays in the purchases and delivers such the container and main pumps. Other problems were related to the acquisition and installation of the unit's control elements and their integration in the PLC by means of the SCADA, which took more time that it was planned.

- **Deliverables:**

- B3.01. Treatment protocols comprising operational indicators (section 10.2.5): AIDIMME was in charge of the preparation of the protocols for the functioning of the processes of advanced oxidation of the second level of treatment and of the protocols of operation of the electrochemical processes. UA was in charge of the preparation of the operational protocols of a)prefiltration and ultrafiltration; b) reverse osmosis and carbon activated filter.
- B3.02. Manual of the pilot plant (section 10.2.6): AIDIMME selected the manuals, technical data sheets and records related to oxidation equipment and control equipment (pressure, flow, ozone sensors), participating in the preparation of the Manual.

Action B4. Demonstration in Benidorm WWTP

Beneficiary responsible		Status
UA		Completed
Time schedule per Annex I	Starting date	End
12 months	01/2018	01/2019
Real time schedule	Starting date	End Date
12 months	06/2018	12/2019

- **Objectives:** The aim of this action is to perform the demonstration of the pilot plant to measure the removal of the compounds under yearly variations.
- **Progress:**

UA as coordinator of the action, and AIDIMME, LTL and CONSOMAR as participants, planned and carried out the demonstration. Activity completed in the range of 100%.

The action is divided into 3 tasks, Demonstration, Maintenance and the EP analytical campaign.

Task B4.1 Demonstration

The plant was designed to treat 5-5.5 m^3/h of secondary effluent of Benidorm WWTP. That effluent was treated firstly in a pretreatment line, conventional filtration followed by ultrafiltration (UF), and posteriorly, the permeate was sent to the reverse osmosis unit. The reverse osmosis permeates were filtered by activated carbon and sent to the Advanced Oxidation Processes (AOPs) unit where different treatments were applied: a) O_3; b) O_3+UV; c) O_3+H_2O_2; d) H_2O_2+UV. Each month a program was tested, starting with O_3.

The concentrates of the UF/RO membranes were treated in the line of concentrates where 2 treatments were applied: a) electro-oxidation; b) ultraviolet radiation (UV) combined with electro-oxidation. As observed in Figure 1, initially it was planned to alternate treatments every 4 months. However, once the combination UV+electro-oxidation was tested, it was observed the UV treatment was not efficient due to the low quality of the concentrates (high turbidity, and presence of SS) responsible for the low transmittance, and it was decided to apply the electro-oxidation directly.

The schedule of the processes during the demonstration period is shown in Figure 2.

Period	July 2018	August 2018	September 2018	October 2018
Pretreatment	Conventional filtration + ultrafiltration			
Line of permeates	Reverse Osmosis + Activated carbon + AOPs. Programs:			
	P1: O_3	P2: O_3/UV	P3: O_3/H_2O_2	P4: H_2O_2/UV
Line of concentrates	Reactors			

Period	November 2018	December 2018	January 2019	February 2019
Pretreatment	Pretreatment (conventional filtration + ultrafiltration)			
Line of permeates	Reverse Osmosis + Activated carbon + AOPs. Programs:			
	P1: O_3	P2: O_3/UV	P3: O_3/H_2O_2	P4: H_2O_2/UV
Line of concentrates	Reactors+UV			

Period	March 2019	April 2019	May 2019	June 2019
Pretreatment	Pretreatment (conventional filtration + ultrafiltration)			
Line of permeates	Reverse Osmosis + Activated carbon + AOPs. Programs:			
	P1: O_3	P2: O_3/UV	P3: O_3/H_2O_2	P4: H_2O_2/UV
Line of concentrates	Reactors			

Figure 2. Schedule of the processes during the demonstration period

Regarding the operation of the plant, the most important information from data sheets is analysed below: a) period Jul.18 to Oct.18; b) period Nov.18 to Feb.19; c) Mar.19 to Jun.19.

a) Period Jul.18 to Oct.18:

The average flow of the influent to the EMPORE plant (secondary effluent of Benidorm WWTP) for the period Jul.18 to Oct.18 was 5.18±0.30 $m^3 \cdot h^{-1}$ and its average turbidity was 4.14±2.21 NTU. As it was expected, the crystal filter (F-101) reduced the turbidity of those effluents to an average value of 1.75±1.02 NTU. The removal percentage of turbidity was variable, with a mean value of 52.1±25.3 %.

The UF operated at an average flux of ~52 $L \cdot h^{-1} \cdot m^{-2}$ (LMH) with a high average conversion >98%. There was a good distribution of the flow in the membranes. In general, although the operation was manual and backwashing cycles were only conducted during automation tests, the fouling was not excessive. The average inlet pressure was 0.87±0.14 bar and the average transmembrane pressure (PTM) was 0.64±0.14 bar.

The RO unit produced an average permeate flow of 3.21±0.26 $m^3 \cdot h^{-1}$ and a rejection flow of: 1.59±0.33 $m^3 \cdot h^{-1}$. The average total conversion was 67.0±5.6 % and the average percentage of salt rejection was 96.2±1.1 %. The inlet pressure was 11.33±0.87 bar and the differential pressure was 6.42±1.11 bar (4.08±0.43 bar in the first stage and 2.34±0.73 bar in the second stage).

In the AOPs unit, the pH was maintained slightly acid (pH 5.36 - 6.78). The reagents added in the different processes were: O_3 (0.18-0.61 $mg \cdot L^{-1}$ of dissolved - residual - ozone), UV (28.1-50.8 $W \cdot m^{-2}$) and hydrogen peroxide (2-4 $L \cdot h^{-1}$ at 17%).

The electro-oxidation unit operated in two ranges of voltage current. In Jul.18 and Aug.18, it worked between 4.2 and 5.0 ±0.2 V (1.2 and 5.7 ±0.29 A) and in Sep.18 and Oct.18, it worked on 5.3 ±0.1 V (10.4 ±1.2 A). In Sep.18 and Oct.18, the applied voltage and corresponding intensity remained more stable, being this range the one that was applied to the two reactors during the rest of the demonstration stage. The pH of water was stable at 7.00 ±0.09.

b) Period Nov.18 to Feb.19:

The average flow of the influent for the period Nov.18 to Feb.19 was 5.12±0.30 $m^3 \cdot h^{-1}$ and its average turbidity was 3.26±3.06 NTU. After the filter, the turbidity decreased to 1.25±0.70 NTU. The removal percentage of turbidity was variable, with a mean value of 49.0±25.7 %.

The UF operated at an average flux of ~52 $L \cdot h^{-1} \cdot m^{-2}$ (LMH) with a high average conversion >98%. There was a good distribution of the flow in the membranes. The plant operated with backwashing cycles. The average inlet pressure was 1.34±0.26 bar. It was observed that PTM slowly increased; its average value was 1.10±0.25 bar.

The RO unit produced an average permeate flow of 2.76±0.20 $m^3 \cdot h^{-1}$ and a rejection flow of: 1.93±0.18 $m^3 \cdot h^{-1}$. The average total conversion was 58.8±2.9 % and the average percentage of salt rejection was 97.2±0.7 %. The inlet pressure was 12.35±0.70 bar and the differential pressure was 7.77±0.81 bar (4.49±0.47 bar in the first stage and 3.28±0.42 bar in the second stage). In that period, the conversion fell, and the pressure drop increased, especially, in the second stage. A CIP cleaning was carried out.

In the AOPs unit, the pH was comprised between 5.5-4.9±0.10 in Nov.18 and Dec.18. In Jan.19 and Feb.19, the pH was 5.2-4.4±0.10, slightly lower, coinciding with the processes with hydrogen peroxide (H_2O_2), weak acid. The reagents added in the different processes were: O_3

(0.22-0.85 mg/L of dissolved ozone - residual), UV (28.3-50.8 W/m^2) and hydrogen peroxide (3.5 L/h at 30%).

The electro-oxidation unit operated in manual mode and by charges during Nov.18 and Dec.18, and automatically in Jan.19 and Feb.19. The plant operated mostly in the voltage-current range of 5.1 and 5.7 ±0.1 V (9.2 and 11.5 ±0.20 A). It should be noted that during the months of Nov.18 and mid-Dec.18, the operation was carried out with a single reactor (C302). The pH was maintained between 6.50 and 6.90 ±0.10.

c) Period Mar.19 to Jun.19:

The average flow of the influent for the period Mar.19 to Jun.19 was 5.22±0.24 m^3·h^{-1} and its average turbidity was 3.96±4.12 NTU. After the filter, the turbidity decreased to 1.18±0.96 NTU. In May. and Jun.19, the effectiveness of the decantation in the Benidorm WWTP worsened and some days (ea. 16th and 29th May.19 and 4th Jun.19) the concentration of solids increased up to 30 mg·L^{-1} as well as the turbidity (up to 40 NTU). It was observed a higher fouling in the crystal filter. The mean removal percentage of turbidity in that period was 65.15±22.70 %.

The UF operated at an average flux of ~52 L·h^{-1}·m^{-2} (LMH) with a high average conversion >98%. There was a good distribution of the flow between the membranes. The average inlet pressure was 1.76±0.67 bar and the average PTM was 1.55±0.68 bar.

The RO unit produced an average permeate flow of 2.94±0.16 m^3·h^{-1} and a rejection flow of: 1.68±0.10 m^3·h^{-1}. After the chemical cleanings carried out (CIP-HCl and CIP-GENESOL) the conversion increased up to an average value of 63.6±2.2 %. The average percentage of salt rejection was 97.2±0.5 %. The inlet pressure was 11.27±0.46 bar and the differential pressure was 6.91±0.67 bar (3.99±0.22 bar in the first stage and 2.92±0.61 bar in the second stage). In that period, the conversion fell, and the pressure drop increased, especially, in the second stage. A CIP cleaning was carried out.

In the AOPs unit, the pH was between 5.59-4.37±0.10. The reagents added in the different processes in the third period of the demonstration action were: O_3 (0.22-0.65 mg/L of dissolved - residual - ozone corresponding to a production of 100%), UV (25.7-49.6 W/m^2) and hydrogen peroxide (3.5 L/h at 30%).

The process carried out from Mar.19 to Jun.19 was electro-oxidation; the UV treatment was not applicated due to the high concentration of suspended solids and turbidity in the rejections. The reactors operated at a current of 10 A and with 1 cycle. In addition, other tests were carried out, operating at different currents (10, 20 and 30 A) at different contact time (1 cycle and 3 cycles). The pH was maintained between 6.0 and 7.0 ±0.10.

In summary, the plant was operated semi-automatically with the supervision of operators during most of the demonstration. The average flow of secondary effluent treated from Jul.18 to Jun.19 was 5.17±0.28 m^3·h^{-1}. By means of the pretreatment (conventional filtration followed by ultrafiltration), suspended solids were almost completely removed from the secondary effluent and turbidity was reduced to values < 0.1 NTU, preparing the effluents to the subsequent unit. From Jul.18 to Jun.19, the reverse osmosis operated with an average total conversion of 63.1±5.2 % and the average salt rejection was 97.0±0.9 %. The average permeate flow produced was 2.97±0.28 m^3·h^{-1} and the average rejection flow was 1.74±0.27 m^3·h^{-1}. The electro-oxidation was carried out using a fixed intensity of 10 A and only 1 pass through the reactor cells.

Regarding energy consumption, when all the processes were operating, the general power reached values up to 12 kW. From 30th Oct.18 to 27th Jun.19, the average energy consumption ratios related to the water produced per process were in descending order: reverse osmosis (2.77±0.83 kWh·m^{-3}) > EAOPs (2.93±2.02 kWh·m^{-3}) > AOPs (1.49±0.73 kWh·m^{-3}) > Pre+UF (0.33±0.13 kWh·m^{-3}). The mean value of the total energy consumption ratio related to the total water treated was 1.8 kWh·m^{-3}.

The main important incidents during the demonstration were related to the automation of the plant and the operation of the electro-oxidation reactors. UA and AIDIMME members detected problems in the automatic operation of the pilot plant. CONSOMAR members visited the plant in several occasions to solve the incidences related to plant automation (SCADA) and it was necessary the technical assistance of the company ITE S.L. The following operations were carried out: adjustment of the frequency inverters and pumps, adjustment of the position of the automatic valves, troubleshooting of equipment connection with SCADA, etc. The advances in automation from Jul.18 to Oct.18 allowed to operate the UF, RO and electro-oxidation units in automatic mode as well as the different programs carried out in the AOPs unit. However, during the automatic operation some failures were detected not periodically, so that, the plant was operated semi-automatically with the supervision of operators.

On the other hand, the electro-reactors failed several times during the demonstration. A technician from STS Control visited the plant to solve electrical problems with both electro-reactors (19th Sep.18). From Jul.18 to Dec.18, the regulation and setting of the voltage in reactor C-301 was impossible, reversing the polarity cyclically, which could damage the electrodes of that reactor. The power supply failure was firstly checked in AIDIMME facilities, and posteriorly, the supplier confirmed that it was very damaged due to exposure and contact with corrosive environments (acids, oxidants, etc.) and could not be repaired. So, the source was temporarily replaced by a unit provided by AIDIMME laboratories. During Jan.19 and Feb.19, the electro-oxidation unit operated with two reactors, the reactor C-302 with its original power supply (this unit began to oscillate in the application of voltage the 21st Jan.19) and the reactor C-301 with the source ceded by AIDIMME. In Mar.19, once the replacement of both power supplies was carried out by more robust and efficient sources, the electro-oxidation was operated with both reactors.

Other incidences were: failure of the ozone generator, breakdown of the UV lamp A-101, breakdown of some flow meters (FI-103-01 and FI-103-02), failure of the carbon filter due to its microrruptor (F-206); breakdown of some dosing pumps (AP-201, AP-202, AP-203), breakdown of pumps P-201 and P-103, humidity in the screen of the SCADA, corrosion in the container of the DEMO plant, etc.

Considering the daily and weekly fluctuations of the DWTP input flow (information provided by EPSAR and action B1), the sampling days to analyse micropollutants were rotatably scheduled. Weekly samples were taken by LTL and were analysed in its laboratory (task 4.3). The parameters analysed were a) concentration of the selected micropollutants (20 compounds); b) general parameters: conductivity, pH, suspended solids and turbidity.

Task B4.2 Maintenance

In this task, all partners participated in order to guarantee a successful pilot plant maintenance and operation tasks. AIDIMME, UA, LTL and CONSOMAR participated in the operation and maintenance of the plant according to schedule. AIDIMME controlled chemical and electrochemical processes (AOPs and EAOPs). UA controlled the pre-filtration and membrane processes. LTL performed analytical monitoring of contaminants. CONSOMAR controlled the SCADA and recorded the electrical consumption of the plant.

A set of registers was elaborated to collect all the information produced during this action. The registers were elaborated in EXCEL version with the participation of all members.

- B4_01_Register of power consumption during demonstration.

ACCIÓN B4
Registro: B4_01_Registro de consumos eléctricos N°: _

FECHA										
HORA										
AR1 GENERAL PLANTA	Energía Activa (KWh)									
	Energía Aparente (KVAh)									
	Potencia Activa (KW)									
	Potencia Aparente (KVA)									
	Factor de Potencia (cos phi)									
	Potencia Máx (KW)									
	Volumen FT-P102 (m3)									

- B4_02_Data sheets: control process
  - ✓ Operation prefiltration

ACCIÓN B4
Registro: B4_02_Prefiltración N°: _

$SDI = (1 - t1/t2)/15 \cdot 100$ $AP = P_{entrada} - P_{salida}$

		DEPÓSITO B-101								BOMBA UF		FILTRO F-101							
		sonda portátil			ORP-B101	TB-B101	SDI entrada planta			P-102	FT-P102	XPI-F101-01	XPI-F101-02	-------	SDI salida F-101			TB-F101	
FECHA	HORA	Conduct. 20 ºC (uS/cm)	T (Cº)	pH	Redox (mV)	Turb. (NTU)	t1 (s)	t2 (s)	SDI	Frec. (Hz)	Q_{total} (m^3/h)	$P_{entrada}$ (bar)	P_{salida} (bar)	AP (bar)	t1 (s)	t2 (s)	SDI	Turb. (NTU)	Firma operador

  - ✓ Operation ultrafiltration

ACCIÓN B4
Registro: B4_02_Ultrafiltración N°: _

$AP = P_{entrada} - P_{salida}$ $SDI = (1 - t1/t2)/15 \cdot 100$

		ULTRAFILTRACION (F-103)											LÁMPARA A-	DEPÓSITO ULTRAFILTRACION				
		PT-F103			FI-F103-01	FI-F103-02	FT-F103	$Q_2 = Q_{tot} - Q_1$	XPI-V101	SDI agua UF			UV cabezal	pH-B102		ORP-B102	C-B102	
FECHA	HORA	$P_{entrada}$ (bar)	P_{salida} (bar)	AP (bar)	$Q_{F103-01}$ (m^3/h)	$Q_{F103-03}$ (m^3/h)	$Q_{total\ UF}$ (m^3/h)	$Q_{F103-02}$ (m^3/h)	P_{salida} (bar)	t1 (s)	t2 (s)	SDI	Contador (h)	T (ºC)	pH	Redox (mV)	Conduct. 20 ºC (uS/cm)	Firma operador

  - ✓ Operation reverse osmosis and activated carbon

ACCIÓN B4
Registro: B4_02_Ósmosis inversa y carbón N°: _

$SDI = (1 - t1/t2)/15 \cdot 100$ $AP = P_{entrada} - P_{salida}$ $Y = Conversión(\%) = \frac{Q_{permeado}}{Q_{alimentación}} \cdot 100$

						ÓSMOSIS INVERSA (F-202)																				
		BOMBA OI	FILTRO F-201			Entrada			Primera etapa					Segunda etapa				Producción global				FITRO DE CARBÓN (F-103)				
		P-201	XPI-F201-	XPI-F201-	-------	FT-F202-	FI-F202	PT-F202-01-	FT-F202-02	PT-F202-02	-------		-----	-----	PT-F202-01-	AP 01	FT-F202-	C-F202		----	P-103	FI-F203	PT-F203			
FECHA	HORA	Frec. (Hz)	$P_{entrada}$ (bar)	P_{salida} (bar)	AP (bar)	$Q_{1,tot}$ (m^3/h)	Q_{2} (m^3/h)	$P_{entrada}$ (bar)	$Q_{p,1}$ (m^3/h)	$P_{r,1}$ (bar)	$Q_{r,1}$ (m^3/h) = $Q_{1,tot}$ - Q	Y_1 (%)	$Q_{p,2}$ (m^3/h) = $Q_{p,tot}$ - Q	Y_2 (%)	$P_{r,2}$ (bar)	P1-P2 (bar)	$Q_{p,tot}$ (m^3/h)	Conduct. 20 °C	T (°C)	Y_{tot} (%)	Frec. (Hz)	Q (m^3/h)	$P_{entrada}$ (bar)	P_{salida} (bar)	AP (bar)	Firma operador

  - ✓ Operation Advanced Oxidation Processes (AOPs)

			ACCIÓN B4 Registro: B4_02_AOPs Nº: __					Número de programa (Nº Pr.): 1) O3: O3+Filtro carbón F-206 2) O3+UV: O3+filtro F-205 + Lámparas UV + Filtro carbón F-206 3) O3+H2O2: O3+reactivos + Filtro carbón F-206 4) UV+H2O2: reactivos + Filtro F-205 + Lámparas UV									AP= (P_{SALIDA}-$P_{ENTRADA}$)			
			BOMBA P-203		REACTORES			O3		FILTRO DE CARBÓN F-206			FILTRO F-205			LÁMPARAS UV		REACTIVOS		
			P-203	FT-C203	pH-C201		ORP-C201	O3 A201	T	PT-F206			PI-F205-01	PI-F205-02	-------	UV A202	UV A203	AP-101	AP-203	
FECHA	HORA	Nº Pr.	Frec. (Hz)	Q_{total} (m^3/h)	T (ºC)	pH	Redox (mV)	O_3 (mg/l)	T (ºC)	$P_{entrada}$ (bar)	P_{salida} (bar)	AP (bar)	$P_{entrada}$ (bar)	P_{salida} (bar)	AP (bar)	UV (%)	UV (%)	NaOH (L/h)	H2O2 (L/h)	Firma operador

✓ Operation Electrochemical Advanced Oxidation Processes (EAOPs)

										AP= (P_{SALIDA}-$P_{ENTRADA}$)										
												PROGRAMA 1				PROGRAMA 2				
	DEPÓSITO RECIRCULACIÓN B-302				BOMBA ALTA P-302			FILTRO F-301				REACTOR C301		REACTOR C302		LAMPARA A-301	REACTOR C301		REACTOR C302	
	pH-B302		C-B302	TB-B302	P-302		FT-C302	PI-F301-01	PI-F301-02	-------	PT C301	VT C301	IT C301	VT C302	IT C302	UV A301	VT C301	IT C301	VT C302	IT C302
HORA	T (ºC)	pH	Conduct. 20 ºC (uS/cm)	(NTU)	Frecuencia (Hz)	I (A)	Q_{total} (m^3/h)	$P_{entrada}$ (bar)	P_{salida} (bar)	AP (bar)	$P_{entrada}$ (bar)	(V)	(A)	(V)	(A)	(%)	(V)	(A)	(V)	(A)

✓ Operation Repumping and cleanings

				ACCIÓN B4 Registro: B4_02_Rebombeo-limpiezas Nº: __								
		DEPÓSITO RECIRCULACIÓN B-301				BOMBA ALTA P-301						
		pH-B301		C-B301	TB-B301	P-301	PT-P301	FT-P301	PT-F202-01-1	FT-F202-01		
FECHA	HORA	T (ºC)	pH	Conduct. 20 ºC (uS/cm)	(NTU) o Redox	Frec.(Hz)	(bar)	Q_{total} (m^3/h)	(bar)	Q_{total} (m^3/h)	Operación	Firma operador

✓ Verification of some sensors by means of a portable meter.

	ACCIÓN B4 Registro: B4_06_Sondas												
		SCADA	PORTÁTIL	SCADA	PORTÁTIL	SCADA	PORTÁTIL	SCADA	PORTÁTIL	SCADA	PORTÁTIL	SCADA	PORTÁTIL
DEPÓSITO B-101	Conduct. (uS/cm)												
	pH												
	ORP-B101												
	TB-B101												
FILTRO F-101	TB-F101												
DEPÓSITO UF B-102	pH-B102												
	ORP-B102												
	C-B102 (uS/cm)												
	Turbidez (NTU)												
Permeado OI	pH												
	ORP (mV)												
	C-F202 (uS/cm)												
	Turbidez (NTU)												
AOPS	pH-C201												
	ORP-C201												
	Conduct. (uS/cm)												
	Turbidez (NTU)												
EAOPS	pH-B302												
	C-B302 (uS/cm)												
	ORP (mV)												
	TB-B302												
DEPÓSITO B-301	pH-B301												
	C-B301 (uS/cm)												
	ORP (mV)												
	TB-B301												

- B4_03_List of fungibles expenses

ACCIÓN B4
Registro: B4_03_Consumo de reactivos Nº: __

FECHA	REACTIVOS																							
	AP-201				AP-202				AP-101				AP-102				AP-103				AP-301			
	Conc. Antiincrus-tante (%)	Nivel tanque (L)	Consumo (L)	Relleno (L)	Conc. Bisulfito sódico (%)	Nivel tanque (L)	Consumo (L)	Relleno (L)	Conc. NaOH (%)	Nivel tanque (L)	Consumo (L)	Relleno (L)	Conc. HCl (%)	Nivel tanque (L)	Consumo (L)	Relleno (L)	Conc. NaOCl (%)	Nivel tanque (L)	Consumo (L)	Relleno (L)	Conc. H2O2 (%)	Nivel tanque (L)	Consumo (L)	Relleno (L)

- B4_04_Register of incidents during demonstration

ACCIÓN B4
Registro: B4_04_Registro de incidencias Nº: __

REGISTRO DE INCIDENCIAS

FECHA	HORA	INCIDENCIA	TIPO DE INCIDENCIA (MARCAR CON X DONDE CORRESPONDA)							OPERARIO
			HIDRÁULICA	FALLO EQUIPO	SUMINISTRO ELÉCTRICO	SCADA	EDAR	PERSONAL	SOLUCIONADO	

- B4_05_Register of non-fungibles (repairs, acquisitions, etc.) during demonstration

ACCIÓN B4
Registro: B4_05_Registro de no fungibles (equipos, piezas o reactivos- adquisición o reparación) Nº: __

REGISTRO DE NO FUNGIBLES (equipos, piezas o reactivos - adquisición o reparación)

FECHA	CATEGORÍA	CÓDIGO	DESCRIPCIÓN	PROVEEDOR / TÉC. DE REPARACIÓN	SOLUCIÓN/RECEPCIÓN	OPERARIO

- B4_06_Data sheet: Analytical parameters (general parameters and emerging pollutants)

Punto de Muestreo:
Freciencia de Muestreo: 1

X	No hay dato
ND	No Detectado

semana	Fecha	Hora	ND	pH (Ud. pH)	Conductividad 20ºC (µS/cm)	Turbidez (NTU)	SS (mg/l)	1.3-01 Clorpirifós (ug/l)	1.3-02 Trifluralina (ug/l)	1.3-03 Octilfenol (ug/l)	1.3-04 DEHP (ug/l)	1.3-05 Diurón (ug/l)	1.3-06 Isoproturón (ug/l)	1.3-07 Diclofenaco (ug/l)	1.3-08 17alfa-Etinil Estradiol (ug/l)	1.3-09 17beta-Estradiol (ug/l)	1.3-10 Eritromicina (ug/l)	1.3-11 Cloramfenicol (ug/l)	1.3-12 Carbamazepina (ug/l)	1.3-13 Ibuprofeno (Ácido 2-(p- (ug/l)	1.3-14 Hidrocloruro de fluoxetina (ug/l)	1.3-15 Estrona (ug/l)	1.3-16 Sulfatomethoxazol (ug/l)	1.3-17 Ketoprofeno (ug/l)	1.3-18 AMPA (Ácido Aminometilfosfón (ug/l)	1.3-19 Glifosato (ug/l)	1.3-20 Estriol (ug/l)
				parámetros físico-químicos				Contaminantes emergentes prioritarios (Regulados Directiva 2013/39/UE)						Contaminantes emergentes (lista observación Directiva 2013/39/UE)				Contaminantes no regulados									
	Límite cuantificación:			-	-	-	-	0,03000	0,03000	0,30000	1,00000	0,05000	0,05000	0,01000	0,05000	0,00500	0,05000	0,00500	0,05000	0,05000	0,05000	0,00500	0,05000	0,05000	0,05000	0,05000	0,02000
	Límite legislación:			-	-	-	-	0,03000	0,03000	0,10000	1,30000	0,20000	0,30000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								plaguicida	herbicida	fabricación productos limpieza	fabricación productos plásticos	herbicida	herbicida	antiinflamatorio	hormona	hormona	antibiótico	antibiótico	anticonvulsivo	antiinflamatorio	antidepresivo	hormona	antibiótico	antiinflamatorio	herbicida (degradación glifosato)	herbicida	hormona
1																											
2																											
3																											
4																											
5																											

- B4_08_Maintenance operations.

ACCIÓN B4
Registro: B4_08_Registro de operaciones de mantenimiento realizadas Nº: __

REGISTRO DE NO FUNGIBLES (EQUIPOS Y REPARACIONES)

FECHA	HORA	CÓDIGO EQUIPO	EQUIPO	OPERACIÓN DE MANTENIMIENTO	Firma operador

A paper copy that includes the registration sheets B4_01, B4_02, B4_03, B4_04, B4_05 and B4_08 was in the plant. Those sheets were continuously filled with the operation data obtained in the plant by UA, AIDIMME, LTL and CONSOMAR. UA was in charge of collecting these sheets and passing the information to the corresponding EXCEL files.

Registers B4_06 were directly filled in EXCEL format by LTL, with the analytical results of the samples taken (concentration of emerging pollutants and general parameters).

Since the demonstration began, UA was weekly transcribing the information collected in the paper sheets to the EXCEL sheets in the file "B4_Plant Data.xls". This file was shared in Dropbox with AIDIMME, LTL and CONSOMAR. In this file, UA elaborated some graphics to monitor the evolution of the most important parameters of filtration and reverse osmosis processes (ea. reduction of turbidity by the crystal filter F-101; transmembrane pressure in ultrafiltration; conversion, conductivity, pH, temperature, redox, pressure and flow rates in reverse osmosis; pressure drop in carbon filter F-203).

UA and AIDIMME identified the maintenance operations of the filtration and reverse osmosis processes and oxidation processes, respectively, as well as participated in the identification of the maintenance operations of the auxiliary equipment. Maintenance operations were carried out to avoid plant shutdowns due to the breakage of any element or the obtaining of erroneous data that could damage the indicators.

UA elaborated the data sheet "B4_00_Treatment plan.xls". This document contains: a schedule of the processes during the demonstration period (Figure 2), a sampling calendar, and a maintenance schedule with the actions defined by LTL in action B3. UA was in charge of updating this document.

DESCRIPCIÓN	FECHA	DÍA	ESTADO	PUNTOS DE MUESTREO																
				TM INFLUENTE	TM 1	TM 2	TM 3	TM 4	TM 5	TM 6	TM 7	TM 8	TM 9	TM 10	TM 11	TM 12	TM-D	TM-C	TER. UF	TER.-OI
Muestreo visita Comisión Europea	19/06/2018	Martes	Realizada	M	M	M	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arranca muestreo AOPs 1: O3 / Reactores	05/07/2018	Jueves	Realizada	M	M	M	M	M	M	--	--	--	--	SS	--	--	--	--	--	--
	12/07/2018	Jueves	Realizada	M	M	M	M	M	M	--	--	--	M	SS	--	--	--	--	--	--
	18/07/2018	Miércoles	Realizada	M	M	M	--	M	M	--	--	--	M	SS	--	--	--	--	--	--
TM-11 tomado a partir de 26/7/18 por fallo de lámpara UV.	26/07/2018	Jueves	Realizada	M	M	M	M	M	M	--	--	--	M	SS	M	--	--	--	--	--
	30/07/2018	Lunes	Realizada	M	M	M	M	M	M	--	--	--	M	SS	M	--	--	--	M	M
Arranca muestreo AOPs 3: O3 + UV / Reactores	03/08/2018	Viernes	Realizada	M	M	M	M	M	--	M	M	--	M	SS	M	--	--	--	M	M
	07/08/2018	Martes	Realizada	M	M	M	M	M	--	M	M	--	M	SS	M	--	--	--	M	M
	09/08/2018	Jueves	Realizada	M	M	M	M	M	--	M	M	--	M	SS	M	--	--	--	M	M
	04/09/2018	Martes	Realizada	M	M	M	M	M	--	M	M	--	M	SS	M	--	--	--	M	M

Figure 3 Sampling calendar (period shown: July-August)

The more frequent maintenance operations were displacement in RO, backwashing of UF membranes, cleanings (crystal filter, activated carbon filters), change of filter cloths, filling of reagent tanks, verification of probes and measure of the Sludge Density Index (SDI).

Task B4.3 EPs removal analytical campaign

The quality of water was analysed **once a week** following the sampling calendar in the different sampling points. The parameters analysed were the concentration of the selected micropollutants and conductivity, pH, turbidity and concentration of suspended solids.

The concentration of the pesticide AMPA (metabolite of glyphosate) was initially monitored; however, many of the results for AMPA were strange and meaningless. In multiple samples the concentrations after reverse osmosis, activated carbon, AOPs or EAOPs were superior to the inlet effluent without any convincing analytical or procedural reason. Thus, it was decided not to report this compound, because the results were no reliable. Therefore, in action B4, 19 micropollutants were monitored.

The micropollutants monitored were: pesticides (chlorpyrifos, trifluralin, diuron, isoproturon and glyphosate), industrial products (DEHP and 4-octylphenol), pharmaceutical products (diclofenac, erythromycin, chloramphenicol, carbamazepine, ibuprofen, fluoxetine, sulfamethoxazole and ketoprofen), hormones (17-α-ethinylestradiol, 17-β-estradiol, estriol and estrone). It should be noted the analysis of their concentration was complex, due to the low concentration detected for many of those compounds, either in the secondary effluent or in the effluents of the processes carried out in the EMPORE plant.

Due to the presence of priority substances and emerging pollutants, the quality of the secondary effluent of Benidorm WWTP was poor from Jul.18 to Jun.19. The micropollutants trifluralin, 4-t-octylphenol, 17-α-ethinylestradiol, 17-β-estradiol, chloramphenicol and estriol were never detected in the secondary effluent. Nevertheless, there were others intermittently detected, such as estrone, ibuprofen, ketoprofen, chlorpyrifos and isoproturon. It is worth noting that DEHP and chlorpyrifos were detected in some samples at concentrations superior to the Directive 2013/39/EU threshold (1.3 and 0.030 $\mu g \cdot L^{-1}$, respectively). Conversely, the pharmaceutical products fluoxetine, carbamazepine and sulfamethoxazole and the pesticide glyphosate were continuously detected in the secondary effluent during the demonstration with concentrations in the range of 0.028-0.087 $\mu g \cdot L^{-1}$, 0.180-2.68 $\mu g \cdot L^{-1}$, 0.120-2.97 $\mu g \cdot L^{-1}$ and 0.065-3.02 $\mu g \cdot L^{-1}$, respectively. The quality of this effluent was also poor due to the high presence of salts as its conductivity indicates (2500-3500 $\mu S \cdot cm^{-1}$).

The pre-treatment (conventional filtration followed by ultrafiltration) had a small contribution to the removal of microcontaminants since, as evidenced by the removal efficiencies achieved, part of these compounds was associated with suspended matter and were eliminated in the concentrate stream. The pore size of ultrafiltration membranes (0.03 µm) is greater than the molecular weight of the micropollutants studied, which allows them to pass through. It dares highlighting that chlorpyrifos was associated to the suspended matter and was derived to the concentrates in the pre-treatment. The average removal efficiencies reached by this step for the period Jul.18 to Jun.19 were low (0 - ~50%) for diuron, diclofenac, erythromycin, carbamazepine, sulfamethoxazole, glyphosate, ketoprofen, fluoxetine, DEHP, isoproturon, estrone and ibuprofen.

Conversely, the reverse osmosis unit showed exceptional micropollutant removal efficiency. The RO unit produced high-quality permeates, almost free of micropollutants and with low conductivity (< 200 $\mu S \cdot cm^{-1}$). The occasional traces of glyphosate, sulfamethoxazole, diclofenac and carbamazepine detected in permeates were removed by activated carbon. After the processes of reverse osmosis and activated carbon, none of the 19 micropollutants was detected during the demonstration period in Benidorm WWTP, and therefore, it was not possible to evaluate the effectiveness of the advanced oxidation processes (AOPs) in this WWTP.

The objectives of the project are analysed comparing the concentration of each micropollutant in the influent of the DEMO plant (secondary effluent) with the concentration in the effluents of the line of permeates. For most compounds, the objectives were complied after the combination of technologies Pretreatment+Reverse Osmosis. The concentrations of all priority substances detected in the secondary effluent of Benidorm WWTP (chlorpyrifos, DEHP, diuron and isoproturon) were reduced below the annual average environmental quality standard (AA-EQS) of Directive 2013/39/EU. The average concentrations of the pharmaceutical compounds erythromycin, ibuprofen, fluoxetine, estrone and ketoprofen were reduced by 99% of their original concentration. After the subsequent filtration by Activated Carbon, the average concentration of the pharmaceutical compounds diclofenac, carbamazepine and sulfamethoxazole and the pesticide glyphosate were reduced by 99% of their original concentration.

In conclusion, the combination of technologies Pretreatment (conventional filtration followed by ultrafiltration)+Reverse Osmosis is successful in removing most of the micropollutants studied. If traces are detected, subsequent treatment with Activated Carbon can remove them. In general, there was a good correlation between the removal efficiencies reached by the ultrafiltration and reverse osmosis units of EMPORE pilot plant and IRAD Benidorm (full-scale plant), which supports the extrapolation of the technology to a large-scale level, as it is detailed in action B7.

As it was expected, after the membrane processes in EMPORE plant, both micropollutants and salts (conductivity: 6000-8000 $\mu S \cdot cm^{-1}$) were concentrated in the rejections. These effluents were sent to the electro-oxidation unit (line of concentrates) in order to remove the micropollutants present (isoproturon, chlorpyrifos, ketoprofen, ibuprofen, estrone, diuron, glyphosate, diclofenac, erythromycin, carbamazepine, fluoxetine and sulfamethoxazole).

In general, there was a good correlation between the removal efficiencies reached by the ultrafiltration and reverse osmosis units of EMPORE pilot plant and "Instalación de Regeneración de Aguas Depuradas" (IRAD) Benidorm (full-scale plant), which supports the extrapolation of the technology to a large-scale level, as it is detailed in action B7.

The UV treatment was not efficient due to the low quality of the concentrates (high turbidity, high presence of salts and presence of SS); the transmittance was poor and it was decided to apply directly electro-oxidation. The electro-oxidation was carried out using a fixed intensity of 10 A and only 1 pass through the reactor cells. The efficiency of this process was different depending on the compounds. There were micropollutants highly removed, with mean removal efficiencies above 60-90%, such as glyphosate, isoproturon, estrone and ketoprofen. Others were partially removed, with mean removal efficiencies above 35-60%, such as sulfamethoxazole, diclofenac, erythromycin, ibuprofen and chlorpyrifos. And finally, there were micropollutants slightly removed, with mean removal efficiencies < 35%, such as diuron, carbamazepine and fluoxetine.

The objectives of the project are analysed comparing the concentration of each micropollutant in the UF/RO concentrates with the concentration in the effluents of the line concentrates. The priority substances diuron and isoproturon detected in the UF/RO concentrates generally complied with their reduction below the annual average environmental quality standard (AA-EQS) of Directive 2013/39/EU after the treatment by electro-oxidation. This objective was not achieved for chlorpyrifos. After the electro-oxidation, the average concentrations of the pharmaceutical compounds diclofenac, erythromycin, carbamazepine, ibuprofen, fluoxetine, estrone, ketoprofen and sulfamethoxazole and the pesticide glyphosate were not reduced by 99% of their inlet concentration. However, it is worth noting that the removal efficiencies were high for glyphosate, ketoprofen and estrone.

Probably, the contact time and/or the current applied was insufficient to completely remove those compounds. Nevertheless, the quality of the electro-oxidation effluents was often greater than the quality of the secondary effluent regarding the presence of micropollutants, as it is shown in the report of action C1. Future tests could be carried out increasing the applied current and the contact time.

As a general conclusion, it can be stated that there is no single treatment capable of removing micropollutants from secondary effluent of WWTPs. The results confirm that the selected methodology, in the line of permeates combination of a pretreatment (conventional filtration followed by ultrafiltration) with a reverse osmosis unit, allows to produce high-quality effluents, almost free of micropollutants. A posterior filter with activated carbon ensures the removal of traces of some remnant compounds. In the line of concentrates, the electro-oxidation improves the quality of the rejections, reducing the discharge of micropollutants to the environment.

- **Schedule:**

The start of the demonstration period (action B4) was delayed due to problems arising in the set-up of the plant during action B3, especially due to the automation. The starting date of the demonstration period was in 07/2018, and, the completion date was 06/2019. During the following months, different maintenance operations were carried out in the plant and the information was compiled and analysed to prepare the deliverables. The final report was completed in 12/2019.

- **Deliverables:**

An internal deliverable with results obtained during the operation of the plant from July to October 2018 and the information of the data sheets was elaborated in December 2018 (Deliverable B4.01).

According to the project plan, different deliverables should have been elaborated, but, the coordinator of the action, UA, considered more practical to include all the information in a final deliverable "Deliverable B4.01. Demonstration in Benidorm WWTP. Final report: Analyses of results" (12/2019). The theorical deliverables are included as sections in that deliverable:

- Register of power consumption during demonstration (annex 4)
- Final report: Analyses of results (deliverable B4.01 and its annex 5 and annex 9)
- Compilation of data sheets (register) corresponding to the different analyses carried out (ea. DBO5, COD, turbidity, EPs…) (annex 2, annex 3 and annex 5)
- List of non-fungible expenses (reparation/replacement of equipments) (annex 8)
- List of fungible expenses (fillers, reactives, etc.) (annex 6)
- Register of incidents during demonstration (annex 7)

Action B5. Definition of the methodology for Emerging Pollutants removal in WWTPs

Beneficiary responsible		Status
LTL		Completed
Time schedule per Annex I	Starting date	End
10 months	01/2019	10/2019
Real time schedule	Starting date	End
10 months	01/2019	10/2019

- **Objective:** The aim of this Action is to obtain a common methodology for the best technical and economical solution for the removal of the studied pollutants.
- **Progress**

Task B5.1. Evaluation of the results gained during Analytical Action and Demonstration Action.

For the achievement of this action, in addition to the use of the results of Action 1, there were employed the outputs of the following actions:

- Action B1, after which are been characterized and quantified the emerging pollutants and the emerging pollutants, together with their yearly variability, at Benidorm WWTP.
- Action B4, after which the best solution for the removal of the emerging pollutants and was obtained.

Task B5.2. Processing of results.

All the information above was processed and analysed for each unitary process and for the global configuration studied in order to obtain the following:

- Analytical performance of each industrial/agricultural pollutant and each emerging pollutant, and analytical parameter control analysed.
- Energy rates.
- Energy reagents consumption.
- Summary of maintenance and operation costs.

This final deliverable summarizes the most effective technology for removing emerging pollutants included in the project. The results are presented for each individual pollutant. In first place priority emerging pollutants are present, then “watch list” emerging pollutants and finally not regulated emerging pollutants. The data necessary to elaborate this deliverable have been obtained by LTL, UA, AIDIMME and CONSOMAR.

Before presenting the individual results per contaminant, the results show the annual average of the detected EP’s in the secondary effluent of Benidorm WWTP. These EP’s are represented by two different graphs corresponding to the continuously detected pollutants from the occasionally detected pollutants in this secondary effluent, as well as, the different technologies for eliminating them.

The results have been analysed pollutant by pollutant. The pollutants have been classified according to their use (agriculture / industry / pharmacy) and a brief description of the pollutants is shown, in addition to classifying them as a priority, “watch list” or not regulated pollutant. The GHS (Global Harmonized System) hazards statements of these pollutants have also been shown.

To analyse the results of the measured concentrations in the effluents of the tested technologies in the permeate line, the most related physical-chemical properties of the compounds with the membrane technologies are described in tables and the 2D chemical structure of the compounds has been drawn.

The results of electrochemical advanced oxidation process (EAOP’s) applied to the concentrate line resulted of the rejections of UF and RO processes were presented. The percentage of elimination by EAOP’s of the EP’s detected in WWTP effluent of Benidorm that remained in the rejection of UF and RO processes are represented in two bar diagrams.

The last part of the results shows the energy consumption of the entire plant and of each of the technologies tested in the project, in order to analyse the cost of each of them.

The operational control elements of each technology and the arisen difficulties during the performance of the project are added as annexes, as well as possible corrective measures to reduce these problems.

Task B5.3. Final report with results and conclusions.

The main conclusions are the following:

1. The conventional filtration plus ultrafiltration (UF) treatment removed scarcely the emergent pollutants (EP’s), except for chlorpyrifos, that was completely removed. The hydrophobicity of this compound allows its removing by membrane technologies.
2. An effluent of high quality was obtained from reverse osmosis (RO) during the demonstration period. In this effluent, only traces of the compounds glyphosate, carbamazepine, diclofenac and sulfamethoxazole in a few specific samples were detected
3. The filtration by activated carbon of the effluent from RO removed the traces of the above mentioned EP’s. Therefore AOP’s processes were unnecessary.
4. The rejections or concentrates of UF and RO processes contained several EP’s such as diclofenac, glyphosate, fluoxetine, among others. The elimination efficiencies of the electrochemical process (EAOP) were diverse, depending on the nature of the compounds, being significant for compounds such as glyphosate.
5. The proposed methodology allows for the elimination of priority substances and other EP’s present in the WWTP effluents, reducing the environmental impact of the discharge of these effluents into the aquatic environment.
6. The ratios of energy consumption of reverse osmosis process were slightly smaller than those corresponding to EAOP’s process. Therefore, given its high removal efficiency and cost-effective action, reverse osmosis is a sustainable methodology for Emerging Pollutants removal in WWTPs.

- **Problems encountered and deviations:** No problems neither deviation encountered.
- **Schedule:** The deliverable was done in due time according to the schedule.
- **Deliverables:** B5. Emerging Pollutants WWTPs methodology removal.

Action B6. Transferability of the methodology for Emerging Pollutant removal

Beneficiary responsible		Status
UNESCO-IHE		On-going
Time schedule per Annex I	Starting date	End
3 months	04/2019	06/2019
Real time schedule	Starting date	Expected End
18 months	01/2018	06/2019

- **Objectives:** This action is necessary to guaranty the replicability and transferability of the project actions, mainly the methodology for emerging pollutants removal action.
- **Progress:**

Action was started earlier than foreseen considering the following circumstances: developing a complete decision support system (DSS) for transferring the action to other regions may take more time than planned, taking the advantage of IHE Delft (UNESCO-IHE) master student's calendar, and also considering that that since January 2018 the results of the reports corresponding to stage A1 "Evaluation of the situation on priority and emerging pollutants in Europe" and B1 "Characterization of water samples for the WWTPs" have been reviewed and already available. Those reports are the key inputs for the development of this action. In addition, progress has been made in the literature review.
It is for this purpose that the conception and development of a methodology for evaluating the feasibility of applying treatment technology to other localities is being carried out. The methodology for evaluating the feasibility of applying the treatment technology to other WWTPs in Europe was set to be carried out based on a DSS.
Due to the connection with other actions, IHE Delft has started collaborating with UA and CONSOMAR in order to collect information required for the DSS development.
Moreover, one of the activities carried out to better synchronize the actions was the visit to Delft by representatives of all the institutions involved in the project in April 2018. During this visit to Delft, in addition to holding meetings to discuss specific aspects of the project, a seminar was held on the particularities of the project.

The architecture of the DSS model has been done based upon three steps: (i) Input of the information, (ii) screening step and (iii) evaluation step. It has been set screening and evaluation criteria, and for the later the associated indicator.

Screening criteria:

1. Known issues of EPs in the WWTP
2. Existence of secondary treatment as a minimum level of treatment*
3. Power supply availability
4. Different source of wastewater contribution other than domestic
5. Need for reuse
6. Wastewater discharged into a water body
7. The effluent discharges upstream a DWTP
8. Sewage sludge management
9. Existence of a local Regulation or Policy regarding EPs

Evaluation criteria:

1. Capital and Operative Expenditures (Indicator: unitary water production cost [€/m^3])
2. Need for reuse (Indicator: Water exploitation Index [%])
3. Social perception (Indicator: Water pollution perceived by Europeans as the main environmental issue [%])
4. Environmental impact of the discharge (Indicator: water body indicator predicted environmental concentration [µg/L])
5. EPs occurrence frequency (Indicator: Occurrence[-])

It has been done an extensive literature review, which justifies each evaluation and screening criteria of the evaluation step.

The results of the reports corresponding to action A1 "Evaluation of the situation on priority and emerging pollutants in Europe" is an input of evaluation criteria number 5, and action B1 "Characterization of water samples for the WWTPs" have been reviewed, and is used (along with further literature review) to establish screening criteria number 2 of minimum level of treatment before the advanced technology.

- The DSS was programmed in Microsoft Visual Basic. That is, as an outcome of this action a software was developed on a user friendly platform; this outcome exceed the deliverables commitment when planning the action. However, we think it will provide decision makers with a more solid and reliable tool to explore the possibilities for transferring the evaluated and validated technolgogy. Several possible locations were evaluated including two cities in Croatia, the city of Delft in The Netherlands (with the contribution of a big hospital) and the project site city of Benidor. These examples cover a wide range of treatment capacities, technologies, and local characteristics. For instance, the treatment capacity ranges from 43,500 PE in Koprivnica Croatia, to 1,430,000 PE in Zagreb, Croatia. The facilities from Croatia and The Netherlands do not exhibit a strong need for water reuse; however, the facilities in Spain highly appreciated reusing the treated wastewater. The treated wastewater in Croatia is discharged into rivers, while the treated wastewater in The Netherlands and in Spain are conducted to the sea. Moreover, the case study in The Netherlands (Harnaschpolder case study) includes the contribution of wastewater from a large hospital located in the city of Delft. Figure 4 below shows the wastewater treatment plant in The Netherlands (Harnaschpolder) receiving the wastewater discharge of the large local hospital in the city of Delft. Anyhow, having the software tool developed makes it extremely easy to evaluate several other cities simultaneously.

Figure 4 – Delft hospital discharge to the Harnaschpolder wastewater treatment plant

- **Schedule:** As already introduced, this task has started before than expected in order to coordinate it with the participation of students from The IHE Delft Master's Program which ends in April 2019. The action was entirely finalized

- **Deliverables:**

Deliverables as in the action B6.

Moreover, the consortium has positively considered the option of putting to the public the questionnaire linked to the developed decision support system and related software, thorough the project's website.

Action B7. Economic feasibility analysis

Beneficiary responsible	Status	
AIDIMME	On going	
Time schedule per Annex I	Starting date	End
8 months	01/2019	08/2019
Real time schedule	Starting date	End date
10 months	01/2019	12/2019

Objectives: Action B7 includes work to economically validate the methodology, confirm its potential national and international market, and know the environmental impacts.

Progress: This action began in 01/2019, and, its completion date has been in December 2019.

Task B7.1 Economic viability of the proposed methodology/s

The goal of Task B7.1 is to "Determine the cost in €/m3 of treated water, using the methodology developed in the project".

Based on the EMPORE methodology determined with the development of Action B4, where three levels of treatment are proposed, with the splitting of the secondary effluent into two streams, a main stream free of priority pollutants (70% of the effluent) and a second concentrated stream, with a quality similar to the input to EMPORE (30% of the effluent input to EMPORE), AIDIMME proposed the task of specifying the equipment, works and facilities required for the implementation and operation of EMPORE on the effluents of a full-scale WWTP.

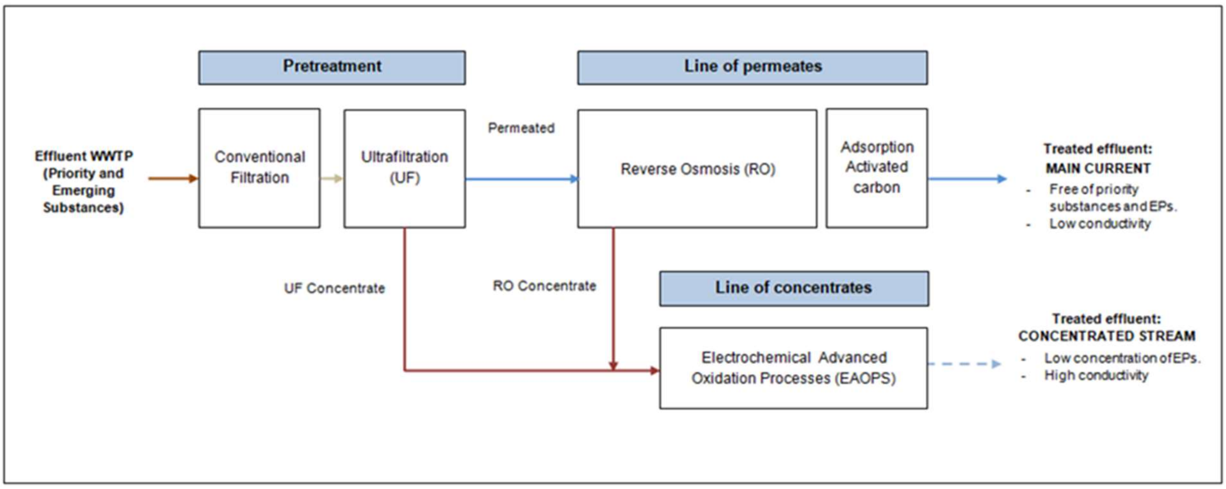


Figure 4 Conceptual scheme of EMPORE plant.

For the scaling of the technologies involved in EMPORE, as a tertiary treatment, a processing capacity of 35,000 m^3/day was established. The size is due to the fact that it represents the scale of a tertiary treatment for a medium sized treatment plant, directly transferable to urban centres of the same range and coincides with the flow processed in the tertiary treatment of the Benidorm plant (33,000 m^3/day), being able at all times to contrast the scale with reality.To carry out the economic/financial feasibility study of EMPORE, two chapters were developed; Costs and Revenues.

Below are some tables summarizing the investment costs / execution of works and operating costs and annual maintenance of the plant.

A) Material Execution Budget, PEM

Concept	Cost(€)
Civil Works	2.973.151,48
Mechanical Equipment	11.892.605,90
Electrical equipment	1.308.186,65
Health and Safety	178.389,09
Budget for improvements	237.852,12
Budget for plant tests	178.389,09
TOTAL	**16.768.574,32**

B) Contractual performance budget, PC

Concept	Cost(€)
Budget for material execution	16.768.574,32
19 % PEM Overheads and Industrial Profit	3.189.029,12
TOTAL Contractual execution budget	**19.954.603,44**

C) Other costs

Concept	Cost(€)
10 % VAT to PCI	1.995.460,00
Architect fees (9% PEM)	1.509.172,00
VAT (21 % architect's fee)	316.926,00
Health and safety fees (3% PEM)	503.057,00
VAT (21 % health and safety fees)	105.642,00
Building permit (4.5% PC)	897.957,00
TOTAL	**5.328.214,00**

TOTAL A+B+C	**25.282.817,93**

Figure 5 Investment costs

Operating costs/expenses

Concept		Cost (€)
Fixed Costs	Maintenance and repairs	65.395,06 €
	Electricity (power + consumption)	1.766.615,62
	Reagents	316.722,93
	Staff (6 technicians)	211.055,66
	Miscellaneous (5,3 % M,P,E,R)	125.084,73
	FIXED COSTS	**2.484.910,74**
	GG+BI 19% (CF)	472.135,56
	Financial expenses (1)	1.265.684,64
	Amortization (10 years)	2.531.369,28
	% depreciation (10 years)	0,10
TOTAL FIXED COSTS		**6.754.113,46**
Varible Costs	Purchases of consumables	240,00
	Other expenditure (training 0,14 % of staff)	294,48
TOTAL VARIABLE COSTS		**545,48**

Costs por m3

Year of entry into operation	Enero 2021
m3/day invoiced (m3/day)	35.000,00
No. of days operation (days)	365,00
Production capacity (m3/year)	12.775.000,00
Maintenance cost m3 produced ('/m3)	0,19

Figure 6 Operating costs/annual maintenance

Two options were considered for the calculation of revenues based on the income that EMPORE can generate through the application of tariffs and charges, as provided for in the Water Framework Directive. The options worked with were

OPTION A: To tax consumption with a fixed charge that would be given by the operating and amortization costs of the technology (during the amortization period) and income from sanctions.

OPTION B: To tax consumption with a fixed charge that would be given by the operating and amortization costs of the technology (during the amortization period), to tax the reuse directly to the consumers of the processed water with EMPORE (irrigators) and income from sanctions.

Finally, the economic feasibility study is carried out to check the possibility of recovering the investment and maintenance costs of EMPORE through the income provided by the proposed options and the following conclusions are drawn:

- The operation of the EMPORE methodology involves a cost of 0.19 euros/m3 calculated on the basis of operating costs and treatment capacity.

The economic feasibility study developed in deliverable B7.1 concludes:

- Option B provides economic benefits and is a clear example of sustainable consumption and therefore optimal use of existing resources.

- Option B differs clearly from Option A, in that 70% of the treated water is reused for agricultural irrigation and other uses. This option, apart from providing economic benefits, is a clear example of sustainable consumption and therefore optimal use of existing resources.
- With option A, the costs are covered, and the plant is depreciated.

- The facilities would start to be amortised after 10 years (option A) and in the case of option B after 5 years thanks to the benefit obtained from the water reuse tax.
- The difference lies in the fact that in option A the consumer is taxed, the water treatment with EMPORE, in the sanitation fee on consumption and in option B, the consumer is taxed, the water treatment with EMPORE, in the sanitation fee on consumption and the irrigator for the reuse and distribution of the treated water.
- The final costs of the water (consumer) will vary depending on the establishment of rates and those reflected in deliverable B7.1, are always those calculated in the worst-case scenario, i.e. in those in which the methodology has to be installed completely.

After the evaluation of the financial indices (NPV, IRR) listed in deliverable B7.1 it can be stated that the two options are technically valid, although economically only option "B" is profitable. The following is an example of the costs that the application of EMPORE with a treatment capacity of 35,000 m3/day on the secondary effluent of a WWTP could entail for the consumer and/or irrigator.

Table 1. Example of total cost of EMPORE on consumer and/or irrigator

OPTION	Sanitation fee (1)	EMPORE treatment fee (2)	EMPORE reuse fee(3)	Total (4) (€/m3)	Return On Investment, (years)
B.1	0,412	0,509	0,410	1,331	5,18
B.2	0,412	0,509	0,410	1,331	5,20
B.3	0,412	0,509	0,100	1,021	7,51

(1) Sanitation fee[3] = a fee currently applied by EPSAR to all consumers and therefore applied to consumption (section 10,001-50,000 p.e) for management, distribution and treatment expenses of wastewater (euros/m3).
(2) EMPORE treatment fee = fixed fee on water consumption, by EMPORE application after WWTP (euros/m3).
(3) EMPORE reuse fee = fixed fee on the consumption of water treated with EMPORE, for the reuse of quality water (euros/m3 reused).
(4) Total: total to be paid by the consumer who reuses water treated with EMPORE.

The difference between Options B1, B2 and B3 lies in the "Total" and in the return period (ROI):

- In Option B.1: there is income from: 1) the WWTP treatment fee, 2) the EMPORE treatment fee, 3) the fee for reusing water treated with EMPORE and sanctions for non-compliance with quality regulations. The investment in the installation is recovered in 5.18 years.

[3] Sanitation fee (Canon saneamiento in Spanish): applied by EPSAR (Community of Valencia, 2019) for water management, distribution and treatment, on the consumption corresponding to the section of 10,001-50.000 p.e is 0.421 euro/m3, plus an annual service fee of 43.81 euro/year.

- Option B.2: there is income from: 1) the EMPORE treatment fee, 2) the EMPORE treatment fee and 3) the fee for reusing water treated with EMPORE. The investment in the installation is recovered in 5.20 years.
- Option B.3: there is income from: 1) the WWTP treatment fee, 2) the EMPORE treatment fee and 3) a low EMPORE treated water reuse fee (0,100 euros/m3). The investment in the installation is recovered in 7.51 years.

Currently, in the Valencian Community, EPSAR applies a fixed tariff on consumption, called the SANITATION CANON (for water management, distribution and treatment). Specifically in the 10001-50000 p.e range, this fee represents 0.412 euros/m3 for the taxpayer, plus an annual service fee of 43.81 euros/year. In the event of implementing EMPORE, the consumer could end up paying a total of nearly 0.921 euros/m3, applied on consumption, as opposed to a total of 1.331 euros/m3 that an irrigator would end up paying for reused water, always in the most unfavourable scenario.

Task B7.2 Economic analysis of the implementation in WWTP in EU and national level (transferability of the results)

Action B7 includes two different works to economically validate the methodology and confirm its potential national and international market. On the one hand, AIDIMME carried out an economic study of the implementation of the EMPORE methodology on a real scale and determined the cost (EUR/m3) of its implementation (deliverable B7_01).

On the other hand, and to complete the economic study and validation of EMPORE at scale, in task B7.2 AIDIMME conducted a study aimed at understanding the potential users, of the proposed methodology for the elimination of emerging pollutants (CECs), at national and international level.

Key to this task was the tool developed in Action B6 "Methodology developed for the transfer of EMPORE to other parts of the European Union through a Decision Support System (DSS)".

The work carried out in B7.2 has been key to understanding the magnitude of the transfer of EMPORE to EU countries with emerging problems, which have secondary treatment and are consistent with the application of water quality regulations applied to EU member states.

In the development of task B7.2, the following points were given content:

- Identification of the countries detected in preparatory phases (A1) with the presence of emerging pollutants.
- Identification of the main technical conditioning factors for the implementation of EMPORE.
- Identification of the main economic determinants for the implementation of EMPORE.
- Identification of the main legal constraints.
- Transferability Tool. Application criteria and criteria for evaluation. Results obtained in B6.
- Private sectors using EMPORE.

The most relevant conclusions reached with the work carried out were the following:

- The EU Member States reported 23 510 cities/agglomerations with more than 2000 p.e., which generated 604 million p.e. of wastewater load (2016).
- In total 76.0 % of the EU-28 territory applies or has to apply more stringent treatment according to Article 5 of Directive 91/271/EEC on urban wastewater.

- The list of facilities with operational secondary treatment and with special attention to the facilities with "more stringent treatment" can be interpreted as facilities with highly sensitized administrations, which have technologies and/or equipment integrated in EMPORE and therefore facilities where it may be easier to transfer the EMPORE methodology.
- The magnitude of the sector and therefore users of EMPORE in the pharmaceutical manufacturing sector in Spain alone involves 353 companies (2016). The countries with the largest number of pharmaceutical laboratories in Europe are Germany, France and Italy, with 304, 255 and 186 laboratories, respectively.
- The DSS software developed in Action B6 (Decision Support System), has proved to be a useful tool for analysing the transferability of meteorology taking into account the characteristics of the country and specific location analysed.
- The development of the DSS to assess whether the EMPORE methodology is transferable to different locations in the European Union will allow potential users to be identified and the viability of the methodology to be evaluated. With the DSS it is possible to evaluate the transferability of EMPORE in the WWTPs being these the main user of the methodology.
- From the study of the results obtained from applying the DSS tool on four scenarios, corresponding to four WWTPS in Europe (2 in Croatia, 1 in Spain, 1 in Holland), it can be seen that the capacity of the installation seems to be, together with the cost of water production (euros/m3), the determining parameters in the viability of the technology, since it is a strong economic indicator in the evaluation.
- Parameters such as the treatment received in the WWTPs, sludge disposal, place of discharge of the treated effluent and social perception have a similar weight and perhaps not so determining in the final result of the transferability assessment with the DSS tool.
- From the point of view of profitability, the commercialisation of this reclaimed water for irrigation purposes is not a driving force, unless there is a change in European guidelines and water policies, regarding the objective of applying treatments "on the water consumed and transformed by use, into wastewater", in the sense of not treating the water to purify the discharge, but using and returning the water with the same quality as it had before its use.
- With other scenarios such as hospitals, nursing homes, companies in the chemical, pharmaceutical/veterinary and plastics sectors, etc., the steps to be followed would be the same. Once the private or public facilities have been identified, the tool would be applied and for this purpose the specific parameters requested by the transferability tool would be introduced and the viability of the transfer would be evaluated. In the private sector, the economic criterion can again be a strong motive in the decision, i.e. the comparison between the final cost of the water treated with EMPORE (€'/m3) and the price that the user is willing to pay and/or is paying (treatment, drinking consumption).
- The international quality and environmental standards (ISO 14000) as well as the implementation of environmental management systems and the adoption of Environmental Declarations (EMAS) have become strategic tools for the social and economic development of many companies, as they express their environmental behaviour and responsibility towards the environment. The implementation of EMPORE as a methodology to improve the quality of the discharge is an environmental objective to be considered by all these companies that generate discharges with the presence of priority and emerging species.

Task B7.3 Life Cycle Analysis

Task B7.3 includes the "Life Cycle Analysis" of the EMPORE methodology applied to the effluent of a wastewater treatment plant with secondary treatment, on a flow of 35,000 m3 /day and based on the concentration of controlled substances in the input flow and the effluent leaving EMPORE.

The life cycle analysis is a tool normally used to know which is the environmental impact per unit of product/process and to be able to compare it with similar products/processes. An inventory of inputs and outputs to the different phases of the process is made and the importance of the potential environmental impacts is evaluated using the results of the inventory made. In general, this process involves associating data from the inventory with specific environmental impacts. The results obtained are compared with other studies, solutions, or products that fulfil the same purpose or have the same performance and from the result of the comparison decisions are made to improve the results and reduce the impact.

In order to perform Task B7.3 "Life cycle analysis", AIDIMME had to prepare the life cycle inventories and model the information for input into the specialised SimaPro 8 software. AIDIMME, has been compiling and converting information (operational process parameters, reagent data sheets, consumables, energy), results of analysis of physical/chemical parameters and pollutant species selected in the Project, both of the unit processes and of the complete treatment, after identification of the EMPORE methodology (action B5).

The methodology used by SimaPro for the life cycle impact assessment (LCIA) is ReCiPe. The main objective of the ReCiPe method is to transform the long list of results of the prepared life cycle inventory into a limited number of indicator scores. These indicator scores express the relative severity of an environmental impact category. In ReCiPe, indicators are determined at two levels:

- 18 mid-point indicators
- 3 final indicators that can be added in a single final indicator

For this study, the midpoint and endpoint methodologies were used to give a single value that determines the impact or degree of pollution of the modelled scenario.

The result of applying the methodology to the EMPORE scenario was:

> **Scenario**: Flow 35,000 m3/day, average annual load of the secondary effluent from the Benidorm WWTP on which the presence of 20 species is assessed (See deliverable B7.3).
>
> **Score obtained from the EMPORE scenario**: 1,084 kPt

This value -1,084 kPt represents a reference of environmental impact to be compared with the impact produced by any other technology applied to the same scenario and with the same purpose, elimination of traces of priority and emerging pollutants.

The global impact of EMPORE is burdened by energy consumption which represents about 83.8% of the process impact of the process and by the consumption of reagents involved in maintenance in the process itself.

It is likely that the use of alternative energies, which can replace the conventional energies considered in the methodology used, due to their lesser polluting effect, or fundamentally due to their possibility of renewal, can provide lower impact rates in the near future in the EMPORE scenario.

Perhaps the LCA methodology is not the most suitable for assessing emerging processes that require a commitment that goes beyond the application of current regulations, among which there are no limits for all the species that appear and/or potential effects of many species that are daily dumped into the water and land and that ecosystems are probably not capable of metabolizing and assimilating without leaving a footprint.

Schedule: As a result of the delay in completing the demonstration and methodology definition actions (B4 and B5), the tasks under Action B7 were slightly delayed in relation to the planned timetable. The action and its deliverables were finally completed in December 2019.

- **Deliverables:**

  - B7.01 Business plan.
  - B.7.02 Market Analysis: applicability on national and EU level.
  - B.7. 03 LCA Study.

Action B8. Legal feasibility analysis.

Beneficiary responsible		Status
UA		On going
Time schedule per Annex I	Starting date	End
8 months	01/2019	08/2019
Real time schedule	Starting date	Expected End
10 months	01/2019	10/2019

- **Objectives:** detection of the legal and regulatory regime and the possible obstacles to carry out the implementation of the methodology developed for the in-situ removal of emerging pollutants at European level
- **Progress:** This action began in January 2019, and it finished in December 2019.

Task B8.1. Identification of the Community rules applicable to emerging pollutants removal.
In this task, UA identified the current legal EU framework regarding the occurrence of emerging pollutants in water and its transposition to the Spanish legislation.

The main Community rules regarding the presence of pollutants (some already repealed) applicable to river basin management, drinking water management and urban wastewater management and the corresponding transposition regulations to the Spanish legislation were listed and described in Deliverable B.08. Some of the European directives are cited below.

In **river basin management**, it is essential to mention Directive 2000/60/EC. This directive establishes a common framework for Community action in the field of water policy with the aim to reach good ecological status in every EU water body. The framework directive established a list of 33 priority substances. Posteriorly, Directive 2008/105/EC set the environmental quality standards (EQS) for those priority substances and certain other pollutants. Directive 2013/39/EU updated the list to 45 priority substances and also included the Environmental Quality Standards for the incorporated substances. In addition, Directive 2013/39/UE purposed the elaboration of a first watch list of substances for monitoring at Union level. The first watch list was published by Decision 2015/495, which was repealed by the second watch list published by Decision 2018/840/UE.

In **drinking water management**, Directive 98/83/CE, "Drinking Water Directive", concerns standards for water intended for human consumption in the European Union, establishing: a) parameters and parametric values (microbiological, chemical and indicators) required for that destination (annex I); b) monitoring (annex II); c) specifications for the analysis of the parameters. Its objective is to protect human health from adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean. It is worth noting, that in the recent "Proposal for a Directive of the European Parliament and of the Council on the quality of water intended for human consumption (recast)" the terms endocrine disruptors (β-estradiol, bisphenol A and nonylphenol), disinfection byproducts (chlorate, chlorite and haloacetic acids), microcystin, PFAS and uranium have been included as chemical parameters respect to Directive 98/83/CE.

In **urban wastewater treatment**, Directive 91/271/CEE establishes the requirements for discharges from urban wastewater treatment plants considering the parameters chemical oxygen demand, chemical oxygen demand and total suspended solids. In sensitive areas which are subject to eutrophication, this includes nutrients total phosphorus and total nitrogen. However, this directive and Directive 98/15/CE don't regulate the elimination of emerging pollutants in WWTPs.

There is a lack of a policy framework for water reuse that regulates emerging pollutants. Only the recent proposal "Proposal COM (2018) 337 final 2018/0169(COD)" focused on the use of reclaimed water for irrigation, set that when necessary and appropriate to ensure sufficient protection of the environment and human health, specify requirements for water quality and monitoring will be considered, such as the environmental quality standards for priority substances and certain other pollutants laid down in in Directive 2008/105/CE.

The lack of a policy framework for wastewater treatment and water reuse regarding micropollutants hinders the implementation of removal technologies such as the proposed by EMPORE methodology. Future regulations in the European framework should include quality standards for micropollutants in the effluents of wastewaters. In case of reuse, new regulations should focus on different uses of reclaimed water and set quality standards for micropollutants.

Task B8.2. Analysis of the main obstacles and barriers detected in the implementation of emerging pollutants removal technologies.

In this task, UA identified the main obstacles and barriers detected in the implementation of emerging pollutants removal technologies, with the collaboration of EMPORE partners.

Several obstacles can inhibit the adoption of the EMPORE methodology in European countries, such as technical limitations, lack of public acceptance in case of reuse, financial and costs, lack of regulation regarding micropollutants in wastewaters, etc.

Regarding **technical limitations**, the EMPORE methodology can be applied in WWTPs with the existence of a secondary treatment that allows complying with the requirements for discharges stipulated by Directive 91/271/CEE. The design, implementation, automation and operation of the EMPORE methodology was complex because there were different technologies involved (conventional filtration, ultrafiltration, reverse osmosis, adsorption by activated carbon and electro-oxidation). On the other hand, the automation was complex, because it was necessary to integrate the programming of the different processes into a single program. Another technical limitation, it is the high energy consumption of reverse osmosis and electro-oxidation processes.

It is worth noting that the detection and analysis of micropollutants from wastewaters is complex, because a wide variety of micropollutants is continuously discharged into urban wastewaters, and generally, these compounds are detected at low concentrations ($\mu g \cdot L^{-1}$ or $ng \cdot L^{-1}$). The use of highly selective analytical methods to detect micropollutants such as GC-MS/MS and LC-MS/MS is required due to the complexity of the water matrices. In addition, high structural information is needed for the characterization of unknown micropollutants.

On the other hand, the **lack of public acceptance** can hinder the reuse of treated water. According to surveys carried out in action C2, the primary consumers/users of reclaimed water evidenced some inconveniences of the reuse such us the price of water, the difficulty to guarantee traceability and food safety, the need to improve pumping and storage infrastructures and the current regulation. It is necessary to create public awareness about the environmental benefits of the implementation of technologies to remove micropollutants such as EMPORE methodology. The use of a general water quality index considering only the concentration of micropollutants, such as WQIEC (action C), can facilitate the interpretation of the quality of water, especially for non-water experts.

Regarding **financial and costs**, the application of EMPORE methodology in WWTPs requires significant and sustained funding for: design, adaptation, licensing, implementation, training and operation. The responsible authorities should take these into consideration. Furthermore, it is important to set who should pay for the implementation of the micropollutant removal technologies and the willingness to pay. It is necessary users/consumers accept the price of the treated water.

With respect to **regulation and politics**, the implementation of the EMPORE technologies to remove micropollutants is hindered by the lack of a policy framework for elimination of emerging pollutants in WWTPs in the European Union, and also, by the lack of a policy framework for water reuse that regulates the presence of emerging pollutants. The adoption of successful environmental technologies to remove micropollutants in large-scale plants requires a well-functioning public and private sector institutions, with good governance, an effective legal system, and investment in research and development. The adoption of technologies to obtain effluents free of micropollutants might be encouraged with the inclusion of the cost of these treatments in the sanitation taxes.

Task B8.3. Recommendations in order to implement the established methodology

The EMPORE methodology is used as a tertiary treatment to remove emerging pollutants from the secondary effluents of urban WWTPs. So, a fundamental requirement for its implementation is the existence of a secondary treatment in the selected WWTP that allows complying with the requirements for discharges stipulated by Directive 91/271/CEE.

It is essential to verify the economic, social and environmental feasibility of the plant. In addition, a characterization campaign of the effluents of the selected WWTP is required to assess the occurrence of micropollutants.

Concerning urban wastewater treatment, the discharges of the WWTPs are legislated by Directive 91/277/CEE, which establishes the obligation of monitoring some water quality parameters (organic matters, solids and nutrients) and set the quality standards. However, it is important to outstand that the understanding of the removal of micropollutants in wastewaters is restricted since the analyses for these compounds are exceptional. This makes difficult the elaboration of an official European database with information referred to the presence and removal of these compounds from the influents of WWTPs in all the European regions.

EMPORE project proposes to improve the current regulation of wastewater treatment with the obligation of analysing the occurrence of a list of micropollutants in all the European urban WWTPs, submitting the concentrations and the removal efficiencies reached by treatment in a common database. The initial list of compounds to be monitored in WWTPs should include at least, the priority substances included in Directive 2013/39/UE and the micropollutants included in the Watch List proposed by Decision 2018/840/UE or subsequent directives and decisions. The collection of that information will help the European Union to include these pollutants or not as priority compounds.

- **Deliverables:**
- Final deliverable: "Deliverable B8.01 Legal feasibility analysis"
- The final deliverable deadline was December 2019.

Action C1. Effectiveness of the project actions: monitoring of the impact of ECs removal

Beneficiary responsible		Status
UA		Completed
Time schedule per Annex I	Starting date	End
30 months	03/2018	08/2019
Real time schedule	Starting date	End Date
30 months	02/2017	12/2019

- **Objectives:** The aim of this action is to identify a set of indicators and develop the protocols. The indicators selected will allow analysing the outcomes and the impact of the pesticides and industrial products removal in BWWTP.
- **Progress:**

Actions C consists on monitoring the impact of the project actions. Although the proposal did not contemplate starting this action before March 2018, the Consortium reconsidered this starting date. Since monitoring the impact of the project is seen as essential, UA advanced the monitoring actions starting on February 2017. On its side, AIDIMME, LTL and UNESCO-IHE provided UA with the technical data required for this action and invested personal time in the development of the results.
Activity completed 100%

Task C1.1 Verification of specific indicators and monitoring protocol
Initially, UA worked on the selection of specific indicators and developed the monitoring protocol. The list of indicators was proposed at "LIFE EMPORE Indicators List".

UA proposed to monitor the environmental impact of ECs removal by means of: a) an individual analysis of the concentration of each contaminant monitored during actions B1 and B4 (indicators 1.3-01 to 1.3-20); b) a global analysis with the application of two general dimensionless water quality indexes, one directly related to the presence and concentration of micropollutants (indicator 1.3-21), and other, related to the general characterization of water (indicator 1.3-22).

Regarding indicator 1.3-21, the index proposed by UA was based on the Canadian Water

Quality Index (CWQI) considering the concentrations of the micropollutants studied as variables (CWQI-EC). Additionally, UA proposed other index, named as WQIEC, with the inclusion of a weight factor in the calculation of the CWQI that differentiates between the kind of micropollutant (priority substance, watch list substance and others).

Regarding indicator 1.3-22, the application of two indexes was proposed by UA, the Canadian Water Quality Index (CWQI) and the Weighted Arithmetic Water Quality Index (WAWQI) considering the parameters conductivity, pH, turbidity and concentration of total suspended solids.

UA used the first results obtained in action B1 for samples from the influent and effluent of Benidorm WWTP to check the application of those indexes. Initially, only the 12 micropollutants set in the project memory were included in the index 1.3-21 (Deliverable C.01 Monitoring of the impact of the project actions: "Performance Indicators: Progress Statement").

Posteriorly, once action B1 was concluded, 20 micropollutants were included in the index to assess the quality of the influent and effluent of Benidorm WWTP: pesticides (chlorpyrifos, trifluralin, diuron, isoproturon, glyphosate and AMPA), industrial products (DEHP and 4-octylphenol), pharmaceutical products (diclofenac, erythromycin, chloramphenicol, carbamazepine, ibuprofen, fluoxetine, sulfamethoxazole and ketoprofen), hormones (17-α-ethinylestradiol, 17-β-estradiol, estriol and estrone). UA updated the list of indicators (last version: "LIFE EMPORE Indicator List_April_2018") and elaborated "Deliverable C.02 Monitoring of the impact of the project actions: "Performance Indicators: Progress Statement and Verification".

In action B4, 19 substances were monitored during the demonstration period. The concentration of the pesticide AMPA (indicator 1.3-18) was initially monitored. However, it was difficult to detect that compound with accuracy in some effluents of EMPORE plant, so that, it was not included in the calculation of the index 1.3-21.

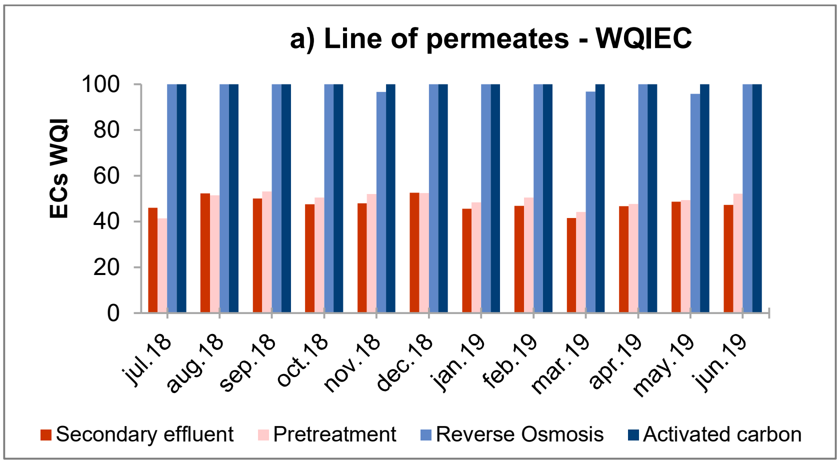
Task C1.2 Regular reporting on monitoring

The indicators 1.3-01 to 1.3-22 were used to assess the quality of the effluents of Benidorm WWTP and the EMPORE plant during the characterization campaign (action B1) and the demonstration period (action B4), respectively. The results of those indicators can be consulted in Deliverable C.07. "Progress Performance Indicators: Final Statement".

It dares highlighting the importance of the application of the general quality indexes CWQI-EC and WQIEC to assess the quality of the effluents regarding the presence of micropollutants. Those indexes enhance the interpretation of the concentration of several micropollutants to a general public, because they consider those concentrations, but the evaluation of the quality is provided by a dimensionless scale of 0 to 100, where 100 is the best value.

The indicator 1.3-21 showed that the influent and secondary effluent of Benidorm WWTP exhibited low water quality during the characterization campaign (period Nov.16 to Dec.17) due to the presence of some of the 20 micropollutants studied (the average monthly value of WQIEC was 27.9 and 39.7 respectively). The concentration of micropollutants often departed from desirable levels, increasing for some micropollutants during Easter holidays and Fallas festivals. The conventional treatment carried out in Benidorm WWTP reduced the concentration of several micropollutants; however, the quality of the secondary effluent was poor, evidencing the need to apply tertiary treatments as the proposed in EMPORE project to remove the remnant microcontaminants. On the other hand, the index 1.3-22 indicated that the secondary effluent of Benidorm WWTP exhibited low-marginal quality regarding the general parameters conductivity, turbidity, pH and concentration of suspended solids (CWQI between 36-57).

The quality of the effluents at the different lines of the EMPORE plant expressed in terms of WQIEC is summarised in Figure 7.



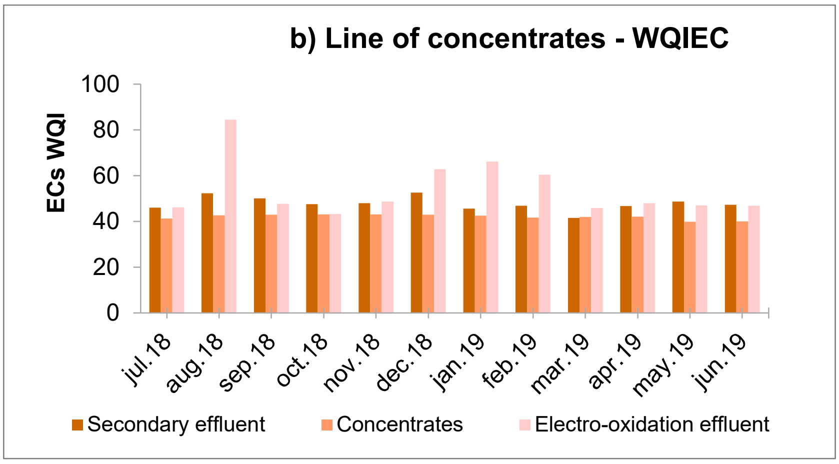


Figure 7 EMPORE plant: quality according to indicator 1.3-21 (variables=19).

In action B4, the quality of the secondary effluent of Benidorm WWTP was poor-marginal (WQIEC=42-53) during the period Jul.18 to Jun.19 due to the presence of micropollutants (indicator 1.3-21). The substances continuously detected in the secondary effluent were diuron, erythromycin, fluoxetine, glyphosate, sulfamethoxazole, carbamazepine and diclofenac; chlorpyrifos, estrone, ibuprofen, ketoprofen, isoproturon and DEHP were intermittently found. The low quality of the secondary effluent evidenced the need to apply tertiary treatments.

The pretreatment of EMPORE plant (conventional filtration followed by ultrafiltration) was efficient to remove suspended solids and turbidity, but barely contributed to the improvement of the water quality regarding micropollutants. In fact, the values of both indexes were like those obtained in the secondary effluent (CWQI-EC=45-59 and WQIEC=42-53).

The results confirmed that the treatments carried out in the line of permeates (reverse osmosis and activated carbon) of the DEMO plant improved the quality of the effluents. The reverse osmosis unit showed exceptional micropollutant removal efficiency and produced high-quality permeates (WQIEC=95-100), almost free of micropollutants and with low conductivity (< 200 $\mu S \cdot cm^{-1}$). The occasional traces of glyphosate, sulfamethoxazole, diclofenac and carbamazepine detected in permeates were removed by activated carbon, obtaining an effluent of excellent quality (WQIEC=100). It was not necessary to apply Advanced Oxidation Processes (AOPs).

As it was expected, after the membrane processes in EMPORE plant, both micropollutants and salts (conductivity: 6000-8000 $\mu S \cdot cm^{-1}$) were concentrated in the UF/RO concentrates, whose quality was poor (WQIEC=39-43) due to the presence of some micropollutants (ea. diuron, diclofenac, erythromycin, carbamazepine, fluoxetine, sulfamethoxazole, glyphosate, isoproturon, ibuprofen, etc.). The electro-oxidation unit was operated at a current of 10 A with 1 pass through the reactor cells; that process improved the quality of the UF/RO concentrates , producing effluents with marginal-fair quality (WQIEC=43-85). The quality of those effluents reached values close/superior to the quality of the secondary effluent.

The results allow to affirm that the EMPORE methodology enables to protect the Benidorm basin, reducing the concentration of micropollutants discharged onto the environment.

It is worth noting that the quality of the effluents after the ultrafiltration process in IRAD Benidorm was poor-marginal (WQIEC=39-45). The quality of the permeates after the reverse osmosis process in IRAD Benidorm was high (WQIEC=87-100). There was a good correlation between the quality of the effluents reached by the ultrafiltration and reverse osmosis units of EMPORE pilot plant and IRAD Benidorm (full-scale plant) regarding the presence of micropollutants, which supports the extrapolation of the technology to a full-scale level, as it is detailed in action B7.

On the other hand, the index 1.3-22, CWQI applicated for general parameters, indicated that the secondary effluent of Benidorm WWTP exhibited low-marginal quality regarding the general parameters conductivity, turbidity, pH and concentration of suspended solids (CWQI=31-68). After EMPORE pilot plant the quality was good (CWQI ≥80) for the line of permeates, whereas the quality of the concentrates was poor-marginal (CWQI= 52).

- **Problems encountered and deviations:**

In general, there are many publications on the application of WQI to assess the quality of water considering general parameters, such as chemical oxygen demand (COD), pH, dissolved oxygen, conductivity, and so on. Nevertheless, there is a lack of information on the application of these indices to assess the quality of water considering several types of emerging contaminants (priority substances, watch list substances and others). For that reason, UA proposed developing an index that modifies the current CCMEWQI index.

- **Schedule:** UA, in collaboration with the other partners involved in the action, collected information and proposed the application of two indices to the other members of the project (in Action C1). The indices were applied to results from B1 to study the quality of the influent and secondary effluent of Benidorm WWTP. Those indices have also been applied to results from action B4 to study the impact of the processes carried out in EMPORE plant on water quality.

- **Deliverables:**

- C.01. “Performance Indicators: Progress Statement” (Submitted in the Progress Report). This deliverable was due for July 2017.
- C.02. “Performance Indicators: Progress Statement and Verification” (section 10.2.2). This deliverable was due for April 2018.
- C.03. “Environmental state Mid Term Report: General Quality Index of Benidorm basin before treatment” (section 10.2.7). This deliverable was due for July 2018, but it was delivered in October 2018 as the general Midterm Report.

- C.04. “Environmental state Mid Term Report: General Quality Index of wastewater before treatment” (section 10.2.8) This deliverable was due for July 2018, but it was delivered in October 2018 as the general Midterm Report.
- C.05. “Progress Performance Indicators: Midterm Statement” (section 10.2.9). This deliverable was due for July 2018, but it was delivered in October 2018 as the general Midterm Report.
- C.07. “Progress Performance Indicators: Final Statement”. This deliverable was delivered in December 2019. It includes the results of the indicators of action C1 and action C2.
- C.08. “Final environmental state report: General Quality Index of wastewater before treatment, General Quality Index of treated water and General Quality Index of Benidorm basin after plant treatment”. This deliverable groups the deliverables indicated in the project plan: “Final environmental state report: General Quality Index of wastewater before treatment and General Quality Index of treated water” and “Final environmental state report: General Quality Index of Benidorm basin after plant treatment”.

Action C2. Monitoring of the socio-economic impact of emergent contaminants removal

Beneficiary responsible		Status
UA		Completed
Time schedule per Annex I	Starting date	End
13 months	08/2018	08/2019
Real time schedule	Starting date	End
30 months	03/2017	12/2019

- **Objectives:** The aim of this action is to assess the socio-economic impact of the EPs removal in Benidorm WWTP in both the population and the local economy, and also in regions with a similar problem detected during preparatory.
- **Progress:**

With the information compiled, UA in collaboration with the other partners involved in the action, has updated the specific indicators proposed at “LIFE EMPORE Indicator List” and elaborated the different deliverables.
Activity completed 100%

Task C 2.1 Verification of specific indicators and monitoring protocol
Initially, UA worked on the selection of specific indicators and developed the monitoring protocol. The list of indicators was proposed at “LIFE EMPORE Indicators List”.

UA proposed to assess the socio-economic impact of the EPs removal by means of: a) two indicators (12.1.1 and 12.1.2) to measure the interest aroused by the project; b) an indicator (12.1.3) to analyze the social acceptation of treated water; c) an indicator to evaluate the dissemination of EMPORE results (13.1); d) indicator to evaluate the incorporation of the proposed technologies in public or private companies (15.5); e) indicator to assess the production of water free of ECs (16.1); f) indicator to assess the running/operating costs during the project (15.1).

The indicators were initially defined and monitored in “Deliverable C.01 Monitoring of the impact of the project actions: “Performance Indicators: Progress Statement”. They were posteriorly verified and analysed in the subsequent deliverables: “Deliverable C.02”, “Deliverable C.03” and “Deliverable C.07”.

Task C2.2 Measurement of the socio-economic impact

The indicators 12.1.1 to 16.1 were used to assess the socio-economic impact of the EPs removal. The results of the indicators have been updated in “Deliverable C.07. Progress Performance Indicators: Final Statement”. That deliverable includes the results of the indicators of action C1 and action C2.

The indicators developed to monitor the socio-economic impact are described below:

Indicator 12.1.1 Number of entrances in the website

- Objective: This indicator allows monitoring the interest aroused by the project.
- How: By means of a visit counter incorporated at EMPORE website.

The visitor counter (Figure 1) registered since the launch of the website the 1st Aug.18 to 31st Dec.19, 1203 visits to the website. The average number of EMPORE sections visited by user per session was 1.93, so the number of visits to the different sections of the website was 2321. 967 users accessed EMPORE website, 10% of whom returned to the website. It is worth noting the percentage of visits from project links was ~70%; this means the diffusion in different websites (EMPORE website, UA website, AIDIMME website, etc.) was effective.

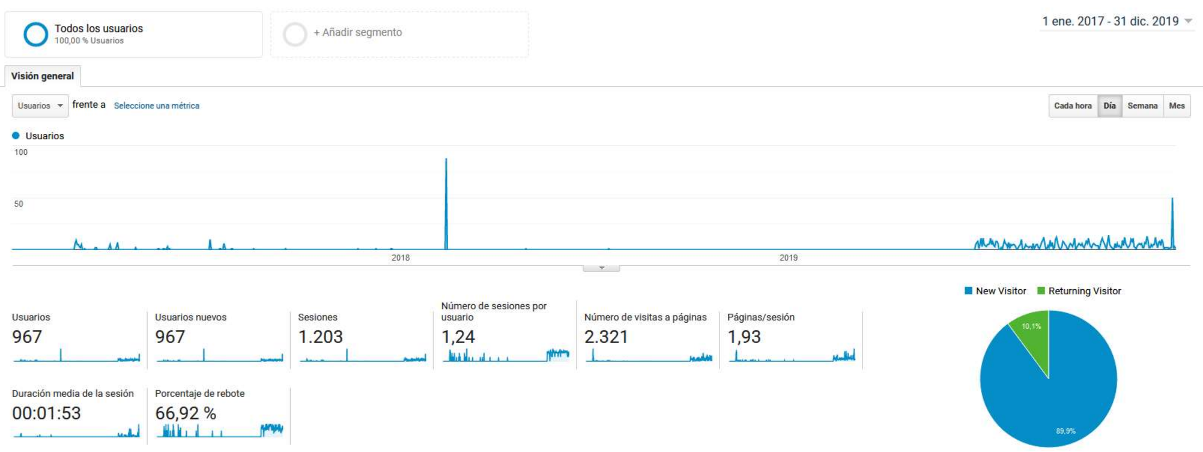


Figure 1 Information provided by the visitor counter (period 1st August 2018 to 31st December 2019).

Indicator 12.1.2 Register of the number of events/exhibitions in which the members of the Project have been invited to promote the technologies proposed in the plant

- Objective: This indicator allows monitoring the interest aroused by the project.
- How: By means of a visit counter incorporated at EMPORE website.
- The visitor counter (Figure 1) registered since the launch of the website to 31st Dec.19, 1203 visits to the website. The average number of EMPORE sections visited by user per session was 1.93, so the number of visits to the different sections of the website was 2321. 967 users accessed EMPORE website, 10% of whom returned to the website. It is worth noting the percentage of visits from project links was □70%; this means the diffusion in different websites (EMPORE website, UA website, AIDIMME website, etc.) was effective.

EMPORE members participated since the beginning of the project until the 31st Dec.19 in 125 events, distributed in: publications in online journals and (own) websites (82), assistance to congresses (24), interview (2), networking sessions with other LIFE projects and companies (14) and technical publications as book chapter (3). The events registered are shown in Deliverable C.06. “Monitoring of the impact of the project actions: Progress Performance Indicators: Final Statement. Actions C1 and C2”.

During the networking events, EMPORE members contacted to several companies and research centres such as Labaqua, Instituto Tecnológico de Galicia (ITG), Laboratorio Ibérico Internacional de Nanotecnología (INL), National Laboratory for Civil Engineering (LNEC), Consejo Superior de Investigaciones Científicas and Cetaqua Galicia, among others.

Indicator 12.1.3 Survey about the acceptation of the water used for irrigation

- Objective: This indicator allows monitoring the social acceptation of treated water.
- How: Different water users will be consulted to know their opinion about the quality of the effluent of the pilot plant and the conventional process in the Benidorm WWTP.

UA carried out an initial survey during the "XIV Congreso Nacional de Comunidades de Regantes" held in Torrevieja (Spain) from 14-18th May.18 to know the opinion of many experts and reclaimed water users (100 participants) about the reuse of reclaimed water in Spain. The survey was general on reuse; it did not focus on micropollutants. The consultation was carried out by means of a survey technique.

A second survey was carried out by UA during the "Jornadas Técnicas de ESAMUR" held in Lorca (Spain) from 21-22nd Nov.18 to know the perception of many water experts and researchers (113 participants) about regulation and risk of micropollutants in wastewaters, technologies for the elimination of micropollutants and socio-economic impact of the elimination of those compounds. The consultation was carried out by means of a survey technique.

A third survey was carried out by UA and AIDIMME in May-Jun.19 to know and value the appreciation that the educational community has about the concept of emerging pollutants and their elimination. The consultation was carried out by means of a survey technique using the online tool "Google Forms" (it was not presential).

Despite some disadvantages related to the use of reclaimed water (price, difficulty to guarantee traceability and food safety, pumping and storage infrastructures), irrigators would use more reclaimed water if the prices were competitive and the quality of the resource was fully guaranteed and suitable for any type of agricultural use.

It is worth noting that both the academic community and water experts are aware of the presence of emerging pollutants in wastewaters and agree on the need to combine technologies to remove them efficiently. Some useful technologies are advanced oxidation processes, reverse osmosis, adsorption onto activated carbon and electrochemical processes. In general, they consider that the elimination of emerging pollutants could have positive impact mainly on public health, environmental and sustainability and in integrated management of water resources.

Considering the opinion of the academic community, the three main factors that can make difficult the detection/removal of emerging pollutants in waters were: development of analytical methods and cost of analytical equipment, requirements of the current regulation and high cost of the existing technology to remove emerging pollutants.

Indicator 13.1. Networking and other professional training or education

- Objective: This indicator allows monitoring the direct dissemination of the main results/technologies through participation in professional networks and educational programs.
- How: UA analyzes the information of professional networks and participation in educational programs registered in indicator 12.1.2 with the collaboration of all members. Detailed information about this indicator is provided in Action D2.

During that period, EMPORE members participated in 14 professional networking sessions to disseminate EMPORE objectives as it is described in Table 1.
Those networking events allowed the diffusion of the EMPORE project and the interchange of ideas and results related to:

- Current and future trends in the monitoring and control of emerging pollution in the water cycle.
- Importance of studying intermediate compounds.
- Improvement of the methodologies for removing pharmaceutical products.
- Comparison of wastewater treatment with microalgae with the treatments proposed by EMPORE regarding the costs.
- Knowledge of other LIFE projects and the results achieved such as projects: BYPROTVAL, FOUNDRYTILE, LIFE2ACID, In-BRIEF, GREENZO, ECOELECTRICITY, RECYPACK, FUTURE, LEMNA, among others.

Table 2 Indicator 13.1 Information registered and categorized for this period

DATE	MEMBER	DESCRIPTION	CATEGORY
3/11/2016	EPSAR	- EPSAR organized a Technical Workday called "New technologies applied for wastewater treatments", where LIFE-EMPORE was introduced for the first time.	NETWORKING EVENT (professional)
30/11/2016	LTL	- Participation in networking CFIS-ECOPHARMA. - Contact with other LIFE projects such as IMPETUS.	NETWORKING EVENT (professional)
24/02/2017	LTL	- First contact with the Coordinator of LIFE Project IMPETUS to start networking activities.	NETWORKING (professional)
24/05/2017	LTL	- The ESPP (European Sustainable Phosphorus Platform) contacted with the Laboratorios Tecnológicos de Levante, S.L in order to include EMPORE project to their list of R&D projects on nutrient recycling and management (not only phosphorus), for promotion on their website (www.phosphorusplatform.eu) and in their network of companies, public bodies and other stakeholders.	NETWORKING (professional)
30/05/2017	LTL	Participation in networking PROGRAMA LIFE 2017 "INFODAY REGIONAL" in Paterna (Valencia)	NETWORKING EVENT (professional)
28/06/2017	AIDIMME	Participation in the networking event "Eliminación de nitrógeno y fósforo en aguas residuales" and first contact with the Coordinator of LIFE Project BIOSFER.	NETWORKING (professional)
24/08/2017	UA	Visit of SYDVATTEN AB, Sout Sweden Water Supply company.	NETWORKING (educational and professional)
06/04/2018	LTL	First contact with the Coordinator of LIFE Project BACIWATER and LIFE SOLUTIONS in order to start networking activities.	NETWORKING (professional)
09/05/2018	AIDIMME	Participation in networking PROGRAMA LIFE 2018 "INFODAY REGIONAL" in Paterna (Valencia).	NETWORKING (professional)
12/06/2018	LTL	First contact with the Coordinator of a non-LIFE Project WATINTECH in order to start networking activities.	NETWORKING (professional)
28/11/2018	LTL	Dissemination of the LIFE EMPORE project in the Water Knowledge Event	NETWORKING (professional)
28/02/2019	UA	Participation of EMPORE-LIFE project in the Cultural Month of the University of Alicante Polytechnic School: Students visited the EMPORE demonstrator and the tertiary plant in Benidorm	NETWORKING (educational)

DATE	MEMBER	DESCRIPTION	CATEGORY
		WWTP (Event organized by UA with the collaboration of: AIDIMME, CONSOMAR, IHE-UNESCO and EPSAR).	
27/03/2019	UA	Participation of EMPORE-LIFE project by UA in the "Interregional workshop on water reuse technologies. How to apply the appropriate technologies to water reuse across the agricultural, industrial, urban and recreational sector of each region" organized by AQUARES project. Milan, 27-28th March 2019.	NETWORKING (professional)
07/05/2019	AIDIMME	Participation in the EU LIFE Regional Infoday-Networking Event. Presentation of results of LIFE-EMPORE project.	NETWORKING (professional)

Indicator 15.1. Running cost/operating costs during the project and expected in case of continuation/replication/transfer after the project period

- How: Once the demo results are available UA with the collaboration of all members will quantify operating costs.

The running/operating costs of the EMPORE pilot plant during the demonstration (Jul.18 to Jun.19) were calculated considering the following items: energy consumption (power and consumption) and consumables. The mean value of the total energy consumption ratio related to the total water treated was 1.8 $kWh \cdot m^{-3}$ according to Deliverable B4.01. The following items were considered to calculate the energy consumption of the EMPORE plant: operation 24 h/day, 365 days (12 months) and an inlet flow of 5.5 $m^3 \cdot h^{-1}$.

In action B4, the energy consumption cost of EMPORE plant was 0.14 $€ \cdot m^{-3}$ of water treated. The consumables cost was 0.19 $€ \cdot m^{-3}$ of water treated. Finally, the running/operating cost of EMPORE pilot plant considering both terms was 0.35 $€ \cdot m^{-3}$ of water treated.

Indicator 15.5. Incorporation of the proposed technologies in advanced tertiary treatments for removal of ECs

- Objective: This indicator allows monitoring the incorporation of the proposed technologies in public or private companies.
- How: Once the project ends, UA, with the collaboration of all members, will create a list with the companies and institutions to contact. These will receive an e-mail survey to know if they intend to implement EMPORE technologies in their plants.

EMPORE members consider appropriate to continue with the diffusion of results over the next three years after the completion of the project and to assess the intention of public/private companies to incorporate any of the technologies used in EMPORE methodology.

Each year after the completion of the project, UA with the collaboration of EMPORE members will distribute an e-mail survey with questions about the intention to implement any of the technologies include in EMPORE methodology through public management entities of water treatment plants (ea. EPSAR, ESAMUR, etc.), AEAS association, AEDyR association and contacts of EMPORE members.

Indicator 16.1 Tendencies change about the availability of treated water free of Ecs for reuse

- Objective: This indicator allows monitoring the production of water free of Ecs (m^3/year) for reuse.
- How: During the demonstration (action B4), summary operation sheets will be completed indicating (volume of influent per period, concentration of Ecs, etc.).

To obtain availability of treated water free of Ecs for reuse, UA considered that effluents are free of Ecs if:

- CWQI-EC and WQIEC (indicator 1.3 Ecological status-water pollutants-21) are over 85;
- And the concentration of priority substances is below the Maximum Allowable Concentration (MAC) of Directive 2013/39/EU (indicators 1.3 Ecological status-water pollutants-01 to -06).

In the period Jul.18 to Jun.19, the line of permeates (Pretreatment+Reverse Osmosis+Activated Carbon) allowed to obtain effluents with WQEIC > 85 and free of priority substances. The average percentage of production of water free of Ecs for reuse from Jul.18 to Jun.19 was 63.1±5.2 % (the average monthly mean ratio can be consulted in Table 2). Conversely, the effluents from the line of concentrates didn't accomplish those requirements.

Table 3. Ratio of production of treated water free of Ecs for reuse by the EMPORE plant.

DATE	$Q_{influent}$ (m^3/h)	$Q_{effluent}$ (m^3/h)	Ratio
July-2018	5.37±0.1	3.25±0.39	65.1±8.6
August-2018	5.16±0.17	3.06±0.02	67.8±0.4
September-2018	5.03±0.09	3.41±0.05	68.5±1.2
October-2018	5.14±0.53	3.13±0.17	67.8 ±5.5
November-2018	5.28±0.42	2.94±0.19	58.9±3.4
December-2018	4.86±0.18	2.85±0.12	59.3±1.3
Januray-2019	5.11±0.15	2.58±0.10	56.9±1.2
February-2019	5.22±0.06	2.68±0.17	60.6±3.7
March-2019	5.26±0.09	2.80±0.09	62.0±2.4
April-2019	5.21±0.18	2.87±0.14	62.4±1.3
May-2019	5.23±0.37	3.05±0.07	65.0±0.7
June-2019	5.14±0.22	3.10±0.07	65.4±1.0

Task C2.3 Regular reporting on monitoring: Conclusions

In action C2 "Monitoring of the socio-economic impact of Ecs removal", a set of indicators, and the protocols to obtain them, were developed to monitor the socio-economic impact of Ecs removal. The purpose of these indicators are: to analyse the interest aroused by the project (indicators 12.1.1 and 12.1.2); to monitor the social acceptation of treated water (12.1.3); to disseminate the main EMPORE project results (indicator 13.1); to analyse the industrial incorporation of the proposed technologies (indicators 15.5); to know the production of high quality water (free of Ecs) for reuse that EMPORE plant can produce (indicator 16.1); and to know the operating costs during the project (indicator 15.1).

The interest aroused by the project was measured by indicators 12.1.1 and 12.1.2. The EMPORE members made a great effort to raise awareness of the need to remove priority substances and Ecs from the secondary effluent of conventional wastewaters during the project. In that sense, EMPORE members tried to disseminate the importance of the EMPORE methodology. The visitor counter registered since the launch of the website to December 2019, the access of 967 users to the EMPORE website, and in addition, the EMPORE members participated in 125 activities, distributed in: publications in online journals and (own) websites (82) , assistance to congresses (24), interview (2), networking sessions with other LIFE projects and companies (14) and technical publications (3).

The networking events allowed the dissemination of the EMPORE project and the interchange of ideas and results related to: current and future trends in the monitoring and control of emerging pollution in the water cycle; importance of studying intermediate compounds; improvement of the methodologies for removing pharmaceutical products; knowledge of other LIFE projects; among others. The EMPORE methodology has been explained in congresses and networking events with a professional audience. Hitherto, the EMPORE members have participated in 14 networking events.

To contribute in the incorporation of the proposed technologies in the current wastewater treatment plants, it is necessary to raise awareness of the importance of protecting the environment from these harmful substances and contribute to the social acceptance of the reclaimed water. Indicator 12.1.3 allowed to assess the social acceptation of reclaimed water of some companies and communities of irrigators, water experts and researchers and members of the academical community in Spain.

Despite some disadvantages related to the use of reclaimed water (price, difficulty to guarantee traceability and food safety, pumping and storage infrastructures), irrigators would use more reclaimed water if the prices were competitive and the quality of the resource was fully guaranteed and suitable for any type of agricultural use.

It is worth noting that both the academic community and water experts are aware of the presence of emerging pollutants in wastewaters and agree on the need to combine technologies to remove them efficiently, since conventional wastewaters are not currently prepared for that purpose. Some useful technologies are advanced oxidation processes, reverse osmosis, adsorption onto activated carbon and electrochemical processes. In general, they consider that the elimination of emerging pollutants could have positive impact mainly on public health, environmental and sustainability and in integrated management of water resources.

Considering the opinion of the academic community, the three main factors that can make difficult the detection/removal of emerging pollutants in waters were: development of analytical methods and cost of analytical equipment, requirements of the current regulation and high cost of the existing technology to remove emerging pollutants.

The use of the quality index (1.3-21 and 1.3-22) will contribute to the social acceptation of reclaimed water because these indexes allow a simple assessment of water quality. The measurement of water quality through a global index on a scale of 0 to 100, facilitates the interpretation of the results regardless of the knowledge that each one has. This fact contributes to making all sectors (experts or not on water issues) participants of the improvements reached

For the design, set up and preliminary operation of the DEMO plant several water technicians were required (Mª Ángeles Bernal and Lyvia Mendes-UA; Silvia Oyonarte- AIDIMME; Javier Andreu-CONSOMAR; Antonio Sánchez and Raúl García – LTL) due to the complexity of the plant, apart from the technical staff team. Therefore, if the technologies were scaled and implanted in the BWWTP, the creation of new jobs to operate the plant would be required.

On the other hand, the implantation of the EMPORE technologies in Benidorm WWTP would also produce positive effects on the regional development of La Marina Alta due to the increase on the production of high-quality water available for irrigation. According to indicator 16.1, the percentage of production of water free of ECs and salts during demonstration (Jul.18 and Jun.19) was 63.1±5.2 %.

Finally, the energy consumption cost of EMPORE plant was 0.14 $€·m^{-3}$ of water treated. The consumables cost was 0.19 $€·m^{-3}$ of water treated. The running/operating cost of EMPORE pilot plant considering both terms was 0.35 €·m^{-3} of water treated (personnel costs not included).

- **Problems encountered and deviations:** No problem neither deviation were observed.
- **Schedule:** This action was running ahead of schedule.
- **Deliverables:**

- C.06 Initial report on Conventional Activated Sludge (CAS) process in the Benidorm WWTP effluent quality and its possible uses (irrigation, cleaning…).

- C.07. "Progress Performance Indicators: Final Statement". This deliverable was delivered in December 2019. It includes the results of the indicators of action C1 and action C2.

- C.09. "Monitoring of the impact of the project actions: Final report on pilot plant effluent quality and its possible uses (irrigation, cleaning…)". This deliverable was reported in Dec.19.

Action D1. Dissemination and transferability of the project results

Beneficiary responsible		Status
LTL		Completed
Time schedule per Annex I	Starting date	End
36 months	09/2016	08/2019
Real time schedule	Starting date	End
40 months	09/2016	12/2019

- **Objectives**

The main goal of the dissemination activities within the LIFE EMPORE project is to communicate, raise awareness to the main target audience and demonstrate the effectiveness of project main results and key messages. LTL has been in charge of this action all over the project, with the collaboration of the other partners.

- **Progress**

Task D1.1. Communication and Dissemination Plan

A first version of the Communication and Dissemination Plan (CDP) has been prepared and submitted with the Progress Report, while the Final version is enclosed to this Mid Term Report (section 10.2.10).

This plan has been elaborated by EPSAR and LTL and all partners have contributed in order to cover the entire stakeholders' spectrum. The CDP includes the following contents:

- The dissemination methods and their specific associated activities.
- Schedule for dissemination elements, means and activities, according to the project milestones and completion of actions among partners.
- Classification of target stakeholders and audiences which will be targeted during the action. Preparatory action A1 will be taken into account to complete this issue.
- Expected impacts and indicators of dissemination activities.
- Role of the beneficiaries in dissemination and communication activities
- The conditions to ensure proper dissemination of the generated knowledge, related to confidentiality, publication and use of knowledge according to LIFE Programme, Grant Agreement and General Conditions.

Task D1.2. Production of Dissemination and Communication materials and means

Regarding Action D.1, the LIFE EMPORE website is fully running (please see Task D1.4). The project has its own logo since the very beginning and along the whole project the completed corporative image of the project has been created and used in all the Dissemination and Communication material. Nevertheless, some delay has been experienced regarding the Corporate Image, for what a specialised company has been hired (Pixelarte). In fact, this external assistance is working for LTL, developing not only the corporate image, but all related material such as the project brochure design, power point presentations, etc. In detail, the project has already generated the following merchandising material:

- **450 Notebooks and 150 pens** (design of all dissemination material can be found in section 10.3). We have distributed them amongst the different partners, in order to guarantee the project image is always accompanying our beneficiaries. We have also distributed some of them in the different conferences we have attended in the period.
- **Project brochure** in two languages, English and Spanish. 400 copies were printed offset while 100 copies were printed using digital printing techniques. We have distributed them in the different conferences we attended in this period.
- **Project roll-up**
- **PowerPoint template** to use it when partners are invited to present the LIFE EMPORE project in different events (more information about the different events where we have disseminated project overview is provided in Task D1.6)

Furthermore, one panel and two notice boards (more information in Task D1.3) have been designed for the project dissemination and communication at partners' facilities, a demo-film and the Layman's Report.

Task D1.3. Notice Boards: elaboration and maintenance

An initial poster, including the main information of LIFE EMPORE was designed during the first year of the project execution. Later, with Pixelarte's (External assistance) support we designed two notice boards that were fully aligned with the project corporate image. The first one aims to disseminate project objectives and expected results at partners' facilities, while the second was installed at the pilot plant to inform visitors about LIFE EMPORE pilot plant in-situ. This second one was approved by the European Commission in July 2017. This second one was designed and printed in September 2018. EPSAR was in charge of printing 6 copies of the first notice board and distribute it amongst the different partners.

Task D1.4 LIFE-EMPORE website

As in previous tasks, LTL counted with Pixelarte to design and setup the LIFE EMPORE project website, as main element to disseminate the project. It is presented in Spanish and English and it contains all the reference information about the project. It also includes an intranet which is being used as repository of internal documents to facilitate the exchange of information between beneficiaries.

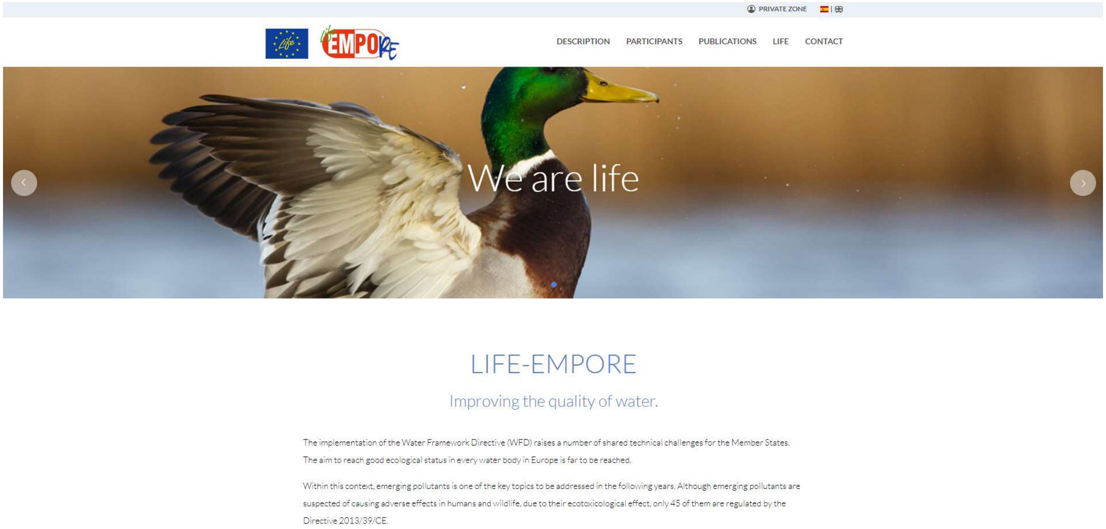


Figure 8. LIFE EMPORE website: http://www.life-empore.org/

In detail the following information is provided in LIFE EMPORE webpage:

"Description" section:

Which includes the environmental problem targeted, project objectives, main activities, background information, milestones, expected results, involvement of project of the associated beneficiaries. This section also includes the gallery of images that show LIFE EMPORE presence in different events, pilot plant, internal meetings, visits from the EMT team, etc.

"Participants" section:

This section includes an introduction of the different participants of the project and the link to their websites.

"Publications" section:

LTL, as project coordinator has periodically updated the webpage from the beginning of the project up to the MTR (and afterwards):

NEWS:

- 2nd March 2017: LIFE-EMPORE website is already available!
- 13th March 2017: Ist Follow-up Meeting of LIFE EMPORE Project
- 8th June 2017: LIFE EMPORE project receives the first visit of the LIFE External Monitoring Team of the European Commission
- 8th June 2017: LIFE-EMPORE projects joins to the celebration of the 25th anniversary of LIFE Programme
- 21st July 2017: AIDIMME introduces LIFE-EMPORE Project at the Technical Workshop "Nitrogen and Phosphorous removal in wastewater"
- 5th June 2018: AIDIMME participates in the regional Infoday of the Life 2018 program, giving last news about the European project Life EMPORE
- 5th June 2018: 2nd Follow-up Meeting of LIFE EMPORE Project
- 5th June 2018: 3rd LIFE-EMPORE's follow up meeting in Delft (The Netherlands)
- 5th June 2018: 2nd Water JPI Conference. Emerging Pollutants in freshwater ecosystems.
- 3rd August 2018: LIFE EMPORE project receives the second visit of the LIFE External Monitoring Team of the European Commission.
- In June 2018, EMPORE attends the Water JPI Conference 2018 "*Emerging pollutants in freshwater ecosystems*" in Helsinki (Finland) with an oral communication.
- In June 2018, EMPORE participates in "*META Leon Conference 2018"* with an oral communication. Publicized in META Leon 2018 website.
- EMPORE attended the 12th International Congress of the Spanish Association of Desalination and Reuse (AEDyR) the 23th of October 2018 in Toledo, Spain.

- EMPORE presentation on the Working Day called "Climate Change and Sustainable Food" the 12th of November 2018 in Valencia, Spain.
- EMPORE visited ECOFIRA 2018, an international fair celebrated during 6, 7 and 8th of November of 2018.
- EMPORE attended "WATER KNOWLEDGE EUROPE" event, celebrated in Brussels the 28th and 29th of November and organised by WssTP (Water Supply and Sanitation Technology Platform).
- LIFE EMPORE Project attended the technical conference 'Treatment and elimination of pollutants, emerging from effluents by urban treatment plants', organized by EPSAR on February 12th, 2019.
- On February 28th,, 2019, students from the Higher Polytechnic School of the University of Alicante (EPS Alicante) visited EMPORE pilot plant.
- EMPORE project participated in the National Water congress held on February 2019 in Orihuela (Alicante, Spain) organized by the University of Alicante.
- EMPORE project participated in the AQUARES interregional project workshop held on March in Milan Last 27th and 28th of March, 2019.
- On May 8th took place the 10th International Congress organized by the Wessex Institute of the United Kingdom and the University of Alicante. The conference was celebrated in Alicante and counted with the participation of the LIFE EMPORE Project.
- EMPORE PROJECT was at the first convention on micro contaminants in water at the Santiago de Compostela University during the13th y 14th of June, 2019.
- EMPORE Project participated in the 'XIII International Research Conference on Wastewater Treatment and Treatment Plants' held on last 12th of December in Rome, (Italy).
- Final Infoday took placed the 16th of December 2019.

DOWNLOADS: where the following documents are available to download:
- Project poster
- Notice boards (2)
- Brochure in English
- Roll up
- Brochure in Spanish
- Demo-film
- Layman's Report

"Life" section: This section gives an overview of the LIFE programme.

"Contact" section: To facilitate the request for more information about the LIFE EMPORE project.

Task D1.6. Organization of dissemination activities

- **Problems encountered and deviations:**

Regarding Action D1, and due to practical reasons, LTL has assumed the External Assistance for hiring the website of the project instead EPSAR. In exchange, EPSAR assumed cost related to "Noticeboards printing" (which was initially allocated to LTL).

Only a delay on the printing and placing of the Noticeboards has been suffered.

Furthermore, the demo film was done in October 2018, and not in March 2018 as it was scheduled. The reason is the delays in the setup of the prototype, which should be included in the film.

In terms of general progress though, no significant deviations have occurred.

The Final project event was finally carried out in Valencia, though it had been planned to be held in Brussels because more benefits will be obtained. Water Public Administrations (from

Valencia and Murcia) were invited, strengthen future collaborations and the possibility of implementing the EMPORE methodology in local WWTPs. The objectives of the conference were presented and discussed the results of the project, as well as highlighting the problems are future lines of research in the field. The conference brought together the panel of partners of LIFE EMPORE and several invited speakers from the university sector and public administration from Spain and the Netherlands, as well as professionals from the water industry, technology providers, press and general public. In this way, all the foreseen objectives and expected results of this event were achieved.

- **Schedule:** This action will be running until the end of the project.
- **Deliverables:** D1. Communication and Dissemination Plan. A review of the Communication and Dissemination plan can be found in section 10.2.10 of this document. D2. Demo film and D3. Layman's Report.

During the first six months of the After-Life period, the current website will be updated with the following:

- The period of project implementation.
- The list of emerging pollutants actually targeted by the project.
- The expected results section will be updated with the project findings and conclusions.

Action D2. Networking with other LIFE and/or non-LIFE projects.

Beneficiary responsible		Status
LTL		On going
Time schedule per Annex I	Starting date	End
36 months	09/2016	08/2019
Real time schedule	Starting date	End
36 months	09/2016	12/2019

- **Objectives:** The aim of this Action is to exchange good practices and synergies, opportunities and new methodologies related to the scope of the LIFE-EMPORE project. Further, networking aims to improve the transferability of the results of the LIFE-EMPORE project.
- **Progress:**

The Action is completed.

1. On 30th of November of 2016, took place the "CFIS ECOPHARMA Networking Event", organized by CETAQUA-Galicia in the city of Santiago de Compostela, where some projects connected with EP presented their results and interchanged valuable experiences. At the event, LIFE EMPORE project was presented to a very specific audience, where it was possible to meet new professionals and companies working in issues involved with Eps problem by means of different perspectives. Finally, an interesting debate took place, where diverse issues related to EP and its monitoring were addressed. It was possible to ask questions regarding the current and future trends in the monitoring and control of emerging pollution in the water cycle, from general questions to other more specific dealing with the project and the different technologies proposed, the most relevant EP. It was necessary not only to prepare a presentation but also potential questions as replies and anticipate the inquiries that may come up.
2. The Coordinator of EMPORE, LTL, has established contact with the Coordinator of LIFE Project IMPETUS in order to start networking activities. Both attended the CIS-ECOPHARMA Networking Event (Santiago de Compostela), a good opportunity for exchanging ideas and looking for synergies in the future.
3. On 24th of May the ESPP (European Sustainable Phosphorus Platform) made contact with the Laboratorios Tecnológicos de Levante, S.L in order to include EMPORE project to their

list of R&D projects on nutrient recycling and management (not only phosphorus), for promotion on their website (www.phosphorusplatform.eu) and in their network of companies, public bodies and other stakeholders.

4. A first identification of LIFE 2015 Networking Projects, which are listed below. Contact will be made with these projects on the forthcoming months: LIFE15 ENV/DE/000162– ISOBEL; LIFE15 ENV/ES/000252– LIFE LEMA; LIFE15 ENV/ES/000373– LIFEVERTALIM; LIFE15 ENV/ES/000379– LIFE MCUBO; transferability of the results of the LIFE-EMPORE project; LIFE15 ENV/ES/000382– LIFE LEMNA; LIFE15 ENV/ES/000394– LIFE DrainRain; LIFE15 ENV/ES/000480– LIFE REWATCH; LIFE15 ENV/ES/000530– LIFE LEACHLESS; LIFE15 ENV/ES/000591– LIFE-ANSWER; LIFE15 ENV/IT/000332– LIFE BITMAPS; LIFE15 ENV/IT/000391– LIFE MARINAPLAN PLUS; LIFE15 ENV/IT/000417– LIFE Paint-it; LIFE15 ENV/SE/000279– LIFE SURE and LIFE15 ENV/SE/000465– Hg-rid-LIFE.
12. On 3th of November of 2016, EPSAR organized a Technical Work day called “New technologies applied for waste water treatments”, where LIFE-EMPORE was introduced for the first time.
13. The Coordinator of EMPORE, LTL, has established contact with the Coordinator of LIFE Project BACIWATER and LIFE SOLUTIONS in order to start networking activities.
14. A parter of EMPORE, AIDIMME, has established contact with the Coordinator of LIFE Project BIOFER in order to start networking activities
15. A first identification of LIFE 2016 Networking Projects, which are listed below. Contact will be made with these projects on the forthcoming months: LIFE16 ENV/ES/000437– ALCHEMIA; LIFE16 ENV/ES/000419– LIBERNITRATE; LIFE16 ENV/ES/000390– BACIWATER; LIFE16 ENV/ES/000196– ECOGRANULARWATER; LIFE16 ENV/ES/000169– CLEAN UP; LIFE16 ENV/ES/000156– NEWEST; LIFE16 ENV/ES/000180– ALGAECAN;
16. LTL attended the Water JPI Conference 2018 “Emerging pollutants in freshwater ecosystems” in Helsinki (Finland) where took contact with a non-LIFE project WATINTECH.
17. Dissemination of the LIFE EMPORE project in the Water Knowledge Event in November 2018. At the event, LIFE EMPORE project was presented to a very specific audience, where it was possible to meet new professionals and companies working in issues involved with Eps problem by means of different perspectives. We made contact with the Emerging Pollutants Working Group to exchange results an up to date information on the issue of emerging contaminants and future legislation.
18. Participation of EMPORE-LIFE project in the Cultural Month of the University of Alicante Polytechnic School: Students visited the EMPORE demonstrator and the tertiary plant in Benidorm WWTP (Event organized by UA with the collaboration of: AIDIMME, CONSOMAR, IHE-UNESCO and EPSAR).
19. Participation of EMPORE-LIFE project by UA in the “Interregional workshop on water reuse technologies. How to apply the appropriate technologies to water reuse across the agricultural, industrial, urban and recreational sector of each region” organized by AQUARES project. Milan, 27-28th March 2019. LIFE-EMPORE participated in the aforementioned event and advised the different European delegations on the subject of legislation, technologies for the treatment of water and contaminants of emerging attention as a Stakeholder, with the presentation “Water reuse: The challenge of Emerging Pollutants” in which she put the LIFE EMPORE project as a case study.
20. Participation of EMPORE-LIFE project by AIDIMME in the “EU LIFE Regional Infoday-Networking Event” held on May 2019 in Valencia. Presentation of results of LIFE-EMPORE project and make contact with other coordinators for future proposals.

21. Participation of EMPORE-LIFE project by IHE and LTL in 16th IWA Leading Edge Conference on Water and Wastewater Technologies in Edinburgh. The presentation was accepted as a panel. With the increased public concern related to pollution by emissions of microconstituents of effluents, water utilities have to evaluate the impact of these emissions. The session, and the projects such EMPORE, addressed conversions in wastewater treatment plants and efficient technologies for the removal of these compounds.

DATE	MEMBER	ACTION	CATEGORY
03/11/2016	EPSAR	EPSAR Technical Work day	NETWORKING
30/11/2016	LTL	Attendance to Networking Event CFIS-ECOPHARMA	NETWORKING
24/02/2017	LTL	First contact with the Coordinator of LIFE Project IMPETUS to start networking activities.	NETWORKING
24/05/2017	LTL	The ESPP (European Sustainable Phosphorus Platform) contacted with the Laboratorios Tecnológicos de Levante, S.L in order to include EMPORE project to their list of R&D projects on nutrient recycling and	NETWORKING
30/05/2017	LTL	Participation in networking PROGRAMA LIFE 2017 “INFODAY REGIONAL” in Paterna (Valencia).	NETWORKING
28/06/2017	AIDIMME	Participation in the Technical Workshop Life BIOFER.	NETWORKING
24/08/2017	UA	Visit of the company SYDVATTEN AB, Sout Sweden Water Supply company. Oral presentation of the updated results of EMPORE project (UA).	NETWORKING
06/04/2018	LTL	First contact with the Coordinator of LIFE Project BACIWATER and LIFE SOLUTIONS in order to start networking activities.	NETWORKING
09/05/2018	AIDIMME	Participation in networking PROGRAMA LIFE 2018 “INFODAY REGIONAL” in Paterna (Valencia).	NETWORKING
06-07/06/2018	LTL	JPI WATER-Conference Helsinki. Contact with non-life project JPI www.watintech.eu	NETWORKING
12/06/2018	LTL	First contact with the Coordinator of a non-LIFE Project WATINTECH in order to start networking activities.	NETWORKING
28/11/2018	LTL	Dissemination of the LIFE EMPORE project in the Water Knowledge Event	NETWORKING
28/02/2019	UA	Participation of EMPORE-LIFE project in the Cultural Month of the University of Alicante Polytechnic School: Students visited the EMPORE demonstrator and the tertiary plant in Benidorm WWTP (Event organized by UA with the collaboration of: AIDIMME, CONSOMAR, IHE-UNESCO and EPSAR).	NETWORKING
27/03/2019	UA	Participation of EMPORE-LIFE project by UA in the “Interregional workshop on water reuse technologies. How to apply the appropriate technologies to water reuse across the agricultural, industrial, urban and recreational sector of each region” organized by AQUARES project. Milan, 27-28th March 2019.	NETWORKING
07/05/2019	AIDIMME	Participation of EMPORE-LIFE project by AIDIMME in the “EU LIFE Regional Infoday-Networkin Event” held on May 2019 in Valencia. Presentation of results of LIFE-EMPORE project.	NETWORKING
10-14/06/2019	IHE-LTL	Participation of EMPORE-LIFE project by IHE and LTL in 16th IWA Leading Edge Conference on Water and Wastewater Technologies in Edinburgh.	NETWORKING

More information is explained in the deliverable.

- **Problems encountered and deviations:** No problems neither deviation encountered.
- **Schedule:** The Action is progressing as scheduled.
- **Deliverables:** Deliverable is attached to this Final Report.

Action E1. Project management and operation.

Beneficiary responsible		Status
LTL		On going
Time schedule per Annex I	Starting date	End
36 months	01/09/2016	31/08/2019
Real time schedule	Starting date	End
	01/09/2016	31/08/2019

▪ **Objectives:** The aim of this action is to ensure the technical actions of the project are developed according to schedule and budget.

- To ensure that the deadlines for deliverables and milestones are met and risk management, providing with contingency solutions should a jeopardizing situation arise.
- To organize consortium meetings every six months
- To control project actions in terms of time and budget.

▪ **Progress:**

Within the activities carried out in Action E.1 (Project management and operation), the Consortium Agreement was signed, and the Project Management Guidelines were worked out and handed in to all the partners of the project.
Regarding Action E.1, LTL attended the LIFE Projects Call 2015 kick-off meeting that took place in Brussels, Belgium, in October 2016.
Four meetings were organized:
- The LIFE-EMPORE Project kick-off meeting in LTL's facilities in Paterna (Valencia, Spain) in September 2016.
- The 1st and 2nd Consortium Meetings both held in LTL's facilities in Paterna (Valencia, Spain) in March and September 2017, respectively.
- The 3rd Consortium Meeting, which took place in IHE's facilities in Delft (The Netherlands).
In addition to this, on 25/05/2017 and on 19/06/2016 EMPORE received the first and second visits of NEEMO EMT on behalf of the European Commission.

- The 4th Consortium Meeting took place in LTL's facilities in Paterna (Valencia, Spain) in November 2018.
- The 5th Consortium Meeting took place in LTL's facilities in Paterna (Valencia, Spain) in April 2019.

During the period of time covered by this report, LTL has managed all the project actions described above in terms of time and budget.
The External Expert Advisory Board (EEAB) is being created. In this sense, we have already done the first query to the Dirección General de Farmacia y Productos Sanitarios of the Generalitat Valenciana to obtain their feedback and advice. Other members of the EEAB are Dr. Diego Cortes and Dra. Yolanda Picó, from the Faculty of Chemist's (University of Valencia) and Professor Dr Antonio Camacho from the Cavanilles Institute of Biodiversity and Evolutionary Biology (University of Valencia).
Due to the delay in action B3, the consortium has requested an extension of the project until the end of 2019.

More information is explained in the deliverable.

▪ **Problems encountered and deviations:** No problems neither deviation encountered.

▪ **Schedule:** The Action is progressing as scheduled.

Deliverables: Deliverable is attached to this Final Report.

Action E2. After Life Plan.

Beneficiary responsible	Status

LTL	Completed	
Time schedule per Annex I	Starting date	End
36 months	01/09/2016	31/08/2019
Real time schedule	Starting date	End
	01/09/2016	31/12/2019

- **Objectives:** The aim of this action is to prepare a plan to disseminate the project results after the end of LIFE- EMPORE actions. All partners will be involved in this action and will be maintained during 5 years after the end of the project. This action will take advantage of established channels and means used during the project. However, no additional cost will be taken into account for After LIFE execution activities.
- **Progress:**

Completed.

During the las year, some meetings have been attended by the member of the consortium to design the AfterLIFE Plan. It was decided to include how the dissemination and communication of the results will continue after the end of the project and will give details regarding what actions will be carried out, when, by whom, and using what sources of finance.

The Consortium defined the Topics that will be covered as well as the Target Groups:

- Policy relevance
- Scientific community
- End-Users technology (Public Administrations/private companies)
- Public awareness (general public and citizens).

In the current condition of the pilot plant after B4 activities, it is not advisable to transport the plant to other European City to continue the demonstration. The structure of the transport container and the internal structures that hold the equipment are damaged, and breakdowns might occur during the transportation. On the other hand, it is necessary to make a great investment to do replacements and repairs of a great number of elements. All is explained in a new deliverable attach to this report.

Moreover, the consortium has positively considered the option of putting to the public the questionnaire linked to the developed decision support system and related software, thorough the project's website. This tool will be promoted during the After-Life period.

During the first six months of the After-Life period, the current website will be updated with the following:

- The period of project implementation.
- The list of emerging pollutants actually targeted by the project.
- The expected results section will be updated with the project findings and conclusions.

EMPORE project proposes to improve the current regulation of wastewater treatment with the obligation of analysing the occurrence of a list of micropollutants in all the European urban WWTPs, submitting the concentrations and the removal efficiencies reached by treatment in a common database. The initial list of compounds to be monitored in WWTPs should include at least, the priority substances included in Directive 2013/39/UE and the micropollutants included in the Watch List proposed by Decision 2018/840/UE or subsequent directives and decisions. The collection of that information will help the European Union to include these pollutants or not as priority compounds. The European Commission is who should consider this proposal, once it studies this Final Report.

Finally, the Coordinator will be constantly in contact with the emerging pollutant working group of the WWssTPplatform for support regarding policy relevance.

More information is explained in the deliverable.

- **Problems encountered and deviations:** No problems neither deviation encountered.
- **Schedule:** The Action is progressing as scheduled.

Deliverables: Deliverable is attached to this Final Report.

6.2 Main deviations, problems and corrective actions implemented

Several challenges have been encountered during the project development, which are listed as follows:

Action B1. Annual Analytical Campaign: As expected, analytical results are displaying the enormous variability in the concentration of Eps in wastewaters, as well as the seasonal variability which characterizes Benidorm. Some pollutants, fundamentally priority compounds, have not yet been detected, which could be due to the fact that these could have not been consumed or used during this period of time, but could appear in future samples. In order to ensure the objective of the action, the range of EP has been widened and additional compounds have been added to the previous list, more compounds are being analysed without extra financial consequences for the project. Main conclusions of **Action A1 (Evaluation of the situation on priority and emerging pollutants in Europe)** have been taken into account in the Initial Report, especially those regarding the physical-chemical parameters that could predict the behaviour of the selected pollutants. For this reason, staff of UNESCO-IHE and LTL have been coordinated and have collaborated actively during action B1, although UNESCO-IHE contribution to Action B1 was not initially foreseen.

Action B3. **Demo plant implementation and set up:** Adjustments in the optimization of the plant, equipment selection and plant programming have meant a deviation of four months in the completion date of task B3. The delays were caused by purchasing and deliver process of the container and main pumps. Other problems were related to the acquisition and installation of the unit's control elements and their integration in the PLC by means of the SCADA, which required more effort than what was foreseen. As a consequence, the start and end of the demonstration and maintenance task belonging to action B4 (Demostration in Benidorm WWTP) was put off 2 months and started in June 2018. It will last 12 months as foreseen so action B4 will be on-going until July 2019 including the increased list of pollutants targeted by the project. To ensure the achievement of the project objectives and to solve the delay, an amendment request has been sent to the European Commission modifying the project calendar for all the remaining B, C, D and E actions.

Action B6, which is led by UNESCO-IHE, was planned to start date in April 2019 (M32). However, the action implementation team includes participants in the IHE Delft master's program. The IHE Delft Master's Program ends in April 2019; therefore, UNESCO-IHE needs to initiate such action earlier in the year in order to give it enough time to the team for the correct implementation of the action. IHE Delft would need to initiate such action in May 2018 (month 21 of the project) and finalize it as stipulated in the initial implementation schedule in June 2019.

In this way, sufficient time would be given to the IHE Delft team, as well as to the IHE Delft team to better coordinate the LIFE EMPORE project work plan with the bi-annual timeline of the IHE Delft master's program. The proposed change does not imply a new departure budget for UNESCO-IHE, nor a redistribution of the budget between the budget lines. (staff, travel, etc.); simply, change involves a redistribution of resources and the staff load time initially budgeted for UNESCO-IHE. The UNESCO-IHE would also **start work earlier on action B5**: Definition of the methodology for pollutants removal in WWTPs.

In the end, the Consumables item is higher due to the extra analysis that were done during actions B1 and B4.

6.3 Evaluation of Project Implementation

Lessons learned:

In B1 LTL has learnt the enormous variability in the concentration of EPs in wastewaters as well as the importance of intermediate compounds, which will be taken into account in future projects.
In B2, AIDIMME became aware that technologies such as EAOPS require significant periods of time for its acquisition and manufacture. Consequently, to avoid risks of delays in the delivery of equipment and construction of the pilot, AIDIMME advanced the start of the design and contacted companies specialized in involved technologies. For future developments, this is something to consider when defining the workplan.
In B3, the partners became aware of the difficulties to install all the equipment in such a confined space as a container. To have in such small space, all the auxiliary equipment needed to perform all the operations have complicated the automatization process. Due to the limited space, a couple of the auxiliary equipment have more than one operation process involved. If another pilot plan will be design, enough room for a dedicated equipment will be taken into account.
In B4, LTL refined the analytical techniques lowering the detection limit of the emergent pollutants.
In B6, UNESCO-IHE has developed a DSS tool. During the execution of the tasks, they considered that the usability of the information gathered within the action, will be increased if each stakeholder will be able to perform a self-assessment of the transferability of LIFE EMPORE methodology results.
In C1, UA has developed a specific Water Quality Index that takes into account the presence of emergent pollutants. It is not easy to assess or compare the Water Quality without a measurable indicator.
In action D1, LTL has detected the necessity to have professional support regarding the communication activities. For that reason, they have contracted PixelArte to provide support. Communication is a key activity to impact the stakeholders and professional help is needed to ensure that impact.

Overview of results obtained:

Action	Foreseen in the revised proposal	Evaluation
A.1 Evaluation of the situation on prioritary and emerging pollutants in Europe	**Objectives:** Evaluate the situation on prioritary and emerging pollutants in Europe **Results:** the list of pollutants to guide the characterization of water samples for the WWTPs (B1 action)	Deliverable A1.01. European Emerging Pollutant Characterization (Already submitted in the Progress Report) and support to deliverable B1.01. Initial Analysis Report

A.2 Administrative procedures for access permission on demonstration WWTPs	**Objectives:** to obtain permission for the demonstration **Results:** Access permission authorisation to Benidorm WWTP	Deliverable A2. Official access permission to Benidorm WWTP (Already submitted in the Progress Report) got on October 2016.
B.1 Characterization of water samples for the WWTPs	**Objectives:** Quantify the pre-selected pollutants and their seasonal variabilities. **Results:** identify priority objective EP for designing and operate the future pilot plant.	Deliverables B1.01. Initial Analysis Report (Already submitted in the Progress Report) and B1.02 Final Analysis Report
B.2 Pilot plant design for pollutants removal	**Objectives:** Design of a demonstration plant for the elimination of selected contaminants in the project. **Results:** Design of a demonstration plant with a treatment capacity of 5.5 m3/h for water treatment at the Benidorm WWTP.	Dossier of technical specifications of the technologies designed Hydraulic flow diagrams of the three treatment levels.
B.3 Demo plant implementation and set up	**Objectives:** to install all units that were designed in Action B2. Ok **Results:** the pilot plant ready to start the demonstration. ok	Deliverables: B3.01. Treatment protocols comprising operational indicators (section 10.2.5) and B3.02. Manual of the pilot plant (section 10.2.6)
B.4 Demonstration in Benidorm WWTP	**Objectives:** to carry out the demonstration of the LIFE EMPORE project in a pilot plant. **Results:** elimination of emergent pollutant in BWWTP.	Deliverable B4.
B.5 Definition of the methodology for Emerging Pollutants removal in WWTPs	**Objectives:** The aim of this Action is to obtain a common methodology for the best technical and economical solution for the removal of the studied pollutant. **Results:** Define the best methodology for each compound.	Deliverable B5. For each selected emergent pollutant in Benidorm's WWTP, the optimal elimination methodology has been detailed. In this way, a stakeholder with a specific emergent pollutant problem, can select the best methodology for his situation.
B.6 Transferibility of the methodology for Emerging Pollutants removal	**Objectives:** to guarantee the replicability and transferability of the project actions, mainly the methodology for emerging pollutants removal action. **Results**: to transfer LIFE EMPORE demonstration results to 2 WWTP's placed in specific locations in Europe (different from Spain)	Deliverable B6. An assessment of 4 possible transfer locations has been done. The transferability depends largely on the previous equipment of the WWTP, as LIFE EMPORE methodology requires secondary treatments to operate at its optimum.
B7. Economic feasibility	**Objectives:** validate the methodology, confirm its potential national and	Deliverable B7. Different scenarios have been developed and the only viable option is to increase the sanitation fee. The action also has established the environmental impact

	international market, and know the environmental impacts. **Results:** a price range for water recovered and a ROI for the installation of the methodology in a new WWTP.	baseline for elimination of emergent pollutants in WWTP.
B8. Legal feasibility	**Objectives:** detection of the legal and regulatory regime and the possible obstacles to carry out the implementation of the methodology developed for the in-situ removal of emerging pollutants at European level **Results:** Legal assessment of the current situation of emergent pollutants	Deliverable B8.The lack of a policy framework for wastewater treatment and water reuse regarding micropollutants hinders the implementation of removal technologies such as the proposed by EMPORE methodology.
C.1 Effectiveness of the project actions: monitoring of the impact of ECs removal	**Objectives:** Monitoring of the impact of ECs removal **Results:** - Design of a set of monitoring indicators and the protocols to obtain them - Calculation of the quality indexes with the results obtained in actions B1 and B4	Deliverables C.01. Performance Indicators: Progress Statement (submitted in the Progress Report), C.02. Performance Indicators: Progress Statement and Verification. (section 10.2.2), C3 Environmental state MidTerm Report (section 10.2.7 and 10.2.8) and C.04. Performance Indicators: Progress Statement and Verification. (section 10.2.9). C.05. "Progress Performance Indicators: Midterm Statement" - C.07. "Progress Performance Indicators: Final Statement". - C.08. "Final environmental state report: General Quality Index of wastewater before treatment, General Quality Index of treated water and General Quality Index of Benidorm basin after plant treatment".
C.2 Monitoring the socio-economic impact of emergent pollutants removal	**Objectives:** Monitoring the socio-economic impact of emerging contaminants removal **Results:** - Design of a set of monitoring indicators and the protocols to obtain them - Calculation of the quality indexes with the results obtained in actions B1 and B4	Deliverables C.01. Performance Indicators: Progress Statement (submitted in the Progress Report), C.02. Performance Indicators: Progress Statement and Verification. (section 10.2.2), C3 Environmental state MidTerm Report (section 10.2.7 and 10.2.8) and C.04. Performance Indicators: Progress Statement and Verification. (section 10.2.9). C.06 Initial report on Conventional Activated Sludge (CAS) process in the Benidorm WWTP effluent quality and its possible uses (irrigation, cleaning…). - C.07. "Progress Performance Indicators: Final Statement". C.09. "Monitoring of the impact of the project actions: Final report on pilot plant effluent quality and its possible uses (irrigation, cleaning…)".
D.1 Dissemination and transferability of the project results	**Objectives:** communicate, raise awareness to the main target audience and demonstrate the	Project corporative image, project webpage setup, 350 notebooks, 50 pens. 500 copies of the project brochures in two languages,

	effectiveness of project main results and key messages. **Results:** obtain relevant impact on the project dissemination.	English and Spanish, project roll-up, a power point template, 1 panel 2 notice boards and more than 40 actions to disseminate the project (publications in websites, interviews, technical workdays, conferences oral presentations, etc.)
D.2 Networking with other LIFE and/or non-LIFE projects	**Objectives:** to exchange good practices and synergies, opportunities and new methodologies related to the scope of the LIFE EMPORE project **Results:** identify synergies and opportunities to collaborate with other projects.	Deliverable D2. Different networking activities have been performed
E.1 Project management and operation	**Objectives:** to coordinate the project execution, follow-up activities, control of budget while establishing communication with the EASME and EMT. **Results:** LIFE EMPORE successful execution and reporting to the EASME.	Progress Report was submitted in November 2017, while two different visits from the EMT took place during this period. Periodic consortium meetings were organized.

Results immediately visible:

- The situation in Europe regarding EP has been identified.
- The priority targets EP for designing and operate the future pilot plant have been identified.
- The pilot plant has been designed and set up and is Benidorm WWTP.
- A DSS has been developed and the transferability of 4 European locations have been done. 3 of the locations has scored as a possible site for using the methodology.
- For each emergent pollutant a defined methodology has been described, and they have been compiled into a deliverable to be used as a handbook
- An economic feasibility study has been done and the price for treated water has been calculated. This result has been communicated to the regional competent authorities.
- A quality water index for emergent pollutants has been developed to assess the current situation of emergent pollutants in WWTPs.
- Dissemination and Communication activities has been carried out, engaging key stakeholders in the emergent pollutant problem.

Results from replication efforts: In action B6, 4 different locations have been studied as replication sites. 3 of them are suitable to use LIFE EMPORE methodology. The project intended to transfer the pilot plant to Croatia for one of those sites, however, after an evaluation of the status of the pilot plant, we have decided not to transfer the pilot plant itself as serious problems due to corrosion and water leaks have appeared in the pilot plant. For that reason, only transfer of the knowledge will be performed during the After Life Plan

Effectiveness of the dissemination activities:

Expected results	Associated Action	Deadline	Objective	Status
Communication and Dissemination Plan	D1.1	December 2016	Plan the communication and dissemination actions to be performed within the project execution	100% done
EMPORE printed promotional materials	D1.2	No deadline was set in Technical Annex	Provide different merchandising and promotional material to disseminate the project	100% done
Demo video	D1.2	March 2018	To show in a video demo results	The video edition has been done and is available in our website.
Technical publications	D1.2	No deadline was set in Technical Annex	To disseminate project results via technical publications	Not published yet (0%)
Scientific publications	D1.2	No deadline was set in Technical Annex	To disseminate project results via technical publications	2 Scientific Articles, a PH D Thesis and a book chapter
Trade fairs and exhibitions	D1.6	No deadline was set in Technical Annex	To disseminate project results via conferences attendance and oral presentations	The project beneficiaries have attended to 72 conferences and workshops where they have disseminate LIFE EMPORE project objectives and achieved results (50%).
Workshop organizations /technical visits	D1.6	No deadline was set in Technical Annex	To organize specific workshops and technical visits to disseminate project results.	100% done
NoticeBoards	D1.2	March 2017	To design and install at the different beneficiaries premises notice boards	1 panel was initially designed, and 2 notice boards with the project corporate image have been designed (100%).
Final Infoday	D1.6	December 2019	To organize the final infoday of the project	100% done
Website	D1.3	December 2016	To design and setup the project website.	Already available (100%)
Layman's report	D1.5	December 2019	To design an easy to read document where the project results are described	100% done available

Networking activities	D2.1	February 2017, 2018 and 2019	To identify and contact to the different LIFE and non-LIFE projects with potential sinergies with LIFE EMPORE	100% done

6.4 Analysis of benefits

Environmental benefits:

The indexes used to assess the quality of the effluents regarding the presence of micropollutants in indicator 1.3-21, CWQI-EC and WQIEC, enhance the interpretation of the concentration of several micropollutants to a general public, because they consider those concentrations, but the evaluation of the quality is provided by a dimensionless scale of 0 to 100, where 100 is the best value.

Due to the presence of priority substances and emerging pollutants, the quality of the influent and secondary effluent of Benidorm WWTP, measured by means of the indicator 1.3-21, was poor during the characterization campaign (period Nov.16 to Dec.17) in action B1. The conventional treatment carried out in Benidorm WWTP reduced the concentration of several micropollutants; however, the quality of the secondary effluent was poor, evidencing the need to apply tertiary treatments as the proposed in EMPORE project to remove the remnant microcontaminants.

In action B4 (period Jul.18 to Jun.19), the quality of the secondary effluent of Benidorm WWTP was poor-marginal (WQIEC=42-53) due to the presence of micropollutants. The substances continuously detected were diuron, erythromycin, fluoxetine, glyphosate, sulfamethoxazole, carbamazepine and diclofenac; chlorpyrifos, estrone, ibuprofen, ketoprofen, isoproturon and DEHP were intermittently found. The pretreatment of EMPORE plant (conventional filtration followed by ultrafiltration) was efficient to remove suspended solids and turbidity. The treatments carried out in the line of permeates (reverse osmosis and activated carbon) of the DEMO plant improved the quality of the effluents. The reverse osmosis unit showed exceptional micropollutant removal efficiency and produced high-quality permeates (WQIEC=95-100), almost free of micropollutants and with low conductivity (< 200 $\mu S \cdot cm^{-1}$). The occasional traces of glyphosate, sulfamethoxazole, diclofenac and carbamazepine detected in permeates were removed by activated carbon, obtaining an effluent of excellent quality (WQIEC=100).

In conclusion, the combination of technologies Pretreatment + Reverse Osmosis + Activated Carbon reduced the concentrations of all priority substances detected in the secondary effluent of Benidorm WWTP below the annual average environmental quality standard (AA-EQS) of Directive 2013/39/EU and reduced the concentrations of the pharmaceutical compounds by 99% of their original concentration, producing a high quality effluent (flowrate = ~3.5 m^3/h).

On the other hand, the quality of the UF/RO concentrates was poor (WQIEC=39-43). The electro-oxidation unit, operated at a current of 10 A with 1 pass through the reactor cells, improved the quality of the UF/RO concentrates, producing effluents ((lowrate = ~1.5 m^3/h) with marginal-fair quality (WQIEC=43-85). Although the objectives were met only to priority substances DEHP, isoproturon and diuron, it dares highlighting that the Electro-oxidation improved the quality of the rejections, reducing the discharge of micropollutants to the environment.

The EMPORE methodology enables to protect the Benidorm basin, reducing the concentration of emerging contaminants discharged onto the environment.

Economic and Social benefits:

The interest aroused by the project has increased since the last Progress Report, as indicators 12.1.1 and 12.1.2 evidence. The EMPORE members have made a great effort to raise awareness of the need to remove priority substances and ECs from the secondary effluent of conventional wastewaters. In that sense, we have tried to disseminate the importance of the EMPORE methodology. The visitor counter registered since the launch of the website to 31st December 2019, the access of 967 users to the EMPORE website, and in addition, the EMPORE members have participated in 125 events, distributed in: publications in online journals and (own) websites (82) , assistance to congresses (24), interview (2) and networking sessions with other LIFE projects and companies (14) and technical publications (3).

The networking events has allowed the dissemination of the EMPORE project and the interchange of ideas and results related to: current and future trends in the monitoring and control of emerging pollution in the water cycle; importance of studying intermediate compounds; improvement of the methodologies for removing pharmaceutical products; knowledge of other LIFE projects; among others. The EMPORE methodology has been explained in congresses and networking events in front of a professional audience. Hitherto, the EMPORE members have participated in 14 networking events.

To contribute in the incorporation of the proposed technologies in the current wastewater treatment plants, it is necessary to raise awareness of the importance of protecting the environment from these harmful substances and contribute to the social acceptance of the reclaimed water. Indicator 12.1.3 has allowed to assess the social acceptation of reclaimed water of some companies and communities of irrigators, water experts and researchers and members of the academical community in Spain. Despite some disadvantages related to the use of reclaimed water (price, difficulty to guarantee traceability and food safety, pumping and storage infrastructures), irrigators would use more reclaimed water if the prices were competitive and the quality of the resource was fully guaranteed and suitable for any type of agricultural use.

It is worth noting that both the academic community and water experts are aware of the presence of emerging pollutants in wastewaters and agree on the need to combine technologies to remove them efficiently, since conventional wastewaters are not currently prepared for that purpose. Some useful technologies are advanced oxidation processes, reverse osmosis, adsorption onto activated carbon and electrochemical processes. In general, they consider that the elimination of emerging pollutants could have positive impact mainly on public health, environmental and sustainability and in integrated management of water resources.

Considering the opinion of the academic community, the three main factors that can make difficult the detection/removal of emerging pollutants in waters were: development of analytical methods and cost of analytical equipment, requirements of the current regulation and high cost of the existing technology to remove emerging pollutants.

The use of the quality index (1.3-21 and 1.3-22) will contribute to the social acceptation of reclaimed water because these indexes allow a simple assessment of water quality. The measurement of water quality through a global index on a scale of 0 to 100, facilitates the interpretation of the results regardless of the knowledge that each one has. This fact contributes to making all sectors (experts or not on water issues) participants of the improvements reached.

For the design, set up and preliminary operation of the DEMO plant several water technicians have been required (Mª Ángeles Bernal and Lyvia Mendes-UA; Silvia Oyonarte- AIDIMME; Javier Andreu-CONSOMAR; Antonio Sánchez and Raúl García – LTL) due to the complexity of the plant, apart from the technical staff team. Therefore, if the technologies were scaled and implanted in the BWWTP, the creation of new jobs to operate the plant would be required.

On the other hand, the implantation of the EMPORE technologies in BWWTP would also produce positive effects on the regional development of La Marina Alta due to the increase on the production of highquality water available for irrigation. According to indicator 16.1, the percentage of production of water free of ECs and salts during demonstration (July 2018 to June 2019) was 63.1±5.2 %.

Replicability:

In general, there was a good correlation between the removal efficiencies reached by the ultrafiltration and reverse osmosis units of EMPORE pilot plant and “Instalación de Regeneración de Aguas Depuradas” (IRAD) Benidorm (full-scale plant), which supports the extrapolation of the technology to a large-scale level, as it is detailed in action B7.

Innovation and demonstration value:

The processes used in the EMPORE plant are well known individually in some European countries and, outside Europe, only in few countries such as Singapore, Israel or EE.UU. Nevertheless, their combination is not yet widespread. Therefore, the combination of technologies proposed by EMPORE is innovative.

The methodology followed by the EMPORE project to measure the water quality is also innovative, by means of the application of the Canadian Water Quality Index referred to the concentration of priority substances and emerging pollutants (CWQI-EC) and the proposal of a new index based in the CWQI named WQIEC, which includes a penalization factor in the calculation of the excursion that differentiates between the kind of contaminant (priority substance, watch list substance and others).

Both indexes (CWQI-EC and WQIEC) enhance the interpretation of the concentration of several micropollutants to a general public, because they consider those concentrations, but the evaluation of the quality is provided by a dimensionless scale of 0 to 100, where 100 is the best value.

The use of the quality index (1.3-21) will contribute to the social acceptation of reclaimed water because this index allows a simple assessment of water quality.

Policy implications and impact:

The EMPORE methodology is used as a tertiary treatment to remove emerging pollutants from the secondary effluents of urban WWTPs. So, a fundamental requirement for its implementation is the existence of a secondary treatment in the selected WWTP that allows complying with the requirements for discharges stipulated by Directive 91/271/CEE.

It is essential to verify the economic, social and environmental feasibility of the plant. In addition, a characterization campaign of the effluents of the selected WWTP is required to assess the occurrence of micropollutants.
Concerning urban wastewater treatment, the discharges of the WWTPs are legislated by Directive 91/277/CEE, which establishes the obligation of monitoring some water quality parameters (organic matters, solids and nutrients) and set the quality standards. However, this directive and Directive 98/15/CE don't regulate the elimination of emerging pollutants in WWTPs.

The lack of a policy framework for wastewater treatment and water reuse regarding micropollutants hinders the implementation of removal technologies such as the proposed by EMPORE methodology. Future regulations in the European framework should include quality standards for micropollutants in the effluents of wastewaters. In case of reuse, new regulations should focus on different uses of reclaimed water and set quality standards for micropollutants. Only the recent proposal "Proposal COM (2018) 337 final 2018/0169(COD)" focused on the use of reclaimed water for irrigation, set that when necessary and appropriate to ensure sufficient protection of the environment and human health, specify requirements for water quality and monitoring will be considered, such as the environmental quality standards for priority substances and certain other pollutants laid down in in Directive 2008/105/CE.

For instance, it is important to outstand that the understanding of the removal of micropollutants in wastewaters is restricted since the analyses for these compounds are exceptional. This makes difficult the elaboration of an official European database with information referred to the presence and removal of these compounds from the influents of WWTPs in all the European regions.

EMPORE project proposes to improve the current regulation of wastewater treatment with the obligation of analysing the occurrence of a list of micropollutants in all the European urban WWTPs, submitting the concentrations and the removal efficiencies reached by treatment in a common database. The initial list of compounds to be monitored in WWTPs should include at least, the priority substances included in Directive 2013/39/UE and the micropollutants included in the Watch List proposed by Decision 2018/840/UE or subsequent directives and decisions. The collection of that information will help the European Union to include these pollutants or not as priority compounds.

7 Key Project-level Indicators

All the Key Project level indicators can be found in Annex 9. The indicators has been divided into two blocks as the plant has two different exists with different emerging pollutants concentration.

8 Comments on the financial report

8.1 Summary of Costs Incurred

In the table below, the total incurred costs until the end of the project are presented:

PROJECT COSTS INCURRED				
	Cost category	Budget according to the grant agreement in €*	Costs incurred within the reporting period in €	%
1.	Personnel	1.139.489,00 €	1.093.681,79 €	96%
2.	Travel and subsistence	108.497,00 €	58.127,14 €	54%
3.	External assistance	46.700,00 €	56.120,57 €	120%
4.	Durables goods: total non-depreciated cost	235.477,00 €	234.077,23 €	99%
	- Infrastructure sub-tot.	- €	- €	
	- Equipment sub-tot.	- €	- €	
	- Prototype sub-tot.	235.477,00 €	234.077,23 €	99%
5.	Consumables	108.335,00 €	129.182,81 €	119%
6.	Other costs	28.700,00 €	20.699,56 €	72%
7.	Overheads	116.703,00 €	111.432,00 €	95%
	TOTAL	1.783.901,00 €	1.703.321,09 €	95%

A detailed description of each category cost per action and partner can be found in Annex 9.6

9 Annexes.

List of Annexes

Annex 1. Dissemination and Communication activities list
Annex 2. Cost incurred per partner per category
Annex 3. Cost incurred per action
Annex 4. Communication with the EASME
Annex 5. Communication with the EMT
Annex 6. Breakdown salary complements used in the daily rate calculation per partner.
Annex 7. Deliverables
Annex 8. Financial Statements
Annex 9. KPI Excel files

9.1 Annex 1. Dissemination and Communication activities list

The list of the dissemination and communications activities, which have been done during the project is the following:

Nº	ACTIVITY	PARTNER	LINK	DATE
1	Publication in the Coordinator's website the grant received from LIFE Programme	LTL	http://www.ltlevante.com/noticias.php?id=30&pag=0 www.life-empore.org	06/09/2016
2	Publication in the Coordinator's website the kick-off meeting in Paterna (Valencia, Spain)	LTL	http://www.ltlevante.com/noticias.php?id=31&pag=0 www.life-empore.org	28/09/2016
3	Interview on the portal "Actualidad universitaria" General information and presentation of LIFE EMPORE.	UA	-	19/10/2016
4	Publication in the on-line journal AGUAS RESIDUALES the KoM Paterna.	LTL	http://www.aguasresiduales.info/revista/noticias/arranca-el-proyecto-life15-empore-de-eliminacion-de-contaminantes-emergentes-de-edar--sme4g	11/10/2016
5	Publication in the on-line journal AGUAS RESIDUALES kick off of EMPORE project .	UA	http://www.aguasresiduales.info/revista/noticias/la-universidad-de-alicante-investiga-la-eliminacion-de-contaminantes-emergentes-en-ed-rvZIS	26/10/2016
6	EPSAR Technical Work day	EPSAR	-	03/11/2016
7	Daniel Prats, from Universidad de Alicante is interviewed about EMPORE project.	UA	http://www.ua.es/	04/11/2016

8	Publication in the Coordinator's website the kick-off of Action B.1	LTL	http://www.ltlevante.com/noticias.php?id=33 www.life-empore.org	28/11/2016
9	Publication in the on-line journal AGUAS RESIDUALES kick off of Action B.1	LTL	http://www.aguasresiduales.info/revista/noticias/arranca-el-proyecto-life15-empore-continua-con-la-campaña-de-analisis-de-contaminantes-emergentes-realiza-hz1RS	30/11/2016
10	Attendance to Networking Event CFIS-ECOPHARMA	LTL	www.life-empore.org	30/11/2016
11	Publication in the on-line journal AGUAS RESIDUALES the attendance to Networking Event CFIS-ECOPHARMA	LTL	http://www.aguasresiduales.info/revista/noticias/laboratorios-tecnologicos-de-levante-presenta-el-proyecto-life-empore-en-el-cfis-ecop-vWP7c	14/12/2016
12	Publication (by CETAQUA) in the on-line journal AGUAS RESIDUALES the attendance to Networking Event CFIS-ECOPHARMA	LTL	http://www.aguasresiduales.info/revista/noticias/cfis-ecopharma-celebra-un-networking-sobre-contaminantes-emergentes-en-santiago-de-co-zPviC	09/12/2016
13	Publication in the on-line magazine NOTICIAS HABITAT objectives and start-up of the EMPORE project	AIDIMME	http://www.noticiashabitat.com/2016/metodologia-eficiente-para-eliminar-contaminantes-emergentes-en-las-edars/	31/12/2016
14	Publication of the EMPORE methodology on facebook	AIDIMME	http://www.facebook.com/pg/aidimme.Instituto Tecnologico/post/Tret+page_internal	02/01/2017
15	Publication in AIDIMME newsletter the grant received from LIFE Programme	AIDIMME	http://actualidad.aidimme.es/2017/02/16/metodologia-eficiente-eliminar-contaminantes-emergentes-las-edars-aidimme-participa-proyecto-europeo-life15-empore/	17/02/2017
16	Publication in the on-line journal AGUAS RESIDUALES kick off of EMPORE website.	LTL	http://www.aguasresiduales.info/revista/noticias/ya-esta-disponible-la-web-del-proyecto-life-empore-para-la-eliminacion-de-contaminant-ooBdz www.life-empore.org	28/02/2017
17	Publication in the on-line journal AGUAS RESIDUALES 1st EMPORE meeting.	LTL	http://www.aguasresiduales.info/revista/noticias/los-socios-del-proyecto-life-empore-para-la-eliminacion-de-emergentes-celebran-su-pri-TjK4w. www.life-empore.org	14/03/2017
18	Communication LIFE Project website is already available.	LTL	life-comm@neemo.eu	16/03/2017
19	Publication of the first visit of the LIFE External Monitoring Team of the European Commission.	LTL	www.life-empore.org	25/05/2017
20	Communication and publication that LIFE-EMPORE project joined to the celebration of the 25th anniversary of LIFE Programme	LTL	http://life-25.eu/ life-comm@neemo.eu www.life-empore.org	30/05/2017
21	Participation inTechnical Workshop on N and P removal in WASTEWATER (life+ TL-BIOFER)	AIDIMME	http://www.aguasdecordoba.es/files/JORNADAS/PROGRAMA%20JORNADAS.pdf	28/06/2017
22	Publication in AIDIMME newsletter the participation in Technical Workshop Life TL BIOFER	AIDIMME	http://actualidad.aidimme.es/2017/07/20/aidimme-participo-en-la-jornada-tecnica-eliminacion-de-nitrogeno-y-fosforo-en-aguas-residuales/	20/07/2017

23	Publication in the on-line journal NOTICIAS HABITAT of participation inTechnical Workshop on N and P removal in WASTEWATER	AIDIMME	http://www.noticiashabitat.com/2017/aidimme-participo-en-la-jornada-tecnica-eliminacion-de-nitrogeno-y-fosforo-en-aguas-residuales-proyecto-life-empore/	20/07/2017
24	Publication in the on-line journal NOTICIAS HABITAT description of the EMPORE methodology	AIDIMME	http://www.noticiashabitat.com/2017/desarrollo-de-una-metodologia-eficiente-y-sostenible-para-la-eliminacion-de-contaminantes-emergentes-de-edars/	07/09/2017
25	Publication of the III Follow up meeting-Seminar of EMPORE project in Delft.	AIDIMME	http://actualidad.aidimme.es/2018/05/17/aidimme-participa-en-el-ihe-de-delf-a-una-reunion-de-seguimiento-del-proyecto-empore-life15-env-es-000598/	17/05/2018
26	Publication AIDIMME introduces LIFE-EMPORE Project at the Regional LIFE Infoday.	AIDIMME	http://actualidad.aidimme.es/2018/05/31/infoday-regional-presentacion-proyecto-life-empore/	01/06/2018
27	Communication and publication that LIFE-EMPORE project joined to the celebration of the 25th anniversary of LIFE Programme	AIDIMME	http://actualidad.aidimme.es/2017/06/08/programa-life-2017-infoday-regional-presentacion-resultados-proyectos/	08/06/2017
28	Attendance to Networking Event LIFE-BIOFER	AIDIMME	http://actualidad.aidimme.es/2017/07/20/aidimme-participo-en-la-jornada-tecnica-eliminacion-de-nitrogeno-y-fosforo-en-aguas-residuales/	20/07/2017
29	Attendance to Networking Event LIFE-BIOFER.	LTL	www.life-empore.org	21/07/2017
30	UA participated in the congress "La reutilización en la industria en el marco de la economía circular", held in Madrid (1st June 2017), with an oral presentation introducing, among others, LIFE EMPORE project. Presentation: Andrés Molina Giménez (IUACA member)	UA	http://aedyr.com/language/es/jornada-2/	01/06/2017
31	Visita de la empresa SYDVATTEN AB, Sout Sweden Water Supply company. Presentación oral sobre los proyectos desarrollados por el IUACA (UA), mención especial al proyecto LIFE EMPORE (LIFE15 ENV/ES/000598).	UA	https://iuaca.ua.es/es/noticias.html	24/08/2017
32	Publication in IUACA newsletter of the visit of SYDVATTEN AB	UA	https://iuaca.ua.es/es/noticias.html	07/09/2017
33	Publication of the II Follow up meeting of EMPORE project .	LTL	http://www.life-empore.org/en/2nd-follow-up-meeting-of-life-empore-project/	27/09/2017
34	Participation in the congress "Primer seminario internacional sobre contaminantes emergentes; Colombia". Oral presentation: "LIFE EMPORE	UA	http://encuentros.universia.net/agenda/universidad_santo_tomas-primer_seminario_internacional_de_contaminantes_emergentes/eventos/medio-ambiente/2018/16337/100/129.html	08/03/2018

	(LIFE15 ENV/ES/000598). Programe publicated in UNIVERSIA.			
35	Participation in the congress "V Jornadas hispano-brasileñas sobre Gobernanza del agua en la smart city". Oral presentation: "LIFE EMPORE (LIFE15 ENV/ES/000598). Oral Communication. 16/04/2018	UA	https://iuaca.ua.es/es/documentos/documentos/congresos/2018-v-jornada-hispanobras.pdf	16/04/2018
36	Publication of the III Follow up meeting-Seminar of EMPORE project in Delft.	LTL	http://www.life-empore.org/en/3rd-life-empores-follow-up-meeting-in-delft-the-netherlands/	27/04/2018
37	Participation in the "XIV Congreso Nacional de Comunidades de Regantes" held in Torrevieja (Spain) from 14-18th May 2018, carrying out a survey.	UA	https://congresoregantesalicante.org/wp-content/uploads/2018/05/PROGRAMA-SOLO-FINAL-17.00h.pdf	14/05/2018
38	Publication AIDIMME introduces LIFE-EMPORE Project at the Regional LIFE Infoday.	LTL	http://www.life-empore.org/en/aidimme-participates-in-the-regional-infoday-of-the-life-2018-program-giving-last-news-about-the-european-project-life-empore/	01/06/2018
39	Attendance to JPI Conference 2018. Oral Communication.	LTL	"http://www.life-empore.org/en/aidimme-participates-in-the-regional-infoday-of-the-life-2018-program-giving-last-news-about-the-european-project-life-empore/	09/06/2018
40	Publication of the EMPORE leaflets in IUACA newsletter.	UA	https://iuaca.ua.es/en/news.html	14/06/2018
41	Attendance to META Leon Conference 2018. Oral Communication. Publication in META Leon 2018 website	UA	http://meta2018.congresos.unileon.es/wp-content/uploads/sites/6/2018/06/PROGRAMA-XIII-CONGRESO-ESPA%C3%91OL-DE-TRATAMIENTO-DE-AGUAS.pdf	19/06/2018
42	Publication of the presentation of LIFE EMPORE in the II Workshop of Climate Change website + linkedin (News)	LTL	http://www.life-empore.org/presentacion-del-proyecto-life-empore-en-la-ii-jornada-sobre-el-cambio-climatico/	01/11/2018
43	Publication of the presentation of LIFE EMPORE in the Ecofira website + linkedin	LTL	http://www.life-empore.org/life-empore-visita-la-ecofira-2018/	01/11/2018
44	Presentation of the LIFE EMPORE project in the III Go Global Congress	LTL	http://www.life-empore.org/en/news/	01/11/2018
45	Publication of the presentation of LIFE EMPORE in the III Go Global event (website + linkedin)	LTL	http://www.life-empore.org/life-empore-y-biowat-kit-dos-ejemplos-de-exito-de-la-internacionalizacion-de-pymes-valencianas/	01/12/2018
46	Dissemination of the LIFE EMPORE project in the Water Knowledge Event	LTL	http://www.life-empore.org/en/news/	01/12/2018

47	Publication of the presentation of LIFE EMPORE in Water Knowledge Europe (website + linkedin)	LTL	http://www.life-empore.org/noticias/	01/12/2018
48	Publication of the presentation of LIFE EMPORE in Water Knowledge Europe website of LTL	LTL	http://www.ltlevante.com/noticias.php?id=52	01/12/2018
49	Publication of the presentation of LIFE EMPORE in the III Go Global event in LTL website	LTL	http://www.ltlevante.com/noticias.php?id=51&pag=0	01/12/2018
48	Presentation of LIFE EMPORE project in CONAMA	ADIMME	http://actualidad.aidimme.es/2018/12/16/conama-acoge-la-presentacion-del-proyecto-life-empore/	01/12/2018
49	Publication of LIFE EMPORE in Go Global Congress 2018 by Aguas Residuales	LTL	https://www.aguasresiduales.info/revista/noticias/life-empore-y-biowat-kit-dos-ejemplos-de-exito-de-la-internacionalizacion-de-pymes-va-zE9Us	01/12/2018
50	LIFE-EMPORE realiza una encuesta sobre Contaminantes Emergentes durante las XIV Jornadas Técnicas ESAMUR sobre Saneamiento y Depuracióncarries out a survey on Emerging Pollutants during the 14th ESAMUR Technical Conferences on Sanitation and Water Depuration	UA	http://www.life-empore.org/en/life-empore-carries-out-a-survey-on-emerging-pollutants-during-the-14th-esamur-technical-conferences-on-sanitation-and-water-depuration/	01/12/2018
51	PARTICIPACIÓN DEL PROYECTO LIFE15 EMPORE EN EL CONGRESO NACIONAL DEL AGUA ORIHUELA	UA	https://iuaca.ua.es/es/noticias-mas_noticias.html	01/01/2019
52	JORNADA TÉCNICA "TRATAMIENTO Y ELIMINACIÓN DE CONTAMINANTES EMERGENTES EN EFLUENTES DE ESTACIONES DEPURADORAS URBANAS"	UA	https://iuaca.ua.es/es/noticias-mas_noticias.html	01/01/2019
53	VISITA A LA PLANTA PILOTO DEL PROYECTO LIFE15-EMPORE Y AL TERCIARIO DE LA EDAR DE BENIDORM	UA	https://iuaca.ua.es/es/noticias-mas_noticias.html	01/03/2019
54	JORNADA TÉCNICA "TRATAMIENTO Y ELIMINACIÓN DE CONTAMINANTES EMERGENTES EN EFLUENTES DE ESTACIONES DEPURADORAS URBANAS"	LTL	http://www.life-empore.org/en/life-empore-carries-out-a-survey-on-emerging-pollutants-during-the-14th-esamur-technical-conferences-on-sanitation-and-water-depuration/	01/01/2019
55	JORNADA TÉCNICA "TRATAMIENTO Y ELIMINACIÓN DE CONTAMINANTES EMERGENTES EN EFLUENTES DE ESTACIONES DEPURADORAS URBANAS"	ADIMME	http://actualidad.aidimme.es/2019/02/27/life-empore-jornada-tratamiento-eliminacion-contaminantes-valencia/	01/01/2019
56	Evolución del proyecto LIFE EMPORE	LTL	http://www.life-empore.org/evolucion-del-proyecto-life-empore/	01/01/2019

57	INFODAY PROGRAMA LIFE 2019	ADIMME	http://actualidad.aidimme.es/2019/05/16/aidimme-participa-infoday-regional-programa-life-2019/	16/05/2019
58	LIFE EMPORE en el workshop del proyecto AQUARES en Milán	UA	http://www.life-empore.org/life-empore-en-el-workshop-del-proyecto-aquares-en-milan/	01/06/2019
59	LIFE EMPORE en el Congreso Internacional del Wessex Institute y la Universidad de Alicante	UA	http://www.life-empore.org/life-empore-en-el-congreso-internacional-del-wessex-institute-y-la-universidad-de-alicante/	01/06/2019
59	In June 2018, EMPORE attends the Water JPI Conference 2018 “Emerging pollutants in freshwater ecosystems” in Helsinki (Finland) with an oral communication.	LTL	http://www.life-empore.org/en/news/	05-06/06/2018
60	In June 2018, EMPORE participates in “META Leon Conference 2018” with an oral communication. Publicized in META Leon 2018 website.	LTL	http://www.life-empore.org/en/news/	01/06/2018
61	EMPORE attended the 12th International Congress of the Spanish Association of Desalination and Reuse (AEDyR) the 23th of October 2018 in Toledo, Spain.	LTL	http://www.life-empore.org/en/news/	23/10/2018
62	EMPORE presentation on the Working Day called “Climate Change and Sustainable Food” the 12th of November 2018 in Valencia, Spain.	LTL	http://www.life-empore.org/en/news/	12/11/2018
63	EMPORE visited ECOFIRA 2018, an international fair celebrated during 6, 7 and 8th of November of 2018.	LTL	http://www.life-empore.org/en/news/	06-07/11/2018
64	EMPORE attended “WATER KNOWLEDGE EUROPE” event, celebrated in Brussels the 28th and 29th of November and organised by WssTP (Water Supply and Sanitation Technology Platform).	LTL	http://www.life-empore.org/en/news/	29/11/2018
56	LIFE EMPORE Project attended the technical conference ‘Treatment and elimination of pollutants, emerging from effluents by urban treatment plants’, organized by EPSAR on February 12th, 2019.	LTL	http://www.life-empore.org/en/news/	12/02/2019
66	On February 28th, 2019, students from the Higher Polytechnic School of the University of	LTL	http://www.life-empore.org/en/news/	28/02/2019

	Alicante (EPS Alicante) visited EMPORE pilot plant.			
67	EMPORE project participated in the National Water congress held on February 2019 in Orihuela (Alicante, Spain) organized by the University of Alicante.	LTL	http://www.life-empore.org/en/news/	01/02/2019
68	EMPORE project participated in the AQUARES interregional project workshop held on March in Milan Last 27th and 28th of March, 2019.	LTL	http://www.life-empore.org/en/news/	27-28/03/2019
69	On May 8th took place the 10th International Congress organized by the Wessex Institute of the United Kingdom and the University of Alicante. The conference was celebrated in Alicante and counted with the participation of the LIFE EMPORE Project.	LTL	http://www.life-empore.org/en/news/	08/05/2019
70	EMPORE PROJECT was at the first convention on micro contaminants in water at the Santiago de Compostela University during the13th y 14th of June, 2019.	LTL	http://www.life-empore.org/en/news/	13-14/06/2019
71	EMPORE Project participated in the 'XIII International Research Conference on Wastewater Treatment and Treatment Plants' held on last 12th of December in Rome, (Italy).	LTL	http://www.life-empore.org/en/news/	12/12/2019
72	Final Infoday took placed the 16th of December 2019.	LTL	http://www.life-empore.org/en/news/	16/12/2019