E 2.3.1 Final report on TWIST Living Labs

Report on GT 2

October 2021

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List of acronyms

AAC – Agencia Andaluza del Conocimiento (España)

ADRAL - Agência de Desenvolvimento Regional do Alentejo (Portugal)

AdTA – Águas do Tejo Atlântico, S.A. (Portugal)

CENTA– Centro de las Nuevas Tecnologías del Agua (España)

EIUIG - External Institutes and Utilities Interest Group

ENOLL- European Network of Living Labs (Red Europea de Living Labs)

FUERM – Fundación Universidad Empresa de la Región de Murcia (España)

IFTS – Institut de la Filtration et des Techniques Séparatives (Francia)

ISA – Instituto Superior de Agronomía (Portugal)

IST – Instituto Superior Técnico (Portugal)

OIEau – Office International de l'Eau (Francia)

PPA – Parceria Portuguesa para a Água (Portugal)

UNILIM – Université de Limoges (Francia)

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1 Introduction

In the framework of the TWIST (Transnational Water Innovation Strategy) project, three Living Labs have been set up in each of the countries that are part of the Consortium.

Experimental infrastructures already existing in Andalusia, New Aquitaine and Lisbon have been used for the creation of these Living Labs. These infrastructures have been selected because of the availability of access to wastewater and the existing trans-regional cooperation between the neighbouring regions participating in the project (Andalusia and Murcia; Lisbon and Alentejo; New Aquitaine and Occitanie).

Each Living Lab specialises in different but complementary aspects:

- **Open Water Living Lab (OWL2)**: Spanish Living Lab specialised in wastewater treatment and regeneration.

- **LaVISo**: French Living Lab specialised in solutions for wastewater treatment and associated infrastructure management.

- **Urban Lisbon Living Lab (uL3)**: Portuguese Living Lab specialised in wastewater treatment for reuse and resource recovery (water, nutrients and energy).

These Living Labs work in a network and in a complementary way, favouring transregional and transnational technological cooperation (thus multiplying the impacts of the project).

This report includes the progress made in each of the three Living Labs. It should be noted that the situation caused by the COVID-19 pandemic has restricted the development of the work.

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2 Open Water Living Lab (OWL2)

The Open Water Living Lab (OWL2) is the Spanish living laboratory created within the framework of the TWIST project.

2.1 Institutions involved in the constitution of OWL2

2.1.1 Fundación Pública Andaluza Centro de las Nuevas Tecnologías del Agua (CENTA)

The **Fundación Pública Andaluza Centro de las Nuevas Tecnologías del Agua (CENTA)** is a water research centre promoted by the Consejería de Medio Ambiente de la Junta de Andalucía with the support of other public and private organisations in the water sector. With a research career backed by more than 20 years of experience in the water sector, wastewater management and water resources, CENTA has become an international reference in the field.

The CENTA Foundation works extensively as a knowledge agent and research centre and has signed collaboration agreements with eight Andalusian universities. It carries out projects in collaboration with other Spanish universities, such as the University of Alcalá de Henares in Madrid and the Polytechnic University of Catalonia; it collaborates closely with other leading research centres (the Centre for Study and Experimentation -CEDEX-, the Catalan Institute for Water Research -ICRA-, the Higher Council for Scientific Research -CSIC-, the Technological Institute of the Canary Islands -ITC- and the Institute for Advanced Studies of Madrid -IMDEA-, among others).

Its **mission** is to contribute, through the generation and dissemination of excellence and knowledge, to the efforts made by public administrations, research centres and companies to make Andalusia a reference point in the field of water.

The **values** of the entity are:

- Innovation: incorporating knowledge for the development of new technologies and processes, developing new solutions and/or improving existing ones.

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- Transfer: with a relentless effort to obtain knowledge where it is needed and should be applied, improving the competitiveness of the sector as well as the quality of life of citizens.
- Tertiarisation: incorporating a holistic view of the world and its relationships that favours the flow of knowledge and experience and the creation of collaborative networks.
- Commitment: to promote the transmission of social and environmental values and to develop technologies for the most disadvantaged, thus contributing to the achievement of the Millennium Development Goals and the Europe 2020 Strategy.
- Knowledge: as the core of its activity and understood as a public good, developed on the basis of the intellectual capacity and the scientific and technical activity of its human team.

The mission of the CENTA Foundation is addressed through two types of **objectives**, strategic and operational, which are described below:

Strategic objectives:

- To improve the competitiveness and internationalisation of the water sector in Andalusia and to generate new activities and employment through the generation of knowledge and its application to respond to market demands.
- To contribute to maximising the competitive advantages of the Andalusian water sector, and to position it as an area of strategic innovation in the national and international context.
- Providing independent, evidence-based scientific-technical support during all phases of Andalusian policy development and advice for adaptation to European standards.

Operational objectives:

- Generate knowledge: Developing our own research projects and in collaboration with other regional, national and international entities.
- Disseminate and transfer knowledge: creating transfer networks and enhancing its role as a dynamic sector, promoting synergies between the different scientific, economic and financial agents and society in general, promoting the concept of the Living Laboratory at the experimental plant in Carrión de los Céspedes.

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- Strengthen R&D and investment in innovation in the water sector: seek efficiency in our own activity, influence the sector's R&D agendas and favour collaboration strategies between the different agents in the knowledge system.
- Promote the use of technologies, products and services to support the generation of knowledge and experimentation on a semi-industrial scale between companies, knowledge agents and administrations acting as a gateway between research and the market.
- Develop and generate tools for capacity building around opportunities for innovation and the creation of new markets.

2.2 Type of Living Lab

Open Water Living Lab

The CENTA Foundation, as the driving force behind OWL2, through a participatory debate with different actors (public entities, innovation agents, technology producers, researchers and civil society) has defined and configured the OWL2 ecosystem, making progress in the creation of its user community and its relationship model (functional and organisational),

The innovation created by OWL2 has to be aligned with the objectives of European, national and regional water policies and programmes. Likewise, as a Living Lab, through co-creation and under a multi-stakeholder approach, OWL2 also aims to influence the orientation and development of these policies.

The scope of the work carried out in OWL2 is closely related to the areas requiring innovation. This maintains the differentiating character of the research and work of the CENTA Foundation, focused on the field of solutions for the treatment and reuse of wastewater adapted to the needs of small urban agglomerations, providing innovative solutions to the needs of rural areas.

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On the one hand, this is an area where CENTA mainly concentrates its know-how and can therefore generate a greater impact and, on the other hand, in the medium to long term, the higher demands on the quality of treated effluents from small agglomerations will require the development of new innovations that respond to the current context, which is obviously significantly different from that of 20 years ago.

CENTA is a research centre and continues to play this role within the Living Lab. Thus, in the process of transferring from research to innovation, OWL2 provides services and develops products (its own technologies) but at the same time these technologies are not only an end in themselves, but also an enabler of social change both at the level of citizenship and at the level of the individual citizen.

OWL2 works as a collaborative network in which the members of its user community are involved, favouring the opening of scientific infrastructures to the public. To this end, OWL2 can incorporate citizen science processes that, in addition to facilitating the collection of data and information, can favour behavioural change processes.

The effort to incorporate citizens into the co-creation and innovation process is not only the responsibility of CENTA but should be a collective effort of all members of the network. Therefore, other actors can be integrated into the community of users who may have a more appropriate role for it.

2.3 Objective of OWL2

The mission is to contribute, through the generation and dissemination of excellence and knowledge, to the efforts of public administrations, research centres and companies to make Andalusia a benchmark in the field of water.

Values:

Innovation: incorporating knowledge for the development of new technologies and processes, developing new solutions and/or improving existing ones.

Transfer: with a relentless effort to bring knowledge to where it is needed and should be applied, improving the competitiveness of the sector as well as the quality of life of citizens.

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Outsourcing: incorporating a holistic view of the world and its relationships that favours the flow of knowledge and experience and the creation of collaborative networks.

Commitment: to promote the transmission of social and environmental values and to develop technologies for the most disadvantaged, thus contributing to the achievement of the Millennium Development Goals and the Europe 2020 Strategy.

Knowledge: as the core of its activity and understood as a public good, developed from the intellectual capacity and the scientific and technical activity of its human team.

2.4 Physical context of OWL2

2.4.1 Location of infrastructure

Fundación Centro de Nuevas Tecnologías del Agua is located in the municipality of Carrión de los Céspedes (2,500 inhabitants), 30 km from Seville. Next to the A-49 motorway, CENTA covers an area of 41,000 m^2 which houses its Experimental R&D&I Centre, its laboratories and the main building used as the Foundation's headquarters and for dissemination and training activities.

The Experimental Centre was built in 1990, as a fundamental part of the Research and Development Plan for Wastewater Treatment of Non-Conventional Technologies directed by the Andalusian Ministry of the Environment (1987-present). The CENTA Foundation is responsible for its management.

This experimental centre, which has a treatment capacity of 700 m3/day and 40 different treatment systems, is unique in the world due to its scale, technological diversity and traceability.

This technology platform, which consists of a large set of technologies containing the most sophisticated systems together with the most natural ones, supports CENTA in its research activity and other scientific agents, as well as companies working in the water sector.

Research projects or experimental developments are evaluated under the same test conditions (influent characteristics, climatic conditions, laboratory and technical equipment), allowing for robust comparative studies.

One of its specificities is undoubtedly its versatility, its ability to combine technologies and the fact that it can offer both research centres and companies the opportunity to carry out their research.

Its facilities also include a complete analysis laboratory and an official meteorological station. It is undoubtedly a centre endowed with great singularity and dynamism where technology and biodiversity go hand in hand.

Figure 2.1: Aerial view of CENTA's Experimental Centre in Carrión de los Céspedes (Seville).

2.4.2 Treatment units

The Experimental Centre has been working mainly on the development, implementation and dissemination of non-conventional technologies for the treatment of wastewater generated by small populations. However, since 1995, the PECC has accepted prototypes in a study or test step from various companies commercialising wastewater treatment systems.

The Experimental Centre has a pre-treatment unit that receives untreated wastewater from the municipality of Carrión de los Céspedes. The preliminary treatment and distribution characteristics are as follows:

Screening: automatic screening with bar screen (3 cm) and sieve (3 mm) and manual screening with bar screen (2 cm).

Sand and grease chamber: aerated sand and grease removal chamber, sand classifier and grease concentration.

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Pumping tank: 3 pumps (2 + 1) (2 kW power unit)
Distribution system: with a volume of 18 m^3. Level controlled by probes. 11 outlets equipped with an electromagnetic flow meter.

Figure 2.2: Pre-treatment unit of the Experimental Centre

Figure 2.3: Water distribution system of the Experimental Centre

The main primary treatment system is an Imhoff tank that treats a flow of 60 m^3/day. Two new chambers were built in 2020.

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Figure 2.4: Imhoff tank

Conventional and non-conventional technologies have been implemented in an area covering an area of 41,000 m^2. The non-conventional technologies implemented are: lagoon, artificial wetlands, intermittent sand filters and different combinations of these, as well as trickling filters and rotating biological contactors.

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Figure 2.5: Extensive technologies at CENTA's Experimental Centre

It also has intensive systems such as extended aeration or Membrane Biological Reactors (MBR):

Figure 2.6: Intensive technologies in the CENTA Experimental Centre

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The plant also has a sludge treatment system comprising a centrifuge and a sludge thickener:

Figure 2.7: Centrifuge and sludge thickener

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On the other hand, the Experimental Centre has a prototype testing area for companies, specially prepared for CE marking.

Figure 2.8: Technology validation area

During the last year, several innovative treatment units have been implemented at the pilot plant:

1 French-style vertical flow wetland
1 horizontal flow bioelectrogenic (METland®) wetland
1 aerated wetland with a novel filter media (Filtralite P) for phosphorus removal
1 High-Rate Algal Pond Photobioreactor (HRAP)
1 sludge drying system with solar energy
2 intensified wetlands (one aerated floating helophyte filter and one Rhizoshp' Air wetland)

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Figure 2.9: French style vertical flow wetland

Figure 2.10: Bio-electrogenic wetland (METland®) horizontal flow wetland

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Figure 2.11: Aerated wetland H20 (Ecolagunas)

Figure 2.12: HRAP photobioreactor

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Figure 2.13: Sludge drying system with solar energy

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Figure 2.14: Aerated flotation helophyte filter

Figure 2.15: Rhizoshp' Air Wetland

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Water reuse facilities

The plant has an experimental area for the reuse of water for agricultural irrigation of 1,200 m^2.

Figure 2.16: Water irrigation area reclaimed water

2.4.3 Main building

The main building that houses the Foundation is unique and modern, although it is integrated into the rural environment in which it is located. Its design is based on bioclimatic construction elements that minimise its energy consumption and provide a healthy habitat.

Its surface area of more than 500 m^2 houses researchers and administrative staff, as well as training rooms. On the upper floor there is a large working area for workshops and dissemination events.

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Figure 2.17: Main building

2.4.4 Laboratory

The facilities include a complete laboratory for analysing wastewater samples that form part of the research studies and other work carried out at its facilities. This laboratory has modern equipment for physical, chemical and microbiological analysis. The aim of this laboratory is to support the centre's research activity and to monitor the systems installed.

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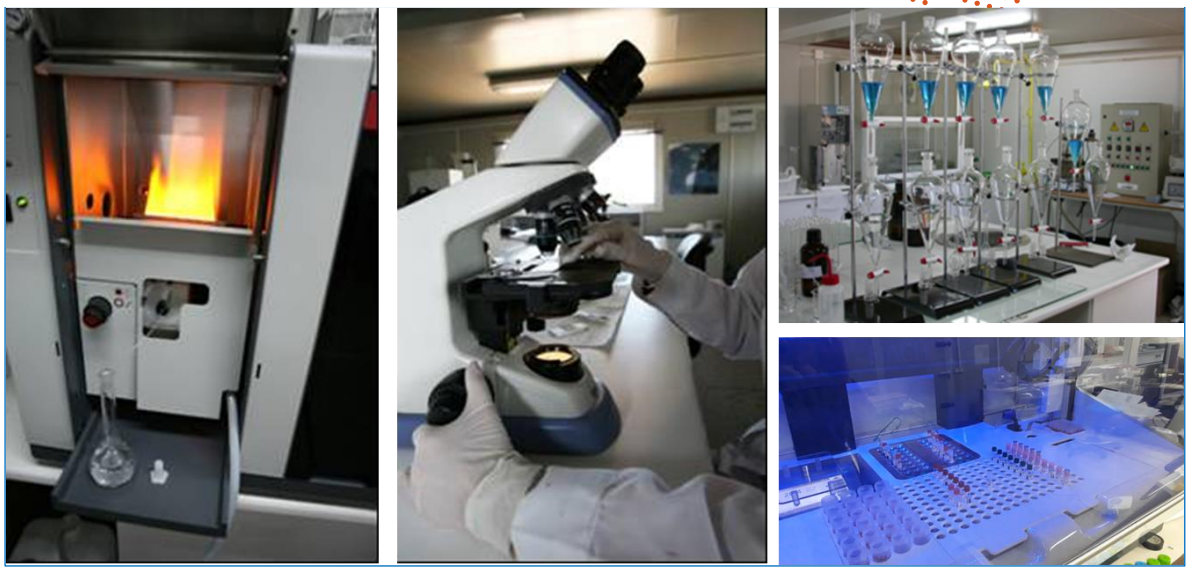

Figure 2.18: Laboratory equipment of the Experimental Centre

2.4.5 Weather station

The Experimental Centre also has an official meteorological station, belonging to the State Meteorological Agency of the Ministry of the Environment. Each technology validation report prepared by CENTA is accompanied by a report on the meteorological parameters of the period. The information from the weather station can be consulted online.

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Figure 2.19: Weather station

2.5 Technical/informational context

2.5.1 Platforms for disseminating information

On the TWIST project website (https://twistproject.eu/) the OWL2 has a section where news related to the activities and projects developed in the Living Lab are published.

The CENTA Foundation also disseminates information about the OWL2 on social networks through its LinkedIn, Facebook and TWITTER accounts.

On the other hand, OWL2 activities are also disseminated through specialised websites in the water sector (Aguasresiduales.info) and the website of the Ministry of Agriculture, Livestock, Fisheries and Sustainable Development of the Andalusian Regional Government. The CENTA Foundation has two associated blogs in the iAgua journal by its research staff: Juan José Salas and Juan Ramón Pidre.

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2.5.2 Technologies for hosting online events

The Living Lab has contracted the Webex platform for holding online events. It is

For online events, OWL2 has contracted the Webex platform, which allows up to 500 attendees to participate in the events organised through the platform.

A manual for the use of the platform is available and given to the participants before the organised meetings.

2.6 User community

The main target groups of OWL2 are Academia (Research Centres, University), water companies providing water services, Public Administration and technology companies.

The involvement of all actors does not imply that all members of the user community play the same role, but that success also depends on each actor, each element of the quadruple helix, developing the role that corresponds to it in the functional model of the OWL2. In other words, it is not about citizens doing basic research, but about researchers being able to incorporate citizen research processes.

OWL2 functions as a collaborative network involving the members of its user community, which promotes the opening of scientific infrastructures to the public.

Within OWL2, the participation of the different actors is articulated according to the role they play in the functioning of the Living Lab. Thus, the relationship with the partners of the different projects is carried out through Agreements included in the framework of the respective projects.

The following tools are used for communication with OWL2 users:

- TWIST project website

- Mailing list

- TWIST Project Newsletter

Within the framework of the projects, communication protocols are established by the project coordinator. In general, and in the case of OWL2 in particular, communication between the actors involved takes place via a mailing list that

includes all the actors involved, except for specific communications addressed to certain actors.

2.7 OWL2 Services

The services offered by OWL2 include:

1. **Knowledge generation** - Demand-driven research: OWL2 acts as a bridge to guide the R&D lines of research centres and companies. OWL2's facilities include experimental plots for the development and validation of R&D&I under real operating conditions, an analysis laboratory, a visitor reception centre and meeting and training rooms. Research focuses on technologies for the treatment of urban wastewater, wastewater from small industries, minimisation of by-products generated during treatment, water reuse, resource recovery, water quality, urban water management and ecosystem water management.

2. **Technological intermediation**: as a technological intermediary, OWL2 plays an active role as a driving force in the wastewater treatment sector for small towns, developing various initiatives aimed at promoting the interrelation of knowledge generators and users (public and private). By identifying the joint needs of the public sector in the field of water, OWL2 acts as a bridge to guide the R&D&I lines of research centres and companies towards the needs of the public sector and to favour the development of innovative public procurement processes.

Technology transfer: OWL2 offers advice and support for technology transfer, innovation and entrepreneurship. With this objective, the existing facilities at the Carrión de los Céspedes Experimental Plant offer technological support to companies and SMEs in the sector to carry out technical and economic feasibility studies of their technologies and services. This technological support helps its users to carry out a correct validation of the R&D&I results before they are put on the market and, therefore, to develop more competitive products at European level. It is therefore an ideal environment to promote initiatives such as the incubation of start-ups or the promotion of technology-based companies, as well as the opening of new lines of innovation in existing companies.

4. **Technological validation**: CENTA is internationally recognised as a technological validation entity. Its unbeatable experimental facilities make it the largest testing laboratory and a true Living Lab in the field of water treatment.

Technological validation provides competitive advantages to the companies installed in the Experimental Centre:

- It allows testing the performance of technologies at all Technology Maturity Levels (TRLs), which differentiates them from competing technologies.
- It validates the innovative features that make the technology truly unique.
- It serves the company both to increase its market share and to facilitate the access of technologies to new national or international markets.

5. **Technology watch**: OWL2 carries out a systematic procedure to capture, analyse and exploit useful information for strategic decision-making: market forecasts, existing R&D&I systems and products, current public-private investments at European level, are some of the information necessary to highlight the current R&D&I panorama and detect future trends. OWL2 participates, on the one hand, in the identification of the needs of the Administration and, on the other hand, in the identification of innovative products and services that are being carried out in the region and are ready to be exploited in the market.

6. **Technical assistance**: OWL2 provides exclusive and continuous technical advice through the projects in which it participates, as well as to entities that wish to apply non-conventional techniques in wastewater treatment. These projects facilitate the technical training of qualified personnel to ensure both the maintenance of the installations and to promote the implementation of these technologies in other areas of the country. The technical advisory activities include solutions for small municipalities, adaptations of treatment according to the conditions of the territory, adaptation to new regulations, etc. A very important task is the technical support for new constructions.

7. **Specialised training**: One of the lines of training is the carrying out of comparative analyses of the different national legislations on sanitation and urban wastewater treatment, as well as technical training for technicians from public institutions and companies, or graduate students. Another line of training, financed through different agents (AACID, AECID, etc.), consolidates CENTA's presence in Latin America where, for several years, technical training initiatives have been developed in several countries.

8. **Knowledge dissemination**: OWL2 also disseminates knowledge through publications such as guides, books, contributions to scientific congresses and publications in scientific and specialised journals. OWL2 also has a programme of

visits aimed at different sectors of society and divided into secondary and high school students, university students, technicians, institutions and citizens.

2.8 Networking with other Living Labs and innovation networks in the water sector

As a first step to obtain Living Lab certification and become a member of the European Network of Living Labs (ENOLL), OWL2 has participated in the annual ENOLL Living Lab Development Workshop.

On the other hand, CENTA attended the EU Water Innovation 2019 conference in Zaragoza (11-12 December 2019) where it participated in the Workshop organised by Water Europe on Living Labs for a Water Smart Society.

2.9 Activities carried out in OWL2

The projects developed in OWL2 are outlined below:

2.9.1 Research projects

Object of the Contract: Circular economy strategy applied to the conversion of slaughterhouse wastewater treatment plants into biorefineries (Water2Return).	  
OWL2 users involved in the project: Bioblue University of Cadiz University of Seville	**Contract Number:** AMD-730398-9 **Name of contractor:** European Commission Research Directorate-General H2020 Framework Programme
Start date (month/year): 2017 **Completion date (month/year):** 2020	**Value of the contract:** 615.125,00 €.
https://water2return.eu/es	

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Object of the Contract: New Strategy for Re-Naturing Cities through Nature-Based Solutions (URBAN GreenUP)	
OWL2 users involved in the project:	**Contract Number:** 730426 **Name of contractor:** European Commission Research Directorate-General H2020 Framework Programme
Start date (month/year): 2017 **Completion date (month/year):** 2022	**Value of the contract:** 183.065,00 €.
http://www.urbangreenup.eu/	

Object of the Contract: KETs for the removal of emerging pollutants in reclaimed water in the SUDOE area (4KET4Reuse)	
OWL2 users involved in the project: CSIC-Instituto de Recursos Naturales y Agrobiología de Sevilla. Spain Nanoelectra SL. Spain.	**Contract Number:** SOE1/P1/E0253 **Name of contractor:** European Commission INTERREG SUDOE Programme
Date of initiation (month/year): 09/2016 **End date (month/year):** 08/2019	**Value of the contract:** 187.534,81 €
https://interreg-sudoe.eu/proyectos/los-proyectos-aprobados/140-kets-para-la-eliminacion-de-contaminantes-emergentes-en-aguas-regeneradas-en-el-espacio-sudoe	

Object of the Contract: Promotion of R&D&I of excellence in the field of water treatment in small urban agglomerations (IDIAQUA).	
OWL2 users involved in the project: University of Seville Andalusian Water Supply and Sanitation Association (ASA-Andalucía) University of Cadiz PROMEDIO - Consortium for the Management of Environmental Services. Provincial Council of Badajoz. Parceria Portuguesa para a Água (PPA) University of Extremadura Regional Ministry for the Environment and Territorial Planning. Regional Government of Andalusia. Gestión Integral del Agua de Huelva, S.A. (GIAHSA)	**Contract Number:** **0066_IDIAQUA_6_E** **Name of contractor:** European Commission INTERREG POCTEP Programme
Start date (month/year): 2017 **Completion date (month/year):** 2021	**Value of the contract:** 523.452,75 €.
http://idiaqua.eu/proyecto/	

Object of the Contract: Promotion of innovative technologies for the improvement of efficiency in the process of wastewater sludge drying and municipal solid waste drying through the use of solar technologies in Andalusia-Algarve-Alentejo (SECASOL).	
OWL2 users involved in the project: Huelva Provincial Council	**Contract Number:** **0029_SECASOL_5_E** **Name of contractor:** European Commission INTERREG POCTEP Programme
Start date (month/year): 2017 **End date (month/year):** 2019	**Value of the contract:** 472.219,45 €
http://www.diphuelva.es/secasol/	

Object of the Contract: Identification of Best Available Technologies for Decentralised Wastewater Treatment and Resource Recovery for India (Saraswati 2.0)	
OWL2 users involved in the project:	**Contract Number:** 821427 **Name of contractor:** European Commission Research Directorate General H2020
Starting date (month/year): 09/2019 **Completion date (month/year):** 07/2023	**Value of the contract:** 2,009,472.50 €
http://www.diphuelva.es/secasol/	

Object of the Contract: Innovative hybrid wastewater resource recovery in small communities (INTEXT)	
OWL2 users involved in the project: Aqualia	**Contract Number:** LIFE18 ENV/EN/000233 **Name of contractor:** European Commission LIFE Programme
Starting date (month/year): 07/2019 **Completion date (month/year):** 06/2023	**Value of the contract:** 1,596,470 €
https://life-intext.eu/	

Object of the Contract: Empowering academia for knowledge transfer for value creation in the Atlantic Area (EMPORIA4KT)	
OWL2 users involved in the project: Technological Corporation of Andalusia (CTA) Andalusian Knowledge Agency (AAC)	**Contract Number:** EAPA_842/2018 **Name of contractor:** European Commission Interreg Atlantic Area Programme
Starting date (month/year): 03/2019 **Completion date (month/year):** 02/2022	**Value of the contract:** 2.3 million €.
https://www.emporia4kt.com/	

Object of the Contract: Non-Conventional Land Reuse in Agriculture in Mediterranean Countries (MENAWARA)	
OWL2 users involved in the project:	**Contract Number:** **Name of contractor:** ENI-CBCMED Cooperating across borders in the Mediterranean
Starting date (month/year): 09/2019 **Completion date (month/year):** 08/2022	**Value of the contract:** 2.9 million €.
http://www.enicbcmed.eu/projects/menawara	

Object of the Contract: Promoting the sustainable development of the Andalusian olive grove (REUTIVAR)	
OWL2 users involved in the project: University of Cordoba	**Contract Number:** **Name of contractor:** Junta de Andalucía and the European Union through the EAFRD
Date of initiation (month/year): **Completion date (month/year):**	**Value of the contract:** 205.660,79 €
https://reutivar.eu/	

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bject of the Contract: Microbial and trophic bioindicators of the ecological status of the SUDOE coastal zone ecosystem (BIOMIC)	
OWL2 users involved in the project:	**Contract Number:** SOE4/P1/F0993 **Name of contractor:** European Commission INTERREG SUDOE Programme
Date of initiation (month/year): 11/2020 **Completion date (month/year):** 02/2023	**Value of the contract:** 1.399.702,00 €
https://www.biomic-project.eu/es/inicio/	

2.9.2 Training activities

In the framework of the project "Evaluation of sustainable sanitation alternatives for rural areas and implementation in the municipality of Cuisnahuat and San Julián (El Salvador)", with file number 0C073 / 2014 and financed by the Andalusian Agency for International Development Cooperation (AACID), OWL2 staff have carried out the following training, strengthening and awareness-raising workshops:

Training	Celebration date	Place
1 training workshop on the technologies implemented for technicians from municipalities and water and sanitation boards.	13/11/2019	San Julián, El Salvador
1 reinforcement workshop for governmental agencies and civil society on wastewater treatment	14/11/2019	San Julián, El Salvador
3 awareness-raising campaigns targeting women in the beneficiary municipality on the importance of wastewater treatment.	1/11/2019 5/11/2019 7/11/2019	Cuisnahuat, El Salvador
Publicity campaign to encourage women's participation in water training and empowerment workshops	Radio spots, print material and digital products	

The staff has also participated in numerous national and international training courses, masters and webinars on wastewater treatment systems applied to small towns and rural areas.

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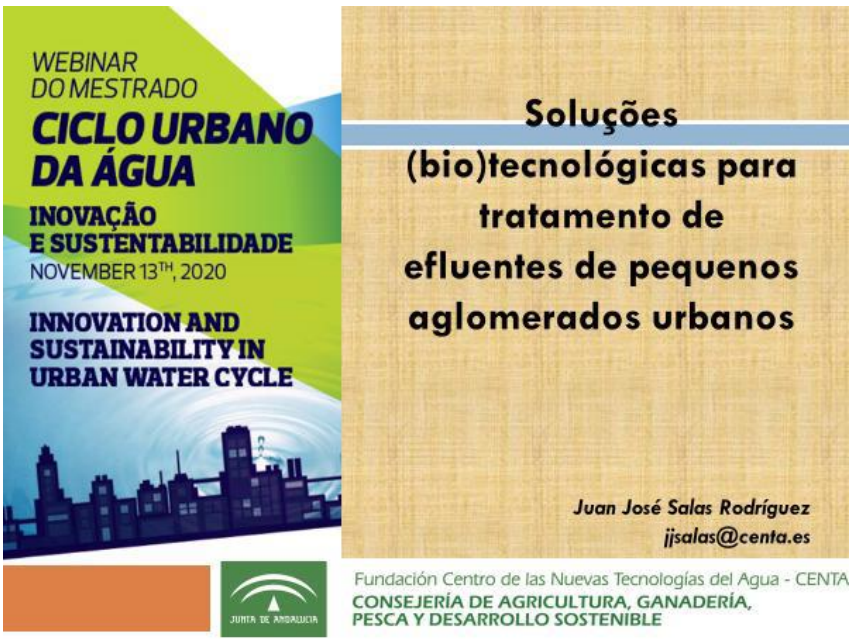

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https://www.youtube.com/watch?app=desktop&v=6GM-mVnLt2c00

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https://www.youtube.com/watch?app=desktop&v=5UjUiwMWiPs&feature=youtu.be

https://www.youtube.com/watch?app=desktop&v=SqDTQ3vcAlc&t=305s

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Juan José Salas, Director of the technical services of OWL2 has developed a blog to disseminate knowledge on wastewater treatment in small towns, on the iAgua website, the most important in the water sector in Spain. These are the links to the published posts.

- Wastewater treatment in small urban agglomerations (13/4/2020) https://www.iagua.es/blogs/juan-jose-salas/depuracion-aguas-residuales-pequenas-aglomeraciones-urbanas
- Wetlands for wastewater treatment: questions and answers (I) https://www.iagua.es/blogs/juan-jose-salas/humedales-tratamiento-aguas-residuales-preguntas-y-respuestas-i
- Wetlands for wastewater treatment: more questions and more answers (II) https://www.iagua.es/blogs/juan-jose-salas/humedales-tratamiento-aguas-residuales-mas-preguntas-y-mas-respuestas-y-ii
- Wetlands for wastewater treatment: last questions, last answers (and III) (11/8/2020) https://www.iagua.es/blogs/juan-jose-salas/humedales-tratamiento-aguas-residuales-ultimas-preguntas-ultimas-respuestas-y
- Depuration by floating macrophytes as told by its author (10/2/2020) https://www.iagua.es/blogs/juan-jose-salas/depuracion-mediante-macrofitas-flotacion-contada-autor-i
- Purification by "Floating Helophyte Filters" as told by its author (and II) (20/2/2020) https://www.iagua.es/blogs/juan-jose-salas/depuracion-mediante-filtros-flotantes-helofitas-contada-autor-y-ii
- The fascinating biofactory in all of us (30/12/2019) https://www.iagua.es/blogs/juan-jose-salas/fascinante-biofactoria-que-todos-llevamos-dentro
- The sewage treatment plant is dying: call the iAgua experts https://www.iagua.es/blogs/juan-jose-salas/depuradora-se-nos-muere-llamen-expertos-iagua
- Basics of wastewater disinfection in turbulent times (28/4/2020) https://www.iagua.es/blogs/juan-jose-salas/nociones-basicas-desinfeccion-aguas-residuales-tiempos-convulsos-0

2.9.3 Participation in events

OWL2 has organised the SmallWat2 Congress on 17-18 June 2021. This is the fourth edition of this congress, consolidating it as a space for reflection and debate for scientists, technicians, companies, policy makers and society in general, in relation to the technological, political and management challenges of sanitation and wastewater treatment services in small municipalities. The aim of the congress was to capitalise on the results of the IDiaqua project, developed within the framework of the POCTEP programme (Interreg Spain-Portugal), as well as to share innovative experiences in the field of wastewater treatment and reuse in small towns.

The activities carried out by OWL2 have also been disseminated at numerous conferences and expert meetings, such as the following.

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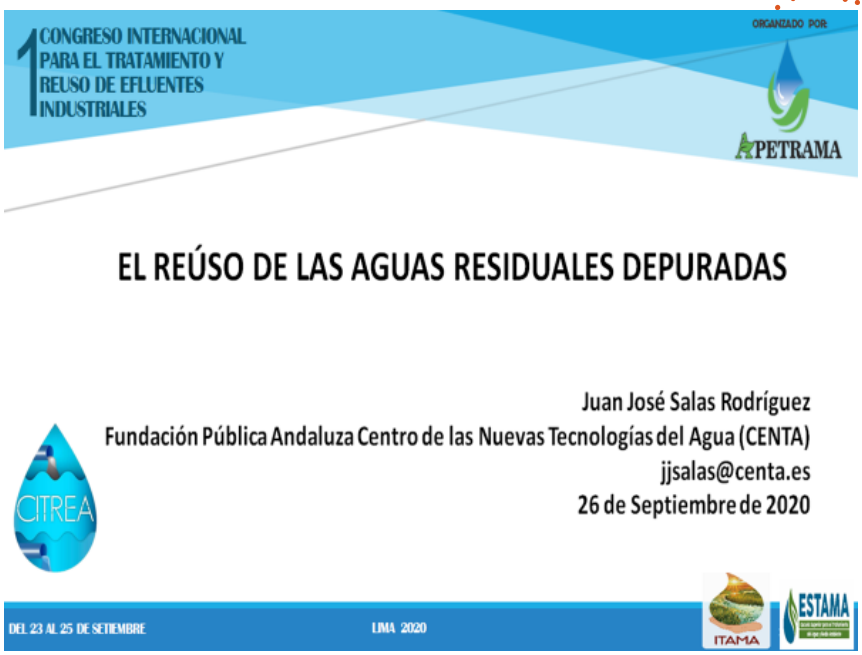

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2.9.4 Visits attended at OWL2

Details of the visits received at OWL2 are given below:

In 2018, a total of 503 visitors visited the OWL2, corresponding to 319 university and high school students, 86 to technical visits from the water sector and 98 to institutional visits.

In 2019, the number of visitors amounted to 662 people, of which 427 were from the academic sector (students and teachers from universities and secondary schools), 186 from technical visits and 49 from the public sector.

In 2020, due to the COVID pandemic, OWL2 only received visits in the first quarter of the year, 143 in total, from the three sectors mentioned above, 18 from public institutions, 10 from technical visits and 115 students from universities.

In 2021 the total number of visits was 166, 39 from public institutions, 29 from technical visits and 98 students from universities.

2.9.5 Knowledge transfer

The knowledge transfer actions carried out are detailed below:

- Technical conference on nitrogen and phosphorus removal. Date: 23 October 2019. Participants: Luis Larrea, co-founder of the Environmental Engineering Group of CEIT San Sebastian, Technology Centre of the University of Navarra.
- Presentation of the course on fundamentals and technologies of activated sludge and biofilm for nitrogen (nitrification and denitrification) and phosphorus removal for different population sizes.
- Presentation of consultancy studies
- Presentation of ACAI's innovative technologies in the field of wastewater treatment: biodiscs, bacterial beds, moving bed.

2.9.6 Validation of technologies

The prototype "Forced aeration constructed wetland with Filtralite-P substrate for phosphorus removal" of the company Ecolagunas has been completed in the facilities of the Open Water Living Lab (OWL2) of CENTA. The implementation of the prototype is the result of a contract between the company Ecolagunas and the CENTA Foundation for the monitoring and validation of the prototype in real conditions, as well as to serve as a demonstration for the transfer of technology to the market.

Figure 2.20: Aerated wetland H20 (Ecolagunas)

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The pilot system of the Israeli company Fluence has been tested and validated for one year in the experimental plant, thanks to the contract signed between Fluence and CENTA. CENTA technicians have been in charge of the monitoring and validation of the system, as well as the relevant water analyses. The heart of this treatment system is the MABR (Membrane Aerated Biological Reactor) technology, which is based on passive aeration, i.e. the diffusion of oxygen through the membranes by means of a low-pressure aeration flow.

Figure 2.21: Membrane Aerated Biological Reactor

Bioelectrochemical wastewater treatment wetlands (METland®) for small populations are being tested and validated at the Spanish OWL2 facilities in the pilot plant.

METland® (a registered product) is a concept developed by the start-up METfilter S.L., a technology-based company created by IMDEA Agua and the CENTA Foundation whose objective is to design, build and commercialise water purification systems based on the principle of microbial electrogenesis.

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METfilter has solutions and applications for the treatment of municipal and industrial wastewater.

Figure 2.22: Metfilter module

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3 Laboratoire Vivant du Sud-Quest pour l´Eau (LaVISo)

The Laboratoire Vivant du Sud-Quest pour l´Eau (LaVISo) is the French living laboratory created within the framework of the TWIST project.

3.1 Institutions involved in the constitution of the Living Lab

3.1.1 Office International de l´Eau (OIEAU)

OIEau is a non-profit making organization created in 1991 State approved. The missions of the association are:

- to gather competencies of public organizations and private companies
- to provide services of public interest in the water field
- to promote French know-how for sustainable management of water resources at international level

The OiEau is a non-profit association under French law declared to be in the public interest by the Decree of 13 September 1991. OiEau core-activities deal with the development of skills for better water management in France, in Europe and worldwide.

History

OiEau was born from the merger of three organizations.

- **The Water Institute (or the Water Foundation)** in Limoges, created in 1978 on the initiative of the University of Limoges (Water curricula), local authorities, the Ministry for the Environment and of water companies.
- **CEFIGRE (International Training Center for Water Resources Management)** in Sophia-Antipolis, created in 1976 jointly by the French Government and the United Nations Environment Program (UNEP) to meet the needs of the international community regarding water resources management.
- **AFEE (French Association for the Study of Water)** in Paris, created in 1949 on the initiative of representative "industrial groups", of "industries interested in water supply and distribution" and "consumer industries with a special interest in water quality".

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OiEau was created to coordinate and synergize the resources and activities of the three organizations. From the outset, it aimed to develop skills for better water management in France, Europe and worldwide by intervening in "its four pillars": training of water professionals, institutional and technical support, dissemination and sharing of knowledge or data as well as the animation and coordination of actors' networks.

Since its creation, OiEau has been working on the following themes

- professional training for better water management
- innovation to make documentation and information accessible to all
- efforts to improve water data management in France
- expertise and support to water stakeholders in France and Europe
- assistance to the development of training over the world
- facilitate the establishment and development of Water Information Systems
- working for a better governance of drinking water supply and sanitation utilities
- support for the effective application of the European Water and Waste Directives
- upport for the implementation of Integrated Water Resources Management in river basins
- adaptation to climate change and allocation of water resources for agriculture

3.1.2 Université de Limoges (UNILIM)

The laboratory Peirene-Eau has become the E2Lim laboratory.

The E2Lim laboratory, a research unit of the University of Limoges (UR 24133), brings together leading-edge skills in the field of the environment in various disciplines: chemistry, biology, microbiology, soil sciences and process engineering. The 40 permanent staff provide answers to environmental problems for economic and social players in the field of diagnosis as well as in that of processes. E2Lim is developing in a national and international context where the environment is a priority with the existence of strong partnerships with companies within the framework of research, development or training courses for students and engineering students.

The research is organised with four themes.

- Development of passive samplers (PS) for the quantification and speciation of contaminants
- Physicochemical reactions and bacterial adaptation/remanence in treatment processes
- Contaminant dynamics within the critical zone and remediation strategy
- Reaction mechanisms endogenous to water reservoirs and impact on water quality

3.1.3 Institut de la Filtration et des Techniques Séparatives (IFTS)

IFTS, the Institute of Filtration and Separative Technology, is a non-profit association founded in 1981.

- IFTS's expertise is based on a long experience of separation techniques, state-of-the-art testing facilities and a team of scientists, engineers and technicians who are among the best in their fields of expertise.
- The knowledge developed at IFTS applies to all industries. Thus, daily, the teams of the institute meet the needs of various industrial sectors such as aeronautics, agribusiness, chemistry, environment, mechanics, nuclear, pharmacy ...

3.2 The type of Living Lab

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LaVISo is a partnership between the International Office of Water (OiEau), the Institute for techniques separation and filtration (IFTS) and the laboratory Peiren-eau from the University of Limoges (UNILIM). It is in the south-west of France and its focus is on waste-water treatment technologies and associated infrastructure management. While this may be its primary focus, the living lab is not limited in its capacities and interest to provide support for solutions in a wide range of applications.

LaVISo is the name given to the Southwestern Living Laboratory This structure is set up in accordance with the objectives of the SUDOE TWIST project.

The aim of this Living Lab is to encourage business investment in Research & Development & Innovation (and associated employment), in the field of water management, by developing links and synergies between businesses, research and development centres and the higher education sector, by accelerating technology transfer, and the marketing of innovation. The topic of the expected studies concerns more particularly wastewater management, development of new wastewater treatment associated to further management ways governed by new challenges, considering particularly climate change.

3.3 Objective of LaVISo

The Living Lab aims to:

- Strengthen the mechanisms for coordination and transfer of knowledge and capacity in R&D&I to the society-science-policy-industry interface;
- Ensure communication and marketing that promotes the New Aquitaine region as a major centre of innovation for water and sanitation management: "Communities working together within a territory for a better protected and enhanced environment";
- To guarantee collaborative work with key players in the State services, local authorities and companies involved in the field of sanitation, with the skills and capacity to act in the innovation value chain;
- To benefit from the network built in the SUDOE TWIST project and to strengthen the capacities and opportunities for development at national and international level;

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- To work together on tenders and construction of modern and innovative technological projects by their processes or by their applications.

Each partner brings its expertise to the benefit of this collaborative vision:

- The laboratory E2Lim from UNILIM with its expert role in fundamental research (chemical engineering, water treatment process development, passive sampling), pilots at lab scale, its interaction with society and the involvement of students in the innovation process. ("Participating in the production of innovation"; "Scientific production").
- OiEau has pilot platforms in Limoges and La Souterraine allowing the reception of innovative products on functional installations. Moreover, OiEau has a recognised experience in training and expertise in the fields of management and control of water and sanitation infrastructures.
- IFTS - a pilot platform in Agen with experience in the speciality of Liquid-Solid Separation issues. A tool dedicated to the testing of water treatment devices: Its Roger Ben Aïm Test Centre.

3.4 Physical context of LaVISo

3.4.1 Location of Infrastructures

OIEau:

The infrastructures of the living-lab are located in Limoges and La Souterraine. The technical experts that will be involved for testing the pilots are member of the National Training Centre for Water Professions (CNFME –Centre National de Formation aux Métiers de l'Eau).

CNFME:

- employs 30 permanent trainers;
- owns 30 000 m² of pedagogical units:
  - 18 training rooms;
  - 20 technical plants.
- open 600 training sessions (on catalogue and on demand) each year;

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- trains 6 000 professional a year.

In Limoges, the presentation materials and operational installations are gathered in two technical halls, representing 800m² of covered and heated educational space. Outdoors, the centre has an experimental network of mesh, buried and leaking drinking water pipes and a functional ditch (for stormwater management).

In La Souterraine, the centre brings together educational facilities dedicated to the laying of pipes, sanitation networks (self-monitoring, control and inspection, intervention, etc.), non-collective sanitation and operational pilots dedicated to the production and refining of drinking water and processes, urban and industrial wastewater treatment, WWTP sludge treatment, flow-metering and remote management. In 2010, an additional 700m² was created, a large part of which is dedicated to laboratory and analytical techniques. OIEau have made classical technical studies involving the pilots before 2018 but clearly the civil society was not involved as a co-creation actor. Technical training plants: Pumping and hydraulic regulation plant.

Figure 3.23: Pumping and hydraulic regulation plant

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Figure 3.24: Show room for leak research and pipe detection materials

Figure 3.25: Place dedicated to drinking water supplies

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Figure 3.26: Plant for laying out of drinking water pipelines

Figure 3.27: Unit dedicated to water meters and metrology

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Figure 3.28: Automation and remote management training session

Figure 3.29: Process and drinking water production plant

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Figure 3.30: Metrology canal

Figure 3.31: On-site sanitation systems

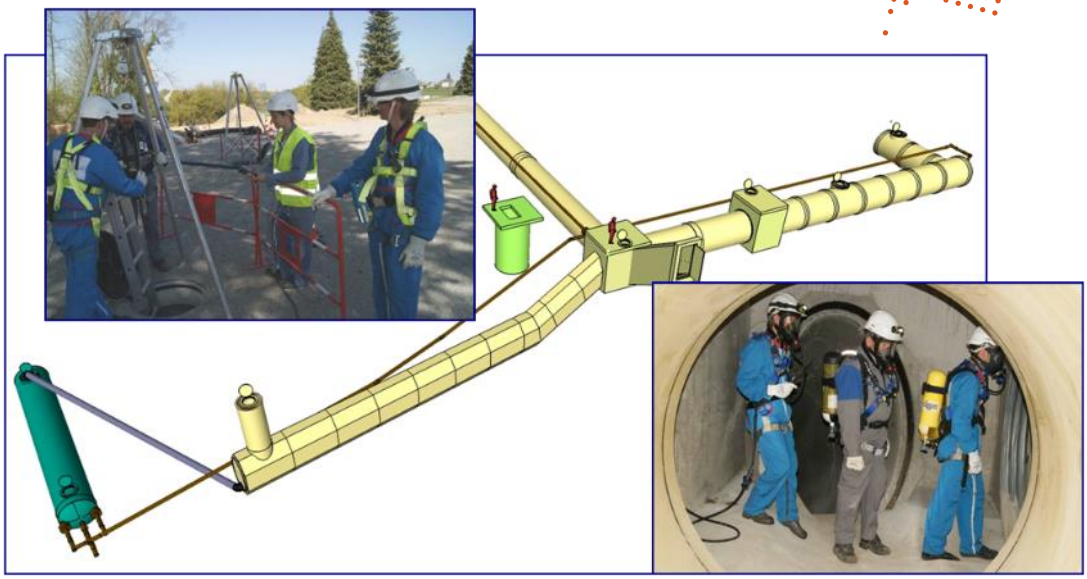

Figure 3.32: Underground sanitation network that can be accessed

Figure 3.33: Urban and industrial wastewater treatment plant

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Figure 3.34: Water analyses laboratory

IFTS:

IFTS's expertise is based on a long experience of separation techniques, state-of-the-art testing facilities and a team of scientists, engineers and technicians who are among the best in their fields of expertise.

The knowledge developed at IFTS applies to all industries. Thus, daily, the teams of the institute meet the needs of various industrial sectors such as aeronautics, agribusiness, chemistry, environment, mechanics, nuclear, pharmacy...

Based in Foulayronnes, between Bordeaux and Toulouse in southwestern France, IFTS has an international positioning and has two subsidiaries: one in the USA (Middlesex, NJ) and the other in China (Shanghai). The Chinese subsidiary has integrated a new building in 2014, where our local sales team is based as well as a testing laboratory for filters and cleanliness control.

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Figure 3.35: Laboratory for Liquid/Solid separation process studies - Feasibility – Optimization

Figure 3.36: Laboratory for filter testing

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Figure 3.37: Laboratory for Characterization and cleanliness

Figure 3.38: Laboratory for Water analysis

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Figure 3.39: Laboratory for studies and expertise in membrane separation

Already inaugurated at the end of 2018, IFTS will make fully operational, in early 2019, its brand-new Roger Ben Aïm Test Centre, a research and experimental centre designed to evaluate the behaviour of pilots and industrial equipment on real waters with specific characteristics.

Located in Lot-et-Garonne, in Agen (France), the Roger Ben Aïm Test Centre is located between two sites in the city: the drinking water production plant and the effluent treatment plant. This positioning gives him direct access to their water through a network of interconnected pipes. It is also close to the Garonne and the Canal des Deux-Mers between Atlantic and Mediterranean.

The Centre has ideal working conditions for its personnel who offer their services to private companies to test and prove objectively the performance of any technologies or innovations in order to treat water or sludge over a significant period of time (a few days, weeks or several months continuously ...)., in complete confidentiality to:

- Evaluate and qualify technologies and equipment for treatment and reuse of water or sludge management,
- Test and compare competing technologies at the pilot or semi-industrial scale, under controlled conditions,
- Organize equipment demonstrations in real conditions,
- Establish the equipment consumption budget in real conditions of use,
- Evaluate in-situ measuring instruments and online sensors,
- Test the endurance of equipment and sensors ...

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The Test Centre is also intended to conduct research (researchers, doctoral students, academics...) by French and international teams, including tests on natural waters or at various stages of their treatment of clarification, purification or on sludge.

The building, on stilts to avoid the risk of flooding, has at the first level, a parking and experimentation area covering several underground water storage tanks. Upstairs, a large space of 360 m² is dedicated to experimentation of treatment devices, a mechanical workshop, offices and a meeting room. It is surmounted by a soon vegetated roof which will serve as ground for experiments of irrigation and air cooling by the plants.

Figure 3.40: Roger Ben Aim Test Centre

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Figure 3.41: Location of the Roger Ben Aim Test Centre

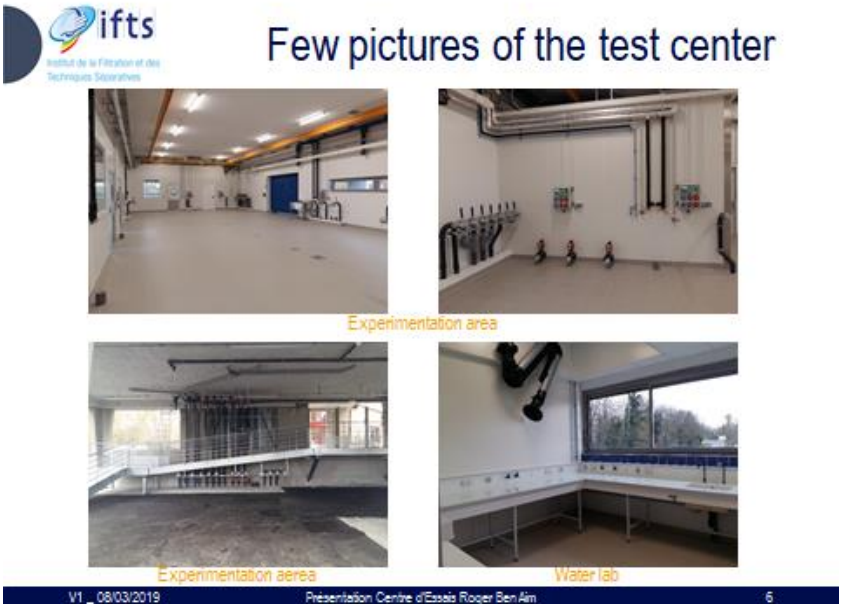

Figure 3.42: Facilities of the Roger Ben Aim Test Centre

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UNILIM's research themes in the field of water and the environment are as follows:

- Evaluation of the mobility of contaminants in complex environments:
- Natural environment (sediment, water bodies, soil)
- Methods for treating water or sludge
- Determination of the mechanisms controlling the mobility of contaminants
- Adsorption/desorption mechanisms; dissolution/precipitation; redox
- Interactions between solid / liquid / gas phases
- Interactions with organic matter
- Innovative sampling methods:
- Passive sampling
- Inorganic contaminants ◊ DGT
- Inorganic Contaminants ◊ POCIS, Chemcatcher
- Macrophytes

The contaminants studied are the major elements in the environment, the parameters of the quality of wastewater; organic and inorganic trace elements. The analytical tools available are:

- Sampling material for soils and sediments:
  - Drill, auger, sieves
- Water sampling material (surface and ground water) and flow measurements:
  - Automatic samplers (as ISCO), sampler for piezometer, piezometric probe, passive samplers, flowmeters
- Sample preparation:
  - Micro-wave mineralisator, lyophilizator, ASE for organic pollutant extraction in solid or biologic matrix, SPE automat, evaporator for small volumes
- Solid characterization:
  - Optic microscopy and picture analyse, SEM, XR-diffraction (Carmalim platform of Limoges University), XRF, CHONS analyzer, zetameter
- Materials for metals and metalloids analyse:

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- Inducted coupled plasma mass spectrometry (ICP-MS), microwave plasma atomic emission spectrometer (MP-AES), atomic absorption (flame and furnace), polarography

- Analytical materials for organic compounds:
  - LC MS QTof - LC detector DAD/fluorescence - GC MS/MS QQQ – LC MS QQQ to obtain soon
- Analytical materials for water characterization:
  - TOC/TN meter, ionic chromatography, automatic titrator, global parameters (pH, conductivity, O2, …), spectrophotometers (UV and fluo) and field material for water analysis
- Test laboratory:
  - Pilot units, columns, pumps, …
- In vitro culture material, histology, molecular biology:
  - Electrophorese DGGE, PCR (non-quantitative)

3.5 Technical/information context

Currently, information is provided through targeted actions

- Participation in trade fairs
- Publication of news on different media (websites, activity reports, workshop meetings)

The information available is:

- The characteristics of LaVISo
- Technical platforms
- Services offered

3.6 User community

In order to encourage user participation, workshops, events, meetings, videoconferences and webinars are organised, all with a focus on co-design and co-construction.

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Some organisations in the region have also shown interest in collaborating in the promotion of the French Living Lab:

City of Limoges: Local authority. Limoges wants to be involved in the Living Lab, promote it, and make some of its facilities available, including for prototype testing

The Nouvelle-Aquitaine region: The Nouvelle-Aquitaine region wants to get involved in the Living Lab, promote it, and make some of its infrastructures available for animation, workshops etc.

SOLTENA / Pôle Environnement Nouvelle-Aquitaine: SOLTENA wants to get involved in the Living Lab, promote it, and make some of its infrastructures available for animation, workshops etc

ASTEE Limousin, Poitou-Charentes: ASTEE Limousin, Poitou-Charentes extends its action to the northern part of the Nouvelle Aquitaine region in a low-density territory with a significant coastline. The water issues in this region are varied.

It brings together members from all disciplines who wish to be actively involved in promoting the association and contributing to the exchange of information and knowledge in all the fields covered by Astee. The board defines and organises a programme of activities with the support of structures, organisations or companies, thus enabling inter-professional exchanges to be intensified.

ASTEE Nouvelle-Aquitaine wants to get involved in the Living Lab, promote it, and make some of its infrastructures available for animation, workshops etc

These different stakeholders are very involved in the approach and are willing and motivated to knowledge exchange.

3.7 Services of the Living Lab

The services offered by LaVIo include:

Support for innovation

The three main partners and their represented organizations offer to support entrepreneurs in the development of new technological processes and the marketing of innovative products and services.

At the beginning of the innovation process, we can propose the facilitation of discussions in a climate of innovation and development of water technologies in the New Aquitaine region. For this we set up co-creation workshops with CODEmaker and mobilize a co-design organization hosted at the University of Limoges. These workshops can include all the key stakeholders identified in the quadruple helix concept (academy, industry, government and public). An example of such workshop is the one proposed concerning wastewater management in rural area. It can correspond to innovation development at all TRL levels.

Generate innovative research

The Living Lab aims to respond to technological needs with the construction of research projects that will bring together expertise in the fields of environment and water technologies, including chemistry, biology, microbiology, science soil and process engineering. LaVISo can propose trials on a pilot scale or process on semi-industrial units with performance monitoring thanks to the expertise of the project partners.

LaVISo offers assistance in research funding for research and technology transfer projects, the construction of appropriate consortia and the implementation of technical studies hosted on test platforms.

Technology transfer

"Technology transfer and research-industry cooperation are powerful levers of innovation and for companies, a development accelerator. »CCI France LaVISo wants to sustainably strengthen the competitiveness of companies by providing innovative solutions of a high technological level that will lead quickly to the establishment of new products and services. With the presence of several networks in the consortium such as Water and Climate, the expertise available within each consortium member, the availability of platforms, LaVISo offers technical support covering all levels of preparation, ranging from the definition from concept to technology validation. The transfer can lead to a financial transaction, and materialize in different ways: patent acquisition, cooperation, provision of human resources, etc. This would concern high TRL levels.

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Training

The partners are experts in many technologies and methodologies that will benefit from the innovation process, with the expertise to provide leading edge water treatment technology. It will also be possible to provide on-demand training for technical processes.

Labeling. Normalization

LaVISo makes an important contribution to the development of vocabulary standards, measures or tests that contribute to the clarification of technical and commercial exchanges, for example IFTS creates standardization commissions, researches and develops new procedures for essays and drafts the draft standards on which all agree.

Intellectual property

Thanks to the support services for innovation and transfer from the University of Limoges grouped together in AVRUL, the work done within the framework of the SVSO will ensure that intellectual property rights are taken into account throughout the entire period.

Market Analysis and Marketing

The consortium also aims to provide studies on market opportunities for technologies that will be evaluated, in particular through the external partners of the TWIST project, such as the CCIs in New Aquitaine. The partnership also has access to a wide range of support actors.

3.8 Activities carried out in LaVISo

TWIST French Living Lab, specifically in OiEau - Office International De L'eau, has two new Pilots working, one to test Triton ™ filter floor from Johnson Screens regarding their efficiency and environmental impact and the other to test an innovative method to detect cavitation and other pumps faults with a Schneider Electric variable speed drive.

Aqseptence Group SAS and OiEau collaborate on a pilot

Aqseptence Group trusted the Office International de l'Eau to support it in its R&D projects by entrusting it with the tests of the Triton ™ filter floor from Johnson Screens, a brand of the Aqseptence group.

This partnership is part of the ERDF - SUDOE project TWIST (Transnational Water Innovation Strategy) in which OiEau is a partner.

Figure 3.43: Installation the new pilot

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Figure 3.44: The new pilot in place

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Figure 3.45: Inauguration of the new pilot

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Figure 3.46: Structure for the Aqseptence pilot is identified as a part of LaVISo 1

Figure 3.47: Structure for the Aqseptence pilot is identified as a part of LaVISo - 2

In order to adapt to changing market needs and maintain its leadership, Aqseptence Group is constantly optimising its processes, including Johnson Screens' Triton™ filtering floor manufactured in France. The company has entrusted the performance qualification of this product to the OiEau, in order to guide it in its future innovations.

In 3 months, the OiEau teams created a pilot on a semi-industrial scale at their La Souterraine site, which allows them to test the efficiency of the Triton™ system in real-life situations and to optimise its environmental impact (water and energy consumption).

The results obtained demonstrate the strengths of the current product and we focussed on the axes of new developments. Inaugurated on Monday 7 September, in the presence of teams from Aqseptence Group and the International Office for Water, this pilot project initiated a long-term collaboration.

Schneider Electric & OiEau : Innovative method to detect cavitation and other pumps faults

Centrifugal pumps driven by asynchronous motor are widely used in industrial applications because of their low cost, high performance and robustness. However theses pumps can be damaged by wear and the performances of the machine can be altered.

Figure 3.48: System for detecting pump cavitation

This research work deals with fault detection and diagnosis of fault that may appear in a pump. Usually, a vibratory or noise monitoring can be established, but it's often really costly and can be cumbersome. A different approach based on the analysis and processing of the stators' current is proposed here in order to highlight theses faults. This method can detect a torque drop in the pump shaft, and coupled with a flow measure it can determine if a cavitation is occurring or not. This provisional maintenance gives the health state of a pump in real time and only requires acquiring the current and using RMS and spectral analysis.

For 2 years, Schneider Electric and International Office for Water have work together on this subject.

For now, the methodology researches have been done and a first set of experiments has been led on an existing pedagogical platform at IOW (multi-stage

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centrifugal pump with an asynchronous motor, current, voltage, pressure and flowrate measurement).

OiEau has developed another facility with additional features:

- Torque and speed measurement
- Test on a synchronous motor
- Use of a mono-stage centrifugal pump

With this new pumping loop, we test this new detection method on a different pumping structure (different pump, different motor), and to compare it with mechanical measurements.

Figure 3.49: Part of the new pilot

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Figure 3.50: The new pilot of Schneider

Figure 3.51: Members of Schneider visiting the pilot

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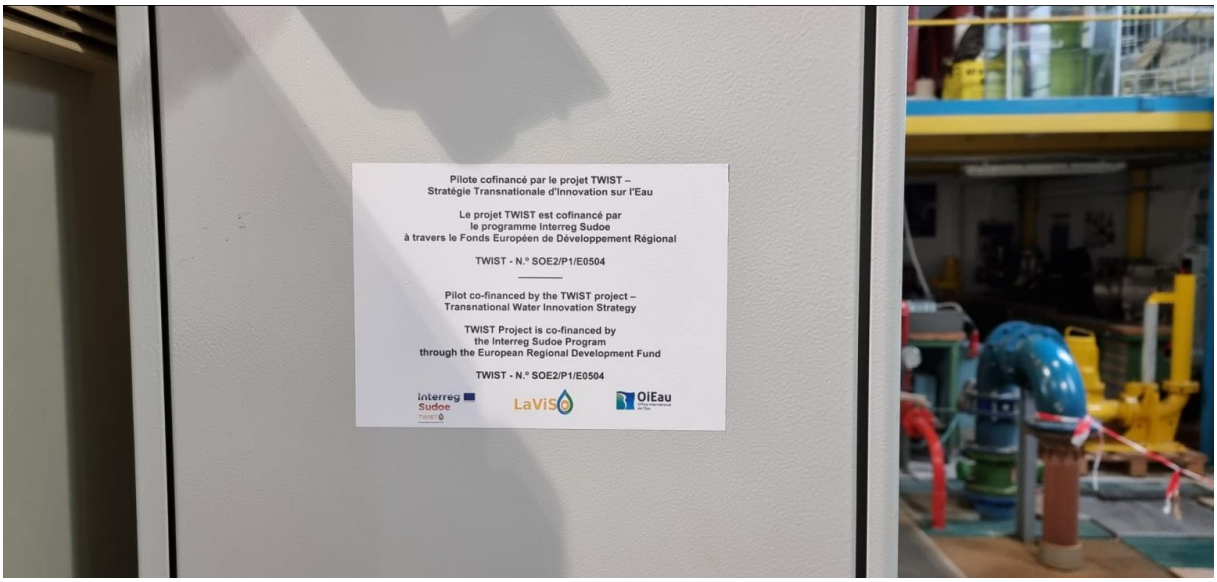

Figure 3.52: Structure for the Schneider pilot is identified as a part of LaVISo - 1

Figure 3.53: Structure for the Schneider pilot is identified as a part of LaVISo - 2

In order to give continuity to the projects, the partners have established and validated a memorandum of understanding.

It is therefore possible for structures to continue working within the framework of LaVISo. The structures set up for the pilots at OiEau could be used with modifications for other pilot tests in the future.

Schneider decided to contract OiEau to carry out new pilot tests in order to continue its research in this area (fault detection and diagnosis of fault that may appear in a pump). The configuration of the living lab suits the company, as the exchange of information with different actors is beneficial for the research.

The format is probably less well suited to the situation of Aqseptence. For this company, the research aims to lead to the filing of a patent for its innovation. This patent is essential for its future development in a very competitive sector. Also, the data sharing that supports the operation of a living lab is not really adapted to the company's needs. If pilot tests continue, at OiEau or elsewhere, it will not be in the framework of the living lab but with a very strict confidentiality agreement.

OiEau have learned that in this type of case, a pilot test should not be proposed in the context of a living lab.

Various companies are interested in carrying out pilot tests at OiEau. However, this activity is still slowing down due to the COVID crisis. In addition, the current soaring prices of raw materials and other manufactured products make it very difficult to plan such tests. Both OiEau and interested companies are currently waiting for the market to stabilise before undertaking pilot tests.

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4 Urban Lisbon Living Lab (UL3)

The Urban Lisbon Living Lab (UL3) is the Portuguese living laboratory created within the framework of the TWIST project.

4.1 Institutions involved in the constitution of the Living Lab

The Portuguese partners of the TWIST project are developing the Urban Lisbon Living Lab (UL3) under the topic of water reuse and resource recovery (water, nutrients and energy) from wastewater.

The partnership includes Instituto Superior Técnico (IST), Instituto Superior de Agronomia (ISA) and Águas do Tejo Atlântico, S.A. (AdTA). These institutions have their own research and have experience working together, having collaborated in several projects. They are experienced partners that can equally contribute to the development and support of the multiple projects embraced by UL3.

4.1.1 Águas do Tejo Atlântico (AdTA)

Águas do Tejo Atlântico, S.A. (AdTA) is a public company and is responsible for managing and operating the wastewater treatment system of Greater Lisbon and West[1], guaranteeing the quality, continuity, and efficiency of the service. It exploits a system that includes 104 Wastewater Resource Recovery Facilities (WWTP), 292 pumping stations and 922 km of main sewage system, and treats around 244 Mm^3/yr, serving a population of 2,4 million inhabitants (23 municipalities).

AdTA has as mission contributing to the pursuit of national objectives in wastewater collection and treatment within a framework of economic, financial, technical, social and environmental sustainability. AdTA is a strong and well recognised R&D+i agent within the industry – which includes its own R&D+i dedicated department. It has already in its profile several R&D activities in partnership with other institutions, companies, and universities in a wide range of subjects, including novel treatment processes and implementation of management and simulation tools for optimizing wastewater treatment and collection. R&D

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activities include the participation in several national as well as in European projects and include international awards recognition, by International Water Association (IWA) with a Global Honour Award for the project "AQUASAFE" developed in partnership with European SME, which is related to operational platform for decision support systems in Lisbon sewage system.

By partaking on TWIST, AdTA has the opportunity not only to share its knowledge, but also to improve in skills and human capital in relevant topics, such as, nutrients recovery, wastewater treatment and reuse and/or processes modelling and optimization. AdTA will put at disposal of TWIST project and Portuguese partners its infrastructure for N/P recovery and wastewater reuse.

Currently, AdTA hosts at its facilities and in partnership with other water industry related companies and academia, experimental projects, related with energy efficiency, operational management optimization, wastewater treatment for reuse, among others.

It is also common AdTA receive master and doctoral students to conduct their Master thesis in partnership with academia.

4.1.2 Instituto Superior Técnico (IST)

Instituto Superior Técnico (IST) is a Higher Education Institution, the largest school of Engineering, Science and Technology in Portugal. IST's mission is to contribute to the development of society by providing top quality higher education in the areas of Engineering, Science, Technology and Architecture, at undergraduate and postgraduate levels, as well as developing Research, Development and Innovation (RD&I) activities to allow it to provide teaching in line with the highest international standards. Its mission is therefore expressed in the three functions which characterize the concept of a modern university: to generate knowledge, to transfer skilled professionals and to transfer and apply knowledge and innovation.

IST consists of 9 departments and is involved in some of the most prestigious RD&I and technology transfer institutions in Portugal, with remarkable impact internationally in many scientific and technological domains. There are about 10,500 full-year equivalent under and post graduate students, and about 1,500 full time equivalent teaching and non-teaching staff.

The contribution of IST to apply knowledge and innovation is also described by the creation of 53 Spin-off companies since 2009, which further apply into society the research developed in this institution. IST also stimulates intellectual property protection as a means of fostering knowledge valorisation currently has a portfolio of more than 250 patents, being the Portuguese institution with the largest number of patents registered. Many of these patents result from research projects involving companies that have preferential rights for commercial exploitation. Licensing other intellectual property rights, such as computer programs copyright or technology products associated brands, among others, is also carried out by IST. Some of IST's start-ups have license agreements that enable exploitation of intellectual property rights of the school and associated research centres.

Research at IST is organised in 23 Centres and Institutes that pursue challenging research programmes with a strong social impact in the fields of Architecture, Engineering, Science and Technology. These Centres and Institutes address multidisciplinary research in an international and multicultural atmosphere.

4.1.3 School of Agriculture, Instituto Superior de Agronomia (ISA)

The **School of Agriculture, Instituto Superior de Agronomia (ISA)** is one of the faculties of the University of Lisbon. The core mission of ISA is Higher Education, Research & Development, and Technology Transfer in the scientific fields of Agriculture, Forestry and Natural Resources Engineering, Food Science and Engineering, Animal Production Engineering, Environmental Engineering, Biology, and Landscape Architecture. Within Higher Education, ISA is attended by 1500 undergraduate, master and PhD students. The 130 professors and 125 Researchers are PhD graduates with recognized scientific work published in international journals. Presently, ISA is involved in more than one hundred research & development projects, financed by EC and national funds. ISA is also involved in several projects concerning technology transfer with research institutes and private enterprises.

ISA hosts four nationally recognized scientific research centres:

i) the Forest Research Centre (CEF) is a research unit devoted to the integrated research of forestry and related ecosystems, forestry products and forest related service,

ii) the Centre Linking Landscape, Environment, Agriculture and Food (LEAF) focused on the entire Agro-Food chain, combining basic and applied sciences, from the cell and microorganisms to the landscape, for the knowledge and promotion of effective solutions aiming at the conservation of natural resources and the production and food quality,

iii) the Research Network on Biodiversity and Evolutionary Biology (Associated Laboratory), in partnership with CIBIO, University of Porto and

iv) the Centre for Applied Ecology "Prof. Baeta Neves" (CEABN) an integrated research centre integrates a whose mission is to promote scientific research in applied ecology to forest and agricultural ecosystems, contributing to management and use.

4.2 Type of Living Lab

Taking into consideration the existing types of Living Labs, the closest description of the one established by UL3 is an 'Intermediary Living Lab', in which different partners are invited to collaboratively innovate in a neutral arena. As said, the work developed is mostly focused on water reuse and resource recovery.

As the above-mentioned document states, there are many different types of Living Lab environments. In the case of UL3 the three institutions that form the Urban Lisbon Living Lab maintain their autonomy and each Living Lab projects are based in one of the existing facilities which are selected on a case-by-case approach. The location of the projects relies on its TRL level and on the topic to be addressed.

Depending on the need, all UL3 partners contribute to the development of the projects according to the type of tasks required.

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4.3 Objective of UL3

UL3 has as main objective the creation of an environment that is favourable to the development of R&D+i products and services focused on reuse and recovery of resources – water, energy, and nutrients from urban wastewater. Open innovation is key, giving to users an active role on the creation process.

The defined specific objectives are in close relationship to the thematic areas in which it is focused:

- Reuse of recycled wastewater,
- Nutrient recovery, and
- Energy recovery and management.

The engagement of relevant actors in the water sector is a key feature to reach these objectives. Such actors include recycled wastewater users, such as municipalities and other public institutes, research institutions and companies developing wastewater treatment technologies and civil society institutions.

4.4 Physical context of UL3

4.4.1 Location of infrastructures

UL3 has multiple infrastructures and facilities at its disposal, which will be used according to each project needs and characteristics. Furthermore, if required, *ad-hoc* structures will be developed/built for specific projects. Each partner has their own facilities and infrastructures that are at the service of the living lab and will be used on a case-by-case necessity.

AdTA has made available to UL3 all its infrastructure which serves a total of 23 municipalities. A total of 103 WWTP in both urban and rural areas, 292 pumping stations and 922 km of main sewage system. Depending on the location, population served, and the receiving environment different treatment options are available from conventional to advanced technologies. Some WWTP are equipped with anaerobic digestion and produce energy, others can use recycled water at the

facility and others to be reused externally for street cleaning, irrigation and refrigeration of commercial surfaces.

Currently, the projects at AdTA facilities are located at Alcântara, Beirolas (Lisbon) and Guia (Cascais). The Alcântara WWTP at the heart of Lisbon, is the headquarters of AdTA having conference and meeting rooms where, for instance the workshop took place. Also, in Lisbon at Chelas WWTP an Innovation Centre will be implemented, which will function as an R&D+i hub of the company to the world. All facilities are equipped with at least one meeting room and internet is available, an essential tool to guarantee an easy communication between all UL3 partners and engaged actors.

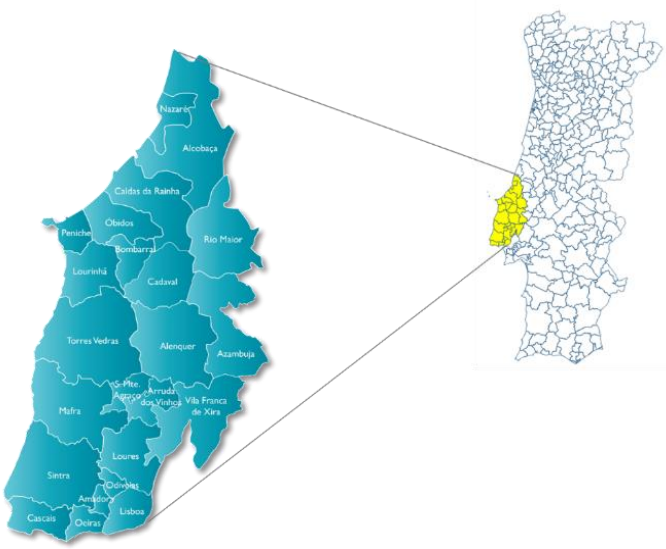

Figure 4.54: Councils served by AdTA infrastructures

IST has multiple laboratories inside Campus where lower TRL experimental setups can be installed, and perform water quality analysis.

The main laboratories involved in UL3 are the main Analysis Laboratory and the Environmental Laboratory. The main laboratory is a certified laboratory that performs physic-chemical and microbiology analysis to water samples.

The Environmental Laboratory is equipped with instruments to perform *in situ* analysis and field analysis. The main equipment includes:

- spectrophotometer UV-VIS
- Oven up to 1000 °C
- Oven up to 200 °C
- Portable OD probes
- Portable pH probes
- Portable Electrical conductivity probes
- Refrigerator and freezing chambers
- Heating blankets
- Heat bath
- Cooled incubator

The Environmental Laboratory can house bench scale and mesocosms experiments. Depending on the technology, pilot scale applications can also be installed in Campus.

Figure 4.55: General view of the Environmental Lab at IST.

IST also has a Congress centre with a main room with a capacity for 200 people and 3 smaller rooms.

The School of Agriculture (ISA) has full responsibility over a university campus with 100 hectares, known as Tapada da Ajuda. This space is a multifunctional urban, agriculture, forest and botanical area within the city of Lisbon. Tapada da Ajuda is

an open case regarding multiple and complex pressures. Currently, Tapada da Ajuda is a kind of a patchwork of urban zones (residential and offices) with an agricultural area that attains more than 32 hectares (namely vineyard, orange and olive orchards). In addition, Tapada da Ajuda comprises an expanding urban farming zone (approximately 1 hectare), a well-known classified botanic garden, forest areas and several biodiversity hotspots, among them a temporary river and a small lake. Therefore, the living lab of Tapada da Ajuda is a mesocosm of the real world and has all ingredients that can be required to test any environmental solution, from lab to full scale.

An overview of Tapada da Ajuda is presented below:

Figure 4.56: Aerialviewof Tapada da Ajuda

A picture of the *sustainable house* (living lab) is presented:

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Figure4 .57: A view of the sustainable house – resource recovery lab at Tapada da Ajuda

In addition, **ISA** implemented at the urban farming in the campus (Campo de Minas) a constructed wetland for wastewater reuse in the framework of TWIST. The project is intended to be a demonstration of nature-based solutions.

4.5 Technical/information context

UL3 counts with several platforms to disseminate information and knowledge. The preferential means of communication are emails and team meetings. The TWIST website is pivotal to disseminate information, both from the project itself and from the Living Labs. Social media, including LinkedIn are also key to publicize the project and its living labs. Each UL3 partner also makes use of their own website to promote the Living Lab, its projects, activities, and results.

UL3 and some of its projects have been presented on the TWIST Portuguese national conference for the development of innovation capacities of the water sector. All UL3 partners have been represented and made a presentation of their projects.

Additionally, all partners contributed and participated on the project final video.

The detailed dissemination of project results is also available through the TWIST Market Place web platform (twistmarketplace.eu). This platform displays a summary of the main products of TWIST project as well as technical information about the products developed and the partners involved.

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Beyond the above-mentioned activities, and due to the pandemic constraints, dissemination activities carried out by **AdTA** have been largely limited to the use of social media platforms, mainly LinkedIn.

4.6 User community

Most of the activities aiming to increase UL3 community of users took place before 2021. Nonetheless, further engagements were made to progress some of the UL3 projects in 2022 and beyond.

Since the mid-term report, **AdTA** has engaged with universities and companies of the private sector, mostly technology and equipment providers in other to progress with the projects' planned works. **ISA** opened the sustainable house facilities to the students of environmental engineering. **IST** engaged with companies, citizens associations and municipalities to collaborate in funding acquisition.

For the development of the disinfection of urban wastewaters treated with peracetic acid project, **AdTA** engaged with Nova School of Technology and Science for the development of the project's second phase. Due to the nature of this institution, academia, they are open to share the acquired knowledge if property rights are safeguarded. **ISA** and **IST** have multiple on-going partnerships with private companies.

4.7 UL3 Services

In the beginning of TWIST project, the services offered by the UL3 included mostly research studies and testing of equipment under a specific research project. Some Academic training in the Urban Water Cycle also occurred.

Since then, and despite COVID-19 limitations, UL3 has expanded its activity conducting R&D+I projects with some results having been achieved. Events have been organised and/or participated in where UL3 was represented. Despite limitations that COVID-19 brought to the project, **AdTA** continued receiving graduate and post-graduate students and supporting them in conducting their research studies to obtain a degree. To overcome those limitations this support was mostly provided online. Several funded projects have also been initiated with

different stakeholders – PMEs, major companies and research centres, with experiments occurring, as much as possible, in real-life settings. On-the-job training has also become a common activity promoted and different workers have been exposed to different types of projects and activities in view of expanding the skills of the company's human capital.

At **IST** the research work carried out at UL3 under the MAARTE project acted as a demonstrator to promote the contract of research services by Lisboa E-nova. This engagement was a direct result of the environment created by the Living Lab demonstrating that UL3 already has the structure to carry on after TWIST is finished.

At **ISA** several initiatives were promoted in cooperation with private companies. Perhaps the major one is the cooperation with Esporão, a large wine company that will move to the campus next year thanks to the innovative atmosphere that evolves at the campus. Other one is the small agricultural fields that are now available to Lisbon community. That´s just examples on how the **ISA** living lab offer an array of services to private companies and to the local community.

4.8 Interrelation with other Living Labs and innovation networks

Innovation cannot be achieved in a closed environment. As such, UL3 and its partners continued to connect with other entities of different nature to expand its network and create new formal and informal partnerships.

Additionally, the existing relationship with the other TWIST Living Labs was reinforced and experiences were shared, and the developed technologies presented.

AdTA is beneficiary of otherH2020 co-funded project, the B-WaterSmart. The B-WaterSmart project has created six living labs across different European cities, including Lisbon where a water reclamation pilot will be operated.

Thus, the B-WaterSmart project capitalizes the knowledge developed on UL3's project VIRA - Craft Beer made from Recycled Water as itaims to demonstrate a range of promising technologies for water reuse/nutrient recovery, and smart data applications for more efficient, safe allocation & use of resources.

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In 2021 **IST** participated in a H2020 call with UL3 as one of the flagship Living Labs to support demonstration projects in the country. The call included a network for Living Labs across Europe and UL3 team would be responsible for the Portuguese Living Lab cluster. Although the proposal was not successful, the experience obtained with UL3 strongly contributed for its development and enabled contact with other Living Labs for future collaborations.

Since 2021, **ISA** participates in the *Lisbon living lab region* that is focused in the urban-rural interaction and local food production (Project ROBUST). Among other projects, ISA it should be noted that is involved in the AGRO ULISBOA network. Finally, **ISA** goal now is to belong to the European network of living labs (ENOLL) and will work for this.

4.9 Activities carried out in UL3

UL3 has, during the course of TWIST, received 9 different projects where several activities were carried out across its different facilities.

AdTA developed through UL3:

- Wastewater treatment and energy recovery by Microalgae-Based Process.
- Disinfection of urban wastewaters treated with peracetic acid.
- Development of treatment processes using photocatalytic surfaces.
- VIRA - Craft Beer made from Recycled Water.

IST developed through UL3:

- Adaptation of green walls to treat greywater
- Assessing microbial contamination in green areas irrigated with treated wastewater - Project MAARTE
- Comparative analysis between drop irrigation and sprinkler irrigation (contract)

ISA developed through UL3:

- Smart Home of Tapada da Ajuda(Sustainable lab)
- Urban farming TA – constructed wetland for water reuse

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At the time of the mid-term report, **AdTA** had already concluded the predicted works of the development of treatment processes using photocatalytic surfaces and VIRA - Craft Beer made from Recycled Water projects. Regarding the first, no further developments were considered due to the COVID-19 pandemic restrictions, whereas the knowledge acquired by the latter was capitalized in a new and different H2020 co-funded project, the B-WaterSmart. The planned works of the wastewater treatment and energy recovery by microalgae-based process project had to be abandoned as they were severely impacted by the lockdowns imposed by the Portuguese government since March 2020 and all needed health and safety measures required by the Covid-19 pandemic.

This project was divided in the 5 phases shown below, and by the time of the last report only the first one had taken place.

1. Pilot-scale testing for secondary and tertiary treatment in a semi-continuous mode.
2. Pilot-scale testing for secondary and tertiary treatment in a continuous mode.
3. Pilot-scale testing for runoff from sludge treatment.
4. Anaerobic co-digestion study with microalgae substrate and sludge.
5. Technical-economic viability of the technology scale-up.

The required works to carry on this project in 2021 were considered unmanageable by the project team as, amongst others, included a re-start of the experiments and a change of the pilot facilities with some construction works required after the second phase. Despite all restrictions, the disinfection of urban wastewaters treated with peracetic acid project has progressed. At the time of the mid-term report, all work on a lab scale was concluded and, in 2021, the required steps to start industrial demonstration started. At the time of this report, all materials and equipment required for project were contracted and the pilot was being assembled at Beirolas WWTP.

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Figure 4.58: Disinfection of urban wastewaters with peracetic acid pilot

All planning for ecotoxicological essays and studies is developed and, currently, the procurement process is underway. After all studies concluded, a study of the economic viability of applying this disinfection method will be developed.

IST had hosted a bench scale research project regarding greywater treatment using green walls in the Environmental laboratory. The experiment consisted of two modules adapted to treat grey water, using recycled materials as plant support media. The materials used were crushed tiles mixed with coconut fiber and leftover fibers from the textile industry. Two types of plants were also tested. The project resulted from a partnership between uL3 and the company Quizcamp that produces Minigarden green wall modules.

Initial results from this experiment were published as a Master thesis and presented at WETPOL Conference (13-17 September 2021, Vienna, Austria – online). The experiment was further extended and full results will be submitted to the scientific journal with peer review Science of the Total Environment, as per invitation of the Scientific Committee of the Conference

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Figure 4.59: green wall for greywater treatment experimental facility, adapted from Minigarden conventional green wall modules.

After the mid-term report the lab green wall experiment was further scaled up to install a pilot green wall in the façade of the Mechanics I building at IST. The design started in March 2021 and implementation started in July 2021. However, several delays related with material and equipment supply due to pandemics restrictions caused a delay in the project. At the time of preparation of this report the pumping system and corresponding tanks are installed. The support structure for the green wall is also in place, and plants are expected to be delivered until the end of March. The hole structure is expected to be fully installed and in operation in the beginning of April 2022.

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Figure 4.60: Pumps and tanks for greywater to irrigate the green wall.

Figure 4.61: Location of the green wall, outside the Mechanics I building.

The microbial assessment of green areas was developed in grassed areas (MAARTE project) through a master thesis. The study developed a method for microbial analysis in grass, including faecal indicator bacteria (*Escherichia coli* and

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intestinal enterococci) and enteric viruses (Norovirus (Genogroup I and II) and Hepatitis A virus), using quantitative Polymerase Chain Reaction.

This method was also used to study the effects of irrigation with recycled water under different irrigation conditions, drop irrigation and sprinkler irrigation, as a contract by Lisboa E-nova. The work was carried out with the collaboration of AdTA and Lisbon Municipality in Beirolas WWTP, using *Hedera helix* as the test plant.

Figure 4.62: – Test beds in Beirolas WWTP. The front ones have drip irrigation system and the ones at the back have a sprinkler irrigation system.

The work contracted by Lisboa E-nova was developed between December 2020 and March 2021 and monitoring was further extended between April and July 2021 through a master thesis.

The dissemination activities of **IST** included online conferences and an online seminar for secondary school students.

The experimental green wall was used as a showcase for students and the pilot green wall will be available for visits from the general public, such as those that are organized during Técnico's day (23rd May).The results of MAART project were submitted to be presented at IWA's World Water Congress to be held in September 2022 in Copenhagen, Denmark, and results from the irrigation studywill submitted to be presented at the XX SILUBESA, an international congress to be held in June in Aveiro, Portugal.

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In March 2022, although after the end of the project, the head of the lab at IST participated in an activity of science dissemination at Pavilhão do Conhecimento (in Lisbon). In this activity some of UL3 project results were explained to the public under the scope of the current topic under exhibition at Pavilhão do Conhecimento "Water, an unfiltered exhibition".Pavilhão do Conhecimento is an interactive science museum located in Lisbon with an average of 750 visitors per day.

ISA has completed the Sustainable House as a full-scalelaboratory for innovation regarding resources recovery in the wastewater treatment domain. The concept is to prove that all implemented innovations for resource recovery are ready to use and can be tackled by the industry and citizens. Thus, according to the plan, a family from ISA staff will live in the house from April 2 onwards. This project is an opportunity to attract many visitors, and some technical visits were already organized.

Below are some photos concerning of the Living Lab at ISA campus.

5 Innovation management in TWIST Living Labs

Innovation is the commercial application of an idea and its management addresses the process of organizing and directing the organization's resources (human, material, economic) in order to increase the creation of new knowledge, generate ideas that allow the development of new products, processes and services or improve existing ones, and transfer this knowledge to all areas of activity of the organization (Virtual Observatory for Technology Transfer, OVTT).

To ensure proper innovation management, TWIST Living Labs follow a specific procedure (included in the Quality and Management Plan of the TWIST project) based on the "Practical Guide. Innovation Management in 8 steps" and focused on the systematic processes to capture creative ideas and their treatment. This Guide has been elaborated by the Association of the Industry of Navarra (AIN).

This innovation management procedure consists of 8 steps that arise around 4 major blocks or aspects to consider:

Block 1. Strategic Dimension

- Step 1. The innovation as strategy: Technological Strategic Plan

Block 2. Identification of ideas to develop

- Step 2. Creativity and Innovation: techniques of creativity, design and product development
- Step 3. Technological surveillance, Benchmarking and Competitive Intelligence

Block 3. Development of projects

- Step 4. Management of technological and innovation projects
- Step 5. Innovation financing

Block 4. Exploitation of results

- Step 6. Assurance of innovation: patents, industrial property and competitiveness
- Step 7. Exploitation of the innovation: innovation and business strategies

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- Step 8. Generation, maintenance and knowledge management in the enterprise.

5.1 Strategic dimension

Innovation Management thus has a strategic dimension for the organizations, insofar as it can contribute substantially to the success or failure of the institution. This strategic dimension, in the field of R&D&I projects, requires put on the same level innovation and technology in order to consider technology (innovation) as a crucial strategic resource for the organization and a key element of its Technology Strategy.

5.1.1 Step 1. The innovation as strategy: Technological Strategic Plan

Figure 4.63: Technological Management Process. Source: AIN (2010)

This set of processes begins with a Technological Diagnosis to define "the starting situation regarding the use of available technologies, client requirements and needs of products/services that want to be developed. Likewise, a series of objectives to be achieved must be set, considering the current technological panorama in which the organization is inserted" (AIN, 2010).

With the results obtained from the Technological Diagnosis, a **Technological Strategic Plan** (TSP) will be drawn up to "define the process to be followed in order to advance from the current technological situation to the desirable one in a reasonable period of time" (AIN, 2010), or whatever

the same, deciding what actions to carry out so that, starting from the current technological situation in the organization, the desirable situation can be reached.

Once the TSP has been defined, the **Transfer and Diffusion of the Technology** will proceed, understanding i) technology transfer as the "process of transferring the technology that is currently being used in the organization to the technology that is going to be achieved and implemented according to the decisions taken in the organization (linked to TSP)" (AIN, 2010), and ii) diffusion of the technology as the adequate communication to the rest of the organization of the adopted technologies.

5.2 Identification of creative ideas

The purpose of this phase is to develop creative faculties in order to identify new opportunities through technological innovation, as well as learning to systematize the detection of opportunities and threats from the environment.

This phase includes two steps in the innovation management process:

- Step 2. Creativity and Innovation: techniques of creativity, design and product development
- Step 3. Technological surveillance, Benchmarking and Competitive Intelligence

5.2.1 Step 2. Creativity and Innovation: techniques of creativity, design and product development

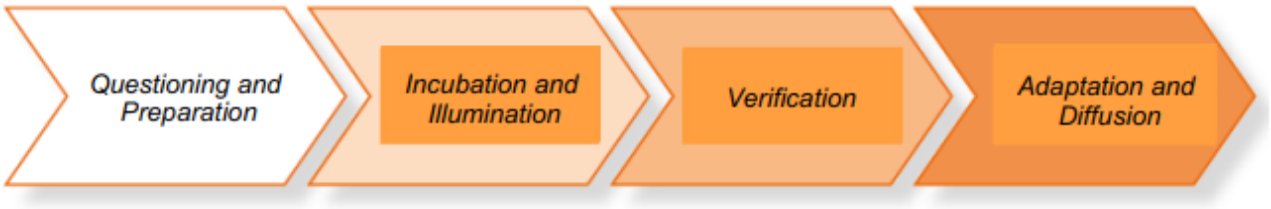

Figure 4.64: Creative process. Source: AIN (2010)

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The creative process begins with the **Questioning and Preparation** that look for the detection of problems or issues of interest to which it is necessary to give a technological response.

The next phase in the creative process is the **Incubation and Illumination**, Incubation understood as the search for solutions to the technological needs detected in the previous step, and Illumination as the finding of a clear solution to the problem.

The **Verification** will allow, on the one hand, the discrimination of ideas that have not a practical use and, on the other hand, validate that the chosen solution meets the necessary aspects for its successful implementation (costs, time, market acceptance, etc.).

Lastly, **Adaptation and Diffusion** will allow knowing the viability of the technological solution, as well as its materialization in a new product, service or process that will have to be introduced to the market and, if necessary, adapt it to end users.

5.2.2 Step 3. Technological surveillance, Benchmarking and Competitive Intelligence

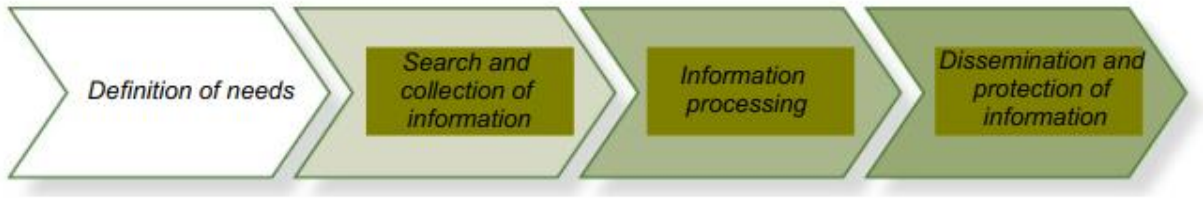

Figure 4.65: Competitive Intelligence Process. Source: AIN (2010)

This step in the Innovation Management process aims to respond to threats and opportunities in the environment. Therefore, it is necessary to begin by defining what information needs the organization requires in order to identify the sources from which to extract it, taking into account not only what type of information is relevant and useful for the organization, but for what purpose or for what information is necessary.

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The search and collection of information will provide data that, in the information processing phase, will have to be validated, checking its reliability, and processed so that it can be used by the organization in the information dissemination and protection phase, all this with a view to achieving decision-making supported by reliable data.

5.3 Projects development

This phase aims the implementation of innovative initiatives about technological and innovation projects.

This phase includes two steps in the innovation management process:

- Step 4. Management of technological and innovation projects
- Step 5. Innovation financing

5.3.1 Step 4. Management of technological and innovation projects

Figure 4.66: Process or life cycle of any project. Source: AIN (2010)

The definition of the project is a **preparation phase** in which the objectives of the project and the resources necessary for its execution are defined. This phase is complemented by the **planning phase** of the project in which the tasks to be carried out are structured (definition and duration of the tasks, order of execution and necessary resources) so that the objectives of the project can be achieved. Both phases are key to the success or failure of the project.

In this planning phase, it must be made a *"Risk management plan where the risks that may affect the project and the preventive measures are defined, to avoid and/or minimize them or the contingent actions that will be taken in the event that the risk appears"* (AIN, 2010).

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The **execution and control phase** is divided into two phases that have to be carried out in parallel:

- The project execution phase, consisting of conducting the tasks and activities defined for the project, managing resources appropriately, carrying out the specific methodologies to each technique, etc.
- The project control phase, consisting of verifying the actual progress of the project, so that in the event of differences between what is planned and reality (delay of activities, expenses that exceed what is budgeted, etc.) apply corrective actions to correct deviations..

The **completion and closure phase** consists, once the work related to the project has been completed and the service or product initially defined has been achieved, in a series of activities aimed at identifying points of improvement that allow optimizing future work.

5.3.2 Step 5. Innovation financing

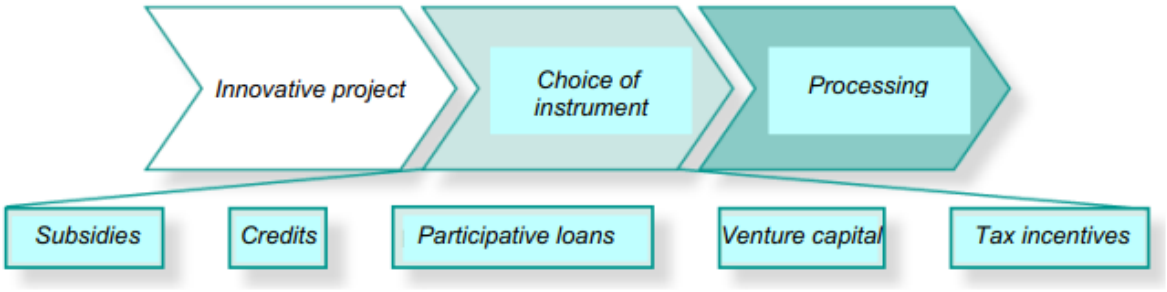

Figure 4.67: Innovation financing process. Source: AIN (2010)

Financing of innovation requires taking into account the circumstances surrounding the project (available resources, time planning, degree of innovation, etc.) to assess which financing instrument is the most appropriate and to be able to start its processing.

The main financing instruments are:

- Subsidy: *"delivery of an amount of money by the Administration, to an individual or to a company, without obligation to reimburse it, to carry out a certain activity of public interest. Therefore, the subsidy creates a legal*

relationship that links the Administration and the beneficiary. The latter, having fulfilled the legal conditions, is entitled to receive the subsidy, thereby committing himself to carry out the activity benefited" (AIN, 2010).

- Credit: *"the one in which the financial institution undertakes to make funds available to the client up to a certain limit and a predetermined term, periodically receiving interest on the amounts drawn down, movements that will be reflected in a current account"* (AIN, 2010).
- Participatory loan: the loan contract is *"that in which the financial institution delivers an amount of money to the client, the latter being obliged, after a specified period, to return said amount, plus accrued interest. [...] The participative loan is a complement or alternative to venture capital for financing innovative small and medium-sized companies. It avoids the tensions generated by the entry of third parties into the capital and eliminates the processes of valuation of the participations and of divestment. The financial expenses derived from the loan are deductible from Corporation Tax"* (AIN, 2010).
- Venture capital: *"minority and temporary long-term investments in small and medium-sized companies with great prospects for profitability and/or growth. [...] Focuses its activity on the development of business projects that are in early stages"* (AIN, 2010).
- Tax incentive: tax benefits.

5.4 Exploitation of results

The purpose of this phase is to protect the results obtained from the project, recover the capital invested in the projects and generate profitability on the investment made, as well as manage the knowledge of the organization as a Source of competitive advantages.

This phase includes 3 steps in the innovation management process:

- Step 6. Assurance of innovation: patents, industrial property and competitiveness.
- Step 7. Exploitation of the innovation: innovation and business strategies.

- Step 8. Generation, maintenance and knowledge management in the enterprise.

5.4.1 Step 6. Assurance of innovation: patents, industrial property and competitiveness

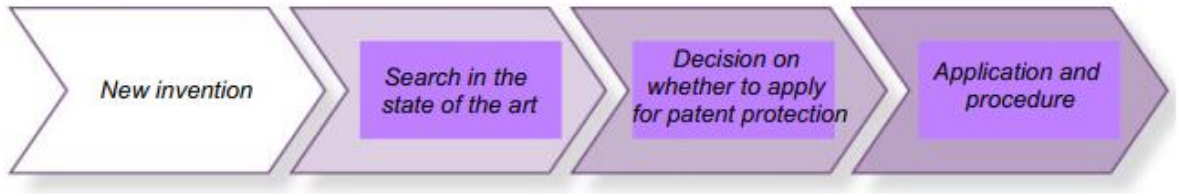

Figure 4.68: Process to obtain a patent. Source: AIN (2010)

The **assurance of innovation** consists in the protection of the innovations generated throughout the project; for this reason, it starts with the existence of a new invention, which should not be confused with innovation: *"invention is understood as, in the field of insurance, any new and inventive solution to a technical problem. This solution may consist of creating a completely new mechanism, product, method or process, or it may simply be an improvement of an already known product or process. […] The concept of innovation […] implies the application of the invention to a marketable product or process"* (AIN, 2010).

An invention can be protected through Intellectual Property legislation, which, depending on each country, is articulated in one way or another:

"In Spain, industrial property protects all creations related to industry: patents and utility models, distinctive signs and designs. In contrast, intellectual property is reserved for protecting creations of the mind in which the author's personality is captured, and that are unique creations, not industrially manufactured or mass-produced... For each one there are different laws and the authorities responsible for their management are also different: the Spanish Patent and Trademark Office deals with the recognition of industrial property rights and the Intellectual Property Registry deals with intellectual property rights." (OEPM, online).

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The Portuguese Institute of Industrial Property (INPI) of the Ministry of Justice is the Portuguese public organization that protects and promotes industrial property. Industrial property ensures the exclusive use of a trademark, a patent or a design.

In France, the National Institute of Industrial Property (INPI) is the public organization that protects and promotes industrial property.

However, in all cases:

"Industrial property is materialized in different instruments, among which are patents, utility models, trademarks, names, industrial designs, etc. [...] we are going to focus mainly on patents, since it is one of the most used ways when proceeding with insurance" (AIN, 2010).

The **state of the art search** *"should cover all pertinent documentation not related with patents, including scientific and technical bulletins, textbooks, conference proceedings, theses, websites, company brochures, trade publications, and newspaper articles, etc."* (AIN, 2010).

The search in the state of the art allows the organization, before starting the expensive procedure of protection of the invention through the patents, to know if the invention in question meets the patentability requirements: new, with inventive step and susceptible of industrial application.

There are tools from the intellectual property offices, accessible online, to assess the degree to which an invention can be considered as such and, therefore, is capable of being patented

The assessment of the decision on whether to proceed with patent protection should *"bear in mind that not always that an invention is susceptible of patent it must apply for patent protection, since the latter does not necessarily imply that it will lead to a commercially viable technology or product. For all these reasons, it is a priority to assess the advantages and disadvantages of proceeding with the patent and take into account other possible alternatives" (AIN, 2010) such as the utility model, the plant variety, the trade secret, the industrial design, the brand, copyright, etc.*

The **patent application and process** will begin, once the protection of the invention has been decided, with the presentation of the patent application (or other form of protection) at the patent office, the entity that will assess the

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susceptibility of the invention to be patented and will proceed to grant the industrial property title after paying the fees associated with the patentability process.

At this point it is crucial to consider the implementation or not of a valuation patent procedure in a broad sense in order to facilitate the transfer of the knowledge generated throughout the project to the market.

5.4.2 Step 7. Exploitation of the innovation: innovation and business strategies

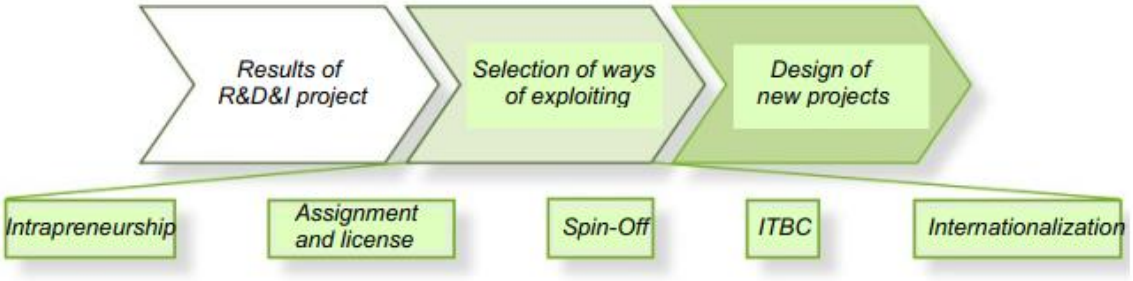

Figure 4.69: Results exploitation process. Source: AIN (2010)

The exploitation of innovation requires taking into account the results obtained during the execution of the project, the characteristics of the project, the strategic plan, etc. to proceed with the selection of the way of exploitation of the results.

The main **ways of exploiting the results** of an R&D&I project, besides the classic ones (publications, attendance at fairs, congresses, etc.) are:

- Intrapreneurship: *"internal form of exploitation of the results obtained from the innovation processes that means an expansion strategy for the organization based on the development of new businesses within it"* (AIN, 2010).
- Assignment: *"an assignment involves the sale and transfer of ownership of the invention by the assignor to the assignee"* (AIN, 2010).
- License: *"the license granting of a patent takes place when the owner of that patent (licensor) grants the exploitation rights of the same to a third party (licensee) in exchange for a consideration"* (AIN, 2010).

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- Spin-Off: *"enterprise born from another by separating its subsidiary divisions or departments to become a company by itself"* (AIN, 2010).
- ITBC (Innovative Technology-Based Company): *"enterprise that bases its knowledge on the application of new technologies, through sophisticated technical procedures or through the development of basic research"* (AIN, 2010).
- Internationalization: process of expansion of project results to other countries that favours technological collaboration with entities from countries not involved in the initial consortium.

5.4.3 Step 8. Generation, maintenance and knowledge management in the enterprise

Figure 4.70: Knowledge management process. Source: AIN (2010)

Knowledge is created in all organizations as their members interact with each other and with the environment. Knowledge creation can be tacit (subjective) or explicit (objective) and *"for tacit knowledge to be transmitted and shared within the organization, it must be converted into explicit knowledge"* through coding (AIN, 2020).

"When tacit knowledge becomes explicit, knowledge is created within the organization", hence the importance of reducing the factors that hinder the process of knowledge transfer within the organization (fear of sharing what is known, lack of time, lack of meeting places, etc.). However, for *"we to consider a full transfer of the knowledge, it is not enough that it is sent to a series of recipients, but also it is necessary that they must proceed with its assimilation. Hence, if the knowledge has not been assimilated, it is possible to affirm that the knowledge has not been transferred"* (AIN, 2020).

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Furthermore, as this process of generating knowledge is dynamic and depends on many factors, methodologies that allow the measurement of organizational knowledge are necessary, with the goal of improving knowledge management in the organization.

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6 Ensuring the future sustainability of the Living Lab

Financial sustainability is essential for a Living Lab to be viable in the long term and to eventually expand its activities. Social value should be at the core of any Living Lab project, but it is also the most difficult to obtain: long-term viability is necessary to have a concrete impact on society.

Living Labs require continuous funding and a sustainable funding model to support their innovation. However, they are often not financially sustainable and struggle to transfer the value created to a sustainable business model. Therefore, a good number of Living Labs are temporary and financial sustainability seems to be the most important issue to be the key condition to become permanent and remain operational in the long term. In addition, the ability to implement solutions with a concrete impact throughout the life of a Living Lab must be ensured.

Most Living Labs that are adequately funded rely mainly on public grants and subsidies. Even if it is a viable short-term funding option, it does not guarantee long-term viability.

Funding can be provided through different options, which are categorised as fee-for-service (PPS), subsidies (SUB), out-of-network funding (ONF), and cross-cutting financing (CRF) (Gualandi and Romme, 2019). In the following paragraphs, the four categories are explained in more detail.

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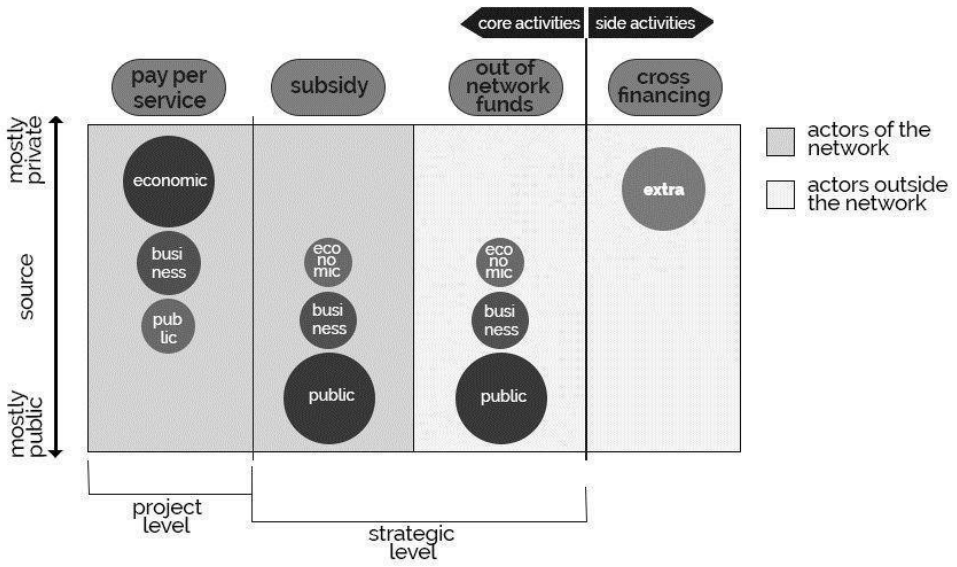

Figure 4.71: Mixed funding framework. Source: Gualandi & Romme, 2019.

1. Payment for Service (PPS). Payment for Service (PPS) is the most immediate monetary recognition of the services offered by the Living Lab. In fact, the source of PPS is mainly private. In rare cases, PPS may be related to business and social value. In these cases, the source may be partially shifted to the public sector. Finally, PPS is a project-level financing option: in fact, PPS relates to the services provided by the LL in the context of a specific project.

2. Grants (SUB). Grants are the most frequent funding option related to social and business value and are guaranteed by the strategic partners. Indeed, social and business value is mainly recognised by actors committed to a long-lasting relationship, where the interest is not limited to projects, but aims at developing shared goals and objectives. Therefore, SUB is a financing option that relies mainly on public sources.

3. Out-of-network funds (ONF). Living Labs have the possibility to raise significant funds by systematically applying for funding in EU, national and regional calls. Living Lab projects are often compatible with public policies, and open calls are good options for funding public value creation. Funds are mainly

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made available by public bodies and therefore mainly come from public sources.

4. Cross funding (CRF). Unlike PPS, SUB and NFOs, this funding option is not linked to the Living Lab activities, nor does it contribute to the network. In fact, cross-funding is rather an alternative way to benefit from Living Lab assets, such as physical location (i.e., the LL can permanently sublet part of its space to a bar or co-working office, or temporarily to events, conferences, meetings) or complementary equipment (i.e., the Living Lab can lease software, etc.). The source of CRF is almost exclusively private and completely external to the Living Lab activities. TWIST Living Labs should describe the funding options they can achieve for long-term viability. In the framework of the project, the objective of the Living Lab funding should be to ensure viability, not financial profit.

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