



**Upgrading wastewater treatment plants by Low
cost Innovative technologies for energy
Self-Sufficiency and full recycling**

LIFE ULISES Deliverable

**D.E.6.1. Replicability and Transferability
Plan of LIFE ULISES project**

Project acronym:	LIFE ULISES
Project full title:	Upgrading wastewater treatment plants by Low cost Innovative technologies for energy Self-Sufficiency and full recycling
Grant agreement no.:	LIFE18 ENV/ES/000165
Responsible partner for deliverable:	AQUALIA
Contributing partners:	CETIM
Author(s):	Santiago Garcia (CETIM), Rebeca Varela (CETIM)
Nature of deliverable ¹ :	R
Dissemination level ² :	CO
Delivery date:	30/06/2023

Version control

Number	Date	Description	Publisher	Reviewer
1.0	01/02/2022	Guidelines Structure	Rebeca Varela (CETIM)	All partners
2.0	15/03/2023	First draft	Santiago García (CETIM)	All partners
3.0	30/06/2023	Final version	Santiago García (CETIM)	All partners

¹ **Nature of Deliverable:** **P**= Prototype, **R**= Report, **S**= Specification, **T**= Tool, **O**= Other.

² **Dissemination level:** **PU** = Public, **RE** = Restricted to a group of the specified Consortium, **PP** = Restricted to other program participants (including Commission Services), **CO**= Confidential, only for members of the Consortium (including the Commission Services)

Contents

1	Introduction	4
2	Summary of the LIFE ULISES project	4
3	Methodology of the guidelines	5
4	Guidelines for the replicability of LIFE ULISES technology in a WWTP	6
4.1	Market sector analysis	6
4.2	Local context analysis	7
4.3	Evaluation of the existing conditions of the WWTP system	8
4.4	Deployment of Life Ulises Technologies	8
5	Guidelines for the replicability of biogas technology in other sectors	11
5.1	Sector analysis	11
5.2	Territorial analysis	11
5.3	Analysis of the characteristics of the installation	12
5.4	Installation	12
6	Guidelines for the transfer of solar treatments	13
6.1	Transfer of Linear Fresnel Collector technology	13
6.2	Transfer of the Photo-Fenton treatment	14
7	Guidelines for nutrient recovery technology transfer	14
7.1	Enzymatic hydrolysis technology	14
7.2	Struvite precipitation technology	15
8	Tips for technology transfer to other sectors	15
9	Main barriers and risks in the replication and transfer of the LIFE ULISES technology	18
10	Good practice tools	20
11	Conclusions	21
	Annex 1 - Limiting criteria for ULISES technology	22
	Annex 2 - List of applications and software used	24
	Annex 3 - Institutional support	26

1 Introduction

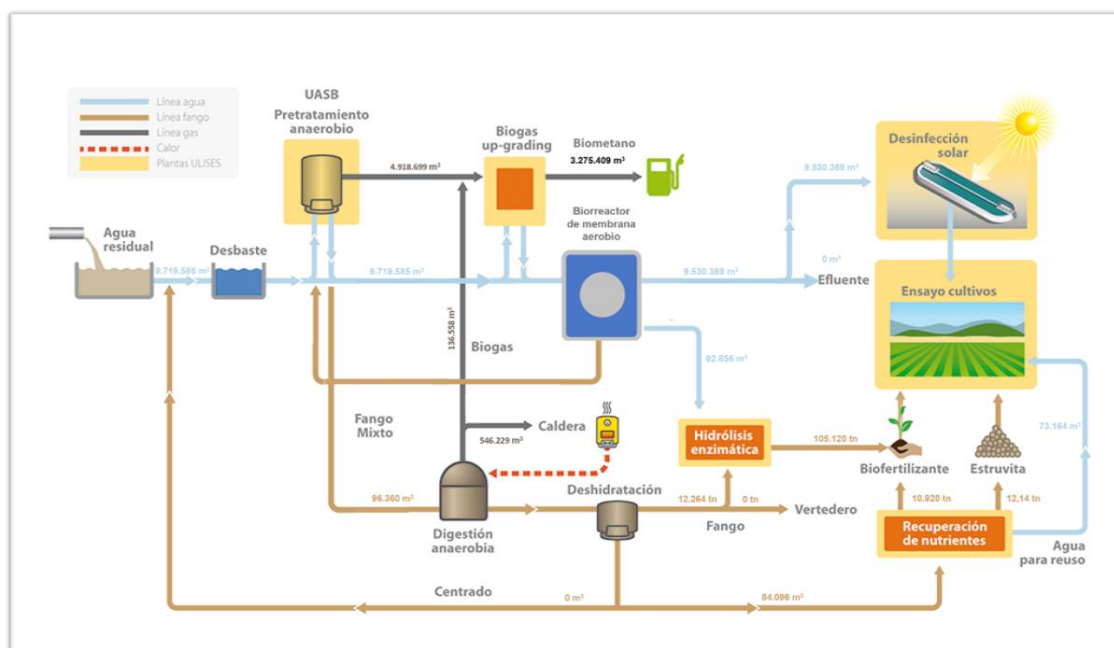
This set of guidelines is conceived as a reference document that is not intended to establish legal or procedural guidelines or to be binding in relation to the identification, negotiation, transfer and, more generally, the management of technologies. Its aim is to provide guidance and information on the main aspects to be considered before and during the process of technology replication and the different types of situations and relevant aspects to carry out a successful transfer to other sectors, thus promoting the creation of new technological settings and applications, or the improvement of existing ones.

Throughout its different sections the document analysis and defines the key elements that will allow the entities receiving the ULISES technology to carry out replication efficiently and successfully, both in WWTPs and in other sectors where the technology can be transferred. In this way, the guide aims to be a tool for the actors involved in the process, establishing uniform criteria and common procedures for successful replication and transfer of the LIFE ULISES results. The guidelines cover as well as IP protection and technology transfer requirements, as well as the promotion of knowledge production and management, thus fostering the entrepreneurial spirit.

2 Summary of the LIFE ULISES project

The LIFE ULISES project aims to revolutionise conventional wastewater treatment processes through a range of novel technologies that produce valuable resources such as biofuel for its use in vehicles, agricultural biofertilizers and water suitable for reuse from wastewater. The project also aims to reduce the energy consumption and carbon footprint associated with water treatment by increasing the efficiency of a conventional wastewater treatment plant (WWTP) through the integration of different technologies in each of its main lines (water, gas, and sludge):

- Biogas enrichment with the ABAD Bioenergy® system to produce renewable biofuel for vehicles.
- PUSH anaerobic pre-treatment combined with AeMBR System to halve energy consumption in the treatment process.
- Solar photo-Fenton and Fresnel collector disinfection treatments to produce recycled water for reuse in irrigation.
- Enzymatic hydrolysis treatment of sludge to obtain a high quality agricultural biofertilizer.
- Technology for the recovery of struvite from centrifuges using an osmosis-based process.



3 Methodology of the guidelines

Two different methodologies are used in this guide, one for the replicability guidelines and a separate one for the transferability guidelines. For the replicability guidelines, the methodology consists of 4 phases: 1. Understanding the situation of the sector through qualitative data, 2. Analysis of the characteristics of the site, 3. Study of the characteristics of the facilities wishing to adopt the technology, 4. Evaluation and implementation. This methodology is flexible and can be adapted to the characteristics of each site.

The sections cover the technology transfer to other sectors follow a different scheme, first explaining in which sectors solar treatment technology, on the one hand, and nutrient recovery technology, on the other, could be of interest, and then introducing a series of key factors to be considered in technology transfer. On the other hand, the guidelines for technology transfer to other sectors follow a different scheme, first explaining which sectors could be of interest and then giving a series of wide advice and indications on technology transfer.

The last sections of the guide deal with cross-cutting issues that complement in a general way what is presented in the document, such as obstacles and risks limiting the scope of ULISES technologies, good practice tools and final conclusions.

4 Guidelines for the replicability of LIFE ULISES technology in a WWTP

4.1 Market sector analysis

The aim of this section is to understand the main characteristics of the water treatment sector in order to understand the scope of the Life Ulises technological value proposition, comparing data from the European sector with data from Spain, where Life Ulises technology validations have been carried out, to establish the interest that the Life Ulises solutions may generate.

- **Source of flow:** In Europe³, cooling use in electricity generation is the largest contributor to total annual water abstraction (32%) according to data from 2019, followed by agriculture (28%), public water supply (20%), manufacturing (13%), cooling in manufacturing (5%), and finally mining, quarrying and construction, which each account for only 1% of total abstraction. On the other hand, in Spain⁴, agriculture accounts for 70% of water consumption, followed by public water supply (15%), cooling in electricity generation (14%) and the remaining sectors (1%).

These data on sectors of consumption can be used as indicators of potential pollutants present in the wastewater to be treated and the possible need for certain treatments associated with each pollutant. As stated above, the three main uses are the same in Europe and in Spain, although in the latter the agricultural use is much higher, which may give place, in other EU countries to a lower presence of biological pollutants and a lower amount of recoverable organic matter dissolved in the water. Although this is not determinant, it needs to be considered since, a priori, the efficiency of some technologies, such as tertiary treatment and nutrient recovery, could be limited by the distribution of consumption in European countries where agriculture is less important, especially further north.

- **Number and average size of plants:** In 2020, the European Union had 21,351 WWTPs, of which 2,110 were in Spain. 86.62% of the WWTPs in Europe have a capacity between 2,000 and 100,000 PE, while Spain follows the same distribution, with a slight increase, to 88.91%⁵.

This data shows that the capacities of the treatment plants in Europe and Spain are similar, which makes it easier to upgrade the plants to ULISES technology, which has been validated in plants with the same capacity.

³ [EEA, Water Abstraction by Economic Sector, 2000-2019.](#)

⁴ [EEA, Water Abstraction by Economic Sector for Spain, 200-2019.](#)

⁵ Urban Wastewater Directive Treatment Plants Data Viewer

- **The population connected to the network with at least secondary treatment**, in 2020, achieved 81.12% in European Union and 86.93% in Spain, both growing at an average of 1% per year over the last 20 years. Showing that the need for water treatment is increasing⁶. The demand for water treatment technologies such as the ones developed in Ulises will increase as the population connected to the network continues to grow.
- **Reuse rate:** In Europe, less than 3% of treated wastewater was reused in 2016, while in Spain the rate reached around 12%⁷. Spain is one of the leading countries in water reuse, an advantage that can be exploited by the project in its exploitation strategy and market penetration.
- **Uses of recycled water:** In Europe, recycled water is mainly used for agricultural purposes, between 60% and 80% depending on the area and increasing in southern countries (Contentidosemc, 2020), reaching 72% in the case of Spain in 2020 (INE - Instituto Nacional de Estadística, s. f.) Other uses are: environmental use to improve other water sources, recreational, urban and industrial uses. The distribution of reused water consumption follows the same pattern as that of abstracted water. This aspect adds value to the ULISES tertiary treatment technologies and shows a consolidated market in which they can be exploited.
It is important to note that reused water is prohibited for any other use that poses a risk to human health or harms the environment. These include human consumption, the food industry and refrigeration, use in hospitals and similar institutions, the cultivation of filter-feeding molluscs in aquaculture, bathing water, etc.

In conclusion, the innovations proposed by ULISES have a wide scope for adaptation in Spain and the rest of Europe, especially in areas where agriculture has a greater weight in the economy.

4.2 Local context analysis

WWTPs are very sensitive to the geographical conditions of the site, so it is important to understand the specifics of the site where the ULISES technology is to be replicated. In addition, at the organisational level, a variety of scenarios may arise due to a multitude of factors, which may be of a legal, institutional, or environmental nature, which must also be understood. As a guide, some of the main features to be considered are listed below.

- **Geographical conditions:** Location, demography (population to be served and project horizon population...), climatology (annual distribution of irradiance, temperature, number of hours of sunshine, rainfall patterns...), water uses and quality,

⁶ https://ec.europa.eu/eurostat/databrowser/view/SDG_06_20/default/table?lang=en

⁷ Sala-Garrido, R., Molinos-Senante, M., Fuentes, R., & Hernández-Sancho, F. (2020). *Reutilización de agua: estado actual y perspectivas*. Fedea. Recuperado 16 de agosto de 2023, de <https://documentos.fedea.net/pubs/dt/2020/dt2020-09.pdf>

determination of expected flood levels, possible environmental impact on the surrounding area (noise, odours...).

- **Administrative organisation** (framework of responsibilities, planning, regulations and management, hydrological plan, discharge requirements, existence of ecological zones: natural parks, ZEPAS, Natura 2000 network...).

4.3 Evaluation of the existing conditions of the WWTP system

The study of the records of previous measurements, if possible, depending on the availability of accurate up-to-date monitoring systems, allows us to know the main characteristics of the flow rates, and it is also necessary to analyse the technical characteristics of the equipment already installed. In doing so, knowledge on the values of the main parameters, and cross-reviewing them with the limit values for the optimal operation on LIFE Ulises technologies, as shown in the appendix of this guide, it is possible to determine whether the project technologies are suitable for the new site.

Additionally, knowing the technical characteristics of the equipment and infrastructure already existing at the WWTP, makes it possible to determine whether it will be necessary to replace obsolete technologies or just improvements, and also to make an approximation of the cost of updating the installation before carrying out any action.

Some of the most common parameters to be analysed are:

- **Flow characteristics:** Water flow rate of the treatment plant, flow rate of treated water discharged into the sea, regenerated water flow rate, indicator of the adequacy of the flow received to the design flow (under sizing of treatment plants), biological oxygen demand (BOD) of treated water discharged to the sea, chemical oxygen demand (COD) of treated water discharged into the sea, suspended solids (SS) of treated water discharged into the sea, total nitrogen in treated water discharged into the sea, total phosphorus in treated water discharged into the sea.
The need for this step, and whether it requires specific tests or just compilation on data, depends on whether the WWTP can provide the data.
- **Technical characteristics of the installation:** existing technical standards, available technology and treatments, existing supply, sewerage, and treatment installations, management of supply and sanitation systems, rainwater management, possible reuse of treated effluents.

4.4 Deployment of Life Ulises Technologies.

This section outlines a path that needs to be followed for the implementation of the LIFE Ulises technologies into a given WWTP, which is the same as the one followed in the ULISES pilots.

- The first step will be to install new meters and upgrade the SCADA system for monitoring and control (if this is already in place, it will only be necessary to upgrade the system). Measurements need to be taken over a significant period, ideally between 6 and 12 months, to have an annual series of data or to get an idea of the possible variations during the different seasons of the year.
- Preliminary characterisation of flow rates, gas and sludge flows will then take place. This includes:
 1. Characterise the gas flows (characterisation of organic matter and quality and quantity of biogas produced).

It may be that the plant does not have gas production facilities, if so, it would be advisable to take a sample of the biomass produced by the WWTP and simulate its digestion at laboratory scale in order to test whether the gas obtained is within typical parameters.

In any case, we will quantify those parameters that are considered most important for biogas production: L/G ratio, CH₄, CO₂, O₂, H₂S, Humidity and the rest of the parameters listed in Annex 1.
 2. Chemical and biological characterisation of influents/effluents: identification of threats to be treated depending on the uses/destinations of the effluent (Ph, COD, IC, E. Coli, conductivity, turbidity, anions and CECs).
 3. Characterisation of the sludge line: dewatered sludge and centrate flow (number of metals, E. Coli and Salmonella, electrical conductivity, pH, etc.).
- Compare the measurements with the typical values of the parameters (see Annex 1) to assess whether the technology can be installed and is likely to achieve its optimal application.
- Post-evaluation phase and calibration of the models based on the data collected: development of the calculations, constraints, and simulations in Easy JavaScript Simulations (not necessarily the same programme as that used for the LIFE ULISES demonstration) and their optimisation.
- Determine the technical characteristics of the installation: necessary works, new equipment and infrastructure needed and their size, a life cycle costing and a life cycle assessment in order to determine an estimate of the necessary budget. It may be necessary to increase the size of the pilot used in the LIFE_ULISES.
- Apply for the necessary licences and permits (environmental impact, works, etc.).
- Installation of the technology in the water line including:

1. If the system has a UASAB, it would be necessary to see if it is possible to install the modifications of the PUSH system. If this is not possible, or if there is no UASAB, a new reactor will be installed.
 2. The AeMBR system is coupled to the PUSH system, so the installation of both technologies will take place simultaneously.
- Installation of the technology in the gas line (ABAD Bioenergy System)
 1. It is necessary to have a water line for the operation of the system.
 2. If there is no gas line, a digester, preferably a UASAB, should be installed.
 - Installation of the technology in the sludge line:
 1. Hydrolysis reactor for the treatment of the dehydrated fraction of the sludge and the extraction of liquid fertilisers.
 2. Struvite precipitation system based on FO-MD membranes for the recovery of nutrients in the form of struvite from the centrate stream obtained from dewatering.
 - Installation of tertiary treatment: LIFE ULISES project counts with two types of solar treatment technologies, both types of treatment are substitutes for each other. By studying the characteristics of the site and based on simulations we will decide which is the most appropriate before installation.
 1. Solar treatment by FRESNEL solar collectors
 - a) Technical characterisation of the mirrors (size, number, inclination of the reflecting surface, solar tracking).
 - b) Determination of the reagent concentration (H_2O_2), environmental conditions (temperature and radiation), hydraulic residence time, treatment capacity, etc.).
 - c) Control system design (modelling, tuning, and simulation).
 2. Disinfection by the Solar photo-Fenton process
 - a) Determination of the reagent concentrations (oxidant and catalyst), pH, environmental conditions (temperature and radiation), hydraulic residence time, treatment capacity, etc.).
 - b) Development of kinetic models to simulate the process and calibration of them based on the data collected.

5 Guidelines for the replicability of biogas technology in other sectors

The same methodology explained in this guide is to be followed for the case of replication only of the biogas technology in sectors outside the wastewater treatment one.

5.1 Sector analysis

At the end of 2019, there were almost 19.000 biogas plants in the European Union. Of these, 2,800 are sewage sludge plants, 1,600 are landfill waste plants and 14,600 are agro-industrial plants. In addition to these 19,000 biogas plants, there are around 725 biomethane plants in Europe⁸.

In Spain, the number of biogas plants in the same year was 146, of which 46 were located in landfills, 34 in wastewater treatment plants, 13 in the agricultural sector, 7 in the paper sector and the rest in the chemical, food and other sectors. In the same year, Spain had one plant for converting this gas into biomethane.⁹

The European Commission estimates that by 2050 biogas will account for between 20% and 60% of current gas demand. We can therefore conclude that this is a booming sector in which ULISES technologies could be well received.

When looking at the distribution of biogas plants by sector, it is possible to see that the sectors where the technology can be applied, without considering the WWTP, are generally the agri-food industry, the agricultural sector, and urban landfills. In general, it can be any sector that produces organic waste with a high content of vegetable oils, animal fats, sugars, or starches.

Other sectors where biogas plants could achieve good results are the fisheries sector, the oil industry, the sugar industry, or the fermented alcoholic beverage industry such as beer, wine, and cider.

5.2 Territorial analysis

In the case of biogas production, the geographical conditions are not too limiting, although it is known that tropical or high temperature climates they favour the implementation of anaerobic technologies, since they favour the decomposition of matter and also allow for the reduction of the size required for the system structures.

⁸ <https://smallops.eu/numero-plantas-biogas/>

⁹ <https://www.idae.es/tecnologias/energias-renovables/uso-termico/biogas>

In terms of regulatory or organisational constraints, the same variables must be considered as in the previous section, where replication in a WWTP was explained.

5.3 Analysis of the characteristics of the installation

In this step there can be two different situations, a first scenario in which the site already has the technology to produce biogas and we are going to upgrade it with ULISES technology, and a second scenario in which we do not have a previous biogas production plant.

1. If there is already a biogas plant in operation, the steps to follow are as follows:
 - Analysis of the previously installed plant
The presence of a water line and the type of digester is the main component to be investigated:
 - a) There are a water pipe and digester: it is possible to add the ABAD system, increasing the quality of gas.
 - b) There is no water pipe: it will be necessary to install a water line to allow the ABAD system to work.
 - Biogas characterisation: this step is somewhat redundant, as we assume that the plant already produces biogas and data on the main parameters should be available. If not, it will be necessary to install meters to indicate the quality and quantity of biogas produced. We will then compare the values obtained with the typical values for gas produced depending on the type of waste, given in Annex 1 of this guide.
2. If the site does not have a gas production plant, it will be necessary:
 - Study the availability of a water line or the feasibility of creating one.
 - Choosing the most suitable digester type.
 - Characterize the waste to be used: take a sample to test whether the quality of the gas produced is in accordance with the parameters of Annex 1.

5.4 Installation

The installation of the ABAD system is not very complex, the main complication will be the creation of a water line in cases where this is necessary, requiring building permits, licences, land studies and economic feasibility studies.

6 Guidelines for the transfer of solar treatments

Solar technologies are the ones that pose more issues since they require very specific conditions, and their application is rather limited to a few sectors. The thermal energy demand of the process, the production profile, the available space, the geographical location, the climatic conditions, the low cost of fossil fuels, the thermal storage systems- which are still in the research phase-, and inefficient or non-existent energy policies are very important conditioning factors when implementing this type of solar technologies.

Despite the difficulty of transferring them, some interesting data that can guide operators is shown below.

6.1 Transfer of Linear Fresnel Collector technology

The Fresnel solar collector treatment is a well-known method in the wastewater treatment sector. Another sector where its use is widespread is the food sector due to the fact that many processes require very high temperatures. In particular, it is the medium temperature industrial processes, those requiring temperatures between 100 °C and 400 °C, where this technology is most widely used.

This table summarises the different industries and processes where this technology is useful:

INDUSTRY	PROCESS	TEMPERATURE RANGE (°C)
Mining	Drying, concentrate smelting, solution heating, washing	100-400
Wood by-products	Slurry preparation	120-170
Desalination	Heat transfer fluid temperature increase	100-250
Canned food	Sterilisation	110-120
Paper	Bleaching	130-150
Chemicals	Soaps, synthetic rubber, process heat, oil	100-260
Textile	Drying, degreasing, fixing	100-180
Dairy	Sterilisation	110-120

Plastics	Preparation, distillation, separation, extension, drying, mixing	120-220
Heat treatment	Medium tempering	350-450
Refrigeration	Double-acting absorption machine	120-190

Nevertheless, the improvements proposed by ULISES, such as the heat exchanger, which helps to improve the efficiency of the technology by using the heat from the outflow with the inflow and the electro-valve that allows better control of the flow, are easily transferable to installations where Fresnel technology already exists.

6.2 Transfer of the Photo-Fenton treatment

The Fenton reaction is widely used in wastewater, contaminated soils and sludges for organic contaminant removal, toxicity reduction, biodegradability improvement, BOD/COD reduction, odour and colour removal or elimination of resin in radioactive contaminated sludge. In general, any industry that produces water containing persistent organic contaminants because of its production process, such as the petrochemical, pharmaceutical, dairy, microbiological laboratory or solvent industries, could use this technology to treat their effluent and obtain water for reuse.

On the other hand, the strategy used for the development of kinetic models as well as the use of virtual sensors for process control are also methodologies that are used in other sectors. In this way the software developed in the project can be easily adapted to other processes to be transferred to other sectors.

7 Guidelines for nutrient recovery technology transfer

7.1 Enzymatic hydrolysis technology

In general, the enzymatic hydrolysis reactor can be used with any type of biomass or organic waste, whether animal or vegetable. The most interested sectors would be those that can reintroduce the resulting products, i.e., biofertilizers, into their production process, in this case the agricultural sector, or those that can easily market them, such as the livestock sector, which has a strong interaction with the agricultural sector.

Another interested segment are the current companies trading in biofertilizers and solutions for organic agriculture. Some of the companies that have based their business model on these products are Biorizon Biotech, Symborg, Asfertglobal, Syngenta, Valagro, among others.

7.2 Struvite precipitation technology

The biofertilizer market is in full expansion since the adoption of European legislation, which considers biofertilizers as a group of fertilisers and unifies the different national regulations that existed until now, giving greater guarantees to suppliers of these products. In addition, the EU's objectives for 2030 are to reduce the use of chemical fertilisers by 20% and to make 25% of the agricultural surface area organic, which will serve as a driving force for the sector.

As the main constituents of struvite are magnesium, phosphorus and nitrogen, the sectors or companies interested are those that produce waste with a high content of these components. The following is an indicative list of products with these characteristics, and therefore sectors where transfer of the LIFE ULISES struvite technology could result optimal.

- Wastes with high P content: wastewater from the dye industry (cochineal-carmine), leather tanning, fertiliser industry, soft drink industry, yeast, nylon, rare earths, poultry wastewater, pig wastewater, cattle manure, landfill leachate, dairy products such as yoghurt, milk and cheese, cereals such as bread, tortillas, brown rice and oats, nuts and seeds such as cashew nuts and sesame, or pulses such as lentils, beans and peas, or vegetables such as potatoes and asparagus.
- Waste with high N content: Food waste: fruit, slaughterhouses, manure: Cow, pig, poultry, sheep, wood, and straw: sawdust, wheat straw, pine wood, paper, garden waste, general biomass.
- Waste with high Mg content: Maize, dates, watercress, avocado, seeds, spinach, almonds, chocolate, beans, chickpeas and lentils, walnuts, quinoa, bananas, oats.

Because both enzymatic hydrolysis and the solution used in the struvite precipitator take place in aqueous medium, the presence of a water pipe is a prerequisite for the installation of both technologies.

8 Tips for technology transfer to other sectors

This section describes some of the main aspects to be considered in technology transfer, where the implementation of LIFE Ulises technologies requires a more complex process and further steps, since the validation during the project is not directly replicable and its role as

– Identification of end-users and intermediaries

In general, the main target group for the LIFE Ulises technology is the industrial water treatment sector with a plant capacity of between 2,000 and 100,000 PE. In this field, in the European context, we highlight major companies such as Veolia (France), Suez Environnement S.A. (France), Acciona (Spain), Pentair plc (United Kingdom), United

Utilities Group P.L.C. (United Kingdom), Kingspan Water & Energy (United Kingdom), Kemira Oyj (Finland), BASF SE (Germany), among others.

The agricultural sector is another sector interested in ULISES technologies for biogas production. Recent years have seen extensive growth in the Energy Crops sector, with a focus on growing crops exclusively for biofuel production. In addition, crop residues not related to the energy sector can also benefit from the direct implementation of these technologies or by selling the residues to companies in the gas and biogas sector. A list of companies operating in the sector can be found on the website of the Spanish Gas Association at the following link: <https://www.gasrenovable.org/guia-gas-renovable/>

Similarly, as mentioned in the previous section, the agricultural sector, together with fertiliser suppliers, is the main target market for nutrient recovery technologies.

Regarding solar treatments, in addition to the water treatment sector, we have indicated in the previous sections the sectors that could be used for ULISES technologies.

– **Industrial property protection**

When it comes to protecting R&D results, it is necessary to be aware of the different mechanisms available and to identify which one offers the greatest advantages in terms of technology transfer:

- Patents and utility models: these grant the right to exclusive exploitation in a given territory, subject to annual renewal and payment of fees, and are limited in time (20 years for the patent and 10 years for the utility model).
- Industrial design: This instrument grants protection only to the appearance or shape of all or part of a product for 5 years, renewable in 5-year periods up to a maximum of 25 years.
- Distinctive signs: Trade names and trademarks. Trade names protect signs or designations of natural or legal persons during their business, while trademarks protect signs identifying products or services. They do not expire if they are renewed every ten years.
- Trade secret: protection of practical industrial and commercial processes which are known to a limited number of people, and which confer a competitive advantage on those who do not possess them. It does not require any administrative procedures but depends only on the internal protocols that a company can establish to prevent the leakage of information.
- Confidentiality agreements: These allow the confidentiality or secrecy of information and/or data to which a third party may have access to be maintained.
- Copyright: Protection of creations resulting from the intellectual activity of individuals from the moment of their creation (books, musical compositions, sculptures, photographs, translations, etc.).

- Geographical indications: These protect differences due to origin or production method, such as Protected Designation of Origin and Protected Geographical Indication.

Regarding the strategy followed with the different ULISES technologies:

ULISES TECHNOLOGIES	INTELLECTUAL PROPERTY STRATEGY
ABAD System	Patented
PUSH Reactor	Patented
AeMBR System	Patent Pending
FO-MD struvite precipitation plant	Protection under study
Enzymatic hydrolysis reactor	Protection under study
Solar photo Fenton plant	Utility Model
Linear Fresnel solar collector	Patent pending

– Search for funding

- Public funding: Every year, the main national and European funding agencies issue various calls for proposals to support technology transfer, public-private cooperation or cooperation between research organisations and companies.
- Private funding: In addition to the traditional forms, such as the transfer of exploitation rights to a company that decides to replicate or scale up the technology, there are other initiatives, such as private equity funds dedicated exclusively to financing the creation of spin-offs or start-ups dedicated exclusively to bringing the latest technological innovations to the market.

– Communication and dissemination of results

As part of the exploitation strategy, and following the strategy detailed in the After Life report, attendance or organisation of Brokerage Events, bilateral meetings between two organisations interested in a technological offer or demand or in establishing business cooperation agreements, which are organised within the framework of the most relevant sectorial fairs in Europe, often organised by transfer associations or public administrations.

9 Main barriers and risks in the replication and transfer of the LIFE ULISES technology

The following list includes some of the barriers and risks that have been identified already, but it is not a definitive list, and new ones may be identified as the technology matures in the process of replication and/or transfer.

– Lack of qualified workers

The use of new technologies requires training for the people who use them. The simple solution is to provide internal training for employees. In some specific cases, it may be necessary to recruit new, more qualified staff, thus increasing the cost of implementing LIFE Ulises technologies but at the same improving the socio-economic impact of the project, generating new qualified jobs.

– Biased data collection

An outdated or incomplete monitoring system could interfere with the pre-assessment when deciding which ULISES technologies to install. Mitigating this will depend on a good preliminary assessment of the state of the installation, the need to add new meters, their quality, as well as proper data collection.

– Preliminary analyses and evaluations are costly.

The characterisation work, the consultancy work and, in general, the preliminary studies to decide whether the technologies are suitable are a sunk cost that companies must assume without any guarantee that the technology will be implemented.

– Cybersecurity

The water treatment sector, like others, is not exempt from the dangers that exist on the internet, particularly ransomware attacks, which encrypt databases in exchange for a financial ransom. This can largely be avoided by having good cybersecurity protocols in place for employees - again, employee training is important - and, ultimately, regular backups of servers or cloud services.

– Labour safety

The use of new technologies also presents health risks for workers, again, this can be solved with good prior training and strict safety and occupational risk protocols. The inclusion of a permit/authorisations step in the replication and transfer processes covers this issue as well. Whenever particular issues are identified in the occupational hazard assessment, modifications to the technologies and the way they are operated will be considered, to allow for replication/transfer of the technologies while ensuring safety of the operators.

- **Operational capacity greater than design capacity of WWTPs**

A very common occurrence in wastewater treatment plants is that the design capacity of the plant has been exceeded due to a steady increase in the volume of wastewater flowing into the plant over the years. This ultimately results in lower treatment efficiencies. In addition, previous measurements may not be meaningful, and the installation of ULISES technology may not have a major impact and an extension of the plant may be more convenient.

- **Change in the contracted electricity tariff**

The incorporation of new technology may require the plant to have more electrical capacity installed and although this technology may result in cost savings and increased plant efficiency; initially, a new electricity tariff may result in higher costs for the operator until the plant is fully modernised.

- **Climate change**

Climate change can lead to changes in rainfall patterns, levels of solar radiation, temperatures and many of the climatological and geographical factors previously commented, affecting the efficiency of plant systems. In the cross-referencing of the location/installation characteristics against Life Ulises technologies limits, as defined in Annex 1, a range with a margin to ensure that the technologies will generate benefits, even in the ever-changing scenario of climate change.

- **Economic capacity**

While it is true that switching to ULISES technologies will result in cost savings for the operator, the initial investment may be too high for the company to bear. It may be necessary to seek grants, subsidies, or other forms of external funding.

- **Productive fabric made up mainly of SMEs**

Countries with a business fabric dominated by small and medium-sized enterprises, such as Spain, find it more difficult to absorb the various innovations on the market. This characteristic to some extent hinders the transfer of research results to companies. The modular nature of LIFE Ulises technologies can be of assistance, since it allows for the implementation of one of them at a time, reducing the investment requirements.

- **Need for a regulatory framework with greater safeguards**

It is possible that some of the LIFE Ulises innovations may not be regulated in a way that allows them to reach their full potential, either because of excessive regulation or because of a lack of regulation. An example of this is the biogas sector, which is constantly growing and changing, and which needs an updated, homogeneous regulation that provides guarantees for the various actors in the sector.

10 Good practice tools

This section comprises a series of recommendations and useful information for anyone interested in the water reclamation ecosystem, replicability, technology transfer and R&D developments.

– Evaluation and monitoring system

Once the technology is up and running, continuous monitoring and follow-up is essential to identify further improvements or potential problems in the functioning of the systems, thus contributing to further cost savings.

Similarly, it is advisable to establish a set of indicators to evaluate the success of the replication or technology transfer:

- Companies involved
- Total investment
- Total savings achieved
- Number of deviations
- Hours of staff training
- Other indicators

Some of these indicators also allow us to make comparisons between the results of the sending and receiving organisations, and to identify patterns and improvements in the scheme set out in this guide.

– Key information for businesses, consumers and interested bodies on wastewater treatment, landfills, ecosystem regeneration and new water technologies

Even without being involved in wastewater treatment, it is possible to contribute to making wastewater treatment easier for the various operators. This section contains several tips that can be applied daily by the various players in society in order to reduce the load on wastewater treatment plants, thereby contributing to better waste management, greater sustainability and environmental protection, less likelihood of overflows, longer system life and, in general, greater availability of water resources.

Responsible water use is possible:

- Avoid non-functional use such as flushing solids, paper, wet wipes, and tampons down the toilet. These wastes should be disposed of in the appropriate container.
- Avoid wasting water: Turn the tap off between uses, do not leave the tap running while brushing your teeth, washing dishes, etc.
- Keep water pipes in good condition: repair broken pipes, leaks, regular inspections, etc.

- Install low-flow or moderate-flow taps.
 - Optimise the use of water-consuming appliances such as washing machines and dishwashers.
 - Use products such as fabric softeners in moderation as they use a lot of water.
 - Minimise or avoid the use of rubbish disposals; pouring food down the drain increases nitrogen levels in wastewater.
 - Do not pour oil, grease, degreasers, acids, industrial oils, paints, disinfectants, and pesticides down the drain.
- **List of contacts and companies associated with the project**

To facilitate the information to any interested party or to attend to any doubt or problem that may arise in the replication and technology transfer process, the main contacts of the Life ULISES project are provided below.

- **Aqualia**
Website: <https://www.aqualia.com/>
Office directory: [Canales de atención al cliente \(aqualia.com\)](#)
- **CETIM**
Website: <https://cetim.es/>
Telephone: +34 881 105 624
e-mail: info@cetim.es
- **Energylab**
Website: <https://energylab.es/>
Telephone: +34 986 120 450
e-mail: info@energylab.es
- **CIESOL**
Website: <https://ciesol.com/>
Telephone: +34 950 214 423
e-mail: info@ciesol.es

11 Conclusions

The LIFE Ulises project has developed these guidelines with the aim of contributing to the transfer of research results to the market, thus improving the water innovation ecosystem and the exchange and transparency of information.

This document is addressed to all stakeholders, but especially to water professionals from river basin agencies, authorities, water utilities, suppliers of related technologies, as well as researchers, research funding agencies and knowledge transfer institutions involved in the water management process, with the aim of changing their attitudes for the better.

In conclusion, the implementation of ULISES technology can bring significant benefits to the wastewater treatment sector by reducing operating costs, reducing water losses and optimising energy consumption. The implementation of ULISES technology in water systems across Europe would benefit citizens by allowing operators to reduce water tariffs. Reduced water losses due to proper monitoring and maintenance of infrastructure will result in less water being taken from other sources, allowing for better management of natural resources. In addition, reduced electricity consumption contributes to the protection of the environment, as most electricity today is still produced from non-renewable sources, usually fossil fuels, with the associated CO₂ emissions.

The technical requirements for the implementation and use of this technology in a wastewater treatment plant and in other potential sectors have been identified, as well as the main barriers to its implementation, making it clear that the ULISES technology has potential for success in a wide range of companies.

Finally, it should be mentioned that these guidelines have received financial support from the European Community under the LIFE programme.

Annex 1 - Limiting criteria for ULISES technology

The following table shows the recommended values for ULISES technologies to compare them with the available data. In the case of obtaining different results from these values in the previous measurements at the new site, the installation is not recommended as its efficiency could be affected.

LIFE ULISES TECHNOLOGY	OPTIMAL PARAMETERS
ABAD System	L/G ratio: between 1,5-3. No more than 4 CH ₄ : 85% minimum CO ₂ : 10% maximum O ₂ : 1% maximum H ₂ S: 5ppm maximum Humidity: 50-100 ppmv
PUSH Reactor	SST: outflow<inflow Productivity: CH ₄ Kg ⁻¹ COD >0,1 m ³

AeMBR System	NH ₄ ⁺ : outflow<inflow
FO-MD struvite precipitation plant	Amount of solute for 500l draw solution: 15kg Relation MG/PO ₄ : 2:1 Ph:8 Reaction time 2h at 450 rpm
Enzymatic hydrolysis reactor	Dewatered sludge ratio (DS): maximum 35kg:300l water Ph: 7 Enzyme dose: 2,5% Alcalase
Solar photo Fenton plant	Contaminants of emerging concern Microbiology Determination of H ₂ O ₂ consumption in-situ in the process by probes (online measurement) or spectrophotometric analysis (offline measurement) (< 5 min) Process duration: 24h
Linear Fresnel solar collector	Microbiology Operating temperature Process duration: 24h

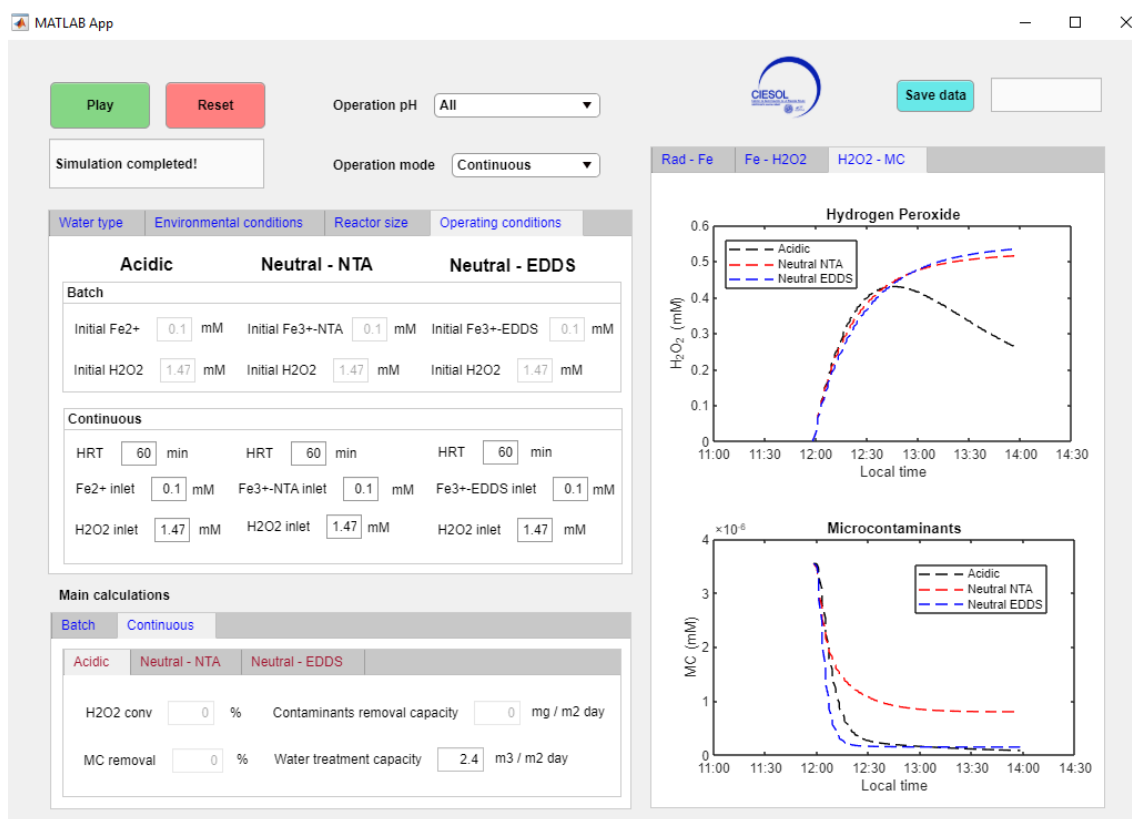
AVERAGE BIOGAS PARAMETERS BY BIOMASS SOURCE					
Gas	Agricultural waste (%)	WWTP sludge (%)	Industrial waste (%)	MSW landfills (%)	Effect
Methane	50-80	50-80	50-70	45-65	Combustible
CO ₂	30-50	20-50	30-50	34-55	Inert
Vapour H ₂ O	Saturation	Saturation	Saturation	Saturation	Prejudicial

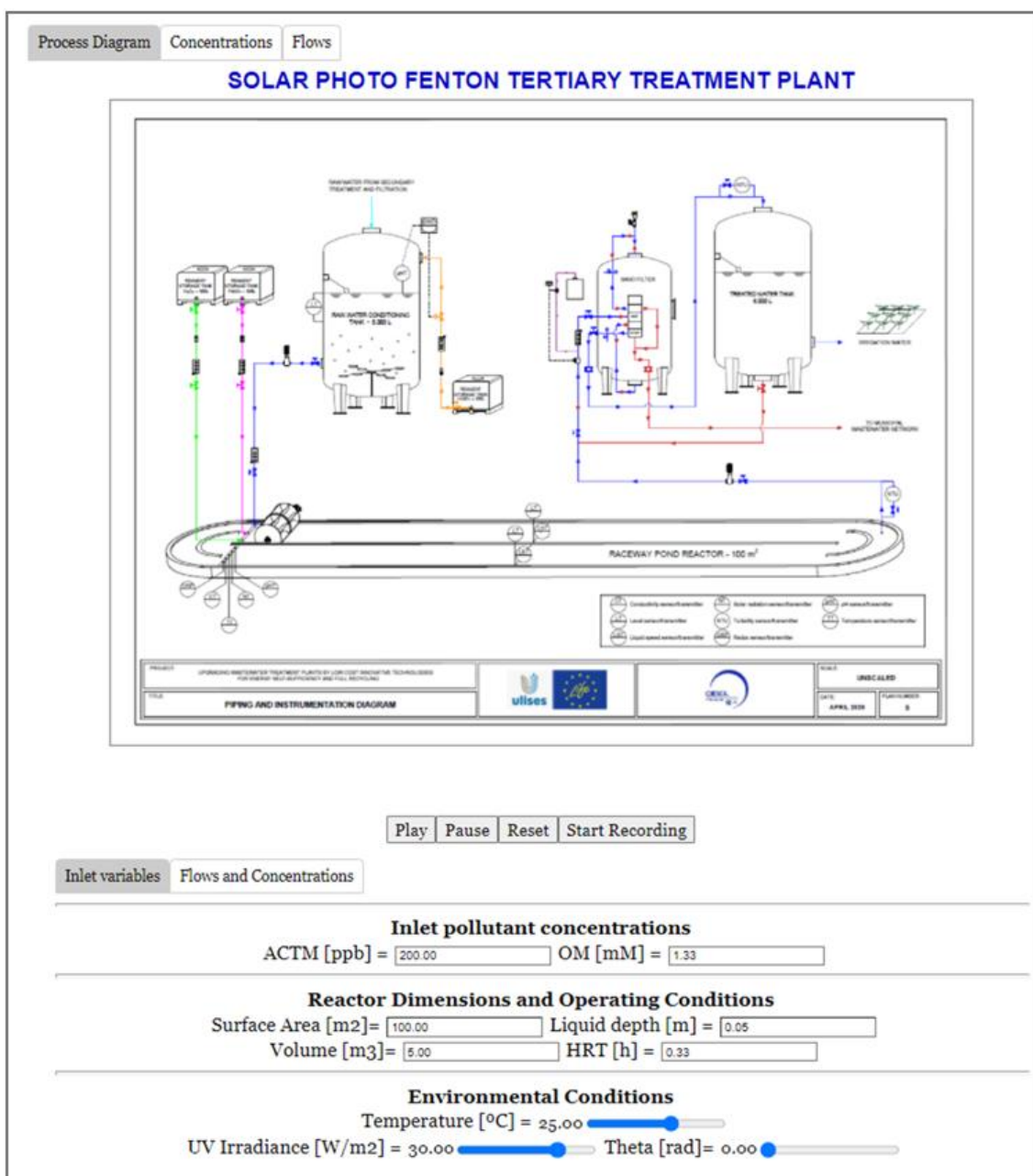
H ₂	100-7.000 ppm	0-1	0-8	0,5-3000 ppm	Corrosive
NH ₃	50-100 mg/m ₃	Traces	Traces	Traces	Corrosive
CO	0-1	0-1	0-1	Traces	Combustible
N ₂	0-1	0-3	0-1	0-20	Inert
O ₂	0-1	0-1	0-1	0-5	Corrosive
Siloxanes	n/a	0-100 mg/m ₃	n/a	0-50 mg/m ₃	Abrasive
HCH	n/a	Traces	n/a	10-4000 mg/m ₃	Prejudicial

Annex 2 - List of applications and software used

- SCADA software: widely used in wastewater treatment plants for control, monitoring, reporting, data collection and analysis. A licence is required.
- Easy JavaScript Simulations: an open-source program, so no licence fee is required, which allows you to easily create simulations of scientific phenomena and does not require extensive programming skills to use effectively.
- Fenton Dynamics: Also developed by CIESOL in Easy JavaScript for the simulation of Photo-Fenton processes. Protected under licence but available free of charge from the following link: https://w3.ual.es/docencia/idiq/LIFE_ULISES/index.html

- FentonSims: developed by CIESOL using MATLAB, is an interactive simulation tool for the solar photo-Fenton process for the removal of micropollutants from water under different operating modes and conditions. It presents a friendly, interactive, and simple graphical interface that allows the user to carry out design and optimisation studies of the process from a didactic approach. Available free of charge from the CIESOL website: <https://ciesol.com/software/>





Annex 3 - Institutional support

In the case of needing institutional support or advice with administrative procedures, these are the main institutions linked to replication and technological transfer.

- **Enterprise Europe Network (EEN)**
 Website: [Enterprise Europe Network | Enterprise Europe Network \(europa.eu\)](https://www.europe.eu)
 Directory of contact points: [Find your local contact point | Enterprise Europe Network \(europa.eu\)](https://www.europe.eu)
- **World Intellectual Property Organisation (WIPO)**

Website: <https://www.wipo.int/portal/es/index.html>

Telephone: (+41) 22-338-9111

– **European Patent Office (EPO)**

Website: [EPO - Home](#)

Telephone: 00 800 80 20 20 20

– **Ministerio de Cultura y Deporte. Dirección General de Industrias Culturales, Derechos de autor y Cooperación. Subdirección General de Propiedad Intelectual**

Website: <https://www.culturaydeporte.gob.es/cultura/propiedadintelectual/portada.html>

e-mail: propiedad.intelectual@cultura.gob.es

– **Oficina Española de Patentes y Marcas. Ministerio de Industria, Comercio y Turismo (OEPM)**

Website: <http://www.oepm.es>

Telephone:

e-mail: informacion@oepm.es