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ULTIMATE

WATER SMART INDUSTRIAL SYMBIOSIS

D3.2 WSIS-Living Labs

Gap analysis and recommendations

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[1] PU = Public
PP = Restricted to other programme participants (including the Commission Services)
RE = Restricted to a group specified by the consortium (including the Commission Services)
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1			

Executive Summary

The awareness that the earth's resources are finite, and pollution is a long-term problem that affects us all, coupled with the need to preserve and strengthen the global and local economy have prompted governments, institutions, and industry to work together to seek solutions to reduce the impact of waste material on the environment, while maintaining and possibly increasing the competitiveness of the industry sector.

Our society must achieve a paradigm shift in the way resources are managed and used. Waste generation must be minimised beginning with the design stage of materials and products. Process industries can only achieve this change if robust and novel collaboration models are permanently established across industrial sectors, across value chains and with regions, living labs, municipalities, and citizens along with the required technology developments, including industrial symbiosis.

In this report, Industrial Symbiosis is defined as the process by which waste or by-products of an industry or industrial process become the raw materials for another. Application of this concept allows materials to be used in a more sustainable way and contributes to the creation of a circular economy.

Water Europe (WE) leads task T3.4 of "Industry water-utility symbiosis for a smarter water society" (ULTIMATE) project WP3. The task is intended to provide recommendations to the projects' Case Studies (CSs) for the creation of a new type of water-oriented Water Smart Industrial Symbiosis Living Lab (WSIS LL) suited for symbiosis with industry. Water Europe contribution focuses on leveraging existing Water-Oriented Living Labs (WOLLs) in the regions of the ULTIMATE cases by engaging additional stakeholders and citizens to build a symbiosis between water service providers and industries. WOLLs are LLs that commit to develop, test and validate technologies, business models and innovative policies with water at their core.

WE role in this task is to contribute to targeting the WOLLs making use of the WE's WOLLs methodology and WOLLs Atlas to provide recommendations for the creation of a new type of water-oriented WSIS LLs suited for symbiosis with industry. This is achieved by assessing CS's maturity to *evolving into **Living Labs** (LLs) with an approach oriented to water and suited for Industrial Symbiosis (IS).* The setup of a Living Lab would allow different sites to share knowledge and experience and to mutually benefit from the know-how gathered during the symbiosis establishment process. Living Labs are defined as user-centred innovation ecosystems based on a systematic user co-creation approach, integrating research and innovation processes in real life communities and settings[1].

Water-Oriented Living Labs are considered the most effective mean to build a water-smart economy and society in Europe and the best tool to support the realisation of its vision strategy to develop a Water-Smart Society according to Water Europe long-lasting experience. Water Smart Society is a society in which the true value of water is recognised and realised, and all available water sources are managed in such a way that water scarcity and pollution of water is avoided, and water and resource loops are closed to a large extent to realise a circular economy and optimal resource efficiency, while the water-system is resilient against the impact of climate change, and all stakeholders are involved.

[1] https://enoll.org/

T3.4 builds on previous work connected to T3.2 "Business-to-business engagement" under the lead of KWR and NTNU where all the nine Case Studies were trained and supported on establishing and coordinating dedicated Communities of Practice and 3 case studies were involved in co-creation activities for communication with a broad range of stakeholders about circular water solutions in industrial symbiosis. It also builds on D3.1 "Criteria for linking existing LLs to the Case Studies issued by ULTIMATE partners' NTNU and Water Europe.

In ULTIMATE task T3.4 is aimed at providing recommendations to the projects' Case Studies for the creation of a **new type of WOLL suited for symbiosis with industry**. The goal of Deliverable D3.2 is to inform Case Studies owners on the state of the art of their water orientation and advise them on what activities to integrate in their agendas to **evolve into water-oriented Water Smart Industrial Symbiosis Living Labs (WSIS LL).**

This is achieved by completing 3-steps:

1. **The first step of the assessment study consists of a mapping exercise of Case Studies and revolves around the collection of general information (Name, Location, Scope, estimated Maturity) and selected criteria concerning the characteristics of Mission, Focus and Organisation of each CS.**
2. **The second step is the assessment in form of a survey for the six foundational elements of any Living Lab which are: 1) User Involvement, 2) Service Creation, 3) Infrastructures, 4) Governance, 5) Innovation Outcomes and 6) Methods & Tools. The analysis of each of these foundational elements allows to determine the maturity level of each CS and to identify development opportunities. This phase ends with each CS being awarded a score.**
3. **The third step requires Case Studies leaders to evaluate and define SMART objectives to improve low-scored foundational elements for their Case Studies. This last step is not developed in the present document.**

The recommendations developed in this document are based on the findings of the "*Study and portfolio review of the projects on industrial symbiosis in DG Research and Innovation"*[2]*,*the Processes4Planet roadmap [3], and the WE publication "Water-Oriented Living Labs. How to assess and evolve Water-Oriented Living Labs. A manual with a vision. Notebook Series#2" [4] which includes the WOLLs methodology based on the Harmonisation Cube and adapted to the water sector, in this report referred as the "Harmonisation Cube methodology".

The Harmonization Cube methodology is an assessment method developed to structure the repository of the European Network of Living Labs (ENOLL) that was specifically adapted to the water sector to allow a co-ordinated assessment, analysis, synergic development, harmonisation, and networking of regional Water-Oriented Living Labs initiatives.

To give Task T3.4 activities a longer-term perspective, Water Europe will use the Atlas of Water-Oriented Living Labs inventory to identify existing settings with similar objectives to the project's Case Studies, with the aim of learning from the experience of existing Water-Oriented Living Labs, building symbiosis between service providers and industries, and generating a local environment conducive to cooperation and co-creation. Water Europe will

[2] https://ec.europa.eu/info/publications/study-and-portfolio-review-projects-industrial-symbiosis-dg-research-and-innovation-findings-and-recommendations_en
[3] https://www.aspire2050.eu/sites/default/files/pressoffice/publication/processes4planet_2050_roadmap_jan2021.pdf
[4] https://watereurope.eu/wp-content/uploads/Dossier-WoLL-A4-2-03-pliegos.pdf

link existing WOLLs with the project's Case Studies, and dialogue among ULTIMATE Communities of Practice and Water-Oriented Living Labs will be supported and fostered through workshops and brokerage events. Existing WOLLs will be investigated to analyse gaps and critical factors for success to build symbiosis between services providers and industries and to generate a local enabling environment for cooperation and mutual learning with ULTIMATE CSs.

Recommendations

Not all Case Studies have the readiness, motivation, or the indispensable conditions to evolve towards Living Labs or Water-Oriented Living Labs, therefore for those Case Studies (CS6, CS7 and CS8) no recommendations are provided. Detailed and tailored recommendations for the remaining Case Studies can be found in each CSs section and in the conclusion of the report. These recommendations are based on findings from the assessment surveys.

In a long-term perspective and with the objective of turning ULTIMATE CoPs into WOLLs suitable for industrial symbiosis, we propose ULTIMATE CSs to maintain, consolidate and expand the CoPs created for industrial symbiosis. This could be done with the establishment of an entity with a mandate to promote and enhance industrial symbiosis, identify best practices, communicate its benefits and help in educating and establishing industrial symbiosis. Some key activities recommended for the community of practice are:

- **share knowledge and experience with other industrial symbiosis sites and to learn from the experience that other sites have gained during the period of establishing the symbiosis.**
- **publish a set of industrial symbiosis guidelines in a handbook, which would help drive the understanding and acceptance in an accelerated way.**
- **run an on-line platform to share experiences and technologies helpful in building the cooperation necessary for industrial symbiosis.**
- **develop an up-to-date inventory of industrial symbioses and of opportunities for cross-sectoral cooperation. This inventory could be used for the design of site (clusters) and regional planning in Europe and beyond.**

For CSs to evolve into water-oriented Water Smart Industrial Symbiosis Living Labs (WSIS LL), common recommendations are the followings:

- **Consider to establish a formal entity with all the stakeholders defined in the quadruple helix, trying to involve all the 4 stakeholder categories: Knowledge Institutes (research and academic), Public actors (including local authorities), Private actors (local industry representatives), Water technologies users to foster co-creation and technology acceptance;**
- **Clearly state the goal of the Living Labs under establishment and include water explicitly in the entity vision.**
- **Envision and promote a participative approach;**
- **Establish pilot and demonstration cases of first-of-a-kind industrial symbiosis implementations to show potentialities in terms of greenhouse gas emissions reduction and circularity;**
- **Provide visibility and successful examples to create motivation and show advantages in terms of competitiveness.**

- **Improve digital tools: software for rapid screening of industrial symbiosis potential; methodology and software platform to implement innovative industrial symbiosis; digital twinning.**
- **Identify the availability of a waste water stream as an attractive raw material; promote it to the potential users.**
- **We propose to use the concept of SRL (Symbiosis Readiness Level) to identify and drive the progress of industrial symbiosis projects and initiatives.**
- **The potential and the benefits of industrial symbiosis should be included in the education of engineers and business students to ensure the availability of a sufficient skill base.**

Disclaimer

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List of acronyms

C	Contextual perspective
CAP	Common Agriculture Policy
CoP	Communities of Practice
CS	Case Study
CSs	Case Studies
DGR&I	DG Research and Innovation
ENOLL	European Network of Living Labs
EU	Europe
Gov	Governance
ICT	Information and Communications Technology
INFRA	Infrastructure
Inn	Innovation Outcomes
IS	Industrial Symbiosis
iWWTP	Industrial Wastewater Treatment Plant
KWR	KWR Water Research Institute
LLs	Living Labs
M&T	Method and Tools
NTNU	Norges Teknisk-Naturvitenskapelige Universitet
O	Organizational perspective
P4P	Processes4Planet
RED	Renewable Energy Directive
SC	Service Creation
SH	Stakeholder
SRIA	Strategic Research and Innovation Agenda
T	Technological perspective
U	User Involvement
SDGs	Sustainable Development Goals
SME	Small Medium Enterprises
WFD	Water Framework Directive
WE	Water Europe
WELL	Water Europe Living Lab
WOLL	Water-Oriented Living Lab
WP	Work Package
WSIS	Water Smart Industrial Symbiosis
WSIS LL	Water Smart Industrial Symbiosis Living Lab
WSS	Water-Smart Society
WWTP	Wastewater Treatment Plant

1. Introduction

The recognition that the Earth's resources are finite has led governments to work towards reducing the use of natural resources. This urgency led the European Commission to present a long-term vision for decarbonising Europe by 2050[5] and strengthen the EU efforts towards a “Green Deal for Europe”[6]. One of the most ambitious targets included in EU policies is the cut of green-house gas (GHG) emissions to be achieved, among other factors, by decoupling economic growth from natural resources depletion. Europe’s goals and targets encourage to use all possible routes to cut CO_2 emissions, reduce waste, foster circularity, and strengthen industrial symbiosis.

In this report, Industrial Symbiosis is defined as the process by which waste or by-products of an industry or industrial process become the raw materials for another. Application of this concept allows materials to be used in a more sustainable way and contributes to the creation of a circular economy.

Aiming at fostering the transformation of the European industrial sector, in 2020 the European Commission established the Processes4Planet[7] (P4P) partnership devoted to achieving circularity towards climate neutrality. The partnership introduces, develops, and implements the concept of **Water Smart Industrial Symbiosis** (WSIS) in Europe. The goal of the partnership is to support industries in becoming frontrunners in the transition to climate neutrality and circularity in alignment with the EU Green Deal goals. P4P aims to achieve a near-zero landfilling and near-zero (waste) water discharge in Europe.

There is a growing demand for water from various economic activities and increasing stress on natural water sources. To secure water for our society, available and reliable alternative water resources of various qualities are needed, and this water should be suitable for different functions and multiple users. This includes making better use of water resources and all the valuable substances that could be obtained through the wastewater treatment and reuse process. Processes4Planet partnership intends to close the loops of water reuse across industrial sectors, and across value chains, proposing the establishment of novel collaboration models based on circularity.

In this context, the Horizon 2020 programme launched the call CE-SC5-04-2019 aimed at 'Building a water-smart economy and society'; the ULTIMATE project was funded under this call. The call asks for actions that should demonstrate the feasibility of a 'water smart' economy and society in which all available water resources, including surface, groundwater, waste water, and process water, are managed in such a way as to avoid water scarcity and pollution, increase resilience to climate change, appropriately manage water-related risks, and ensure that all valuable substances that could be obtained from waste water treatment processes, or are embedded in used water streams, are recovered.

ULTIMATE aims to establish and support a Water Smart Industrial Symbiosis by implementing circular economy solutions for water, material, and energy recovery. The

[5] Commission communication– ‘A Clean Planet for all– A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy’, COM(2018)773.

[6] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

[7] https://www.aspire2050.eu/p4planet/about-p4planet

circular economy solutions will create a win-win situation for both the water sector and the industry. In the nine case studies involved in ULTIMATE project the water sector forms those symbiosis with companies from the agri-food, beverage, petrochemical, chemical and biotech industry. The water sector actors involved in the case studies include service providers, municipal utilities, multi-industry utilities, specialised small and medium enterprises, and water service providers.

This Deliverable belongs to Work Package 3 (WP). The main objective of WP3 is to design and promote active stakeholder (SH) engagement and co-creation engaging industry, water utilities and the general public. Specifically, ULTIMATE dedicates WP3 to develop and implement innovative ways to creatively engage with public/private stakeholders (industrial partners, technology providers, regulators, and investors) and the general public and co-create with them.

Water Europe (WE) leads task T3.4 of ULTIMATE project WP3. The task is intended to provide recommendations to the projects' Case Studies (CSs) for the creation of a new type of water-oriented Water Smart Industrial Symbiosis Living Lab (WSIS LL) suited for symbiosis with industry. Water Europe contribution focuses on leveraging existing Water-Oriented Living Labs (WOLLs) in the regions of the ULTIMATE cases by engaging additional stakeholders and citizens to build a symbiosis between water service providers and industries. **WE role in this task is to contribute to targeting the WOLLs making use of the WE's WOLLs methodology and WOLLs Atlas to provide recommendations for the creation of a new type of WSIS LLs suited for symbiosis with industry**.

This was achieved by assessing CS's maturity to evolving into **Living Labs** (LLs) with an approach oriented to water and suited for Industrial Symbiosis (IS). The setup of a Living Lab would allow different sites to share knowledge and experience and to mutually benefit from the know-how gathered during the symbiosis establishment process. Living Labs are defined as user-centred innovation ecosystems based on a systematic user co-creation approach, integrating research and innovation processes in real life communities and settings.

Water Europe considers Water-Oriented Living Labs the most effective means to build a water-smart economy and society in Europe and the best tool to support the realisation of its vision strategy to develop a Water-Smart Society (WSS). A Living Lab is not only a network of infrastructures and services, but also a collaborative ecosystem based on iterative feedback processes that is established to sustain community-driven innovations in a multi-stakeholder context. It offers an effective research methodology for sensing, prototyping, validating, and refining innovative solutions in multiple and evolving real-life environments.

In ULTIMATE, WOLLs are not simply experimental laboratories but rather ecosystems for experimentation and co-creation with real users in real life spaces. WOLLs in ULTIMATE aim to contribute to enable the establishment of a **Water Smart Society** at European level.

Water Smart Society is a society in which the true value of water is recognised and realised, and all available water sources are managed in such a way that water scarcity and water pollution are avoided, and water and resource loops are closed to a large extent to realise a circular economy and optimal resource efficiency, while the water-system is resilient against the impact of climate change, and all stakeholders are involved. (Water Europe)

By exploiting the concepts of WOLLs, ULTIMATE offers an active and inclusive stakeholder engagement environment around the innovations demonstrated, setting up participation and collaboration platforms for both industry-to-industry engagement and citizen participation.

T3.4 builds on previous work connected to T3.2 “Business-to-business engagement” under the lead of KWR and NTNU where all 9 Case Studies were trained and supported on establishing and coordinating dedicated Communities of Practice (CoPs) and 3 case studies were involved in co-creation activities for communication with a broad range of stakeholders about circular water solutions in industrial symbiosis. It also builds on D3.1 “Criteria for linking existing LLs to the Case Studies issued by ULTIMATE partners NTNU and Water Europe.

To give Task T3.4 activities a longer-term perspective, Water Europe will make use of the **Atlas of Water-Oriented Living Labs** inventory to identify existing settings with similar objectives to the project's Case Studies, with the aim of learning from the experience of WOLLs, building symbiosis between service providers and industries and generating a local environment conducive to cooperation. Water Europe will link existing WOLLs with the project’s Case Studies and dialogue among ULTIMATE CoPs and existing WOLLs will be supported and fostered through workshops and brokerage events. Existing WOLLs will be investigated to analyse gaps and critical factors for success to build symbiosis between services providers and industries and to generate a local enabling environment for cooperation with ULTIMATE CSs.

1.1. Purpose of the Deliverable

The goal of Deliverable D3.2 is to inform CS owners on the state of the art of their water orientation and advise them on what activities to integrate in their agendas to evolve into a new type of WOLL suited for Industrial Symbiosis, the water-oriented Water Smart Industrial Symbiosis Living Labs (WSIS LL).

This deliverable presents recommendations for ULTIMATE Case Studies resulting from the WOLLs assessment methodology based on the “**Harmonisation Cube**” and tailored to the water sector, and the Strategic Research and Innovation Agenda (SRIA) of the Processes4Planet Partnership, where Water Europe is one of the founders’ partners.

The Harmonization Cube is an assessment method - developed to structure the repository of the European Network of Living Labs (ENOLL) - that was specifically adapted to the water sector to allow a co-ordinated assessment, analysis, synergic development, harmonisation, and networking of regional Water-Oriented Living Labs initiatives.

The purpose is to give guidance to CS owners, and CoPs coordinators on what activities to focus on to align the Case Studies with water orientated WSIS LL goals, not only during ULTIMATE lifespan but foremost beyond the project duration.

1.2. Structure of the Deliverable

Deliverable D3.2 consists of 5 sections or chapters. These are followed by 9 Annexes.

Chapter 1 introduces a general overview and the purpose of the Deliverable. It also includes a short description and definition of the main contents of this work.

Chapter 2 presents the concept of Water Smart Industrial Symbiosis. To this end, an overview of the Processes4Planet partnership is provided, together with an overview of the establishment of novel collaboration models based on circularity.

Chapter 3 is dedicated to defining the methodology to assess the water orientation of ULTIMATE Case Studies. This chapter also defines what Living Labs are, and the basic concepts of Water-Oriented Living Labs are introduced.

Chapters 4 is devoted to present the results of the assessment exercise. It describes ambitions, gaps, assessment results, recommendations, and the potential to develop, test, validate and implement water-oriented innovations for the 9 Case Study of the ULTIMATE project.

Chapter 5 draws the conclusions and summarises the main recommendation for each CS on activities to integrate into their action plans to evolve towards Water-Oriented Living Labs suited for industrial symbiosis.

Annex 1 define the six foundational elements objectives.

Annex 2 reports CS1 data outputs.

Annex 3 reports CS2 data outputs.

Annex 4 reports CS3 data outputs.

Annex 5 reports CS4 data outputs.

Annex 6 reports CS5 data outputs.

Annex 7 reports CS6 data outputs.

Annex 8 reports CS9 data outputs.

CS7 and CS8 did not compiled the survey, therefore no data outputs are provided.

1.3. Methodology

The methodology used to assess the water-oriented attitude of ULTIMATE Case Studies is grounded on the WOLLs methodology based on the “Harmonization Cube”, adjusted specifically for the water sector to allow a co-ordinated assessment, analysis, synergic development, harmonisation, and networking of regional Water-Oriented Living Labs initiatives. In this deliverable we will refer to this assessment methods as the “Harmonization Cube methodology”. The references of the methodology are the following publications of WE:

- **Water-Oriented Living Labs: Notebook Series #1. Definitions, practices, and assessment methods.**
- **Water-Oriented Living Labs: Notebook Series#2 How to assess and evolve Water-Oriented Living Labs. A manual with a vision.**

The **Harmonization Cube methodology** allows the users to analyse the foundational elements of any Living Lab, identify development opportunities and enhance a participative approach with key stakeholders in the water sector. This is achieved by completing 3-steps:

The first step of the assessment study consists of a **mapping exercise** of the projects' CSs to assess their water-oriented attitude and their potential to develop, test, validate and implement water-oriented innovations. This first step revolves around the collection of general information (Name, Location, Scope, estimated Maturity) and selected criteria concerning the characteristics of Mission, Focus and Organisation of the CSs. This information was collected from the ULTIMATE case studies to gain a broader understanding of their status but was not included in this report as it is not directly relevant to the purposes of Task T3.4.

The second step consists of an **assessment survey** for the six foundational elements of any Living Lab which are: 1) User Involvement, 2) Service Creation, 3) Infrastructures, 4) Governance, 5) Innovation Outcomes and 6) Methods & Tools. This assessment provides insights on the degree of maturity of the case studies and highlights the areas that need to be improved by providing quantitative results and radar graphs. The recommendations to the CSs stem from the analysis of the results of this evaluation survey. Gaps and reasons for these gaps have been analysed and critical success factors have been identified. Analysing each of these foundational elements allowed to determine the maturity level of each CS, identify development opportunities while enhancing a participative approach with key stakeholders in the water sector. This phase ends with each CS being awarded a score.

The third step concerns the evaluation and definition of SMART objectives to improve CSs' low-scored foundational elements. The qualitative analysis allows to prepare **Implementation Plans** to be implemented in the CSs.

2. Water Smart Industrial Symbiosis

The awareness that the earth's resources are finite, and pollution is a long-term problem that affects us all, coupled with the need to preserve and strengthen the global and local economy have prompted governments, institutions, and industry to work together to seek solutions to reduce the impact of waste material on the environment, while maintaining and strengthening the competitiveness of the industry sector.

There are many methods to reduce the impact of resource use. One strategy is the **circular economy**. The circular economy approaches to mitigate resource limitations are based on the concept of reduce, reuse, recycle. These include avoiding the use of a resource, reducing the need for the use of a resource, reusing the resource, recycling a resource and using waste as a resource, depending on the circumstances, the current understanding of the need and the possibilities available.

Within the realm of circular economy, **industrial symbiosis** is one practical way to operationalize circular economy. As stated in the report "*Study and portfolio review of the projects on industrial symbiosis in DG Research and Innovation (DGR&I): Findings and recommendations*"[8], published in 2020, recycling "*is a building block, a mosaic piece that can be used in setting up a circular economy, but the scope of industrial symbiosis is broader, more ambitious, and more complex, since multiple actors (industrial and/or public) must come together and develop a joint commercial, organisational, technological, and ecological approach".*

Industrial symbiosis is the process by which waste or by-products of an industry or industrial process become the raw materials for another. Application of this concept allows materials to be used in a more sustainable way and contributes to the creation of a circular economy.

In 2018, a European Committee for Standardisation workshop agreed on defining industrial symbiosis as '*the use by one company or sector of underutilised resources broadly defined (including waste, by-products, residues, energy, water, logistics, capacity, expertise, equipment and materials) from another, with the result of keeping resources in productive use for longer'*[9].

Further to this, the DGR&I's study underlined the need to go beyond optimisation at process and/or plant level, and to have a more systemic approach moving towards optimisation at multi-plant/cluster level and beyond (e.g. local communities). A holistic approach is suggested to achieve improvements for resource and energy efficiency, which are necessary to move towards a zero-waste circular economy.

DGR&I's study recommends also "*to establish a **community of practice (CoP)** for industrial symbiosis which could be an entity with a mandate to promote and enhance industrial symbiosis, identify best practices, communicate its benefits and help in educating and establishing industrial symbiosis*". In ULTIMATE, all 9 Case Studies established a Community of Practice with the support of KWR in the context of Task 3.2 (WP3).

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[8] https://ec.europa.eu/info/publications/study-and-portfolio-review-projects-industrial-symbiosis-dg-research-and-innovation-findings-and-recommendations_en

[9] European Committee for Standardisation and European Committee for Electrotechnical Standardisation, 'Industrial Symbiosis: Core elements and implementation approaches', workshop agreement, 2018, p. 5 (ftp://ftp.cencenelec.eu/EN/ResearchInnovation/CWA/CWA17354.pdf).

Our society must achieve a paradigm shift in the way resources are managed and used. This change can only be achieved if robust and novel collaboration models are permanently established. An effective management of water resources is also an essential component of the circular business models of the future.

The Processes4Planet partnership, established by the European Commission in 2020 under the umbrella of Horizon Europe, introduces, develops, and implements the concept of Water Smart Industrial Symbiosis in Europe. This partnership is devoted to transform the European process industries to achieve circularity and overall climate neutrality at the EU level, while enhancing their global competitiveness.

The Processes4Planet SRIA 2050 document details the Partnership's unique collaborative approach to delivering the cross-sectorial innovation setting the basis for the development of recommendations for WSIS LLs in the European framework. The goal is to support industries in becoming frontrunners in the transition to climate neutrality and circularity, towards near zero landfilling and near zero waste-water discharge, in alignment with the EU Green Deal goals.

By launching specific Calls for proposals, P4P can support ULTIMATE Case Studies in their transition to Water-oriented Living Labs.

2.1. WSIS Living Labs

Living Labs are entities that operates in a real-life context with a user-centric approach. The scope, aims, objectives, duration, actor involvement, degree of participation, and boundaries of a Living Lab are open for definition by its participants.

Living Labs serve as a bridge between research niche where innovations are developed and tested on a small scale and the validation of the innovations for a wider market uptake. They operate as systemic intermediaries among cities, regions, firms, third sector and research organisations as well as citizens **for joint value co-creation, rapid prototyping, testing, and validation to scale up and speed up innovation and businesses for the achievement of a Water-Smart Society.**

The core features of Living Labs can be summarised as follows:

- **Experimental approaches in real-life context**
- **Participation and user involvement**
- **Collaboration and co-production of knowledge**

From the industrial perspective, Living Labs, or living laboratories, are tools to validate and implement innovation in a real-life environment. Industry is one of the main water users in Europe, accounting for about 40% of total water abstractions[10]. For this reason, in the industrial environment it is crucial to create industrial symbiosis and to manage them in a participative way using the tool of the Living Labs. **Water Smart Industrial Symbiosis Living Labs have a special focus on water and are suited for the Industrial Symbiosis context**.

[10] https://ec.europa.eu/environment/water/pdf/water_reuse_factsheet_en.pdf

When water is at the core of the decision-making process with regards to co-creation, testing, and evaluation of innovations, we can define LLs as Water-oriented. The concept of WOLLs is based on a systematic user co-creation approach. Innovations are integrated through the co-creation, exploration, experimentation and evaluation of innovative ideas, scenarios, concepts, and related technological artefacts in real life use cases involving user communities, not only as observed subjects but also as a source of creation.

In the next section (Chapter 3) the concept of Water-Oriented Living Labs is illustrated, and the WOLLs' assessment methodology is presented. Recommendations to ULTIMATE Case Studies suited to the industrial symbiosis context are provided in Chapter 4.

3. Assessment methodology

Water-Oriented Living Labs are entities that operate as intermediaries among cities, regions, firms, third sector and research organisations as well as innovations users and citizens for joint value co-creation, rapid prototyping, testing, and validation through iterative feedback processes to scale up and speed up innovation and businesses for the achievement of a Water-Smart Society.

WOLLs are aimed at ensuring continuity and reproducibility to Research and Development. They gather existing water-oriented interventions, research, and innovation with a cross-sector approach to learning and innovation ecosystems.

Water-Oriented Living Labs are considered a key driver for future research agenda in the water sector. This means that a harmonised approach would be beneficial so that research results, innovation and good practices can be generates, compared, and shared in a coordinated and concerted manner. Furthermore, Living Labs enable the more effective resolution of societal challenges, acceleration of innovation, internationalisation of industries and Small Medium Enterprises (SME), and the creation of a pan-European experimentation environment supporting the realisation of a Green and Digital Europe.

More broadly, Living Labs are considered an important concept to foster innovation and user-engaged co-creation. They are human-centric environments whereby innovations are co-created, tested, and evaluated in an open, collaborative, multi-contextual real-world settings while facilitating the interactions among other relevant stakeholders, including academia, research organisations, SMEs, business industry, civic sector, Information and Communications Technology (ICT) professionals and public partners. WOLLs are LLs that commit to develop, test and validate technologies, business models and innovative policies with water at their core.

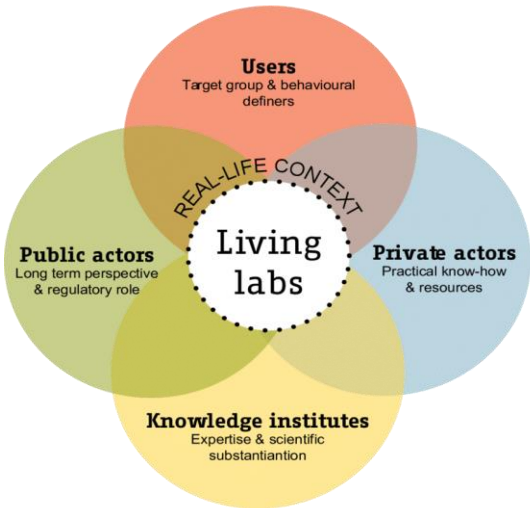


Figure 1 Quadruple Helix model of Water-Oriented Living Labs

To reach their goals WOLLs engage with the four stakeholders recognised in the Quadruple Helix model, visualised in Figure 1. The Quadruple Helix involves representatives from all members of society: public authorities, industry, academia, and citizens. The WOLLs and LLs approach puts the end-user in focus.

Living Labs mostly function in the capacity of delivering services to its members and stakeholders for societal and market demand. Their setting facilitates co-creation of products, services, application towards market launch; smooth integration of products and services to obtain feedback and trust; and reduces data complexity fostering comparability of results.

The next section is dedicated to defining the methodology for the assessment of Water-Oriented Living Labs and provides guidance on how to use the Harmonisation Cube tool.

3.1. Methodology

The methodology used to assess ULTIMATE Case Studies water orientation is based on the Harmonization Cube methodology, a method developed under the EU funded CoreLabs project to structure the repository of the European Network of Living Labs (ENOLL[11]). The methodology was further adjusted specifically for the water sector to allow a coordinated assessment, analysis, synergic development, harmonisation, and networking of regional Water-Oriented Living Labs initiatives. This methodology is promoted by Water Europe in the Notebook Series #1[12] and Notebook Series #2[13].

To apply the methodology a practical assessment tool has been created. This tool allows the users to:

- **Assess and analyse six foundational elements inherent to any Living Lab's functioning and development. These are User Involvement, Service Creation, Infrastructure, Governance, Innovation Outcome, Methods and Tools[14]**
- **Identify development opportunities**
- **Enhance a participative approach with key stakeholders in the water sector.**

This is achieved by completing 3-steps (mapping – assessing – evaluating and improvement planning) which are described in detail in the following paragraphs. The methodology has been applied to the ULTIMATE Case Studies to assess their water-oriented attitude and their potential to develop, test, validate and implement water-oriented innovations.

3.1.1. Step 1 – Mapping

The first step concerns a **mapping exercise** for the identification of the initial information about the Case Studies. This first step revolves around the collection by the CS owners of general information about their CSs (Name, Location, Scope, and a self-assessment on the estimated Maturity, the latter explained in more detail in the next paragraph) and selected criteria concerning the characteristics of Mission, Focus and Organisation, as shown in Table 1.

Name of the candidate WOLL	
Location of the candidate WOLL	
Scale (Municipal, Regional, Industrial)	
Estimated Maturity	

[11] https://enoll.org/

[12] Water Europe, Water-Oriented Living Lab Notebook Series #1 'WOLLs – Definitions, practices and assessment methods'

[13] Water Europe, Water-Oriented Living Lab Notebook Series #2 'How to assess and evolve a Water-Oriented Living Lab. A manual for a vision'

[14] Water Europe, Water-Oriented Living Lab Notebook Series #2 'How to assess and evolve a Water-Oriented Living Lab. A manual for a vision'

Table 1 Questionnaire for the initial information gathering

To fill the **Scale** field CS owners should refer to the spatial scale and the related governance. This dimension distinguishes on (i) regional scale, public river basin level; (ii) urban scale, public-private domain level; and (iii) local scale, private and industrial level. Concerning the **Maturity** dimension, it addresses the developmental level of the Case Studies. The degree of maturity is distinguished into 3 levels: (iv) start-up; (v) sustainable; (iv) scalable.
A further collection of information revolves around investigating **mission statement**, **focus areas** and **organisation type**. Table 2 provides the contents of this part of the questionnaire. For the ULTIMATE case studies, all this information was collected to check whether water orientation had already been considered by the CS.

Initial Selection Criteria	
MISSION STATEMENT	
Mission statement aligns to Water Europe's Vision? *To assess this statement, a short version of Water Europe's Vision was provided.*	(Yes/No)
Mission statement related to EU WFD[15], RED[16], CAP[17] or Green Deal?	(Yes/No)
Mission statement related to UN SDG[18] approach?	(Yes/No)
Mission Statement to specific National Member State Issues?	(Yes/No)
FOCUS	
Reference to Water infrastructure Asset Management Issues?	(Yes/No)
Reference to Water security and/or Water safety Issues?	(Yes/No)
Reference to Total Cost of Ownership Issues?	(Yes/No)
Reference to Integrated Spatial Planning Issues?	(Yes/No)
Reference to Water-Food Sustainability Issues?	(Yes/No)
ORGANIZATION	
A permanent setup of the LL?	(Yes/No)
Designated real-life test environment?	(Yes/No)

[15] Water Framework Directive (WFD), https://ec.europa.eu/environment/water/water-framework/index_en.html
[16]Renewable Energy Directive (RED), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001
[17] Common Agriculture Policy (CAP), https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-glance_en
[18] Sustainable Development Goals (SDGs), https://sdgs.un.org/goals

An open-test environment?	(Yes/No)
Involvement and commitment of Multiple stakeholders from the water sector (including water authorities)?	(Yes/No)
Involvement of cross-linking Nexus partners from different sectors (Water-Food-Energy)	(Yes/No)
A credible continuity plan of the LL (e.g. planned revenue streams for multi-annual economic sustainability)?	(Yes/No)

Table 2 Questionnaire for mission and focus information gathering

This information was collected from ULTIMATE Case Studies to have a broader understanding of the current situation, but it was not included in the analysis of the present Deliverable as this information is not directly relevant to the Deliverable's purposes.

3.1.2. Step 2 – Assessment

The following step relates to the assessment of WOLLs through the Harmonisation Cube. This methodology provides detailed evaluation criteria for the six foundational elements of any Living Lab (the six faces of the cube) as shown in Figure 2. These are User Involvement (U), Service Creation (SC), Infrastructure (Infra), Governance (Gov), Innovation Outcome (Inn), Methods and Tools (M&T).

Each face of the cube includes a 3x3 evaluation matrix: the horizontal axis focuses on the **Organizational (O), Contextual (C) and Technological (T) perspective**, and the vertical axis considering three development phases of a Living lab life cycle**: setup, sustainability, and scalability**.

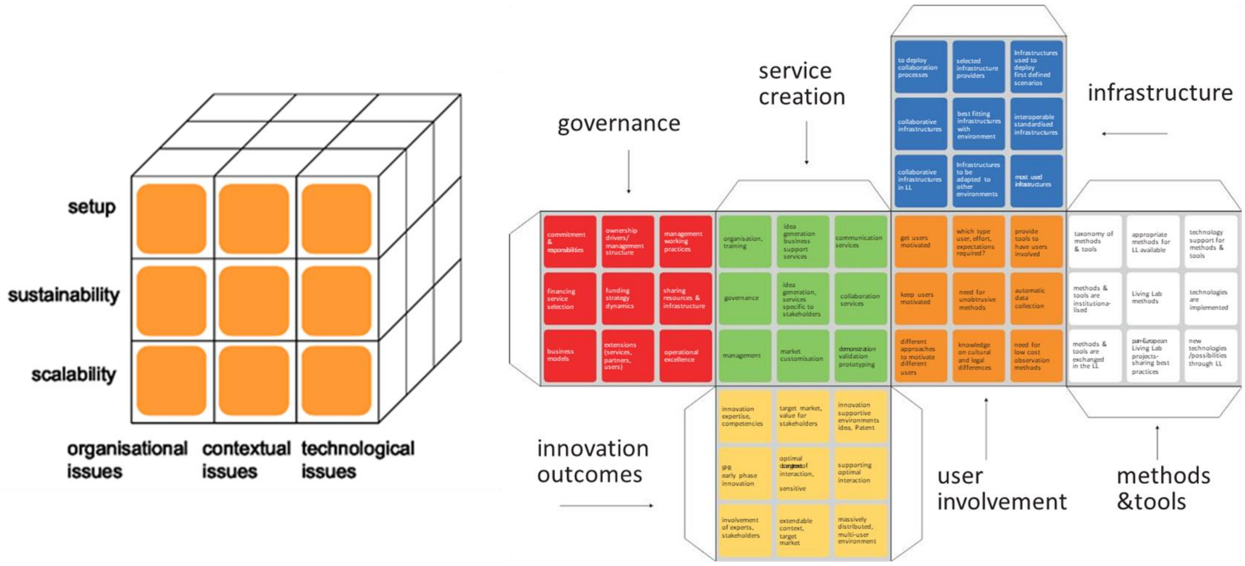


Figure 2 Visualisation of the six foundational elements for the Harmonisation Cube

Each foundational element can then be rated according 9 criteria to determine its stage of development and highlight opportunities to further increase their impact on the implementation of water innovations. The application of the tailored Harmonisation Cube to Water-Oriented Living Labs allows WOLLs to be scored through the analysis of 54 metrics.

To apply the methodology to the ULTIMATE Case Studies, a survey was conducted aiming at evaluating all foundation elements of the Cube. The assessment included questions tailored to the Research, Development, and Innovation requirements in the water sector. The questionnaire is outlined in Section 3.2 of this report.

3.1.3. Step 3 – Evaluating and Improvement Planning

The third and final step “Maturity Level Evaluation and Improvement Plan” is a qualitative analysis that can be performed if improvement opportunities have been identified. The WOLL scoring tool has been set-up to allow each assessor to focus on specific improvement points, develop a plan and measurable results using SMART approach. Where needed, i.e. where the maturity lever shows opportunity for improvement, the SMART approach can be carried out by following the explanations of the 5 key actions:

1. **Specific: Define specific challenges and actions to improving the LL maturity level**
2. **Measurable: Define deliverables or concrete progress on targeted challenge**
3. **Actionable: Verify if you as a Living Lab organisation can actual DO something to realise these improvements (and indicate who is in the position to implement the improvement action)**
4. **Reasonable: Secure that the improvement actions are within the scope of your available resources: define how much resources (FTE, budget) would be required to realise the improvements**
5. **Timely: Make sure it is realisable within acceptable timing: define a reasonable timeline to realise the improvements.**

The identified improvement points can be included in the relevant boxes of the SMART objective table (shown in Figure 3) for future reference. This step of the methodology related to identifying SMART opportunities for improvement is not part of the present deliverable.

SMART opportunities for WOLL maturity development	UO Score	100%	UC Score	67%	UT Score	33%
S = Specific: Define a specific challenges and action to improving your LL maturity level	UO Improvements		UC Improvements		UT Improvements	
M = Measurable: Define deliverables or concrete progress on targeted challenge						
A = Actionable: Verify if you as a Living Lab organisation can actual DO something to realise these improvements						
R = Reasonable: within the scope of your available resources: define how much resources would be required to realise the improvements						
T = Timely: realisable within acceptable timing: define a reasonable timeline to realise the improvements						

Figure 3 SMART objectives table

3.2. Assessment survey

This part presents the assessment survey proposed to the 9 Case Studies of the ULTIMATE project. The six foundational elements of any Living Lab have been investigated from an **organizational (O), contextual (C) and technological (T) perspective**. These elements considered are User Involvement, Service Creation, Infrastructure, Governance, Innovation Outcome, Methods and Tools. The definitions of the objectives referred by these six elements are reported in Annex 1.

The six elements have been investigated with three levels of questions, reflecting the increasing degree of maturity through these maturity levels, they are **Set Up; Sustainability; Scalability**. Each question needed a yes/no answer, and each answer have been scored with 1/0 accordingly. The overall outcome figure reflects the maturity degree of the case studies, while the percentage score of the six foundational elements highlights the strong areas versus the areas that need to be improved.

The overall scores that resulted by analysing the surveys are archived in Annex 2 to Annex 8. The following tables show the survey proposed to the Case Study owners.

The following sections report the questions of the survey for each of the six foundational elements. The questions are gathered into three groups for the exploration of the organizational, contextual, and technological contexts separately. In each group the questions are organised in a way to explore the maturity level of CSs following the conventional path of development phases: setup, sustainability, and scalability.

3.2.1.Use Involvement

Table 3 shows the User Involvement metrics for the Organisational setting.

UO Metrics	
Setup Do you focus the LL on at motivating at least one of the key water user groups to be involved in measurements and the design process of water innovations (urban/citizens, industry and/or agriculture)	(Yes/No)
Sustainability Did you agree on longer term arrangements with user groups of water or related technologies	(Yes/No)
Scalability Did you consider to expand user engagement and research, e.g. towards other type of water users, or (collaborate with) other geographical areas (including confrontation with other LLs)	(Yes/No)

Table 3 User Involvement Organisational Metrics

Table 4 shows the User Involvement metrics for the Contextual setting.

UC Metrics	
Setup Did you characterise the type of water or water related technology users you want to engage in the innovation process (type of water user, water related technology user), to take into consideration their differences	(Yes/No)
Sustainability Did you design an engagement strategy for water users or technology users, as part of the co-creation process? E.g., to keep users motivated	(Yes/No)
Scalability Did you adapt engagement strategy e.g., towards other type of water users, or other geographical areas taking into account knowledge on cultural and legal differences	(Yes/No)

Table 4 User Involvement Contextual Metrics

Table 5 shows the User Involvement metrics for the Technological setting.

UT Metrics	
Setup Did you set-up methods and tools to engage with the defined user groups (e.g., online tools for social networking, apps, cameras, Video etc. design workshops and consultation meeting, brain storming etc held in the local places as schools, libraries, cafes).	(Yes/No)
Sustainability Did you set-up methods and tools for continuous feedback from users e.g., permanent industry sounding board, citizens communities	(Yes/No)
Scalability Did you set-up low-cost continuous user observation technologies and standards e.g., automated data collection of water use in the LL environment etc), that allow for sharing research results with other LLs or external research?	(Yes/No)

Table 5 User Involvement Technological Metrics

3.2.2. Service Creation

Table 6 shows the Service Creation metrics for the Organisational setting.

SCO Metrics	
Setup Did you set up and train the stakeholders for a collaborative and co-creation process within the WOLL targeted at tackling challenges in the water sector, covering at least technical services (e.g. demo and prototyping)	(Yes/No)
Sustainability Do you have a stable governance structure, that reflects all relevant stakeholders of water value chain for the co-creation process within the focus area of your WOLL	(Yes/No)
Scalability Do you manage the service creation process taking into consideration intra-network services (collaborations and learning with external parties, beyond your core-partners and other Living Labs)	(Yes/No)

Table 6 Service Creation Organizational Metrics

Table 7 shows the Service Creation metrics for the Contextual setting.

SCC Metrics	
Setup Did you identify and set-up new idea generation approaches through identifying critical or important aspects to the water smart society and do you have a business support (market strategies) services in place.	(Yes/No)
Sustainability Did you set-up a sustainable mechanism for user involvement in idea generation, services to specific stakeholders, considering open innovation and interoperability aspects as well as and customer services (e.g., market customisation etc)	(Yes/No)
Scalability Do you facilitate the design of user engaged market uptake strategy for the resulting products and services for the water sector, including IPR and business models.	(Yes/No)

Table 7 Service Creation Contextual Metrics

Table 8 shows the Service Creation metrics for the Technological setting.

SCT Metrics	
Setup Did you set-up a clear communication plan and services to engage users in the co-creation process; and do you consider sharing valuable lessons of communication from successful and unsuccessful water related projects and teams.	(Yes/No)
Sustainability Did you set-up durable collaboration services using technologies or other similar tools to support and enable cooperation between all parties involved.	(Yes/No)
Scalability Did you have supporting technologies to enable cooperation between all parties involved to make demonstration, validation and prototyping	(Yes/No)

Table 8 Service Creation Technological Metrics

3.2.3. Infrastructure

Table 9 shows the Infrastructure metrics for the Organisational setting.

InfraO Metrics	
Setup Did you set-up a collaboration process to deploy and operate networks, sensors, data collection mechanisms that provide meaningful insights in the performance of water related innovations (as targeted in your water mission)	(Yes/No)
Sustainability Do you have collaborative infrastructure in place to operate networks, sensors, data collection processes, analysis etc to external infrastructures surrounding the LL to be able to acquire real life user data of sufficient quality and over time	(Yes/No)
Scalability Did you set-up the collaborative data-collection process, to enable easy exchange and collaborative research with other (Wo)LL's (e.g., within ENoLL)	(Yes/No)

Table 9 Infrastructure Organizational Metrics

Table 10 shows the Infrastructure metrics for the Contextual setting.

InfraC Metrics	
Setup Did you select (external) infrastructure providers (such as water utilities, urban authorities, industries etc), to set up the necessary infrastructure needed for your project (local or regional level)	(Yes/No)
Sustainability Based on previous results, did you already identify the best fitting (external) water related infrastructures on which to deploy the data-collection mechanisms and tools, securing longer term collaboration e.g., through legal arrangements	(Yes/No)
Scalability Do you have the possibility to adapt and expand the infrastructure for data-collection to other environments (e.g. to integrate other urban water users, or to integrate industry and/or agriculture)	(Yes/No)

Table 10 Infrastructure Contextual Metrics

Table 11 shows the Infrastructure metrics for the Technological setting.

InfraT Metrics	
Setup Have you already deployed the necessary infrastructures to run your first test scenarios using appropriate water related (external) infrastructures hardware, Software, servers etc	(Yes/No)
Sustainability Did you set-up the technologies, tools and standard, such that collaborative data-collection can also be done together with others (e.g. other external water infra-structures in the region(country) or other WOLLs)	(Yes/No)
Scalability Have you identified the most used (external) infrastructure (that secure relevant user feedback on water innovations, also for collaborations with other WOLLs and that enable scalability)	(Yes/No)

Table 11 Infrastructure Technological Metrics

3.2.4. Governance

Table 12 shows the Governance metrics for the Organisational setting.

GovO Metrics	
Setup Did you set-up responsibility, authority structure and contractual arrangements to involve the key stakeholders for the quadruple helix in the water sector (see above)	(Yes/No)
Sustainability Did you agree on longer term financial arrangements for the joint infrastructures as well as mutual arrangement in respect to using each other's technologies and services	(Yes/No)
Scalability Did you define business models to scale up your WOLL to increase its activities over time	(Yes/No)

Table 12 Governance Organizational Metrics

Table 13 shows the Governance metrics for the Contextual setting.

GovC Metrics	
Setup Did you set-up overall ownership, management structure, IPR rules and priorities of the WOLL in line with the goals of the involved organizations (such us research driven, innovation driven, or business driven)	(Yes/No)
Sustainability Do you have funding and financing strategy/service in place to continuously "fuel" the WOLL with relevant projects	(Yes/No)
Scalability Did you organise the WOLL in a way that it is open to external parties, including other LL's, to carry out user tests	(Yes/No)

Table 13 Governance Contextual Metrics

Table 14 shows the Governance metrics for the Technological setting.

GovT Metrics	
Setup Do you have business management working practices (working methods and innovations that managers use to improve the effectiveness of work system)	(Yes/No)
Sustainability Do you have technologies, management, tools (e.g., management software) and practices in place to allow for monitoring and sharing the use of resources &infrastructure	(Yes/No)
Scalability Do you apply management approaches to aim for operational excellence problem-solving, consistency in external collaboration.	(Yes/No)

Table 14 Governance Technological Metrics

3.2.5.Innovation Outcomes

Table 15 shows the Innovation Outcomes metrics for the Organisational setting.

InnoO Metrics	
Setup Did you arrange for the relevant innovation expertise and competencies within the WOLL to support the targeted water innovations (SRIA related)	(Yes/No)
Sustainability Do you have processes in place to solve possible IPR issues and identified processes and phases to secure continued stakeholder engagements in water-oriented R&D&I	(Yes/No)
Scalability Have you identified a wider pool of (external) experts (including through other WOLLs) and the possibility to engage them if required for expanding developing water related innovations and solutions	(Yes/No)

Table 15 Innovation Outcomes Organizational Metrics

Table 16 shows the Innovation Outcomes metrics for the Contextual setting.

InnoC Metrics	
Setup Did you define and detail your mission, to aim for water-oriented innovations that result in relevant impact to create societal and market value for the stakeholders (e.g. a SRIA)	(Yes/No)
Sustainability Do you have optimal degree of interaction with the involved parties to work together, share innovation outcomes and regularly update your mission in order to take into account new developments and adaptations to different/new contexts	(Yes/No)
Scalability Is your Living Lab ready to expand its focus or collaborate with other WOLLs to tackle challenges in adjacent markets, application or geographic areas	(Yes/No)

Table 16 Innovation Outcomes Contextual Metrics

Table 17 shows the Innovation Outcomes metrics for the Technological setting.

InnoT Metrics	
Setup Did you set-up innovation supportive environments (services) to foster Ideas, technology and Patents for the stakeholders, in line with your water-oriented mission	(Yes/No)
Sustainability Do you have a supporting technology or tools to steer the interaction between the involved parties towards the targeted outcomes	(Yes/No)
Scalability Do you have technological support to engage - if required - very large multi-user engagement towards targeted innovation outcomes	(Yes/No)

Table 17 Innovation Outcomes Technological Metrics

3.2.6. Methods and Tools

Table 18 shows the Methods and Tools metrics for the Organisational setting.

M&TO Metrics	
Setup Did you define taxonomy of methods (categorization or classification) & tools to enable meaningful results from user experiments	(Yes/No)
Sustainability Are your selected methods and tools validated and endorsed by the relevant stakeholders connected to the WOLL	(Yes/No)
Scalability Did you standardize your methods & tools (e.g., open source) and search best practices, so that to enable data exchange with other WOLLs	(Yes/No)

Table 18 Methods & Tools Organizational Metrics

Table 19 shows the Methods and Tools metrics for the Contextual setting.

M&TC Metrics	
Setup Are your selected methods and tools for large scale (in-situ) user monitoring and measurement available for use	(Yes/No)
Sustainability Are your methods and tools geared for continued and longer-term Living Lab experiments with users, within a sustainable WOLL	(Yes/No)
Scalability Did you set-up best practices sharing methods, tools and mechanisms at pan-European Water-Oriented Living Lab projects	(Yes/No)

Table 19 Methods and Tools Contextual Metrics

Table 20 shows the Methods and Tools metrics for the Technological setting.

M&TT Metrics	
Setup Do you deploy a tech-watch process to support continuous validation of state-of-the-art methods and tools for user monitoring and measurements in the water sector	(Yes/No)
Sustainability Did you set-up technology support (develop, testing and acceptance) to update methods and tools to the state of the art where necessary (e.g., new IoT devices)	(Yes/No)
Scalability Did you design your methods and tools in a way (open source) to accept and interface new technologies/possibilities that comes through external networks (e.g., WOLLs)	(Yes/No)

Table 20 Method and Tools Technological Metrics

4. Findings and recommendations

This chapter reports the findings resulted from the survey analysis and describes the results obtained from the application of the Harmonisation Cube to the case studies. Each section provides an overview of the case study, shows the data generated and describes the survey results, supplemented by graphs.

As a first step the overall degree achieved by the Case Study is presented. This value represents a broad picture of the CS maturity. The total score results from the combination of the six foundational elements: user involvement (U), service creation (SC), infrastructure (Infra), governance (Gov), innovation outcomes (Inn) and method and tools (M&T). The scores reached by each of the six foundational elements are therefore shown. These scores give a more detailed vision of the maturity degree of the key elements common to all Living Labs.

Then, a more detailed bar graph of the metrics relating to the six foundational elements is presented. The metrics of the six foundational elements in the bas diagrams are colour-coded to ease the reading: Organisational metrics are visualised with orange, context metrics are in grey, technology metrics in yellow. The average result of the three is visualised in dark blue. The blue bars reflect the overall average score of the foundational elements. Where bars reach a percentage less than 40% that metric is considered at setup level. Values between 40% and 80% are counted as sustainability degree. Where bars reach 100% means the CS has reached the highest degree for that metric (scalability degree).

As opposed to living laboratories, for ULTIMATE Case Studies the focus must be on achieving the highest score for the level of setup for each foundational element. To highlight these needs a radar diagram focused on setup results is shown. The radar diagrams illustrate on which foundational element to focus on to become a Water Smart Living Lab suited for industrial symbiosis.

The recommendations are given in two parts, one is by providing advice common to all Case Studies, the second, for each Case Study customised recommendations based on the results of their assessment survey are listed.

In a long-term perspective and with the objective of turning ULTIMATE CoPs into WOLLs suitable for industrial symbiosis, we propose ULTIMATE CSs to maintain, consolidate and expand the CoPs created for industrial symbiosis. This could be done with the establishment of an entity with a mandate to promote and enhance industrial symbiosis, identify best practices, communicate its benefits and help in educating and establishing industrial symbiosis. Some key activities recommended for the community of practice are:

- **share knowledge and experience with other industrial symbiosis sites and to learn from the experience that other sites have gained during the period of establishing the symbiosis.**
- **publish a set of industrial symbiosis guidelines in a handbook, which would help drive the understanding and acceptance in an accelerated way.**
- **run an on-line platform to share experiences and technologies helpful in building the cooperation necessary for industrial symbiosis.**

- **develop an up-to-date inventory of industrial symbioses and of opportunities for cross-sectoral cooperation. This inventory could be used for the design of site (clusters) and regional planning in Europe and beyond.**

For CSs to evolve into water-oriented Water Smart Industrial Symbiosis Living Labs (WSIS LL), common recommendations are the followings:

- **Consider to establish a formal entity with all the stakeholders defined in the quadruple helix, trying to involve all the 4 stakeholder categories: Knowledge Institutes (research and academic), Public actors (including local authorities), Private actors (local industry representatives), Water technologies users to foster co-creation and technology acceptance;**
- **Clearly state the goal of the Living Labs under establishment and include water explicitly in the entity vision.**
- **Envision and promote a participative approach;**
- **Establish pilot and demonstration cases of first-of-a-kind industrial symbiosis implementations to show potentialities in terms of greenhouse gas emissions reduction and circularity;**
- **Provide visibility and successful examples to create motivation and show advantages in terms of competitiveness.**
- **Improve digital tools: software for rapid screening of industrial symbiosis potential; methodology and software platform to implement innovative industrial symbiosis; digital twinning.**
- **Identify the availability of a waste water stream as an attractive raw material; promote it to the potential users.**
- **We propose to use the concept of SRL (Symbiosis Readiness Level) to identify and drive the progress of industrial symbiosis projects and initiatives.**
- **The potential and the benefits of industrial symbiosis should be included in the education of engineers and business students to ensure the availability of a sufficient skill base.**

In addition to these points, Case Study owners are suggested to consider the specific recommendations listed in the case study sections.

4.1. CS1 Tarragona (Spain)

Case Study 1 is located in Tarragona, Spain, in an industrial area hosting a petrochemical complex. CS1 focuses on AITASA Water Reclamation Plant, a private company held by shareholders from the Tarragona Industrial Cluster. In ULTIMATE, AITASA and EURECAT are jointly developing a tertiary treatment to reuse and reintroduce treated water into other Tarragona's installations. The goal of Case Study 1 is to extend the water synergies already implemented in the complex.

The plant reclaims municipal Wastewater Treatment Plant (WWTP) effluent using reverse osmosis as its main process. The reclaimed water is used primarily for cooling towers and boilers, but its use is limited due to high ammonia content. To meet future water requirements, an industrial WWTP will be commissioned to polish the aggregated wastewater from the petrochemical complex and to produce reclaimed water for the complex.

CS1 aims to extend the water synergies already implemented in the complex by increasing water availability for future demands with new reclaimed water production from the industrial WWTP. This goal drives CS1 to further close the loop of water in the complex, reclaiming water from the future industrial Wastewater Treatment Plant (iWWTP) with near ZLD systems and optimising the current urban WRP so to maximise its water production and diminish the energy consumption.

Reflections from CoPs meetings.
No public authorities were involved in the first CoP meeting, indeed the CS representatives and the attendees agreed in involving regional public administration (Catalan Water Agency, MTD´s) in future meetings to discuss the legal framework, authorizations and restrictions for the technical solution proposed in ULTIMATE case study 1. Research institutes, end-users, water industry representatives and a delegation of external stakeholders attended. The participation and the engagement of the members were successful. A general willingness of bringing things further was sensed. These could be considered as good premises for evolving into a successful Living Lab.

4.1.1. Assessment results

Table 21 shows the overall result of the CS1 assessment analysis. This figure reflects the degree of maturity of Case Study 1 towards evolving into a WSIS LL.

CS1 Percentage Total score	67%

Table 21 CS1 total score

The detailed scores of the six foundational elements for CS1 are shown in Table 22. The table reveals that the strongest foundational elements for CS1 are User Involvement, Infrastructure, Governance, Innovation Outcomes.

U	SC	Infra	Gov	Inn	M&T
78%	33%	78%	78%	89%	44%

Table 22 Foundational elements scores for CS1

Figure 4 shows the visual representation of the maturity scoring for CS1.

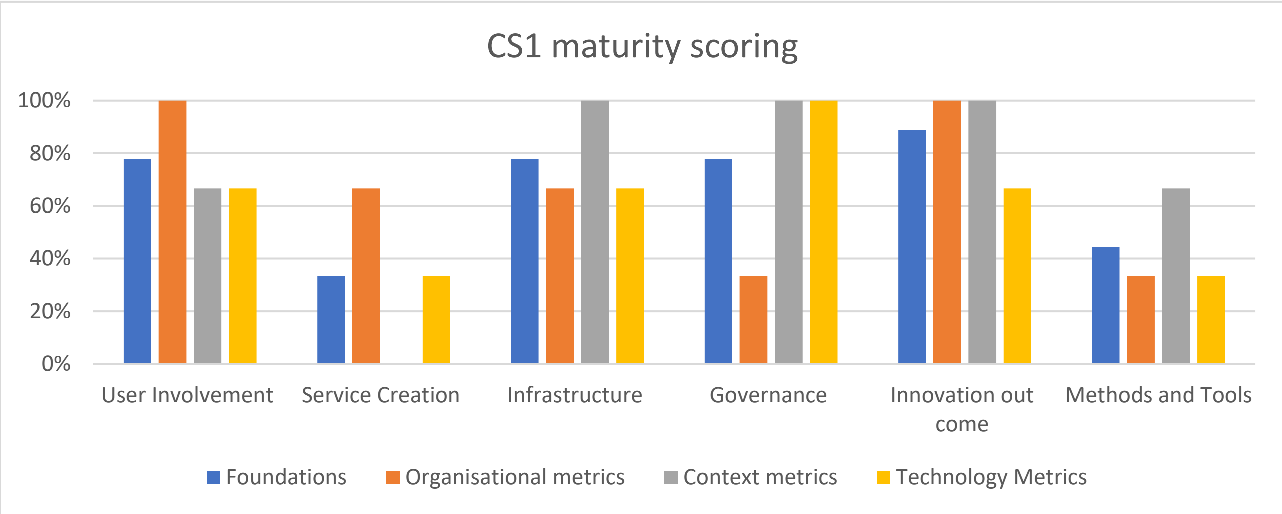


Figure 4 Foundational elements maturity scoring for CS1

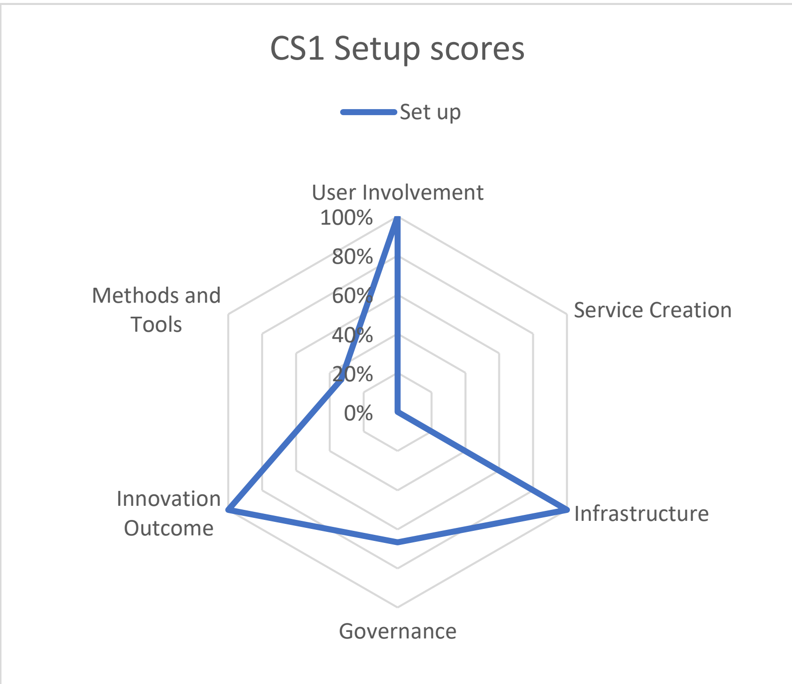


Figure 5 CS1 Setup scores

The radar diagram in Figure 5 illustrates that to become a Water Smart Living Lab suited for industrial symbiosis CS1 should focus its next activities on improving the areas of Service Creation and Method and Tools. Governance shall be also improved.

In the next sub-section detailed recommendation are provided.

4.1.2. Recommendations

The following recommendations can be listed for CS1 to integrate ongoing tasks with activities aimed at evolving towards the status of Water Smart Living Lab suited for symbiosis with industry (WSIS LLs).

- **Support the development of new services by training the stakeholders for a collaborative and co-creation process to tackle challenges for the water sector.**
- **Support the development of new ideas by identifying significant aspects to the water smart society and by having business support (market strategies) services in place.**
- **Set-up a clear communication plan to engage users in the co-creation process.**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by setting up responsibilities, authority structure and contractual arrangements.**
- **Define taxonomy of methods & tools to enable meaningful results from user experiments.**
- **Provide and update interoperable user data to support user monitoring and measurements in the water sector.**

4.2. CS2 Nieuw Prinsenland (Netherlands)

CS2 is located in the Westland in the Netherlands. This region is among the most important greenhouse horticulture in the world. Greenhouses in this region are known for growing vegetables and flowers with a state-of-the-art technology, and for its continuous innovation development. CS2 demonstrator is developed in a group of around 60 greenhouses that are organised in a cooperative sharing a common WWTP. The goal of case study 2 is to close water, energy, and material loops.

To optimise their work, cooperatives are looking into different opportunities involving the reuse of water and nutrient. By doing this they are not only optimising their own internal system from the point of symbiosis but also expanding the opportunity to cooperate with neighbouring greenhouses and industries. To overcome water scarcity problems in this coastal area, an innovative water system (UV/H2O2 and Activated Carbon) is already in place to treat, store in aquifers, and distribute treated wastewater from the sugar factory for reuse in the area.

The existing symbiosis will be extended in two ways with ULTIMATE: 1) The wastewater stream from the greenhouse is currently discharged to the sewer, although it contains high concentrations of nutrients and represents value for the water itself. Re-use of this water is hampered by the risk of introducing plant diseases upon recycling of this water. ULTIMATE will improve and demonstrate the functionality of advanced wastewater treatment for reliable removal of pesticides and plant pathogens via advanced oxidation, activated carbon filtration, and final disinfection to remove pathogens. The suitability of the treated water for crop production will be validated.

Reflections from CoPs meetings.
One of the main points/issues that emerged during the first CoP meeting relate the limited stakeholder engagement. Few collectives were invited, no other stakeholders were invited (e.g. authorities, legislators), so as to create an environment in which the participants could express themselves freely without possible repercussions. This trait is a threat for a potential LL to function well. Research institutes, end-users' representatives and one NGO together with a significant number of external stakeholders attended the first meeting. Furthermore, to this, farmers showed minor interest in the topic of 'how to organise involvement of the collective's members in this collective / share responsibility and the feeling of shared ownership'.

Case Study 2 is not provided with a mission statement, the site agreed on an operational objective of treating wastewater.

4.2.1. Assessment results

Table 23 shows the overall result of the CS2 assessment analysis. This figure reflects that this Case Study is currently in its initial stage.

CS2 Percentage Total score	6%

Table 23 CS2 total score

The detailed scores of the six foundational elements for CS2 are shown in Table 24. The table flags that the all the foundational elements for CS2 need to be improved to evolve towards a WSIS LL.

U	SC	Infra	Gov	Inn	M&T
22%	0%	11%	0%	0%	0%

Table 24 Foundational elements scores for CS2

Figure 6 shows the visual representation of the maturity scoring for CS2.

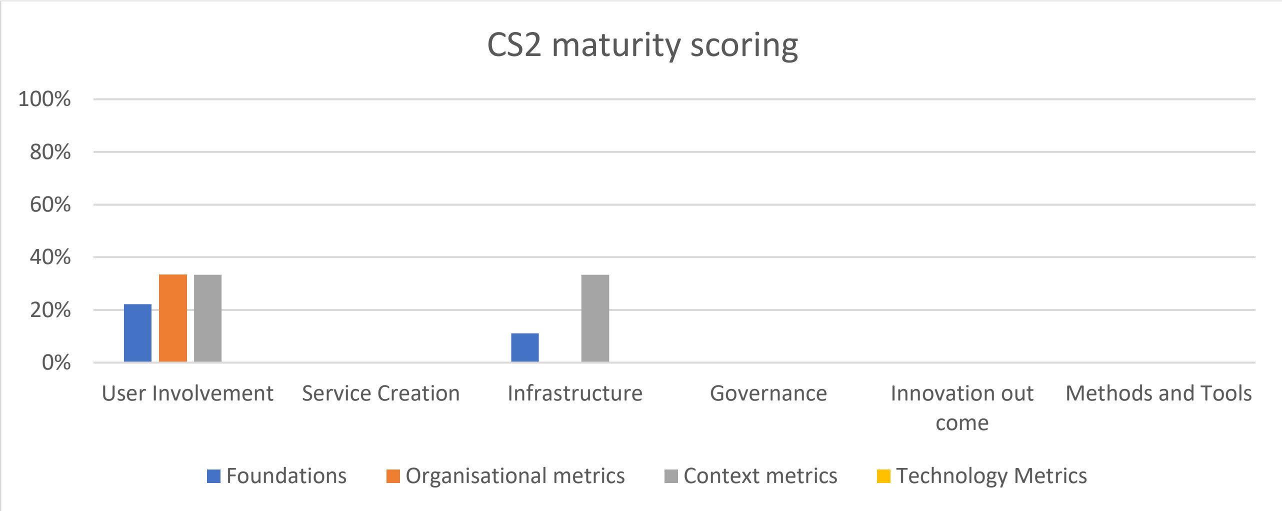


Figure 6 Foundational elements maturity scoring for CS2

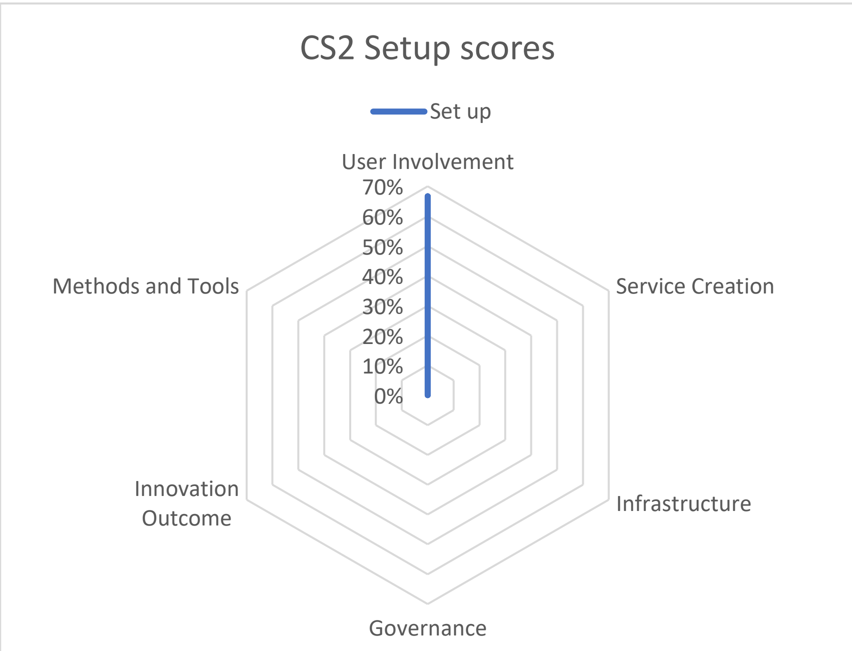


Figure 7 CS2 Setup scores

The radar diagram in Figure 7 illustrates that CS2 is still at an early stage. In order to become an WSIS LL suited for Industrial Symbiosis, detailed recommendations are suggested.

4.2.2. Recommendations

The following recommendations can be listed for CS2 to integrate ongoing tasks with activities aimed at evolving towards the status of Water Smart Living Lab suited for symbiosis with industry (WSIS LLs).

- **Involve water users by setting up low-cost continuous user observation technologies and standards that allow to sharing research results with other LLs or external research.**
- **Support the development of new services by training the stakeholders for a collaborative and co-creation process to tackle challenges for the water sector.**
- **Support the development of new ideas by identifying significant aspects to the water smart society and by having business support (market strategies) services in place.**
- **Set-up a clear communication plan to engage users in the co-creation process.**
- **Set-up a collaboration process to deploy and operate networks, sensors, data collection mechanisms.**
- **Select infrastructure providers (such as water utilities, urban authorities, industries etc), to set up the necessary infrastructure needed to validate and measure the performance of water innovations.**
- **Deploy the necessary infrastructures to run your first test scenarios using appropriate water related infrastructures (hardware, software, servers etc).**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by setting up responsibilities, authority structure and contractual arrangements.**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by setting up overall ownership, management structure, IPR rules and priorities in line with the goals of the involved organizations.**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by introducing working practices and innovations to improve the effectiveness of the work system.**
- **Facilitate innovation and knowledge that contribute to a sustainable water smart society by supporting expertise and competencies.**
- **Facilitate innovation and knowledge that contribute to a sustainable water smart society by creating societal and market value for the stakeholders.**
- **Set-up innovation supportive environments to foster ideas, technology and patents for the stakeholders, in line with your water-oriented mission.**
- **Define taxonomy of methods & tools to enable meaningful results from user experiments.**
- **Identify and select methods and tools for large scale user monitoring and measurement.**
- **Provide and update interoperable user data to support user monitoring and measurements in the water sector.**

4.3. CS3 Rosignano (Italy)

Case Study 3 is located in Rosignano, Italy and works in the development and expansion of the symbiotic relationship, ARETUSA, already existing between the Municipal utility ASA and Solvay, to producing industrial water for Solvay from municipal wastewater treatment.

Consorzio ARETUSA is a PPP among water utility, industry and tech provider established in Tuscany in 2001. ARETUSA replaces high-quality groundwater with treated wastewater for industrial use and uses groundwater wells for drinking water production in coastal areas. Up to 3.8 Mio. m3/y of treated municipal wastewater is already reused by the industrial partner Solvay, freeing up private industrial wells for drinking water use.

The catchments of Cecina and Rosignano WWTPs are affected by unpredictable and relevant seawater intrusion that increases the chloride up to levels higher than generally acceptable and contractually agreed. In addition, other parameters (e.g. surfactants) can irregularly and unpredictably exceed the concentrations required for industrial reuse. The goal of case study 3 beyond ULTIMATE, is to enhance the already existing symbiotic relationship between Utility (ASA), technology provider (TME) and industry (Solvay) to boost the quality and quantity of treated water by closing water and material loops. This is planned to be achieved by increasing the technical, economic and environmental sustainability of industrial reuse, in a local circular economy background.

ULTIMATEs proposed technological solutions consists of two main points. The first focusses on the quality of treated water by monitoring, modelling, and controlling system to avoid high chloride concentrations in reuse water. The second proposes using by-products of local industries for wastewater treatment.

Smart data-driven equalization and management of two municipal secondary effluents will be developed to target critical parameters in the WWRP influent, maximizing water reuse while preventing the need for additional advanced treatment via reverse osmosis. An early warning system for salinity management will also be established at full-scale. To enhance the reuse capacity in Solvay and allow flexible fit-for-purpose treatment within the WWRP, different industrial water demands will be characterized in detail for relevant quality parameters, also evaluating other options for local water reuse both in industry and agriculture. A platform will be developed to match industrial and agricultural water demand & supply from various sources (water reuse, ground-, surface water).

Reflections from CoPs meetings.
During the first meeting in April 2022 between Water Europe and ARETUSA, the consortium representatives raised the willingness to aspire becoming a Living Lab.

A consistent number of stakeholders attended the first CoP meeting: 35 professionals shared by public authorities, engineering companies, research institutes, end-users, water industry delegated, and other external stakeholders including 6 project’s partners representatives.

They could conduct an analysis of the short-term and long-term benefits for the stakeholders in conducting CoP’s meetings, as reported below:

- **Analysis of CoP’s short -term benefits of greatest interest for the stakeholders.**

- **Arena for problem solving and new challenges: 29%**
- **Reduced time and costs: 9%**
- **Improved quality of decisions: 12%**
- **Coordination, standardization and synergies across stakeholders: 12%**
- **Resources for implementing strategies: 13%**
- **Ability to take risk with backing of the community: 3%**
- **Team Working: 22%**

- **Analysis of CoP's long-term benefits of greatest interest for the stakeholders.**
  - **Ability to execute a strategic plan: 24%**
  - **Forum for "Benchmarking": 10%**
  - **Capacity for knowledge-development projects and future alliances: 24%**
  - **Pro-Active approach: ability to foresee technological developments and to take advantage of emerging market opportunities: 19%**
  - **Enhanced professional reputation: 6%**
  - **Strong sense of professional identity: 17%**

At the date of the drafting of the present deliverable, the second meeting on "Legal and social barriers on water reuse was already conducted with 40 attendees. The main objective of this 2nd CoP meeting was to focus on water reuse barriers, considering legal, technical and social aspects.

They also conducted activities in some local schools to ensure the public involvement.

4.3.1. Assessment results

CS3 representatives were asked to compile the survey considering the activities currently carried out without mentioning the activities they are willing to implement in the future. This gives back a picture of the present situation, even if CS3 aims at achieving more ambitious goals.

Table 25 shows the overall result of the CS3 assessment analysis. This figure reflects the degree of maturity of Case Study 3 towards evolving into a Water-Oriented Living Lab.

CS3 Percentage Total score	30%

Table 25 CS3 total score

The detailed scores of the six foundational elements for CS3 are shown in Table 26. The figures highlight that the strongest foundational element for CS3 to evolve towards a WSIS LL is User Involvement.

U	SC	Infra	Gov	Inn	M&T
78%	22%	33%	22%	22%	0%

Table 26 Foundational elements scores for CS3

Figure 8 shows the visual representation of the maturity scoring for CS3.

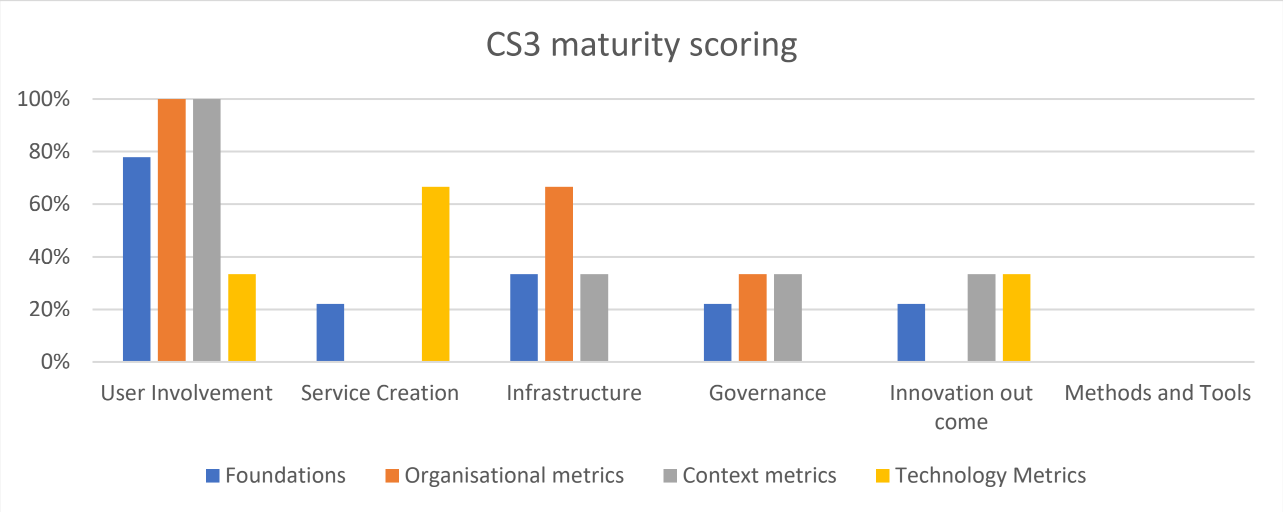
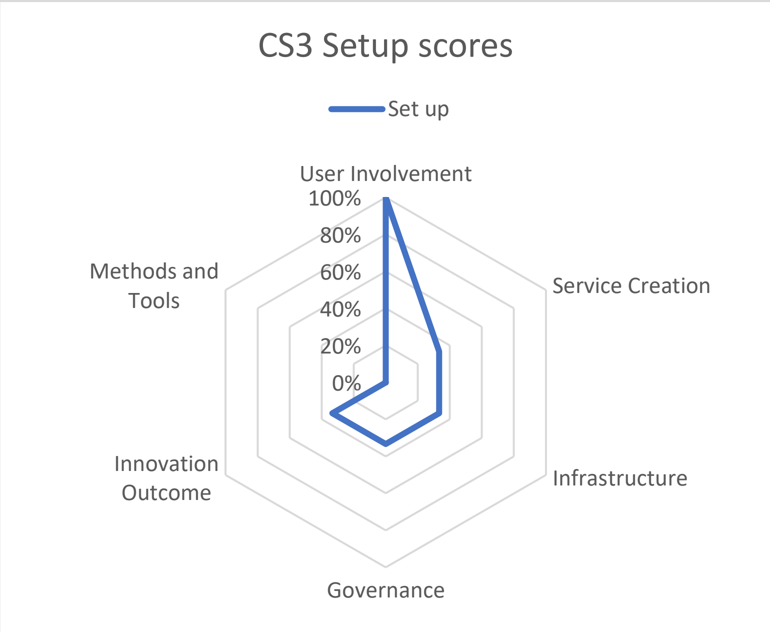


Figure 8 Foundational elements maturity scoring for CS3



The radar diagram of Figure 9 illustrates that to become a Water Smart Living Lab suited for industrial symbiosis CS3 should focus its next activities on improving the areas of Service Creation, Infrastructure, Governance, Innovation Outcomes, Method and Tools.

Figure 9 CS3 Setup scores

In the next sub-section detailed recommendation are provided.

4.3.2. Recommendations

The following recommendations can be listed for CS3 to integrate ongoing tasks with activities aimed at evolving towards the status of Water Smart Living Lab suited for symbiosis with industry (WSIS LLs).

- **Support the development of new services by training the stakeholders for a collaborative and co-creation process to tackle challenges for the water sector.**
- **Support the development of new ideas by identifying significant aspects to the water smart society and by having business support (market strategies) services in place.**
- **Select infrastructure providers (such as water utilities, urban authorities, industries etc), to set up the necessary infrastructure needed to validate and measure the performance of water innovations.**
- **Deploy the necessary infrastructures to run your first test scenarios using appropriate water related infrastructures (hardware, software, servers etc).**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by setting up overall ownership, management structure, IPR rules and priorities in line with the goals of the involved organizations.**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by introducing working practices and innovations to improve the effectiveness of the work system.**
- **Facilitate innovation and knowledge that contribute to a sustainable water smart society by supporting expertise and competencies.**
- **Facilitate innovation and knowledge that contribute to a sustainable water smart society by creating societal and market value for the stakeholders.**
- **Define taxonomy of methods & tools to enable meaningful results from user experiments.**
- **Identify and select methods and tools for large scale user monitoring and measurement.**
- **Provide and update interoperable user data to support user monitoring and measurements in the water sector.**

4.4. CS4 Nafplio (Greece)

Case Study 4 is located in Nafplio, Greece in a highly productive citrus fruit region in the eastern Peloponnese. This CS is a collaboration for the development of a secondary WWT for the Alberta fruits and vegetables processing plant. Alberta S.A. is a Hellenic Fruit Processing Industry that specializes in the production of fruit and vegetable concentrates for juice, purees and clarified juice.

CS4 highlights the need for different stakeholders of the area to work together in solving the increase in water demand for irrigation and high cost of wastewater treatment. The problems include an increase in water demand for irrigation purposes as well as a high-water consumption of the fruit processing industry that is straining the regional aquifer resources. An additional problem is the quality of groundwater in the area that has been reported as relatively poor as a result of over-irrigation and subsequent intrusion of the sea into the aquifer. For the time being there is no symbiosis established between the different stakeholders of the area that would enable water reuse or recovery of any valuable resource.

The goal for case study 4 is to close the loops of water and material. Through CS4 ULTIMATE aims to extend and strengthen the symbiotic relationship of Alberta and the fruit processing sector with the water service provider. They aim to achieve this by reducing freshwater production cost and demand. A reduction of the water usage cost is expected due to the processing plant. Additionally, the municipal biological treatment unit will process better quality water, allowing it to put less pressure on its operation.

Reflections from CoPs meetings.
The CS would aspire to become a LL but some obstacles need further investigation. Water end users and different industry sectors have been included in the CoPs meeting of the project, coupled with public authorities, engineering companies, research institutes and other external stakeholders. This is a good premise for the establishment of a LL

4.4.1. Assessment results

Table 27 shows the overall result of the CS4 assessment analysis. This figure reflects the degree of maturity of Case Study 4 towards evolving into a Water-Oriented Living Lab.

CS4 Percentage Total score	31%

Table 27 CS4 total score

The detailed scores of the six foundational elements for CS4 are shown in Table 28. The table highlights that the strongest foundational elements for CS4 to evolve towards a WSIS LL is User Involvement

U	SC	Infra	Gov	Inn	M&T
67%	33%	44%	11%	11%	22%

Table 28 Foundational elements scores for CS4

Figure 10 shows the visual representation of the maturity scoring for CS4.

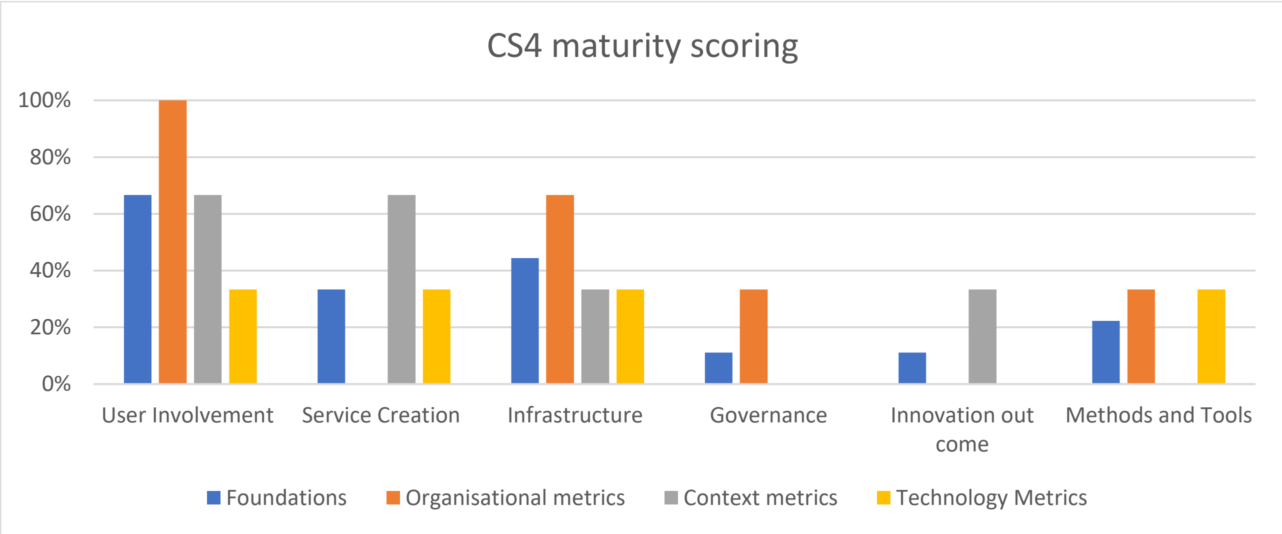
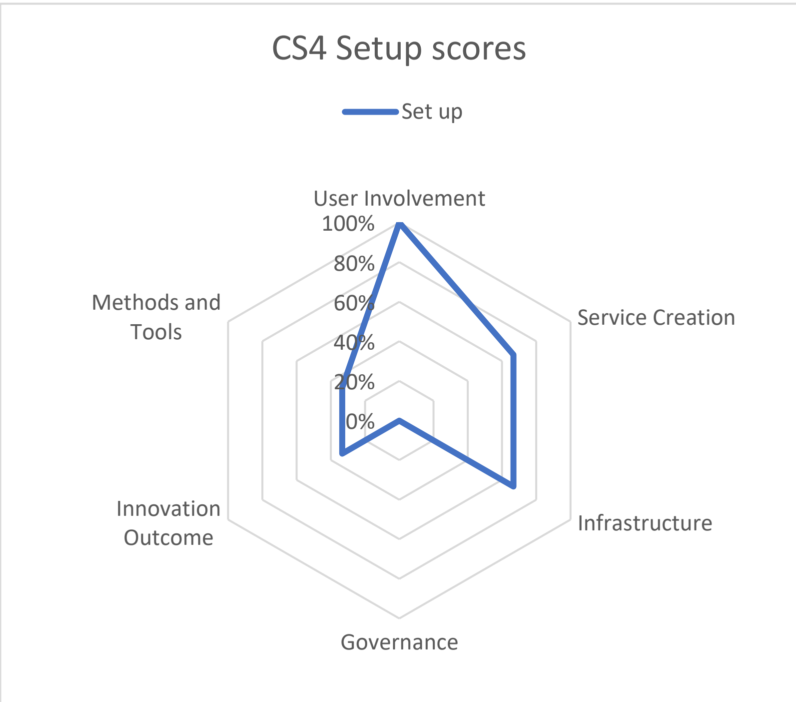


Figure 10 Foundational elements maturity scoring for CS4



The radar diagram in Figure 11 illustrates that to become a Water Smart Living Lab suited for industrial symbiosis CS4 should focus its next activities on improving the areas of Governance, Innovation Outcomes and Method and Tools. Service Creation and Infrastructure shall be also improved.

Figure 11 CS4 Setup scores

In the next sub-section detailed recommendation are provided.

4.4.2. Recommendations

The following recommendations can be listed for CS4 to integrate ongoing tasks with activities aimed at evolving towards the status of Water Smart Living Lab suited for symbiosis with industry (WSIS LLs).

- **Support the development of new ideas by identifying significant aspects to the water smart society and by having business support (market strategies) services in place.**
- **Select infrastructure providers (such as water utilities, urban authorities, industries etc), to set up the necessary infrastructure needed to validate and measure the performance of water innovations.**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by setting up responsibilities, authority structure and contractual arrangements.**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by setting up overall ownership, management structure, IPR rules and priorities in line with the goals of the involved organizations.**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by introducing working practices and innovations to improve the effectiveness of the work system.**
- **Facilitate innovation and knowledge that contribute to a sustainable water smart society by supporting expertise and competencies.**
- **Set-up innovation supportive environments to foster Ideas, technology, and Patents for the stakeholders, in line with your water-oriented mission**
- **Identify and select methods and tools for large scale user monitoring and measurement.**
- **Provide and update interoperable user data to support user monitoring and measurements in the water sector.**

4.5. CS5 Lleida (Spain)

Case Study 5 is located in Lleida and focusses on the relationship between the Mahou San Miguel (MSM) brewery, a multinational utility Aqualia, the local municipal utility of Lleida and the Catalan Water Agency. CS5 aims at finding solutions for the problem faced by each of the bodies. These include lack of reclaimed water and no energy recovered by the brewery and a 10% reduction of water consumption by 2025 (Mahou San Miguel).

The goal of Case Study 5 focusses on closing water, energy, and material loops. The main premise for achieving this is that the current symbiosis between the parties involved will produce water for industrial reuse. This should lower the consumption of fresh water for industrial purposes, concerning green energy production in the form biogas, electricity, and heat. Another expected benefit is the opportunity to recycle the nutrients from brewery wastewater. These aims would be achieved by reusing wastewater for the brewery's cooling towers, applying anaerobic treatment methods to the wastewater to recover biogas, recovering nutrients from treated wastewater, and using a solid oxide fuel cell fed with biogas to create electricity as well as heat generation.

Nowadays, breweries are major consumers of water with an average of 5L of water per 1L of beer, accounting for a water demand of 550,000 m^3/d for EU breweries. The resulting brewery wastewater is rich in organic matter and nutrients. Several post-treatment solutions will be tested to increase water recycling in production and establish 3L water consumption per 1L of beer as an industry benchmark. Furthermore, in ULTIMATE new strategies for solids handling will be developed and enhance biomethane production with co-digestion at municipal WWTPs (zero waste to landfill/incineration). With ULTIMATE the company expects to reduce water and energy consumption and their carbon footprint.

Reflections from CoPs meetings.
In the first CoP meeting the attendees met in a common question: the GAP between existing proposed emergent solutions and their implementation / spreading in the water sector. This question that gained interest for all the attendees will be considered as the base of the main topic of the CoP for next editions. Suppliers want to spread their solutions in the market. Concerning further steps: besides of the next annual meeting the members asked for a newsletter demonstrating interest in the discussed topics.

4.5.1. Assessment results

Table 29 shows the overall result of the CS5 assessment analysis. This figure reflects the degree of maturity of Case Study 5 towards evolving into a Water-Oriented Living Lab.

CS5 Percentage Total score	57%

Table 29 CS5 total score

The detailed scores of the six foundational elements for CS5 are shown in Table 30. The table suggests that the strongest foundational element for CS5 to evolve towards a WSIS LL is Innovation Outcomes

U	SC	Infra	Gov	Inn	M&T
22%	67%	56%	67%	89%	44%

Table 30 Foundational elements scores for CS5

Figure 12 shows the visual representation of the maturity scoring for CS5.

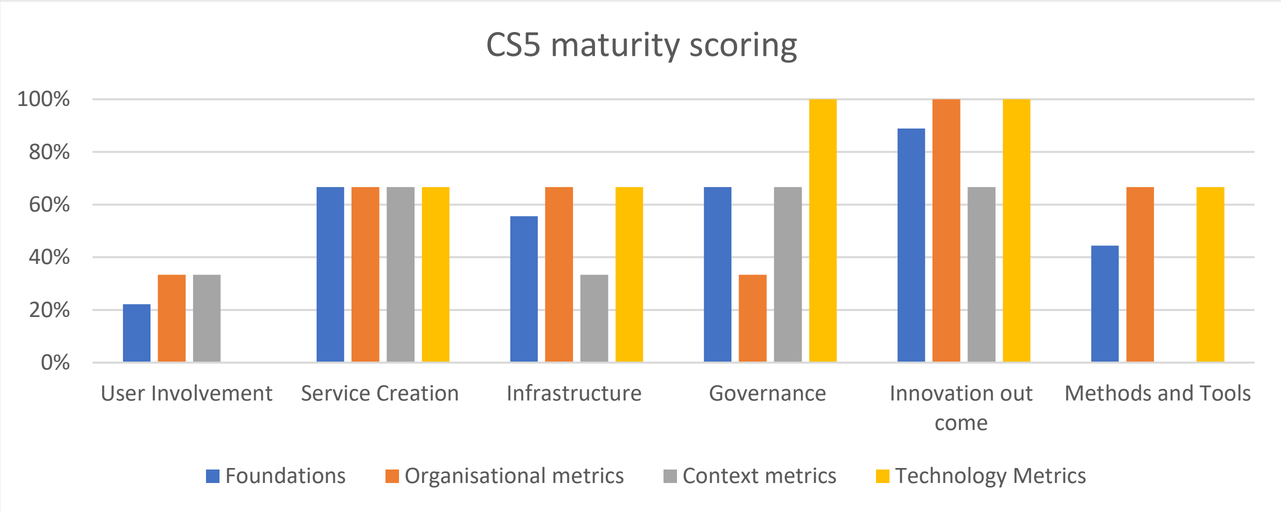


Figure 12 Foundational elements maturity scoring for CS5

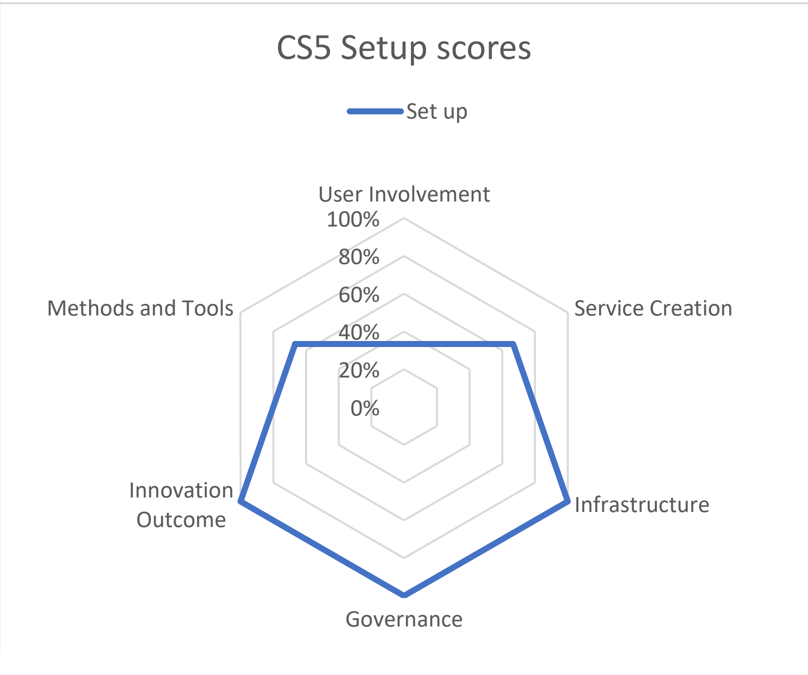


Figure 13 CS5 Setup scores

The radar diagram in Figure 13 illustrates that to become a Water Smart Living Lab suited for industrial symbiosis CS5 should focus its next activities on improving the area of User Involvement. Service Creation and Method and Tools shall be also improved. The graph also highlights that the setup degree for Governance, Infrastructure and Innovation Outcomes are already reached.

In the next sub-section detailed recommendation are provided.

4.5.2. Recommendations

The following recommendations can be listed for CS5 to integrate ongoing tasks with activities aimed at evolving towards the status of Water Smart Living Lab suited for symbiosis with industry (WSIS LLs).

- **Involve at least one of the key water user groups in measurements and the design process of water innovations (urban/citizens, industry and/or agriculture).**
- **Involve water users by setting up low-cost continuous user observation technologies and standards that allow for sharing research results with other LLs or external research.**
- **Set-up a clear communication plan to engage users in the co-creation process.**
- **Identify and select methods and tools for large scale user monitoring and measurement.**

4.6. CS6 Karmiel and Shafdan (Israel)

CS6 is located in two different demonstration sites: Karmiel and Shafdan, in Israel. In both sites, CS partners work to improve and increase the capabilities of the urban WWTP of Mekorot (MEK) - the National Water Company - and make it fit to receive agro-industrial effluents. Mekorot provides diverse types of water related services including urban and industrial wastewater treatment.

The goal of Case Study 6 is to close energy and material loops. The focus areas include mostly agro-industrial sector such as agriculture, food industry, olive oil mills and water treatment. To shelter the WWTPs of Karmiel and Shafdan from sudden shocks of agro-industrial wastewater and at the same time allowing recovery of high added value products like polyphenols the symbiotic relationship between the SMEs and the public wastewater utility is to be expanded.

4.6.1. Assessment results

The assessment analysis' overall outcome for CS6 is visualised in Table 31.

CS6 Percentage Total score	52%

Table 31 CS6 total score

The percentage scores of the six foundational elements for CS6 are shown in Table 32:

U	SC	Infra	Gov	Inn	M&T
67%	56%	56%	11%	67%	56%

Table 32 Foundational elements scores for CS6

The strongest foundational elements for CS6 are User Involvement and Innovation Outcomes. Figure 14 visuals the maturity scoring for CS6.

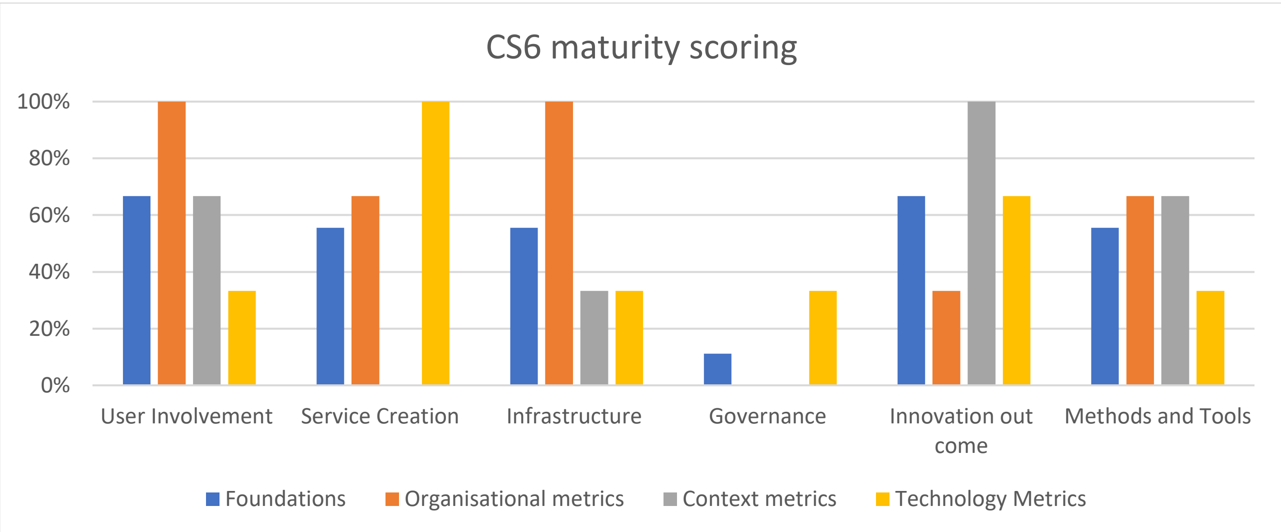
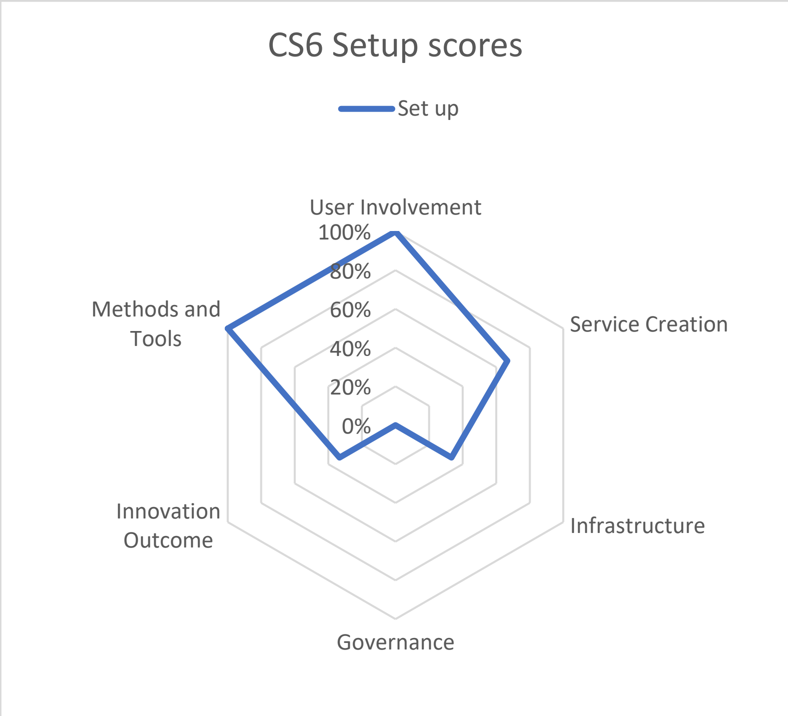


Figure 14 Foundational elements maturity scoring for CS6



The radar diagram in Figure 15 illustrates that to become a Water Smart Living Lab suited for industrial symbiosis CS6 should focus its next activities on improving the area of Governance. Innovation Outcomes, Service creation and Infrastructure shall be also improved.

Figure 15 CS6 Setup scores

According to the information provided by CS6 via e-mail with regards on CoP's Vision, the case study does not plan to set up a Living Labs in the future, therefore no recommendations are provided. The snapshot of the communication is shown in Figure 16.

Here are the requested issues for our meeting on Monday.
1) Vision of the CoP
GALSOC has already organized one Communities of Practice (CoP) meeting, and plans to hold one more. It has not set up Living Labs (LLs), and does not plan to do so in the future. The CoP meetings, as defined and set up, differ from LLs in that they target stakeholders, but do not include local communities, as LLs do. As such, CoP meetings can be viewed as LLs with which the target audience is more specific.

The CoP meetings aim to provide a platform for regulators, municipalities, water utility corporations, olive mill presses, wineries, dairies and engineers, as well as interested individuals, to exchange ideas and knowledge about dealing with agro-industrial waste, and the existing and proposed solutions. This is obviously done under the ULTIMATE project umbrella, and the ULTIMATE technologies therein, and involves knowledge sharing and discussions about the successful design and implementation of water-related technologies and innovations.

Figure 16 CS6 communication on unwillingness for LL creation

4.7. CS7 Tain (United Kingdom)

CS7 is located in Tain, United Kingdom and works in the improvement of the circularity of the current WWT of the Grenmorangie whiskey distillery and currently belonging to the Louis Vuitton Malletier Holdings. The distillery is not a partner in the ULTIMATE project but an industrial stakeholder. Aquabio and Cranfield University partnered with the Glenmorangie distillery to evaluate possible options to expand the circular economy (CE) approach at the site. Opportunities for heat and nutrients recovery have been identified.

The goal of Case Study 7 is to close water, energy and material loops. There will be and expansion of the collaboration between Glenmorangie distillery, Alpheus, Aquabio and Cranfield University. This will be done in order to check for opportunities and options to produce water for internal reuse as well as recover heat and nitrogen.

As shown in Figure 17, the Case Study Leader disclosed that the case study does not plan to set up a Living Labs in the future, therefore no recommendations are provided.

> The CS was not set up to be a Living lab. Unfortunately, it's been quite complicated from the start as the actual site, the Glenmorangie distillery, is not a partner in the project. They agreed to be part of the work by giving us access to their site to install the systems and of course they are part of the stakeholders involved in the decision and the study but there is no interest from them to make this site a long lasting trial site.

Figure 17 CS7 communication on LL creation contraints

4.8. CS8 Saint Maurice l’Exil (France)

Case Study 8 is located in Saint Maurice l’Exil in the south-east of France. This CS focusses on the Roches-Roussillon chemical platform that brings together 15 companies which specialise in the chemical industry. The demonstration site is the Hazardous waste treatment and recovery facilities that is within the Roches-Roussillon chemical platform. Two hazardous waste incinerators are used to treat some proportion of the platforms chemical waste. Additionally, there is a biomass recovery unit that provides 15% the steam requirement of the platform.

Case Study 8 links the water by collecting water used to wash flue gas resulting from incineration and sent this water to a Waste Water Treatment Plant (WWTP) on-site. The case study ambition is to improve the environmental footprint, including improving the operation of the industrial WWTP on-site by recovering metals, sulphates and gypsum from the liquid waste. Furthermore, advance data-driven techniques will be integrated in real-time monitoring of WWTP for automatic diagnosis and predictive analysis.

According to the information provided by CS8 during the bilateral meeting, Case Study 8 does not plan to set up a Living Labs in the future, therefore no recommendations are provided. The Case Study had not compiled the survey as it was not on its scope, therefore no analysis was conducted.

They are conducting resource recovery from water, with no re-use of treated wastewaters.

4.9. CS9 Kalundborg (Denmark)

Case Study 9 focusses on the Kalundborg Symbiosis Association that connects private and public companies from different sectors. Although, various circular economy approaches concerning water, energy and materials have already been implemented, there are still some areas that could be improved and developed further, such as intensifying the recovery and reuse of water. One big difficulty that the Association has connected to water reuse in the production processes of the food, pharma and biotech industries are the Danish and European laws.

The goal of case study 9 is to close water, energy, and material loops by expanding the internal cooperation to allow an increase in energy efficiency of plant operation and reducing chemical consumption. This would be achieved by locating and incorporating future users of the produced water, the recovered heat, and the recycled material.

Additional options for water reuse will be investigated by treating the effluents from the industrial and municipal WWTPs for cooling and steam production or cleaning and flushing purposes. As the WWTP effluent contains a high share of non-degradable carbon from biotech industry which leads to high fouling of RO membranes, a novel ultrafiltration pre-treatment (ultra-tight UF) will be demonstrated at pilot scale.

To accelerate the follow-up investment on water reuse, the Kalundborg utility will form a cross-learning group with the operator of the Tarragona site (CS1) as a similar treatment scheme is already in operation. In addition, a cloud-based data integration and model-predicted control system will be developed in order to explore synergetic operational strategies of the existing industrial and municipal WWTPs to decrease energy consumption and to maximize the possible wastewater load coming the different industries.

Reflections from CoPs meetings.
Equinor is member of the Kalundborg Symbiosis association and is one of few non-food/biotech & pharma industries in Kalundborg. Equinor consumes primarily surface water from Lake Tissoe with a quantity close to 1.500.000 m3/year. The results of CoPs meetings point out that reuse of water seems to be possible, despite current legislation on reused water to process hampers innovations in the field. Potentialities emerged from meetings encompass:

• Reused water for purpose like cooling- and kettle-water seems potential for Equinor.
• Reused water for cooling and kettle purpose needs to be defined regarding water quality.
• Reused water for cooling is not specified yet, and choice of future technology must be made before this topic will be discussed.

4.9.1. Assessment results

Table 33 shows the overall result of the CS9 assessment analysis. This figure reflects the degree of maturity of Case Study 9 towards evolving into a WSIS LL.

CS9 Percentage Total score	56%

Table 33 CS9 Total score

The percentage scores of the six foundational elements for CS9 are shown in Table 34. The table suggests that the strongest foundational elements for CS9 are Innovation Outcomes and Method and Tools.

U	SC	Infra	Gov	Inn	M&T
33%	44%	67%	56%	67%	67%

Table 34 Foundational elements scores for CS9

Figure 18 shows the visual representation of the maturity scoring for CS9.

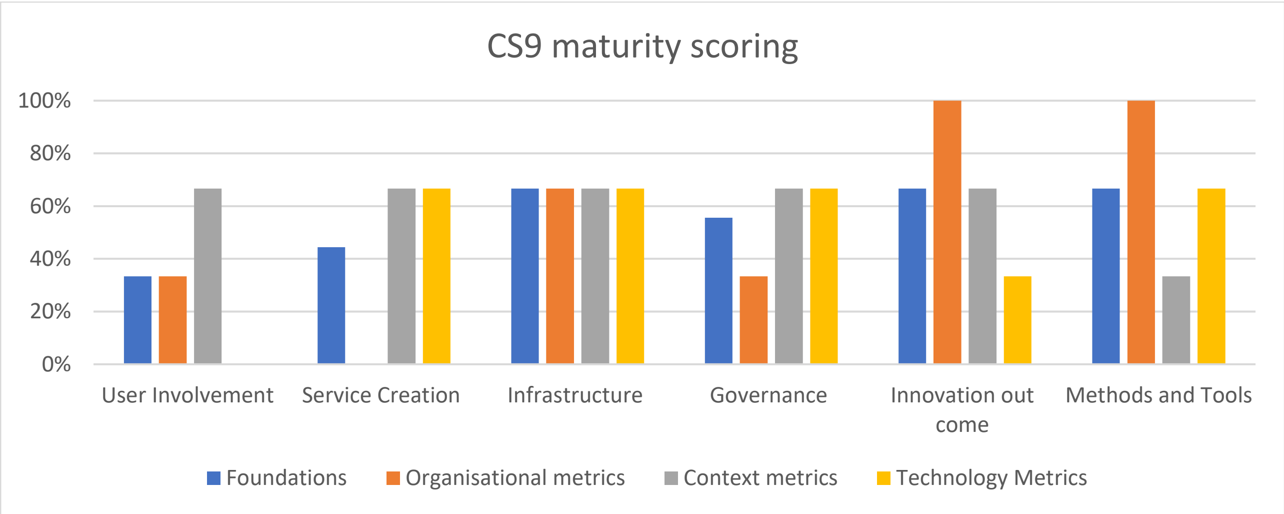
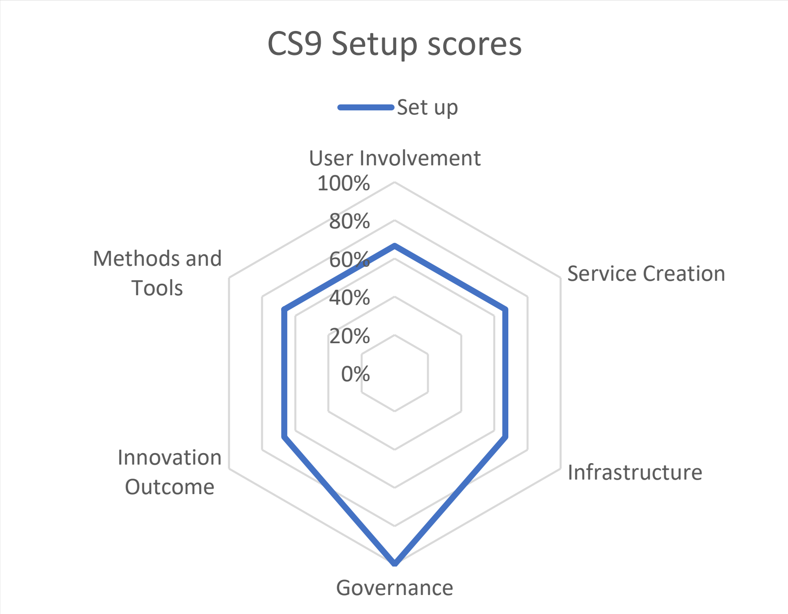


Figure 18 Foundational elements maturity scoring for CS9



The radar diagram in Figure 19 illustrates that to become a Water Smart Living Lab suited for industrial symbiosis CS9 should focus its next activities on improving the areas of User Involvement, Service Creation, Infrastructure. The setup stage of Innovation Outcomes and Method and Tools shall also be improved.

In the next sub-section detailed recommendation for CS9 are provided.

Figure 19 CS9 Setup scores

4.9.2. Recommendations

Currently CS9 is putting more pressure on where the water comes form rather than its quality. The recommendations listed below are suggested to the CS9 owner to be integrated to ongoing tasks to evolve towards the status of Water-Oriented Living Lab.

- **Connect relevant stakeholders that would support both policy and decision makers in the water reuse and circular economy solutions fostering process.**
- **Involve water users by setting up low-cost continuous user observation technologies and standards that allow for sharing research results with other LLs or external research.**
- **Support the development of new services by training the stakeholders for a collaborative and co-creation process to tackle challenges for the water sector.**
- **Set-up a collaboration process to deploy and operate networks, sensors, data collection mechanisms.**
- **Set-up innovation supportive environments to foster Ideas, technology, and Patents for the stakeholders, in line with your water-oriented mission.**
- **Provide and update interoperable user data to support user monitoring and measurements in the water sector.**

5. Conclusions

The ULTIMATE project aims to establish and foster water smart industrial symbiosis by implementing circular economy solutions for water, material, and energy recovery. The circular economy solutions proposed will create a win-win situation for both the water sector and the industry. In ULTIMATE Case Studies, the industrial sector consists of the agri-food, beverage, petrochemical, chemical and biotech industry. Actors involved in the project activities for the water sector represent service providers, municipal utilities, multi-industry utilities, specialised small and medium enterprises, and water service providers.

Based on its long-lasting experience with Living Labs, Water Europe considers Water-Oriented Living Labs the most effective mean to build the water-smart economy and society in Europe and the best tool to support the realisation of its vision strategy to develop a Water-Smart Society.

In ULTIMATE Water Europe leads task T3.4 aimed at providing recommendations to the projects' Case Studies for the creation of a new type of Water-Oriented Living Lab (WOLL) suited for industrial symbiosis: the Water Smart Industrial Symbiosis Living Lab (WSIS LL). The WSIS LL uses the concept and methodology of the WOLL, with which WE has extensive experience, to build a LL that is suited for symbiosis with industry in relation to water issues. Through Deliverable D3.2 Water Europe intends to **advise the ULTIMATE Case Studies on the integration of current activities with those suitable for evolving towards the status of WSIS LL**. The analysis reported in this document is based on the "*Study and portfolio review of the projects on industrial symbiosis in DG Research and Innovation"* the Processes4Planet roadmap, and the **WE publication "Water-Oriented Living Labs. How to assess and evolve Water-Oriented Living Labs. A manual with a vision. Notebook Series#2 which includes the Harmonisation Cube methodology adapted to the water sector**. The latter allows a co-ordinated assessment, analysis, synergic development, harmonisation, and networking of regional WOLLs initiatives. **The methodology has been applied to the ULTIMATE Case Studies to assess their water-oriented attitude to develop into WOLLs suited for Industrial Symbiosis (WSIS LL)**.

The process towards a WSIS LL using the describe methodology includes 3-steps:

1. The first step is a mapping exercise and revolves around the collection of general information (Name, Location, Scope, estimated Maturity) and selected criteria concerning the characteristics of Mission, Focus and Organisation of the case studies.
2. The second step is the assessment in form of a survey for the six foundational elements of any Living Lab which are 1) User Involvement, 2) Service Creation, 3) Infrastructures, 4) Governance, 5) Innovation Outcomes and 6) Methods & Tools. The analysis of each of these foundational elements allowed to determine the maturity level of each CS and to identify development opportunities. The recommendations to the CS stem from the analysis of the results of this evaluation survey. This phase ends with each CS being awarded a score.
3. The third step allows CS leaders to evaluate and define of SMART objectives for their Case Studies to develop a WSIS LL. The qualitative analysis allows to prepare

improvement Implementation Plans to be implemented in the CSs. This last step was not developed in the present document.

For the drafting of the present deliverable only the second step of the Harmonisation Cube was considered to identify CS needs. The recommendations are given in two parts, one is by providing advice common to all Case Studies, the second, for each Case Study customised recommendations based on the results of their assessment survey are listed.

CS6, CS7 and CS8 do not foresee to establish a Living Lab therefore no recommendations are provided for these Case Studies.

For CS1, CS2, CS3, CS4, CS5 and CS9 common recommendations to all CSs and customised recommendations based on the results of their assessment survey are provided.

In a long-term perspective and with the objective of turning ULTIMATE CoPs into WOLLs suitable for industrial symbiosis, we propose ULTIMATE CSs to maintain, consolidate and expand the CoPs created for industrial symbiosis. This could be done with the establishment of an entity with a mandate to promote and enhance industrial symbiosis, identify best practices, communicate its benefits and help in educating and establishing industrial symbiosis.

Some key activities recommended for the community of practice are:

- **share knowledge and experience with other industrial symbiosis sites and to learn from the experience that other sites have gained during the period of establishing the symbiosis.**
- **publish a set of industrial symbiosis guidelines in a handbook, which would help drive the understanding and acceptance in an accelerated way.**
- **run an on-line platform to share experiences and technologies helpful in building the cooperation necessary for industrial symbiosis.**
- **develop an up-to-date inventory of industrial symbioses and of opportunities for cross-sectoral cooperation. This inventory could be used for the design of site (clusters) and regional planning in Europe and beyond.**

Common recommendations:

- **Consider to establish a formal entity with all the stakeholders defined in the quadruple helix, trying to involve all the 4 stakeholder categories: Knowledge Institutes (research and academic), Public actors (including local authorities), Private actors (local industry representatives), Water technologies users to foster co-creation and technology acceptance;**
- **Clearly state the goal of the Living Labs under establishment and include water explicitly in the entity vision.**
- **Envision and promote a participative approach;**
- **Establish pilot and demonstration cases of first-of-a-kind industrial symbiosis implementations to show potentialities in terms of greenhouse gas emissions reduction and circularity;**
- **Provide visibility and successful examples to create motivation and show advantages in terms of competitiveness.**

- **Improve digital tools: software for rapid screening of industrial symbiosis potential; methodology and software platform to implement innovative industrial symbiosis; digital twinning.**
- **Identify the availability of a waste water stream as an attractive raw material; promote it to the potential users.**
- **We propose to use the concept of SRL (Symbiosis Readiness Level) to identify and drive the progress of industrial symbiosis projects and initiatives.**
- **The potential and the benefits of industrial symbiosis should be included in the education of engineers and business students to ensure the availability of a sufficient skill base.**

Customised recommendations based on findings of the assessment surveys:

CS1 Tarragona (Spain)

- **Support the development of new services by training the stakeholders for a collaborative and co-creation process to tackle challenges for the water sector.**
- **Support the development of new ideas by identifying significant aspects to the water smart society and by having business support (market strategies) services in place.**
- **Set-up a clear communication plan to engage users in the co-creation process.**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by setting up responsibilities, authority structure and contractual arrangements.**
- **Define taxonomy of methods & tools to enable meaningful results from user experiments.**
- **Provide and update interoperable user data to support user monitoring and measurements in the water sector.**

CS2 Nieuw Prinsenland (Netherlands)

- **Involve water users by setting up low-cost continuous user observation technologies and standards that allow to sharing research results with other LLs or external research.**
- **Support the development of new services by training the stakeholders for a collaborative and co-creation process to tackle challenges for the water sector.**
- **Support the development of new ideas by identifying significant aspects to the water smart society and by having business support (market strategies) services in place.**
- **Set-up a clear communication plan to engage users in the co-creation process.**
- **Set-up a collaboration process to deploy and operate networks, sensors, data collection mechanisms.**
- **Select infrastructure providers (such as water utilities, urban authorities, industries etc), to set up the necessary infrastructure needed to validate and measure the performance of water innovations.**
- **Deploy the necessary infrastructures to run your first test scenarios using appropriate water related infrastructures (hardware, software, servers etc).**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by setting up responsibilities, authority structure and contractual arrangements.**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by setting up overall ownership, management structure, IPR rules and priorities in line with the goals of the involved organizations.**

- **Involve and engage the key stakeholders of the quadruple helix for the water sector by introducing working practices and innovations to improve the effectiveness of the work system.**
- **Facilitate innovation and knowledge that contribute to a sustainable water smart society by supporting expertise and competencies.**
- **Facilitate innovation and knowledge that contribute to a sustainable water smart society by creating societal and market value for the stakeholders.**
- **Set-up innovation supportive environments to foster ideas, technology and patents for the stakeholders, in line with your water-oriented mission.**
- **Define taxonomy of methods & tools to enable meaningful results from user experiments.**
- **Identify and select methods and tools for large scale user monitoring and measurement.**
- **Provide and update interoperable user data to support user monitoring and measurements in the water sector.**

CS3 Rosignano (Italy)

- **Support the development of new services by training the stakeholders for a collaborative and co-creation process to tackle challenges for the water sector.**
- **Support the development of new ideas by identifying significant aspects to the water smart society and by having business support (market strategies) services in place.**
- **Select infrastructure providers (such as water utilities, urban authorities, industries etc), to set up the necessary infrastructure needed to validate and measure the performance of water innovations.**
- **Deploy the necessary infrastructures to run your first test scenarios using appropriate water related infrastructures (hardware, software, servers etc).**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by setting up overall ownership, management structure, IPR rules and priorities in line with the goals of the involved organizations.**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by introducing working practices and innovations to improve the effectiveness of the work system.**
- **Facilitate innovation and knowledge that contribute to a sustainable water smart society by supporting expertise and competencies.**
- **Facilitate innovation and knowledge that contribute to a sustainable water smart society by creating societal and market value for the stakeholders.**
- **Define taxonomy of methods & tools to enable meaningful results from user experiments.**
- **Identify and select methods and tools for large scale user monitoring and measurement.**
- **Provide and update interoperable user data to support user monitoring and measurements in the water sector.**

CS4 Nafplio (Greece)

- **Support the development of new ideas by identifying significant aspects to the water smart society and by having business support (market strategies) services in place.**

- **Select infrastructure providers (such as water utilities, urban authorities, industries etc), to set up the necessary infrastructure needed to validate and measure the performance of water innovations.**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by setting up responsibilities, authority structure and contractual arrangements.**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by setting up overall ownership, management structure, IPR rules and priorities in line with the goals of the involved organizations.**
- **Involve and engage the key stakeholders of the quadruple helix for the water sector by introducing working practices and innovations to improve the effectiveness of the work system.**
- **Facilitate innovation and knowledge that contribute to a sustainable water smart society by supporting expertise and competencies.**
- **Set-up innovation supportive environments to foster Ideas, technology, and Patents for the stakeholders, in line with your water-oriented mission**
- **Identify and select methods and tools for large scale user monitoring and measurement.**
- **Provide and update interoperable user data to support user monitoring and measurements in the water sector.**

CS5 Llieda (Spain)

- **Involve at least one of the key water user groups in measurements and the design process of water innovations (urban/citizens, industry and/or agriculture).**
- **Involve water users by setting up low-cost continuous user observation technologies and standards that allow for sharing research results with other LLs or external research.**
- **Set-up a clear communication plan to engage users in the co-creation process.**
- **Identify and select methods and tools for large scale user monitoring and measurement.**

CS9 Kalundborg (Denmark)

- **Connect relevant stakeholders that would support both policy and decision makers in the water reuse and circular economy solutions fostering process.**
- **Involve water users by setting up low-cost continuous user observation technologies and standards that allow for sharing research results with other LLs or external research.**
- **Support the development of new services by training the stakeholders for a collaborative and co-creation process to tackle challenges for the water sector.**
- **Set-up a collaboration process to deploy and operate networks, sensors, data collection mechanisms.**
- **Set-up innovation supportive environments to foster Ideas, technology, and Patents for the stakeholders, in line with your water-oriented mission.**
- **Provide and update interoperable user data to support user monitoring and measurements in the water sector.**

6. Annex 1: Definition of foundational elements of the WSIS LLs

USER INVOLVEMENT

Objective: *involve* ***users of water*** *(e.g. urban/citizens, industry and/or agriculture) as well as* ***users of innovations that enable a "Water Smart Society"*** *(e.g. users of water + utilities, and related service providers such as waste water management companies etc.), giving them the opportunity to influence the solution that will affect their life later on.*

SERVICE CREATION

Objective: *facilitating and supporting the* ***development of new ideas, services and solutions that contribute to a sustainable and Water Smart Society*** *and offering a* ***representative (semi) real-life environments*** *of water production, distribution and (re)use, for co-design and validation.*

INFRASTRUCTURE

Objective: *providing the* ***physical or virtual environment,*** *to integrate, try-out, validate and measure the* ***performance of water innovations****. This may include an experimental set-up (e.g. in labs, or demo-sites) or in the case of mature WOLLs and Water Europe Living Labs (WELLs[19]) real-life test environments including (external) infrastructures for water production, distribution and (re)use (e.g. at utilities, river basin settings, urban areas, (agro) industrial sites).*

GOVERNANCE

Objective: ***engage the quadruple helix from the water sector in a (inter) regional context,*** *e.g. involving public (water managment) authorities (including utilities), water users (e.g. cities/citizens, industries and/or agriculture), water research organizations and technology developers, which jointly agree on managing and maintaining the WOLL.*

INNOVATION OUTCOME

Objective: *facilitate predominantly* ***innovations that contribute to a sustainable and water smart society ("mission focus")****. These outcomes can be knowledge, new products and services and/or IPR. Outcomes can be in the form of finished end-user applications but also in the form of prototypes or mere knowledge about usage patterns.*

METHODS AND TOOLS

Objective: *provide and continuously update specific (interoperable) methods and tools to acquire relevant* ***large scale user data related to the targeted innovation outcomes within the water sector****.*

19 Water-Oriented Living Labs focused specifically on realising Water Europe's Vision

7. Annex 2: CS1 Tarragona data

Figure 20 shows data collection, metrics, and foundational elements scores, including final overall score of ULTIMATE Case Study 1 Tarragona.

WoLL Harmonisation Cube scoring Tool	User Involvement						Service Creation					
	Objective: Involve **users of water** (e.g. urban/citizens, industry and/or agriculture) as well as **users of innovations that enable a "water smart society"** (e.g. same as above + utilities, and related service providers such as waste water management companies etc.), giving them the opportunity to influence on the solution that will affect their life later on						Objective: Facilitating and supporting the **development of new ideas, services and solutions** that contribute to a sustainable and water smart society, and offering a **representative (semi) real-life environments of water production, distribution and (re)use**, for co-design and validation					
	UO-Metrics		UC-Metrics		UT-Metrics		SO-Metrics		SC-Metrics		ST-Metrics	
Set up	UO 1	Y	UC 1	Y	UT 1	Y	SO 1	N	SC 1	N	ST 1	N
Sustainability	UO 2	Y	UC 2	Y	UT 2	Y	SO 2	Y	SC 2	N	ST 2	N
Scalability	UO 3	Y	UC 3	N	UT 3	N	SO 3	Y	SC 3	N	ST 3	Y
	100%		67%		67%		67%		0%		33%	
	User Organizational Metrics (UO-Metrics)		User Contextual Metrics (UC-Metrics)		User Technological Metrics (UT-Metrics)		Service Organizational Metrics (SO-Metrics)		Service Contextual Metrics (SC-Metrics)		Service Technological Metrics (ST-Metrics)	
METRICS SCORE	78%						33%					

WoLL Harmonisation Cube scoring Tool	Infrastructure						Governance					
	Objective: Providing the **physical or virtual environment**, to integrate, try-out, validate and measure the **performance of water innovations.** This may include an experimental set-up (e.g. in labs, or demo-sites) or (preferably) real-life test environments for water production, distribution and (re)use (e.g. at utilities, urban areas, (agro) industrial sites)						Objective: Engage the **quadruple helix from the water sector in a (inter) regional context** e.g. involving public (water managing) authorities (including utilities), water users (e.g. cities/citizens, industries and/or agriculture), water research organizations and technology developers, which jointly agree on managing and maintaining the WoLL					
	InfraO-Metrics		IC-Metrics		IT-Meytrics		GovO-Metrics		GC-Metrics		GT-Metrocs	
Set up	InfraO 1	Y	InfraC 1	Y	InfraT 1	Y	GovO 1	N	GovC 1	Y	GovT-1	Y
Sustainability	InfraO 2	Y	InfraC 2	Y	InfraT 2	Y	GovO 2	Y	GovC 2	Y	GovT-2	Y
Scalability	InfraO 3	N	InfraC 3	Y	InfraT 3	N	GovO 3	N	GovC 3	Y	GovT-3	Y
	67%		100%		67%		33%		100%		100%	
	Infra- Organizational Metrics (InfraO-metrics)		Infra Contextual Metrics (InfraC Metrics)		Infra Technological Metrics (InfraT-Metrics)		GOV Organizational Metrics (GovO-Metrics)		GOV Contextual Metrics (GovC-Metrics)		GOV Technological Metrics (GovT-Metrics)	
METRICS SCORE	78%						78%					

WoLL Harmonisation Cube scoring Tool	Innovation out come						Methods and Tools						
	Objective: Facilitate predominantly **innovations that contribute to a sustainable and water smart society ("mission focus").** These outcomes can be knowledge, new products and services and/or IPR. Outcomes can be in the form of finished end-user applications but also in the form of prototypes or mere knowledge about usage patterns						Objective: Provide specific methods and tools to **acquire relevant large scale user data** related to the targeted innovation outcomes within the water sector.						
	INNO-Metrics		NNOC-Metrics		INNOT-Metrics		M&TO-Metrics		M&TC-Metrics		M&TT-Metrics		
Set up	INNO 1	Y	InnoC 1	Y	InnoT 1	Y	M&TO 1	N	M&TC 1	Y	M&TT 1	N	
Sustainability	INNO 2	Y	InnoC 2	Y	InnoT 2	Y	M&TO 2	N	M&TC 2	Y	M&TT 2	N	
Scalability	INNO 3	Y	InnoC 3	Y	InnoT 3	N	M&TO 3	Y	M&TC 3	N	M&TT 3	Y	
	100%		100%		67%		33%		67%		33%		
	INNO Organizational Metrics (INNO-Metrics)		INNO Contextual Metrics (InnoC-Metrics)		INNO Technological Metrics (InnoT-Metrics)		Methods and Tools Organizational Metrics (M&TO-Metrics)		Methods and Tools Contextual Metrics (M&TC-Metrics)		Methods & Tools Technological Metrics (M&TT-Metrics)		67%
METRICS SCORE	89%						44%						Total Score

Figure 20 CS1 data collection

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869318

8. Annex 3: CS2 Nieuw Prinsenland data

Figure 21 shows data collection, metrics, and foundational elements scores, including final overall score of ULTIMATE Case Study 2.

WoLL Harmonisation Cube scoring Tool

User Involvement

Objective: Involve **users of water** (e.g. urban/citizens, industry and/or agriculture) as well as **users of innovations that enable a "water smart society"** (e.g. same as above + utilities, and related service providers such as waste water management companies etc.), giving them the opportunity to influence on the solution that will affect their life later on

	UO-Metrics		UC-Metrics		UT-Metrics	
Set up	UO 1	Y	UC 1	Y	UT 1	N
Sustainability	UO 2	N	UC 2	N	UT 2	N
Scalability	UO 3	N	UC 3	N	UT 3	N
	33%		33%		0%	
	User Organizational Metrics (UO-Metrics)		User Contextual Metrics (UC-Metrics)		User Technological Metrics (UT-Metrics)	
METRICS SCORE	22%					

Service Creation

Objective: Facilitating and supporting the **development of new ideas, services and solutions** that contribute to a sustainable and water smart society, and offering a **representative (semi) real-life environments of water production, distribution and (re)use**, for co-design and validation

	SO-Metrics		SC-Metrics		ST-Metrics	
Set up	SO 1	N	SC 1	N	ST 1	N
Sustainability	SO 2	N	SC 2	N	ST 2	N
Scalability	SO 3	N	SC 3	N	ST 3	N
	0%		0%		0%	
	Service Organizational Metrics (SO-Metrics)		Service Contextual Metrics (SC-Metrics)		Service Technological Metrics (ST-Metrics)	
METRICS SCORE	0%					

Infrastructure

Objective: Providing the **physical or virtual environment**, to integrate, try-out, validate and measure the **performance of water innovations.** This may include an experimental set-up (e.g. in labs, or demo-sites) or (preferably) real-life test environments for water production, distribution and (re)use (e.g. at utilities, urban areas, (agro) industrial sites)

	InfraO-Metrics		IC-Metrics		IT-Meytrics	
Set up	InfraO 1	N	InfraC 1	N	InfraT 1	N
Sustainability	InfraO 2	N	InfraC 2	N	InfraT 2	N
Scalability	InfraO 3	N	InfraC 3	Y	InfraT 3	N
	0%		33%		0%	
	Infra- Organizational Metrics (InfraO-metrics)		Infra Contextual Metrics (InfraC Metrics)		Infra Technological Metrics (InfraT-Metrics)	
METRICS SCORE	11%					

Governance

Objective: Engage the **quadruple helix from the water sector in a (inter) regional context** e.g. involving public (water managing) authorities (including utilities), water users (e.g. cities/citizens, industries and/or agriculture), water research organizations and technology developers, which jointly agree on managing and maintaining the WoLL

	GovO-Metrics		GC-Metrics		GT-Metrocs	
Set up	GovO 1	N	GovC 1	N	GovT-1	N
Sustainability	GovO 2	N	GovC 2	N	GovT-2	N
Scalability	GovO 3	N	GovC 3	N	GovT-3	N
	0%		0%		0%	
	GOV Organizational Metrics (GovO-Metrics)		GOV Contextual Metrics (GovC-Metrics)		GOV Technological Metrics (GovT-Metrics)	
METRICS SCORE	0%					

Innovation out come

Objective: Facilitate predominantly **innovations that contribute to a sustainable and water smart society ("mission focus").** These outcomes can be knowledge, new products and services and/or IPR. Outcomes can be in the form of finished end-user applications but also in the form of prototypes or mere knowledge about usage patterns

	INNO-Metrics		NNOC-Metrics		NNOT-Metrics	
Set up	INNO 1	N	InnoC 1	N	InnoT 1	N
Sustainability	INNO 2	N	InnoC 2	N	InnoT 2	N
Scalability	INNO 3	N	InnoC 3	N	InnoT 3	N
	0%		0%		0%	
	INNO Organizational Metrics (INNO-Metrics)		INNO Contextual Metrics (InnoC-Metrics)		INNO Technological Metrics (InnoT-Metrics)	
METRICS SCORE	0%					

Methods and Tools

Objective: Provide specific methods and tools to **acquire relevant large scale user data** related to the targeted innovation outcomes within the water sector.

	M&TO-Metrics		M&TC-Metrics		M&TT-Metrics	
Set up	M&TO 1	N	M&TC 1	N	M&TT 1	N
Sustainability	M&TO 2	N	M&TC 2	N	M&TT 2	N
Scalability	M&TO 3	N	M&TC 3	N	M&TT 3	N
	0%		0%		0%	
	Methods and Tools Organizational Metrics (M&TO-Metrics)		Methods and Tools Contextual Metrics (M&TC-Metrics)		Methods & Tools Technological Metrics (M&TT-Metrics)	
METRICS SCORE	0%					

Total Score
6%

Figure 21 CS2 data collection

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869318

9. Annex 4: CS3 Rosignano data

Figure 22 shows data collection, metrics, and foundational elements scores, including final overall score of ULTIMATE Case Study 3.

WoLL Harmonisation Cube scoring Tool	User Involvement					
	Objective: Involve **users of water** (e.g. urban/citizens, industry and/or agriculture) as well as **users of innovations that enable a "water smart society"** (e.g. same as above + utilities, and related service providers such as waste water management companies etc.), giving them the opportunity to influence on the solution that will affect their life later on					
	UO-Metrics		UC-Metrics		UT-Metrics	
Set up	UO 1	Y	UC 1	Y	UT 1	Y
Sustainability	UO 2	Y	UC 2	Y	UT 2	N
Scalability	UO 3	Y	UC 3	Y	UT 3	N
	100%		100%		33%	
	User Organizational Metrics (UO-Metrics)		User Contextual Metrics (UC-Metrics)		User Technological Metrics (UT-Metrics)	
METRICS SCORE	78%					

	Service Creation					
	Objective: Facilitating and supporting the **development of new ideas, services and solutions** that contribute to a sustainable and water smart society, and offering **a representative (semi) real-life environments of water production, distribution and (re)use**, for co-design and validation					
	SO-Metrics		SC-Metrics		ST-Metrics	
Set up	SO 1	N	SC 1	N	ST 1	Y
Sustainability	SO 2	N	SC 2	N	ST 2	Y
Scalability	SO 3	N	SC 3	N	ST 3	N
	0%		0%		67%	
	Service Organizational Metrics (SO-Metrics)		Service Contextual Metrics (SC-Metrics)		Service Technological Metrics (ST-Metrics)	
METRICS SCORE	22%					

	Infrastructure					
	Objective: Providing the **physical or virtual environment**, to integrate, try-out, validate and measure the **performance of water innovations.** This may include an experimental set-up (e.g. in labs, or demo-sites) or (preferably) real-life test environments for water production, distribution and (re)use (e.g. at utilities, urban areas, (agro) industrial sites)					
	InfraO-Metrics		IC-Metrics		IT-Meytrics	
Set up	InfraO 1	Y	InfraC 1	N	InfraT 1	N
Sustainability	InfraO 2	N	InfraC 2	N	InfraT 2	N
Scalability	InfraO 3	Y	InfraC 3	Y	InfraT 3	N
	67%		33%		0%	
	Infra- Organizational Metrics (InfraO-metrics)		Infra Contextual Metrics (InfraC Metrics)		Infra Technological Metrics (InfraT-Metrics)	
METRICS SCORE	33%					

	Governance					
	Objective: Engage the **quadruple helix from the water sector in a (inter) regional context** e.g. involving public (water managing) authorities (including utilities), water users (e.g. cities/citizens, industries and/or agriculture), water research organizations and technology developers, which jointly agree on managing and maintaining the WoLL					
	GovO-Metrics		GC-Metrics		GT-Metrocs	
Set up	GovO 1	Y	GovC 1	N	GovT-1	N
Sustainability	GovO 2	N	GovC 2	N	GovT-2	N
Scalability	GovO 3	N	GovC 3	Y	GovT-3	N
	33%		33%		0%	
	GOV Organizational Metrics (GovO-Metrics)		GOV Contextual Metrics (GovC-Metrics)		GOV Technological Metrics (GovT-Metrics)	
METRICS SCORE	22%					

	Innovation out come					
	Objective: Facilitate predominantly **innovations that contribute to a sustainable and water smart society ("mission focus").** These outcomes can be knowledge, new products and services and/or IPR. Outcomes can be in the form of finished end-user applications but also in the form of prototypes or mere knowledge about usage patterns					
	INNO-Metrics		NNOC-Metrics		INNOT-Metrics	
Set up	INNO 1	N	InnoC 1	N	InnoT 1	Y
Sustainability	INNO 2	N	InnoC 2	Y	InnoT 2	N
Scalability	INNO 3	N	InnoC 3	N	InnoT 3	N
	0%		33%		33%	
	INNO Organizational Metrics (INNO-Metrics)		INNO Contextual Metrics (InnoC-Metrics)		INNO Technological Metrics (InnoT-Metrics)	
METRICS SCORE	22%					

	Methods and Tools					
	Objective: Provide specific methods and tools to **acquire relevant large scale user data** related to the targeted innovation outcomes within the water sector.					
	M&TO-Metrics		M&TC-Metrics		M&TT-Metrics	
Set up	M&TO 1	N	M&TC 1	N	M&TT 1	N
Sustainability	M&TO 2	N	M&TC 2	N	M&TT 2	N
Scalability	M&TO 3	N	M&TC 3	N	M&TT 3	N
	0%		0%		0%	
	Methods and Tools Organizational Metrics (M&TO-Metrics)		Methods and Tools Contextual Metrics (M&TC-Metrics)		Methods & Tools Technological Metrics (M&TT-Metrics)	
METRICS SCORE	0%					

30%	
Total Score	

Figure 22 CS3 data collection

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869318

10. Annex 5: CS4 Nafplio data

Figure 23 shows data collection, metrics, and foundational elements scores, including final overall score of ULTIMATE Case Study 4.

WoLL Harmonisation Cube scoring Tool	User Involvement					
	Objective: Involve **users of water** (e.g. urban/citizens, industry and/or agriculture) as well as **users of innovations that enable a "water smart society"** (e.g. same as above + utilities, and related service providers such as waste water management companies etc.), giving them the opportunity to influence on the solution that will affect their life later on					
	UO-Metrics		UC-Metrics		UT-Metrics	
Set up	UO 1	Y	UC 1	Y	UT 1	Y
Sustainability	UO 2	Y	UC 2	Y	UT 2	N
Scalability	UO 3	Y	UC 3	N	UT 3	N
	100%		67%		33%	
	User Organizational Metrics (UO-Metrics)		User Contextual Metrics (UC-Metrics)		User Technological Metrics (UT-Metrics)	
METRICS SCORE	67%					

WoLL Harmonisation Cube scoring Tool	Service Creation					
	Objective: Facilitating and supporting the **development of new ideas, services and solutions** that contribute to a sustainable and water smart society, and offering **a representative (semi) real-life environments of water production, distribution and (re)use**, for co-design and validation					
	SO-Metrics		SC-Metrics		ST-Metrics	
Set up	SO 1	N	SC 1	Y	ST 1	Y
Sustainability	SO 2	N	SC 2	N	ST 2	N
Scalability	SO 3	N	SC 3	Y	ST 3	N
	0%		67%		33%	
	Service Organizational Metrics (SO-Metrics)		Service Contextual Metrics (SC-Metrics)		Service Technological Metrics (ST-Metrics)	
METRICS SCORE	33%					

WoLL Harmonisation Cube scoring Tool	Infrastructure					
	Objective: Providing the **physical or virtual environment**, to integrate, try-out, validate and measure the **performance of water innovations.** This may include an experimental set-up (e.g. in labs, or demo-sites) or (preferably) real-life test environments for water production, distribution and (re)use (e.g. at utilities, urban areas, (agro) industrial sites)					
	InfraO-Metrics		IC-Metrics		IT-Meytrics	
Set up	InfraO 1	Y	InfraC 1	N	InfraT 1	Y
Sustainability	InfraO 2	Y	InfraC 2	N	InfraT 2	N
Scalability	InfraO 3	N	InfraC 3	Y	InfraT 3	N
	67%		33%		33%	
	Infra- Organizational Metrics (InfraO-metrics)		Infra Contextual Metrics (InfraC Metrics)		Infra Technological Metrics (InfraT-Metrics)	
METRICS SCORE	44%					

WoLL Harmonisation Cube scoring Tool	Governance					
	Objective: Engage the **quadruple helix from the water sector in a (inter) regional context** e.g. involving public (water managing) authorities (including utilities), water users (e.g. cities/citizens, industries and/or agriculture), water research organizations and technology developers, which jointly agree on managing and maintaining the WoLL					
	GovO-Metrics		GC-Metrics		GT-Metrocs	
Set up	GovO 1	N	GovC 1	N	GovT-1	N
Sustainability	GovO 2	N	GovC 2	N	GovT-2	N
Scalability	GovO 3	Y	GovC 3	N	GovT-3	N
	33%		0%		0%	
	GOV Organizational Metrics (GovO-Metrics)		GOV Contextual Metrics (GovC-Metrics)		GOV Technological Metrics (GovT-Metrics)	
METRICS SCORE	11%					

WoLL Harmonisation Cube scoring Tool	Innovation out come					
	Objective: Facilitate predominantly **innovations that contribute to a sustainable and water smart society ("mission focus").** These outcomes can be knowledge, new products and services and/or IPR. Outcomes can be in the form of finished end-user applications but also in the form of prototypes or mere knowledge about usage patterns					
	INNO-Metrics		NNOC-Metrics		INNOT-Metrics	
Set up	INNO 1	N	InnoC 1	Y	InnoT 1	N
Sustainability	INNO 2	N	InnoC 2	N	InnoT 2	N
Scalability	INNO 3	N	InnoC 3	N	InnoT 3	N
	0%		33%		0%	
	INNO Organizational Metrics (INNO-Metrics)		INNO Contextual Metrics (InnoC-Metrics)		INNO Technological Metrics (InnoT-Metrics)	
METRICS SCORE	11%					

WoLL Harmonisation Cube scoring Tool	Methods and Tools					
	Objective: Provide specific methods and tools to **acquire relevant large scale user data** related to the targeted innovation outcomes within the water sector.					
	M&TO-Metrics		M&TC-Metrics		M&TT-Metrics	
Set up	M&TO 1	Y	M&TC 1	N	M&TT 1	N
Sustainability	M&TO 2	N	M&TC 2	N	M&TT 2	Y
Scalability	M&TO 3	N	M&TC 3	N	M&TT 3	N
	33%		0%		33%	
	Methods and Tools Organizational Metrics (M&TO-Metrics)		Methods and Tools Contextual Metrics (M&TC-Metrics)		Methods & Tools Technological Metrics (M&TT-Metrics)	
METRICS SCORE	22%					

Total Score	31%

Figure 23 CS4 data collection

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869318

11. Annex 6: CS5 Lleida data

Figure 24 shows data collection, metrics, and foundational elements scores, including final overall score of ULTIMATE Case Study 5.

WoLL Harmonisation Cube scoring Tool

User Involvement	Objective: Involve **users of water** (e.g. urban/citizens, industry and/or agriculture) as well as **users of innovations that enable a "water smart society"** (e.g. same as above + utilities, and related service providers such as waste water management companies etc.), giving them the opportunity to influence on the solution that will affect their life later on
Service Creation	Objective: Facilitating and supporting the **development of new ideas, services and solutions** that contribute to a sustainable and water smart society, and offering **a representative (semi) real-life environments of water production, distribution and (re)use**, for co-design and validation
Infrastructure	Objective: Providing the **physical or virtual environment**, to integrate, try-out, validate and measure the **performance of water innovations.** This may include an experimental set-up (e.g. in labs, or demo-sites) or (preferably) real-life test environments for water production, distribution and (re)use (e.g. at utilities, urban areas, (agro) industrial sites)
Governance	Objective: Engage the **quadruple helix from the water sector in a (inter) regional context** e.g. involving public (water managing) authorities (including utilities), water users (e.g. cities/citizens, industries and/or agriculture), water research organizations and technology developers, which jointly agree on managing and maintaining the WoLL
Innovation out come	Objective: Facilitate predominantly **innovations that contribute to a sustainable and water smart society ("mission focus").** These outcomes can be knowledge, new products and services and/or IPR. Outcomes can be in the form of finished end-user applications but also in the form of prototypes or mere knowledge about usage patterns
Methods and Tools	Objective: Provide specific methods and tools to **acquire relevant large scale user data** related to the targeted innovation outcomes within the water sector.

		Set up		Sustainability		Scalability				METRICS SCORE
User Involvement	UO-Metrics	UO 1	N	UO 2	N	UO 3	Y	33%	User Organizational Metrics (UO-Metrics)	22%
	UC-Metrics	UC 1	Y	UC 2	N	UC 3	N	33%	User Contextual Metrics (UC-Metrics)	
	UT-Metrics	UT 1	N	UT 2	N	UT 3	N	0%	User Technological Metrics (UT-Metrics)	
Service Creation	SO-Metrics	SO 1	Y	SO 2	Y	SO 3	N	67%	Service Organizational Metrics (SO-Metrics)	67%
	SC-Metrics	SC 1	Y	SC 2	N	SC 3	Y	67%	Service Contextual Metrics (SC-Metrics)	
	ST-Metrics	ST 1	N	ST 2	Y	ST 3	Y	67%	Service Technological Metrics (ST-Metrics)	
Infrastructure	InfraO-Metrics	InfraO 1	Y	InfraO 2	Y	InfraO 3	N	67%	Infra- Organizational Metrics (InfraO-metrics)	56%
	IC-Metrics	InfraC 1	Y	InfraC 2	N	InfraC 3	N	33%	Infra Contextual Metrics (InfraC Metrics)	
	IT-Meytrics	InfraT 1	Y	InfraT 2	Y	InfraT 3	N	67%	Infra Technological Metrics (InfraT-Metrics)	
Governance	GovO-Metrics	GovO 1	Y	GovO 2	N	GovO 3	N	33%	GOV Organizational Metrics (GovO-Metrics)	67%
	GC-Metrics	GovC 1	Y	GovC 2	Y	GovC 3	N	67%	GOV Contextual Metrics (GovC-Metrics)	
	GT-Metrocs	GovT-1	Y	GovT-2	Y	GovT-3	Y	100%	GOV Technological Metrics (GovT-Metrics)	
Innovation out come	INNO-Metrics	INNO 1	Y	INNO 2	Y	INNO 3	Y	100%	INNO Organizational Metrics (INNO-Metrics)	89%
	NNOC-Metrics	InnoC 1	Y	InnoC 2	Y	InnoC 3	N	67%	INNO Contextual Metrics (InnoC-Metrics)	
	INNOT-Metrics	InnoT 1	Y	InnoT 2	Y	InnoT 3	Y	100%	INNO Technological Metrics (InnoT-Metrics)	
Methods and Tools	M&TO-Metrics	M&TO 1	Y	M&TO 2	Y	M&TO 3	N	67%	Methods and Tools Organizational Metrics (M&TO-Metrics)	44%
	M&TC-Metrics	M&TC 1	N	M&TC 2	N	M&TC 3	N	0%	Methods and Tools Contextual Metrics (M&TC-Metrics)	
	M&TT-Metrics	M&TT 1	Y	M&TT 2	Y	M&TT 3	N	67%	Methods & Tools Technological Metrics (M&TT-Metrics)	

Total Score	57%

Figure 24 CS5 data collection

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869318

12. Annex 7: CS6 Karmiel and Shafdan data

Figure 25 shows data collection, metrics, and foundational elements scores, including final overall score of ULTIMATE Case Study 6.

WoLL Harmonisation Cube scoring Tool	User Involvement					
	Objective: Involve **users of water** (e.g. urban/citizens, industry and/or agriculture) as well as **users of innovations that enable a "water smart society"** (e.g. same as above + utilities, and related service providers such as waste water management companies etc.), giving them the opportunity to influence on the solution that will affect their life later on					
	UO-Metrics		UC-Metrics		UT-Metrics	
Set up	UO 1	Y	UC 1	Y	UT 1	Y
Sustainability	UO 2	Y	UC 2	Y	UT 2	N
Scalability	UO 3	Y	UC 3	N	UT 3	N
	100%		67%		33%	
	User Organizational Metrics (UO-Metrics)		User Contextual Metrics (UC-Metrics)		User Technological Metrics (UT-Metrics)	
METRICS SCORE	67%					

WoLL Harmonisation Cube scoring Tool	Service Creation					
	Objective: Facilitating and supporting the **development of new ideas, services and solutions** that contribute to a sustainable and water smart society, and offering a **representative (semi) real-life environments of water production, distribution and (re)use**, for co-design and validation					
	SO-Metrics		SC-Metrics		ST-Metrics	
Set up	SO 1	Y	SC 1	N	ST 1	Y
Sustainability	SO 2	N	SC 2	N	ST 2	Y
Scalability	SO 3	Y	SC 3	N	ST 3	Y
	67%		0%		100%	
	Service Organizational Metrics (SO-Metrics)		Service Contextual Metrics (SC-Metrics)		Service Technological Metrics (ST-Metrics)	
METRICS SCORE	56%					

WoLL Harmonisation Cube scoring Tool	Infrastructure					
	Objective: Providing the **physical or virtual environment**, to integrate, try-out, validate and measure the **performance of water innovations.** This may include an experimental set-up (e.g. in labs, or demo-sites) or (preferably) real-life test environments for water production, distribution and (re)use (e.g. at utilities, urban areas, (agro) industrial sites)					
	InfraO-Metrics		IC-Metrics		IT-Meytrics	
Set up	InfraO 1	Y	InfraC 1	N	InfraT 1	N
Sustainability	InfraO 2	Y	InfraC 2	N	InfraT 2	N
Scalability	InfraO 3	Y	InfraC 3	Y	InfraT 3	Y
	100%		33%		33%	
	Infra- Organizational Metrics (InfraO-metrics)		Infra Contextual Metrics (InfraC Metrics)		Infra Technological Metrics (InfraT-Metrics)	
METRICS SCORE	56%					

WoLL Harmonisation Cube scoring Tool	Governance					
	Objective: Engage the **quadruple helix from the water sector in a (inter) regional context** e.g. involving public (water managing) authorities (including utilities), water users (e.g. cities/citizens, industries and/or agriculture), water research organizations and technology developers, which jointly agree on managing and maintaining the WoLL					
	GovO-Metrics		GC-Metrics		GT-Metrocs	
Set up	GovO 1	N	GovC 1	N	GovT-1	N
Sustainability	GovO 2	N	GovC 2	N	GovT-2	Y
Scalability	GovO 3	N	GovC 3	N	GovT-3	N
	0%		0%		33%	
	GOV Organizational Metrics (GovO-Metrics)		GOV Contextual Metrics (GovC-Metrics)		GOV Technological Metrics (GovT-Metrics)	
METRICS SCORE	11%					

WoLL Harmonisation Cube scoring Tool	Innovation out come					
	Objective: Facilitate predominantly **innovations that contribute to a sustainable and water smart society ("mission focus").** These outcomes can be knowledge, new products and services and/or IPR. Outcomes can be in the form of finished end-user applications but also in the form of prototypes or mere knowledge about usage patterns					
	INNO-Metrics		NNOC-Metrics		INNOT-Metrics	
Set up	INNO 1	N	InnoC 1	Y	InnoT 1	N
Sustainability	INNO 2	Y	InnoC 2	Y	InnoT 2	Y
Scalability	INNO 3	N	InnoC 3	Y	InnoT 3	Y
	33%		100%		67%	
	INNO Organizational Metrics (INNO-Metrics)		INNO Contextual Metrics (InnoC-Metrics)		INNO Technological Metrics (InnoT-Metrics)	
METRICS SCORE	67%					

WoLL Harmonisation Cube scoring Tool	Methods and Tools						
	Objective: Provide specific methods and tools to **acquire relevant large scale user data** related to the targeted innovation outcomes within the water sector.						
	M&TO-Metrics		M&TC-Metrics		M&TT-Metrics		
Set up	M&TO 1	Y	M&TC 1	Y	M&TT 1	Y	
Sustainability	M&TO 2	Y	M&TC 2	Y	M&TT 2	N	
Scalability	M&TO 3	N	M&TC 3	N	M&TT 3	N	
	67%		67%		33%		
	Methods and Tools Organizational Metrics (M&TO-Metrics)		Methods and Tools Contextual Metrics (M&TC-Metrics)		Methods & Tools Technological Metrics (M&TT-Metrics)		52%
METRICS SCORE	56%						Total Score

Figure 25 CS6 data collection

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869318

13. Annex 8: CS9 Kalundborg data

Figure 26 shows data collection, metrics, and foundational elements scores, including final overall score of ULTIMATE Case Study 9.

WoLL Harmonisation Cube scoring Tool

Foundational element	Objective
User Involvement	Objective: Involve **users of water** (e.g. urban/citizens, industry and/or agriculture) as well as **users of innovations that enable a "water smart society"** (e.g. same as above + utilities, and related service providers such as waste water management companies etc.), giving them the opportunity to influence on the solution that will affect their life later on
Service Creation	Objective: Facilitating and supporting the **development of new ideas, services and solutions** that contribute to a sustainable and water smart society, and offering a **representative (semi) real-life environments of water production, distribution and (re)use**, for co-design and validation
Infrastructure	Objective: Providing the **physical or virtual environment**, to integrate, try-out, validate and measure the **performance of water innovations.** This may include an experimental set-up (e.g. in labs, or demo-sites) or (preferably) real-life test environments for water production, distribution and (re)use (e.g. at utilities, urban areas, (agro) industrial sites)
Governance	Objective: Engage the **quadruple helix from the water sector in a (inter) regional context** e.g. involving public (water managing) authorities (including utilities), water users (e.g. cities/citizens, industries and/or agriculture), water research organizations and technology developers, which jointly agree on managing and maintaining the WoLL
Innovation out come	Objective: Facilitate predominantly **innovations that contribute to a sustainable and water smart society ("mission focus").** These outcomes can be knowledge, new products and services and/or IPR. Outcomes can be in the form of finished end-user applications but also in the form of prototypes or mere knowledge about usage patterns
Methods and Tools	Objective: Provide specific methods and tools to **acquire relevant large scale user data** related to the targeted innovation outcomes within the water sector.

Foundational element	Metrics	Set up		Sustainability		Scalability		Score	Metric name	METRICS SCORE
User Involvement	UO-Metrics	UO 1	Y	UO 2	N	UO 3	N	33%	User Organizational Metrics (UO-Metrics)	33%
	UC-Metrics	UC 1	Y	UC 2	N	UC 3	Y	67%	User Contextual Metrics (UC-Metrics)	
	UT-Metrics	UT 1	N	UT 2	N	UT 3	N	0%	User Technological Metrics (UT-Metrics)	
Service Creation	SO-Metrics	SO 1	N	SO 2	N	SO 3	N	0%	Service Organizational Metrics (SO-Metrics)	44%
	SC-Metrics	SC 1	Y	SC 2	Y	SC 3	N	67%	Service Contextual Metrics (SC-Metrics)	
	ST-Metrics	ST 1	Y	ST 2	N	ST 3	Y	67%	Service Technological Metrics (ST-Metrics)	
Infrastructure	InfraO-Metrics	InfraO 1	N	InfraO 2	Y	InfraO 3	Y	67%	Infra- Organizational Metrics (InfraO-metrics)	67%
	IC-Metrics	InfraC 1	Y	InfraC 2	N	InfraC 3	Y	67%	Infra Contextual Metrics (InfraC Metrics)	
	IT-Meytrics	InfraT 1	Y	InfraT 2	Y	InfraT 3	N	67%	Infra Technological Metrics (InfraT-Metrics)	
Governance	GovO-Metrics	GovO 1	Y	GovO 2	N	GovO 3	N	33%	GOV Organizational Metrics (GovO-Metrics)	56%
	GC-Metrics	GovC 1	Y	GovC 2	Y	GovC 3	N	67%	GOV Contextual Metrics (GovC-Metrics)	
	GT-Metrocs	GovT-1	Y	GovT-2	N	GovT-3	Y	67%	GOV Technological Metrics (GovT-Metrics)	
Innovation out come	INNO-Metrics	INNO 1	Y	INNO 2	Y	INNO 3	Y	100%	INNO Organizational Metrics (INNO-Metrics)	67%
	NNOC-Metrics	InnoC 1	Y	InnoC 2	Y	InnoC 3	N	67%	INNO Contextual Metrics (InnoC-Metrics)	
	INNOT-Metrics	InnoT 1	N	InnoT 2	Y	InnoT 3	N	33%	INNO Technological Metrics (InnoT-Metrics)	
Methods and Tools	M&TO-Metrics	M&TO 1	Y	M&TO 2	Y	M&TO 3	Y	100%	Methods and Tools Organizational Metrics (M&TO-Metrics)	67%
	M&TC-Metrics	M&TC 1	Y	M&TC 2	N	M&TC 3	N	33%	Methods and Tools Contextual Metrics (M&TC-Metrics)	
	M&TT-Metrics	M&TT 1	N	M&TT 2	Y	M&TT 3	Y	67%	Methods & Tools Technological Metrics (M&TT-Metrics)	

56%

Total Score

Figure 26 CS9 data collection

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869318