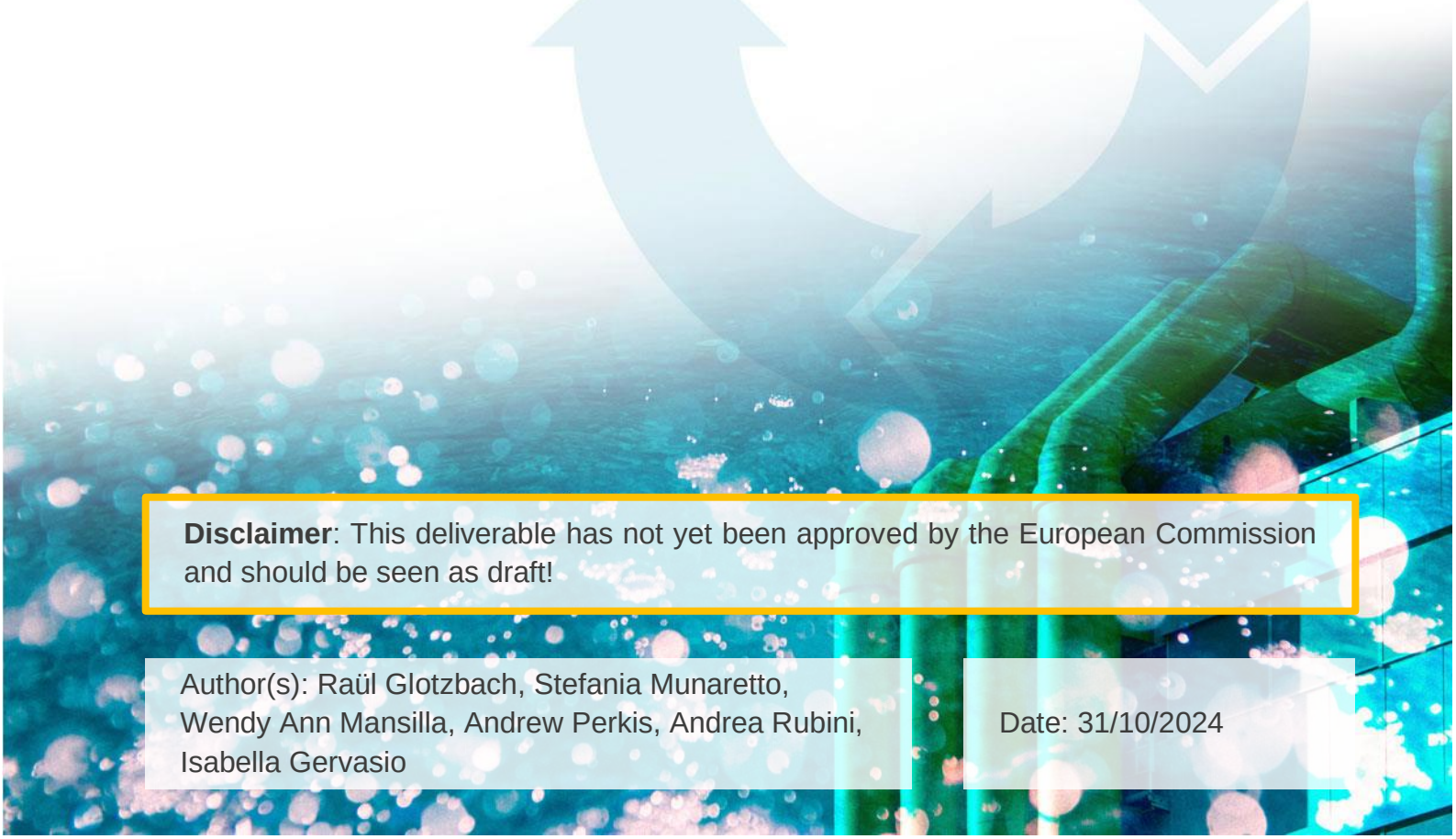
ULTIMATE

WATER SMART INDUSTRIAL SYMBIOSIS

Deliverable 3.8

(Final) results and insights from co-creation exercises in ULTIMATE CSs - updated



Disclaimer: This deliverable has not yet been approved by the European Commission and should be seen as draft!

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Technical References

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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)
CO = Confidential, only for members of the consortium (including the Commission Services)

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Executive Summary

Reuse of wastewater plays a key role in the water sustainability challenge. Wastewater can be a valuable source of energy and materials as well as a good alternative to freshwater abstraction from natural sources. ULTIMATE aims to create economic value from wastewater within a dynamic socio-economic and business oriented industrial symbiosis ecosystem.

Successful uptake and acceptance of technologies and strategies for symbiosis solutions requires the active engagement of relevant stakeholder groups and citizens. By interacting regularly, different stakeholders can exchange knowledge, develop ideas, and learn together, thereby contributing to innovative and effective solutions for sustainable water management in the context of industrial symbiosis.

ULTIMATE promotes active stakeholder engagement and innovation co-creation (T3.1, T3.2, T3.3 and T3.4) across its nine (9) case studies (CS). Stakeholders are engaged through co-creation exercises for the design of multi-use playspaces, Communities of Practice (CoP), and through Living Labs (LL). These activities are implemented in the context of WP3. Deliverable (D) 3.8 provides updated insights and results from co-creation exercises (Subtask 3.2.2 and T3.3) in three (3) CSs (CS2, 3 and 9) and from CoP (Subtask 3.2.1) across the nine (9) CSs, as well as preliminary insights and results from LL engagement activities (T3.4).

The insights and results show the value of co-creation exercises, CoPs and LL engagement to stimulate knowledge sharing, learning and exchange across and among stakeholder groups within and beyond the lifetime of the ULTIMATE project. ULTIMATE benefits from the co-creation activities with new forms of community engagement and action. Locally relevant stakeholders are therefore able to contribute, to share their stories, their ideas and to refine as well as prioritise the ideas shared by others in a systematic multi-stage process. The findings from ULTIMATE on stakeholder engagement through co-creation (including multi-use playspaces), CoPs and LLs offers new and better insights and best practices to be exploited in new European Union (EU) funded projects and initiatives as well as influence the policy developments around the engagement of locally relevant stakeholders in the preparation and ideation of new projects and initiatives. These experience in ULTIMATE can be valuable input in how future projects can better contribute to major societal challenges, support international policies, and fostering collaborative ecosystems with diverse stakeholders, to drive more sustainable and resilient water management systems.

Co-creation engagement, CoP activities and LL engagement will continue to be utilised throughout the project to ensure that the new ideas or solutions generated serve their intended purpose.

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List of Abbreviations

ACA: Catalan Water Agency

ADENE: National Energy Agency

AOP: Advanced Oxidation Process

AR: Augmented Reality

ASA: Azienda Servizi Ambientali SpA

B2B: Business-to-Business

BAT: Best Available Techniques

BOD: Biochemical Oxygen Demand

BREF: Best Available Techniques (BAT) Reference Document

BWS: B-WaterSmart project

CE: Circular Economy

COD: Chemical Oxygen Demand

CoP: Community of Practice

CPTM: Consorzio Polo Tecnologico Magona

CS: Case Study

D: Deliverable

EC: European Commission

EU: European Union

GA: Grant Agreement

GtG: Greener than Green Technologies

ICS-UL: University of Lisbon

ISA: Industrial Symbiosis Association *(also referred to as KSA)*

IWWTP: Industrial wastewater treatment plant

KSA: Kalundborg Symbiosis Association *(also referred to as ISA)*

KSF: Key success factor

KWR: KWR Water Research Institute

LNEC: National Laboratory for Civil Engineering

M: Month

MD: Membrane Distillation

MR: Mixed Reality

MSM: Mahou San Miguel

NEB: New European Bauhaus

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NTNU: Norwegian University of Science and Technology

P4P: Processes4Planet

PPP: Public Private Partnership

RD: Royal Decree

RO: Reverse osmosis

SD: Standard deviation

SME: Small and medium-sized enterprise

Solvay: Solvay Chimica Italia

SPB: Single-Pass Biofilter

SWOT: Strengths, Weaknesses, Opportunities, and Threats

T: Task

UF: Ultrafiltration

UTAUT: Unified Theory of Acceptance and Use of Technology

UWCO: Urban Water Cycle Observatory

VR: Virtual Reality

WE: Water Europe

WP: Work Package

WSIS: Water Smart Industrial Symbiosis

WSIS LL: Water Smart Industrial Symbiosis Living Labs

WSS: Water-Smart Society

WWRP: Wastewater reuse plant

WWT: Wastewater treatment

WWTP: Wastewater treatment plant

ZLD: Zero liquid discharge

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1. Introduction to the deliverable

Reuse of wastewater plays a key role in the water sustainability challenge. Wastewater can be a valuable source of energy and materials as well as a good alternative to freshwater abstraction from natural sources. ULTIMATE aims to create economic value from wastewater within a dynamic socio-economic and business oriented industrial ecosystem. Accordingly, ULTIMATE is dedicated to fostering a Water Smart Industrial Symbiosis (WSIS)[1] by integrating circular economy solutions that focus on the recovery of water, materials, and energy. The goal is to create mutual benefits for the water sector and water-intensive industries, supporting a sustainable economic model.

Within this context, the technical feasibility and performance of innovative technologies and symbiosis strategies is evaluated and demonstrated for important industrial sectors (agro-food, beverages, heavy chemical/petrochemical and biotech) across nine (9) case studies (CSs) in Europe: Denmark (CS9), France (CS8), Greece (CS4), Israel (CS6), Italy (CS3), Scotland (CS7), Spain (CS1 and 5) and The Netherlands (CS2).

Successful acceptance, uptake and sustainability of technologies and strategies for symbiosis solutions requires the active engagement of relevant stakeholder groups and citizens during and beyond the lifetime of ULTIMATE. By interacting regularly, stakeholders can exchange knowledge, develop ideas, and learn together, thereby contributing to innovative and effective solutions for sustainable water management in the context of industrial symbiosis.

ULTIMATE promotes active stakeholder engagement, innovation co-creation and Living Lab (LL) engagement (T3.1, T3.2, T3.3 and T3.4) across the nine (9) CSs. Stakeholders are engaged through co-creation exercises for the design of multi-use playspaces, Communities of Practice (CoP), and engagement activities through LLs. These activities are implemented in the context of Work Package (WP) 3.

1.1. Purpose of the deliverable

Deliverable (D) 3.8 is an update of deliverable D3.5 entitled (Preliminary) results and insights from co-creation exercises in ULTIMATE CSs. The purpose of D3.8 is to provide updated results and insights on stakeholder and citizen engagement activities

[1] In this report, industrial symbiosis is understood 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. The Processes4Planet (P4P) partnership, established by the European Commission (EC) in 2020, is instrumental in promoting Water Smart Industrial Symbiosis (WSIS) across Europe, aiming for near-zero landfilling and wastewater discharge in alignment with the European Union (EU) Green Deal.

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across the ULTIMATE CSs. In addition, results and insights concerning the LLs engagement activities, which took place after D3.5 was written, are included in this report.

The insights and results have been collected as part of the following tasks and subtasks in WP3:

- Subtask 3.2.1 on establishing and implementing CoPs across the nine (9) CSs.
- Subtask 3.2.2 on co-creation exercises in three (3) CSs (CS2, 3 and 9) (as well as Task 3.1 and Task 3.3 on citizen engagement).
- Task 3.4 on LL engagement, with selected CSs.

These approaches are used to promote active innovation co-creation through stakeholder and citizen engagement to ensure that the knowledge produced is capable of addressing the complexities inherent in symbiotic arrangements and explore possible platforms or 'field labs' (in the LLs) to further develop, test, and validate identified solutions.

In month (M) 52, D3.8 will be further revised to include more up-to-date results and insights from the co-creation exercises in ULTIMATE CSs and from the LL engagement activities.

1.2. Structure of the deliverable

D3.8 consists of three (3) main parts:

- Part I – Updated results on ULTIMATE Co-creation Exercises:
  This part includes an introduction to the co-creation process and updated results and insights from co-creation exercises in three (3) CSs.

- Part II – Updated results on ULTIMATE Communities of Practice:
  This part includes an introduction to the CoP approach, including the establishment and implementation of CoPs across the nine (9) CSs and updated results of their implementation.

- Part III – Updated results on ULTIMATE Living Labs:
  This part includes an introduction to Water Europe's (WE) LL approach, namely the Water-Oriented Living Lab (WOLL). It includes final results and insights from two (2) ULTIMATE CSs selected for the establishment of WOLLs.

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1.3. ULTIMATE case studies

1.3.1. Case study 1 - Tarragona, Spain

CS1, located in Tarragona (Spain) in an industrial area hosting a petrochemical complex, works on increasing by 20% the capacity to recover water from the industrial complex of 30 petrochemical companies.

The petrochemical complex of Tarragona already uses water from reclaimed municipal wastewater treatment plant (WWTP) effluent in boilers and cooling towers using reverse osmosis (RO). However, high ammonia concentrations in the reclaimed water limits other possible uses. To meet future water demands, the technology centre EURECAT and on-site partners AITASA are addressing the limitations to the current system through the exploration of a tertiary treatment to reuse and reintroduce treated water into other Tarragona installations.

Water reuse will be boosted through low-cost, zeolite-based ammonia removal by testing different treatments at bench-scale. The most economical and technically feasible solution will be implemented at pilot-scale.

To further close the loop within the complex, the availability of reclaimed water will be increased through a near Zero Liquid Discharge (ZLD) wastewater management system at a new industrial wastewater treatment plant (IWWTP). The system combines advanced RO and membrane distillation. This has been initially tested at pilot-scale in the existing wastewater reclamation plant to be then introduced in the future IWWTP.

1.3.2. Case study 2 - Farmer's water reuse (KWR), The Netherlands

CS2 is located in the west of The Netherlands, a region known for its greenhouses growing vegetables and flowers with state-of-the-art technology, and for its continuous innovation development. The area (160 ha) is organised around 60 greenhouses growing primarily ornamental crops and arranged in a cooperative sharing a common WWTP, Coöperatieve Tuinbouw Water Zuivering de Vlot. CS2 focusses on closing the water, energy, and material loop, looking into different opportunities for water, energy and nutrient reuse. The aim is to both optimise their own internal system and to expand the opportunity to cooperate with neighbouring greenhouses and industries. To overcome water scarcity problems, an innovative water system (UV/H2O2 and Activated Carbon) is already in place to treat, store (in aquifers), and distribute treated wastewater from a sugar factory in the area for reuse.

1.3.3. Case study 3 - Rosignano, Italy

CS3 is located in Rosignano (Italy), focusing on the development and expansion of an already existing symbiotic relationship between the municipal utility Azienda Servizi Ambientali SpA (ASA) and Solvay Chimica Italia (Solvay).

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This development and expansion, called the ARETUSA consortium, is a public private partnership (PPP) between the municipal water utility (ASA), the industrial company that uses reclaimed water (Solvay) and the technology provider (Termomeccanica Ecologia). The aim is to treat municipal wastewater for industrial reuse, and reduce the industrial consumption of high-quality groundwater, thus freeing up private industrial wells for drinking water use. A number of organisations including Università Politecnica delle Marche, West Systems Srl and Consorzio Polo Tecnologico Magona (CPTM) want to drive this collaborative change and further increase circularity in the water and chemical industry.

The proposed technological solutions revolve around two main goals. The first is ensuring the quality of treated water by monitoring, modelling, and controlling systems to avoid high chloride concentrations in water reuse. The second is supporting the use of by-products of local industries for WWT.

Smart data-driven equalisation and management of two municipal secondary effluents will be developed to target critical parameters in the wastewater reuse plant (WWRP) influent, maximising 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 characterised 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 in order to optimise water reuse by minimising water discharge and fresh water supply (groundwater and surface water).

1.3.4. Case study 4 - Nafplio, Greece

CS4, located in Nafplio (Greece) in a highly productive citrus fruit region, investigates stakeholders collaboration for the development of a secondary WWT for fruits and vegetables processing plant. Alberta S.A. is a Hellenic fruit processing industry that specialises in the production of fruit and vegetable concentrates for juice, purees and clarified juice.

The CS partners highlights the need for different stakeholders in the area to work together in solving the increase in water demand for irrigation and high cost of WWT, as well as challenges of groundwater quality due to over irrigation and subsequent saltwater intrusion. For the moment, there is no symbiosis established between the different stakeholders that would enable water reuse or recovery of any valuable resource.

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The focus, as such, is on the reduction of water consumption from fruit processing by stimulating the reuse of wastewater, as well as the recovery of value-added compounds from wastewater. This is to be achieved by developing and strengthening the symbiotic relationship of Alberta and the fruit processing sector with the water service provider.

1.3.5. Case study 5 - Lleida, Spain

CS5, located in Lleida (Spain), focuses on the relationship between the Mahou San Miguel (MSM) brewery, a multinational utility Acqualia, the local municipal utility of Lleida and the Catalan Water Agency (ACA). CS5 aims at finding solutions to improve and introduce reclaimed water in and recover energy from the brewery to achieve a 10% reduction of water consumption by 2025. The implementation of innovative processes at industrial and urban facilities will demonstrate new ways to maximise benefits from residual streams to obtain high quality water, valuable by-products, and bioenergy.

Acqualia has compared the performance of two (2) bioreactor prototypes at the Mahou San Miguel brewery: an Anaerobic Membrane Bioreactor (AnMBR) and an ElectroStimulated Anaerobic Reactor (ELSAR®). Both prototypes have the potential to establish new industry benchmarks for water reuse, energy and material recovery. The aim is to minimise water consumption to fit with the environmental objectives of the brewery.

Biogas from the organic matter contained in the wastewater can also be generated, which can cover a large portion of the brewery's energy demand. To make full use of this chemical energy contained in wastewater, the performance of the anaerobic bioreactors has been optimised. The use of anaerobic technologies is providing significant energy savings and a source of green biofuel (biomethane and biohydrogen).

Brewery wastewater is also rich in nutrients that can help produce fertiliser. A concept study has been conducted, which assessed materials recovery strategies from compounds in brewery wastewater and to find suitable value chains.

1.3.6. Case study 6 - Karmiel and Shafdan, Israel

CS6, located in two (2) sites in Karmiel and Shafdan (Israel), focuses on energy recovery from biogas production and the recovery of polyphenols within the food industry, especially during wastewater shock loads.

Shock loads of wastewater from olive mills during harvest season impact the municipal wastewater treatment plant in Karmiel, Israel. Finding a technically feasible,

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economically viable and socially acceptable solution to pre-treat the wastewater on-site and prior to discharge has been challenging.

A pilot plant system has been installed to pre-treat the olive mill wastewater which is rich in polyphenols. The recovery of these compounds also improves downstream processes which are affected by high polyphenol concentration.

An existing demo-scale system for sludge optimisation has been upgraded to improve biogas production from poorly degradable organic matter. A new anaerobic system has been retrofitted into the existing wastewater treatment plant in Karmiel to serve as a barrier for mixed agro-industrial wastewater and protect the aerobic processes against shock-loads of agro-industrial wastewater, while reducing high organic load in wastewater streams for more efficient energy recovery.

A new anaerobic pre-treatment system has also been implemented in Israel's largest wastewater treatment plant (400000 m3/d) in Shafdan, which collects, treats and reclaims municipal wastewater in the area. The system is coupled with membrane filtration and activated carbon for pre-treatment of agro-industrial wastewater at the enabling the continuation of the current nature-based reuse system and supply water for agricultural activity in the Negev desert, even when receiving more agro-industrial wastewater in the future.

1.3.7. Case study 7 - Tain, Scotland

CS7, located in Tain (Scotland), contributes to an improved circularity of the WWT process of the Glenmorangie whiskey distillery (the industrial stakeholder in the project) through testing new innovations for water, energy and material recovery. Acquabio Limited and Cranfield University partnered with the Glenmorangie distillery and Alpheus (the current operator of the treatment site) to evaluate possible options to expand the distillery's circular economy approach to bolster resource recovery from the current anaerobic membrane bioreactor effluents at the distillery, in which opportunities for heat (e.g., to be utilised in the ammonia stripping process) and nutrient (e.g., to be used as fertiliser on the local barley fields) recovery have been identified.

The distillery requires high-quality water for internal cleaning processes for which it currently uses freshwater. A RO unit is implemented after the anaerobic membrane bioreactor as an additional treatment step. Distillery wastewater can be cleaned to meet the quality requirements and reused internally for cleaning purposes.

For efficient nutrients recovery from the distillery wastewater, a system combining a pre-precipitation step for struvite crystallisation and a stripping column for ammonia

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recovery has been investigated. The recovered products will be considered as potential fertilisers for the local barley fields.

Waste heat is also recovered from the bioreactor effluent and utilised in the ammonia stripping process.

1.3.8. Case study 8 - Saint Maurice L'Exil, France

CS8, located in Saint Maurice l'Exil (France), focuses on the Roches-Roussillon chemical platform, which engages 15 chemical companies, with the aim to reduce pollutant load in flue gas cleaning water of the incineration facility for hazardous and non-hazardous liquid waste. SUEZ Smart Solutions and SUEZ RR IWS Chemicals aim to recover thermal energy and materials from the water used to wash flue gases which result from incineration to make this sector of the chemical industry more eco-friendly and more sustainable.

One concept study evaluates the potential to recover thermal energy from hot flue gas washing water as it is cooled down during the first step of the wastewater treatment. The water temperature is lowered by heat exchangers installed in the plant. Sulphur recovery from flue gases and effluents has also been studied to broaden the chemical spectrum of liquid waste treated on site and in parallel reduce the formation of waste gypsum in the on-site industrial wastewater treatment plant.

A second concept study investigated the potential to recover metals such as iron, copper and zinc, as marketable products from liquid waste.

1.3.9. Case study 9 - Kalundborg Forsyning, Denmark

CS9, located in Kalundborg (Denmark), focuses on the Kalundborg Symbiosis Association (KSA)[2] – also referred to as the Industrial Symbiosis Association (ISA) – that has existed since 1972 and interlinks 13 private and public companies. The local industrial complex includes petrochemical, light building construction material, food, pharma, biotech, energy, and bioenergy, as well as waste processing industries. Even though the symbiosis already recovers and reuses different types of material, water and energy, there are still options to intensify and extend the circular economy related strategies (e.g., aspects to improve energy efficiency, reduction of chemical consumption and wastewater treatment for water reuse by industries in the symbiosis).

[2] The Kalundborg Symbiosis Association (KSA); https://www.symbiosis.dk/en/om-os/, brings together the biggest industrial companies in Kalundborg across sectors to share excess of energy, water, and materials, so that less goes to waste. As public and private companies are physically connected, one company's surplus of resources adds value to another. Today, more than 20 different streams of excess resources flow between the companies, creating a symbiosis of resource exchange, adding more resilience and profit to the partners. The symbiosis model also creates another valuable "surplus", the trust and power of innovation within the community.

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Wastewater treatment is currently done by two (2) companies in the symbiosis, Novozymes and Kalundborg Forsyning (the latter is the municipal WWTP).

ULTIMATE focuses on the optimisation of two (2) WWTPs aiming at developing and implementing a joint control system for both plants, the recovery of the WWTP effluent as fit-for-purpose water and to explore the potential for the recovery of valuable compounds from the industrial wastewater as well as on identifying options to reuse thermal energy recovered from wastewater. Therefore, the symbiotic relationship between Novozymes and Kalundborg Forsyning is extended within ULTIMATE to create a win-win situation for both companies.

To accelerate the follow-up investment on water reuse, Kalundborg Forsyning has been engaging in knowledge exchange initiatives with partners across the ULTIMATE CSs (e.g., the operator in CS1) to explore the replicability of relevant wastewater treatment schemes and circular approaches already in operation in Kalundborg.

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PART I – INSIGHTS: ULTIMATE CO-CREATION EXERCISES

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2. Introduction to co-creation

ULTIMATE promotes active stakeholder engagement and innovative co-creation, which is essential to produce knowledge capable of addressing the complexities inherent in symbiotic arrangements. Stakeholders will be engaged through co-creation activities and Immersive Media Experiences (IMX) in multi-use playspaces, which will contain specific location-based stories and visualisations driven by real data, adding immersive narrative/gamification elements (WP3).

The methodologies and tools that have been proven to achieve best results in the co-creation practice with the three (3) CSs (CS2, 3 and 9) are presented as a best practice in Task (T) 3.3 (citizen engagement). The insights are shared in this part of D3.8.

The final output of the co-creation will be used to develop an immersive narrative intervention or action, which will be elaborated in D3.6.

2.1. Co-creation

Co-creation entails a collaborative process wherein experts closely collaborate with local individuals, end-users, and stakeholders, utilising diverse resources and ideas to propose, discuss, and prototype new actions and solutions to pertinent issues. It fosters the joint creation of value among participants, enabling them to co-construct service experiences tailored to their needs, context, and preferences.

Employing methods and tools, co-creation engages various stakeholders in a collaborative arena. Through this process, participants converge to identify and define common ground and potential solutions through open dialogue and reflection on each other's unique perspectives.

Subsequent to the co-creation process, a report outlining suggestions for future actions can be drafted, providing an early prototype necessary for the development of future services, actions, or interventions, and initiating conversations with decision-makers.

The ULTIMATE project stands to benefit from the co-creation process as it can significantly transform and generate new forms of community action, social engagement, and citizen involvement. Locally relevant stakeholders, including citizens, are invited to contribute, share their stories and ideas, and refine and prioritise shared ideas through a systematic, multi-stage process. Co-creation is integrated throughout the project development process to ensure that newly generated ideas or solutions effectively serve their intended purpose.

By investing in this approach, we anticipate that ULTIMATE CSs will experience an increase in the capacity and velocity of idea generation. This ensures innovation,

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mitigates risks, and fosters a sense of community and project ownership and engagement. Those involved in co-creating ideas and solutions are more likely to agree with and support their implementation. Co-creating envisioned future actions in collaboration with those affected by the issues enables the generation and accommodation of various ideas, anticipation of risks, and creation of solutions optimal for all involved parties.

Within the ULTIMATE project, the co-creation process aims to engage locally relevant stakeholders in each CS, encompassing not only industry representatives but also local citizens, in exploring new ideas and potential solutions to common challenges.

The ULTIMATE co-creation approach aims to be clear, agile, and reusable, facilitating the realisation and design of solutions in physical or combined online spaces. Guided by the concept of “place by design” it involves determining the location and implementation strategies of proposed site-specific actions or interventions. This entails identifying intervention sites, considering local contexts, and establishing necessary structures to support decisions within the environment, audience, and neighbourhood networks. The outcome of our co-creation efforts will lead to co-designed interventions or IMX in selected CS locations.

2.2. Place by Design Playbook

ULTIMATE stakeholder engagement, facilitated by the playbook (D3.7), aims to assemble designers, strategists, developers, and citizens from diverse backgrounds into cohesive teams. This playbook, along with supplementary toolkits, serves as a guiding framework for stakeholders throughout the engagement process. It assists CSs and partners in initiating discussions on complex topics that may initially be challenging to comprehend, thus bridging differences and gaps inherent in multi-stakeholder collaboration practices. Utilising the playbook as a tool enables the design and implementation of stakeholder engagement activities in the form of co-creation for three (3) selected CSs – CS2 (The Netherlands), CS3 (Italy), and CS9 (Denmark) – based on four (4) guiding principles of co-creation, sense of community, openness, and change-making (outlined in section 3.2 of D3.4, and see Annex A).

The developed playbook, which is a publicly available document, guides stakeholders in their co-creation engagement through a number of co-creation activities. These activities consist of scoping the question, identifying relevant community concerns, planning an effective intervention, and then prototyping the intervention to test its impact with the users before development. The playbook guides the team in collecting the required data and evidence, interpreting the findings, and developing better understanding of the community and their needs.

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3. Co-creation methodology

The methodology employed in the ULTIMATE project for co-creation and stakeholder engagement is structured around a multi-stage process designed to enhance collaboration, innovation, and community involvement. The following outlines the key components of the methodology:

Identification and Mapping of Case Studies

The process of identifying and mapping CSs within the ULTIMATE project commenced with an examination of potential candidates. This initial phase was conducted through a comprehensive analysis of diverse sources, including online platforms, project reports, literature reviews, and direct engagements with project partners.

Guided by the four (4) core principles (co-creation, sense of community, openness, and change-making), a selection criteria was established. These criteria served as a compass, directing the identification of CSs that closely aligned with the overarching objectives of the ULTIMATE project.

Appendix A of the project documentation offers in-depth insight into the specific criteria considered for the engagement of co-creation and the development of immersive narrative installations. This process culminated in the selection of three (3) CSs that demonstrated exemplary alignment with the project's vision and goals:

- CS2 – KWR, The Netherlands
- CS3 – Rosignano, Italy
- CS9 – Kalundborg, Denmark

These CSs were identified as prime candidates for further engagement and collaboration within the ULTIMATE project due to their inherent potential to contribute meaningfully to the co-creation process and the development of immersive narrative installations.

Analysis of CS Business Activities

Following the identification of CSs, their business activities were analysed to gain insights into their operations and potential areas for intervention. Visualisations of their transactions were created to better understand their dynamics and inform the selection of appropriate tools and methodologies.

Tool Development and Testing

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Building upon insights from previous experiences and workshops, a suite of tools was developed to facilitate the co-creation process and to guide CSs in effectively engaging with stakeholders. These tools include:

- **Onboarding Kit**: Contains tools that welcome and guide new participants into the project and the team.
- **Facilitator's Slide Deck**: Explains the methodologies and tools that CS facilitators can use in their online co-creation sessions.
- **ULTIMATE Playbook**: Contains tools that guide CSs to engage locally relevant stakeholders from various expertise and backgrounds in their co-creation sites.

Co-creation Framework

The co-creation process was structured around a framework consisting of multiple stages, each aimed at fostering collaboration, idea generation, and solution development. This framework, depicted in figure 1, provides a roadmap for CSs to follow throughout the co-creation process, with detailed guidelines and instructions provided in the ULTIMATE playbook.

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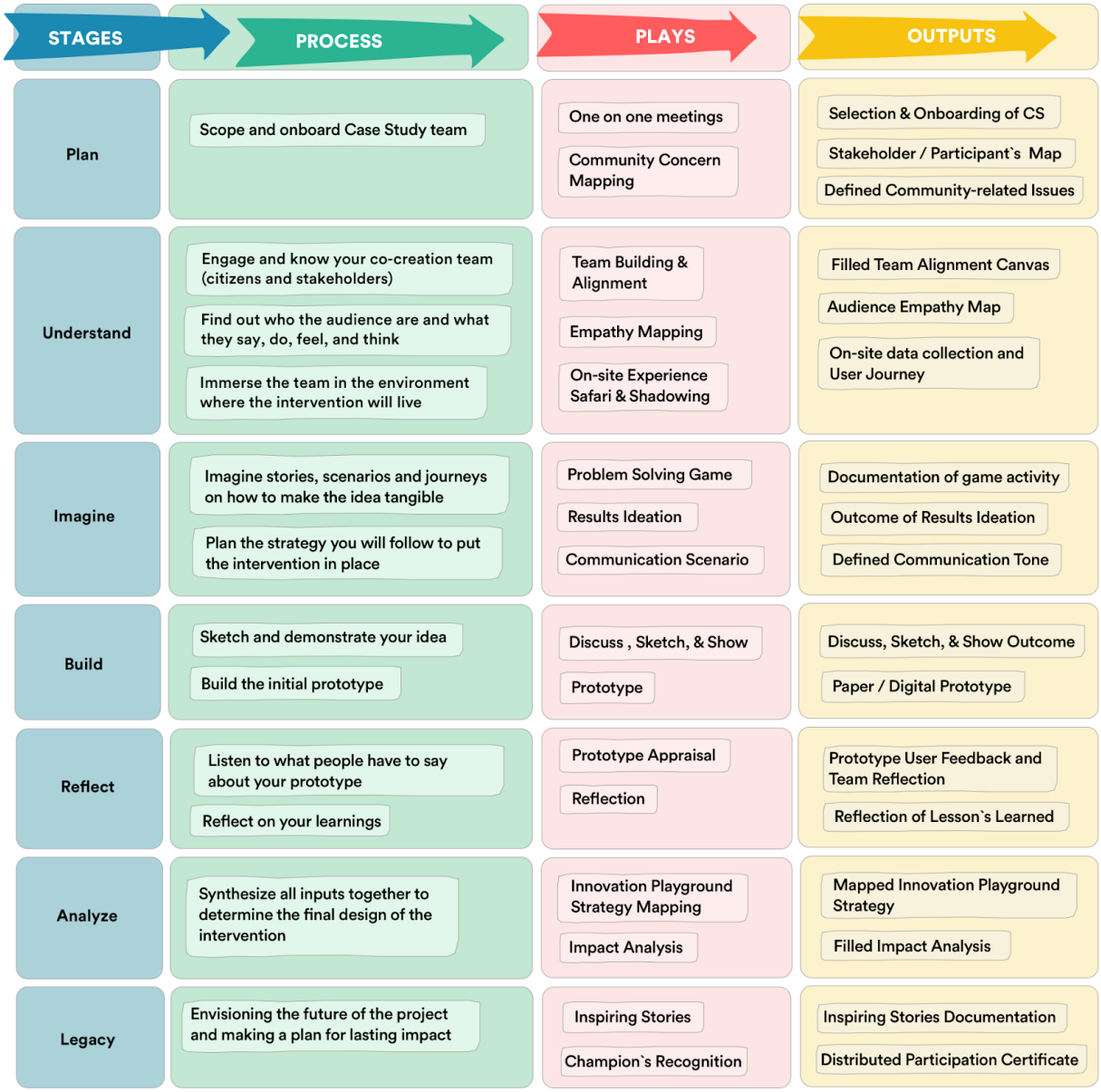

Figure 1 Co-creation framework stages

Evaluation Using the Kirkpatrick Model

To assess the effectiveness of the co-creation exercises, the Kirkpatrick Model[3] was adopted as an evaluation framework. This four-level approach focuses on participants' reactions, learning outcomes, behaviour change, and overall results. Methods and tools were employed at each level to gather feedback and measure the impact of the co-creation process on participants and stakeholders (see table 1).

[3] https://kirkpatrickpartners.com/the-kirkpatrick-model/

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Table 1 The Kirkpatrick level 4 evaluation model used in the 3 case studies

	Evaluation Description	Methods / Tools	Utilisation
Reaction	Understand how the participants felt about the co-creation exercise.	Daily evaluation input from participants and facilitators.	At the end of the day's co-creation session.
Learning	Measure increases in knowledge before and after the co-creation session.	Individual pre and post reflection exercise.	At the end of each co-creation module.
Behaviour	Measure the extent the participants apply knowledge and skills in the co-creation exercises.	Facilitator observation and interview of participants.	From the end of the first co-creation module to the last module (1 to 6 months).
Result	Measure effect on the organisation and the community.	Facilitator observation, interview, and tangible output.	3 to 6 months as the co-creation sessions progresses.

The approach assesses both formal and informal learning methods, and rates them against four (4) levels: reaction, learning, behaviour, and results.

- **Level 1: Reaction**
  The first level focuses on the participants and their thoughts on whether the co-creation is engaging and useful to their roles. It evaluates their overall impressions such as satisfaction, engagement, and relevance.

  The following questions are asked:
  - Was the co-creation exercise worth your time?
  - What are the things you learned from the exercises?
  - Was your co-creation exercise successful?
  - Will lessons from the co-creation be useful to your organisation?

- **Level 2: Learning**
  The second level shows what, if any, learning took place. It evaluates whether the participants acquired the intended knowledge, expertise, skills, and confidence from the co-creation exercises.

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The following questions are asked:

- What did you learn or miss in training?
- Did you acquire any new skills?

- **Level 3: Behaviour**
  Analysing the participant's behaviour is the third level. The facilitators assess the degree to which the participants apply their learnings from the co-creation exercise into their roles. It evaluates how well participants were able to contribute to knowledge and idea creation.

  The following questions are asked:
  - Do the participants know about their improvement after the co-creation?
  - Did the participants use the knowledge and skills they gained from the co-creation sessions to their roles?
  - Can the participants teach the same things they learned during the co-creation exercises to other people?

- **Level 4: Results**
  The final level looks at whether the expectations of the stakeholders were met. In other words, did the co-creation session accomplish what they expected it to accomplish and did the participants enjoy the overall co-creation process?

Continuous Improvement

Throughout the co-creation process, feedback from participants, stakeholders, and project partners was collected and analysed to identify areas for improvement. This iterative approach ensures that the methodology remains flexible and responsive to evolving needs and challenges, fostering continuous learning and adaptation.

The result of the co-creation as a best practice will lead to the development of an immersive narrative experience in D3.6. This multi-stage approach in stakeholder engagement aims to ensure long-term and far-reaching impact of change where there may be continued progress in the communities that have been formed through the ULTIMATE co-creation, in the knowledge that has been explored and learned, and in the tools and methodologies that have been used and formulated together.

4. Insights from co-creation exercises

4.1. Internal workshops

This section provides insights gleaned from a series of co-creation exercises and workshops aimed at refining and optimising the Place by Design Playbook for

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enhanced stakeholder engagement in real-world contexts. Through internal workshops, such as those held at the Norwegian University of Science and Technology (NTNU) Lab and during the ULTIMATE Annual Meeting at KWR Water Research Institute (KWR), in addition to public workshops at events like the Festival of the New European Bauhaus, the effectiveness of the playbook underwent thorough testing and iterative improvements. These workshops facilitated the identification of stakeholder needs in both Business-to-Business (B2B) and citizen engagement settings, leading to adjustments in playbook plays, the introduction of new tools, and the integration of immersive narrative examples to foster rapid ideation and visualisation. The following sections delve into specific workshop outcomes, adjustments made to the playbook, and successful implementations by co-creation stakeholders (CSs).

Regarding the internal workshop at the NTNU Lab, it was observed that while problem-solving games combined with the results ideation play were effective and engaging for citizen engagement, B2B engagement would benefit from activities that require less time. Additionally, participants with no immersive experience background expressed a need for technical introductions and examples of immersive narrative experiences to better contribute to the ideation process.

At the ULTIMATE workshop during the Festival of the New European Bauhaus, adjustments were made based on feedback from the internal workshop at NTNU. Examples and interactive demonstrations of immersive narrative experiences were provided to participants before proceeding to the ideation play. Pre-filled elements and digital audio-visual materials, along with the use of EyeJack, an Augmented Reality (AR) tool, facilitated rapid ideation and visualisation of immersive narrative interventions without the need for extensive user research.

These adjustments and additions to the playbook demonstrate a commitment to meeting the diverse needs of stakeholders and enhancing their ability to participate effectively in co-creation engagements. By providing tools and resources that streamline the ideation process and make immersive narrative experiences more accessible, the updated playbook fosters innovation and collaboration in both B2B and citizen engagement contexts.

During the Annual Meeting in June 2022, several internal workshops were conducted to test the effectiveness of the playbook in various activity scenarios. An internal team workshop at the NTNU Lab, workshops with all partners during the annual meeting, and public workshops (dissemination of work at events) were conducted to further test the effectiveness of the playbook for onboarding a team in a co-creation engagement and developing intervention concepts through rapid prototyping methodology.

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Through these activities, the imagine and build stages of the playbook were updated to ensure that stakeholders in the 'real' Business-to-Business (B2B) and citizen engagement settings can clearly scope their questions, identify relevant community concerns, plan an effective intervention, prototype more rapidly, and reflect on the process of the co-creation engagement.

As a result, the plays defined in the playbook have been simplified in an updated version of the Place by Design Playbook (D3.7). The update also includes more examples of plays in action. By making a distinction between optional and recommended plays, more room has been provided for tailored application of the playbook in both the B2B engagement (T3.2) and citizen engagement (T3.3).

An internal workshop in the NTNU Lab, involving the multi-disciplinary team and students, was held. The ideation play in the first version of the playbook recommended participants to run through a problem-solving game. This required a lot of preparation and facilitation work. However, the exercise provided a playful way to brainstorm, and in a more practical way. The ideation play is followed by another brainstorming activity called results ideation. This exercise guides participants to discuss and reflect on the needs and resources of their chosen intervention.

Although problem-solving games combined with the results ideation play are fun and insightful for citizen engagement, it has been noted that B2B engagement would benefit more from games that require less time spent. Some participants with no immersive experience background also reflected that with a technical introduction and examples of immersive narrative experiences would enable them to provide more input in the ideation process.

During the ULTIMATE workshop at the Festival of the New European Bauhaus, due to time constraints, the results ideation exercise was directly conducted. Participants, including local residents and international event attendees unfamiliar with immersive narrative experiences, were provided with several examples and interactive demonstrations of immersive narrative experiences based on feedback from the initial internal workshop at NTNU. Before engaging in the ideation play, participants were presented with two challenges/questions:

1. How might we prevent plastics from polluting our water?
2. How might we produce more food with less water?

Pre-filled elements were included to swiftly provide participants with information about the challenges, enabling them to rapidly develop their own immersive narrative interventions (see figure 2).

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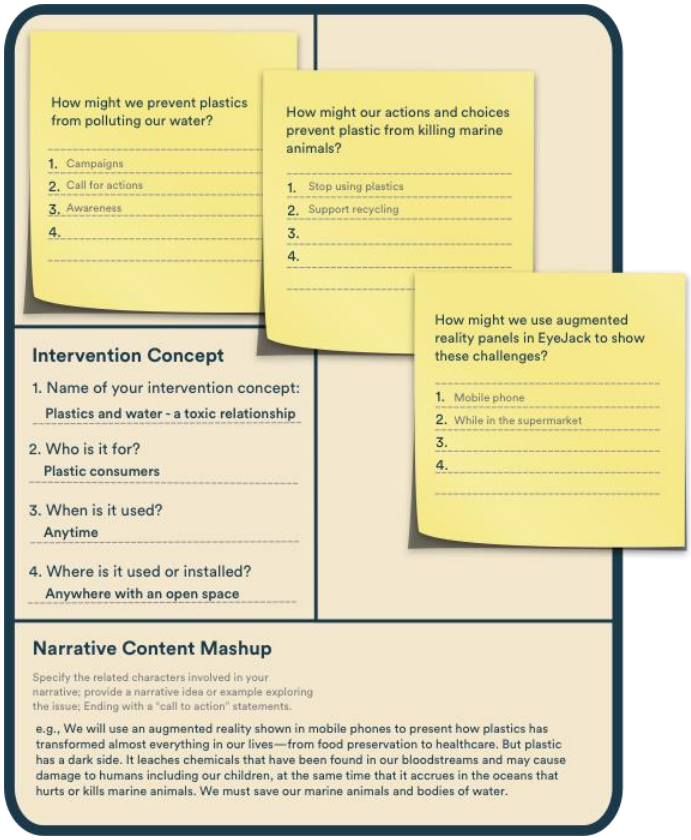

Figure 2 Pre-filled narrative ideation template used in the Festival of the New European Bauhaus workshop

Additionally, digital audio-visual materials and the use of EyeJack[4], an AR tool, were employed to vividly illustrate their ideas without the need for extensive user or audience research (see figure 3).

[4] An EyeJack Creator desktop app is an editor that allows creators to bring their stories to life with animations and sound with three (3) simple steps... 1) Upload art materials, 2) Upload animations, 3) Test new Augmented Reality (AR) art with the EyeJack mobile app. See https://eyejackapp.com/ for more information.

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Figure 3 The EyeJack Augmented Reality app co-created with the participants of the Festival of the New European Bauhaus workshop

In a workshop held during the ULTIMATE Annual Meeting at KWR in Nieuwegein (The Netherlands) in June 2022, participants were provided with several examples and interactive demonstrations of immersive narrative experiences. This prelude aimed to familiarise participants with immersive storytelling techniques before engaging in the ideation phase. Due to time constraints, rather than providing a tool for participants to directly create immersive interventions, an overview of a scenario and the resulting immersive experience co-created during the Festival of the New European Bauhaus workshop in Brussels was presented. This approach prompted participants to concentrate on ideating the narrative content and storylines for incorporation into various story panels of an immersive narrative app facilitated by EyeJack.

The culmination of these workshops yielded positive outcomes, with participants successfully completing their tasks within the allotted time frame. Feedback indicated an enhanced understanding of co-creation processes and a clearer grasp of immersive narrative intervention concepts. Building upon insights from these workshops, the initial version of the Place by Design Playbook was refined. Observations of participant behaviour and the tangible outputs generated, guided the enhancements made in the second version of the playbook. For instance, the narrative ideation play was introduced in the imagine stage, prompting stakeholders to collaboratively explore three (3) main variables to expedite the development of initial immersive intervention concepts and rapid prototypes:

1. Framing and reframing of community challenges
2. Intervention concepts
3. Narrative story content

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Moreover, the updated playbook features an “extra plays” section, allowing participants to select additional engagement activities, particularly valuable for citizen engagement initiatives where elements of fun and team-building are important. In the imagine stage, the narrative ideation play section was incorporated to streamline the initially recommended ideation process. This play fosters stakeholder collaboration in brainstorming different elements, stimulating innovation and fresh intervention ideas. Additionally, the previous results ideation play in the ideation phase now serves as an optional activity. Updates on the “plays in action” section within the build stage of the playbook showcase the co-creation efforts undertaken in various ULTIMATE workshops and dissemination activities, including the Festival at the New European Bauhaus in Brussels and the ULTIMATE Annual Meeting at KWR (see figure 4).

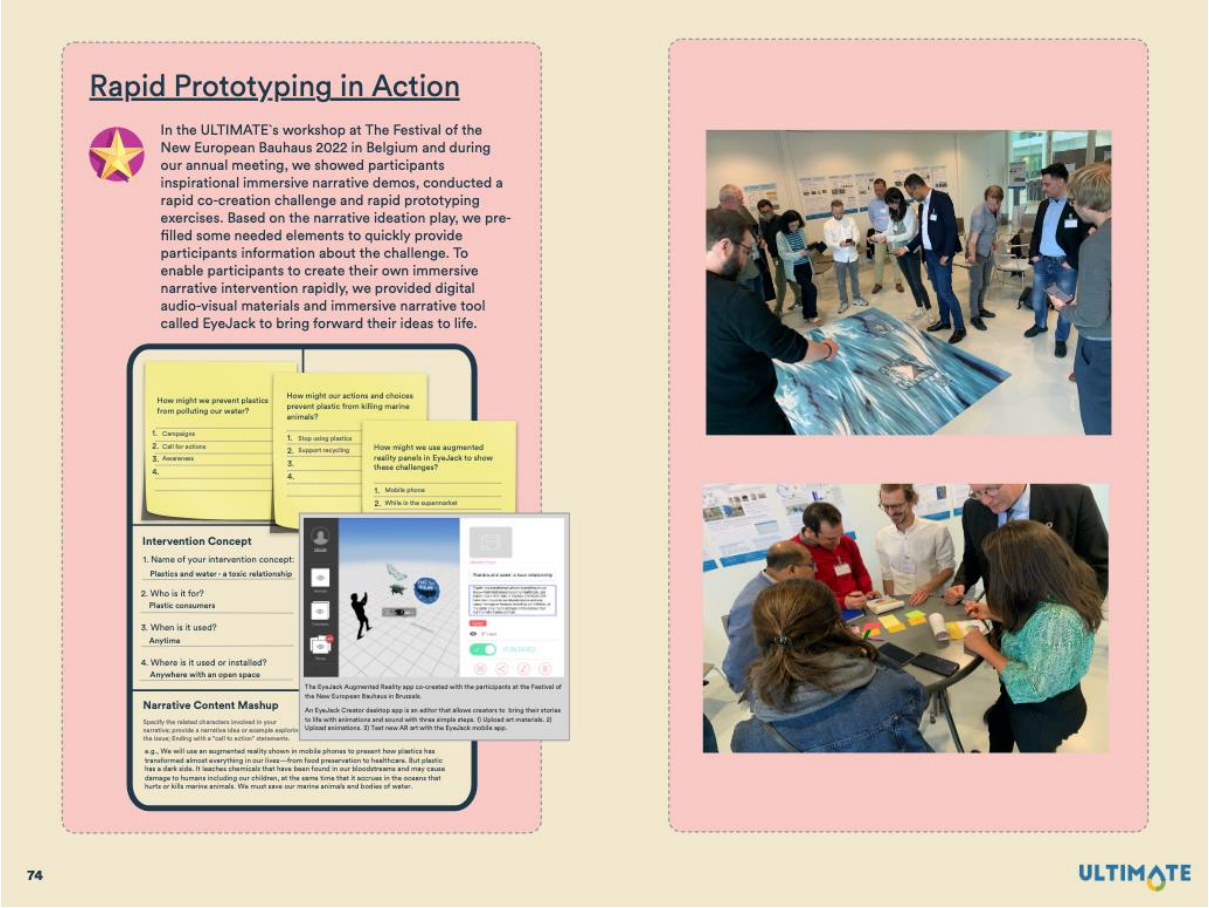

Figure 4 Prefilled template used at the Festival of the New European Bauhaus in Brussels and photos showing the rapid co-creation workshop in the ULTIMATE Annual Meeting at KWR in Nieuwegein

CS2, 3 and 9 have successfully implemented parts of their co-creation engagements using the second version of the playbook as a guide. The outcomes of the co-creation alongside the commitment and effort that our CSs have been put into creating impactful results, which will be reported in D3.6.

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4.2. Co-creation engagements with case study 2, 3 and 9

4.2.1. Co-creation implementation

4.2.1.1. Field research work

The co-creation process starts when the NTNU team of experts in immersive experience visit the CS sites. The first site visit is a field research work where the CS team and an external team of experts explore the potential immersive intervention site and experience and understand the potential community challenges that citizens are facing (see figures 5, 6 and 7). Immersing in the service is key here to experience it from the target audience's perspective.

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Figure 5 Co-creation scenario and immersive intervention site research work with KWR (Nieuwegein, The Netherlands) where the CS2 team and our team of experts from the NTNU explore the potential immersive intervention sites and understand their potential

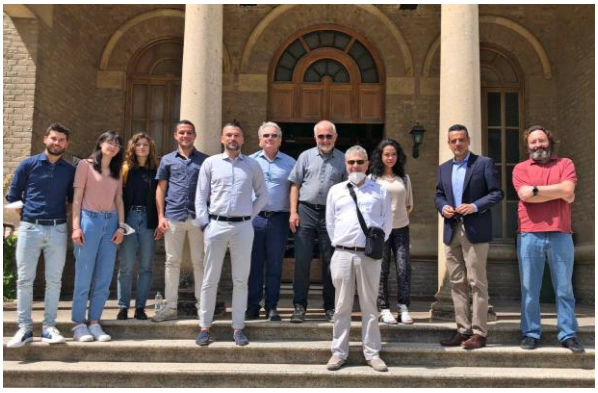

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Figure 6 Co-creation scenario and immersive intervention site research work with Consorzio ARETUSA (Rosignano, Italy) where the CS3 team and our team of experts from the NTNU explore the potential immersive intervention sites and understand their potent

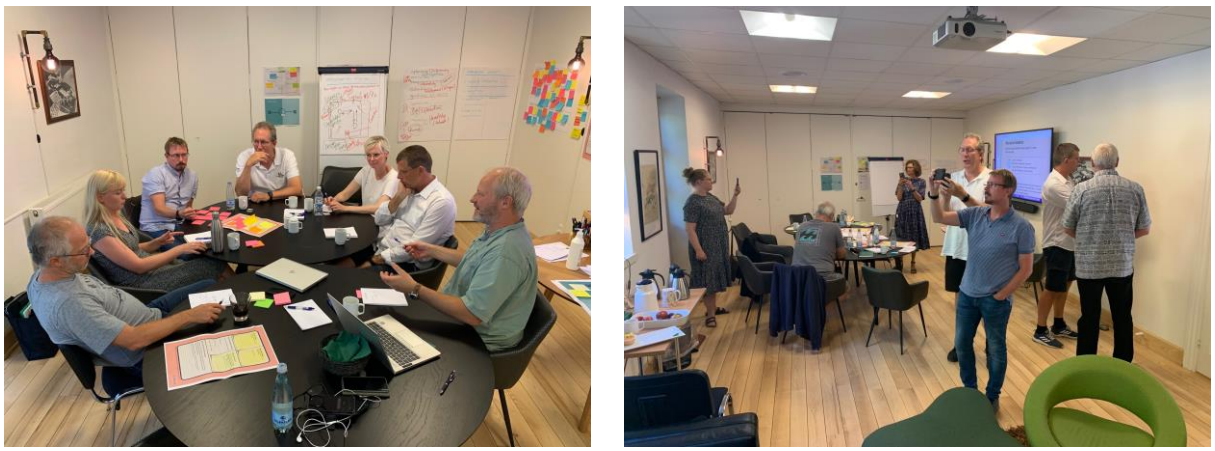

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Figure 7 Co-creation scenario and immersive intervention site research work with Kalundborg Forsyning (Denmark) where the CS9 team and our team of experts from the NTNU explore the potential immersive intervention sites and understand their potential community challenges.

This process gives experts and the CS team, a first-hand understanding of what it is like to be a user (what thoughts, frustrations, and concerns the audience might be having) and discover potential opportunities for that experience or service. This process is called shadowing. The CS team is also asked to select and show the location or locations where the immersive installation will be demonstrated. Using the same process of immersing in the selected immersive installation site, a first-hand perspective is gained of the situation or context. This process is called experience journey.

The fundamental aspect to this research is that it enables the mapping of various touchpoints and understanding of how everything fits together. Touchpoints, environments nearby (e.g., kiosks, restaurants, museums, bus stops, etc.), websites, apps, and physical artefacts (e.g., a ticket, paperwork, etc.) have been explored. In addition and where possible, conversations with locals were held to get additional perspectives on the experience or service.

4.2.1.2. Co-creation meeting roadmap

CS leaders have been provided with the expected co-creation stages roadmap (see figure 1), distributed through the playbook and facilitator's slide deck. CS leaders were then encouraged to define their own co-creation roadmap comprising of:

- Defining one community concern to focus on
- Mapping the stakeholders who will join the co-creation sessions
- Identifying the co-creation plays to use in co-creating with their stakeholders
- Planning how and where the meeting will take place
- Determining the timeline of the meetings

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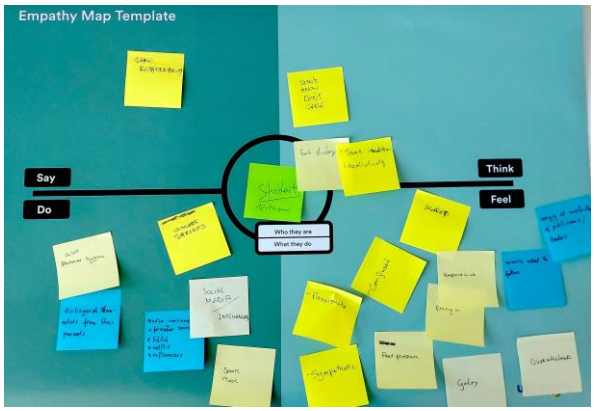
4.2.1.3. Co-creation exercises led by the case study leaders

The co-creation exercises for the understand and imagine stages were facilitated by the CS lead. CSs were provided with a participant onboarding kit (D3.4) that includes co-creation information and tools to work on identifying issues, community and team building, but also ways for participants to contribute to the process. The onboarding kit also includes basic information about immersive narrative experience as a potential way to solve the identified challenge.

Two (2) documents have also been distributed to help CS leaders facilitate the co-creation sessions. There is the facilitator's slide deck, which is a guidance document explaining step-by-step how to facilitate co-creation plays, and the playbook that helps participants follow the co-creation plays; understand the co-creation team and audience and the space where the immersive narrative experience will be installed.

The understand stage in the co-creation process starts with the onboarding of a CS team. Once participants get to know their team, learn about their target audiences, the environment, and the community, they ideate scenarios to develop visions of the future. This is the imagine stage, where participants brainstorm and create strategies to realise their visions and ideas for their project.

The output of the co-creation exercises (see figures 8, 9 and 10) was handed over to the Task leader at NTNU, and will form as the basis of the analysis stage.



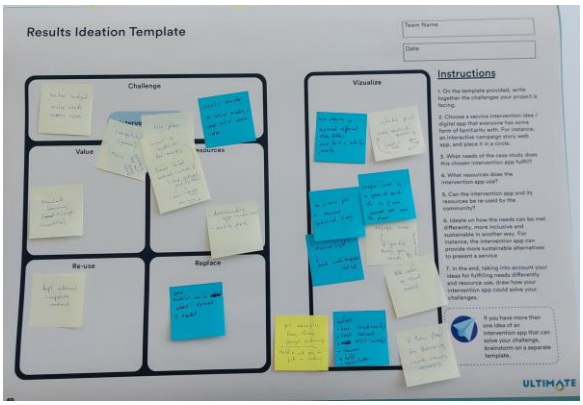


Figure 8 Selected co-creation output from CS2

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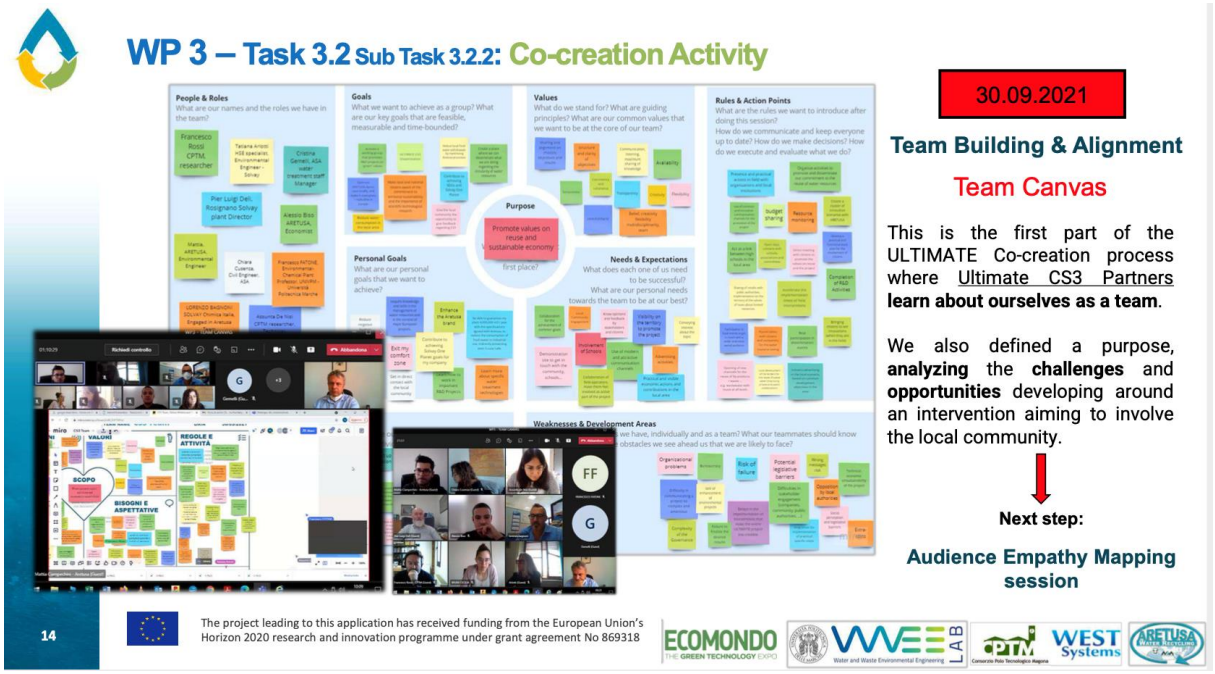
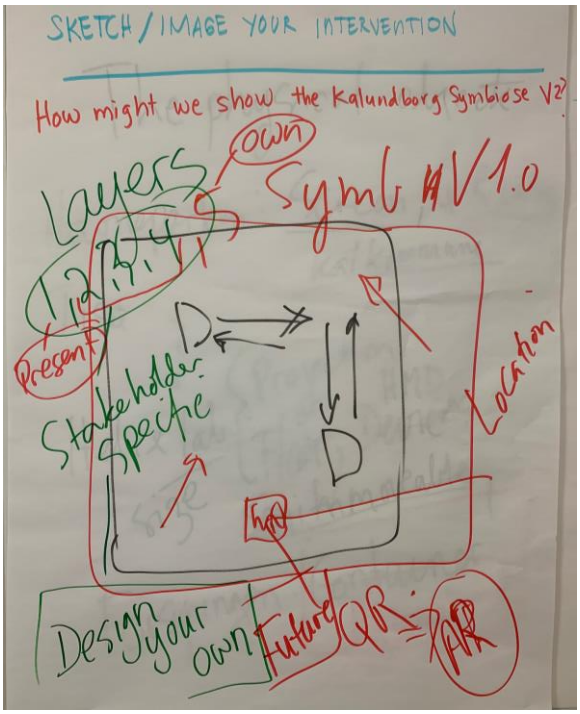
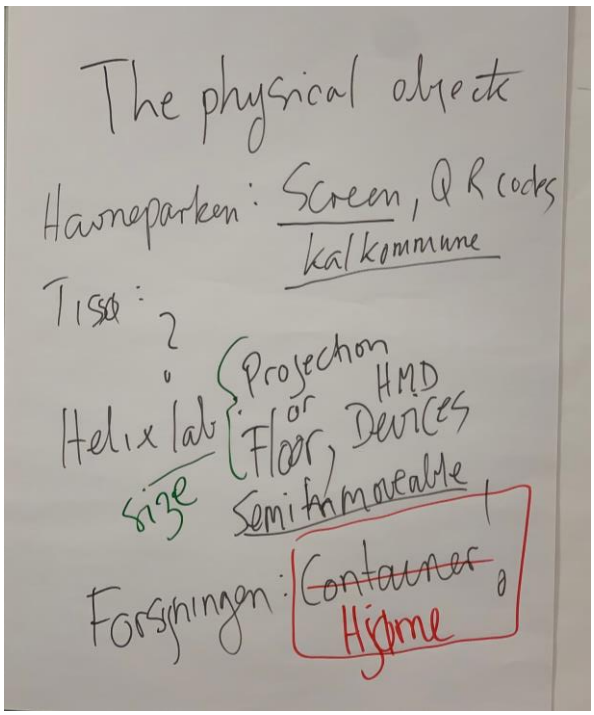


Figure 9 Selected co-creation output from CS3





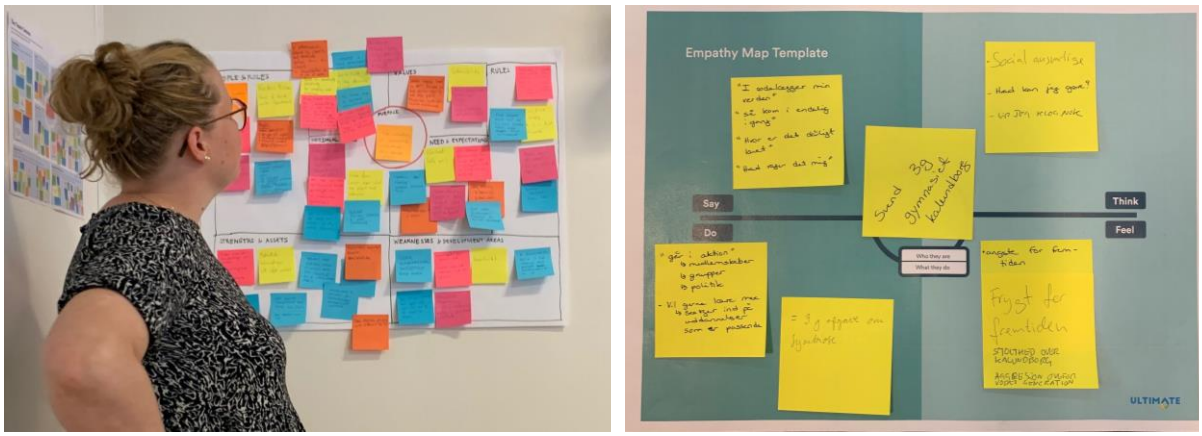


Figure 10 Selected co-creation output from CS9

4.2.1.4. Co-creation exercises led by experts from NTNU

The build stage is an iterative process led by NTNU, composed of team of experts in the development of an immersive prototype. In this stage, participants were gathered to propose courses of action and solutions. Experts in immersive narrative intervention development guided the participants on prototyping design concepts. A prototype is a draft version of a service, product or intervention that allows participants to explore the ideas they work on together and be able to demonstrate a proof of concept before investing time and money into development. Participants were provided with selected demonstrations and immersive narrative digital tools to bring their ideas to life.

In the imagine stage of the playbook, the narrative ideation play brings forward three (3) main variables that participants used to ideate together and visualise their ideas and formulate an initial immersive intervention concept. This process led to a rapid prototype – framing and reframing of the community challenges; intervention concept; and narrative story content. The output of the narrative ideation will be used by the NTNU development team to develop the CS's first prototype further.

The table below provides an overview of co-creation exercises held across the three (3) CSs.

Table 2 Overview of Co-creation meetings across 3 case studies

	# of co-creation plays completed	Average # of participants	Type of organisations engaged	Average Gender diversity (%)	
				M	F
CS2	7	8	Research institutes and end-users	70	30

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	# of co-creation plays completed	Average # of participants	Type of organisations engaged	Average Gender diversity (%)	
				M	F
CS3	5	9	Research institutes, end-users, and water industry and external institutions	70	30
CS9	6	8	Research institutes, end-users, water industry, representatives of other sectors	70	30

4.2.2. Case study co-creation exercise

4.2.2.1. Case study 2 - KWR, The Netherlands

Using Kirkpatrick's model to evaluate the success of the co-creation exercises, the CS2 facilitators through observation and input from participants summarised the responses and feedback deployed before, during, and after training.

Level 1: Reaction

- Was the co-creation exercise worth your time?
  The co-creation exercise was useful in helping us navigate towards a simple but informative experience that we will establish at KWR. Engaging with stakeholders that are not familiar with ULTIMATE has helped to bring in the process different perspectives and ideas that we would have otherwise missed or neglected.

  The co-creation process and immersive experience is a new process and concept for KWR, one that we were very interested in exploring. This exercise helped us gain experience with the process and understand the value of the process, as well as recognising the challenge (and importance) in getting the right stakeholders around the table.

  Overall, it is worth going through the co-creation exercise.

- What are the things you learned from the co-creation exercises?
  Complexity of getting all relevant stakeholders together.
  To keep the idea simple and avoiding trying to cover too much – We realised that trying to incorporate too many (or all) elements into one experience makes the process rather complex and describing the narrative rather difficult.

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- Was your co-creation exercise successful?
  Yes, we eventually came to define an experience that is simple but informative and what we feel would be most appealing to our target audience.

- Will lessons from the co-creation be useful to your organisation?
  Yes, especially in terms of complexity, and how we should also think differently about how we communicate what we do at KWR, especially to reach non-academic audiences.

  In our work we work with a diverse range of stakeholders, and co-creation is a valuable tool to reach out to and involve stakeholders in the process and projects we are working on. We intend to use this in the future activities and to also enrich the practices that we are currently using at KWR to engage stakeholders.

Level 2: Learning

- What did you learn or miss in co-creation?
  We felt that the facilitation/moderation of the co-creation exercises (i.e., implementing the various plays of the playbook) from someone with more experience in the process was limited. We felt that with this facilitation/moderation we would have been able to navigate towards the required output more efficiently. It also helps in terms of knowing when you have reached the intended output, because now we assume that we have completed a play adequately when this might not be the case. Keeping it simple, and not incorporating too many elements

- Did you acquire any new skills?
  Better understanding of the technical boundaries and opportunities of Augmented Reality, and immersive experiences in general, to share a story.

Level 3: Behaviour

It was not a key objective for participants to learn during the co-creation. Any learning would then be seen as a by-product of the co-creation exercise.

- Do the participants know about their improvement after the co-creation?
  Participants will remain actively involved in the co-creation of the immersive experience.

- Did the participants apply what they learned to their roles?
  On the aspects of keeping things simple and not including too many components, to avoid complexities.

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- Can the participants teach/facilitate the same things they learned during the co-creation to other people?
  Yes, if required, but we still see the value of including someone more experienced in the co-creation exercise to co-facilitate.

  As indicated above, it was not the objective of the participants to acquire new skills to teach co-creation to others, however, we feel that elements of co-creation exercises were picked up by the participants and can be applied in future activities.

4.2.2.2. Case study 3 - Consorzio ARETUSA Rosignano, Italy

Using Kirkpatrick's model to evaluate the success of the co-creation exercises, the CS3 facilitators through observation and input from participants summarised the responses and feedback deployed before, during, and after training.

Level 1: Reaction

- Was the co-creation exercise worth your time?
  Yes, depending on the activities but in general the approach has sparked the interest of the participants.

- What are the things you learned from the co-creation exercise?
  We learned that is very important to adapt the approach to the audience through different activities, going from the Team Building phase, to a Library installation site showing a story about Circular Economy. It's not easy to engage people out from the specific industrial context, so it has been crucial the school meeting organised by Solvay and ARETUSA to describe their activities and approach to the water resources with students and citizen of Rosignano and Cecina.

- Was your co-creation exercise successful?
  So far, the activities conducted by CS3 have been fully successful in terms of education and development of social awareness about environmental protection and safeguard of natural resources.

- Will lessons from the co-creation be useful to your organisation?
  Lessons from co-creation are useful for ARETUSA to establish a reputation and promote ULTIMATE activities which regards to the European approach to research and aiming at the valorisation at local level. So, this approach is also giving the possibility to all the citizens to know and get closer to the aims of a Water Oriented Industrial Symbiosis to safeguard the natural resources available for the whole community.

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Level 2: Learning

- What did you learn or miss in co-creation? Did you acquire any new skills?
  We learned how to approach the community on how to make them aware of the industrial and environmental topics. And we learned to balance the mix of these different aspects to engage in this project several people from different backgrounds and interests.

Level 3: Behaviour

- Did the participants apply what they learned to their roles?
  Yes, in terms of awareness about the CS3's concern to tackle community challenges.

- Can the participants facilitate the same things they learned during the co-creation to other people?
  Yes. As a CS3 organiser, we have facilitated the co-creation exercises ourselves with the guidance of the playbook and the facilitator's slide deck and discussions with the NTNU team.

4.2.2.3. Case study 9 - Kalundborg Forsyning, Denmark

Using Kirkpatrick's model to evaluate the success of the co-creation exercises, the CS9 facilitators through observation and input from participants summarised the responses and feedback deployed before, during, and after training.

Level 1: Reaction

- Was the co-creation exercise worth your time?
  Yes, absolutely. We gave insight in a new more systematic method, and created an opportunity to establish a broader understanding and engagement with a larger number of important stakeholders in the future development.

- What are the things you learned from the co-creation?
  New methods to work with stakeholders. We learned that a process like this take time and probably is not suited for very traditional "dusty" technicians. We learned that there is an interest on what new communication technology can do and how it can contribute to a development process. We learn that our own perceptions sometimes can be proved wrong.

- Was your co-creation exercise successful?
  Yes, please see answer to the first question.

- Will lessons from the co-creation be useful to your organisation?

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I do hope so and being part of this co-creation exercise is a start of a process that can help us understand and see where co-creation can be a tool more often used.

Level 2: Learning

- What did you learn or miss in co-creation process? Did you acquire any new skills?
  It is a little difficult to access further before we get more into the tangible results of the installation exercise. We believe the response from the “opinion leaders” participating in the seminar is rather much dependent on this. They are slightly waiting a little but to form their final opinion.

  It was of prime importance to have guidance from WP3 expert team. Without their physical presence it would not have been possible to develop the degree of understanding of the methods, the media, and the possibility to use an art installation as part of a concrete technical development.

  Further, there was and has been a district difference between those who participated one day and those who participated on both days. The “one day” participants as compared to those who participated in two (2) days have shown a significant lower degree of understanding of tools and acceptance of the process as compared to the later.

Level 3: Behaviour

- Do the participants know about their improvement after the co-creation?
  I have noticed, I higher degree of willingness to participate and a higher degree of openness. In addition, a certain “togetherness” among specifically the “two days participant” there speak positively on the experience and look forward to learn and see more.

- Did the participants apply what they learned to their roles?
  There are small signs – but not of any use in a systematic way. We saw a promising use of these tools and methodology in the future in our roles.

- Can the participants facilitate the same things they learned during the co-creation to other people?
  Only a few is familiar with facilitation. Some of us might consider some of the tools in future processes and believe that during the process we learned a higher understanding and knowledge especially to those who have backgrounds in Social Science.

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5. IMX Development and Evaluation

Following the prototyping stage, a reflection process with the CS on the prototype occurs, followed by the analysis stage. The expert team and three (3) CS leaders synthesise all information to design the final prototypes of the three (3) IMXs at each site, aiming to evaluate their impact on engagement and public awareness.
IMX involves creating immersive environments using technologies like Virtual Reality (VR), AR, and Mixed Reality (MR), providing interactive and engaging experiences. These experiences facilitate stakeholder involvement, collaboration, and understanding. They contribute to more informed decision-making processes and sustainable outcomes (Scurati et al., 2021).

After the development of the IMXs, the reflection phase of the ULTIMATE Playbook was repeated. A Research Protocol (or Evaluation Protocol) for measuring the impact of IMX experiences was created and distributed to the CSs[5]. The CS leaders reviewed the protocol, ensuring consistency in methodology across the three (3) IMXs.

Based on the co-creation exercises, the following IMX have been developed and implemented, as reported in D3.6.

- CS2 IMX is situated within the premises of KWR, offering a location-based experience where participants scan a QR code from a marker stand at each stage.
- CS3 IMX of the Aretusa Wastewater Treatment in Rosignano, features an interactive tabletop with AR markers and a Kinect depth sensor.
- CS9 IMX of Kalundborg, presents a 2x3 meters vinyl foam floor with AR image markers, facilitating exploration of industrial symbiosis and water reuse concepts.

5.1. Evaluation Protocol

The Evaluation Protocol outlines the approach to evaluate the efficacy of IMX in promoting stakeholder engagement and public awareness of WSIS concepts within the ULTIMATE project. The aim is to determine whether IMX effectively enables engagement and enhances awareness, utilising statistical hypotheses and questionnaires to gather data from participants. The research seeks to contribute insights into the role of IMX in facilitating socio-economic and business transformation towards WSIS, addressing crucial challenges in water management and sustainability.

[5] https://docs.google.com/document/d/1A8ylGGgvGl4E4QYzvxrvJtFl1OWfT2YR/

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5.1.1. Engagement research

Engagement research, such as that of Christenson et. al (2012), D'Mello et. al (2017) and Zwikael et. al (2012), delves into the intricate dynamics of stakeholder involvement and organisational contexts, particularly within the realm of IMX. Educational research has long underscored the symbiotic relationship between engagement and achievement, emphasising the need for comprehensive measures that capture engagement holistically. Within the context of IMX, understanding engagement as a dynamic cycle informs strategies for fostering collaboration, partnership, and ultimately, the desired outcomes.

By immersing stakeholders in interactive and engaging IMX environments, a sense of involvement and ownership is cultivated, thereby enhancing their understanding and commitment to the underlying concepts of circularity and WSIS. Through co-creation exercises and participatory design approaches, they may become active contributors to the development process, fostering a deeper sense of engagement and investment in the outcomes.

5.1.2. Technology adoption and human factors in IMX

The adoption of IMX technologies and the interplay of human factors are central to shaping user engagement and satisfaction within IMX environments. Drawing insights from established models such as the Unified Theory of Acceptance and Use of Technology (UTAUT), the goal is to understand users' behavioural intentions and acceptance of IMX. By identifying key determinants such as perceived usefulness, ease of use, and social influence, the design and implementation of IMX could be tailored to optimise user acceptance and adoption.

Moreover, human experience frameworks provide valuable insights into the development of engaging content that resonates with users on an emotional and cognitive level. Factors such as presence (Slater & Wilbur, 1997), flow theory (Csikszentmihalyi, 1970), self-efficacy (Bandura, 1997; Kang, 2021), ease of use (Chang & Wang, 2008), emotional influence (Pekrun et al., 2011), aesthetics (Norman, D. A., 2002), and awareness (Piaget, 1964; Marton & Booth, 1997) contribute to shaping the overall user experience within immersive environments. By integrating these factors into the design process, IMX experiences that captivate users' attention, evoke emotional responses, and meaningful interactions could be created.

5.1.3. Multidimensional assessment of user experience

The questionnaire utilised in this study (see table 3) encompass various facets of user experience within immersive environments, including presence, engagement, immersion, flow, usability, emotion, skill, attractiveness, technology adoption, knowledge, and attitude. Each questionnaire item is adapted from established scales to ensure a comprehensive assessment. Additional supplementary questions address

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participants' existing mental frameworks and their engagement with IMX. Participants use a Likert Scale[6] ranging from 1 to 5 to express their agreement or disagreement with each statement, providing valuable insights into their IMX perception. Additionally, open-ended questions will allow participants to offer qualitative feedback, identifying specific areas for improvement and highlighting both positive and negative aspects of their experience.

The IMX evaluation survey gauges participants' perceptions and sentiments regarding various aspects of their interaction with the IMX. By presenting statements related to chosen subscales, respondents will express their agreement or disagreement, offering insights into their overall attitudes. This methodology serves as a valuable tool for scaling attitudes and obtaining comprehensive feedback from participants.

The questionnaires underwent adaptations to suit the unique characteristics of IMX in each CS, with most adapted from VR environments and others formulated based on learning theories. Retaining essential items while aligning with IMX features, the current questionnaire comprises 11 subscales targeting specific dimensions of user experiences, ensuring a thorough assessment.

Table 3 11 subscales of the evaluation survey

Model	Core construct	Definition	Questions
Awareness and Understanding	Constructivism (Piaget, 1964; Marton & Booth, 1997)	Focuses on how individuals construct their understanding of the world based on their prior knowledge and experiences.	How familiar are you with water reuse and symbiosis concepts? Have you previously participated in water-related initiatives like this?
Perceptions and Attitudes	Social Cognitive Theory (Bandura, 1977)	Examines how individuals' perceptions and attitudes influence their behaviour.	Rate your perception of the benefits of water reuse and symbiosis. How often do you engage with events

[6] The Likert scale, developed by social psychologist Rensis Likert in 1932, provides a structured format for gathering data by offering respondents a range of response options. Typically consisting of five or seven points, the Likert scale allows participants to express their opinions on a topic, from Strongly Agree to Strongly Disagree, with a mid-point option for neutrality.

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Model	Core construct	Definition	Questions
			related to environmental sustainability? How interested are you in learning more about water management or conservation practices?
Perceived Impact of the IMX	Constructivism (Piaget, 1964; Marton & Booth, 1997)	Evaluates the extent to which participants construct their understanding of the world by actively engaging with experiences and reflecting on them to create new knowledge.	To what extent has your existing knowledge influenced your understanding of water reuse and symbiosis portrayed in the IMX?
Changes in Perceptions and Attitudes	Social Cognitive Theory (Bandura, 1977)	Assesses whether participants' perception of the importance of water management practices changed after engaging with the IMX which directly captures the cognitive aspect of learning and attitude change./	Has your perception of the importance of water management and conservation practices changed or enhanced after engaging with the IMX?

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Model	Core construct	Definition	Questions
Presence and Engagement	Presence Questionnaire (PQ, Witmer, B. G., & Singer, M. J., 1998)	Measures the degree to which users feel immersed in the IMX environment and evaluates users' involvement and compelling movement within the IMX environment, along with their confidence in selecting objects.	My interactions with the IMX seemed natural. The IMX environment was responsive to actions that I initiated. The sense of moving around inside the IMX was compelling. I felt confident selecting objects in the IMX environment.
Flow	Flow Questionnaire (Flow4D16, Heutte, 2011)	Examines users' sense of control, temporal distortion, and flow experience while interacting with the IMX. It captures the fluid and immersive nature of interactions in IMXs, where users experience a seamless blend of physical and digital stimuli.	I felt I could perfectly control my actions in the IMX. Time seemed to flow differently than usual in the IMX.
Usability	System Usability Scale (SUS, Brooke (1996))	Assesses how easy it is for users to use interaction devices like mobile phones or tablet touch screens and how satisfied they are with the IMX. Ensuring that IMX are easy to use and satisfying for users is important,	I thought the interaction devices and user interfaces were easy to use.

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Model	Core construct	Definition	Questions
		considering factors like interface design, navigation, and overall user satisfaction.	
Emotion	Achievement Emotions Questionnaire (AEQ, Pekrun et al., 2011)	Evaluates users' emotional responses, including enjoyment, tension, and excitement, during their interaction with the IMX.	I enjoyed being in the IMX. It was so exciting that I could stay in the IMX for hours.
Skill	Computer Self-Efficacy Scale (CSE, Murphy et al, 1989)	Evaluates users' confidence and proficiency in using technology (i.e. selecting objects and using interaction devices), providing insights into their ability to engage with an immersive environment.	I felt confident in selecting objects and using interaction devices in the IMX.
Attractiveness	AttrakDiff (Hassenzahl et al., 2003)	Capture users' subjective impressions of the IMX in terms of appeal and usability.	Personally, I would say the IMX is practical. I found this IMX appealing and likable.
Technology Adoption	Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003)	Assesses users' intentions and perceptions regarding future IMX use, as well as the ease of learning and operating the IMX environment.	If I use the same IMX again, my interaction with the environment would be clear and understandable for me.

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Model	Core construct	Definition	Questions
Open-ended Questions		Provides users with the opportunity to express positive and negative points about their IMX experience and offer suggestions for improvement.	What were the positive and negative aspects of your IMX experience? Do you have any suggestions for improving the IMX environment?

5.1.4. Evaluation methodology

5.1.4.1. Theoretical Framework

The methodology is rooted in the theoretical framework of stakeholder engagement and public awareness, drawing from principles in communication theory, environmental psychology, and immersive media studies. These theories provide the foundation for assessing the effectiveness of Immersive Media Experience (IMX) in promoting stakeholder engagement and enhancing public awareness of water reuse and symbiosis.

5.1.4.2. Hypotheses

- **Null Hypothesis**: The mean scores of questionnaires measuring the effectiveness of stakeholder engagement and raising public awareness about water sustainability and symbiosis in WSIS do not differ significantly between participants who engage with the IMX and those who do not.
- **Alternative Hypothesis**: The mean scores of questionnaires measuring the effectiveness of stakeholder engagement and raising public awareness in WSIS differ significantly between participants who engage with the IMX and those who do not.

5.1.4.3. Experimental and Control Group

Data will be collected from two groups of participants:

- **Experimental Group**: Participants who engage with the IMX (on-site).
- **Control Group**: Participants of similar demographics who do not engage with the IMX, receiving information through non-interactive infographics in an online format.

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5.1.4.4. Validity and Reliability

- The questionnaire items are adapted from established measures, ensuring content validity and consistency across the three IMX installations.
- Pilot testing will be conducted to assess clarity, comprehensibility, and internal consistency, enhancing reliability.

5.1.4.5. Data Collection Procedure

Participants will complete pre-treatment and post-treatment questionnaires online via a secure survey platform, ensuring consistency in response format and minimising bias. The questionnaire is structured to capture participants' perceptions, attitudes, and knowledge before and after engaging with the IMX.

During the pre-treatment assessment, participants respond to questions regarding their current level of engagement and awareness of water reuse and symbiosis initiatives using Likert scale responses. In the post-treatment assessment, participants rate the effectiveness of the IMX in increasing their engagement and awareness using Likert scale responses and open-ended questions.

Additionally, participants provide feedback on various aspects of their IMX experience using a Likert Scale and open-ended questions, assessing factors such as engagement, immersion, usability, emotional response, and technology adoption. Open-ended questions allow participants to offer qualitative insights into their IMX experiences, including suggestions for improvement.

5.1.4.6. Data Analysis

Quantitative data will be analysed descriptively, while qualitative data will undergo thematic analysis to extract key themes.

5.1.4.7. Treatment Fidelity

Standardised delivery of the IMXs and infographics will ensure consistency in exposure across participants.

5.1.4.8. Ethics

ULTIMATE ethical guidelines regarding informed consent, participant confidentiality, and data protection were followed to ensure participant well-being and privacy.

6. Insights from the IMX installations

Feedback from the IMX installations at the time of writing now includes data from CS2 and CS3**.** This final deliverable focuses on a comprehensive analysis that incorporates both pre-treatment and post-treatment results, along with controlled group comparison.

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The findings reveal deeper insights into the effectiveness of the IMX in different contexts, offering a holistic view of its impact across the two installations.

6.1. Case study 3 – L'acqua per Tutti IMX

The L'acqua per Tutti IMX installation aims to promote awareness and understanding of water reuse and symbiosis practices in the Rosignano area of Italy. As part of this initiative, an immersive tabletop game has been installed at the Biblioteca Bottini dell'Olio in Livorno. The game serves as a tool to engage stakeholders, including representatives from community groups, local industries, and water utilities, in learning about the benefits of water reuse and symbiosis.

6.1.1. Methodology for data collection

Stakeholder engagement was evaluated through a questionnaire administered to participants during tabletop game sessions at the Biblioteca Bottini dell'Olio. The questionnaire included items related to various constructs, such as presence and engagement, interaction with game elements, feedback, and suggestions. Participants provided responses to rate their experience and provide feedback on the gameplay.

6.1.2. Insights and results

The analysis of stakeholder engagement in the L'acqua per Tutti tabletop game, based on 20 participants' responses, revealed the following key findings:

6.1.2.1. Overall Positive Evaluation

The overall mean score for the L'acqua Per Tutti IMX evaluation was 3.57, indicating a generally favourable but moderate response from participants. While positive, this score highlights areas for improvement, especially in navigation and user guidance. Given the innovative nature of this approach and the limited precedent, the project team views this outcome as promising, establishing a solid foundation for future iterations. The co-creation process that shaped the IMX content tailored it to stakeholder needs, enhancing its effectiveness and relevance. This result reflects a positive user experience, suggesting that participants found the IMX to be an effective tool for engaging with the virtual environment and learning about water reuse and conservation practices.

6.1.2.2. Flow Needs Improvement

Despite the positive reception, the Flow construct received a lower mean score of 3.35 compared to other constructs. This suggests that participants may not have experienced a fully immersive state while interacting with the IMX.

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6.1.2.3. Consistency in Variability

The standard deviations (SD) across constructs show consistency in the participants' responses, with relatively similar levels of variation. The Flow construct, however, has a slightly higher SD of 1.13, indicating that there was more variability in how participants rated their experience in this area. This variation suggests that while some participants may have found the IMX experience immersive, others struggled to engage fully, further underscoring the need for refinement in some areas of the user interface.

6.1.2.4. Strengths: Usability, Attractiveness, and Skill

The L'acqua Per Tutti IMX evaluation revealed several key strengths, with usability, attractiveness, and user skill emerging as top-rated constructs. Usability scored an average of 3.65 (SD = 0.81), indicating that participants generally found the platform easy to navigate, which contributed positively to their experience. Similarly, the attractiveness of the interface also received a score of 3.65, suggesting that the IMX was visually appealing and engaging for users. The skill construct scored 3.62 (SD = 0.83), reflecting that participants felt reasonably confident using the IMX tools and navigating the environment, which implies a sense of control and comfort.

While these scores reflect a generally favourable response, they also reveal a wide range of experiences, with scores across constructs spanning from 2.5 (less positive) to 4.5 (highly positive). The SD, around 0.8 on a 5-point scale, suggest significant variability, indicating that some participants encountered challenges. Thus, while the IMX shows promising strengths, there is also clear room for improvement to further enhance user experience and consistency. This early feedback offers a valuable foundation for refining the platform in future iterations.

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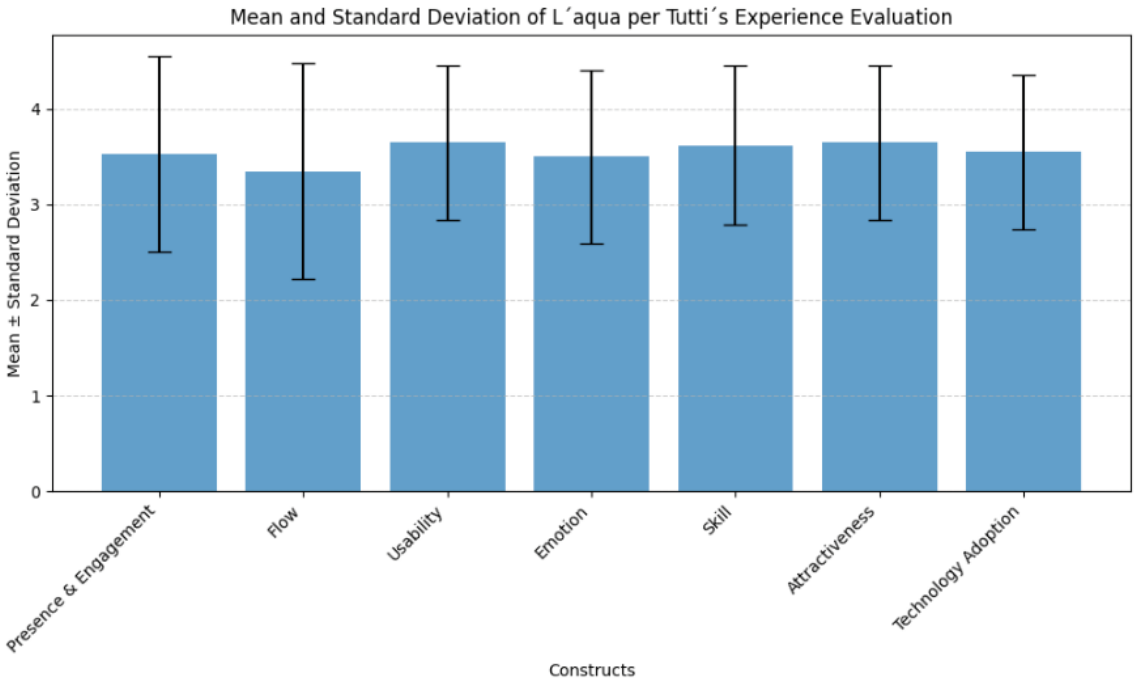

Figure 11 User Experience Plot on 7 constructs in L'acqua per Tutti installation

Table 4 User Experience on 7 constructs in L'acqua per Tutti installation

Constructs	Mean	Standard deviation
Presence & Engagement	3.53	1.02
Flow	3.35	1.13
Usability	3.65	0.81
Emotion	3.5	0.91
Skill	3.62	0.83
Attractiveness	3.65	0.81
Technology Adoption	3.55	0.81

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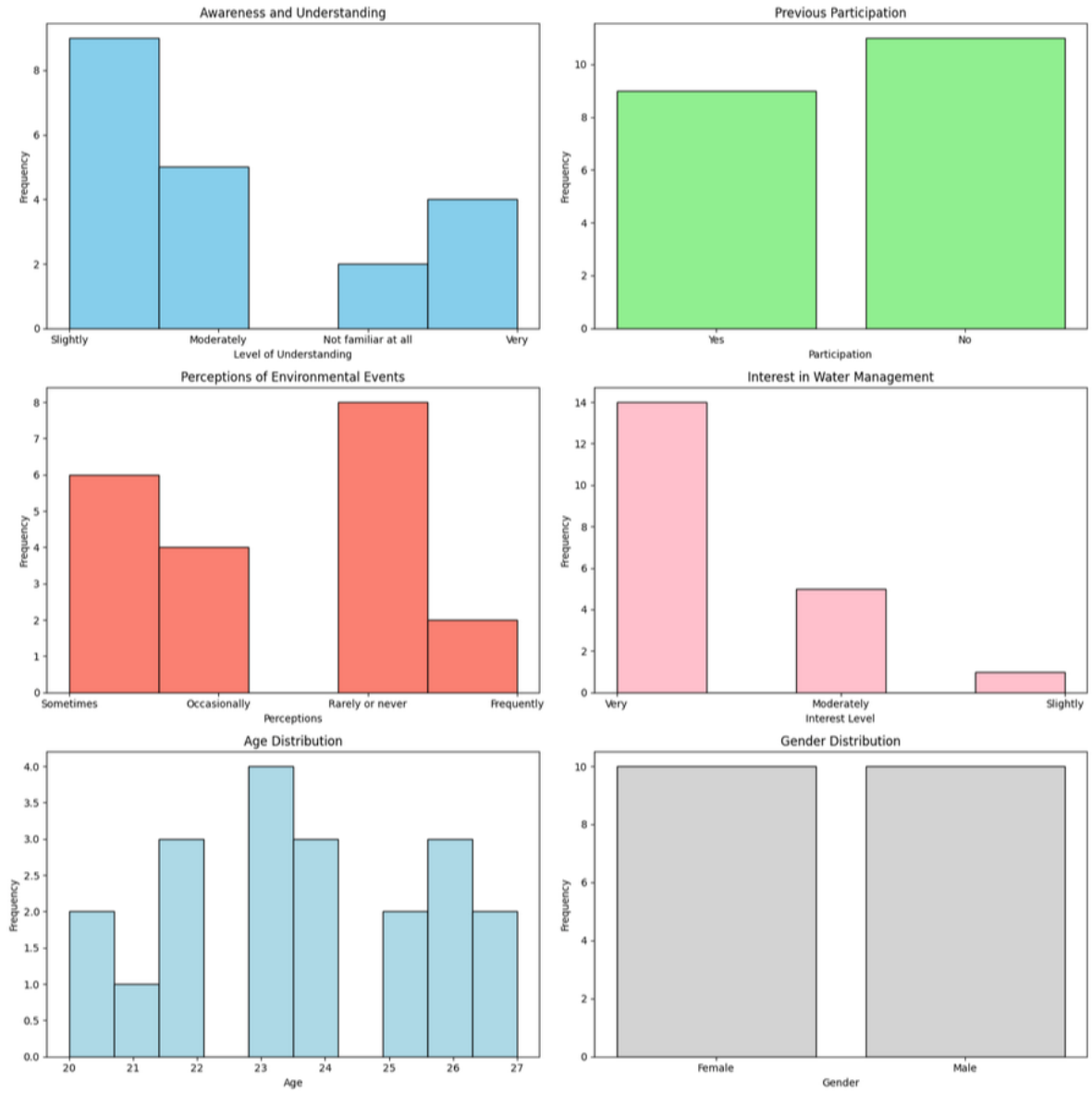

Figure 12 Participant's previous experience and demographics as a pre-treatment response

6.1.3. Post-Treatment perception and impact questionnaire responses

6.1.3.1. Perceived impact of the IMX

The analysis of participants' responses suggests that the IMX had a notable impact on shaping their perceptions and attitudes toward water management practices. Out of 20 participants, half (10 participants) reported a significant or moderate impact of the IMX on their understanding and attitudes. This response aligns with the goals of immersive learning, suggesting that IMX can effectively foster transformative changes in environmental attitudes.

Participants varied widely in their previous familiarity and engagement with environmental topics, with half (10 participants) showing a slight to moderate

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awareness and a tendency to engage with environmental events only occasionally. This diversity in background knowledge suggests that immersive interventions like the IMX can bridge varying levels of initial understanding, catering effectively to both highly interested participants and those less familiar with the subject. The responses from participants with slight or no perceived impact could reflect prior high levels of knowledge or indicate a need for sustained exposure to immersive experiences to enhance impact further.

This variation in responses highlights the adaptability of IMX in engaging people across different levels of familiarity and interest, underlining its potential to broaden environmental awareness and pro-environmental behaviours within diverse audiences.

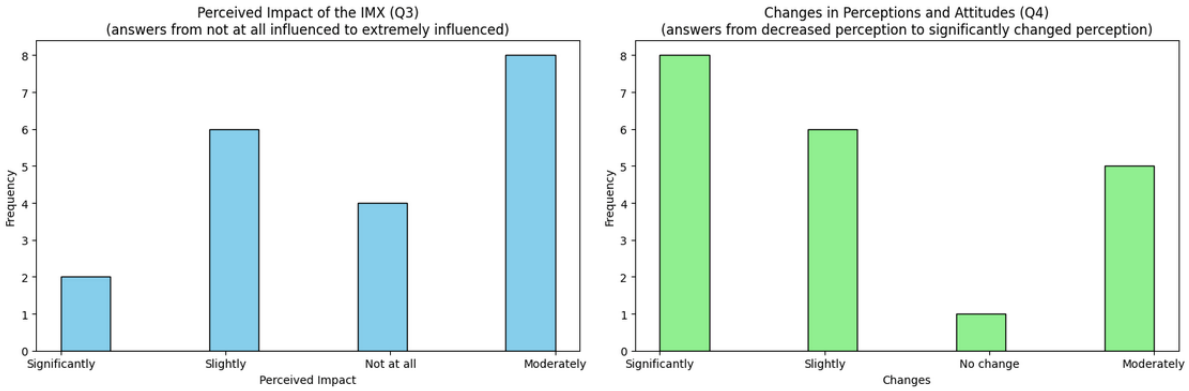

Figure 13 The post-treatment response result evaluating participants' perceived impact and changes in perceptions and attitudes resulting from their engagement with the IMX

6.1.3.2. Changes in perceptions and attitudes

The analysis of participants' responses highlights the positive impact of the IMX on shaping attitudes towards water management practices. A majority of participants (19 out of 20 participants) reported some level of positive change in perceptions or attitudes, ranging from slight to significant. This collective shift demonstrates the potential of immersive experiences to foster a deeper appreciation for environmental sustainability and water conservation efforts.

Notably, a subgroup of participants (eight (8) out of 20 participants) reported significant changes in their perceptions or attitudes, suggesting profound shifts in cognitive schemas or affective orientations towards water management practices. This group exemplifies the transformative power of immersive learning interventions, inspiring participants to adopt more pro-environmental attitudes and behaviours.

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6.1.4. Comparative Analysis of User Experience: IMX Platform vs Traditional PDF Media in Demonstrating the L'acqua per Tutti Narrative for Stakeholder Engagement

This section analyses the key differences in user experience and engagement between two mediums, emphasising learning, usability, and emotional involvement as central components of stakeholder engagement. The objective is to assess the comparative effectiveness of the IMX versus a traditional PDF format in conveying the L'acqua per Tutti narrative (controlled group).

Table 5 Post-Treatment Result on User Experience Constructs during the controlled group

Constructs	Mean	Standard deviation
Presence & Engagement (Q1, Q2, Q3, Q4)	2.6	0.598
Flow (Q5, Q6)	2.38	0.606
Usability (Q7)	2.35	0.671
Emotion (Q8, Q9, Q13)	2.02	0.3
Skill (Q10, Q11)	2.87	0.57
Attractiveness (Q12)	2.4	0.6
Technology Adoption (Q14)	2.32	0.48

Two groups of participants were exposed to the L'acqua per Tutti narrative through either the IMX installation or a traditional media in PDF. Their responses were gathered to measure key constructs such as presence and engagement, emotional connection, usability, and flow. The below table (table 6) provides a summary of the results for both platforms.

Table 6 Summary of the findings of a study that compared the effectiveness of an Immersive Mixed Reality Experience (IMX) platform and a traditional PDF format for conveying the L'acqua per Tutti narrative

Constructs	Mean (IMX)	StD (IMX)	Mean (PDF)	StD (PDF)

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Presence & Engagement (Q1-Q4)	3.53	1.02	2.6	0.6
Flow (Q5, Q6)	3.35	1.13	2.38	0.61
Usability (Q7)	3.65	0.81	2.35	0.67
Emotion (Q8, Q9, Q13)	3.5	0.91	2.02	0.3
Skill (Q10, Q11)	2.9	0.64	2.87	0.57
Attractiveness (Q12)	3.65	0.81	2.4	0.6
Technology Adoption (Q14)	3.55	0.81	2.32	0.48

To quantify the magnitude of the differences, Cohen's d effect sizes were calculated (see table 7).

Table 7 Comparing IMX and PDF Platform using inferential statistics

Constructs	Cohen's d
Presence & Engagement	1.23
Flow	1.01
Usability	1.49
Emotion	1.6
Skill	0.45
Attractiveness	1.32
Technology Adoption	1.27

6.1.4.1. Key Findings

The results indicate significant differences between the IMX and PDF groups across most constructs, with the IMX platform consistently outperforming the PDF format in terms of Presence & Engagement, Usability, Emotion, and Attractiveness. Large effect sizes (Cohen's d > 0.8) for these constructs emphasises IMX's ability to foster a more

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immersive and engaging experience. Although IMX also showed a notable advantage in Flow compared to PDFs, the effect size was smaller (Cohen's d > 0.5), indicating potential for enhancing the platform to create an even more seamless, deeply engaging experience. Additionally, no significant difference was observed between the groups in perceived Skill, suggesting that participants found both platforms similarly approachable in terms of expertise required.

Further analysis of the L'acqua per Tutti IMX evaluation provides deeper insights into stakeholder engagement. The average score for the IMX platform (3.57) reflects a generally positive experience, with notably higher engagement in presence and usability. In contrast, the PDF format received a lower mean score of 2.42, highlighting the challenges static formats have in keeping users engaged and emotionally connected. Flow, which scored moderately across both platforms (IMX mean = 3.35, PDF mean = 2.38), suggests room for improvement within IMX, as its immersive environment could be further refined to captivate users fully. Emotional engagement was also markedly higher for IMX (IMX mean = 3.50, PDF mean = 2.02), indicating its effectiveness in creating enjoyable and memorable learning experiences.

Usability scored higher for the IMX platform (mean = 3.65), indicating that participants found it intuitive and easy to use, compared to the PDF format (mean = 2.35). This usability factor is critical for technology adoption, as stakeholders are more likely to engage with technology that is easy to navigate (Rogers, 2003). The IMX's emphasis on intuitive navigation contributes significantly to its potential for broader adoption within stakeholder groups.

IMX users showed greater variability in responses than PDF users, as indicated by a larger standard deviation. This variability suggests that while IMX offers an innovative, interactive experience, responses are more subjective, likely influenced by individual positionality, familiarity with immersive technologies, and personal preferences. In contrast, PDFs, being a more traditional format, tend to elicit more consistent – albeit less enthusiastic – responses. Although differences in user demographics or previous experience could further illuminate platform preferences, the distinct user groups in this study limit direct comparison. For instance, it remains unclear if users who scored lower on IMX would also rate PDFs lower or if they might prefer the PDF format. Nonetheless, these findings highlight IMX's clear potential to improve stakeholder engagement and learning, particularly in complex topics like water sustainability and management.

6.2. Case study 2 – Water-kennis IMX

The IMX of CS 2, is located within the premises of KWR Water Research Institute in Nieuwegein, Netherlands. The IMX, Water-kennis, is location-based with each stage requiring participants to scan an image from a marker stand to carry out various tasks.

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Prior to commencing the experience, the markers are positioned correctly on their respective stands to ensure smooth progression through the IMX. This setup enhances user engagement by integrating physical elements into the interactive digital environment, providing a seamless and immersive learning experience for stakeholders exploring water reuse and conservation measures.

6.2.1. Methodology for data collection

Stakeholder engagement was evaluated through a questionnaire administered to 24 participants (12 male, 12 female) during the ULTIMATE final meeting in Livorno, held at the Biblioteca Bottini dell'Olio. To simulate the original setup, physical marker stands were placed at a certain distance, reflecting their placement at KWR, the original location for the demonstration. This change in environment from KWR to Biblioteca Bottini dell'Olio could have influenced the participants' engagement levels and overall experience, as the library setting may not fully replicate the original immersive setup. Factors such as the layout, acoustics, lighting, and overall ambiance differ between the two locations and might affect how participants interacted with and perceived the IMX elements. This variation could introduce slight differences in user immersion and focus, as some participants might find the library setting either less immersive or alternatively, novel and engaging. Since all participants were involved in the ULTIMATE water project, no pre-treatment questionnaire was administered.

The questionnaire included items covering various constructs, such as:

- **Presence and Engagement**: Evaluating how immersive the participants found the experience and their level of focus.
- **Interaction with Game Elements**: Measuring the ease of interaction with different game components and understanding of the interface.
- **Feedback and Suggestions**: Collecting qualitative feedback to capture participants' impressions, areas for improvement, and suggestions for future iterations.

Participants were asked to rate their experiences and offer insights on how the gameplay and overall interaction aligned with their expectations, providing valuable data for improving the process.

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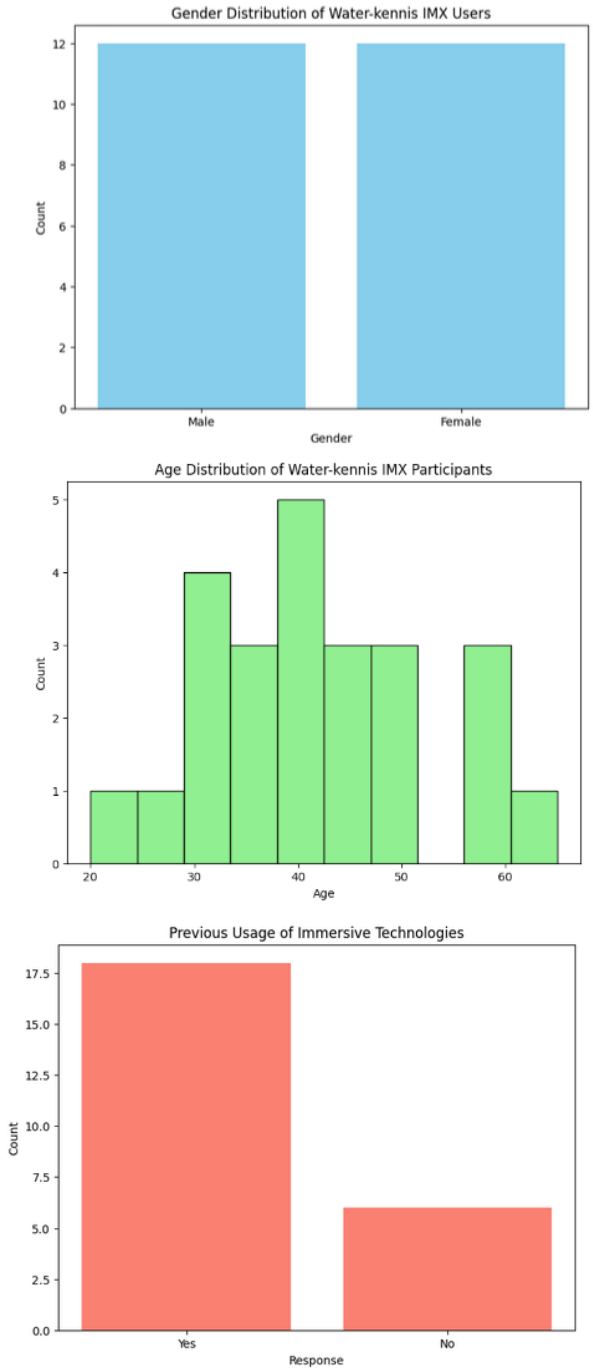

Figure 14 Participants' previous experience in Immersive technologies and demographics as a pre-treatment response

6.2.Insights and Results

The analysis of stakeholder engagement in the Water-kennis IMX, based on participants' report, highlights several key findings.

- **Presence and engagement**: Users reported strong engagement, with an average score of 3.90 (SD = 0.90), indicating that the immersive environment

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effectively held their attention and interactions felt natural. The moderate variability suggests most participants had a consistent experience.

- **Flow**: The mean score for flow was 3.75 (SD = 0.92), showing that participants generally experienced a smooth and immersive interaction. While slightly lower than other aspects, the score still indicates a fairly seamless experience for most users, with moderate variability.
- **Usability**: Users found the Water-kennis IMX easy to navigate, reflected by a high average score of 4.00 (SD = 0.82). The platform's design effectively supported user interaction, ensuring a consistently accessible experience.
- **Emotion**: Participants reported positive emotional responses, with an average score of 4.03 (SD = 0.88). This suggests the IMX was successful in creating excitement and enjoyment, with low variability reflecting shared positive emotions across users.
- **Skill**: Users felt confident in their ability to use the platform, scoring 3.80 on average (SD = 0.85). This shows that participants generally felt skilled enough to interact with the IMX, thanks to its intuitive interface.
- **Attractiveness**: Water-kennis was rated highly for its appeal, with an average score of 4.20 (SD = 0.68), showing that users found the platform both practical and likable with low variability in responses suggesting that most users shared this positive perception.
- **Technology adoption**: The average score for technology adoption was 4.10 (SD = 0.89), reflecting that most participants were comfortable engaging with the technology. While there was moderate variability, the overall response was positive, indicating a broad acceptance of the IMX platform.

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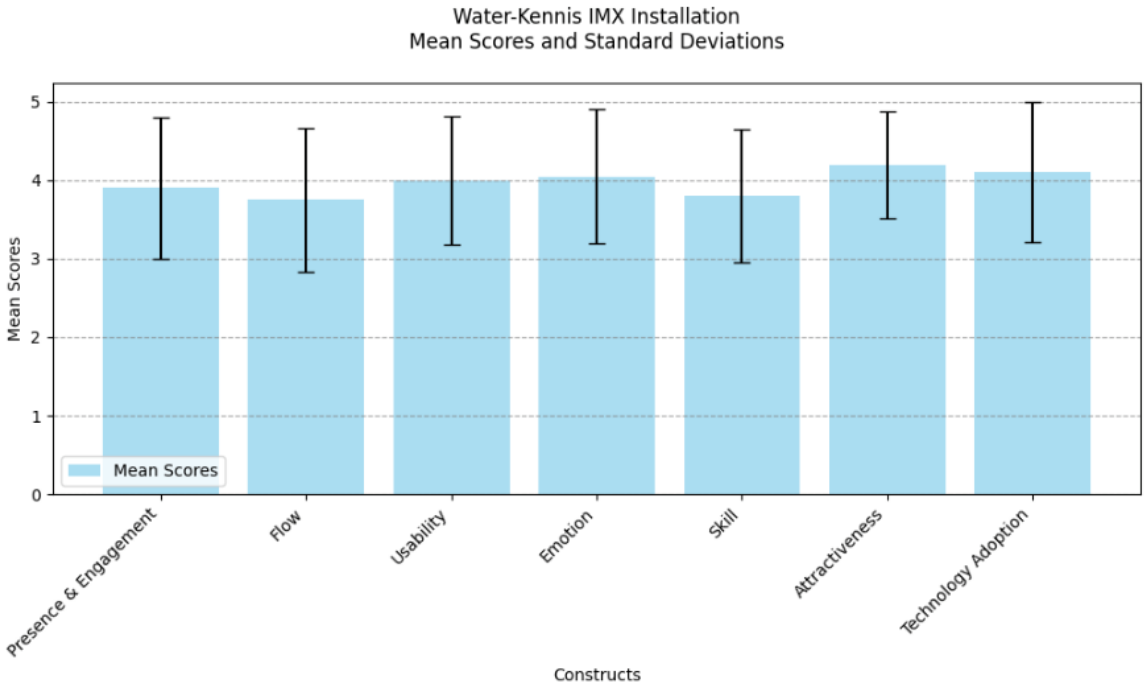

Figure 15 User Experience Plot on 7 constructs in Water-kennis installation

Table 8 User Experience Plot on 7 constructs in Water-kennis installation

Constructs	Mean	Standard deviation
Presence & Engagement (Q1, Q2, Q3, Q4)	2.6	0.598
Flow (Q5, Q6)	2.38	0.606
Usability (Q7)	2.35	0.671
Emotion (Q8, Q9, Q13)	2.02	0.3
Skill (Q10, Q11)	2.87	0.57
Attractiveness (Q12)	2.4	0.6
Technology Adoption (Q14)	2.32	0.48

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6.2.2. Consistency Across Use Cases

A comparison of the two IMX installations, Water-kennis and L'acqua per Tutti, reveals similar trends across key constructs such as Presence and Engagement, Usability, Attractiveness, and Technology Adoption. Both installations showed high Usability scores (4.00 for Water-kennis and 3.65 for L'acqua per Tutti), indicating that the IMX interface is consistently intuitive across different use cases. The low variability in these constructs further supports the reproducibility of the user experience.

6.2.3.1 Engagement and Immersion:

The Presence and Engagement and Flow constructs highlight IMX's ability to provide immersive experiences across various narratives. While there were some variations (Presence & Engagement scored 3.90 in Water-kennis and 3.53 in L'acqua per Tutti) both installations show that the IMX creates environments where users feel involved. Despite these differences, immersion remains a key feature of the platform, reinforcing its consistency across different contexts.

6.2.3.2 Learning Outcomes and Skill Acquisition:

The Skill construct suggests that IMX reliably supports learning and skill development, with Water-Kennis scoring 3.80 and L'acqua per Tutti scoring 3.62. This consistency is crucial for reproducibility, particularly when the IMX platform is applied in educational or professional settings where skill acquisition is a goal.

6.2.3.3 Broad Stakeholder Engagement:

IMX's ability to maintain consistent levels of Technology Adoption (4.10 in Water-Kennis and 3.55 in L'acqua per Tutti) suggests it is well-received across different stakeholder groups. The low variability in these scores reflects the platform's potential to engage diverse stakeholders consistently, supporting its consistency across different use cases and contexts.

6.3. Discussion

The demonstrated IMX installations offer clear advantages over traditional formats like PDFs, particularly for engaging stakeholders in specialised fields such as water sustainability and management. By employing immersive technologies, IMX turns abstract concepts into hands-on learning experiences, promoting active engagement instead of passive information consumption. This section highlights the key findings from both the Water-kennis and L'acqua per Tutti installations, demonstrating the IMX's impact on stakeholder engagement.

6.3.1. Key Findings from Water-kennis IMX

The Water-kennis IMX showcases the value of immersive learning for professional development, especially for experts in water reuse.

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Key findings include:

- **Interactivity and engagement**: Participants were able to engage with 3D objects and augmented reality (AR), which kept them actively involved throughout the experience. QR codes connecting physical and digital content facilitated interaction, as participants moved between real-world locations and virtual environments. This interactivity surpasses traditional learning materials, creating a more dynamic and engaging experience.
- **Tailored content**: The IMXs were designed to match the technical expertise of water professionals and the general public. It balanced complex information with accessibility, ensuring that participants of all levels could benefit from the experience.
- **Visual learning**: AR-driven visual storytelling helped simplify complex water reuse concepts, making technical processes easier to grasp. This visual approach proved more effective than static images or text found in traditional media, which often struggle to clearly convey intricate systems.

6.3.2. Key Findings from L'acqua per Tutti IMX

The L'acqua per Tutti IMX also demonstrated positive results:

- **Positive user engagement**: Users showed high levels of engagement, with interactive and visual components maintaining attention and enhancing the learning experience.
- **Areas for improvement**: Despite its success, some participants pointed out usability and navigation issues, indicating room for improvement. Enhancing these aspects could lead to a smoother and more intuitive experience.

6.3.3. General Comparison: IMX vs Traditional Medium

A controlled study in the L'acqua per Tutti installation compared the IMX platform with traditional PDFs, offering insights into how each medium performs in stakeholder engagement and education:

- **Learning effectiveness**: Participants using the IMX demonstrated a deeper understanding of water sustainability topics than those using PDFs. The IMX's hands-on interaction enabled participants to engage more deeply with the material, making abstract concepts more tangible. PDFs, with their passive format, were less effective at maintaining engagement and promoting retention.
- **Stakeholder engagement**: The IMX created a much higher level of engagement compared to PDFs. Its interactive elements encouraged active participation, while the static nature of PDFs led to quicker disengagement after initial reading.

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- **User experience and accessibility**: Although the IMX was more engaging, some participants experienced issues with navigation, highlighting the need for improvement. PDFs, while easier to navigate, lacked the depth and interactivity needed to sustain long-term engagement and learning.

6.3.4. User Feedback and Recommendations for Improvement

6.3.4.1. Water-kennis IMX

While the Water-kennis IMX successfully engaged stakeholders, feedback pointed out several areas for improvement:

- **Flow and Usability**: Some users struggled with certain tasks within the AR environment. Simplifying the navigation and providing clearer instructions would create a smoother experience.
- **In-depth content**: Some experts felt that elements of the experience, such as the robot game, were too basic. Incorporating more detailed content with adjustable difficulty levels would offer greater value to professionals seeking in-depth insights.
- **Localisation for global relevance**: Participants recommended tailoring the content to reflect regional water management practices, making the IMX applicable to a broader international audience.

6.3.4.2. L'acqua per Tutti IMX

Feedback from the L'acqua per Tutti IMX also highlighted similar areas for improvement:

- **Usability and Flow**: Some participants encountered issues with navigation, which disrupted the overall experience. Improving the technical aspects and flow would enhance the interaction.
- **Interactivity level**: Users suggested adding more complexity to the interactive elements to cater to both novice and expert users. This would make the IMX more versatile and accessible to a wider audience.

The IMXs has proven to be highly effective in engaging stakeholders and enhancing understanding compared to traditional formats like PDFs. By immersing participants in AR and 3D visualisations, IMX encouraged deeper interaction and clearer comprehension of complex topics such as water reuse and sustainability. Participants engaging with IMX showed significantly higher engagement and learning outcomes, supporting the rejection of the Null Hypothesis. Additionally, IMX's ability to cater to both experts and general audiences made it a more versatile and impactful tool not just for engagement but also knowledge sharing.

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6.3.5. Evaluation of the IMX Experience: Insights from the Case Study Support Teams

In addition to the primary user experience study, separate subjective user observations were collected across three case study support teams (CS2, CS3, and CS9), providing insights into the IMX platform's engagement capabilities with diverse audiences.

The IMX offers a dynamic and interactive learning environment with significant potential for stakeholder engagement, especially within water-focused initiatives. Evaluations conducted at both the user level and among support teams – key contributors in the IMX's co-creation and finalisation – have provided valuable feedback on its impact and areas for enhancement. This report integrates findings from the support teams across three case studies: CS2 (Water-kennis), CS3 (L'acqua per Tutti), and CS9 (Ultimate Life of Water), focusing on the IMX's strengths, challenges, and developmental opportunities.

6.3.5.1. Overall Engagement

A core strength of the IMX lies in its ability to engage participants through immersive, interactive experiences. However, the level of engagement varied across case studies, highlighting the importance of customisation based on user needs and backgrounds.

In **CS2 (Water-kennis)** participants responded positively to the interactivity but faced challenges with extensive content. While experts appreciated the detailed content, laypeople found it overwhelming, pointing to a need for balance in content delivery to accommodate different levels of expertise.

In **CS3 (L'acqua per Tutti)**, children showed high levels of engagement, embracing the interactive nature of the IMX. Adults, on the other hand, were less engaged, finding the system challenging to navigate. This highlights the importance of tailoring the IMX to meet the varying preferences and learning styles of its diverse audience.

CS9 (Ultimate Life of Water) demonstrated that group participation can be a highly effective way to enhance engagement. In this case, non-expert participants were drawn in by the collaborative nature of the experience, which allowed them to engage deeply with the content through teamwork and shared problem-solving.

These variations in engagement suggest that while the IMX is effective, it must be adaptable to different user groups, from experts to novices, and children to adults.

6.3.5.2. Preparation and Planning

The effectiveness of the IMX is closely tied to the quality of preparation and planning. Across the case studies, logistical and planning challenges impacted the overall experience, underscoring the importance of thorough preparation.

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In **CS2 (Water-kennis)**, the lack of a dedicated session for the IMX significantly impacted participation. The absence of structured time within the schedule to properly introduce the IMX led to reduced engagement. Additionally, participants faced technical difficulties with app downloads, highlighting the need for better communication and preparation before the sessions. Providing participants with pre-loaded devices or ensuring they download the necessary apps well in advance could mitigate these challenges.

CS3 (L'acqua per Tutti) faced logistical issues related to last-minute changes in the materials used for the installation, leading to confusion and higher costs. These hurdles disrupted the smooth flow of the experience, further emphasising the need for clear communication and comprehensive planning from the outset.

In **CS9 (Ultimate Life of Water)**, logistical challenges also arose when introducing the IMX to new teams, affecting the flow of the experience. This suggests that continued, detailed planning is critical to ensuring smooth implementation, especially when working with multiple stakeholders or teams.

6.3.5.3. Technical Aspects

Technical setup and usability are crucial for the success of immersive experiences like the IMX. While the technical aspects were generally well-received, several issues were identified that impacted the user experience.

In **CS2 (Water-kennis)**, users encountered device-specific challenges, particularly related to the size of the app and the lack of a 'back' button to revisit missed instructions. These issues hampered navigation and engagement, indicating a need for more intuitive design elements and clearer technical instructions.

CS3 (L'acqua per Tutti) experienced technical sensitivity issues, where the precise placement of objects was required to trigger interactions, leading to disruptions when users did not align items correctly. This sensitivity could be reduced to allow for smoother interactions, particularly for non-technical users.

In **CS9 (Ultimate Life of Water)**, minor technical errors during app setup caused frustration, although these issues were generally manageable. Enhancing the overall system reliability and improving user interface elements could further reduce these technical barriers, ensuring a more seamless experience.

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6.3.5.4. Interaction Design

The design of the interactions within the IMX – whether through individual or group modes – played a crucial role in shaping participant engagement and learning outcomes.

In **CS2 (Water-kennis)**, the comprehensive individual mode was highly effective for researchers but overwhelming for non-experts. The abundance of information presented required careful reading, which was not suitable for all users. Introducing both quick and comprehensive modes, where users can choose their level of engagement, could address these differing needs.

CS3 (L'acqua per Tutti) employed both individual and group interaction modes, with children responding particularly well to the system's interactivity. However, adults struggled with the system's complexity. Simplifying the system for adult users or providing clearer instructions could help improve the overall experience for this demographic.

CS9 (Ultimate Life of Water) found that group interaction was particularly effective in promoting engagement. The collaborative design allowed participants to learn from each other, enhancing their understanding of the content. This suggests that incorporating more group-based activities into the IMX can improve engagement, especially for non-expert users.

6.3.5.5. Group Participation

Group participation emerged as an important factor in enhancing engagement across all case studies. Collaborative learning environments encouraged interaction, increased focus, and made the experience more enjoyable.

CS2 (Water-kennis), although originally designed for individual interaction, saw participants naturally gravitate toward group collaboration. This unplanned shift to group interaction fostered discussion and improved overall engagement.

CS3 (L'acqua per Tutti) encouraged group participation, especially among younger users, who benefited from the collaborative environment. The shared learning experience helped to maintain engagement throughout the session.

CS9 (Ultimate Life of Water) relied heavily on group dynamics, which contributed to the overall success of the IMX. Participants were more engaged and motivated when working together, suggesting that group-based activities can be key to fostering effective learning in immersive environments.

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6.3.5.6. Future Recommendations

The evaluations of the IMX across **CS2 (Water-kennis)**, **CS3 (L'acqua per Tutti)**, and **CS9 (Ultimate Life of Water)** underscore its potential as an innovative tool for stakeholder engagement and immersive learning. However, several areas need improvement:

Tailoring the experience: The IMX must be adaptable to different user groups, with the option to choose between quick and comprehensive modes of interaction. This would allow experts to delve deeply into the content while providing less-experienced users with a more accessible version.

Technical challenges: Addressing technical issues such as app size, device-specific problems, and user interface design is essential to improving the overall user experience.

Interaction design: Offering a balance between individual and group interaction modes, with a stronger focus on group-based activities, can enhance engagement across diverse audiences.

Improved planning: Ensuring sufficient preparation, including pre-session instructions and dedicated time for IMX engagement, is crucial for successful implementation.

By addressing these areas, the IMX can become a more effective tool for stakeholder engagement, capable of reaching diverse audiences and fostering deeper learning and collaboration. Future developments should continue to refine the system's technical capabilities, explore new applications in other fields, and assess the long-term impact on both learning outcomes and stakeholder engagement.

Table 9 Summary of the IMX Experience Observations from the Case Study Support Teams

Evaluation Criteria	CS2	CS3	CS9
Overal Engagement	Rating: 3 Contributing factors: Interactive challenges, movement between sites. Participants enjoyed the IMX but faced issues like	Rating: 3 The interactivity was engaging but fell short for adults, who were less familiar with the system. Children enjoyed it more.	Rating: 4 Engagement was positive, particularly with non-expert participants who adapted well to the IMX.

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	too much information for some.		
Preparation and Planning	Rating: 3 Sufficient planning but underestimated difficulties with participant interaction and IMX setup during social activities.	Rating: 3 Preparation was inadequate due to last-minute changes (switching from aluminum to wood for the tabletop) and communication issues.	Rating: 3 Preparation was satisfactory, but logistical challenges such as introducing the IMX to new teams were encountered.
Technical Aspects	Rating: 4 Minor technical issues, including difficulty completing actions and no option to review missed instructions. Device-specific problems were also noted.	Rating: 3 Technical setup was challenging due to object placement issues. The system failed if objects were not placed exactly on the designated cues.	Rating: 3 Minor technical errors occurred, but overall performance was acceptable. Some users experienced difficulties in setting up the application.
Interaction Design	Mode: Individual comprehensive mode Rating: 4 Effective for researchers but overwhelming for laypeople due to too much information.	Mode: Group and individual modes Rating: 3 Children adapted better to the technology. Adults found it overly complex.	Mode: Group mode Rating: 4 Group interaction increased engagement and helped users better understand the IMX.
Group Participation	Group participation occurred naturally and improved engagement	Encouraged group participation, especially among younger students,	Group participation was effective in promoting a collaborative

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	through discussions.	which increased engagement.	learning experience.
Lessons Learned	1. Positive response from researchers, but laypeople faced information overload. 2. Time to complete was too long. 3. Interaction simplicity is crucial to avoid frustration.	1. Young students were the best users. 2. Non-expert users struggled with precision tasks. 3. The system is too sensitive to minor errors.	1. Clear guidance is key. 2. Reducing technical complexity helps increase engagement. 3. Users adapted well to group interaction.
Participant Feedback	Positive from researchers but information overload for laypeople.	Children enjoyed it, but adults found it complex and confusing.	Participants found the IMX engaging, particularly with support from team members.
Improvements Suggested	1. Quick mode for laypeople. 2. Involve target audiences in the development. 3. Consider simplifying mobile application or using a physical alternative.	1. Reduce system sensitivity to minor errors. 2. Develop a standalone version that does not rely on a super-user.	1. Streamline the IMX introduction. 2. Simplify app setup to prevent minor technical issues from frustrating users.

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PART II – INSIGHTS: ULTIMATE COMMUNITIES OF PRACTICE

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7. Introduction to Communities of Practice

Innovative solutions to the most pressing issues will come about as a result of effective collaboration, communication and knowledge exchange. Bringing people together from different backgrounds, expertise and interests can elevate the potential for relevant innovations to be effectively applied at the local level as well as up scaled and diffused. As such, CoPs are a vital component to the ULTIMATE project, to deliver solutions tailored and co-created by a diverse group of individuals.

CoPs are social learning systems bringing together experts with local people, end-users and other relevant stakeholders to develop a common understanding, sharing best practices and creating new knowledge on a given topic, to arrive at solutions that are co-developed, supported, and accepted by the stakeholders. Interaction on an ongoing basis is an important part of this. There are three (3) characteristics of a CoP (Wenger and Wenger, 2015) that make them different from other types of stakeholder engagement, namely:

1. Community members have a shared domain of interest, competence and commitment that distinguishes them from others. This shared domain creates common ground, inspires members to participate, guides their learning, and gives meaning to their actions.
2. Members pursue this interest through joint activities, discussions, problem-solving opportunities, information sharing and relationship building into a community. The notion of a community creates the social fabric for enabling collective learning. A strong community fosters interaction and encourages a willingness to share ideas.
3. Community members are actual practitioners in this domain of interest, and build a shared repertoire of resources and ideas that they take back to their practice. While the domain provides the general area of interest for the community, the practice is the specific focus around which the community develops, shares and maintains its core of collective knowledge.

Literature and practice show that CoPs may help the long-term successful implementation of the technologies and innovations developed and tested in a project context such as ULTIMATE. Accordingly, the establishment of CoPs is fostered and supported in ULTIMATE via WP3. However, it is important to note that within the framework of ULTIMATE we take a flexible approach and allow to adjust the CoP design and implementation to the local circumstances. In particular, there is no minimum number of CoP meetings that should be held across the CSs, nor is there a hard deadline for the CoP meetings to take place. Furthermore, while the design and

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implementation of CoPs has a theoretically its own structure, we allow for adjustments to this structure to account for local circumstances. The role of WP3 is to help the case studies to find the right way to implement the CoP (see e.g., CS9 Kalundborg in section 7.10.3) and support them throughout the project implementation).

Part II of this report illustrates the preliminary findings from the ULTIMATE CoPs, focusing on their preparation and implementation, content discussed and an overview of the CoP stakeholder's experiences.

During the Covid-19 pandemic, most engagement with stakeholders across the CoPs were been limited to online meetings in order to adhere to country specific Covid-19 regulation. While the CSs have been creative in engaging their stakeholders though various online tools, there has been a strong preference among most stakeholders to have face-to-face meetings to improve the dynamics of the CoP and their engagement. Some CoP meeting have remained online (or in hybrid format) to facilitate the participation of a broader group of stakeholders, while others have opted for face-to-face meetings.

8. Communities of Practice Methodology

The technical feasibility and performance of innovative technologies and symbiosis strategies is to be evaluated and demonstrated within ULTIMATE. Successful WSIS modes between water providers and key industries demands the engagement of stakeholders such as end-users, technology providers, utilities, industry in the agriculture, energy, water and other sectors, regulators, local, and regional authorities and researchers who share an interest on water issues, water technologies and industrial symbiosis. By interacting regularly, stakeholders can exchange knowledge, develop ideas, and learn together, thereby contributing to innovative and effective solutions for sustainable water management in the context of industrial symbiosis.

It is in this context that the CoP approach is explored and applied (where in line with the local circumstances) across nine (9) WSIS CSs within the framework of ULTIMATE as part of T3.2 (Business-to-business engagement). The ULTIMATE partner KWR Water Research Institute (KWR) has supported CS leaders to design and implement CoPs, and to engage locally relevant stakeholders from various expertise and backgrounds. Each CoP enables the stakeholders through plenary CoP and topic focus group meetings to discuss, work together and outline the steps towards successful design and implementation of water-related technologies and innovations. Furthermore, the stakeholders benefit from learning from each other and developing

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relationships with local partners on tangible technologies and innovations for a water-wise world.

KWR has outlined an eight (8) step guideline to assist CSs in preparing and implementing a CoP from defining the core team and scope of the CoP, to the engagement of stakeholders, to reporting and evaluating on the CoP performance (see D3.4 for more details on the steps to preparing and implementing a CoP). The eight (8) steps are listed below:

- Step 1: Define the CoP Coordinator, Moderator
- Step 2: Define the Goals and Scope of your CoP
- Step 3: Decide on Preliminary Topics for CoP Meetings
- Step 4: Identify Participants (Stakeholder Mapping)
- Step 5: Reach out to Stakeholders
- Step 6: Prepare and host CoP Meetings
- Step 7: Keep the CoP Engaged in between Meetings
- Step 8: Evaluate and Report

CoPs have been established in all nine (9) CSs, in different forms, with the intention to engage locally relevant stakeholder and experts. The engagement of stakeholders has been facilitated across all CSs, through a combination of online and in person CoP meetings and focus group meetings. The meetings are delivered by CoP coordinators and moderators from project partner institutions. There is no mandatory number of CoP meetings to be held across the CSs. CSs together with their stakeholders define the number and frequency of meetings based on their specific needs and circumstances. These can be defined using, for example, a CoP roadmap.

CoP roadmaps offer CS partners a semi-structured template (see Annex B.1 for more details on the design of a CoP roadmap) to:

- Define the scope of the CoP and focus group meetings
- Define the topic of each of the meetings
- Identify which stakeholders to join the meetings
- Identify the type of meeting (entire community or a subset in focus groups)
- Determine the timeline of the meetings (timing and frequency)

The development of a roadmap is also not a required activity in ULTIMATE. It is however a recommended tool to provide guidance to the CoP planning process. Four (4) of the nine (9) CSs have developed a CoP roadmap (see Annex B.2) using the template provided.

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The roadmaps provide an overview of when CoP meetings and focus group meetings are expected to take place. The planning is merely indicative, as the preparation and implementation of the CoP meetings and focus group meetings are largely dependent on the progress of the CS activities and availability of locally relevant stakeholders.

To measure the success in terms of output and the functioning of the CoPs over time, an evaluation of CoPs is done. The evaluation approach adopted in ULTIMATE is based on a scientific framework from the 2020 work of Fulgenzi, Brouwer, Baker and Frijns (Fulgenzi et al., 2020). The evaluation has been transferred into an online survey, using Survey Monkey, and translated into multiple languages including English, French, Greek, Hebrew, Italian and Spanish. Guidance is also provided with recommendations on best practices for survey circulation to try reach an adequate response rate (see Annex E).

Evaluating the CoPs based on the approach by Fulgenzi et al. (2020) enables the identification of which key success factors (KSF) – (1) organisational aspects, (2) atmosphere, (3) stakeholder inclusion and representation, (4) convergence towards shared perspective, (5) identification opportunities and challenges, and (6) generation of knowledge – are sufficiently present in the CoPs and which aspects deserve more attention based on a set of indicators (or statements). The assessment enables the possibility to implement changes to the CoP meetings to improve their effectiveness as well as draw overall lessons on successful co-creation in CoPs. In the long-term, the evaluations help with continuous learning and improvement of the CoP within ULTIMATE by identifying best practices for CoPs. These insights are useful also for the implementation of CoPs in future EU projects. For example, lessons learned from the ULTIMATE CoPs and those of its 4 sister projects (B-WaterSmart, REWAISE, WATER-MINING and WIDER UPTAKE, forming the CIRSEAU cluster) were compiled into a set of recommendations for stakeholder engagement into EU research projects shared with the EU commission and publicly available[7].

Templates for reporting on CoP meetings and focus group meetings are made available to CS partners to document key achievements and messages from stakeholder engagement in the CoP (see Annex E). Finally, a consent form is also readily available to ensure stakeholder consent to recording meetings, collection of personal data and other personal information captured during the meetings.

In the following sections, an overview on the implementation of the CoPs across the CSs is provided. A separate assessment of CS9 is made, as the Kalundborg case offers a unique perspective on the engagement with stakeholder within the context of industrial symbiosis.

[7] https://ultimatewater.eu/2024/04/03/stakeholder-engagement-is-key-for-societal-impact-of-eu-funded-inter-and-trans-disciplinary-research-projects/

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9. Communities of Practice implementation across case studies

9.1. Overview of Communities of Practice

The table below provides an overview of CoPs held across the CSs. The information provided is taken from the CoP meeting reports that CSs are asked to complete after the implementation of a CoP meeting (see Annex G for a more extensive overview).

Table 10 Overview of CoP meetings across case studies

	# of CoP meetings held	Average # of participants	Type of organisations engaged	Average Gender diversity (%)	
				M	F
CS1	2	12	Authorities, research institutes, end-users, water industry and external stakeholders	50	50
CS2	2	11	Research institutes, end-users and representatives of Glastuinbouw Nederland	88	12
CS3	5	37	Public authorities, engineering companies, research institutes, end-users, water industry and external stakeholders	72	28
CS4	3	22	Authorities, engineering companies, research institutes, end-users, water industry, and representatives of other sectors	64	36
CS5	3	13	Engineering companies, research institutes, end-users and water industry	77	23
CS6	1	37	Engineering companies, research institutes, water industry	73	27
CS7	1	10	Engineering companies, research institutes, end-users and water industry	70	30

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	# of CoP meetings held	Average # of participants	Type of organisations engaged	Average Gender diversity (%)	
				M	F
CS8	1	14	Upstream customer, economic interest group, transport and trading of secondary raw material	57	43
CS9*	7	40	Food/biotech & pharmaceutical industries, authorities, water industry, and representatives of other sectors	63	37
TOTAL	**25**	**22**		**68**	**32**

*See section 9.10 for more information

9.2. Case study 1 - Tarragona, Spain

9.2.1. Community of Practice meeting(s)

There have been a total of two (2) CoP meetings prepared and implemented with stakeholders in Tarragona.

On 16 December 2021 the first CoP meeting was held as an online meeting with seven (7) stakeholders. The objective of the first CoP meeting was to share information on the ULTIMATE project and the activities in CS1 with stakeholders, and to define together an approach and the objectives for the CoP.

Research institutes, end-users, water industry representatives and a delegation of external stakeholders attended the meeting. No public authorities were involved in the first CoP meeting. Stakeholders of the first CoP meeting agreed that engaging the regional public administration in future meetings would be necessary to discuss the legal framework, authorisations and restrictions for the technical solutions proposed for CS1.

The second CoP meeting took place on 7 April 2021, also as an online meeting, with 16 stakeholders. The objective was to share information on the ULTIMATE project and activities in CS1 with representatives of the Catalonia Administration and the Chemical Business Association of Tarragona (AEQT), and to define the legal approach for the scaling-up of ULTIMATE technical solutions with stakeholders from the first CoP meeting. The solutions proposed were positively received among the participants, with

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strong support given to AITASA's ambition to increase reclaimed water production capacity from an environmental point of view.

Additional insights from CS1 on the acceptance, regulatory barriers and technology/solutions to enable water reuse by industry are presented in Annex G.1.

Figure 16 1st online CoP meeting in CS1

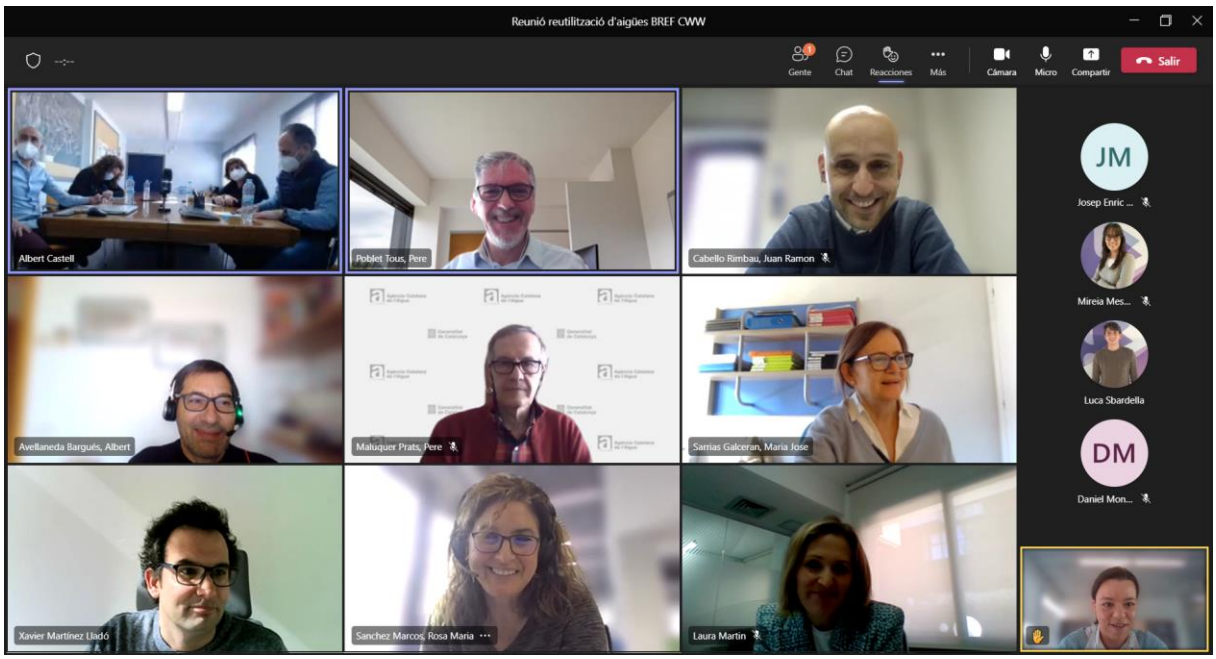

Figure 17 2nd online CoP meeting in CS1

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9.2.2. Stakeholder experience and learning

The following figures provide the average scores across the KSFs[8] [9]. Evidently, the fist CoP meeting scores high, where stakeholders agree or strongly agree with the KSF statements.

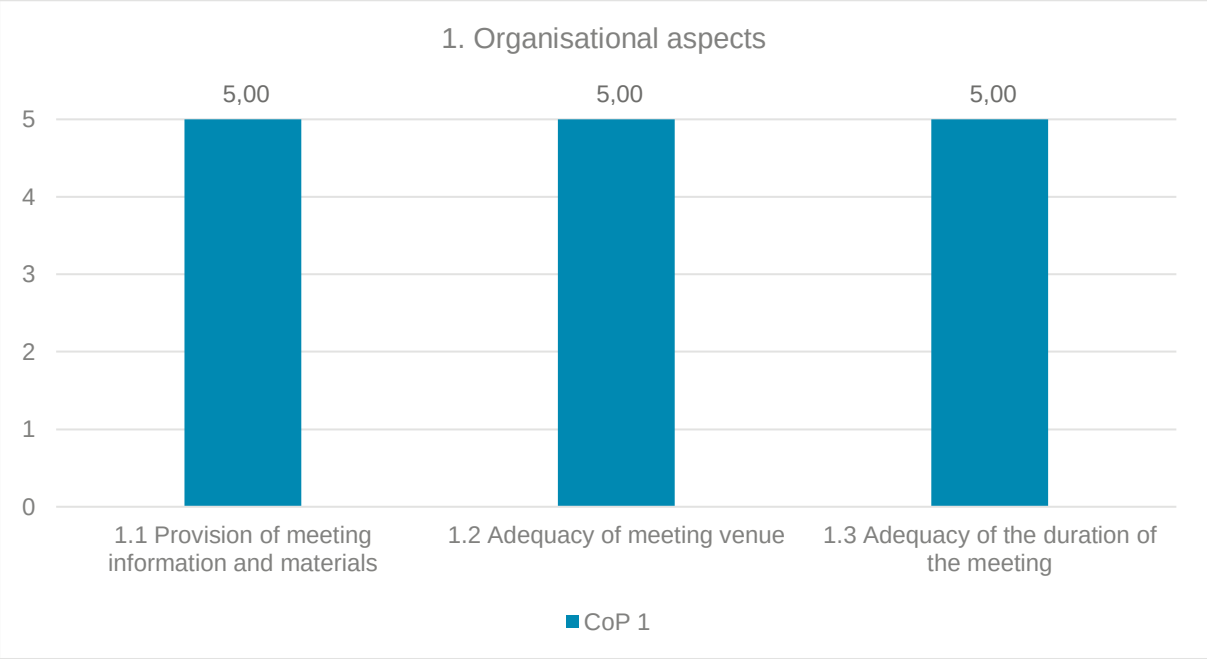

Figure 18 Meeting logistics and stakeholder engagement: Organisational aspects (CS1)

[8] Stakeholders are asked to rate the extent to which they agree with a number of statements (KSF indicators), where 1 is strongly disagree; 2 is disagree; 3 is neutral; 4 is agree; 5 is strongly agree; and N.A is not applicable.

[9] There data provided is only available from the first CoP meeting. Not data is available from the second CoP meeting because participating stakeholders did not respond to the evaluation survey.

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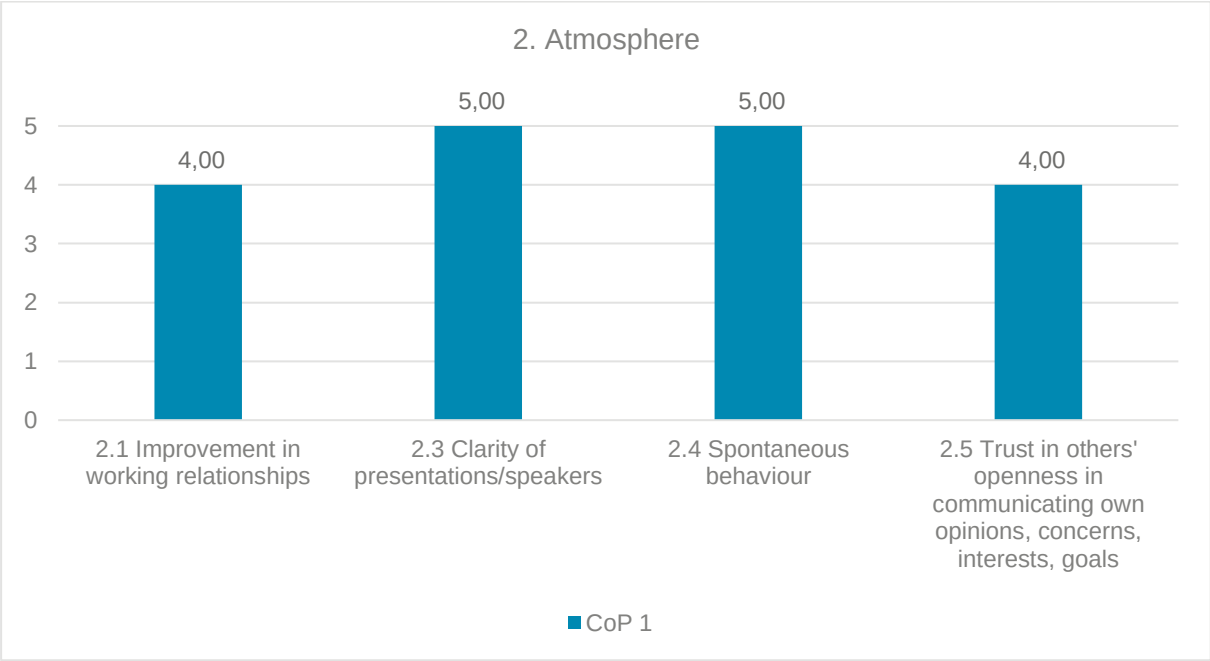

Figure 19 Meeting logistics and stakeholder engagement: Atmosphere (CS1)

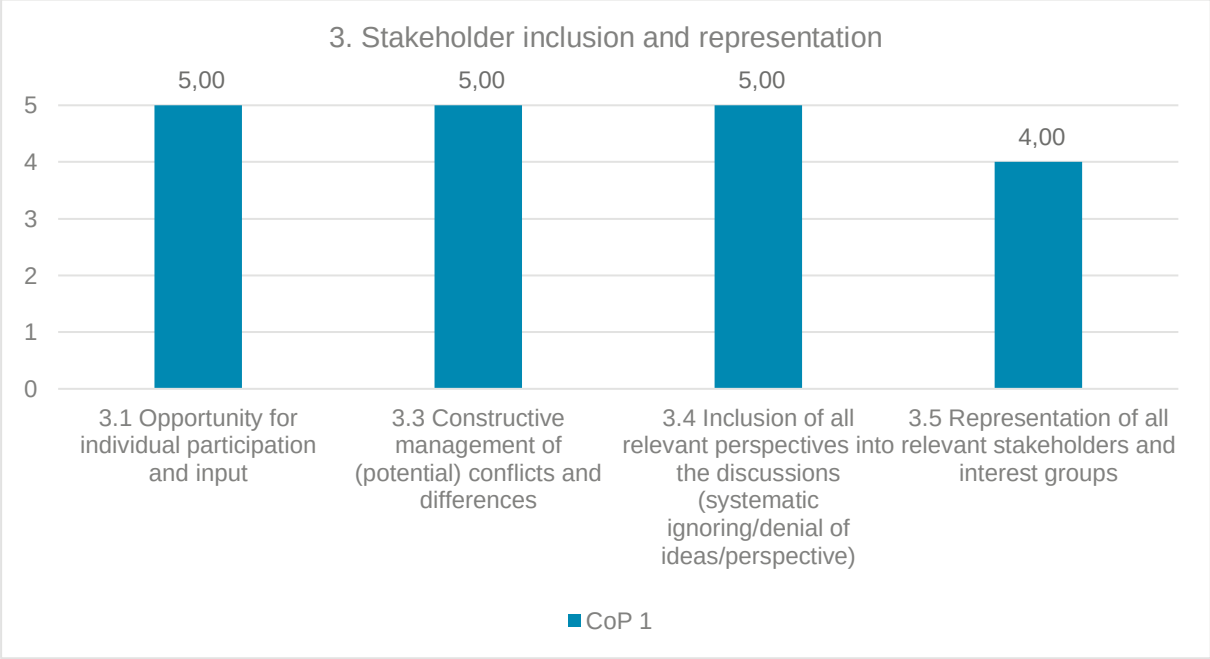

Figure 20 Awareness and increased understanding: Stakeholder inclusion and representation (CS1)

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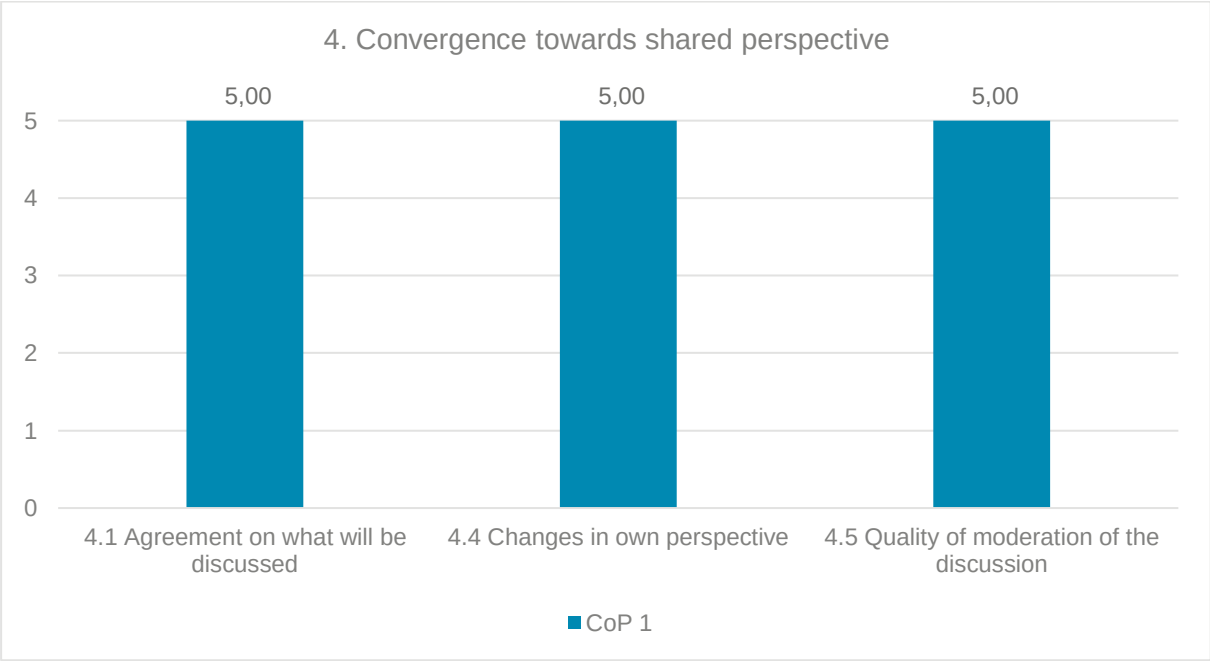

Figure 21 Awareness and increased understanding: Convergence towards shared perspective (CS1)

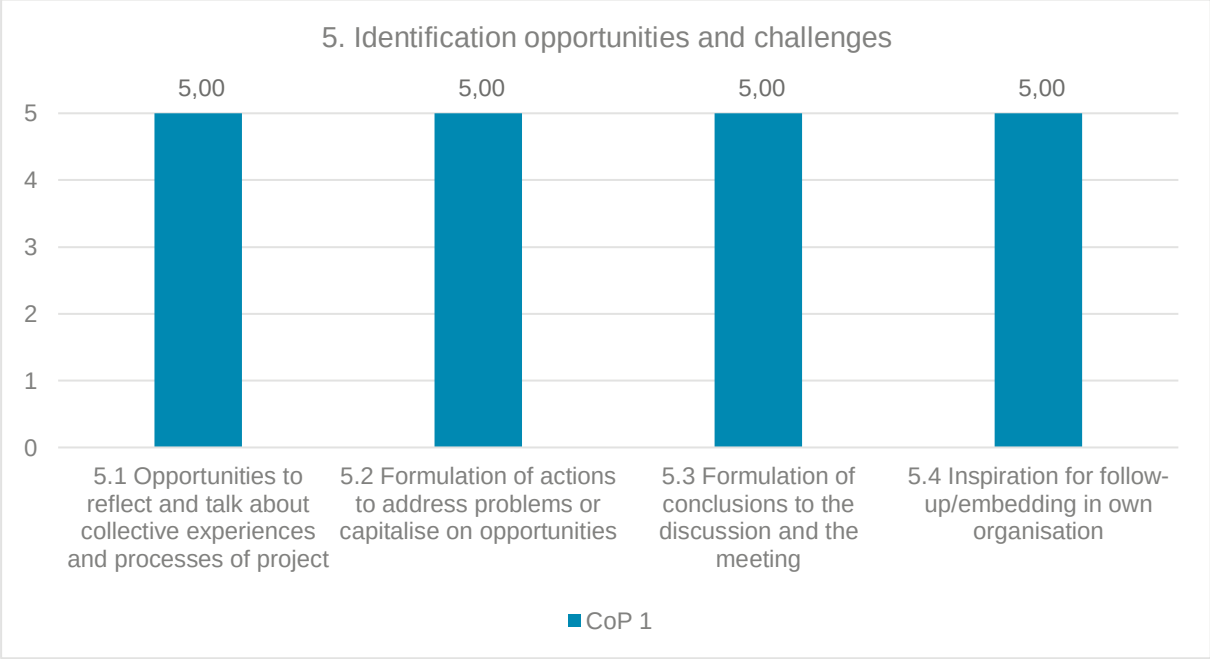

Figure 22 Outcomes and conclusions: Identification opportunities and challenges (CS1)

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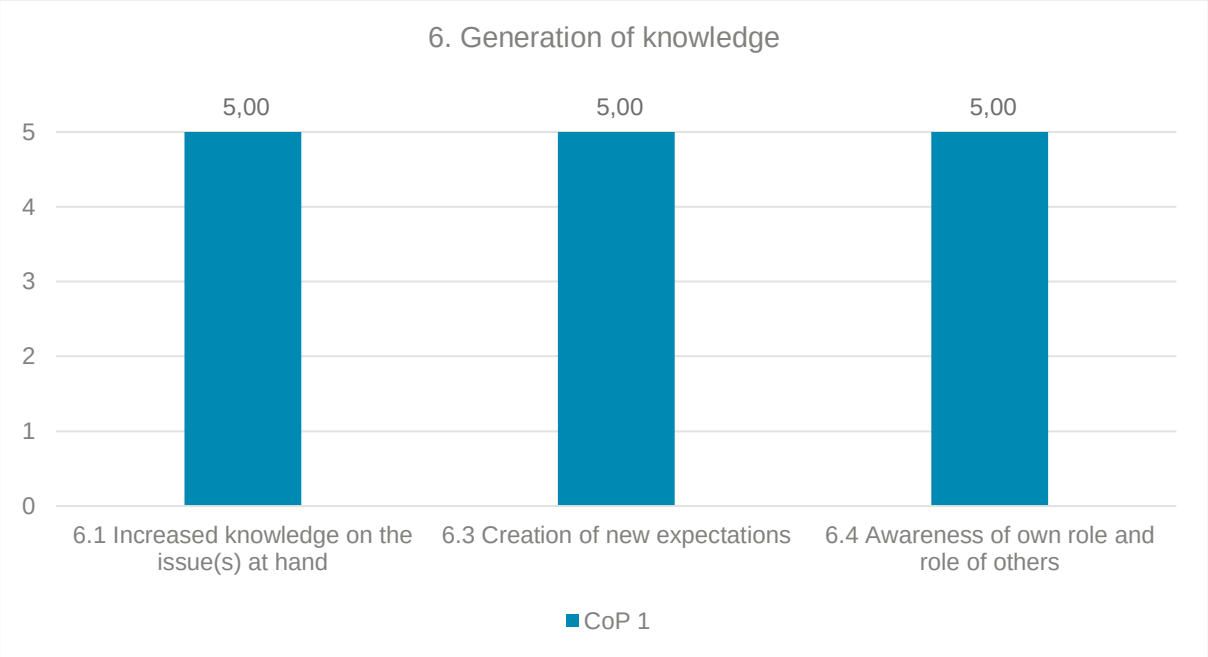

Figure 23 Outcomes and conclusions: Generation of knowledge (CS1)

Drawing insights from the evaluation survey of the first CoP meeting, the participation and engagement of stakeholders was successful. The participating stakeholders generally found the CoP meeting to be extremely valuable[10], showing a good level of interest and willingness to learn.

In the second CoP meeting, the organisers found the participation and the engagement of the stakeholders successful, recognising a general willingness to learn and a good level of curiosity. In fact Chemical Business Association of Tarragona (AEQT), which is a community-based entity that includes Southern Europe's most competitive chemical corporations, and leads a world-famous cluster that seeks to contribute to Tarragona's sustainable development, were very interested in the solution proposed in ULTIMATE, and they strongly supported the objective to increase the reclaimed water production capacity of AITASA from an environmental point of view. The organiser noted a relaxed and comfortable atmosphere, putting participants at ease to share their ideas.

CS partners observed a general willingness from stakeholders to learn new things, as well as curiosity and interest in the introduced technologies and innovations. They also detected a sense of calm and comfort among the stakeholders participating.

[10] The overall rating of the CoP meeting is evaluated on a scale from 1 to 5, where 1 is not at all valuable; 2 is not so valuable; 3 is somewhat valuable; 4 is very valuable; and 5 is extremely valuable (see Annex E).

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While there was not much written feedback from participating stakeholders, the few reflections indicated a willingness to continue with the CoP meeting. This is also positively reflected in the high scores of the evaluation.

9.3. Case study 2 - Farmer's water reuse (KWR), The Netherlands

9.3.1. Community of Practice meeting(s)

There have been two (2) CoP/focus group meetings prepared and implemented with stakeholders in CS2.

The first meeting held on 2 February 2022 with research institutes, end-users, representatives of Glastuinbouw Nederland and the entrepreneurial network in the Dutch greenhouse horticulture sector, had the ambition to initiate, stimulate, and facilitate collective knowledge development and sharing in order to improve the network's business operations.

The CoP meeting objective was to bring together representatives from four (4) collectives and a fifth collective represented by Glastuinbouw Nederland around a virtual table, to inform one another of their respective activities, experience, issues, and challenges. Despite the fact the participating stakeholders are all working towards the same objectives and their members have chosen to organise themselves in collectives to achieve this, they were not familiar with one another. A bottleneck observed is limited engagement of members of the collectives in activities to achieve the common objective. This is especially the case for the larger collectives where members pay their fee with no further involvement nor feeling of responsibility.

Representatives of the collectives, comprised primarily of farmers, showed little interest in how to organise the involvement of the collective's members in the CoP and to create a shared responsibility and a feeling of shared ownership. Instead, more interest was shown on technical issues such as the removal of nitrate. In light of that outcome, the second CoP meeting will be organised around this topic.

Stakeholders groups such as authorities or legislators were not invited to the CoP meeting. This was done by design, to create an environment in which the participating stakeholders could openly discuss ideas also on options that are not contemplated by legislation, without the fear of conflict or tension with the regulators.

The success of the CoP in CS2 is highly dependent on it being organised by KWR and Glastuinbouw Nederland as reputable and respected organisations in the field. Furthermore, as nitrogen removal is a topic of interest for the wider sector, the involvement of other farmers (not organised in collectives), technology providers and

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knowledge institutes will be explored. CS partners also indicated that facilitating roundtables discussion and allotting sufficient time for better explanations of aspects of the project and of the CoP was difficult because the meeting was held online. Although they believe that face-to-face meetings will enable more content oriented discussions, most of the participating stakeholders indicated a preference to engage online to limit travel time.

A second meeting, in the form of a focus group meeting, was organised on 15 March 2024 to share and discuss the results with a smaller group of relevant stakeholders on the research conducted on water and nutrient recovery using electrodialysis (ED).

Discussions with stakeholders emphasised the current high cost of ED produced water (compared to other available water sources), influenced by high energy tariffs and membrane prices, but see ED as a technology that might become competitive. The participating stakeholders were actively engaged in discussion on centralised versus decentralised water treatment. The participants also requested updates from Glastuinbouw Nederland to keep the board informed about further developments and to translate technical advancements into practical applications for growers.

Additional insights from CS2 on the acceptance, regulatory barriers and technology/solutions to enable water reuse by industry are presented in Annex G.2.

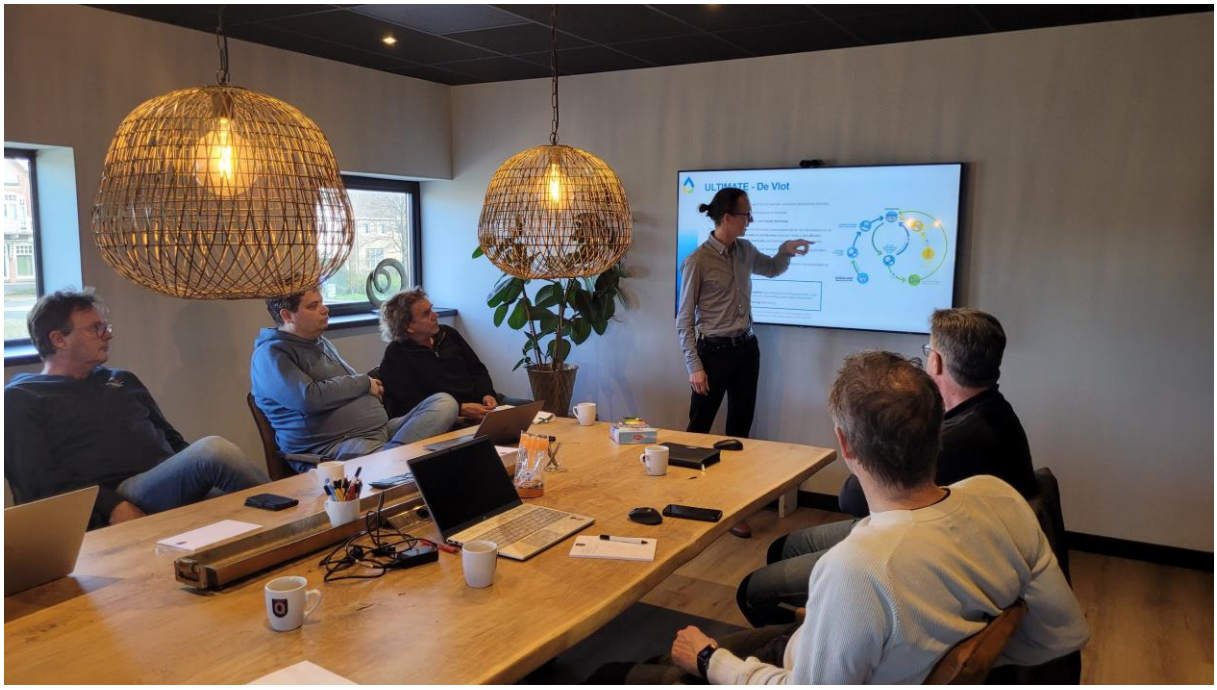

Figure 24 Focus group (CoP 2) meeting in CS2

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9.3.2. Stakeholder experience and learning

The following figures provide the scores across the KSFs[11], where a generally positive score on the statements was provided with the exception of stakeholders' perception on the inclusion and respect of ideas/perspectives during the discussion which had score of 2.5. This could be in part a result of holding the meeting online, given that CS partners indicated a difficulty in facilitating round table discussions. However, when possibility of a physical meeting was discussed, many stakeholders indicated a preference to engage online. The willingness to continue participating online, in spite the challenges, was taken as a sign of interest and/or commitment to the CoP. However, much needs to be done to demonstrate and clarify the benefit of stakeholders engaging in the CoP in person.

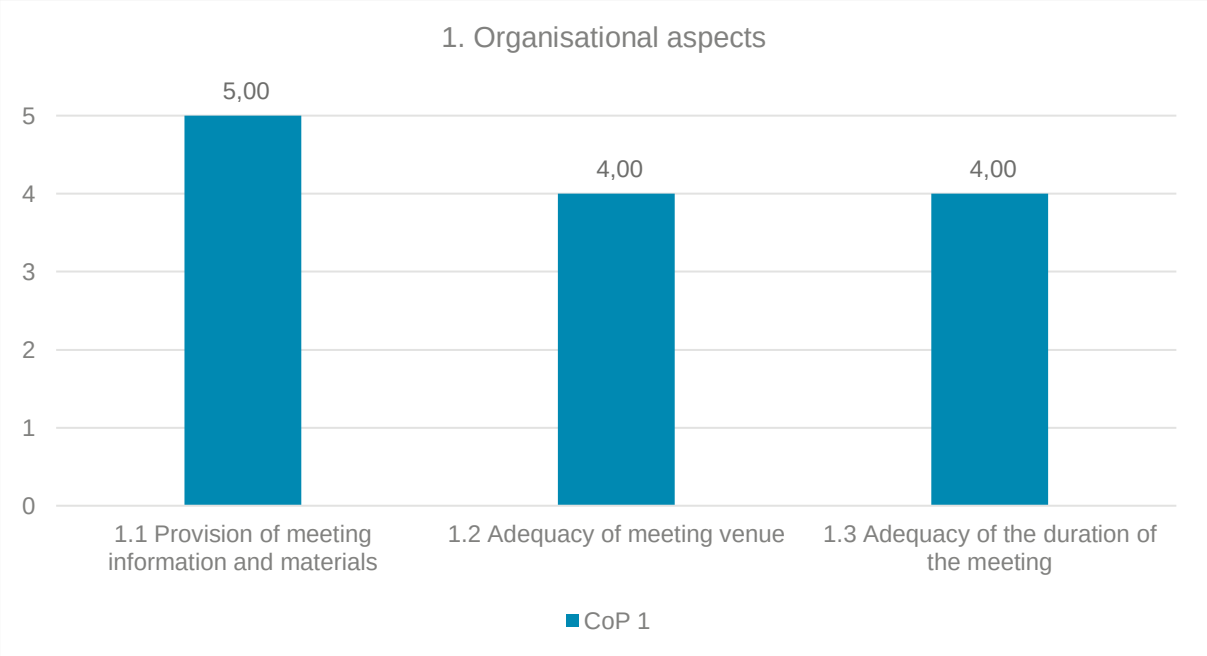

Figure 25 Meeting logistics and stakeholder engagement: Organisational aspects (CS2)

[11] There data provided is only available from the first CoP meeting. Not data was collected from the CoP (focus group) meeting on 15 March 2024.

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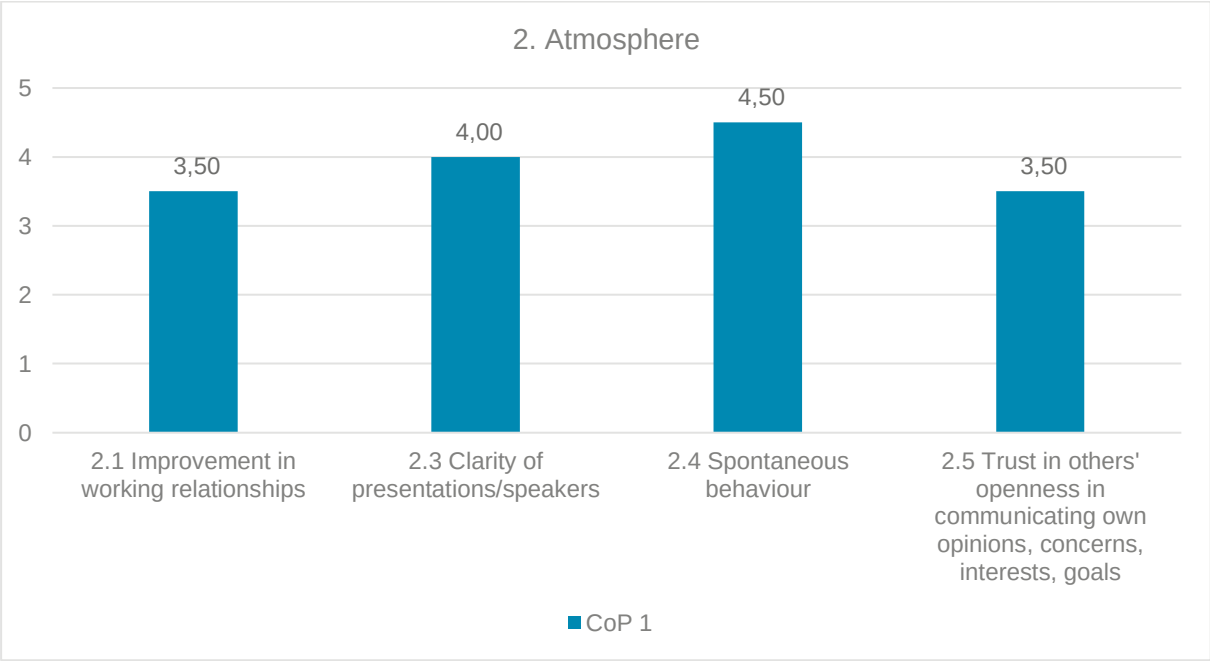

Figure 26 Meeting logistics and stakeholder engagement: Atmosphere (CS2)

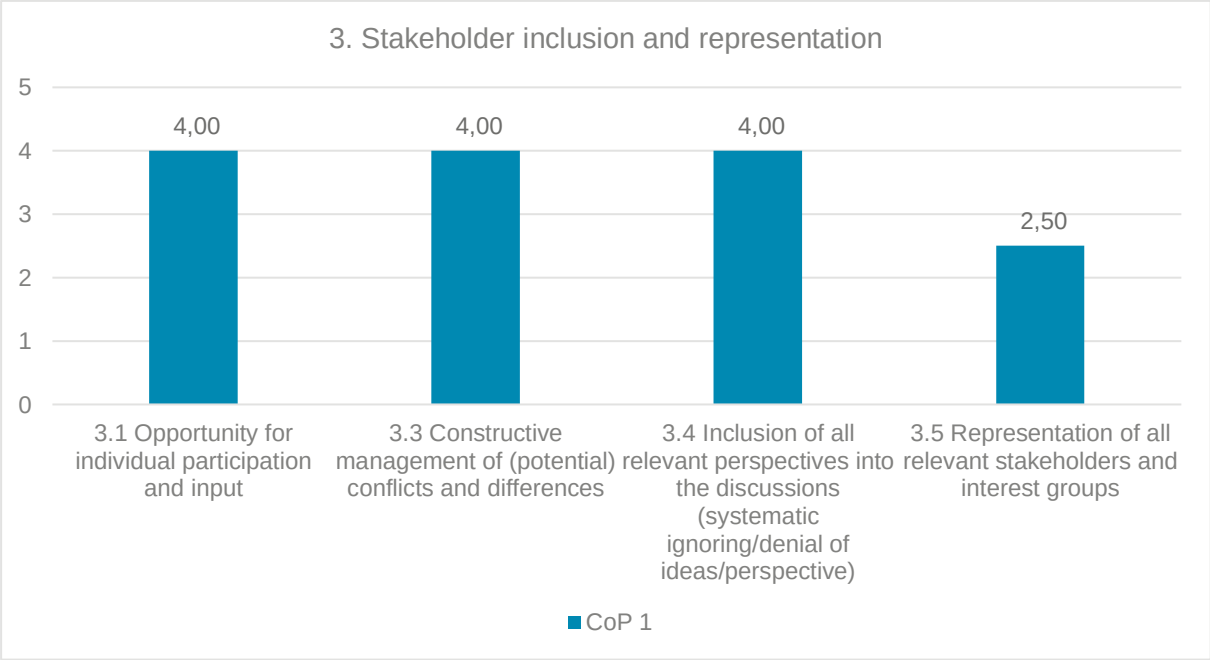

Figure 27 Awareness and increased understanding: Stakeholder inclusion and representation (CS2)

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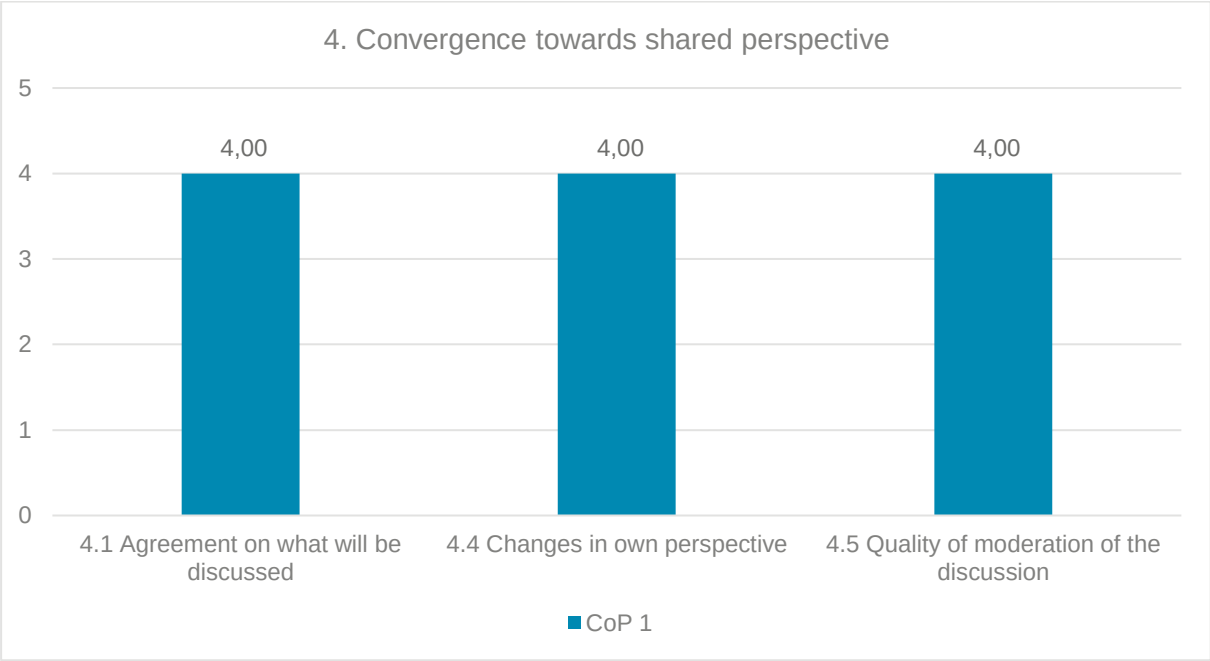

Figure 28 Awareness and increased understanding: Convergence towards shared perspective (CS2)

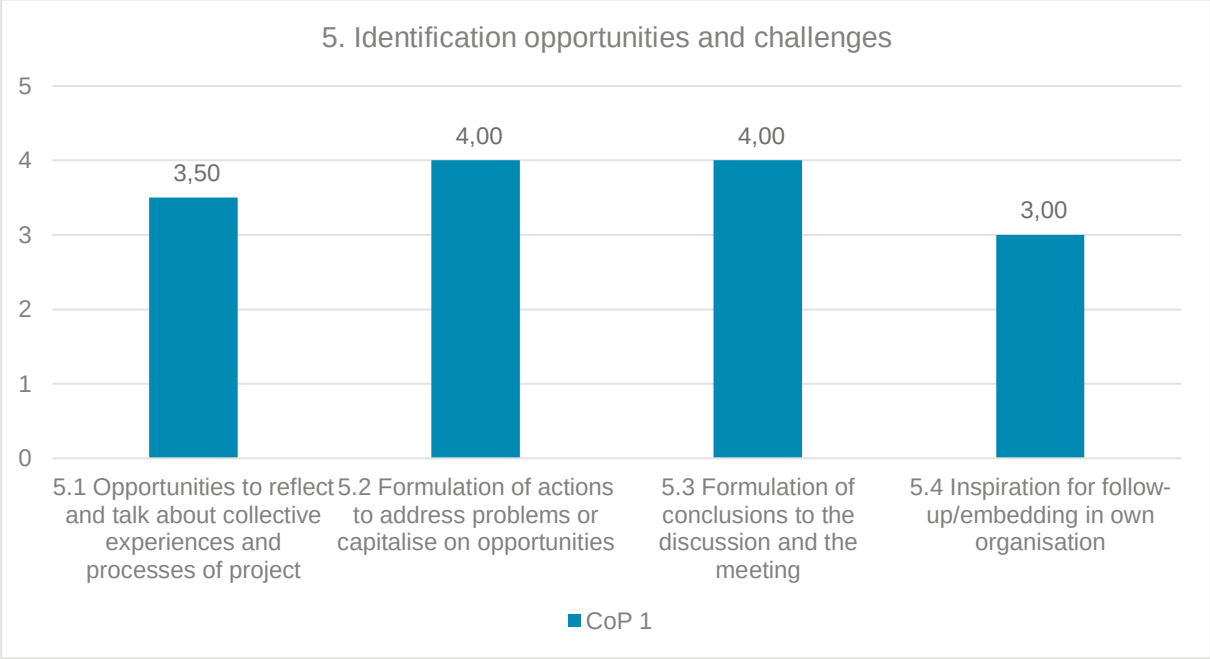

Figure 29 Outcomes and conclusions: Identification opportunities and challenges (CS2)

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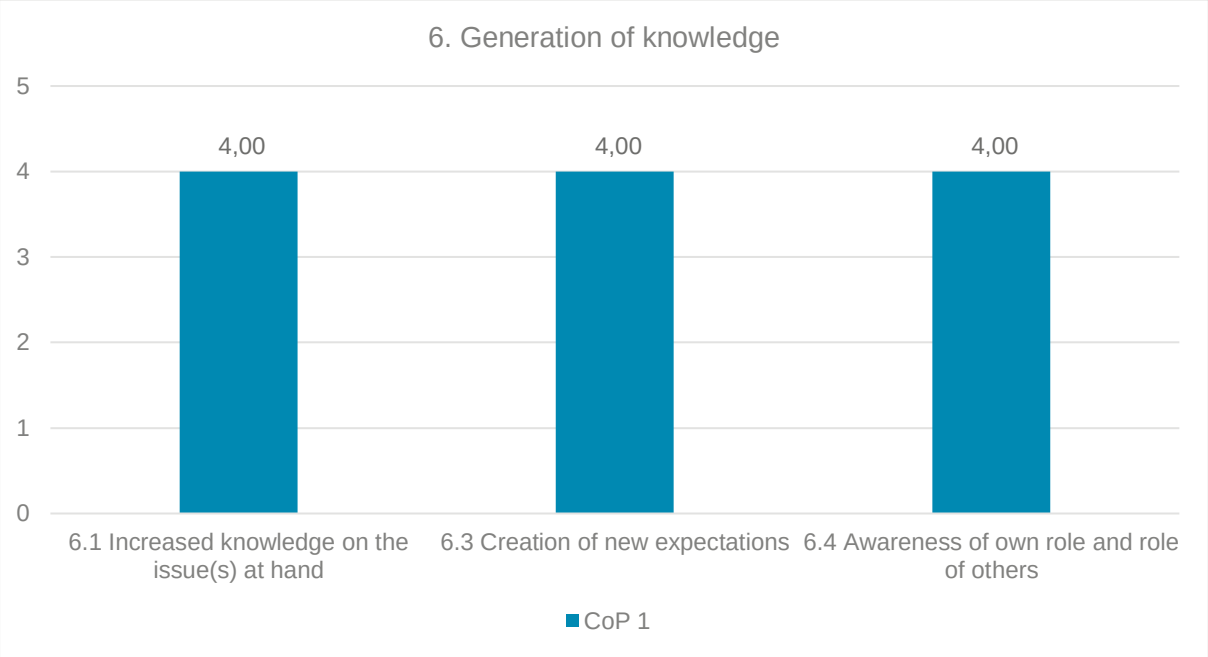

Figure 30 Outcomes and conclusions: Generation of knowledge (CS2)

The evaluation survey showed that stakeholders generally found the CoP meeting to be very valuable, with knowledge sharing being a key success factor of the CoP meeting.

9.4. Case study 3 - Rosignano, Italy

9.4.1. Community of Practice meeting(s)

A total of five (5) CoP meetings (which includes one (1) LL meeting) have been prepared and implemented with stakeholders in CS3.

The first meeting was an introductory (online) meeting held on 8 June 2021, in which 35 stakeholders participated representing public authorities, engineering companies, research institutes, end-users, the water industry, and other external stakeholders.

The meeting was the opportunity to learn more about the stakeholders in the region and introduce ULTIMATE and the activities of CS3. For the moment, there CoP participants agree that there is no need to introduce other stakeholders in future meetings. The different stakeholders groups are well represented with a great level of expertise. This should be exploited to create economic value and increase sustainability in the region.

The meeting was also used to explain the CoP approach, the potential benefits of engaging in the CoP, and to validate its composition and planning (roadmap), and

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agree on the level of engagement and the short- and long-term values and impact of the CoP.

According to the stakeholders, short-term benefits of the CoP include that it is a good arena for problem solving and for addressing new challenges, it offers a space for working together as well as a space for coordination, standardisation and for building synergies across stakeholders. As for long-term benefits, the most relevant ones include the development of knowledge and future alliances, possibility to foster implementation of companies strategic plans and to foresee technological developments and to take advantage of emerging market opportunities.

The second (online) meeting on legal and social barriers on water reuse took place on 14 December 2021 with the participation of 40 stakeholders representing the same stakeholder community as in the first meeting. The main objective of the meeting was to address water reuse barriers, considering legal, technical, and social aspects. This included analysing the current legislation for wastewater reuse to stimulate discussion on viable opportunities for water reuse. Using the stakeholder reuse experiences, the CoP explored the governance opportunities for ARETUSA to pursue multi-purpose water reuse (i.e. combined industrial and agricultural reuse).

As the engagement of stakeholders was limited to an online meeting, the interaction was difficult to facilitate. However, participating stakeholders came with a good and broad level of expertise and knowledge on barriers relevant to the solutions proposed. It was concluded that face-to-face meetings would be necessary for future meetings (if possible given the Covid-19 pandemic).

The third meeting, held on 8 June 2022, focussed on the legal, technical and environmental barriers to material reuse and the collection of local experiences on material reuse. The meeting, also online, convened 50 stakeholders representing public authorities, engineering companies, research institutes, end-users, the water industry, and other external stakeholders. Together, the current legislation and regulation on the definition of a ‘by-product’ and the requirements for the end-of-waste procedures were discussed to explore possibilities and opportunities to enhance material reuse through circular systems. With input from participation stakeholders, example of local best practices around end-of-waste and general local-regional material reuse experiences and strategies were gathered in order to analyse opportunities for Tuscany and beyond.

A forth meeting was held on 24 December 2023, organised as a LL meeting. The meeting focused on laying the foundations for a comparison between the various administrations and potential users on their experiences/good practices around stabilising water quality and quantity, and safeguarding the water resource in the

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Cornia Valley. The meeting convened 21 participants with a multiplicity of skills and competencies around regulatory aspects, operational/management aspects and quality control.

The fifth meeting, held as a hybrid meeting on 14 July 2023, was used to inform the CoP stakeholders on the progress achieved in the ULTIMATE project, starting from the predictive system of the sewage network (smart equalisation) up to the pilot projects, in which by-products from local industries are tested (in this case Solvay) as alternative materials for water treatment. The meeting was used to also discuss water reuse opportunities, considering legal, technical and environmental aspects. The meeting convened 41 stakeholders representing public authorities, engineering companies, research institutes and universities, end-users, the water industry, and representatives of other sectors.

Additional insights from CS3 on the acceptance, regulatory barriers and technology/solutions to enable water reuse by industry are presented in Annex G.3.

Figure 31 Site visit of Solvay's Rosignano plant

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Figure 32 5th CoP meeting in CS3

9.4.2. Stakeholder experience and learning

The following figures provide the average scores across the KSFs for each CoP meeting held. The KSF indicator scores show no major variations between the CoP meeting with positive scores (on average).

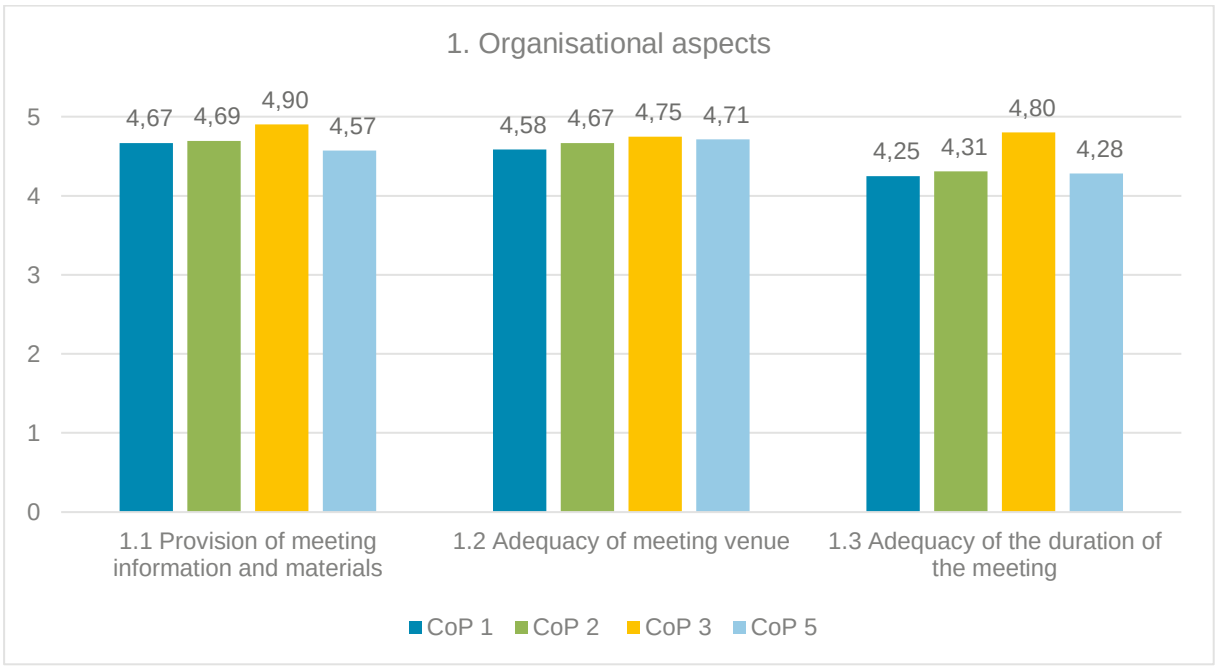

Figure 33 Meeting logistics and stakeholder engagement: Organisational aspects (CS3)

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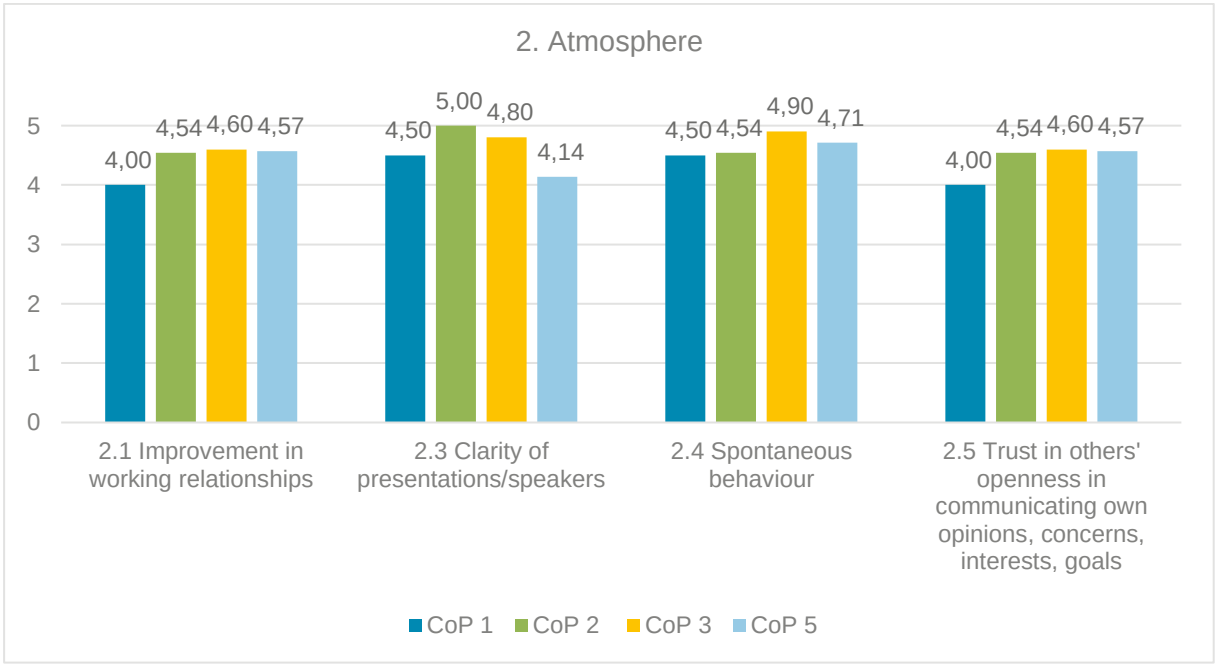

Figure 34 Meeting logistics and stakeholder engagement: Atmosphere (CS3)

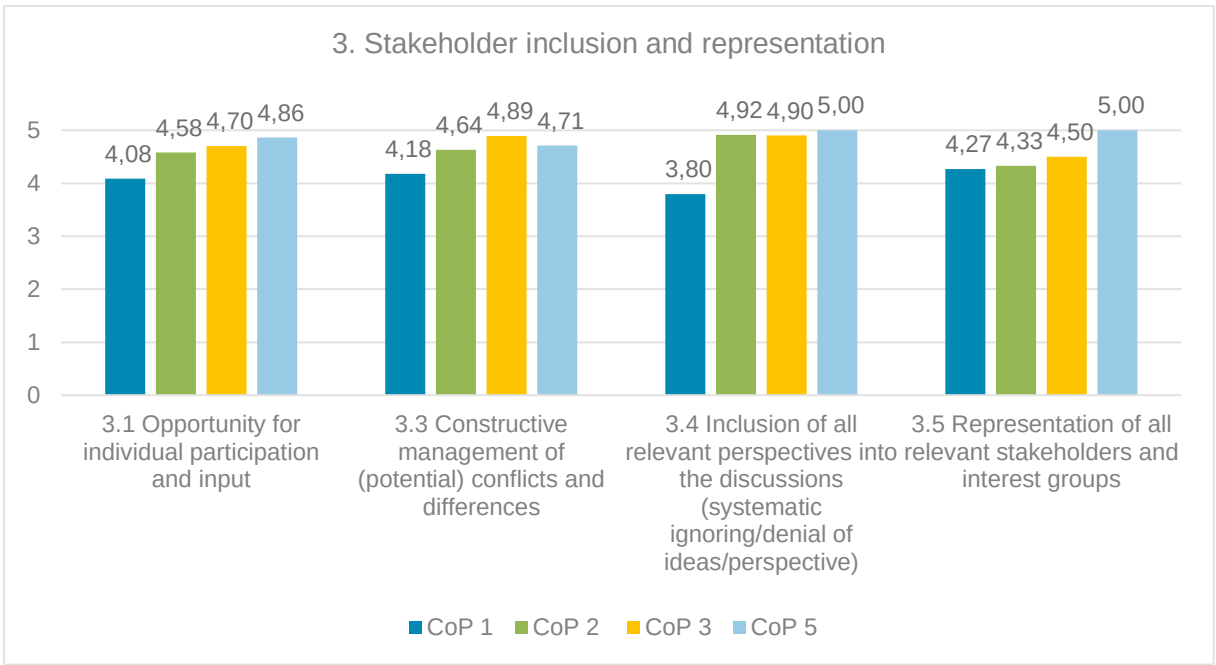

Figure 35 Awareness and increased understanding: Stakeholder inclusion and representation (CS3)

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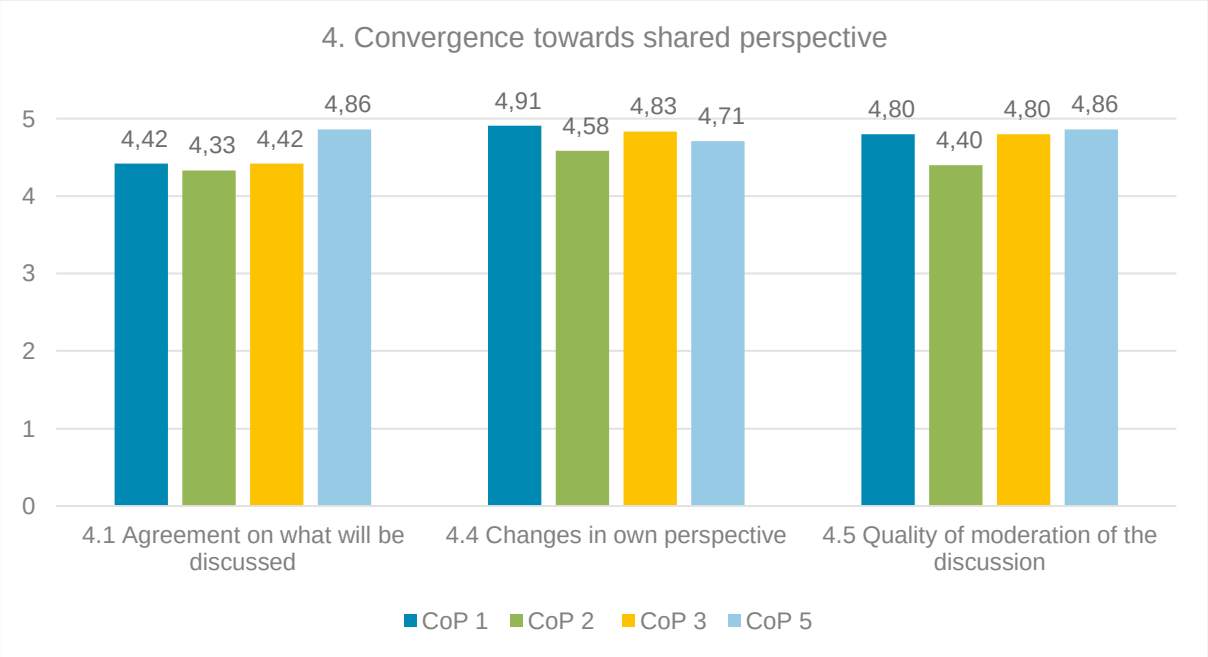

Figure 36 Awareness and increased understanding: Convergence towards shared perspective (CS3)

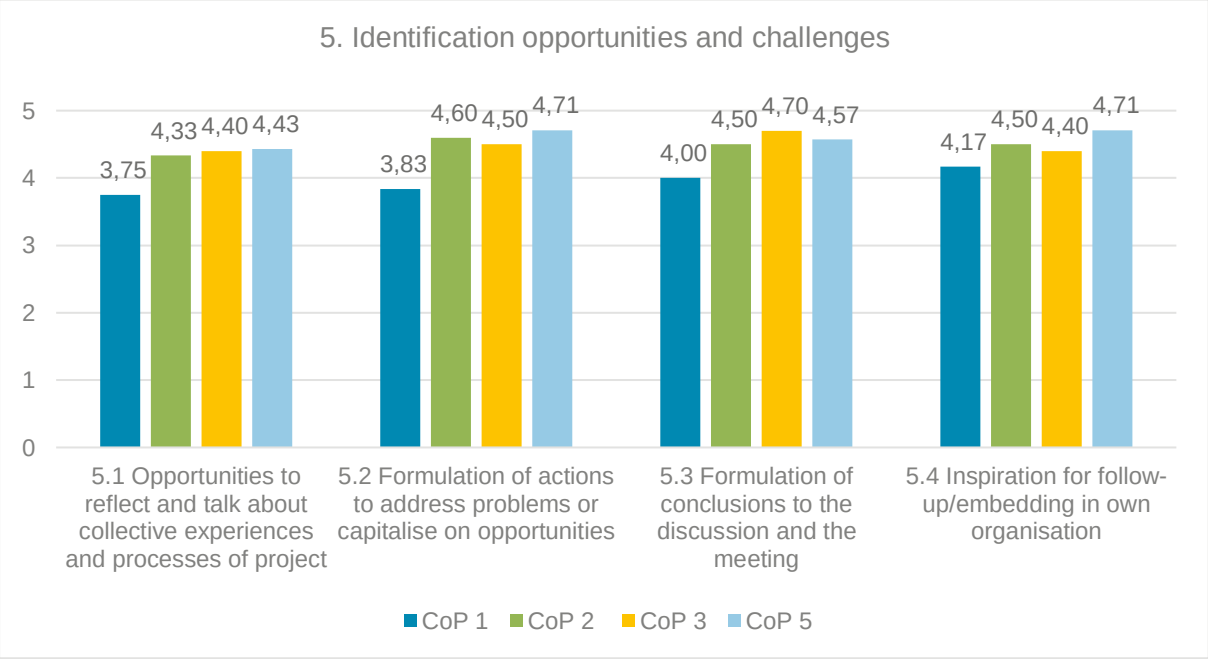

Figure 37 Outcomes and conclusions: Identification opportunities and challenges (CS3)

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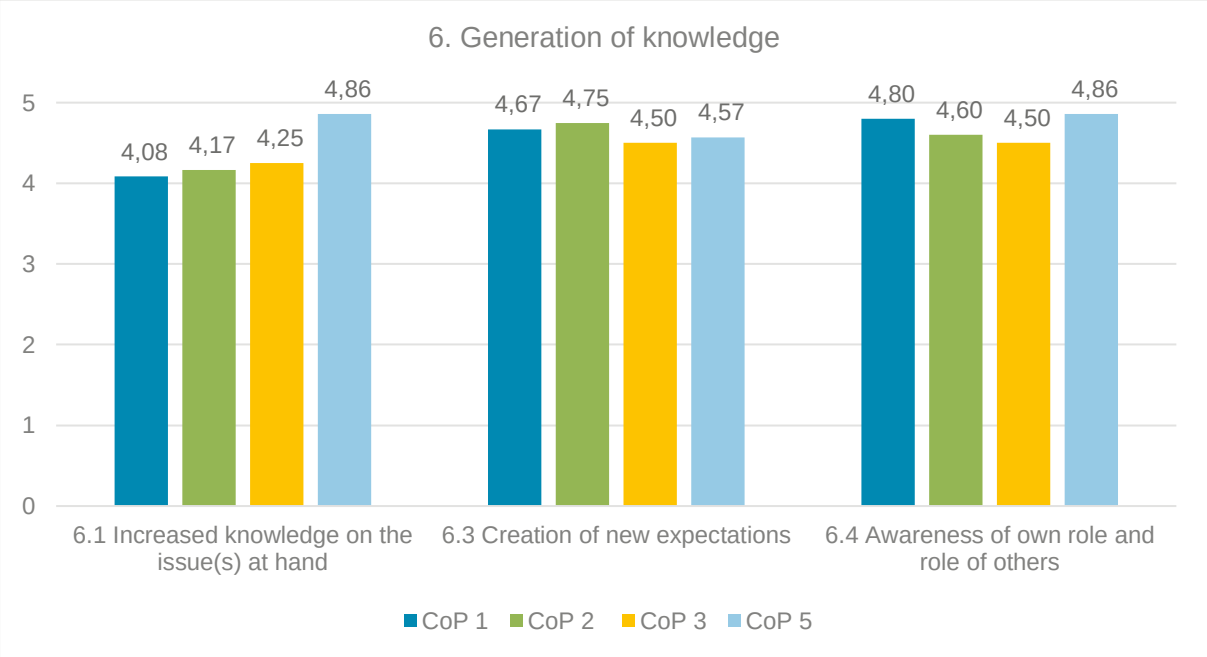

Figure 38 Outcomes and conclusions: Generation of knowledge (CS3)

Drawing insights from the evaluation survey of the CoP meetings held in CS3, stakeholders generally found the CoP meeting to be extremely valuable. Stakeholders found the CoP meetings to be collaborative and open minded. They also found the CoP to be a great opportunity to establish new connections and improve the awareness of other actors within the sector. There were few remarks on the technical level, and level of detail of the information shared, in particular for the first CoP meeting. However, over the course of the following meetings, this was no longer an issue. In fact, stakeholders expressed satisfaction about the fruitful discussions, and the possibility to openly share experiences and perspectives (especially between the public and private sectors), as well as engage with high-level stakeholders. Through the CoP, stakeholders reported that there is a growing recognition of the many circular realities and best practices already in development in the region.

The first three (3) CoP meetings were held online. Stakeholders across the three (3) CoP meetings expressed a need for face-to-face meetings to stimulate better engagement in the CoP. The LL meeting and the fifth CoP meeting were held in person and as a hybrid meeting, respectively. The hybrid approach (though technically challenging) was appreciated, as stakeholders unable to physically attend were still able to actively participate in the meeting, however face-to-face meetings remained the preferred means for meeting.

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9.5. Case study 4 - Nafplio, Greece

9.5.1. Community of Practice meeting(s)

There have been a total of three (3) CoP meetings prepared and implemented with stakeholders in CS4.

The first meeting on 14 October 2021 convened 23 stakeholders representing authorities, engineering companies, research institutes, end-users and the water industry. The online meeting objective was to map the relevant stakeholders and co-define the CoP planning (in terms of meeting frequency, meeting type and content). It was concluded that end-users, such as farmers, should be involved in the CoP. Some farmers are already engaged, however, due to their lack of technical knowledge and the early phase of the pilot, more engagement would be beneficial when progress has been made in the CS. In addition, the participation of different industry sectors (wineries, dairy production units, olive oil mills, etc.) would be essential to better identify the different water needs and the possibilities to apply the technologies and innovations proposed in ULTIMATE, as well as determine the restrictions and possible risks for the implementation of these technologies and innovations.

The CoP discussed the frequency of meetings (preferably face-to-face), with at least one site visit (to make engagement more attractive). In terms of content, topics identified were broadly defined as: WWT, regulation (how to apply new European regulations), value-added compounds, and industrial water reuse.

The second meeting was held on online on 26 May 2022 with 25 participating stakeholders representing the same stakeholder groups as in the first CoP meeting. The second meeting was a focused meeting with the objective of presenting water reuse regulation in Greece and the EU, and to collectively identify the potential barriers, as well as opportunities for the application of ULTIMATE technologies and innovations.

The third meeting was held on 31 October 2023 in a hybrid format to maintain the engagement of participants across Greece and to engage people from the area. The meeting was used to involve stakeholders from the local community, present progress of the project and to motivate and inspire the stakeholders by showcasing examples of industrial symbiotic systems and water reuse installations in a larger scale and different sectors. The meeting also included a demonstration of the pilot unit. This gave the opportunity for those participating physically to discuss the unit’s characteristics, technologies, challenges, limitations and perspectives.

Additional insights from CS4 on the acceptance, regulatory barriers and technology/solutions to enable water reuse by industry are presented in Annex G.4.

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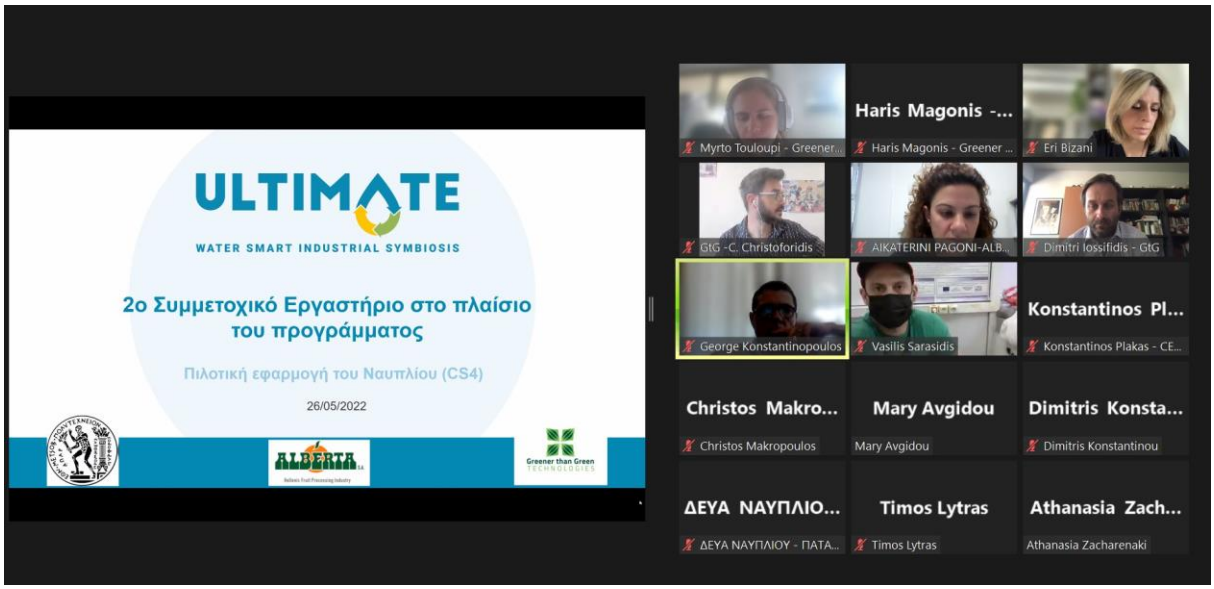

Figure 39 2nd online CoP meeting in CS4

9.5.2. Stakeholder experience and learning

On average, stakeholders in CS4 scored the CoP meetings as very valuable, finding the meetings to be informative and vivid. The figures below provide the average scores across the KSFs showing positive feedback from the CoP stakeholders over the three (3) CoP meetings.

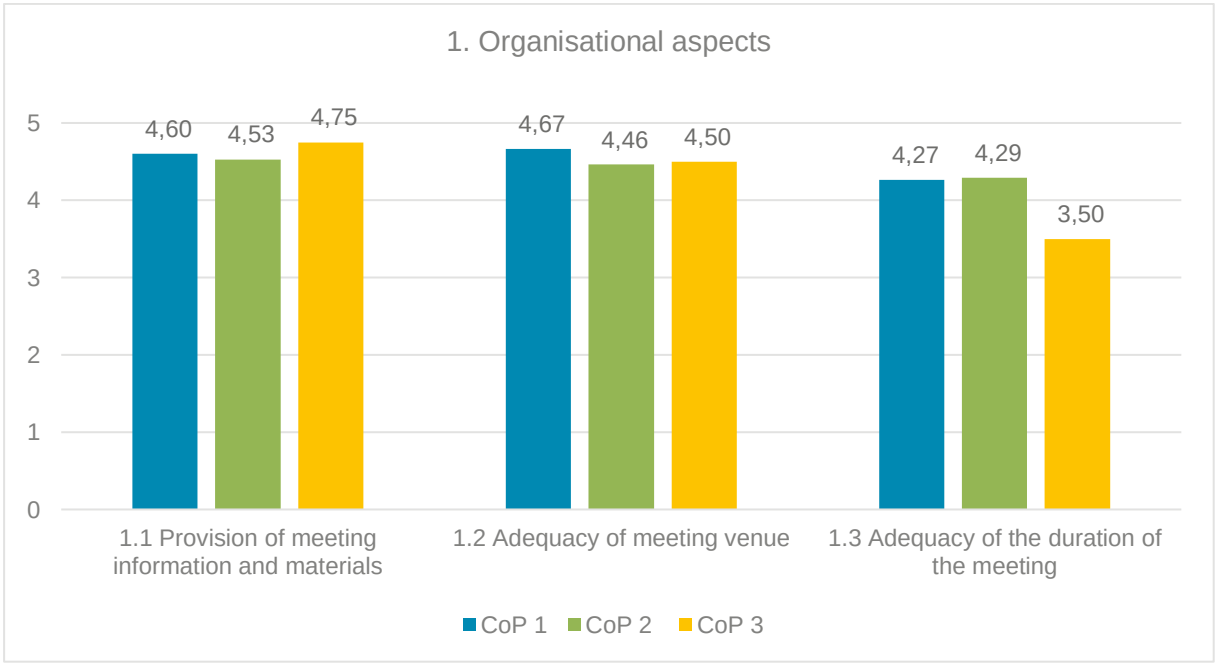

Figure 40 Meeting logistics and stakeholder engagement: Organisational aspects (CS4)

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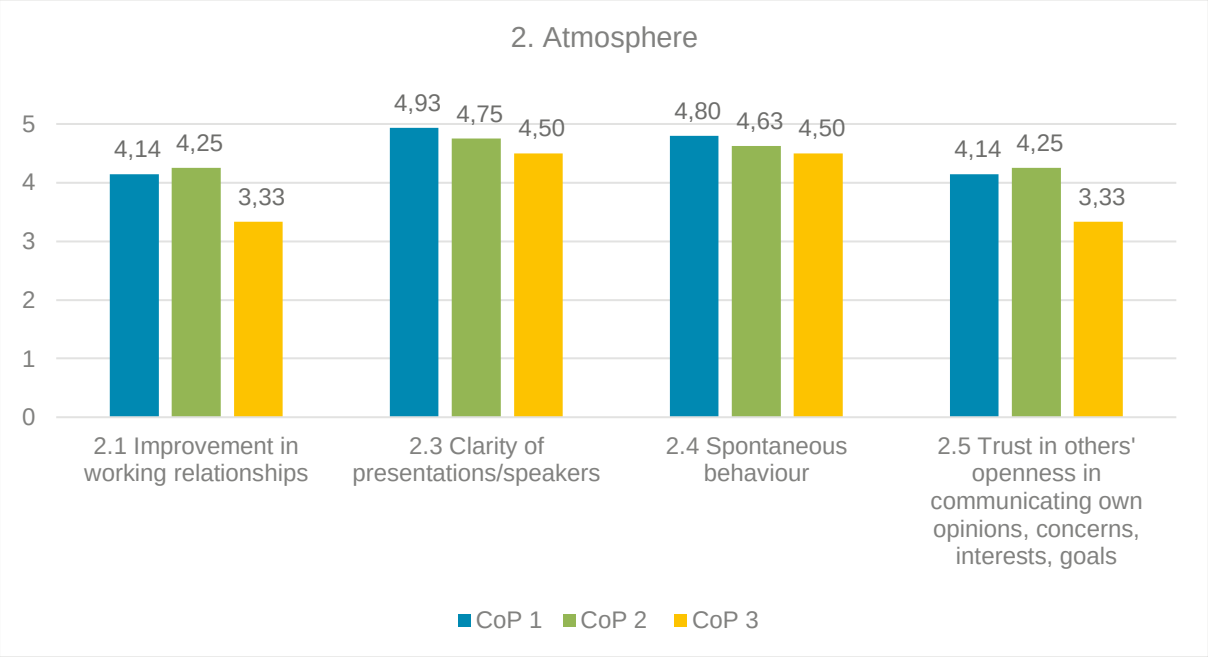

Figure 41 Meeting logistics and stakeholder engagement: Atmosphere (CS4)

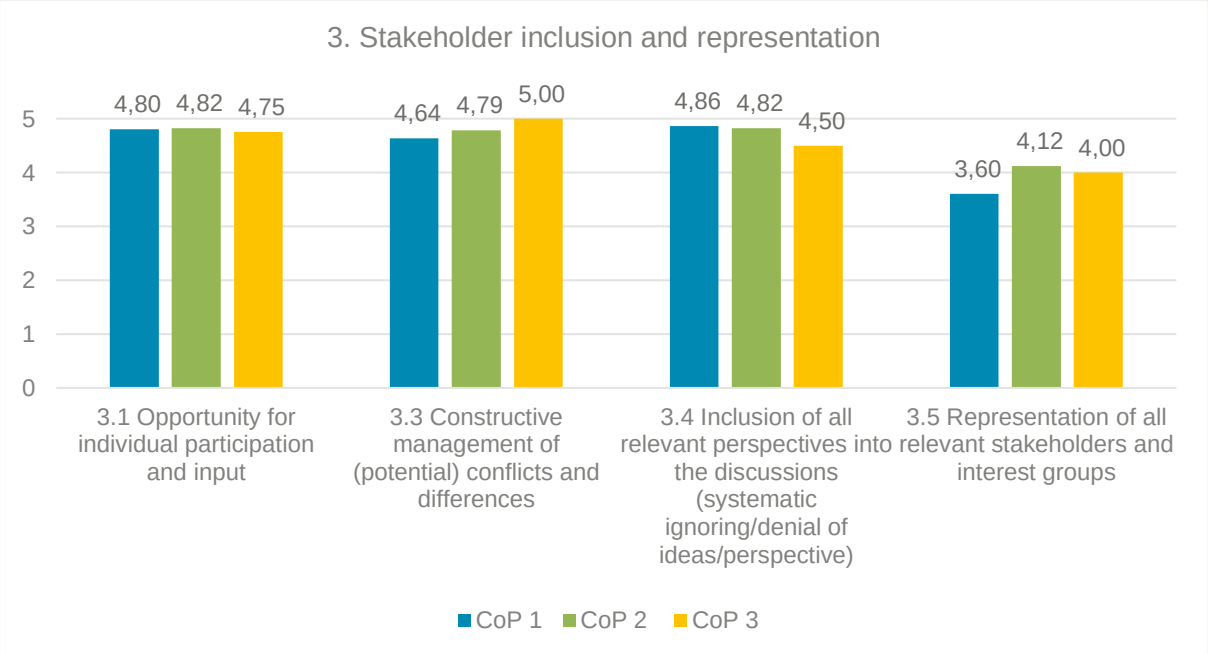

Figure 42 Awareness and increased understanding: Stakeholder inclusion and representation (CS4)

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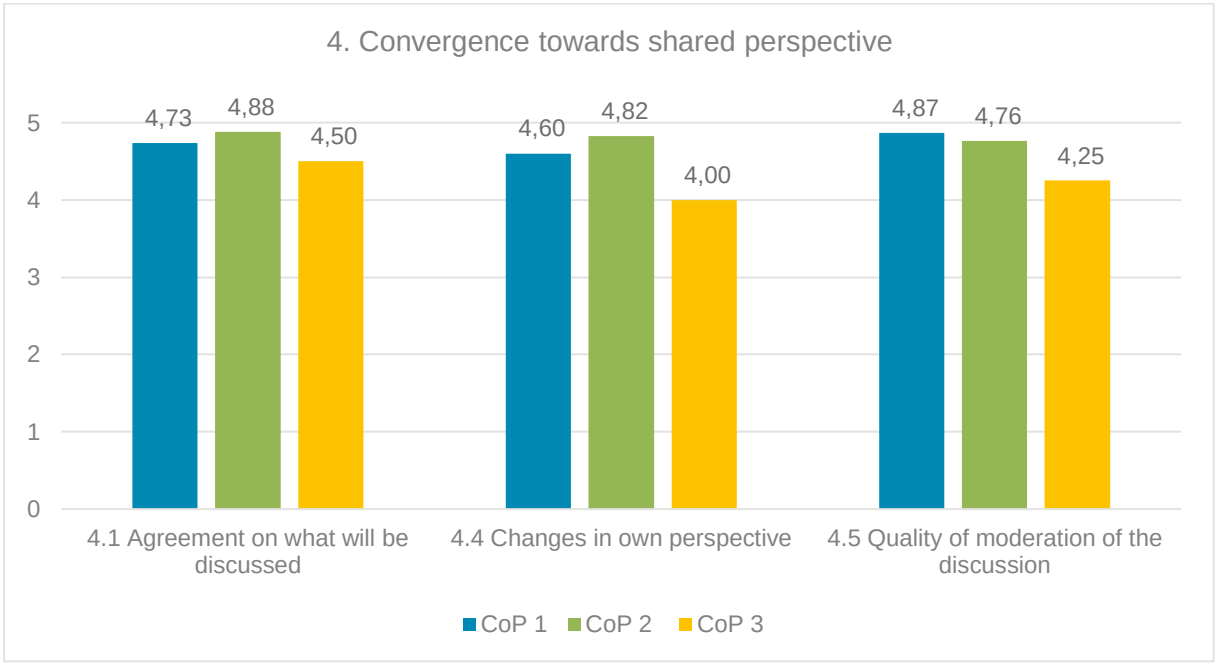

Figure 43 Awareness and increased understanding: Convergence towards shared perspective (CS4)

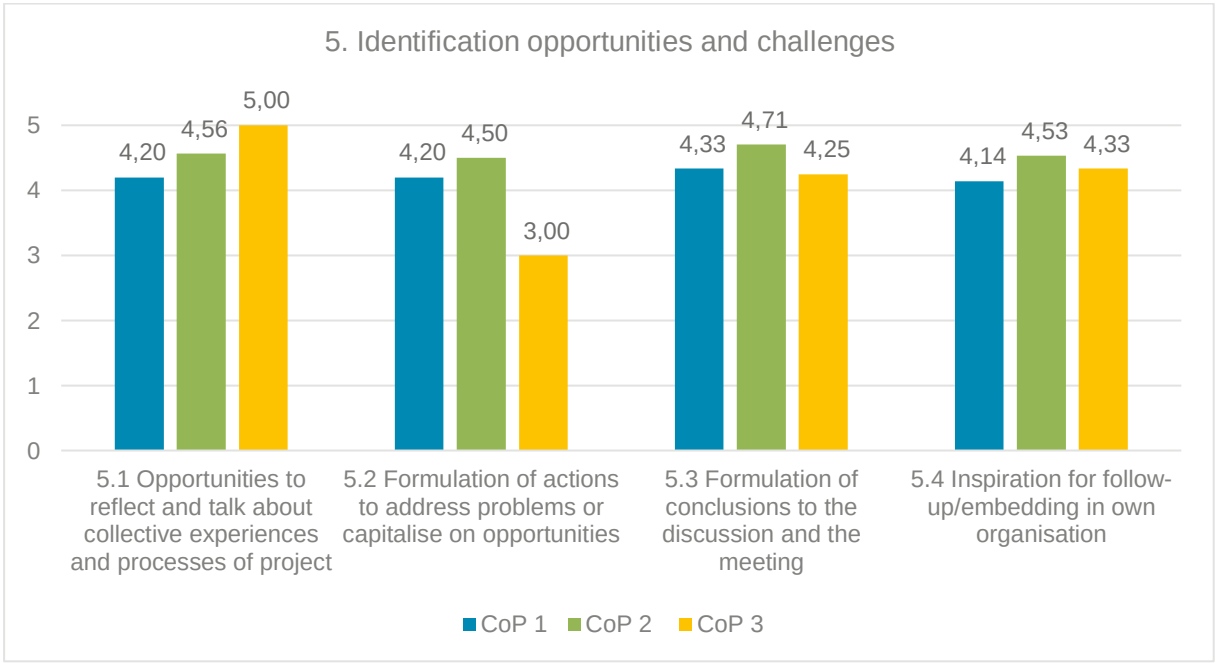

Figure 44 Outcomes and conclusions: Identification opportunities and challenges (CS4)

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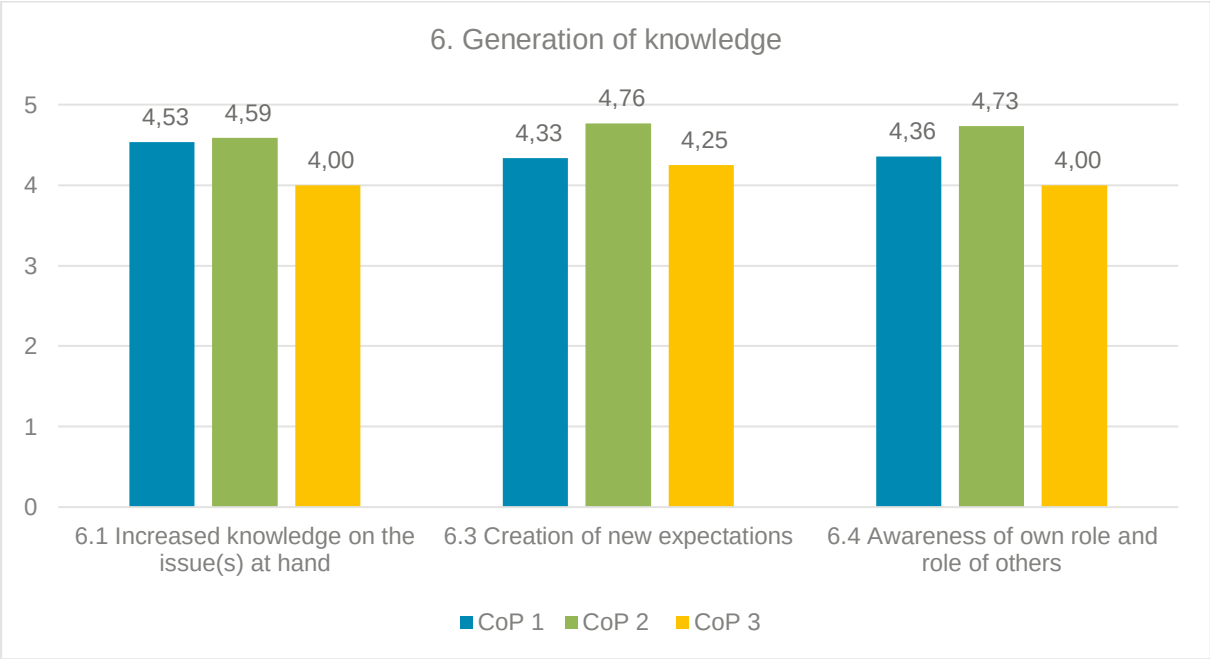

Figure 45 Outcomes and conclusions: Generation of knowledge (CS4)

Generally, stakeholders were satisfied with the meetings, with some areas in which attention should be put. There has been an improvement on the representation of stakeholders since the first CoP meeting. The stakeholders found the meeting to be informative (especially on the operational aspects of the proposed innovation), welcoming presentations on results as well as the opportunity to see pilots in operation. At the start of the CoP process, stakeholders recommended increasing the duration of CoP meetings to discuss topics in more depth, for example on the technological proposals and legislation to meet new environmental objectives. Following the recommendation, the duration of the subsequent CoP meetings was extended. Interestingly, a lower score on duration of the CoP was registered at the third CoP meeting. However, there could be other factors at play to explain such score, such as a need for more interactive modules to come to concrete and agreed next steps, or general discussions which are often challenging to facilitate with online participation.

9.6. Case study 5 - Lleida, Spain

9.6.1. Community of Practice meeting(s)

There have been three (3) CoP meeting prepared and implemented with stakeholders in CS5.

The first meeting was held online on 4 November 2021 with 13 stakeholders representing engineering companies, research institutes, end-users and representatives from the water industry. The objective of the meeting was to introduce

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ULTIMATE and the relevant activities for CS5, and for participating stakeholders to get acquainted with one another.

Stakeholders identified the gap between existing and proposed solutions and technologies and the implementation and spread of this solutions and technologies within the sector as an important issue to address. This will constitute the basis for future CoP meetings in CS5. Accordingly, the next CoP meeting will focus on approaches to overcome barriers for market replication and implementation of innovative solutions around water reclamation in the water sector. Their idea will be to discuss a possible roadmap from ideation to development and implementation.

It was observed that an important element of the CoP process is maintaining the engagement and energy of stakeholders between meetings. Stakeholders participating in the first CoP meeting expressed an expectation to be informed about progress and new developments in relation to ULTIMATE and CS5. As such the distribution of a simple 'newsletter' with project updates will be implemented. Furthermore, CS5 partners agreed to engage in bilateral meetings with the stakeholders to promote specific initiatives as well as send a letter of appreciation to those who attended the first CoP meeting.

The second meeting was held on 27 February 2023 with 9 stakeholders participating face-to-face with online streaming facilitated through Zoom. Compared to the first meeting, the value of physical participation was evident, with synergies better identified among the participating stakeholders, and new ideas learned. The organisers of the meeting reported feeling they had inspired and motivated the participants. For the participants, the meeting gave assurances that the public administration is aware of water reuse opportunities.

The third meeting was held on 5 March 2024 as an in-person meeting. Up to 99 stakeholders attended the meeting, of which 18 were selected to participate actively by means of presentations or on a panel. The meeting was organised to exchange experiences and views between water sector stakeholders (belonging to different areas of the value chain including fertiliser producers, mobility sector, biosolids end-users, etc), either specialists or with experience on water reclamation. The composition of the group reflected the intention to facilitate sectorial networking between attendees and to understand perspectives, drivers, context specific issues and uncertainties that needed to be addressed on issues related to energy in the water cycle. This topic has gained prominence in the region since the war in Ukraine which brought energy security high up in the political agenda. Following stakeholders' feedback on previous CoP meetings, the CoP organiser set up round table discussion, which motivated participants to pose questions and sparked lively discussion.

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Additional insights from CS5 on the acceptance, regulatory barriers and technology/solutions to enable water reuse by industry are presented in Annex G.5.

Figure 46 Site visit during the 2nd CoP meeting in CS5

Figure 47 3rd CoP meeting in CS5

9.6.2. Stakeholder experience and learning

Stakeholders participating in the CoP meetings found it to be generally very valuable. In particular, stakeholders associated the CoP with the opportunity to share challenges, transfer knowledge and experiences, discuss practical solutions, and get

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exposure for demonstration projects. The following figures provide the average scores across the KSFs.

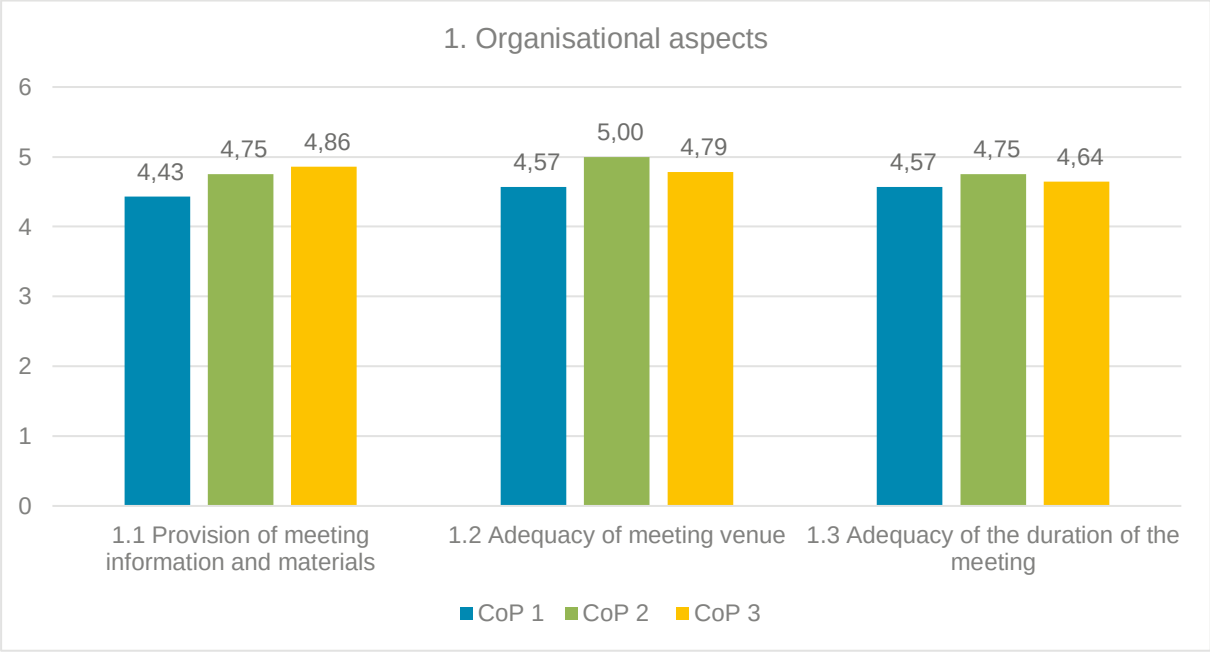

Figure 48 Meeting logistics and stakeholder engagement: Organisational aspects (CS5)

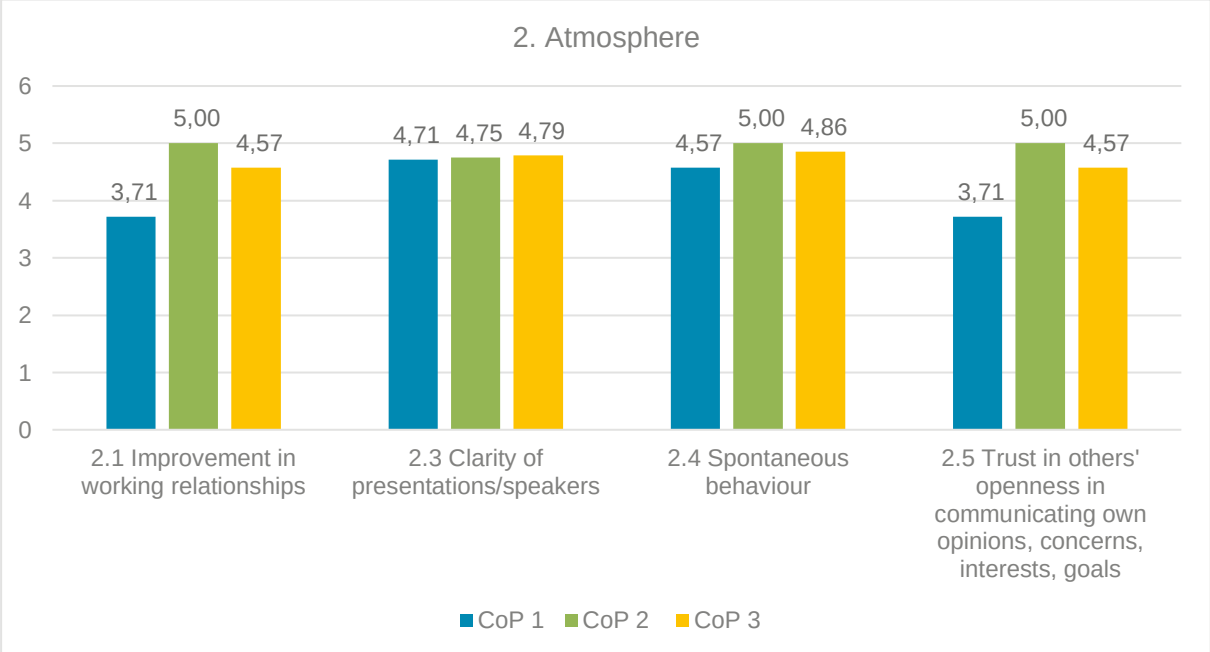

Figure 49 Meeting logistics and stakeholder engagement: Atmosphere (CS5)

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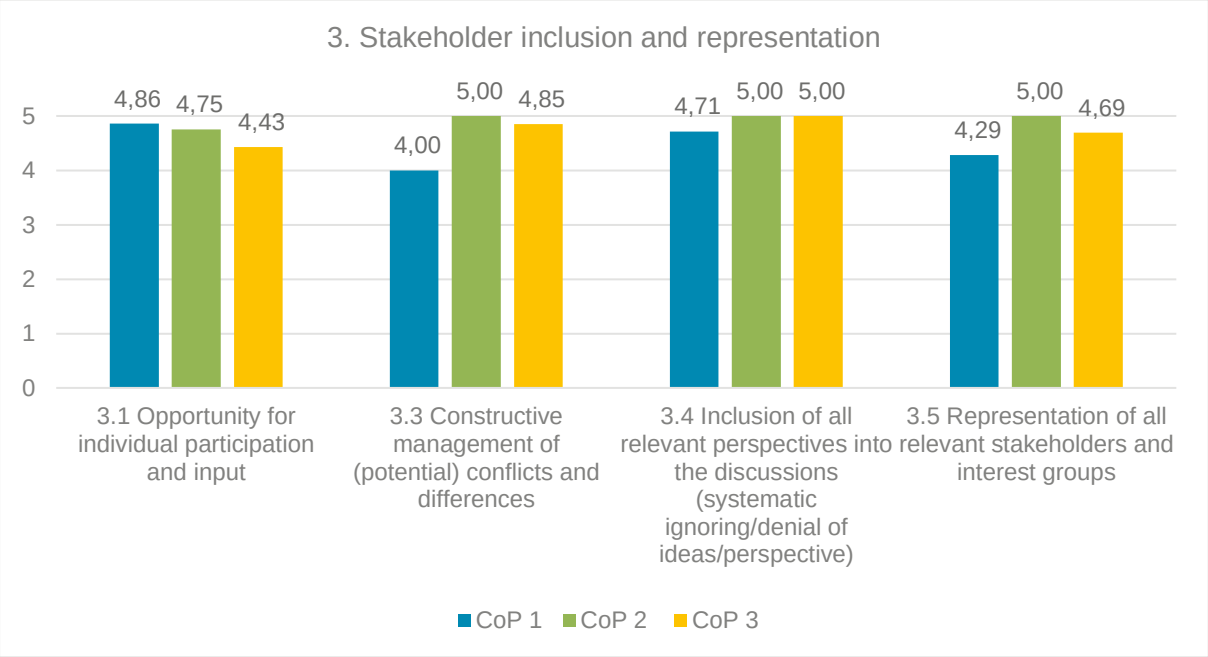

Figure 50 Awareness and increased understanding: Stakeholder inclusion and representation (CS5)

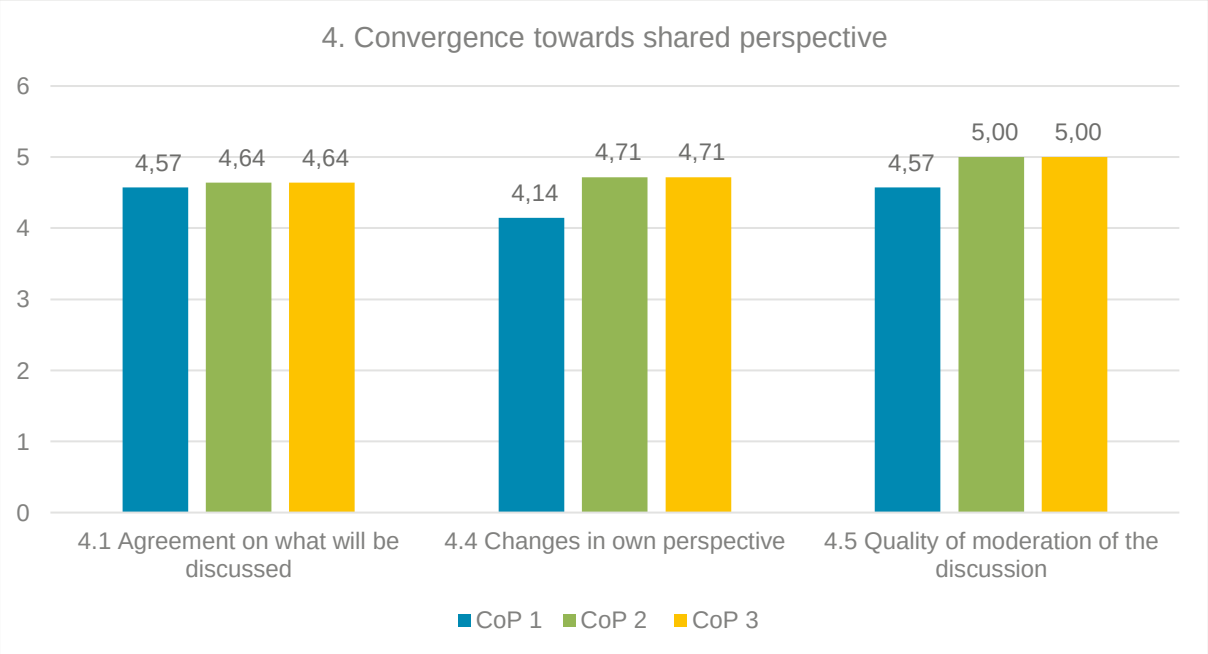

Figure 51 Awareness and increased understanding: Convergence towards shared perspective (CS5)

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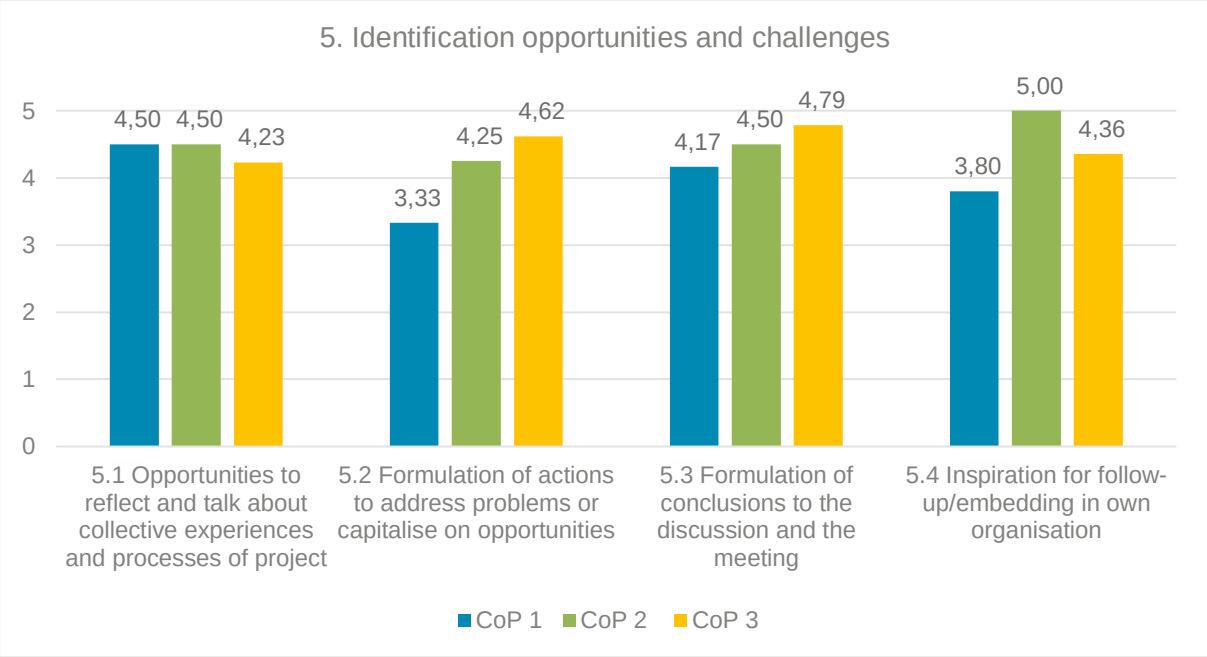

Figure 52 Outcomes and conclusions: Identification opportunities and challenges (CS5)

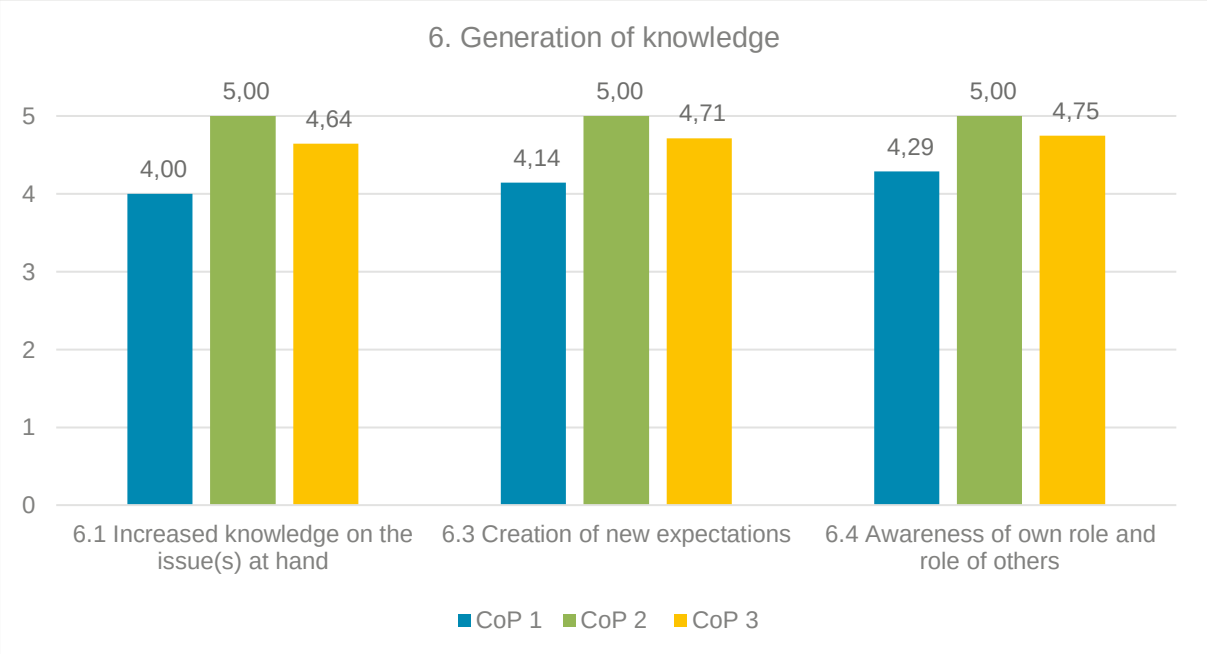

Figure 53 Outcomes and conclusions: Generation of knowledge (CS5)

Stakeholder showed willingness to learn, share and discuss, in particular, about emerging technologies and innovations and their role in implementing and spreading these technologies and innovations within the broader water sector and with other sectors (e.g., the energy sector). This, for them, also means discussing both barriers and opportunities for market replication and implementation.

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The participation of different stakeholder groups ensured that multiple perspectives on the same topic could be shared (e.g., the perspective of technology providers, farmers, public authorities, energy producers, etc.). This in turn enabled stakeholders to formulate a more nuanced and articulated idea of the challenges and potential solutions in the specific context under discussion. Understanding the perception of different stakeholder groups has remained an important aspect in facilitating engagement and dialogue between stakeholders in order to work towards a common objective, and to improve the experience and learning among the CoP stakeholders.

9.7. Case study 6 - Karmiel and Shafdan, Israel

9.7.1. Community of Practice meeting(s)

One (1) CoP meeting has been prepared and implemented with stakeholders in CS6. A second CoP meeting was scheduled on 11-12 October 2023, however this had to be cancelled because the conflict in Israel. The CS partners do not foresee the feasibility of organising future CoP meetings, but are committed to continue the engagement with their stakeholders through online means. The CS6 partners aim to collect more data from a pilot system now in operation, and a subsystem of Greener than Green Technologies (GtG) which will be in operation towards the end of this year. The expectation was to have data from the two (2) pilots and share the results with the CoP stakeholders.

The first meeting was a hybrid meeting held on 16 December 2021 with 23 participating stakeholders representing engineering companies, research institutes and representatives from the water industry. The objective of the first meeting was to present ULTIMATE and outline proposed technologies and innovations to address concerns around the discharge of untreated agro-industrial waste into the central WWT system. The current regulation around waste disposal was also reviewed during the meeting with the stakeholders.

Despite different stakeholder groups were represented, CS6 noted the absence of representatives from the olive mills, wineries and dairy sectors who are important contributors to the agro-industrial wastewater. Their presence is considered essential to address the issues faced in CS6 in dialogue with the regulators and the water corporations. Efforts will be made to ensure their engagement in the next CoP meeting in 2023.

Additional insights from CS6 on the acceptance, regulatory barriers and technology/solutions to enable water reuse by industry are presented in Annex G.6.

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Figure 54 Stakeholders of the 1st hybrid CoP meeting in CS6

Figure 55 1st hybrid CoP meeting in CS6

9.7.2. Stakeholder experience and learning

Despite the missing stakeholders, which resulted in a low score on the stakeholders inclusion and representation, input from the evaluation of the first CoP meeting showed that stakeholders found the CoP meeting to be very valuable. The preparations for the second CoP meeting focussed on securing the engagement of all relevant stakeholders groups to ensure meaningful discussion and agreement on actions around relevant topics.

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The following figures provide the average scores across the KSFs. In general, the scores are positive. Stakeholders appreciated the CoP for stimulating an open discussion between and among stakeholders on knowledge, problems, and solutions. In addition, the new technologies and innovations presented were well received by the participating stakeholders, who appreciated the opportunity to discuss the design of these solutions to ensure their local relevance. However, the absence of key industry representatives who contribute to the wastewater problem was frequently communicated by the stakeholders, and emphasis was put on the need to ensure their engagement in the CoP.

Furthermore, the CoP stakeholders felt that there was not sufficient time to draw conclusions from the sessions and to define concrete next steps and actions together. This is a point of improvement for the next meetings.

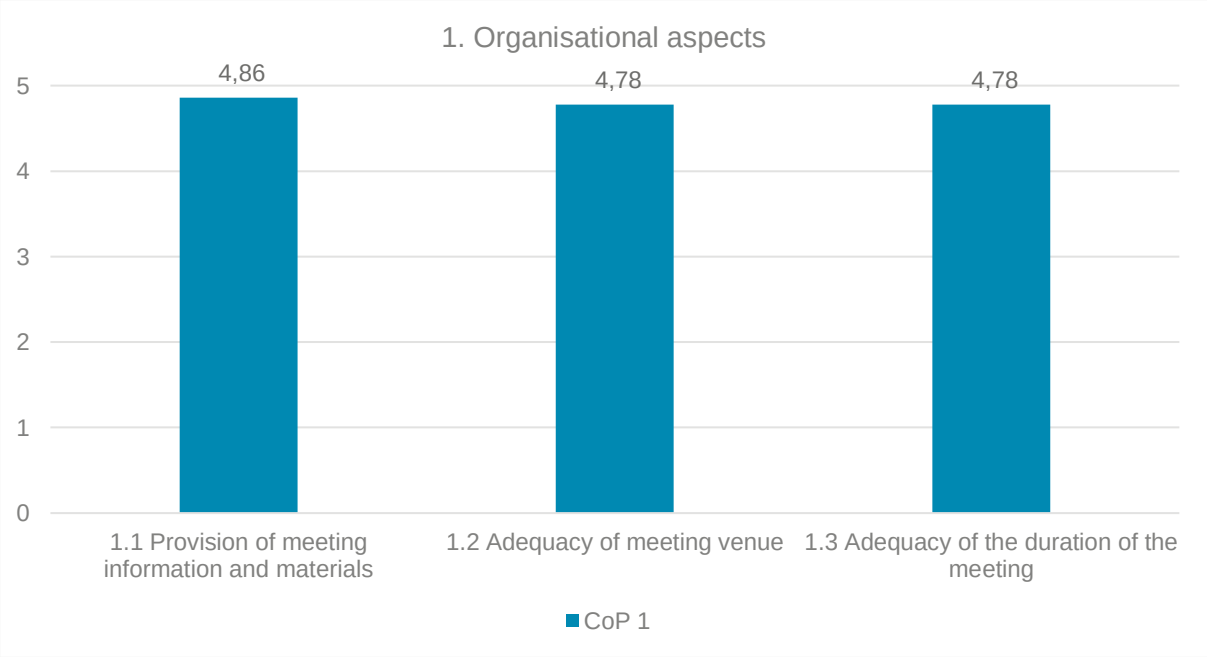

Figure 56 Meeting logistics and stakeholder engagement: Organisational aspects (CS6)

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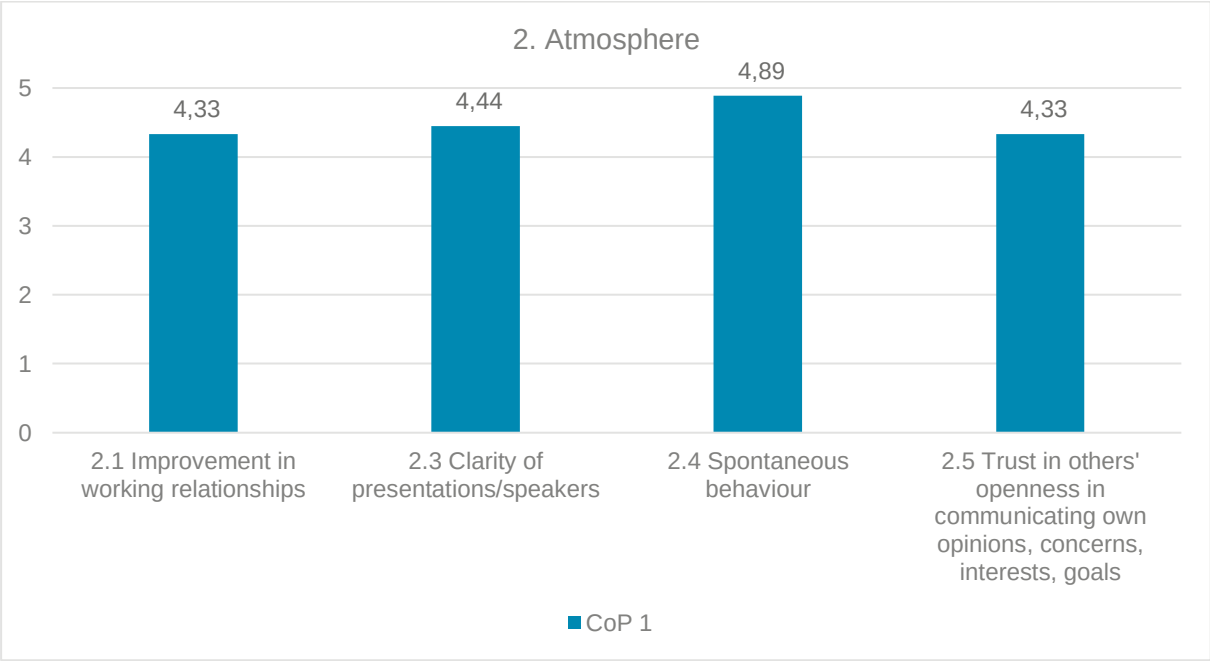

Figure 57 Meeting logistics and stakeholder engagement: Atmosphere (CS6)

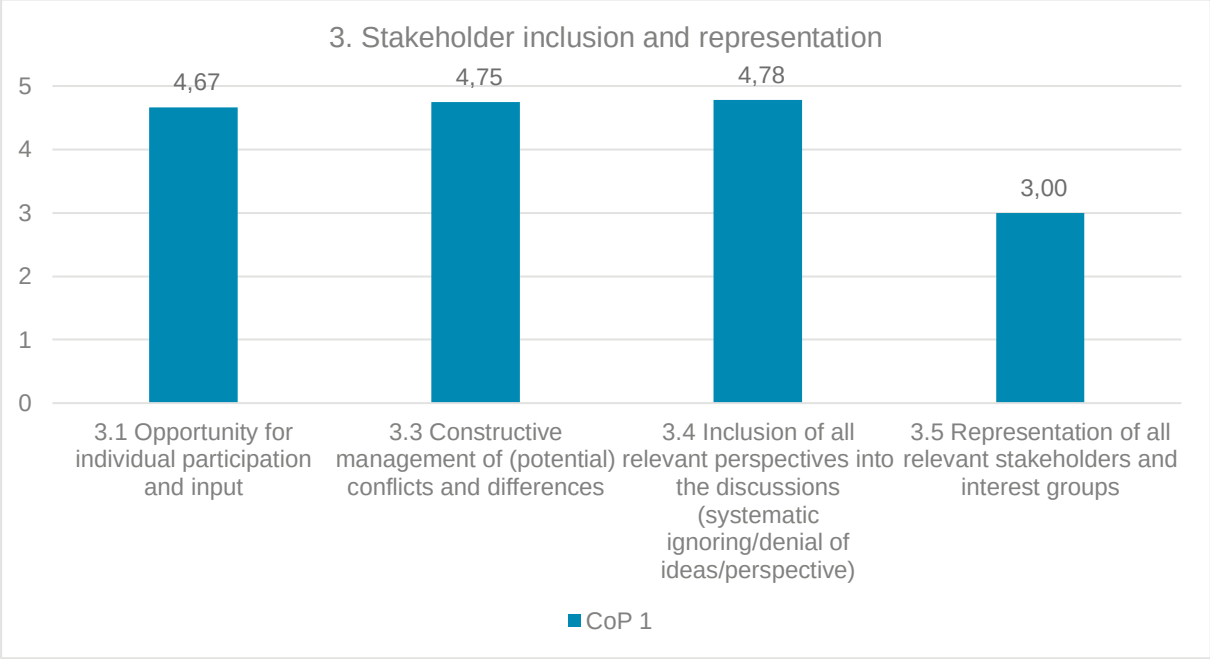

Figure 58 Awareness and increased understanding: Stakeholder inclusion and representation (CS6)

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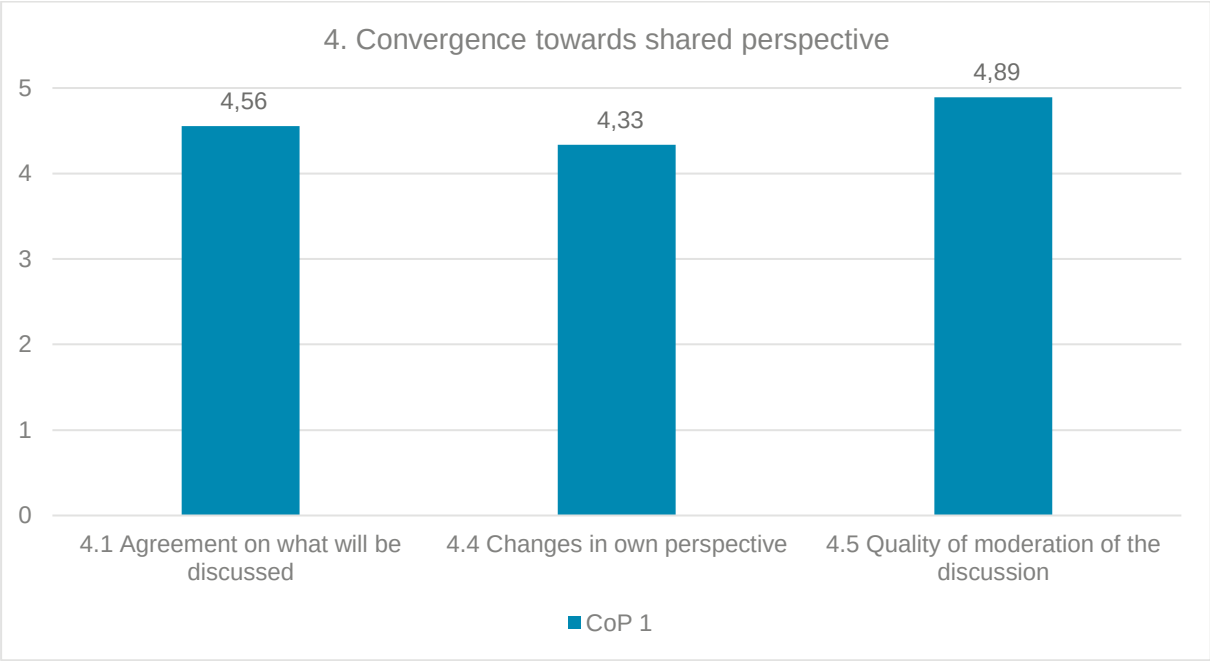

Figure 59 Awareness and increased understanding: Convergence towards shared perspective (CS6)

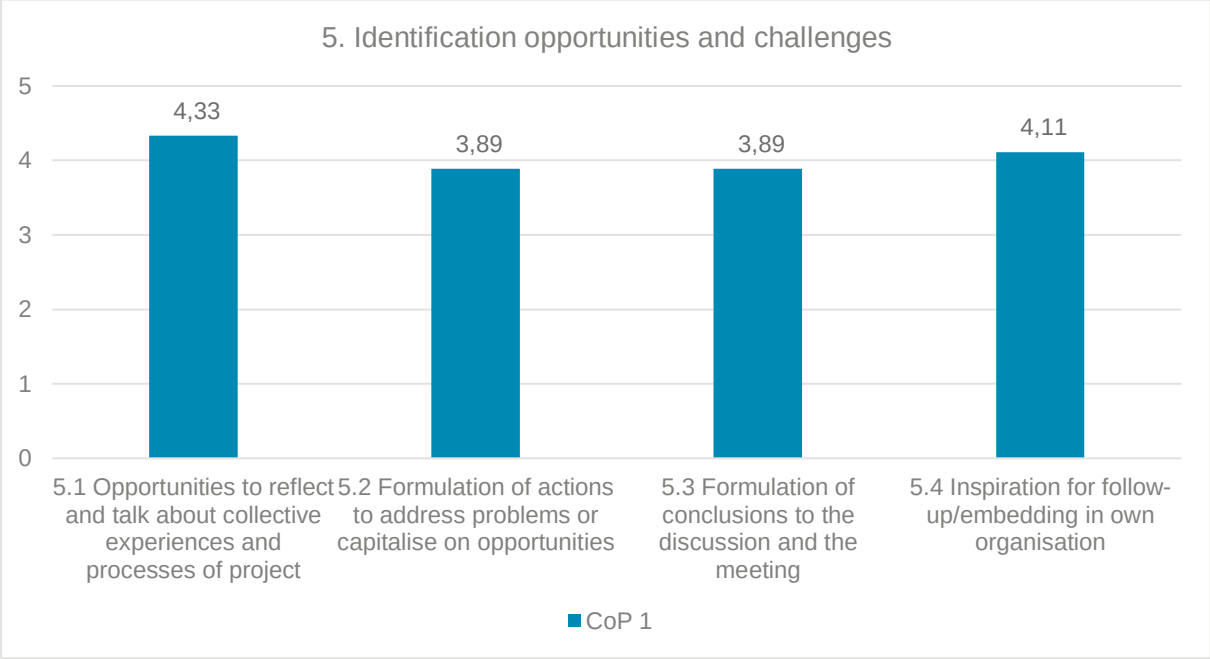

Figure 60 Outcomes and conclusions: Identification opportunities and challenges (CS6)

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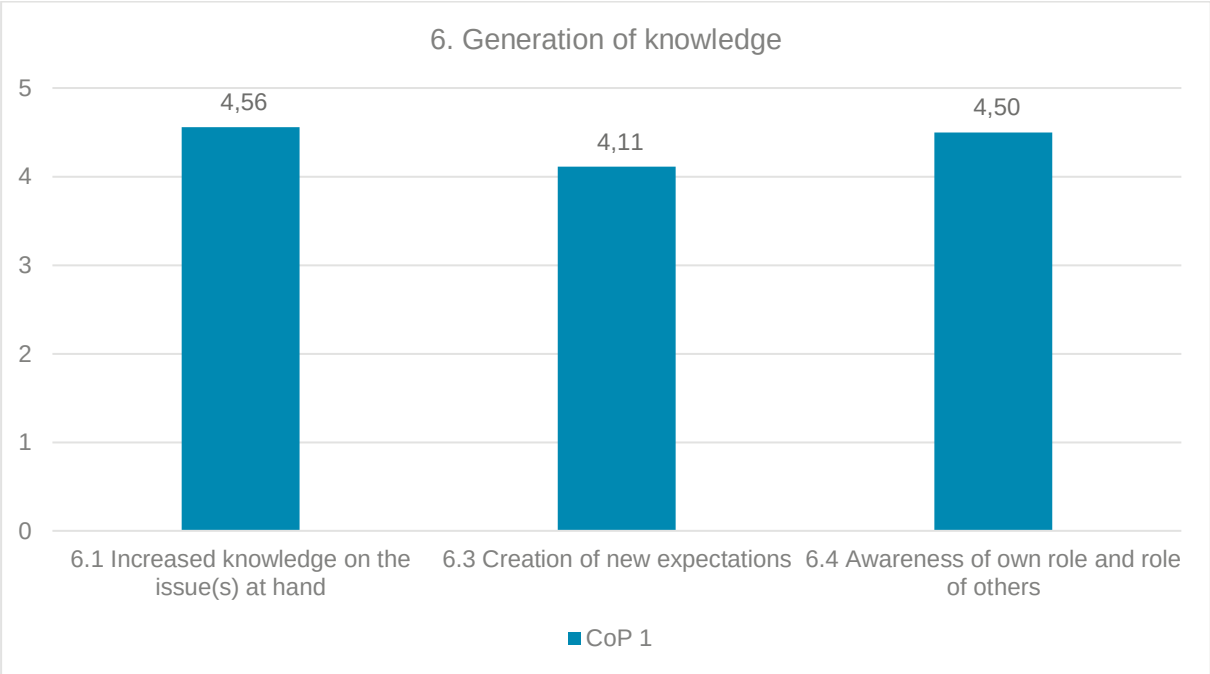

Figure 61 Outcomes and conclusions: Generation of knowledge (CS6)

9.8. Case study 7 - Tain, Scotland

9.8.1. Community of Practice meeting(s)

CS7 held one (1) CoP meeting, followed by an attempt to organise a follow up CoP meeting with stakeholders that were not able to participate in the first one. CS7 encountered several challenges in organising their first CoP meeting due to delays in designing the demonstration system. Due to this delay, the first CoP meeting, originally planned for 2021, was rescheduled to prioritise essential technical work. This prioritisation ensures the system could be built and commissioned by the end of the year. Plans to prepare the first CoP meeting in 2022 were further suspended due to the unavailability of key representatives from the Glenmorangie distillery. The participation of relevant stakeholders is essential to discuss the reasoning and ambitions for the expansion of the existing infrastructure in line with current circular economy approaches. Despite the challenges, CS7 has been engaging in bilateral conversations with relevant stakeholders to secure their engagement in the CoP before setting the date of the CoP meeting. CS7 faced new challenges which interrupted the communication between the project partners and the distillery, affecting the ability to plan a CoP meeting. The ULTIMATE CS7 partners dedicated time to re-establish the communication with the onsite partners to implement the first CoP meeting while maintaining the established link with the already engaged stakeholders. As a result, the first CoP meeting was held on 5 May 2023. The focus of the meeting was to introduce the ULTIMATE project, the case study and some of the initial results, and to

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then discuss with the stakeholders the potential and limitations in the implementation of industrial symbiosis and circular economy solutions in the area.

Insights from CS7 on the acceptance, regulatory barriers and technology/solutions to enable water reuse by industry are presented in Annex G.7.

9.8.2. Stakeholder experience and learning

Stakeholders participating in the CoP meeting found the CoP overall to be very valuable. In particular, stakeholders found the CoP meeting useful for establishing new connections and stimulating conversation with new stakeholders. They were also excited about the prospect of learning about new innovations. Participating stakeholders were satisfied with the open discussion and the many perspectives shared.

Discussion in the meeting led to clear indications about some of the challenges to be faced for the reuse of products recovered for agriculture use (sludge, struvite, ammonium sulphate) due to both regulatory and practical (cost) limitations. In particular, it emerged from the discussion that a number of regulatory and environmental pressures, which could lead to the reduction of water abstraction and/or stricter permits for effluents discharge, represent significant drivers for the implementation of technologies for water reuse and nutrients removal (and recovery) that needs to be considered.

A limited number of stakeholders was actively engaged in the discussion and participants acknowledged that more engagement from the farmers/agriculture sector, the distillery itself and the regulators would benefit the CoP. Based on this observation, it was agreed that key groups, most importantly the regulators, needed to be brought into future discussions.

The following figures provide the average scores across the KSFs.

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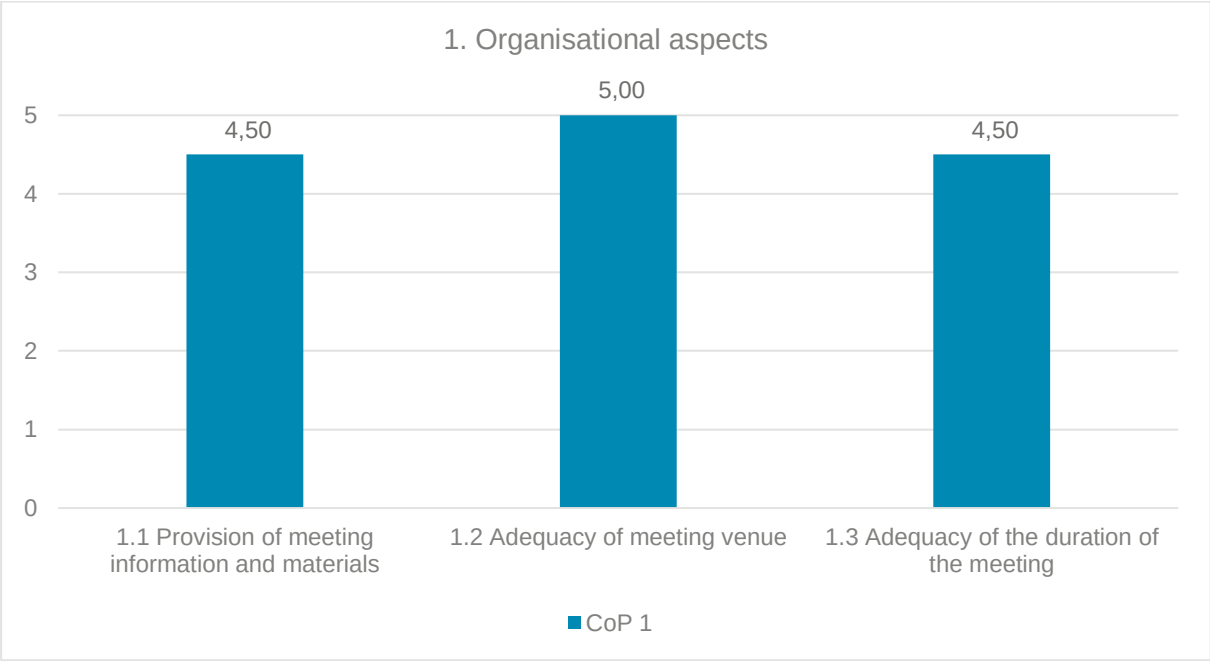

Figure 62 Meeting logistics and stakeholder engagement: Organisational aspects (CS7)

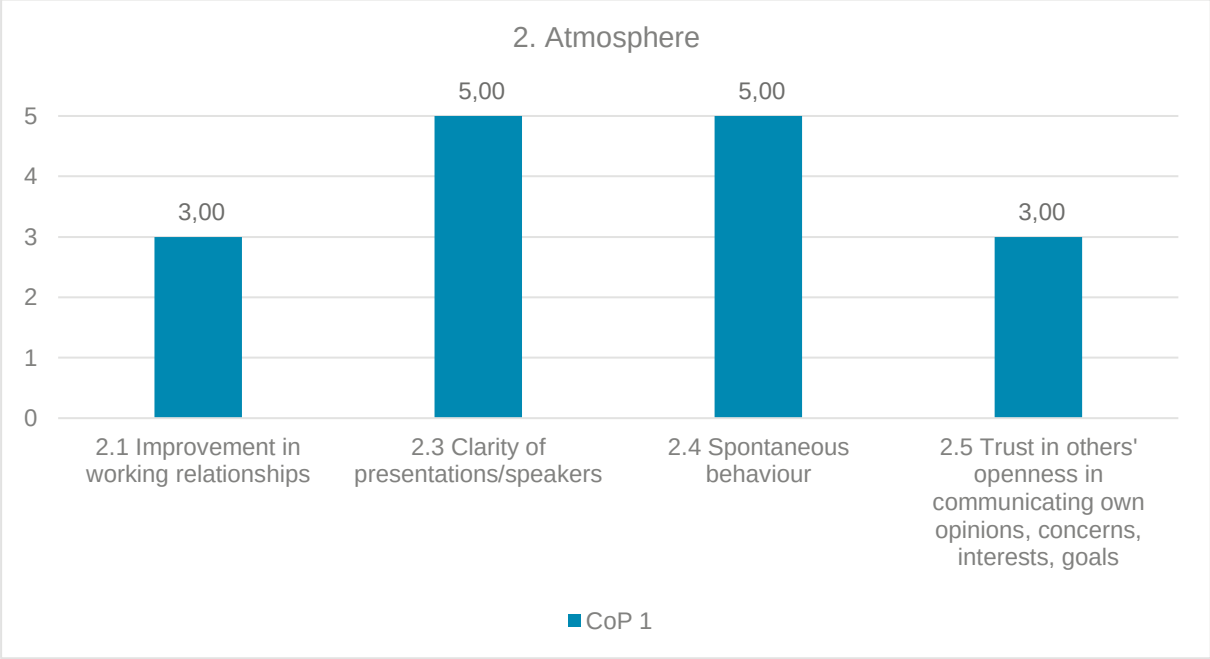

Figure 63 Meeting logistics and stakeholder engagement: Atmosphere (CS7)

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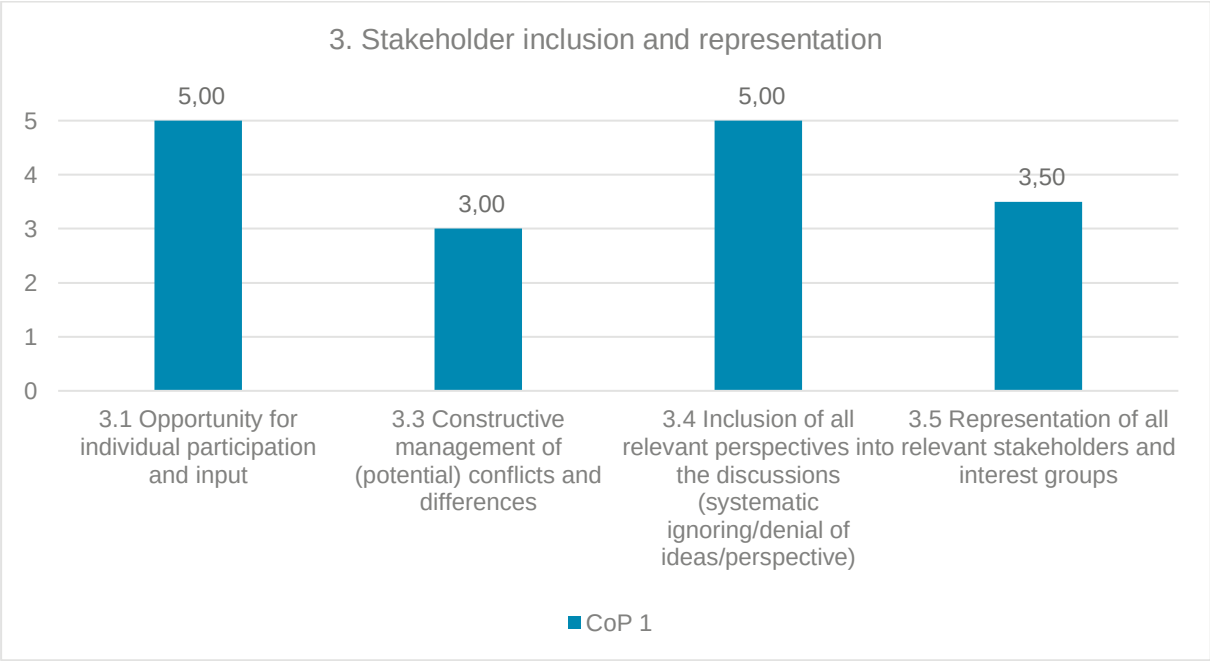

Figure 64 Awareness and increased understanding: Stakeholder inclusion and representation (CS7)

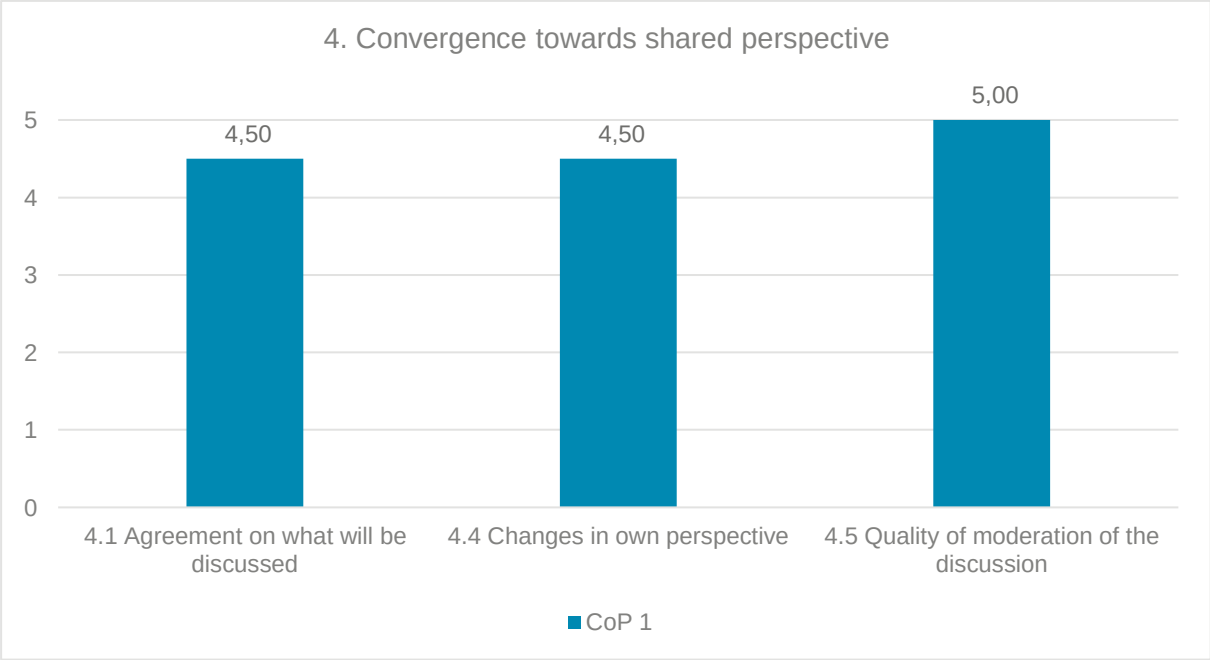

Figure 65 Awareness and increased understanding: Convergence towards shared perspective (CS7)

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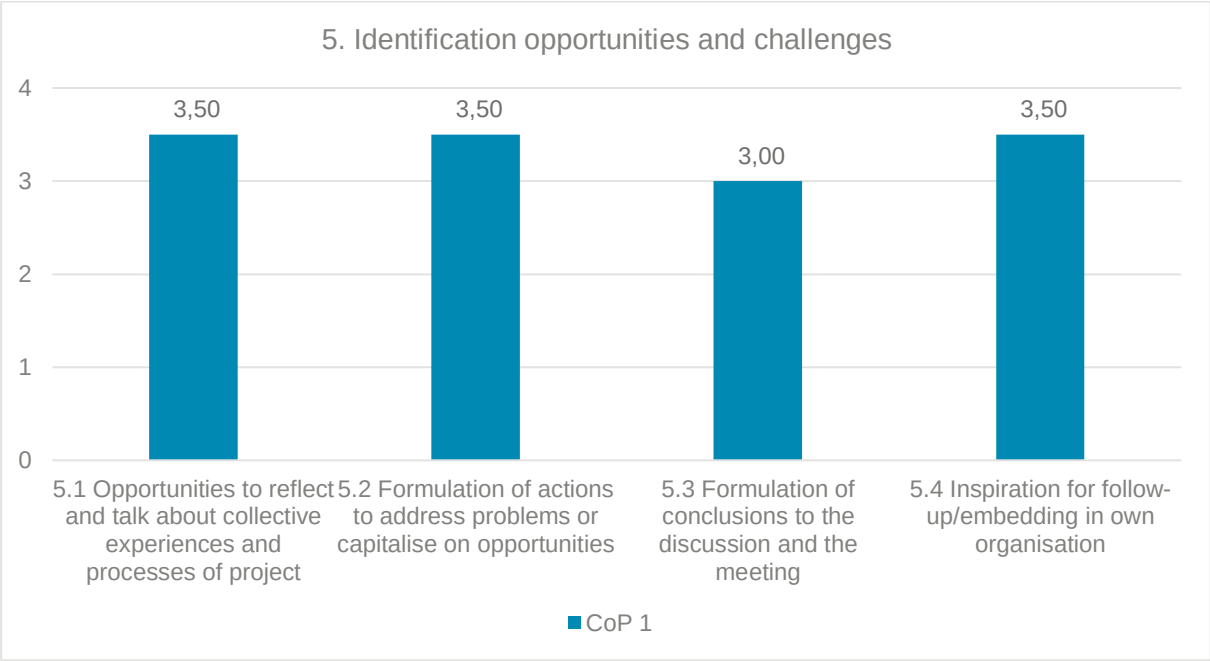

Figure 66 Outcomes and conclusions: Identification opportunities and challenges (CS7)

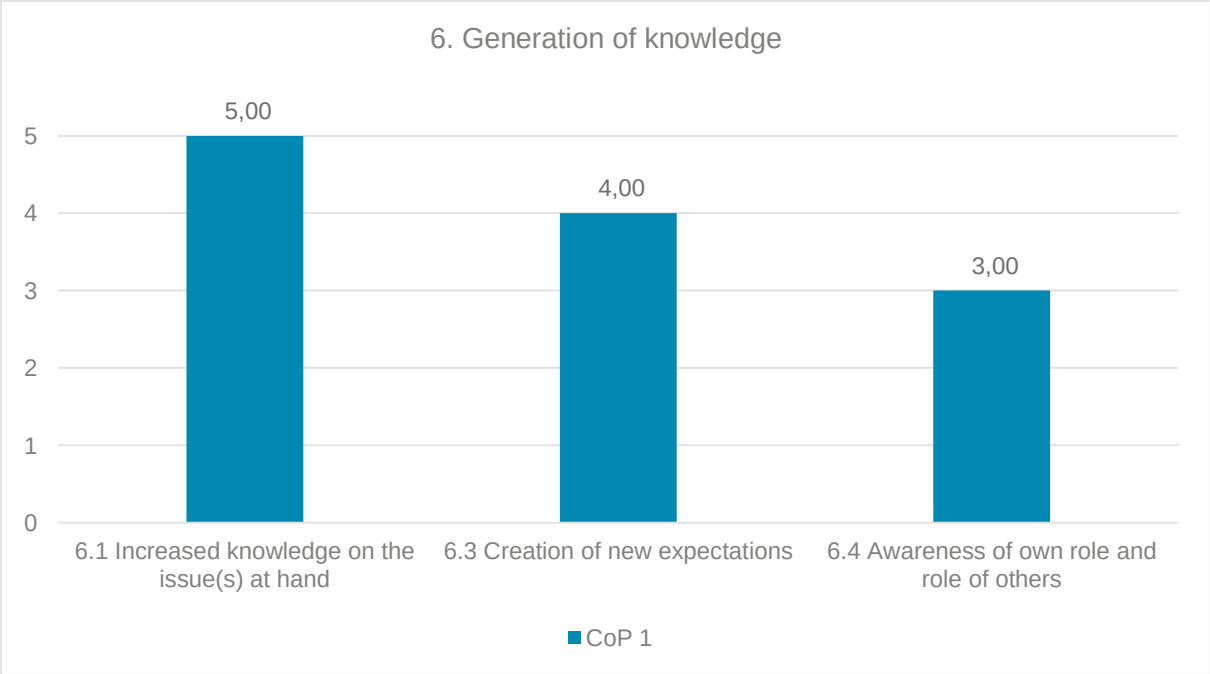

Figure 67 Outcomes and conclusions: Generation of knowledge (CS7)

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9.9. Case study 8 - Saint Maurice L'Exil, France

9.9.1. Community of Practice meeting(s)

One (1) CoP meeting was prepared and implemented on 1 December 2021 with 14 participants taking part in the meeting representing upstream customers, economic interest groups, and representatives engaged in the transport and trading of secondary raw material. Authority representatives were invited but did not accept the invitation to join the CoP meeting.

The first CoP meeting was held to present the European context, and ULTIMATE with a focus on CS8 objectives, resources and planning. The meeting was the opportunity to co-establish the CoP with a clear definition of the objectives and benefits (coordination and synergies between stakeholders, participate in a cross-cutting community of experts, etc.), as well as map out the relevant stakeholders to engage. CS8 partners recognised the need for face-to-face meetings as well as the need to set more targeted agenda topics.

Insights from CS8 on the acceptance, regulatory barriers, and technology/solutions to enable water reuse by industry are presented in Annex G.8.

9.9.2. Stakeholder experience and learning

Stakeholders reported the first CoP meeting to be very valuable. The KSF statements were also scored high. In fact, stakeholders found explanations, particularly on technical aspects, to be clear and simple to understand. They see the CoP as a good opportunity to engage in a dynamic and open exchange on topics of importance to the stakeholder groups, such as the valorisation of materials and energy.

Stakeholders also expressed interest in having meetings on specific topics to collect input from stakeholders with different backgrounds and expertise. Future meetings should be face-to-face to enable better interaction, improve learning and facilitate knowledge exchange.

Stakeholders also pointed out the need to have a summary of the points discussed, and provide intermediate updates between meetings in order to advance on the actions to be implemented. For an effective CoP process, stakeholders also suggested that constraints, whether logistical, technical, etc., should be shared openly.

In CS8, the improved working relationship between stakeholders scored low, compared to the other CSs. The summary of results is always shared with the CS partners to be addressed in future CoP meetings. Through continued monitoring and evaluation of the CoP meetings, changes in the dynamics of the CoP can be observed.

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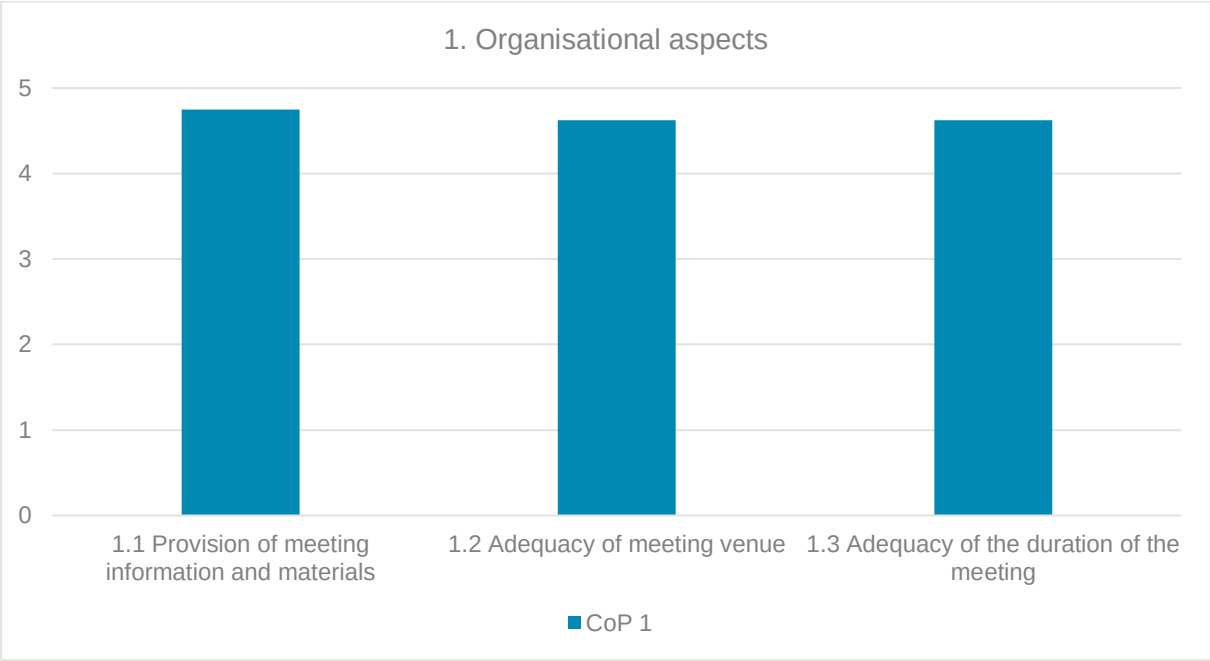

Figure 68 Meeting logistics and stakeholder engagement: Organisational aspects (CS8)

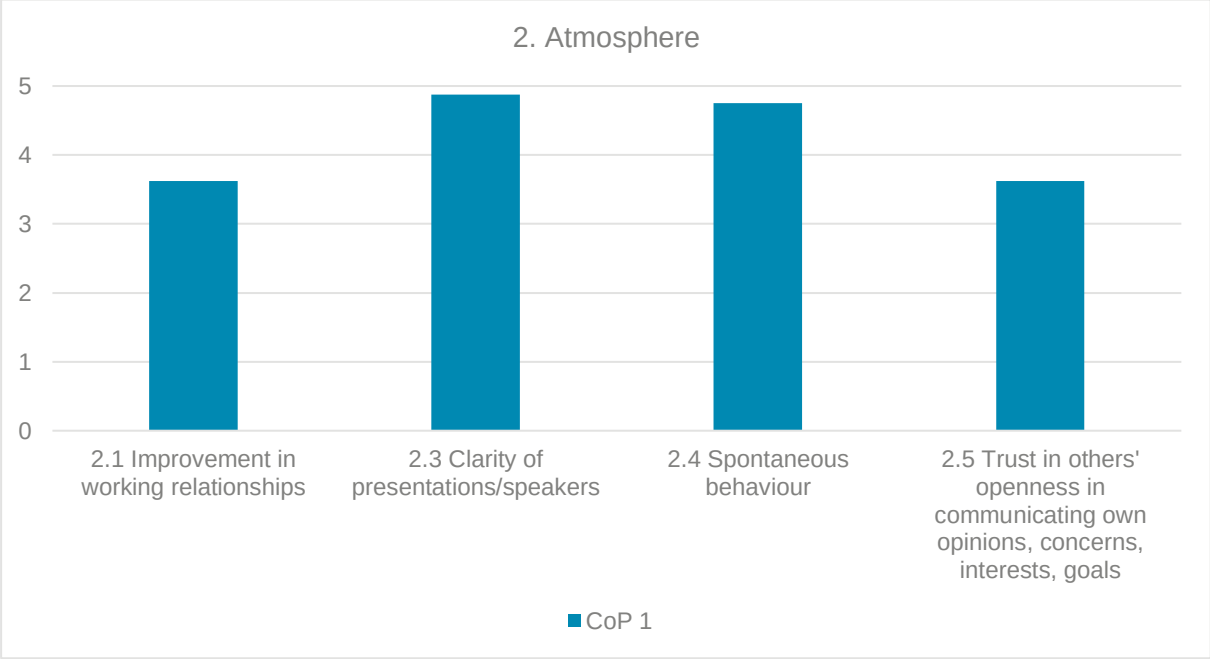

Figure 69 Meeting logistics and stakeholder engagement: Atmosphere (CS8)

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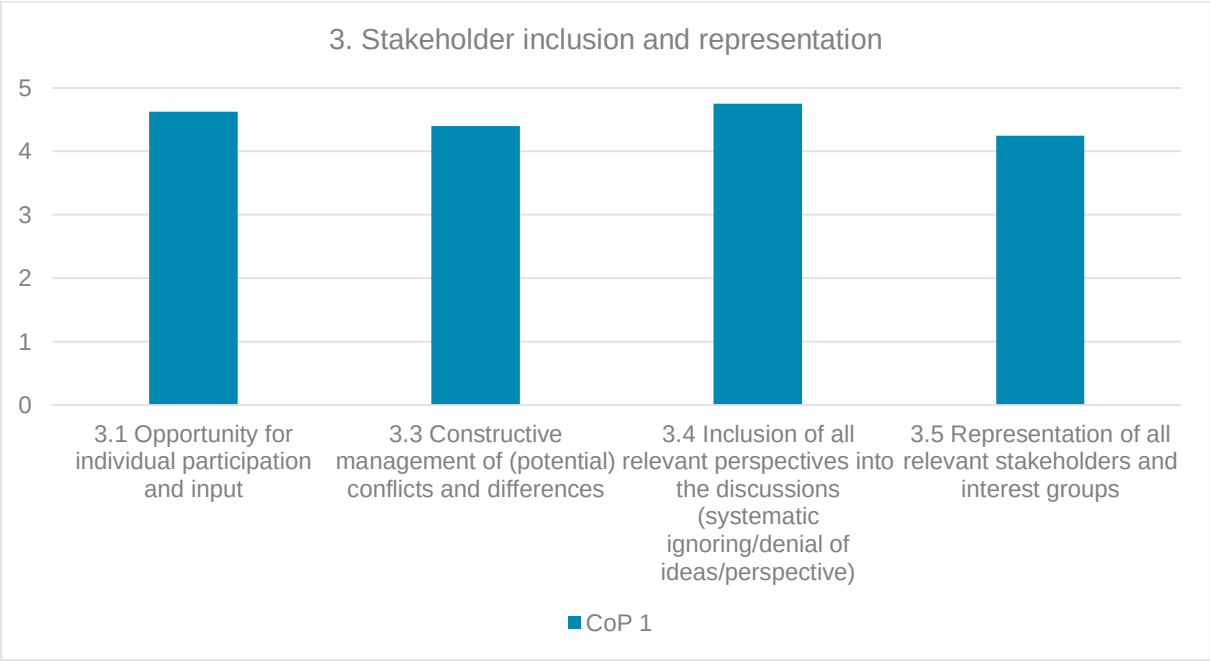

Figure 70 Awareness and increased understanding: Stakeholder inclusion and representation (CS8)

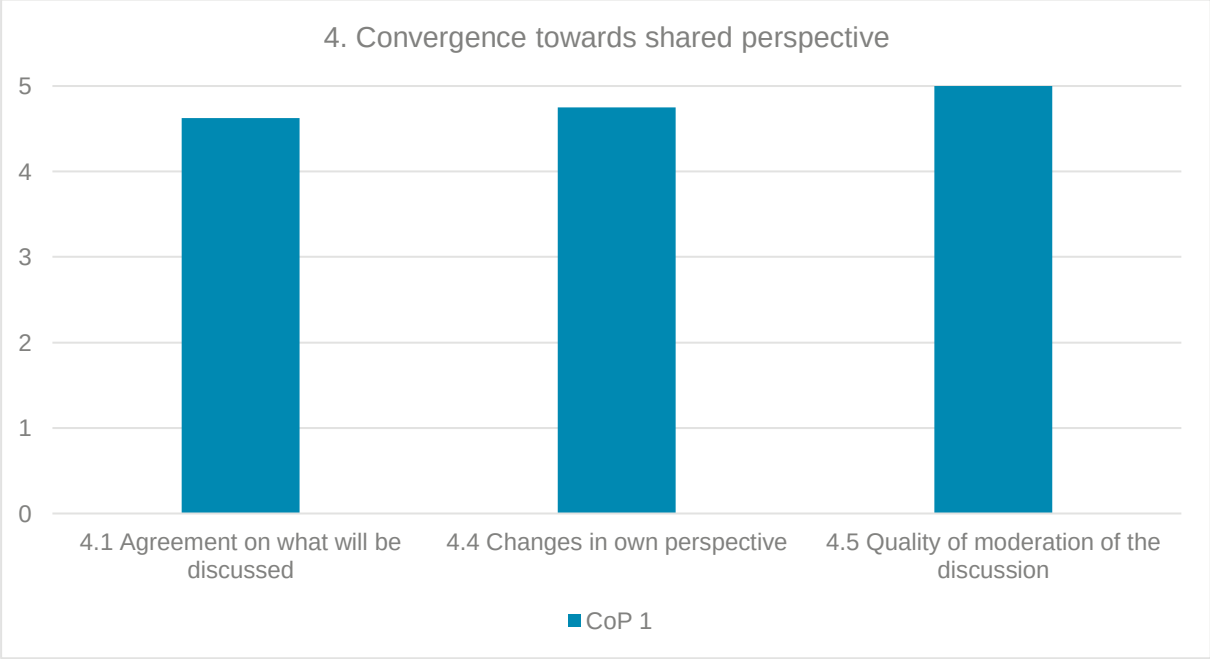

Figure 71 Awareness and increased understanding: Convergence towards shared perspective (CS8)

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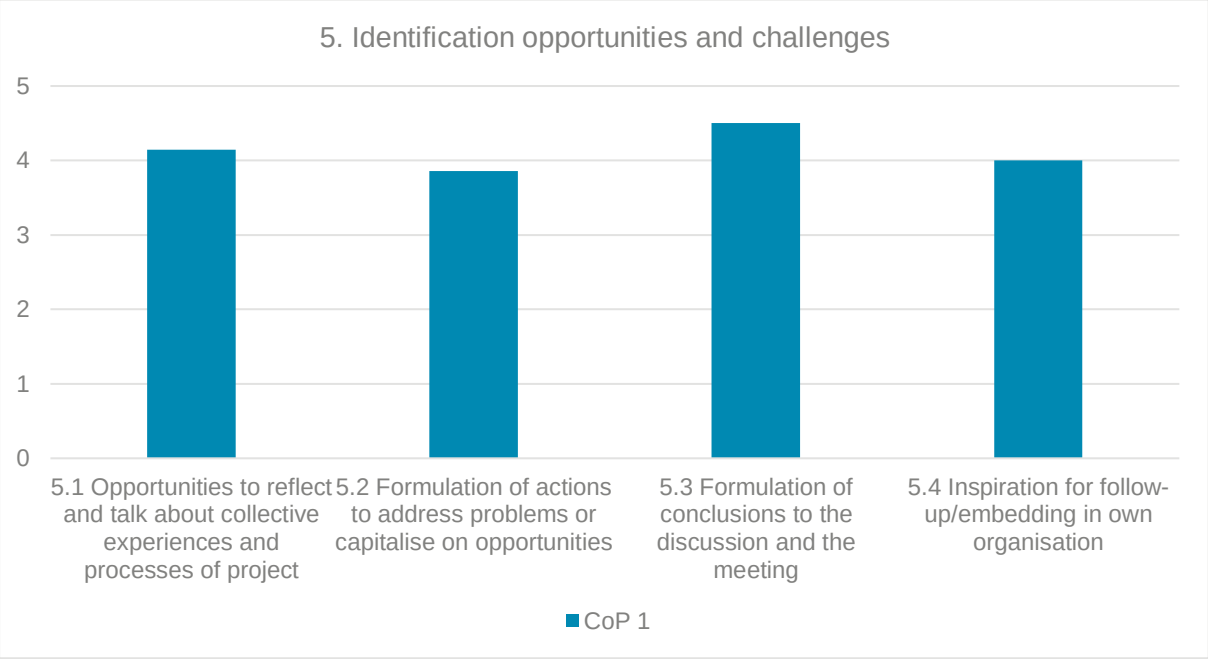

Figure 72 Outcomes and conclusions: Identification opportunities and challenges (CS8)

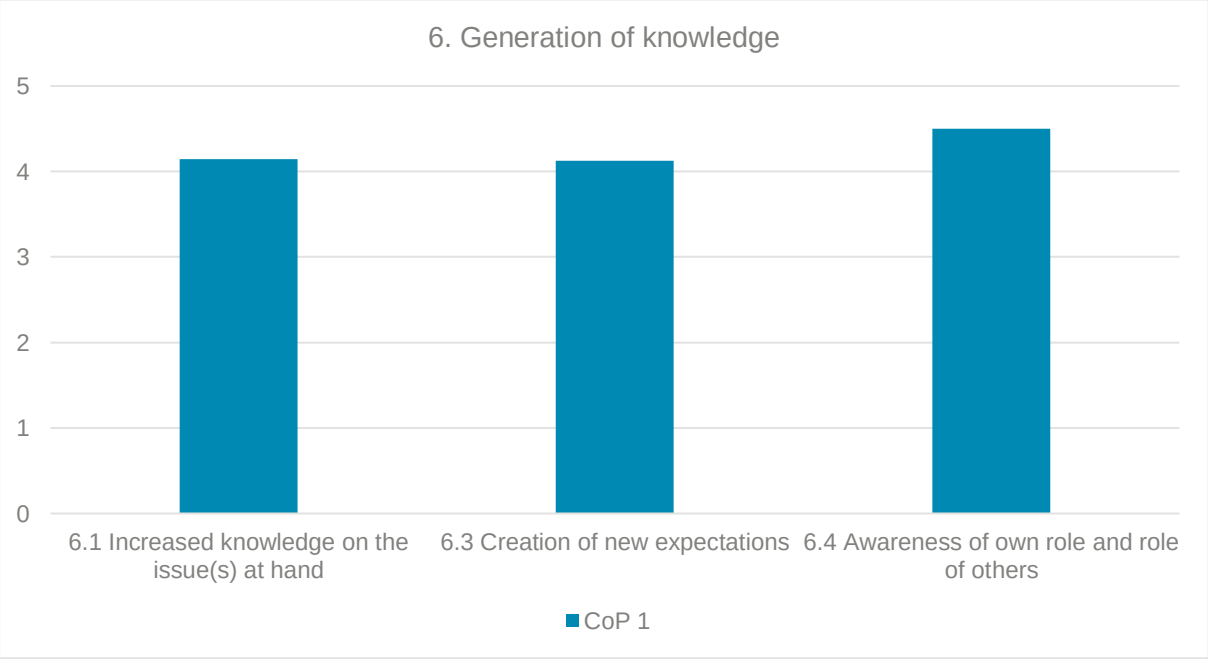

Figure 73 Outcomes and conclusions: Generation of knowledge (CS8)

9.10. Case study 9 - Kalundborg, Denmark

9.10.1. The Community of Practice

In Kalundborg, the establishment of a CoP was approached differently than the other case studies. For over 60 years, a symbiotic ecosystem has existed in Kalundborg

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including more than 30 bilateral agreements between public and private companies which form an active stakeholder ecosystem, known as the Kalundborg Stakeholder Association (KSA). As part of the KSA, several water-intense industries participate in a local working group to share knowledge and experience concerning water issues and explore opportunities such new water technologies of relevance for their use.

At the start of the ULTIMATE project, it was agreed to not establish a new stakeholder engagement group that might disrupt the existing and well-functioning ecosystem. Instead, linking the working group on water within the KSA to the innovations and solutions discussed in ULTIMATE has been explored. In fact, one of the objectives in CS9 was to expand the international cooperation of the KSA to stimulate an increase in energy efficiency of operations, reduction of chemical consumption, and efficient use of available water. In this context, the KSA and its water working group have been considered as the CoP in the context of the ULTIMATE project.

Interestingly, the approach used in Kalundborg, which has been key in bringing international perspectives, experiences and expertise into the KSA, prompted the establishment of a national oriented CoP. This national oriented CoP has grown to be successful in KSAs endeavour to influence national decision makers and spread knowledge on new technologies and opportunities to improve the Danish water sector, notably around water reuse. Although the CoP approach used across the other ULTIMATE CSs was not implemented in CS9, the project leveraged the existing local KSA and the CoP concept was still utilised to raise awareness among national decision-makers and influence the national agenda regarding water reuse in the EU. Industries that are member of the KSA currently participate in the national oriented CoP to show support and give credibility to what is being shared with the rest of the water community in Denmark.

Meeting discussions across these two (2) levels have so far revealed that despite current legislation on water reuse limiting innovation in the field, water reuse is possible and there is interest among the symbiosis industries. In particular, water reuse for cooling seems to be an attractive option. However, water quality requirements for reuse need to be defined and the appropriate technology identified and discussed. At one of the more recent meetings on water related viruses and bacteria results of water tested after the use of RO were presented. The results showed the efficiency of RO in producing good quality water, further demonstrating the relevance of water reuse to address the growing water demand. The assessment was done by a third party. This helped increasing the credibility of the findings and emphasised the value of participating in EU projects and engage in international collaboration in bringing novel water technologies to their attention. The subsequent meetings continued to bring in perspectives and examples form outside Denmark, drawing from the other ULTIMATE

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CSs and their ongoing technological developments, but also from other international collaborations.

Insights from CS9 on the acceptance, regulatory barriers, and technology/solutions to enable water reuse by industry are presented in Annex G.9.

9.10.2. Experience with stakeholder engagement

The long lasting experience of Kalundborg with stakeholder engagement in an industrial symbiosis context offers the opportunity to reflect and learn about stakeholder engagement and the role of CoPs established in the context of EU projects. To this purpose, an interview was conducted with a senior strategic and project manager of the Kalundborg Forsyning wastewater treatment company, who is also one of the key partners in CS9 and has been working to integrate ULTIMATE outcomes in discussion in the KSA working group.

The following insights are presented about the establishment and evolution of the Kalundborg symbiosis, the process that led to establish a successful stakeholder engagement process and stakeholder community in the symbiosis (the KSA), and finally the way in which ULTIMATE has strategically been framed in the context of the existing symbiosis and of the KSA.

History of the Kalundborg symbiosis

From a water perspective, the story of the Kalundborg symbiosis starts in the early 1960s with a project to use surface water from Lake Tissø for a new oil refinery in order to limit the use of groundwater. The city of Kalundborg took the initiative to build the necessary infrastructure, which was financed by the refinery. This initial collaboration triggered a number of new collaborations, which subsequently brought in new partners and new bilateral agreements. By the end of the 1980s, this group of partners realised that they had self-organised themselves into an industrial ecosystem or symbiosis through their many bilateral agreements. This eventually evolved into the currently existing and successfully operating KSA. Essentially, the main principle of the current symbiosis is that a waste stream in one company becomes a resource in another, benefiting both the environment and the economy. Through local partnerships, partners are able to share and reuse resources, saving both money and minimising waste. Figure 72 gives an impression of the flow[12] of resources between companies within industrial ecosystem.

[12] The flows flows change from time to time. An up-to-date representation of the flows can be found on the KSA website: https://www.symbiosis.dk/en/.

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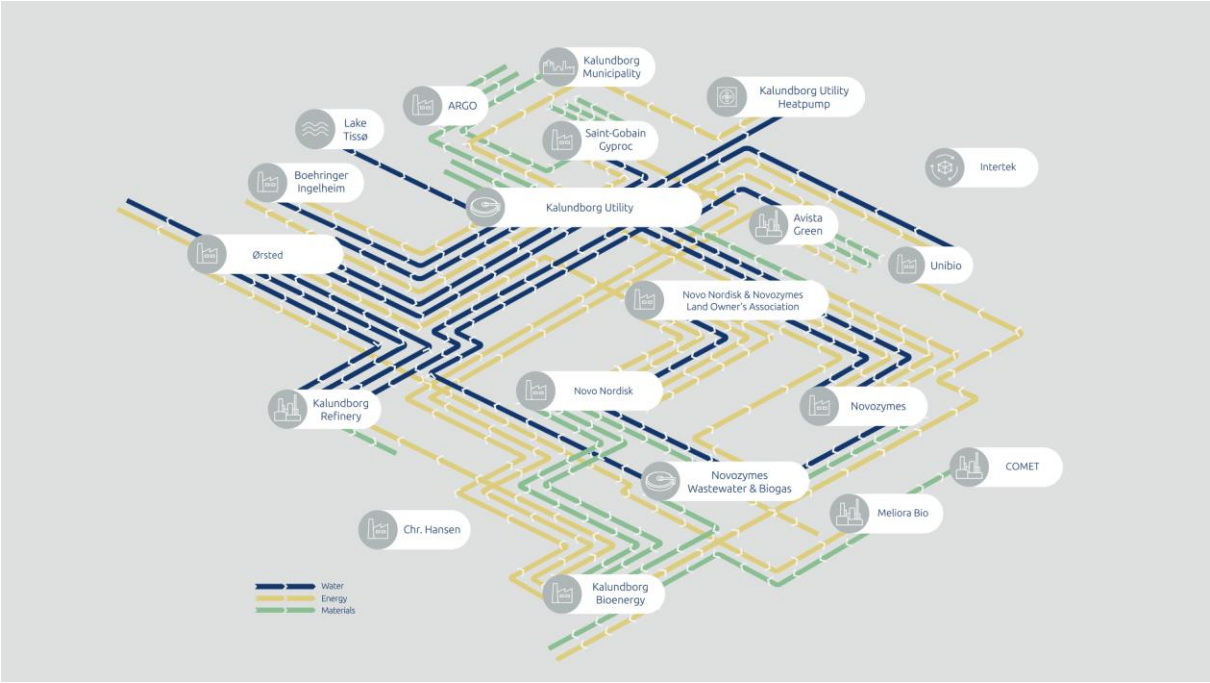

Figure 74 Material flows within the Kalundborg Symbiosis in which companies exchange water, energy and materials

The KSA is a 60 year old year arrangement that took time to mould into the symbiosis of today, currently consisting of more than 30 bilateral agreements between companies. Over the 60 years, the organisational framework has changed from having no formal organisational structure in place, to the engagement between companies was facilitated by a Danish NGO (voluntary organisation) bringing together several company directors around a non-legal statute (i.e., an informal board of directors), to what it is today.

The assembly of the directors, usually an informal meeting held every three (3) or four (4) month, did not focus on specific agreements or the exchange of money. Instead, it focused on policy issues or reasons and areas for collaboration. For example, one topic of discussion was how to increase the collaboration with the regional academic institutes in and around Kalundborg to ensure the training of professionals for the needs of the industries in Kalundborg.

At the time, the senior vice president of Novo Nordisk (the largest company in Kalundborg), who was the chairman of this informal assembly of directors, initiated a significant change to the symbiosis organisation by bringing into the discussion the need to define clear goals and ambitions to be more sustainable. This change would not disrupt the basic arrangements around the exchange of water, energy and materials achieved through the bilateral agreements. Instead, it would build a more structured process to continue the discussions already taking place in the assembly of

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directors, and to establish a direct link to the local political level through the involvement of the municipality of Kalundborg. To this purpose, the mayor of Kalundborg was invited to join this still informal assembly of directors, subsequently expanded to bring in a broader group of industrial and political leaders who would meet more often to agree on the development of the symbiosis. This new way of operating strengthened the informal collaboration between the industries by providing clear and specific direction on where the symbiosis was headed into the future.

This process eventually led to the establishment, of the KSA as a legal entity registered at the chamber of commerce and with capacity to operate on behalf of the participating companies. The secretariat, at the time hosted by the municipality, is now independent and funded partly by the participating companies and partly through external projects. The secretariat sets the agenda for the board of directors, however, all board members have the ability to propose agenda items for discussion. The secretariat has set up a number of permanent groups to deal with strategic matters and issues on related topics. These groups, often with strategic managers of industries and technical staff depending on the topic of the discussion, meet regularly under the direction of the secretariat.

ULTIMATE within the context of the Kalundborg symbiosis

One of the objectives of the ULTIMATE project has been to establish CoPs in the CSs. This process has been initiated at the start of ULTIMATE with the CS9 partners. However, given the existence of the KSA, it was recognised that attempting to set up a new CoP would likely jeopardise the existing collaborations in the symbiosis. Trying to establish a new engagement scheme in parallel to the KSA was perceived negatively, raising a number of questions in the KSA and creating unnecessary tensions, lengthy discussions and reluctance of stakeholders to engage. It was therefore decided to engage the KSA to leverage the existing relationships and collaborations within the symbiosis ecosystem, to achieve the goals of the ULTIMATE project in Kalundborg, and bring the solutions explored in ULTIMATE to the KSA.

To engage with the KSA, a number of aspects needed to be considered. To make water reuse a meaningful water saving solution in line with the ULTIMATE ambitions, the commitment of several companies (existing and upcoming in Kalundborg) and a substantial amount of wastewater fit to reuse purposes is needed. Such a commitment would need to occur in the form of bilateral agreements, to remain aligned with the symbiosis approach, and no multi-industry agreements were to be sought. Furthermore, directly talking about wastewater reuse at the time was not an option as wastewater reuse has been a sensitive topic in Denmark due to the current national regulation. Finally, the issue of how to ensure adequate amount of fit-to-purpose water for reuse to make it an attractive option for the symbiosis industries entailed exploring technological solutions and circular approaches.

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Accordingly, common ground among different companies in the symbiosis was first explored around practical needs and challenges related to water use (e.g., security of water supply) instead of directly focussing on wastewater reuse. When this common ground was identified, the link with ULTIMATE focussing on learning from other ULTIMATE case studies experiences about technologies and circular approaches to address the water supply challenges was shared. This approach made it easier to engage with the KSA and the associated industries because of their interest and long lasting experience of exchanging on technologies and lessons learned among themselves already. It was also made clear that how these challenges could be addressed by the companies would then be stipulated in bilateral agreements, as per their usual symbiosis approach. For example, in the framework of the ULTIMATE project, Kalundborg Forsyning and the Kalundborg refinery are exploring the supply of reclaimed water to ensure the availability of water during drought periods. This would help ensure that the refinery would not need to shut down due to lack of water during such periods. Ultimately, such bilateral agreements create win-win situations for the companies involved but also for other companies which can benefit from more water available for their purposes as result of water reuse by others.

By framing the discussion around the common needs and challenges for water supply and reassuring that these challenges would be addressed in the context of the existing symbiosis structure, the partner of the ULTIMATE project in charge of the CoP (Kalundborg Forsyning) was able to open the discussion around a sensitive topic (i.e., water reuse) and engage the KSA stakeholders in discussing options that are suitable for them based on the experience of the other ULTIMATE CSs. In this context, the Kalundborg “CoP” through the KSA functions as a platform for sharing new concepts and technologies around water reuse for the future development of Kalundborg.

Currently, Kalundborg Forsyning tries to run a “CoP” meeting every second month with interested partners, universities, and political representatives, as well as those with an interest in new water treatment technologies. The agenda is usually defined by CS9 partners (KWB, Pentair, Kalundborg Forsyning and Novozymes) for a one (1) to one and a half (1.5) hour meeting. As partner in ULTIMATE and member of KSA, Kalundborg Forsyning acts as linking pin, learning what others are doing in the ULTIMATE CSs (and beyond), and informing the companies through the KSA about the new solutions and the opportunities to apply these solutions in their respective companies. In particular, one of the permanent groups of the KSA secretariat has worked on developing a list of technologies relevant to the Kalundborg companies. The technologies and innovations developed within ULTIMATE fit within the scope of such an activity, and the ULTIMATE partner is helping embedding the project technologies in this list. This has helped to better position ULTIMATE within the existing symbiosis, and in particular will benefit the efforts of WP5 on replicability of the ULTIMATE solutions. Furthermore, engaging with ULTIMATE connects Kalundborg with an

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international community of peers. Here the hope is that the project may help to influence the political agenda in Denmark to be more open to considerations of alternative water sources, such as rainwater or even wastewater reuse.

Reflections and lessons learned from the case of Kalundborg

The establishment of the KSA and its working groups is a story of long lasting self-organised, informal relations which created trust and capacity to work together among parties and that eventually crystallised into a formal collaboration structure. Operating in an informal way for decades, not only allowed the parties to learn to work together and trust each other but also provided the space to try out collaborations with the possibility to step back with no legal consequences if the collaboration did not work out. This was important to buy the industries into the collaboration. Once trust, respect, mutual understanding and try out of ways to work together were established, times were mature for moving a step forward into a formal collaboration in the form of a structured, legal association. This opened new opportunities for new future developments and improvement of the symbiosis.

Part of Kalundborg's symbiosis success seems to be related to the isolated position of the symbiosis in the geographical map of Denmark. Kalundborg is detached from the central places where market services are located in the country. This fostered a sense of community among the symbiosis industries and the understanding that they needed to collaborate in order to survive on the market. The institutionalisation of the symbiosis around common sustainability goals has strengthened such collaborative attitude. In particular, the Kalundborg symbiosis understands that more can be done and achieved together. As such, the companies go to great lengths to work together and avoid disagreement. The use of bilateral agreements has proven to be a successful way of working together and have played a crucial role in sustaining the symbiotic arrangements in Kalundborg.

Finally, having the right individuals to navigate the different stakeholder's interests has also played a crucial role in ensuring a functioning symbiosis and the embedding of the ULTIMATE CoP approach in Kalundborg. This was the case when the vice president of one of the biggest industries took the lead to set up the symbiosis association, and when the ULTIMATE partner in Kalundborg took the lead to bring the project into the Symbiosis. They both hold a strategic position within their respective companies that allowed them to connect the interests of the Kalundborg industries and those of the KSA to the project, respectively.

Building on the existing symbiosis ecosystem has enabled better engagement for ULTIMATE. This engagement is built on an already existing foundation of established relationships, trust and mutual understanding. This familiarity enables seamless communication and decision-making, fostering a cooperative environment where all

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partners feel valued and heard. By actively engaging partners in the decision-making process, the symbiosis reinforces trust and commitment, ensuring that all stakeholder's interests are considered and aligned with the collective goals, especially when looking to introduce new technologies and knowledge to the symbiosis arrangements. By introducing new technologies and knowledge from EU projects like ULTIMATE and other international collaboration, the KSA has benefited from credible and state-of-the-art technology that might otherwise have been inaccessible. The success of these collaborations highlights the importance of looking beyond local boundaries to draw on a broader pool of knowledge and experience. It also underscores the potential for international cooperation in driving sustainable development and innovation, ultimately benefiting the entire symbiosis by opening up new avenues for growth and improvement.

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PART III – INSIGHTS: ULTIMATE LIVING LABS ENGAGEMENT

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10. Introduction to Water-oriented Living Labs

T3.4 of the ULTIMATE project aims to provide recommendations to the CSs on developing LLs[13] in the form of new Water-Oriented Living Labs (WOLLs)[14]. symbiotically integrated with industry. Building on the foundation laid by T3.2 (*Business-to-Business Engagement*), where nine (9) ULTIMATE CSs have been establishing and coordinating CoPs, and with guidance from D3.1 (*Criteria for Linking Existing LLs to the Case Studies*) and D3.2 (*WSIS Living Lab: Gap Analysis and Recommendations*), CS partners have been informed about integrating relevant activities into their agendas to evolve into Water-oriented LLs suited for industrial symbiosis.

Recommendations in D3.2 focused on maintaining, consolidating, and expanding the CoPs created for industrial symbiosis to enhance the process of evolving into WOLLs. This evolution is crucial because WOLLs offer significant advantages that can enhance the CSs' effectiveness and (long-term) impact.

WOLLs are a key tool for the implementation of WE's Water Vision: "The Value of Water", to promote systematic innovations in the water system. WE considers WOLLs as the most effective means to build a Water-Smart Society (WSS)[15] in Europe, and the best tool to support the realisation of their vision strategy to develop a WSS. A WOLL is not only a network of infrastructures and services, but also a collaborative ecosystem based on iterative feedback processes 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.

[13] LLs are open innovation ecosystems in real-life environments using iterative feedback processes throughout a lifecycle approach of an innovation to create sustainable impact. They focus on co-creation, rapid prototyping & testing and scaling-up innovations & businesses, providing (different types of) joint-value to the involved stakeholders. Living labs focus on a variety of topics, each tailored to address specific challenges and opportunities within different sectors. https://enoll.org/about-us/what-are-living-labs/.

[14] Water Europe defines WOLLs as "real-life, water oriented and demo-type and platform-type environments with a cross-sector nexus approach, which have the involvement and commitment of multi-stakeholders (including water authorities) and a certain continuity, and provide a "field lab" to develop, test, and validate a combination of solutions as defined in the WE Vision, which include technologies, their integration as well as combination with new business models and innovative policies based on the value of water".

[15] A Water-Smart Society is one where the true value of water is recognised and realised, and all available water sources are managed to avoid water scarcity and pollution, closing water and resource loops to achieve a circular economy and optimal resource efficiency. This society is resilient against climate change impacts and involves all stakeholders. (Water Europe)

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In ULTIMATE, WOLLs suited for industrial symbiosis are envisioned not merely as experimental labs but as ecosystems for real-world experimentation and co-creation in synergy with industrial symbiosis needs. By leveraging WOLL concepts, ULTIMATE creates an engaging environment for stakeholder participation, enhancing industry-to-industry and citizen collaboration.

The setup of a WOLL allows different CSs to share knowledge and experience, and to mutually benefit from the know-how gathered during the symbiosis establishment process. This collaborative environment enhances their ability to innovate and implement sustainable water management practices effectively.

10.1.1. Water-Oriented Living Labs suited for industrial symbiosis

LLs 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 LL are open for definition by its participants. The concept of LLs represents a model for innovation that takes research and development out of laboratories and places it in real-life contexts. WOLLs follow this same model but with a specific focus on addressing local issues related to water. While LLs can address a wide range of innovation areas, WOLLs are specifically designed to tackle water-related challenges and solutions in their local contexts.

WOLLs serve as a bridge between the research niche where innovations are developed and tested on a small scale and the validation of the innovations for wider market uptake. They operate as systemic intermediaries among cities, regions, firms, third sector, and research organisations, as well as citizens or joint value co-creation, rapid prototyping, testing, and validation to scale up and speed up innovation and businesses for the achievement of a WSS. They are relevant innovation ecosystems that promote the co-creation, testing, and evaluation of innovations in representative real-life environments, with the ultimate aim of realising a WSS.

The core features of LLs are summarised below:

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

From the industrial perspective, LLs are tools to validate[16]. 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 LLs.

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

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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 in real life use cases, involving user communities, not only as observed subjects but also as a source of creation.

10.1.2. From Assessment to Implementation

The LL activities (T3.4) of the ULTIMATE project operated in two (2) distinct phases to support the evolution of CSs into WOLLs. During the first phase, WE conducted a comprehensive assessment of all CSs to establish a baseline benchmark of the current situation. This initial assessment was crucial for understanding the capabilities and readiness of each CS to evolve toward a WOLL. It involved evaluating the maturity of the CSs in terms of their water orientation with a focus on industrial symbiosis. This assessment was based on a quantitative assessment tool, which provided a percentage score to quantify their readiness. For further reference, Section 11 describes in detail the methodology adopted.

Building on this foundation, the second phase of activities focused on the implementation of the WOLLs methodology exclusively on those CSs identified as mature and ready for further development into WOLLs suited for industrial symbiosis. A second round of assessments targeted only those CSs identified as mature and ready for further development. This selective approach allowed to prioritise the case studies with the greatest potential to evolve into WOLLs within the project's timeframe.

The second round of assessments included repeating the scoring assessment and adding a Word document for each CS to provide detailed information on their vision and Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis, complementing the numeric score from the first assessment.

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WE is currently actively supporting these mature CSs throughout their transition. Upon successful assessment, the mature CSs evolved into WOLL are incorporated into the online version of the "Atlas of Water-Oriented Living Labs" and integrated into the WOLLs Network. Furthermore, the CSs that have evolved into WOLLs will be included in the next update of the printed ATLAS. The WOLLs Network, established under the Water4All Partnership[17], is designed to extend the CSs' impact beyond the lifespan of the ULTIMATE project. The network aims to facilitate learning, promote symbiosis, and create a cooperative environment conducive to industrial synergy.

Figure 75 The new Atlas of WOLLs

Evolving into WOLLs and participating in the Water4All WOLLs Network offers significant advantages to case studies, enabling them to showcase their potential while ensuring the sustainability of their development activities over the medium to long term. By joining this network, case studies benefit from stronger connections with European Commission (EC) institutions and Member States, which enhances their visibility at the European level. Additionally, they gain improved access to targeted funding opportunities and financial resources, which are essential for advancing innovation and expanding their impact. The network also helps remove innovation barriers by providing a collaborative space for regulatory learning and fostering a supportive environment for growth and development.

The list below provides an overview of the status of the CSs at the conclusion of the project's activities. This overview considers the benchmarking results from the first phase, where five (5) of the nine (9) case studies were identified as potentially suited to evolve into WOLLs. These five case studies were supported in assessing whether they could evolve into WOLLs. However, in the second phase, only two (2) CSs submitted the assessment tools, while another two (2) expressed interest but did not submit the tools. One (1) CS is still in need of further information to complete the process. These last three CSs will receive support after the project's completion, should they remain interested in evolving into WOLLs.

- CS1 Tarragona – Will receive further support after the project completion
- CS2 Niew Prinsenland – No further involvement
- CS3 Rosignano – Evolved into WOLL

[17] https://www.water4all-partnership.eu/

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- CS4 Nafplio – Evolved into WOLL
- CS5 Lleida – Will receive further support after the project completion
- CS6 Karmiel and Shafdan – No further involvement
- CS7 Tain – No further involvement
- CS8 Saint Maurice L'Exil – No further involvement
- CS9 Kalundborg – Will receive further support after the project completion

11. Water-Oriented Living Lab methodology

The methodology to assess the water orientation of ULTIMATE CSs is grounded in the WOLLs methodology, based on the Harmonisation Cube specifically adjusted for the water sector. This method facilitates coordinated assessment analysis, synergic development, harmonisation, and networking of regional WOLLs initiatives. In this deliverable, we refer to this assessment methods as the Harmonisation Cube methodology.

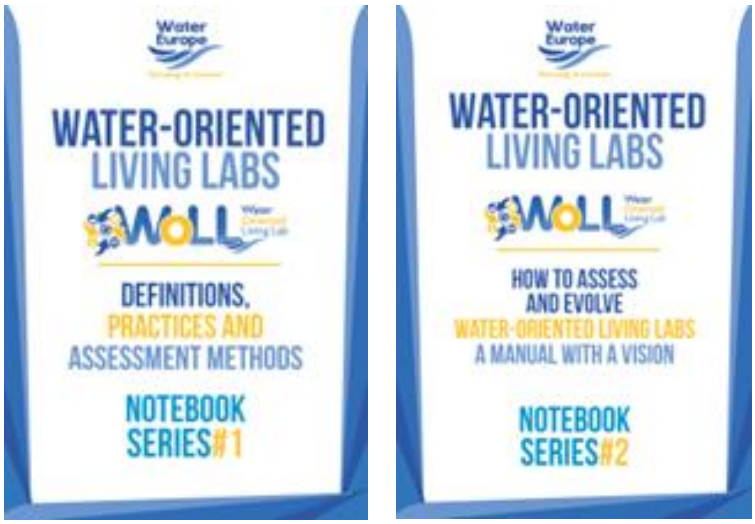

Figure 76 WE Series #1 & #2 publication on WOLLs

WE has embraced the LL approach as the central element of its implementation strategy to realise a WSS. Following the first publication of the Atlas on WOLLs, WE has released two (2) additional publications that delve deeper into the WOLL concept and methodology. The first document, "Water-Oriented Living Labs: Notebook Series #1: Definitions, practices, and assessment methods - Series #1", provides an overview of the history of the LL concept. The second document "Water-Oriented Living Labs: Water-Oriented Living Lab Notebook Series #2. How to assess and evolve towards a network of Water-Oriented Living Labs - Series #2" elaborates on a methodology that enables the comparison of WOLLs across numerous attributes and their assessment using a quantitative tool.

Establishing a shared understanding of what WOLLs entail is crucial for grasping the significance of innovation demonstrations in real-life contexts. The LL concept is highly

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relevant to the innovation process leading towards a WSIS. It takes research and development out of laboratories and sets it in real-life contexts. This allows for a better understanding of what triggers innovations and those that prove being successful in different environmental, social, and cultural contexts. A LL is more than just a network of infrastructures and services; it is a collaborative ecosystem established to sustain community-driven innovations in a multi-stakeholder context. It offers an effective research methodology for sensing, prototyping, validating, and refining complex solutions in multiple and evolving real-life contexts, which go beyond the researcher's perspective.

WOLLs are recognised as a key driver for the future strategic agenda for the water sector. Therefore, it is imperative for WOLLs to adopt a harmonised approach in their establishment and practices, enabling the generation and sharing of innovations and best practices in a coordinated manner to expedite the innovation process aimed at addressing key societal challenges such as pollution and the impact of climate change.

The chosen methodology for developing the assessment process for WOLLs is the LL assessment methodology known as the Harmonisation Cube tailored to the water sector. This assessment method facilitates coordinated assessment, analysis, synergic development, harmonisation, and networking of WOLLs initiatives.

11.1.1. Assessment methodology

The methodology outlined in the WE Series #2 publication has been employed to select and evaluate the WOLLs featured in the WE Atlas of WOLLs. Based on the Harmonisation Cube, this methodology comprises three (3) steps designed to conduct a comprehensive analysis of WOLLs: **Mapping, Assessment and Evaluation**.

- Step 1: Mapping, consisting in two (2) steps: (1) identification in Europe and beyond of demo-type and platform-type environments for the development, testing, and validation of water related innovations; (2) application of the LL Harmonisation Cube assessment method: this step gives back quantitative feedback, including scores and graphs. Moreover, the candidate WOLLs fill in a qualitative document that describes its activities and goals, including a SWOT analysis to assess strengths, weaknesses, opportunities, and threats.
- Step 2: Assessment, consisting in the examination of four (4) fundamental criteria to determine the applicants' maturity for being appointed as WOLLs.
- Step 3: Evaluation of the maturity level of the candidates and consequent assignment of recognised WOLLs and potential WOLLs to appropriate Pillar D Tasks based on their assessment results.

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Harmonisation Cube

What is the Harmonisation Cube? It is referred to as the best available methodology today, that brings harmonisation of methods and tools in the LL analysis. It provides detailed evaluation criteria for the six (6) foundational elements of any LL: (1) governance, (2) service creation, (3) infra-structures, (4) methods & tools, (5) user involvement and (6) innovation outcomes. The tool determines the measure of the WOLLs' maturity. This assessment method allows for co-ordinated assessment, analysis, synergic development, harmonisation, and networking of WOLLs initiatives.

How does this apply to WOLLs? To evaluate the maturity level of Water Oriented Living Labs, a tailored version of the Cube and a practical tool have been developed. The tool adapts the 3x3 = 9 evaluation criteria, towards the basic requirements of Research, Development, and Innovation in the water sector; these are known as the *WOLL metrics* (see Series #2 for reference). They serve to explore the playing field and delve into the contours of a more detailed approach focused on the water sector. This is applied in three (3) categories (regional, municipal, and industrial). The Harmonisation Cube is particularly useful for assessing and analysing the six (6) foundational elements, identifying development opportunities, and promoting a participative approach.

Figure 75 shows the Harmonisation Cube foundational elements and evaluation criteria.

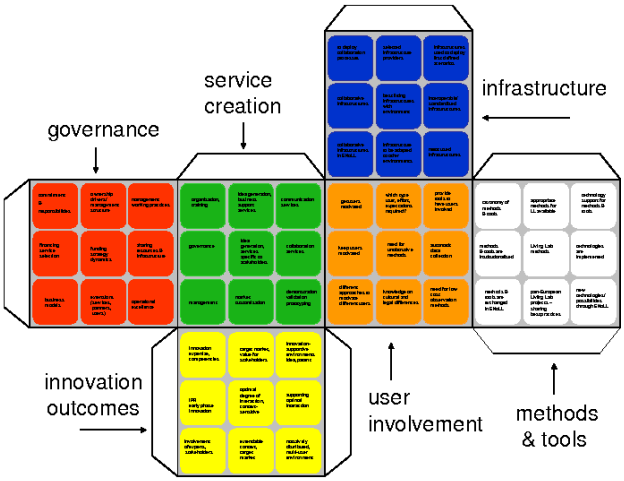

Figure 77 The Harmonisation Cube foundational elements and evaluation criteria

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Quadruple Helix

The Quadruple Helix is an innovation and collaboration model emphasising a citizen/end-user perspective, particularly in innovation processes. Often, there is a noticeable absence of citizen and end-user engagement during innovation creation. This model defines the interaction between the public sector, academia, industry, and citizens. Figure 76 shows the four (4) actors involved in the Quadruple Helix model. In the most recent developments, the environmental perspective is also considered.

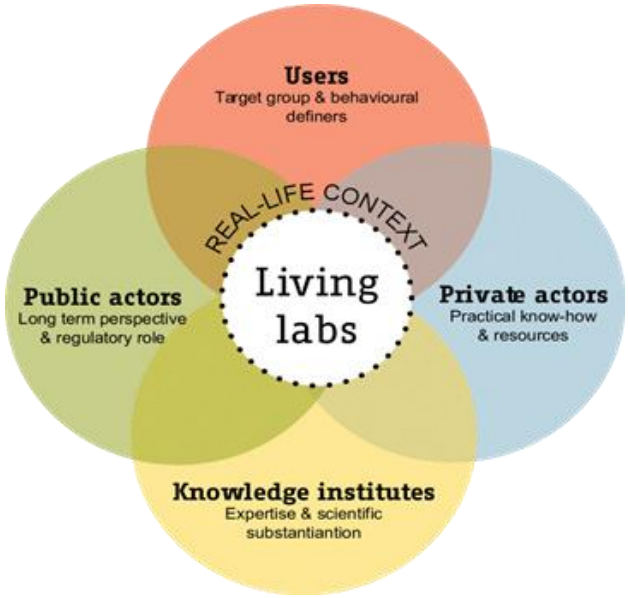

Figure 78 Actors of the Quadruple Helix model

11.1.2. Assessment process

Step 1. Mapping

In ULTIMATE the potential candidates are identified as the nine (9) CSs of the project. The second step of the mapping activities involves compiling two (2) main tools.

- Quantitative Assessment Tool
  This tool uses the Harmonisation Cube model to assess the potential WOLL's maturity level. The model employs a 3x3 metrics evaluation criteria applied to six (6) foundational elements. It aims to derive a percentage score reflecting the WOLL's maturity level, providing quantitative feedback, including scores and graphs.
- Qualitative Documentation Tool
  Applicants are required to fill in a qualitative document that describes their activities and goals, including a SWOT analysis to assess strengths, weaknesses, opportunities, and threats. This documentation collects essential information about the candidate WOLL, such as its name, location, spatial scale, governance structure, perceived maturity level, and specific attributes related to start-ups, sustainability, and scalability. Additionally, it gathers the WOLL's mission, focus areas, organisational settings, and strategy.

Step 2. Assessment

The assessment procedure involves evaluating whether each applicant fulfils the four fundamental criteria of the Water-Oriented Living Labs and assessing the extent to

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which they are developed on an individual basis. This is needed to determine the applicants' maturity for being appointed as WOLLs or high-potential follower Living Labs. The four (4) fundamental criteria considered during the assessment phase include:

- Local Territory Connection Assessment
  The candidates must be geographically situated within the territory and must tackle a territorial water challenge.
- Quadruple Helix Assessment
  Evaluation of the involvement of the Quadruple Helix actors and the extent of stakeholder engagement.
- Sustainability Assessment
  Examination of candidates regarding the presence of a stable governance, structured collaboration, and the presence of a long-term strategy, encompassing financial planning and organisational governance.
- Innovation Demonstration Assessment
  Evaluation of how the potential WOLL showcases innovation within its framework.

Cases in which the candidate does not show a water focus linked to a real-life environment, as well as poor or absent setup efforts in terms of multistakeholder active governance and engagement (following the Quadruple Helix principle), lead to the exclusion from the pool of interesting WOLL candidates.

Step 3. Evaluation

Based on the evaluation results, applicants are identified as WOLLs when they meet all the four (4) fundamental assessment criteria. WOLLs are contextually included in the Atlas of WOLLs and in the subsequent engagement activities of the WOLLs Network.

12. Establishment of ULTIMATE Water-Oriented WSIS LL

In the benchmarking phase, a preliminary assessment of CS's maturity was carried out to evaluate their development stages and provide recommendations for transitioning into WOLLs (see D3.2). However, not all Case Studies showed interest in this transformation.

The final status of each case study is summarised below.

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- **CS6 (Karmiel and Shafdan, Israel)**, **CS7 (Tain, Scotland)**, **CS8 (Saint Maurice L' Exil, France)**: These case studies expressed no interest in establishing a WOLL, leading to no further investigations in subsequent phases.
- **CS2 (Niew Prinsenland, The Netherlands)**: The assessment revealed insufficient maturity to establish a WOLL within the ULTIMATE project duration. This was due to challenges in building a strong stakeholder network to define governance models and long-term strategies, despite progress in addressing technical challenges.
- **CS9 (Kalundborg, Denmark)**: Expressed interest in evolving into a formal LL, but activities were postponed due to internal workload and human resource constraints. Given its maturity, CS9 will be reconsidered for further involvement after the project's completion.
- **CS1 (Tarragona, Spain)**: Identified as potentially suited to evolve into a WOLL. It was supported during the second phase but did not submit the second-round assessment tools within the project timeframe. It will receive further support after the project completion, should they remain interested in evolving into WOLLs
- **CS5 (Lleida, Spain)**: Expressed interest in evolving into a formal LL, but requires additional support. It will receive further support after the project completion, should they remain interested in evolving into WOLLs.
- **CS3 (Rosignano, Italy)**, **CS4 (Nafplio, Greece)**: Both were re-engaged in further activities successfully evolving into WOLLs.

This chapter presents the final results of CS3 (Rosignano, Italy) and CS4 (Nafplio, Greece), which have expressed interest in evolving into WOLLs and provided the necessary information for a second assessment. The results of the second assessment helped evaluate the improvements achieved by these case studies, providing an overview of the strategies implemented for their successful transition into WOLLs.

12.1. Implementation of the WOLLs methodology

As mentioned, during the benchmarking phase, five (5) case studies were identified as potentially suited to evolve into WOLLs. However, in the subsequent phase, only four (4) case studies committed to taking the necessary steps toward this evolution and were provided with assessment tools to begin their mapping process. Of these, only two (2) case studies submitted the completed assessment tools with all the required information, allowing the continuation of the assessment process. These submissions enabled a comparison of results and an evaluation of the progress made by the case studies.

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Additionally, the assessment tools were enhanced with further information on the Water4All Partnership and the benefits of joining the WOLLs Network upon positive evaluation.

Both case studies that completed the second assessment process, namely CS3 and CS4, were successfully identified as WOLLs.

12.1.1. Case study 3 - Rosignano, Italy

In 2022, CS3 underwent a preliminary maturity assessment to evaluate its readiness for evolving into a WOLL. The benchmark evaluation resulted in a score of 30%, indicating that while some foundational elements were present, further development was needed. Nevertheless, CS3 was identified as a promising candidate for transition to a WOLL based on several key factors that emerged during the evaluation:

- **Water Focus**: CS3's mission focused on developing innovative solutions for wastewater reuse and industrial symbiosis, aligning closely with Water Europe's vision of a Water-Smart Society.
- **Territorial Dimension**: The collaboration between ASA (the municipal water utility) and Solvay Chimica Italia aimed to improve water reuse and reduce groundwater consumption, ensuring alignment with regional water needs.
- **Innovation Demonstration**: Through the ARETUSA consortium, CS3 had already initiated symbiotic relationships, focusing on treating municipal wastewater for industrial reuse.
- **Quadruple Helix Engagement**: CS3 demonstrated strong stakeholder engagement across public authorities, industry (e.g., Solvay Chimica Italia), academia, and local communities, essential for collaboration and innovation.
- **Long-Term Sustainability**: The ARETUSA consortium's governance structure provided a foundation for sustained operations and collaboration, further supporting the long-term feasibility of circular water use and innovation. With major players like Solvay as key stakeholders, the continuation of Living Lab activities was feasible due to the relatively low costs of governance and available funding from participating partners.

These strengths positioned CS3 as a case study with clear potential to evolve into a WOLL, despite its initial score. The benchmark assessment emphasised areas for growth, particularly in **Service Creation**, **Infrastructure**, and **Innovation Outcomes**. For further details, refer to Deliverable D3.2.

Second assessment results

In the two years following the initial benchmark assessment, CS3 engaged in an ongoing exchange of emails as part of the assessment process. This communication enabled partners to provide clarifications and additional information, resulting in a more

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complete overview of the case study. After a follow-up call and further discussions, CS3 was identified as a WOLL based on the second assessment.

The second assessment revealed substantial improvements across several areas:

- **Water Focus Assessment**: As previously noted, CS3's mission focused on the development of innovative solutions for wastewater reuse and industrial symbiosis, aligning closely with Water Europe's vision of a Water-Smart Society. Led by the ARETUSA consortium, CS3 prioritised treating municipal wastewater for reuse in industrial processes, reducing reliance on freshwater resources. This effort addressed local water scarcity while contributing to more sustainable industrial operations in the region.
- **Link with Territory Assessment**: CS3 maintained a strong connection with its local territory, focusing on regional water challenges through wastewater reuse and industrial symbiosis. The collaboration between ASA and Solvay Chimica Italia aligned CS3's initiatives with territorial needs, specifically reducing groundwater use and increasing municipal wastewater reuse. Over the past two years, CS3 strengthened relationships with local stakeholders, including businesses, public authorities, and communities, ensuring its activities aligned with the region's environmental and economic priorities. The Circular Economy Laboratory, installed as part of the ULTIMATE project, has become a hub for innovation, supporting both local industries and the agricultural sector, reinforcing the relevance to the region's economic, environmental, and social dynamics.
- **Innovation Demonstration Assessment**: CS3's innovation efforts focused on advanced wastewater reuse technologies and symbiotic industrial processes. The Circular Economy Laboratory played a crucial role in demonstrating these innovations by providing a space for real-world testing. CS3's ability to treat municipal wastewater for reuse in industrial applications, supported by real-time monitoring and control systems, significantly reduced dependence on freshwater resources. Additionally, the integration of by-product recovery into wastewater treatment introduced new ways to enhance resource efficiency, positioning CS3 as a leader in developing circular water management solutions. These innovations contributed to broader environmental sustainability by reducing the environmental footprint of local industries.
- **Quadruple Helix Assessment**: The Quadruple Helix model remained a cornerstone of CS3's development, ensuring broad collaboration among public authorities, industry, academia, and the local community. Over the two years leading up to the second assessment, CS3 deepened these connections through stakeholder engagement initiatives. The ARETUSA consortium organised Living Labs, Communities of Practice, and co-creation activities to bring together stakeholders to co-develop water reuse solutions. Local municipalities, the Province of Livorno, academic institutions, citizens, and

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farmers were actively involved in discussions and participatory events on water conservation, promoting community involvement and aligning the WOLL's activities with stakeholder interests.

- **Long-term Sustainability Assessment**: The long-term sustainability of CS3's efforts was a key focus of the second assessment, with attention given to the governance mechanisms developed by the ARETUSA consortium. In the past two years, significant progress was made in establishing a governance structure that supports the long-term viability of the WOLL. The consortium refined its management and operational strategies, ensuring that financial and organisational aspects were sustainable beyond the project's duration. Although some elements, such as long-term financial models, are still under development, the consortium has made progress in securing stakeholder commitment and aligning the WOLL's objectives with regional priorities.

In addition to meeting these core criteria, CS3 enhanced the stakeholder engagement dimension by promoting educational initiatives on water conservation and sustainability. The involvement of local communities and businesses in co-creation processes further strengthened the project' s ability to address local water needs.

These key areas are the compulsory criteria that need to be in place in order to be identified as a WOLL. The improvements enabled CS3 to meet the necessary conditions to be identified as a WOLL.

Outcomes

CS3 made significant progress across key areas, particularly in addressing the gaps identified in the initial benchmark assessment. The second assessment resulted in an improved score of 65%, reflecting the advancements made in areas such as stakeholder engagement, innovation, and sustainability. The updated evaluation, illustrated in Figure 78, shows a comparison between the benchmark and second assessment results. The figure highlights significant progress across key areas, including User Involvement, Service Creation, Infrastructure, Innovation Outcomes, and Methods and Tools.

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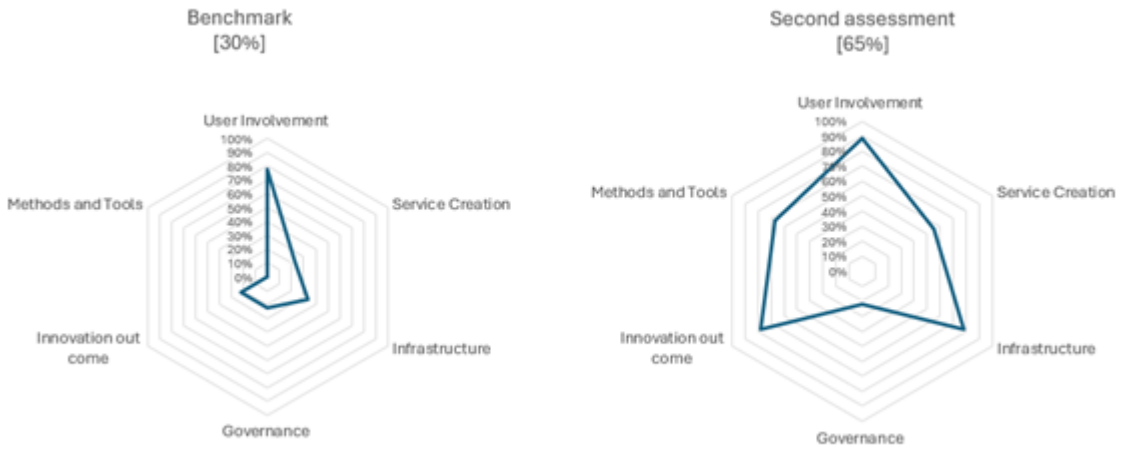

Figure 79 Benchmark and second assessment results for CS3

CS3's successful identification as a WOLL reflects the significant progress made through dedicated stakeholder engagement, innovation, and long-term sustainability planning. Its journey from an initial score of 30% to a final score of 65% in the second assessment underscores the commitment and collaboration that underpinned its transformation, demonstrating its significant potential and dedication to this evolution

12.1.2. Case study 4 - Nafplio, Greece

CS4 Nafplio was evaluated in 2022 to assess its maturity and potential for evolving into a Water-Oriented Living Lab (WOLL). The assessment, which resulted in a 31% score, indicated that while key foundational elements were present, further efforts were needed to support its transition. Nevertheless, CS4 was recognised as a strong candidate for the WOLL transition based on several key factors highlighting its high potential since the very start of the project:

- **Water Focus**: The main objective of CS4 is to develop innovative solutions for wastewater reuse in fruit processing, particularly for irrigation in the highly productive citrus fruit region of Nafplio. This aligns closely with Water Europe's vision of a Water-Smart Society.
- **Territorial Dimension**: The collaboration between Alberta S.A., a Hellenic fruit processing industry, and the local water service providers was essential for addressing local challenges related to water scarcity, groundwater quality degradation from over-irrigation, and saltwater intrusion.
- **Innovation Demonstration**: CS4 aimed to reduce water consumption in fruit processing by promoting the reuse of wastewater and recovering value-adding compounds such as bioactive substances for further use in the agricultural sector.

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- **Quadruple Helix Engagement**: CS4 established strong relationships with stakeholders across public authorities, industry, research institutions, and local communities to drive collaboration and innovation in water management.
- **Long-Term Sustainability**: Governance mechanisms to support long-term sustainability were considered promising, ensuring that CS4's efforts would continue to address regional water needs.

CS4 was highlighted as a case study with clear potential to evolve into a WOLL, despite its initial score. The benchmark assessment emphasised areas for growth, particularly in Service Creation, Infrastructure, and Innovation Outcomes. For further details, refer to Deliverable D3.2.

Second assessment results

In the two years following the initial benchmark assessment, the assessment process concerning CS4 started during the ULTIMATE project Workshop within the ULTIMATE project, which took place in Athens on the 18 April 2024. During this in-person meeting, the opportunities and the process of becoming a WOLL were thoroughly explored with the stakeholders of CS4. In the following months, different meetings and email exchanges occurred, and all the necessary information was provided.

The second assessment revealed substantial improvements across several areas:

- **Water Focus Assessment**: CS4 focuses on wastewater reuse solutions in fruit and vegetable processing, reducing water consumption and enhancing irrigation practices. Efforts are directed at optimising water management strategies to improve irrigation practices and lessen the dependence on high-quality groundwater.
- **Link with Territory Assessment**: Over the past two years, CS4 deepened its relationship with local stakeholders, particularly farmers, water utilities, and agricultural sectors, ensuring that its activities remain highly relevant to the region's water challenges. By improving water availability for agriculture, CS4 contributed to both the productivity of local farming and the long-term sustainability of water resources in the region.
- **Innovation Demonstration Assessment**: CS4 successfully showcased innovative technologies for wastewater reuse through real-world testing in the VesperX unit. This mobile unit, designed specifically for the food processing industry, proved effective in recycling wastewater for irrigation while minimising the environmental footprint. Moreover, by recovering valuable compounds from the wastewater, CS4 enhanced the local agricultural economy.
- **Quadruple Helix Engagement**: CS4 effectively reinforced collaboration across the Quadruple Helix framework, involving public authorities, the local community, industry, and research institutions. This approach ensured that

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stakeholder perspectives were integrated into water reuse strategies, making the project more resilient and aligned with territorial goals. Co-creation processes, including workshops and discussions, supported continuous engagement and decision-making.

- **Long-Term Sustainability Assessment**: The governance mechanisms within CS4 were further developed to ensure the long-term sustainability of the water reuse initiatives. Stakeholder engagement deepened as new operational and financial strategies were introduced, supporting the continued application of wastewater reuse technologies beyond the project's duration. This helped secure long-term commitment from local stakeholders, ensuring that CS4's water management solutions remained viable and effective in addressing future water needs in the region.

The improvements in these key areas resulted in the successful identification of CS4 as a WOLL.

Outcome

CS4 demonstrated significant progress, leading to its recognition as a WOLL. Through continuous engagement and dedicated efforts, CS4 showed marked improvement across multiple key areas such as stakeholder engagement, innovation, and sustainability. The second assessment, which resulted in a final score of **93%**, highlights the advances achieved in User Involvement, Service Creation, Infrastructure, Governance, Innovation Outcomes, and Methods and Tools, as illustrated in Figure 79.

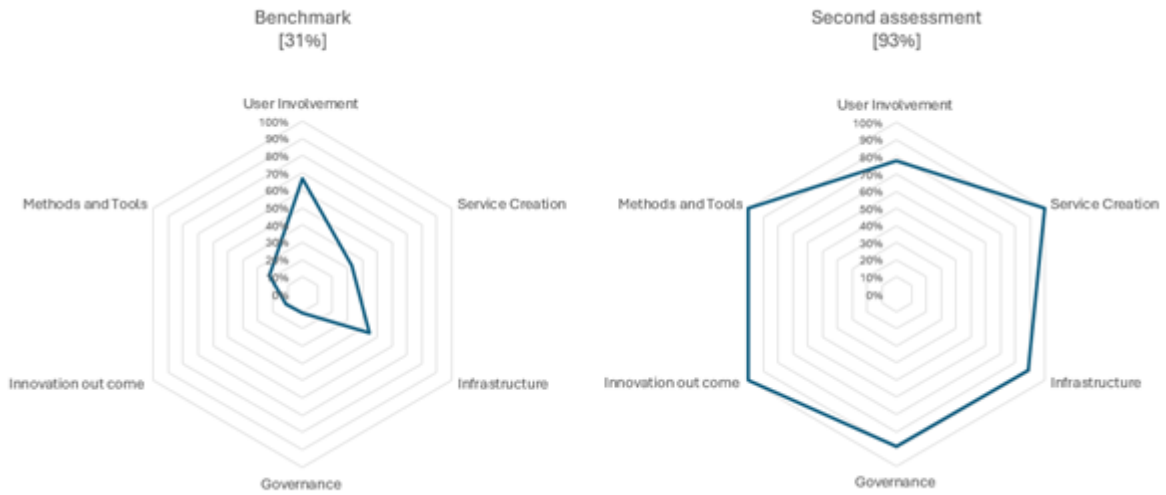

Figure 80 Benchmark and second assessment results for CS4

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CS4's progress over the past two years highlights its proactive approach to driving innovation, deepening stakeholder collaboration, and ensuring sustainable practices. By effectively addressing the key challenges identified in the first assessment—particularly through continuous stakeholder engagement and the successful implementation of innovative water reuse solutions—CS4 boosted its maturity score from 31% to 93%, ultimately securing recognition as a WOLL.

12.2. Successful example of a CS evolved into a WOLL

To highlight the process that leads to the evolution of the ULTIMATE project CSs into WSIS LL, it is useful to present a successful example that illustrates the practical application of the WOLLs methodology. We use the example from one of ULTIMATE's sister project B-WaterSmart[18] (BWS). This example is relevant to share as it provides a tangible example of the process ULTIMATE CSs underwent.

The BWS project addresses significant challenges in the water sector, particularly in coastal areas. These regions face water scarcity, increasing demands due to climate change, and population growth, which lead to resource overexploitation, water quality deterioration, and regional imbalances. The project aims to create water-smart economies and societies by developing and demonstrating smart technologies and circular economy approaches. By collaborating on technical and digital solutions, and new business models, BWS accelerates the transformation towards water-smart economies and societies in coastal Europe and beyond.

Six (6) European coastal cities and regions – Alicante (Spain), Bodø (Norway), Flanders (Belgium), Lisbon (Portugal), East Frisia (Germany), and Venice (Italy) – participate in the project, each developing and demonstrating water-smart technologies and management solutions as WOLLs. These labs involve water companies, research partners, and local technology providers, fostering a collaborative environment for innovation.

The Lisbon CS was recently involved in the Water4All[19] Partnership activities where Pillar D is devoted to demonstrating innovation in the water sector through WOLLs. One of the main tasks of Pillar D is the mapping and assessment of WOLL in Europe and beyond. The Lisbon CS has applied and successfully progressed through all assessment steps described before. In the next paragraphs, results of the assessment process are described.

[18] https://b-watersmart.eu/
[19] http//www.water4all-partnership.eu/

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12.2.1. Introduction

The City of Lisbon WOLL is an ambitious initiative aimed at enhancing the quality of life in Lisbon amidst the challenges posed by climate change, including droughts, heat waves, and floods. By leveraging innovative green-blue infrastructure solutions, the WOLL seeks to optimise water smart demand and supply management for non-potable uses and improve the water-energy-phosphorus efficiency performances as well as fostering climate-resilient housing.

In the framework of BWS, on 22 March 2024 (as part of World Water Day), the municipality of Lisbon, the National Laboratory for Civil Engineering (LNEC), and partners of the BWS project organised a public event to celebrate the establishment of the WOLL of Lisbon, led by the municipality. This event aimed not only to highlight the great efforts made by the city in establishing the WOLL in the BWS project but also to emphasise that this WOLL is part of the Atlas and the Network of WOLLS generated by the EU-funded partnership Water4All[20].

12.2.2. Background and Context (Water focus assessment)

The Lisbon municipality faces significant water management challenges due to its growing population, dependence on freshwater resources that are physically distant, and climate change challenges. The city has implemented a smart management strategy to enhance urban development and water efficiency. Lisbon's designation as the European Green Capital in 2020 has further solidified political will and investments to improve the city's water-smartness.

The City of Lisbon WOLL aims to achieve several strategic objectives:

- Ensuring sustainable water resources for the city's population,
- Protecting and enhancing urban ecosystems through effective water management,
- Creating economic value around water use and management,
- Encouraging adaptive strategies to mitigate climate change impacts, and
- Involving the public and various stakeholders in the governance and co-creation of water management initiatives benefitting the territory.

12.2.3. Main activities and initiatives (Innovation demonstration and link with the territory assessment)

The City of Lisbon WOLL focuses on several key actions to enhance the city’s water smartness. Fit-for-purpose water use strategies are being implemented for non-potable applications, such as irrigation and industrial uses. Infrastructure for the distribution of non-potable water is being developed, alongside measures to reduce

[20] http//www.water4all-partnership.eu/

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drinking water consumption through efficiency improvements. Moreover, upgrading the city's drainage systems to be able to handle extreme weather events and integrating green infrastructure to manage water sustainably and enhance urban resilience are also crucial among the efforts being made.

The City of Lisbon WOLL leverages advanced technologies and digital tools developed in BWS to support its objectives. Water reuse algorithms are being developed to quantify water cycle components and assess the water-energy-phosphorus balance. Certification tools for assessing and enhancing buildings' readiness for climate impacts are being implemented, and an urban water observatory is being established to monitor and manage urban water resources effectively.

Various pilot projects are being conducted to test and demonstrate innovative solutions. Projects activities are advancing to enhance the ability of the city to use reclaimed water for irrigation and industrial applications, such as the artisanal beer industry. Additionally, tools for water-smart management are being tested at the city level with multiple users, including municipal and private stakeholders.

12.2.4. Stakeholder Involvement (Quadruple Helix Assessment)

The City of Lisbon WOLL involves a diverse range of stakeholders. The municipality of Lisbon is the primary coordinator of the lab's initiatives. LNEC serves as a mentor and research partner, focusing on water quality, treatment, and reuse. Águas do Tejo Atlântico is responsible for reclaimed water production, while Baseform, a software house, develops digital tools for water-smart allocation. The National Energy Agency (ADENE) is developing climate readiness certification methodologies, and Lisboa e-Nova is developing the Urban Water Cycle Observatory (UWCO). The University of Lisbon (ICS-UL) coordinates social and governance aspects and moderates the community of practice established in the framework of the BWS project.
The CoP is a crucial element of the City of Lisbon WOLL, involving various stakeholders in collaborative innovation processes. It includes thematic working groups focused on non-potable water reuse, information and communication, and monitoring. The CoP has an invaluable importance in the development of the city of Lisbon WOLL, as it facilitates knowledge sharing and co-creation among participants of the Quadruple Helix.

12.2.5. Future Perspectives and Sustainability (Sustainability assessment)

The City of Lisbon WOLL aims to achieve several long-term goals beyond the B-WaterSmart project lifespan. Establishing an innovative UWCO to engage stakeholders and the public is a key objective. Developing and implementing water-smart building certificates to promote water efficiency and climate resilience is another important goal. The WOLL also seeks to expand its scope to integrate outcomes from

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other projects and apply its solutions to other cities and regions, scaling the solutions developed internally.

The City of Lisbon WOLL has demonstrated a high level of maturity and positive results through its comprehensive assessment framework, within the Water4All partnership activities. Lisbon scored highly across various metrics, reflecting its robust problem-solving mechanisms, strategic planning, and effective stakeholder engagement. Specifically, the overall weighted maturity score for the City of Lisbon WOLL in 2024 stands at an impressive 91%, with a full score in the spheres of Infrastructure, Service Creation and User Involvement, highlighting the success and efforts put into its initiatives.

The strengths of the Lisbon WOLL include robust problem-solving mechanisms and digital tools, strategic planning and co-production mechanisms, and strong partnerships with scalability potential. However, there are weaknesses, such as the lack of formal agreements ensuring long-term governance and resource allocation. Opportunities arise from EU and national frameworks facilitating water reuse and resource recovery, and potential for collaborating with other living labs to address broader challenges. Further opportunities are given by their presence in the Atlas of WOLLs and the Network of the WOLLs, enabling knowledge sharing and collaboration mechanisms, as well a boost in visibility across Europe and beyond and a stronger collective voice in policy making. Threats include insufficient funding for water efficiency projects, bureaucratic hurdles for licensing, and legal limitations on business models.

12.2.6. WOLL assessment criteria and results

The City of Lisbon WOLL fulfils the main criteria of the WOLLs in the following ways. The Local Territory Connection Assessment is satisfied by being strategically situated within Lisbon and directly tackling the city's significant water challenges. The WOLL excels in the Quadruple Helix Assessment through the comprehensive involvement and engagement of diverse stakeholders along with a broad and active community of practice. Regarding the Sustainability Assessment, the WOLL demonstrates robust governance and structured collaboration, supported by a detailed long-term strategy that encompasses financial planning and organisational governance. Additionally, the City of Lisbon WOLL’s strategic planning mechanisms ensure continued stakeholder engagement and scalability of its initiatives. Lastly, the Innovation Demonstration Assessment is met through the WOLLs cutting-edge technological and digital solutions, such as water reuse algorithms, climate readiness certificates, and the urban water observatory, which collectively highlight its innovative approach to sustainable urban water management and its role as a crucial catalyst in the field.

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13. Lessons learned

The following section provides some lessons learned and way forward for the remainder of the project based on the preliminary insights and results from the co-creation exercises and CoP implementation.

13.1. Co-creation and Multi-use Play spaces

Co-creation exercise in the form implemented in ULTIMATE are new to the water sector. Consequently, it has taken quite some time in the beginning to gain the project partners and the stakeholders trust and confidence in the process. A lot of iterations were necessary to accompany the CSs through the process and to help them and their stakeholders understand the co-creation exercise purpose, process, and outcomes.

Initial challenges related to the process and its final outcomes could be addressed with one-on-one online and in person discussions between the CSs and the WP3 co-creation leaders. In particular, a lesson learned here is that when challenges arise it is most productive to address them in person. In spite of in-person meetings being time consuming, the payoff is greater than the time investment.

Furthermore, in the project proposal phase, the fact that the co-creation process was new to the water sector and would have required more time to be established was probably not given sufficient consideration. This is another lesson learned, for the transferability of such an approach to new sectors.

Finally, another point of attention is the communication language. Because co-creation is new to the water sector, its language is also new. The challenge here was for WP3 partners leading the process to be able to communicate with the CS partners and the stakeholders in a language that they could relate to. This required connecting the co-creation exercise to the specific CS processes and discussions. The use of examples, in particular visual examples, proved useful to address the language barrier and will be continued for the rest of the project.

The assessment of the L'acqua Per Tutti and Water-kennis IMX installations demonstrates their effectiveness in captivating stakeholders and enhancing learning on water reuse and symbiosis practices. Participants exhibited high engagement and positive attitudes toward the interactive elements, reaffirming the strength of immersive technologies like AR and 3D visualisations in fostering stakeholder involvement and education. The IMX installations proved significantly more engaging and impactful than traditional formats like PDFs, encouraging deeper interaction and clearer understanding of complex topics like water sustainability.

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Although feedback identified minor areas for improvement, particularly in navigation, the overall experience remained highly intuitive and engaging. The co-creation process that shaped the IMX development ensured that the content was tailored to stakeholder needs, further enhancing its effectiveness. With a few refinements, the IMX has the potential to continue being a leading platform for stakeholder engagement and learning in water sustainability.

13.2. Communities of Practice

When applied intentionally as a learning concept, the overall goal of a CoP is to maintain the already existing knowledge about a specific topic and use it to create new ideas through an ongoing exchange of information (Koti et al., 2017). The interaction among different actors seems to improve the decision-making process at the individual, societal and institutional level mostly when there is a strong investment on working based on a shared vision (Freitas et al., 2018).

Within ULTIMATE, the Community of Practice (CoP) approach is highly project-driven. This necessitates participation to foster collaboration. Through this collaboration, participants can co-create essential knowledge by sharing diverse perspectives on an issue. This, in turn, promotes social learning, a transformative process that empowers change. Ultimately, it is important to remember that CoPs are made of people. People need to experience a sense of belonging, respect, inclusion, flexibility, motivation, and trust to collaborate. These feelings are the emotional driver for stakeholders to join, contribute, engage, share, and learn through the CoP. Finding the right experts capable of facilitating and managing CoP social interactions, especially in technically driven projects, is often challenging but crucial for nurturing those emotional drivers that underpin the engagement of stakeholders.

Clear communication of project objectives and needs, and aligning these with the interests and needs of stakeholders give better meaning and purpose to the CoP as it helps building a shared vision for the future. Ensuring stakeholders understand the project's vision and exploring together how the they fit into that vision, and communicating how engagement translates into practical contributions and influence within the project, is crucial to ensure active engagement of stakeholders in the CoP. However, it is also important to place the CoP’s objectives and goals in the bigger context outside the boundary of ULTIMATE to sustain the relevance of the CoP beyond the lifetime of the project.

CoP roadmaps, when implemented, help CSs to give structure to the CoP process and a plan within the project lifetime. This in turn may contribute to maintain commitment of stakeholders to the CoP. However, insights across the CSs have demonstrated a need for flexibility to accommodate different contexts, institutional arrangements and

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needs. A one-size-fits-all approach to CoPs is therefore not realistic when it comes to preparing and implementing a CoP.

In fact, establishing a new CoP is not always the best approach if similar stakeholder groups already exist. A good overview of existing stakeholder groups is particularly important to choose whether it is best to establish a new structure within the current organisational system or embed the CoP within the existing system. CS9 provides a clear example of how a good understanding of the existing local conditions was crucial to strategically position the CoP approach for the benefit of both the local stakeholders and the project. The CS9 experience showed that building on an existing engagement ecosystem could enable more effective engagement of relevant stakeholder for the ULTIMATE project. This engagement was built on an already existing foundation of established relationships, trust and mutual understanding, fostering a cooperative environment where all partners feel valued and heard.

Documenting the preparation and implementation of the CoP is useful for continued learning and improvement of the CoP. Evaluating the CoP is not only necessary to measure its success in terms of output, but also to measure its functioning over time in terms of process. In particular, it allows for continuous learning and improvement of the CoP throughout the project, with the overall goal of identifying best practices for CoPs at the end of the project. The evaluation of CoP meetings by stakeholders is therefore relevant to measure the CoPs' maturity and structures and processes effectiveness over time. Despite the importance of the evaluation survey, response rates are not always high across the CSs, or not done at all. This may in part be due to survey fatigue. The most effective approach to overcome such fatigue is to dedicate time to the stakeholder evaluation at the CoP meeting. However, due to usually a very dense CoP meeting agenda, or because of group dynamics making stakeholder unwilling to share their feedback on the meeting, this approach is not often adopted. A point for consideration is seeing how the current evaluation of the CoP can be adapted to simplify it or explore complementary or alternative approaches, e.g. interviews with selected CoP stakeholders.

For stakeholder engagement to be successful it is necessary that CoPs are experienced as a safe space where stakeholders and CS partners feel comfortable to share knowledge, learn and exchange. This requires a tailor made approach for stakeholder engagement capable of taking the needs and challenges of stakeholders and the local circumstances of each CS into account. Enough time needs to be allocated to create the right environment to build trust, and ensure transparency and good communication. As ULTIMATE CSs has shown, this time frame can be different across CSs as creating the right environment for meaningful engagement depends on local circumstances and stakeholder group dynamics which can be very different.

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One key objective of ULTIMATE CoPs is to support their continuation beyond the project lifetime. To this purpose, the definition of shared objectives and goals beyond just the context of ULTIMATE is important. Accordingly, WP3 has consistently encouraged CSs of the need to discuss long term goals beyond the project with CoP stakeholders. This is also in line with the replicability and impact objectives of WP5 and T3.4 on LLs.

The CoP approach remains an important element of the CS activities in ULTIMATE. They are a space to create and share knowledge, technologies and innovations based on a shared understanding, vision, and goals for the CSs' local context. Establishing and implementing CoPs is a process that requires time, and should be tailored balancing flexibility and structure in the process. Across the CSs, the CoPs have been initiated as a space to facilitate the exchange of information and knowledge. The CoPs, if locally relevant and appropriate, can eventually develop or fit into a permanent structure such as LLs (see chapters 8-10 for more details) to share best practices and continue to exchange and learn beyond the local context. In this regard, it is important when setting up a CoP to position the engagement of stakeholders in a broader context. That is to say, engagement through a CoP should align or consider broader national and international perspectives, to ensure relevance beyond just project objectives and ambitions that might be too specific and timebound (i.e., relevant only for the duration of the project).

13.3. Living Lab Engagement

The WOLLs approach, as implemented in the ULTIMATE project, has demonstrated both its potential and its challenges. Throughout the engagement process, nine case studies collaborated to develop sustainable water reuse and circular economy solutions. The lessons learned from this provide valuable insights for future initiatives, particularly in terms of stakeholder involvement, project timelines, and the prerequisites for successful transitions into WOLLs.

One of the key lessons is the significant interest in evolving into WOLLs. Out of the nine case studies, three expressed an interest to transition, recognising the tangible benefits of WOLLs in fostering sustainable water management. However, the project's timeframe was too short for these case studies to complete the transformation. The transition into a WOLL requires a certain level of maturity, including established governance structures and deep stakeholder engagement. When these foundational elements are in place, the process is smoother and achievable within a shorter timeframe. For those case studies that were not sufficiently mature, the evolution process became more complex and time-consuming.

For the three (3) case studies that expressed interest but could not complete the transition, the project revealed that evolving into WOLLs depends heavily on

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readiness. If a case study lacks the necessary maturity, the process can extend beyond the duration of typical projects, as establishing governance frameworks and fostering long-term stakeholder commitment take time. However, when these elements are in place, the transition can be achieved more efficiently.

The two (2) case studies that successfully transitioned into WOLLs demonstrated how a sound foundation supports faster evolution. Their success was driven by:

- Strong governance structures, which provided the framework for sustainable water management.
- Active stakeholder collaboration, ensuring that solutions were technically feasible and aligned with local needs.
- Territorial alignment and long-term innovation commitment, which enabled the adoption of innovative water reuse strategies tailored to their contexts.

Below are the key lessons learned from the LL engagement:

- **Readiness accelerates the process**: The transition to a WOLL is achievable within shorter timeframes if the case study has mature governance structures and strong stakeholder engagement from the outset.
- **Interest is high, but foundations are critical**: While many case studies showed strong interest, without the necessary readiness, the process becomes more complex and time-consuming.
- **Successful WOLLs require robust foundations**: The two successful WOLLs benefited from established governance, innovation capabilities, and stakeholder commitment, which are essential for making the transition within the project's timeframe.

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14. Conclusion

ULTIMATE aims to establish and stimulate water smart industrial symbiosis by implementing CE solutions for water, material, and energy recovery in nine (9) CSs across Europe. The development and acceptance of locally relevant CE technologies and solutions require the active engagement of relevant stakeholder groups across the CSs. By interacting regularly, stakeholders can exchange knowledge, develop ideas, and learn together, thereby contributing to innovative and appropriate solutions for sustainable water management in the context of industrial symbiosis. ULTIMATE promotes this active stakeholder engagement and innovation co-creation through co-creation exercises for the design of IMX in multi-use playspaces, CoPs and LLs.

This report, (D3.8), has provided an update on the insights and results from the implementation of co-creation exercises in CS2, CS3 and CS9 (Subtask 3.2.2 and T3.3), and insights and results on the establishment and implementation of CoPs across the nine (9) CSs (Subtask 3.2.1) as previously reported in D3.5. Living labs at the time of D3.5 were not included in the deliverable because they had not been established yet. Preliminary insights and results of the LL activities (T3.4) have been included in D3.8, used to explore possible platforms or ‘field labs’ (in the LLs) to further develop, test, and validate identified solutions.

WP3 partners will continue to collect insights and results from the co-creation exercises, CoP and LLs activities until the end of the project. These insights and results will be included in a revised version of D3.8 in M52.

14.1. Co-creation and Multi-use Playspaces

Co-creation is a collaborative process where experts work closely with local people, end-users and stakeholders using various resources and ideas to propose, discuss and prototype new actions and solutions to relevant issues. It involves joint creation of value by various participants, allowing them to co-construct the service experience to suit their needs, context, and preferences.

CS2, 3 and 9 have successfully implemented parts of their co-creation exercises guided by plays defined in the ULTIMATE playbook (see D3.7). The outcomes of the co-creation will contribute to creating impactful results to stimulate sharing and learning.

The Kirkpatrick Model adopted to evaluate the success of the co-creation exercises across aspects of reaction, learning and behaviour, have shown positive reflections across the three (3) case studies, demonstrating the value that co-creation is bringing in identifying common challenges, and coming to appropriate ways of understanding and addressing these challenges.

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The ULTIMATE project is benefiting from the co-creation process with new and positive forms of community action, social engagement, and citizen involvement. Locally relevant stakeholders are able to contribute, to share their stories, their ideas and to refine as well as prioritise the ideas shared by others in a systematic multi-stage process.

The co-creation approach has been used in three (3) CSs to design the final prototypes of the three (3) IMX installations, aiming to enhance engagement and public awareness. The IMX involves creating immersive environments using technologies like Virtual Reality (VR), AR, and Mixed Reality (MR), providing interactive and engaging experiences.

Based on the co-creation exercises, the following IMX have been developed and implemented, as reported in D3.6:

- CS2 IMX is situated within the premises of KWR, offering a location-based experience where participants scan a QR code from a marker stand at each stage.
- CS3 IMX of the Aretusa Wastewater Treatment in Rosignano, features an interactive tabletop with AR markers and a Kinect depth sensor.
- CS9 IMX of Kalundborg, presents a 2x3 meters vinyl foam floor with AR image markers, facilitating exploration of industrial symbiosis and water reuse concepts.

The findings from our comparative study strongly suggest that co-created IMXs within a multiuse playspace offer a superior user experience compared to traditional communication methods, such as PDFs, in fostering stakeholder engagement. Across multiple dimensions, including engagement, flow, usability, and emotional response, IMX demonstrates its ability to create more immersive and impactful experiences. These results align with existing research highlighting the effectiveness of interactive and immersive media platforms in enhancing engagement and understanding complex topics (Mayer, 2009).

While traditional methods may still have a role in certain contexts, their limitations in creating immersive and emotionally resonant experiences can hinder effective stakeholder engagement. Importantly, these findings also highlight that the effectiveness of IMX depends on adjusting the experience to suit diverse user groups. Tailoring IMX content and interactivity for varying expertise levels and preferences will maximise its impact and ensure more meaningful interactions. Therefore, integrating IMX technology into stakeholder engagement strategies can lead to more meaningful and impactful interactions, ultimately driving better outcomes.

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14.2. Communities of Practice

CoPs are social learning systems bringing together experts with local people, end-users and other relevant stakeholders to develop a common understanding, sharing best practices and creating new knowledge on a given topic, to arrive at solutions that are co-developed, supported, and accepted by the stakeholders. Interaction on an ongoing basis is an important part of this.

CoPs have been established across all nine (9) CSs to engage locally relevant stakeholders. From the start of the ULTIMATE project, a flexible, tailor made approach to CoP design and implementation was adopted by WP3, with no pre-defined, fixed number and frequency of CoP meetings or pre-defined CoP format. Each CS was assisted in the design and implementation of a tailor made CoP suited to their local context.

Overall, experience so far with CoPs show that clear objectives and goals for the project lifetime and beyond, a shared vision for the future, and a good balance between project needs and local CS needs for the operationalisation of CoPs help build and sustain value and relevance of the CoP. This is reflected in the overall, positive feedback of CoP stakeholders across CSs. Stakeholders appreciate CoPs for being a source of valuable information, and as a space for learning and exchanging ideas, and discussing problems and solutions with a broad and diverse group of stakeholders.

CoPs have remained an important tool of the ULTIMATE project to support knowledge development, sharing and stakeholder acceptance of symbiosis solutions. Several CSs will continue to organise CoP meetings until the end of the project to continue to build a common understanding, sharing best practices and creating new knowledge on a given topic, to arrive at solutions that are co-developed, supported, and accepted.

14.3. Water-oriented Living Lab Engagement

The ULTIMATE project is a pioneering initiative aimed at fostering water-smart industrial symbiosis through the implementation of circular economy solutions for water, material, and energy recovery. By leveraging its extensive experience with LL, WE has positioned WOLLs as a crucial tool for building a water-smart economy and society in Europe. This approach aligns with WE's vision of developing a WSS.

The ULTIMATE project's focus on transforming case studies into WOLLs was guided by the foundational document D3.2 "WSIS Living Lab: Gap Analysis and Recommendations" which provided support and guidance to the ULTIMATE CSs. This document helped integrate current activities with those necessary to evolve toward WSIS LL. In the second phase of activities, the more mature case studies – namely

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namely CS1 (Tarragona, Spain), CS3 (Rosignano, Italy), CS4 (Nafplio, Greece), and CS5 (Lleida, Spain) – were further engaged to facilitate their transition into fully operational WOLLs. CS9 (Kalundborg, Denmark), however, faced resource constraints and was not able to participate further in this phase.

Out of the nine case studies in ULTIMATE, two case studies – CS3 (Rosignano, Italy) and CS4 (Nafplio, Greece) – successfully evolved into WOLLs. These successful transitions underscore the effectiveness of the WOLL framework in fostering sustainable water management practices. In addition, three other case studies expressed interest in transitioning but were unable to complete the process within the project's timeframe. This demonstrates that while there is significant interest in becoming WOLLs, a high level of readiness– in terms of governance structures, stakeholder engagement, resource allocation, and innovation capacity– is essential for a smooth and timely transformation.

Key Conclusions

- **WOLL as a driver for innovation**: The two case studies that successfully transitioned into WOLLs demonstrated how the WOLL framework can drive the development and implementation of circular water management practices. These case studies integrated innovative water reuse solutions and developed governance frameworks that support sustainable water management in their regions. Their successful evolution into WOLLs aligned their efforts with the broader goals of the ULTIMATE project and WE's vision for a Water-Smart Society.
- **Importance of readiness**: For the two case studies that expressed interest but did not complete the transition, the process highlighted the importance of maturity. Evolving into a WOLL requires robust governance structures, deep stakeholder engagement, and a supportive innovation ecosystem to implement circular water management solutions effectively. Without these foundational elements, the transformation process becomes more complex and time-consuming.
- **Timing and project constraints**: While the benefits of becoming a WOLL are clear, the project's timeframe proved too tight for some case studies to achieve the necessary level of maturity. This underscores the key lesson that transitioning into a WOLL can require more time than a typical project allows, particularly for less mature case studies.

Participation in the WOLL Network presents a significant advantage for case studies aiming to evolve into fully operational WOLLs. The network offers various benefits that enhance the case studies' potential and sustain their development activities. One of the key advantages of joining the WOLL Network is the increased visibility it offers. By becoming part of this collaborative platform, case studies strengthen their connections

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with important stakeholders, including European Commission institutions, Member States, and other influential bodies. This increased visibility raises their profile within the water management and innovation sectors, positioning them as leading contributors to sustainable water practices at the European level. The network also provides enhanced access to funding opportunities, which are critical for advancing innovation and sustaining development activities. By being part of the WOLL Network, case studies gain access to valuable financial resources and support mechanisms that enable them to continue developing cutting-edge water management solutions and expand their impact. Additionally, the WOLL Network functions as a sandbox for regulatory learning, providing a space where case studies can overcome innovation barriers. The collaborative environment fostered by the network encourages industrial synergy and cooperative development, allowing participants to test new approaches, refine their solutions, and engage in shared learning with other members of the network. This dynamic interaction not only strengthens the innovation process but also supports the long-term sustainability of the case studies involved.

The WOLL engagement process within the ULTIMATE project has revealed the significant potential of WOLLs to transform water management practices through collaborative innovation and circular economy principles. The two case studies that successfully completed the transition demonstrate the clear benefits of the WOLL framework. Meanwhile, the interest shown by three additional case studies underscores the value of WOLLs, despite the challenges posed by project timeframes and maturity requirements. Moving forward, the WOLL Network will play a crucial role in supporting these developments by offering increased visibility, access to funding, and ongoing support for the continuous evolution of case studies toward water-smart solutions.

14.4. Collectively stimulating engagement and innovation co-creation

The ULTIMATE project aims to foster WSIS across nine (9) Case Studies (CSs) in Europe. Central to its mission was the implementation of CE solutions for water, material, and energy recovery, with the overarching goal of promoting sustainable water management practices within industrial symbiosis contexts. To achieve this objective, ULTIMATE adopted a multifaceted approach that emphasised active stakeholder engagement, innovation co-creation, and the integration of cutting-edge technologies.

One of the primary strategies employed by ULTIMATE was the facilitation of co-creation exercises across three selected CSs. These exercises represented collaborative processes where experts, local communities, end-users, and stakeholders converged to brainstorm, prototype, and refine innovative solutions to

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pertinent community water management challenges. Through joint creation of value, participants tailored service experiences to meet specific needs, contexts, and preferences, ensuring that proposed solutions were both innovative and practical.

Complementing the co-creation exercises were CoPs, established across all nine CSs, serving as social learning systems that brought together diverse stakeholders to share knowledge, best practices, and experiences. CoPs provided a platform for ongoing interaction, fostering a common understanding and co-development of solutions that were supported and accepted by stakeholders. This collaborative approach not only accelerated the pace of innovation but also ensures the relevance and applicability of solutions to local contexts.

In parallel, ULTIMATE recognised the pivotal role of LLs in testing and validating solutions in real-world settings. WOLLs were positioned as crucial tools for building a water-smart economy and society in Europe, serving as platforms for experimentation, cooperation, and knowledge exchange. By engaging with the LL approach, ULTIMATE bridges the gap between theory and practice, ensuring that proposed solutions (discussed for example in CoPs) are feasible, effective, and adaptable to dynamic real-world conditions.

Collectively, these components formed a synergistic ecosystem of engagement and innovation co-creation within the ULTIMATE and with diverse stakeholder groups. By involving stakeholders at every stage of the innovation process, from ideation to implementation and evaluation, ULTIMATE can foster a sense of ownership, commitment, and empowerment among stakeholders. This holistic approach not only accelerates the development and adoption of sustainable water management solutions but also cultivates a culture of collaboration, learning, and adaptation essential to addressing complex societal challenges.

ULTIMATE shows a paradigm shift in the approach to sustainable water management, emphasising collaboration, innovation, and stakeholder engagement as key drivers of change. By harnessing the collective intelligence and creativity of diverse stakeholders through these different co-creation and engagement approach, ULTIMATE is able to more effectively create a future where WSIS was not only achievable but also integral to building resilient, inclusive, and sustainable communities.

The ULTIMATE project’s emphasis on engaging end-users and other stakeholders in the innovation process has been a cornerstone of its success. By prioritising user-centric approaches and fostering real-life applications, the project can ensure that the solutions developed are not only innovative but also practical and widely accepted.
The lessons learned from co-creation exercises, CoPs, and WOLLs engagements provide a robust foundation for future projects and initiatives. By building on these

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insights and continuously refining our approaches, we can enhance the impact and sustainability of efforts to create a more resilient and sustainable Water-Smart Society.

14.5. Assessing the Impact of Stakeholder Engagement Tools

14.5.1. Methodology

The survey was administered during the final meeting in Livorno to water-oriented professionals involved within the ULTIMATE project, with voluntary participation and no formal selection process. It included both closed-ended questions (using Likert scales to assess involvement, effectiveness, and value of engagement tools) and open-ended questions to gather qualitative insights on challenges, outcomes, and recommendations.

Data was analysed quantitatively for engagement levels and effectiveness, and qualitatively for recurring themes from open-ended responses. The voluntary nature may have introduced self-selection bias, and feedback reflects participants' experiences at the project's conclusion.

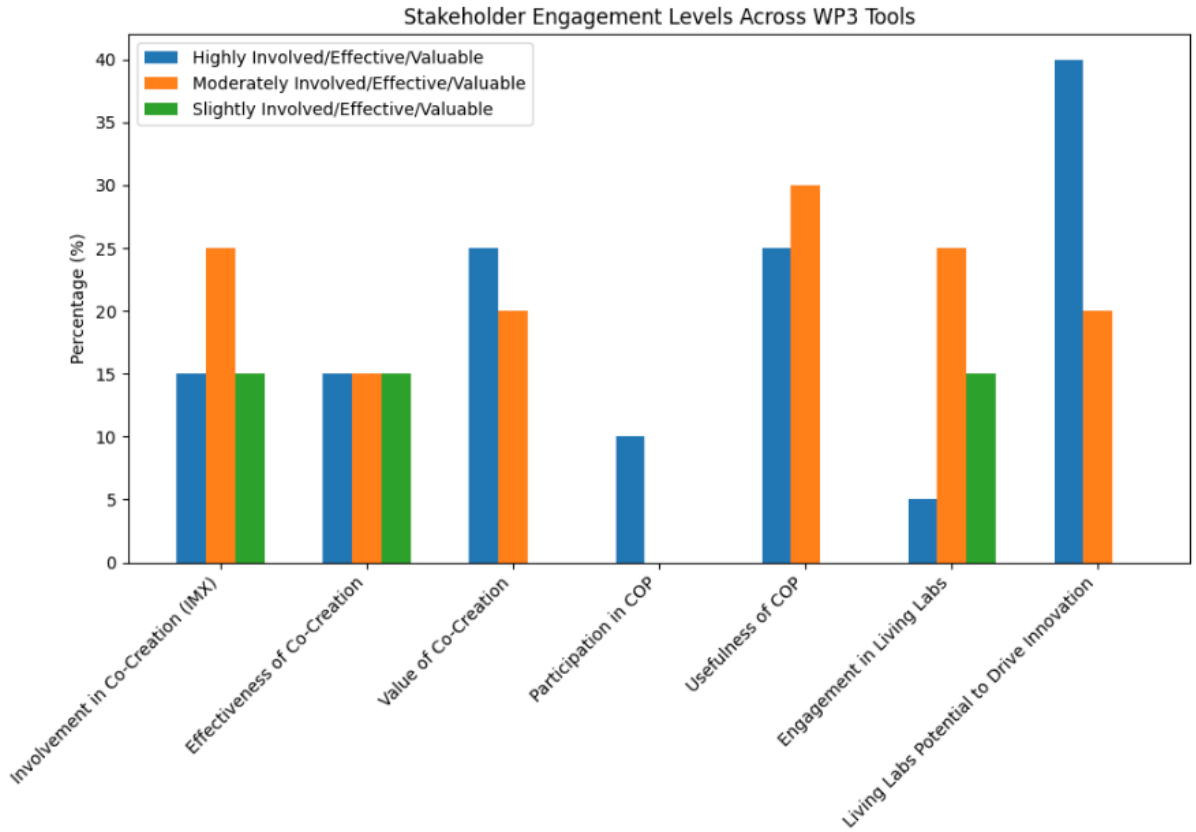

Figure 81 Stakeholder engagement responses to the closed-ended Likert-scale questions levels across the different stakeholder tools (Co-Creation, Communities of Practice, and Living Labs)

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Table 11 Qualitative feedback on challenges faced, outcomes achieved, and recommendations for improvement on the 3 Stakeholder Engagement Tools

	Key Insights	Challenges	Suggested Improvements
Roles and Involvement	Participants varied from principal investigators, case study leaders, technical experts, and researchers from various organisations. Engagement levels varied, with many involved in Co-creation (IMX), CoP, or Living Labs.	Some participants were not involved in any engagement tools.	More involvement of general public
Effectiveness of Co-Creation	Highly effective for key stakeholders. They valued co-creation for ensuring successful IMX implementation.	Time constraints, convincing stakeholders, simulating real environments.	Earlier stakeholder involvement, better alignment to expertise
Effectiveness of CoP Discussions	Most found discussions useful, highlighting customer needs, networks, and addressing water challenges.	Occasional participation, lack of substantial impact.	Sustained involvement of less-engaged stakeholders
Outcomes from CoP	Insights included customer needs, long-term water developments, and promoting technology. Some sector-specific outcomes were reported.	Some respondents noted no significant outcomes.	Continued network-building and stakeholder understanding.

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	Key Insights	Challenges	Suggested Improvements
Engagement in Living Labs	Collaboration, local challenge identification, and political motivation were key outcomes. Stakeholders valued Living Labs for innovation	Varying levels of engagement, disengaged stakeholders.	Better tools for engaging the full range of the quadruple helix stakeholders in an inclusive and timely manner
Integration of Three Tools	The tools worked well together to achieve goals like innovation and collaboration	Lack of alignment between tools and stakeholder backgrounds.	More time for engagement (due to COVID), better customisation to participant expertise.
Overall Impact on Project	Most participants believed the engagement tools positively impacted project outcomes (e.g., technology adoption, decision-making, collaboration).	Some participants reported limited personal impact due to lack of involvement.	Early, continuous stakeholder involvement.
General Challenges	Time constraints, motivation, lack of alignment between participants' expertise and the tools used.	Engagement and motivation challenges, time constraints (especially during COVID).	More preparation time, earlier involvement, and better customisation of tools to stakeholder backgrounds.

14.5.2. Insights from the Stakeholder Engagement Tools Evaluation

The evaluation of stakeholder engagement tools within the ULTIMATE project highlights the importance of tailoring engagement strategies to specific contexts and participant needs. While the tools employed demonstrated varying levels of effectiveness, overall, they contributed to increased stakeholder involvement and positive outcomes.

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Key findings include the importance of clear communication, ongoing engagement, and opportunities for feedback. Challenges faced by participants included limited time and resources, as well as difficulties in balancing competing priorities.

Recommendations for future projects include investing in dedicated resources for stakeholder engagement, conducting regular evaluations, and fostering a culture of open communication and collaboration.

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Annex A: Case Study selection criteria for co-creation engagement and development of an immersive narrative experience

As co-creation is a demanding process for the case studies (CS), only the co-creation exercise, playbook, and immersive narrative installation development have been applied to three (3) selected CSs.

Information about the nine (9) CSs studies was gathered based on their web presence (internet searches, project reports and literature), from presentation materials in meetings with the CS partners, and through one-on-one interviews with the CS partners. Using four (4) guiding principles for the selection process: co-creation, sense of community, openness, and change-making, the CS partners were asked a number of questions. On the basis of this, three (3) of the nine (9) CSs were selected for the co-creation engagement and development of an immersive narrative experience.

	Survey Question	Description
Co-creation	Are you willing to use your resources and connections to conduct frequent meetings within the next 2 to 3 years and to use a wide range of tools and methodologies for co-creation?	The three (3) CSs were selected based on how their organisation is willing to commit their time and resources to work together using a wide range of resources, ideas, methods, and tools in creating actions and bringing changes in their environment.
Sense of Community	How well can you identify your organisation with the idea that the local community matter to your ecosystem and to the co-creation group we are going to form together to effect change?	The potential access, sense of belongingness and responsibility to their neighbourhood community was considered across the CSs.

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	Survey Question	Description
	How well can you identify your organisation addressing not just organisational but also community issue at large?	
Openness	Are you willing to use arts and technology to implement site-specific actions or local artistic interventions such as immersive experiences to address community issues? Do you have access to public or community spaces that can be used to show solutions to these issues?	This refers to the strategic priorities of CSs in innovative solutions using arts, technology, and data to address community-related issues in their organisation.
Change-making	Do you value community-led solutions? Beyond technological solutions, is there a need for you to align your mission and value statement with the community?	Beyond the co-creation of technological solutions, the selection of CSs is also based on whether the organisation values community-led change and innovation. This involves change in individuals, communities, institutions and/or cultures, and in the way of thinking, value creation and societal consciousness.

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Annex B: Evaluating the Impact of Stakeholder Engagement Tools

Methodology

Addresses each tool (Co-creation, COP, Living Labs) separately, while also looking at their collective impact, this evaluation captures a comprehensive picture of stakeholder engagement within the ULTIMATE project.

Explanation of Evaluation Structure

- Open-ended Questions: These provide qualitative insights into specific experiences, such as challenges, solutions, and suggestions for improvement.
- Rating Questions: These capture the degree of impact or effectiveness on various aspects of stakeholder engagement.
- Engagement and Interaction: The focus is on understanding both the direct outcomes (like technology alignment) and indirect factors (such as stakeholder satisfaction or collaboration effectiveness).

Part 1: General Information

The purpose of this section is to gather basic information about your role and involvement in the project. This helps us understand how your experience and participation might influence your responses.

1. Please describe your role in the project (e.g., project manager, technical expert, etc.)
2. How long have you been involved in this project?
3. Which stakeholder engagement tool(s) have you participated in? *(Select all that apply)*
    a. Co-creation (IMX implementation)
    b. Communities of Practice (COP)
    c. Living Labs
    d. All of the above

Part 2: Co-Creation for IMX Implementation

This section aims to assess the impact of co-creation on the usability and alignment of the IMX solution with stakeholder needs. We're also interested in the challenges you may have encountered during the process.

1. To what extent were you involved in the co-creation process leading to the IMX implementation?
    a. Not involved

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   b. Slightly involved
   c. Moderately involved
   d. Highly involved
2. How effective was the co-creation process in integrating your insights into the IMX solution?
   (This question evaluates how well your input influenced the final outcome)
   a. Not effective
   b. Slightly effective
   c. Moderately effective
   d. Highly effective
3. What challenges did you face during the co-creation process? *(Open-ended)*
   (This will help us understand barriers to engagement and areas for improvement)
4. How would you rate the value of the co-creation process in ensuring a successful implementation of the IMX?
   (This question focuses on the overall value that co-creation brought to the project's outcome)
   a. Low value
   b. Moderate value
   c. High value

Part 3: Communities of Practice (COP) for Wastewater Technology Discussions

This section explores how the technology discussions in COP contributed to solving real-world challenges and aligning project goals with stakeholder needs.

1. How often did you participate in COP discussions on technology needs?
   a. Rarely
   b. Occasionally
   c. Frequently
2. Were the COP discussions useful in addressing technology-related challenges in wastewater management?
   a. Not useful
   b. Somewhat useful
   c. Very useful
3. What specific insights or solutions emerged from the COP discussions that contributed to the project's technology development? *(Open-ended)*
   (We want to understand the tangible outcomes from these discussions.)
4. How would you assess the impact of COP on aligning the technology roadmap with stakeholder needs?

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a. Low impact
b. Moderate impact
c. High impact

Part 4: Living Labs for Innovation and Standardisation Discussions

This section evaluates how Living Labs facilitated innovation, collaborative feedback, and refinement of the project's goals, particularly in terms of standardisation and technical requirements.

1. How engaged were you in the Living Labs discussions regarding standardisation or innovation for the project?
    a. Not engaged
    b. Slightly engaged
    c. Moderately engaged
    d. Highly engaged
2. Did the Living Labs format facilitate collaboration among stakeholders?
    a. No
    b. Somewhat
    c. Yes
3. What were the key outcomes of the Living Labs discussions regarding standardisation or innovation?
    (Open-ended)
    (This helps us identify the most significant contributions made during the Living Lab sessions)
4. How would you evaluate the potential for the Living Labs approach to drive innovation in the project?
    a. Low potential
    b. Moderate potential
    c. High potential

Part 5: Overall Evaluation and Recommendations

In this final section, we are looking for your overall perspective on how the three stakeholder engagement tools (Co-creation, COP, Living Labs) work together and what improvements could be made for future initiatives.

1. In your opinion, how well do the three engagement tools (Co-creation, COP, Living Labs) work together to create value for the project?
    a. Not well
    b. Somewhat well
    c. Very well
    (This question focuses on how the tools complement each other to achieve project goals)

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2. What improvements would you recommend for future stakeholder engagement activities?
   (Open-ended)
   (Your suggestions will be invaluable in improving future engagement strategies.)
3. Do you think stakeholder engagement through these tools has positively impacted the project's outcomes (e.g., technology adoption, decision-making, collaboration)?
   a. Strongly disagree
   b. Disagree
   c. Neutral
   d. Agree
   e. Strongly agree

Link to the Questionnaires for the Stakeholder Engagement Tools:

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Annex C: Community of Practice Roadmap

C.1. Community of Practice roadmap guidance

A CoP Roadmap includes:

- Definition of the scope of the CoP and focus group meetings
- Definition of the topic of each of the meetings
- Identification of the stakeholders to join the meetings
- Identification of type of meeting (entire community or a subset in focus groups)
- Timeline of the meetings

Tips and guidance:

The template tables below include the minimum information to include in your roadmap. You can expand them and add more rows as you need. For example, if you want to use this template as starting point to prepare your CoP meetings, you can add a row including Methods to use in the meeting (moderation techniques, engagement tools, etc.), and so forth.

In general, at least 4 CoP meetings should be held throughout the duration of the ULTIMATE project (i.e., one per year), with participation from all identified CoP stakeholders (the entire community). You can plan for more CoP Meetings as needed, either with the entire community or with a subset of the community in “Focus Groups” (depending on the topic to be discussed in further detail). The CoP meetings should address cross-cutting issues, whereas a focus group could address a specific topic with a smaller group of interested individuals from the stakeholders.

Having a roadmap will help you plan your project activities according to what needs to be shared/discussed with stakeholders as well as to allocate adequate time to plan the CoP meetings (do not underestimate the time needed to prepare a CoP meeting, especially online meetings).

Checklist for filling out CoP Roadmap Templates:

1. First Case Study Leaders and Coordinators discuss internally and fill in as many of the template tables as needed.

    1.1 Discuss among case study partners the scope of your CoP: think of your stakeholders and their concerns and interests, think of cross-cutting issues to focus on for each meeting). Below are some examples of cross cutting issues:

    - Legal aspects: legal/regulatory barriers and opportunities (EU and national regulations) e.g., for water reuse or recovered material use
    - Social perception and barriers of use of recovered materials and water

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- Requirements (e.g., quality) for the use/reuse of products (water, recovered material): e.g., water reuse tech: for what purpose? Depending on the purpose, what water quality is needed?
- Market for the products of the project

2. Once you have identified the scope of the CoP, narrow it down to a number of specific topics to be discussed with the CoP stakeholders.

3. Depending on the topics and whether they need to be discussed with the entire CoP community or with a subset of individuals from the community, think of how many CoP and focus groups (FG) meetings you need to have throughout the project (min. 4 CoP meetings with the entire community, i.e., 1 per year to keep continuity of engagement).

4. Then share the pre-filled in tables with WP leaders and Living Labs (LLs) coordinators to ask them to contribute with the related WP/Living Labs content to the different meetings. WPs and LLs certainly have issues they would like to discuss with CoP stakeholders. Some of these issues have already been identified in the project proposal but others may become clear now that WPs have started to work. It is important for both WPs and case studies to know what and when CoPs will engage with WPS so that to plan accordingly.

5. Fill in the infographic below once you have identified the number, tentative date of the meetings and topics.

6. You will validate the planning of the CoP roadmap with all stakeholders at the 1st CoP meeting. Fill in the templates below as much as possible prior to that meeting.

7. Place the finalised document with tables and infographic in the online shared space accessible to all case studies and partners (shared space still to be defined, you will be informed).

First CoP Meeting Template

CoP #1 (first)	***"Setting the Scene" (Or choose another title as you see fit for the first meeting)***
Planning:	*Month (tentative – indicate in project month number and actual month and year)*
Participants:	*All stakeholders identified in stakeholder mapping and involved in the case study*
Objective(s) of the meeting	*Validate with stakeholders pre-identified objectives, mission and scope of CoP* *Validate with stakeholders the composition of the community and fill any gaps (are we missing any important stakeholder?)* *Co-define with stakeholders short and long-term value and impact of CoP* *Co-define with stakeholders the specific ways the CoP will operate: decision-making procedures, communication strategy*

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	in between meetings, activities for the community in between meetings, responsibilities of members, contact person(s), etc. Other as needed
Related WP:	*Indicate which WPs/ Living Labs will add content to this meeting. Also indicate what content the WPs/Living Labs will add*

Template for in-between CoP Meetings / Focus Group Meetings

CoP #X (in-between meetings)	***Topic (define the topics for the subsequent CoP meetings)***
Planning:	*Month (tentative – indicate in project month number and actual month and year)*
Participants:	*All stakeholders identified in stakeholder mapping and involved in the case study, and any new ones identified in the 1st CoP meeting* *Any invited guest as needed (e.g. stakeholders potentially interested in the products of the project, for transferability)*
Objective(s) of the meeting:	*Indicate to the best of your knowledge now the possible objectives for the subsequent CoP meetings*
Related WP:	*Indicate which WPs/ Living Labs will add content to this meeting. Also indicate what content the WP/Living Labs will add*

Focus Group (FG) Meetings (as needed / in between)	***Topic (define the topics for the subsequent FG meetings)***
Planning:	*Month (tentative – indicate in project month number and actual month and year)*
Participants:	*Subset of stakeholders from the CoP community, as needed, based on the topic selected for the FG meeting. You may want to keep the meeting open to also the other CoP members even if it is not their topic of expertise* *Any invited guest as needed (e.g. stakeholders potentially interested in the products of the project, for transferability)*
Objective(s) of the meeting:	*Indicate to the best of your knowledge now the possible objectives for a focus group meeting*
Related WP:	*Indicate which WPs/ Living Labs will add content to this meeting. Also indicate what content the WP/Living Labs will add*

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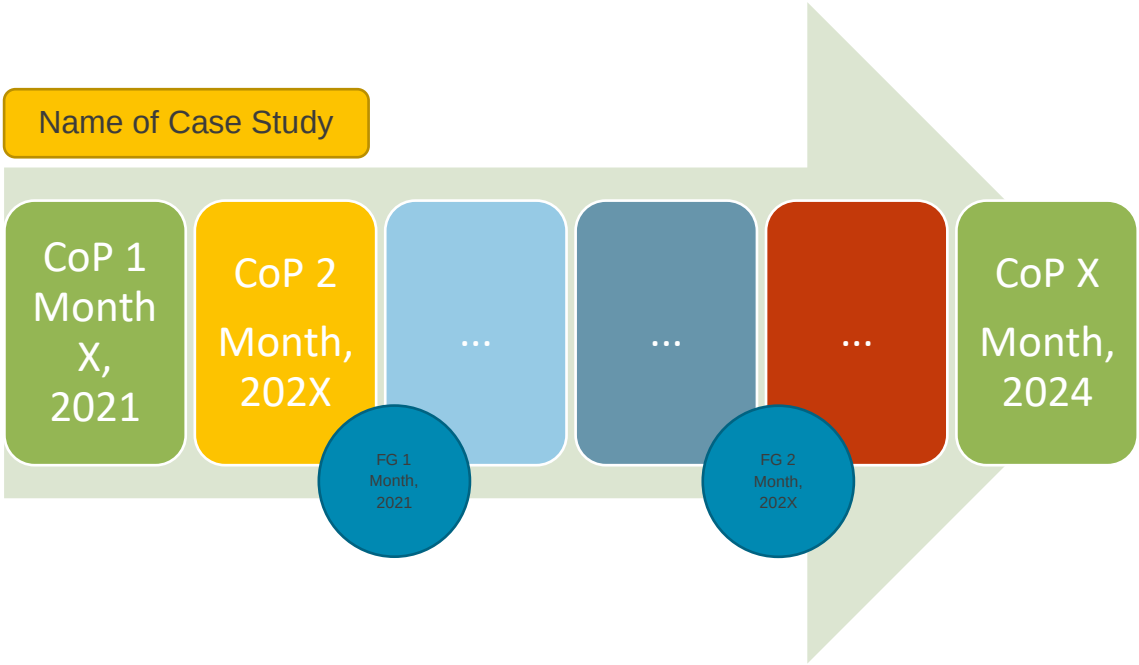
Last CoP Meeting Template

CoP #X (last)	*Final deliberations and next steps*
Planning:	*Month (tentative – indicate in project month number and actual month and year)*
Participants:	*All stakeholders identified in stakeholder mapping and involved in the case study, and any new ones identified in the 1st CoP meeting* *Any invited guest as needed (e.g. stakeholders potentially interested in the products of the project, for transferability)*
Objective(s) of the meeting:	1. *Last resolutions* 2. *Future of CoP/outputs – beyond the project* 3. *Other as needed*
Related WP:	*Indicate which WPs/ Living Labs will add content to this meeting. Please also indicate what content the WP/Living Labs will add*

CoP Meeting Roadmap Infographic

The below is just a suggested roadmap. Please adapt with as many CoP meetings and focus group meetings as needed for you Case Study.



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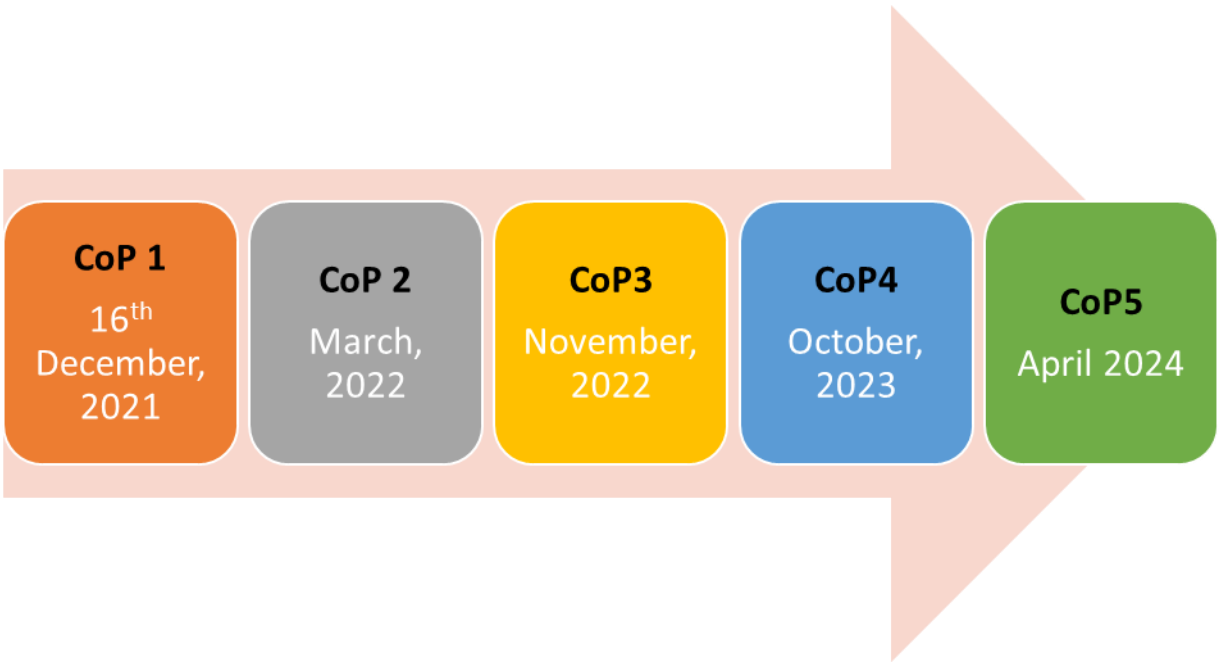
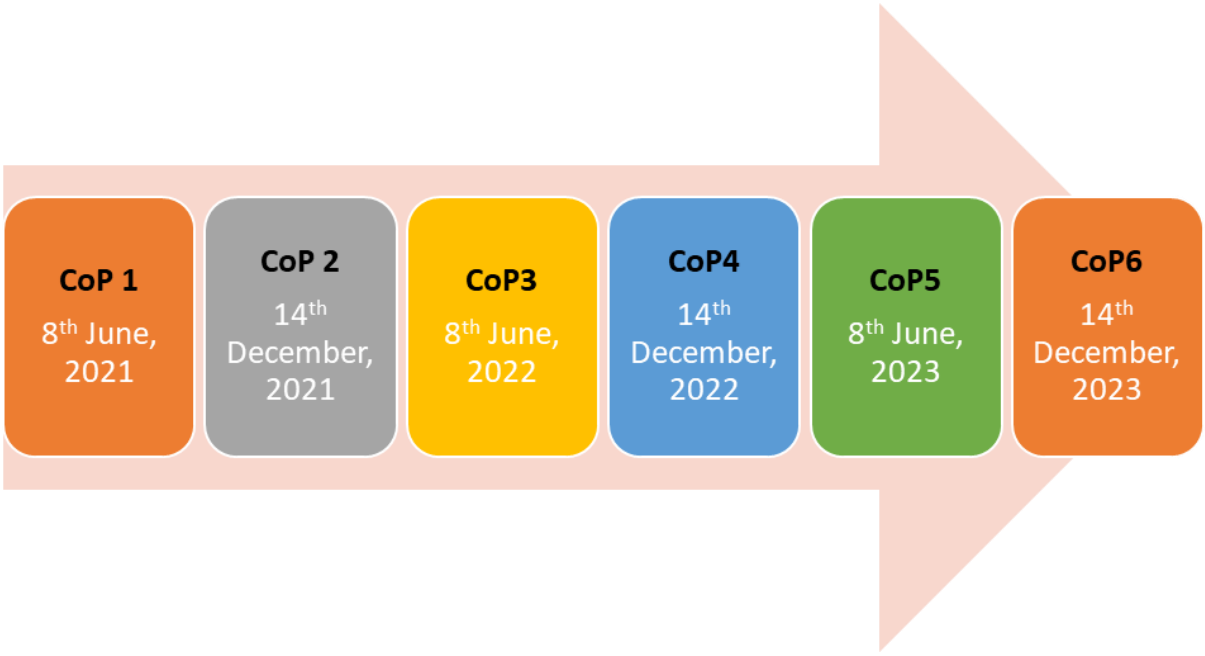
C.2. Case study Community of Practice meeting roadmap infographics

Case Study 1 - Tarragona, Spain



Case Study 3 - Rosignano, Italy



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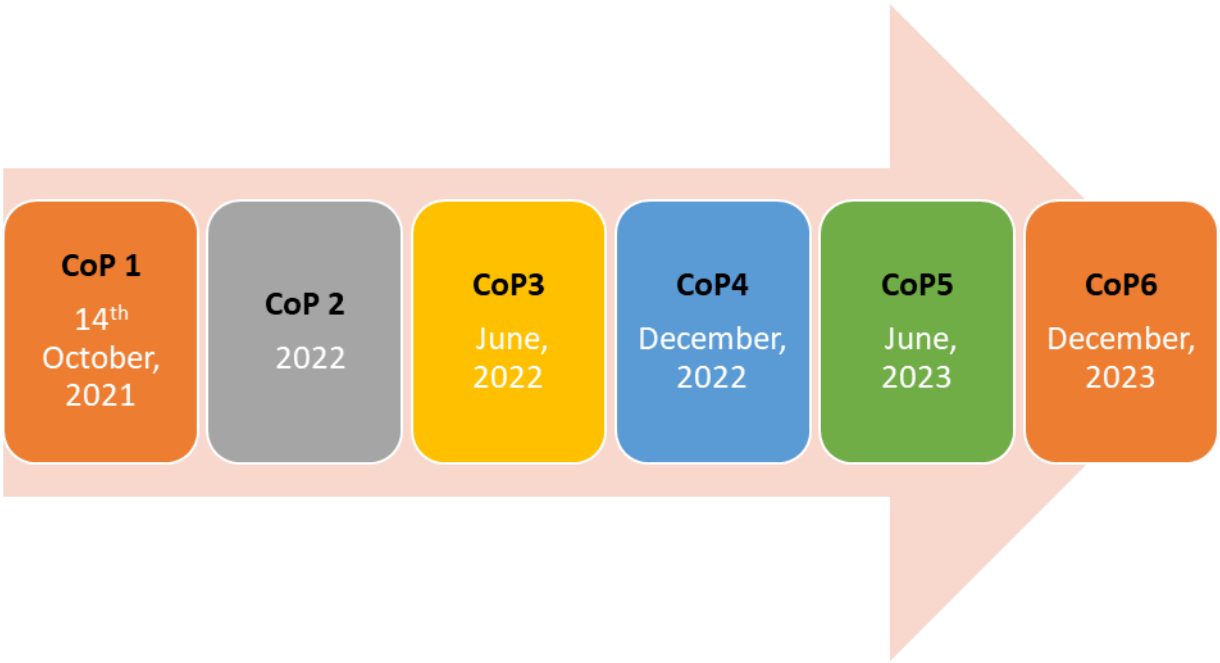
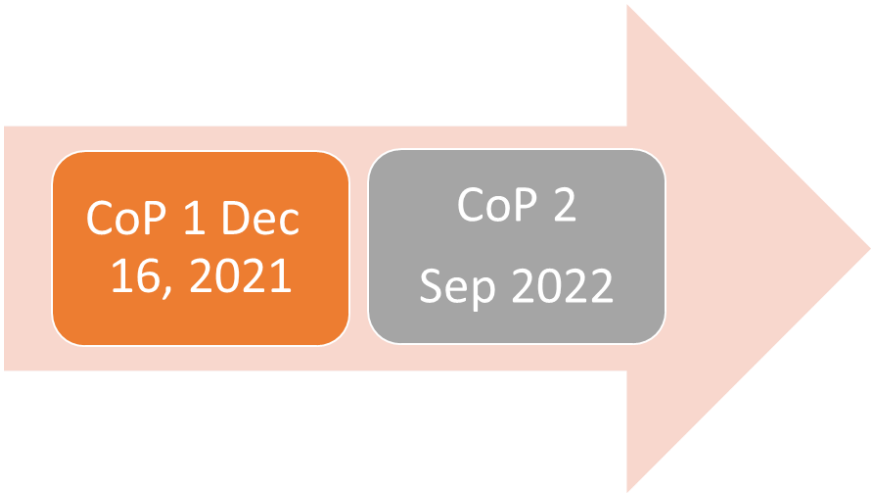
Case Study 4 - Nafplio, Greece



Case Study 6 - Karmiel and Shafdan, Israel



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Annex D: Consent form

Title of Project: **ULTIMATE: industry water-utility symbiosis for a smarter water society**

Researcher in charge of meeting/interview: **[Name/Affiliation]**

Thank you for participating in this meeting/interview, which is intended for research purposes only, and aims at investigating **<purpose>.**

Please confirm whether you agree or not with the following statements by checking the respective boxes.

	Yes	No
1. I confirm that I have read and understood the purposes of this meeting/interview. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	☐	☐
2. I agree to allow researchers of the ULTIMATE project to record the meeting/interview and analyse an excerpt for internal reporting of the project, project deliverables, and to potential publishing of conference/journal papers.	☐	☐
3. I consent to verbatim quotations from my answers to be used in internal reporting of the project, project deliverables, and to potential publishing of conference/journal papers, after reviewing and approving it. The information will be anonymised.	☐	☐
4. I consent to my personal data being securely stored and retained for two years after the completion of the project (May 2024), before ultimately being deleted by the project partner that collected this data from me.	☐	☐
5. I give permission to the researchers to use the pictures taken during the meeting/ interview for the purposes of disseminating the ULTIMATE project.	☐	☐
6. I understand that I am free to withdraw my consent at any time without the need to justify my decision.	☐	☐
7. I confirm that I have read and understood all the above and have been given adequate time to consider my participation.	☐	☐

_____	_____	_____
Name & e-mail participant	Date	Signature

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Annex E: Evaluation form

ULTIMATE Project CoPs Evaluation Form
It was a pleasure to have you in this meeting. With this survey, we would like to know your opinion about the meeting so that we can improve future events and meet your expectations. This survey should take no longer than 6 minutes of your time. Thank you for your collaboration!
1. Please enter your name (optional)
2. Your organisation (optional)
*3. What was the date of the CoP meeting? Date / Time
*4. To which ULTIMATE case study (CS) does the CoP belong?

Meeting logistics and stakeholder engagement
* 5. Please rate the extent to which you agree with each of the following statements from 1 - 5 (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree) • I received the information about the meeting and materials well in advance • The venue was adequate for the purpose of the meeting • The meeting had the right duration in time • During the meeting I improved or made new connections for my professional network • The presentations and speakers were clear and understandable • During the meeting, I felt safe to behave spontaneous and unfiltered • I believe others were communicating openly with me
Comments (optional)

Awareness and increased understanding
* 6. Please rate the extent to which you agree with each of the following statements from 1 - 5 (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree) • I had sufficient opportunities to provide input to the discussion • Differences and (potential) conflicts among us were addressed in a constructive manner

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- All ideas / perspectives were included and respected during the discussion
- I believe that all relevant stakeholders were present at the meeting
- I feel that the right topics were discussed during the meeting
- I have a better understanding of the perspective of the stakeholders
- The way the discussion was facilitated and moderated supported the meeting objectives

Comments (optional)

Outcomes and conclusions

* 7. Please rate the extent to which you agree with each of the following statements from 1 - 5 (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

- There was enough time to reflect on our collective experience and functioning as a group
- I believe that clear actions were formulated to improve solutions
- I believe that clear conclusions were formulated at the end of the meeting
- The meeting inspired me to take follow-up actions in my own organisation
- Participating in the meeting increased my knowledge on the solutions
- My expectations on the outcomes of the meeting were met
- I am aware of my own role in the project and how each of us can contribute to the project goals

Comments (optional)

Pros and cons of meeting

* 8. What is your overall rating of the CoP meeting

- Extremely valuable
- Very valuable
- Somewhat valuable
- Not so valuable
- Not at all valuable
- Comments (optional)

* 9. In your opinion, what were the most positive aspects of the meeting?

* 10. In your opinion, what were the most negative aspects of the meeting?

Suggestions for improvement

* 11. What suggestions for improvement do you have for future meetings?

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Annex F: Meeting report template

F.1. Community of Practice meeting

CoP meeting reporting

Case Study:

The CoP coordinator is responsible to prepare and share a CoP Meeting Report after each CoP meeting. [PLEASE DELETE THIS BOX]

General information

- Title of CoP meeting (key topic):
- Organising partner:
- Moderator:
- Meeting Place:
- Date:
- Number of guests attending:

Agenda for the meeting

- Please insert the agenda from your meeting

Objectives

- Describe the CoP meeting objectives

Participants' characterisation

- The table below shows the number of participants, the respective sector of activity and the level of governance each stakeholder is active in.

Institution / sector	No. of participants (registrations)			
	In total	Male	Female	Non-binary
Project members				
External stakeholders (outside of the project partners)				
Authorities				
Engineering companies				
Representatives of other sectors				

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Institution / sector	No. of participants (registrations)			
	In total	Male	Female	Non-binary
Research institute				
End-users				
Water industry				
Other: name				

A list of participants is available in the annex to this report.

Description of meeting's activities

- Provide a summary of activities carried out. Were there plenary or working group sessions? Presentations by whom on what? (Provide presentations as appendices).
- Describe the moderation technique and method for open dialogue applied.

All presentations given at the meeting are available in the annex to this report.

Main achievements

- Describe briefly the main outcomes and results from the meeting, including the answers on the central questions such as outlined in Section 4.1 'Key topics of CoP meetings', as well as any actions to be taken by members, as agreed upon.
- Summarise the perspectives of the stakeholders (i.e. stories as anecdotal evidence).

Reflection notes

- Describe your observations on stakeholder engagement (e.g. do we need to add others?)
- Describe any relevant observations for further steps
- Questions such as below can be asked:
    - What did you enjoy most/less about this workshop?
    - Which methods/tools were successful/not successful?

In your opinion, what were the positive/negative aspects of the workshop?
Pros: • xxx • xxx

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• xxx Cons: • xxx • xxx • xxx
What suggestions for improvement do you have for future workshops? • xxx • xxx • xxx

Annex

- Please include additional information (e.g., participant list, presentations, summary of results of stakeholder evaluation, etc.).

F.2. Focus group meeting

CoP Focus Group meeting reporting

Case Study:

The CoP coordinator is responsible to prepare and share a CoP Focus Group Meeting Report after each Focus Group meeting. [PLEASE DELETE THIS BOX]

General information

- Title of Focus Group meeting (key topic):
- Organising partner:
- Moderator:
- Meeting Place:
- Date:
- Number of guests attending:

Agenda for the meeting

- Please insert the agenda from your meeting

Objectives

- Describe the CoP meeting objectives

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Participants' characterisation

- The table below shows the number of participants, the respective sector of activity and the level of governance each stakeholder is active in.

Institution / sector	No. of participants (registrations)			
	In total	Male	Female	Non-binary
Project members				
External stakeholders (outside of the project partners)				
Authorities				
Engineering companies				
Representatives of other sectors				
Research institute				
End-users				
Water industry				
Other: name				

A list of participants is available in the annex to this report.

Key messages

- Provide in narrative or list the key messages from the Focus Group meeting.

Annex

- Please include additional information (e.g., participant list, etc.).

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Annex G: Acceptance, regulatory barriers and technologies/innovation for water reuse (by industry)

During the ULTIMATE Annual Meeting held on 20-21 June 2022, a CoP workshop was conducted in which CS partners were asked to share the challenges they experienced in ULTIMATE on the topic of technology acceptance by industry, regulatory barriers to new technologies and technologies/innovations for water reuse, and how these challenges have been addressed through, for example, the engagement of stakeholders in the CoP meetings. A summary of results per CS is provided in the tables below.

G.1. Case Study 1 - Tarragona, Spain

Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
1. What have been the challenges and how have these been addressed in ULTIMATE?	Industries are willing to use reclaimed water as long as it has the required quality. They support the assessment of new technologies and processes to obtain more reclaimed water and promote circular economy.	In CS1, different membrane technologies will be assessed to treat pre-treated industrial wastewater and to obtain reclaimed water to be reused in the petrochemical complex. However, some concentrate streams from RO and MD will be produced and it is	In CS1 pre-treated industrial wastewater will be treated in a pilot plant, where different technologies will be assessed. However, previous laboratory test were not conducted with real water because the Industrial Wastewater Treatment Plant

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Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
	Tarragona is a region with periodic water scarcity episodes, and for this reason, industries are very sensitive to this topic.	expected to be discharged to the sea. It is assumed that these concentrated streams should fulfil discharge BREF limits, although currently, the legal framework is not clear enough. A CoP meeting has been held with Catalonia Administration and Tarragona Industrial Association last April to discuss this issue. The ULTIMATE project has complete support from them in terms of environmental advantages and circular economy promotion.	was put in operation last April and lab tests were conducted during 2021. For this reason, lab tests with real industrial wastewater were carried out and a previous pre-treatment step (UF) to resemble iWWTP treatment needed to be included. The pilot plant design was based on experimental results at lab scale. On the other hand, one of the technologies to be evaluated is patented. For this reason, the industrial partner is not interested in testing the technology. To address this issue, some slight change to the technology configuration were required.

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Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
2. What progress has been made and what have you learned so far?	It is very important to inform involved industries about the ULTIMATE project (the project approach, the potential advantages of the technologies and innovations) and the dissemination of results including the reclaimed water availability achieved, etc. The next CoP is planned in the last quarter of 2022 at the petrochemical complex.	Legal restrictions can stop or limit technological and economically feasible solutions which can increase reclaimed water availability. For scaling up purposes in AITASA, clarity on the legal framework is needed in CS1. If necessary, consultations will be held at EU level.	The next step is to start trials at the industrial pilot plant site. Experimental results will show if the proposed technologies are technically and economically feasible to treat the pre-treated industrial wastewater and obtained reclaimed water with the required quality to be reused as cooling water in the industrial complex.

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G.2. Case Study 2 - Farmer's water reuse (KWR), The Netherlands

Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
1. What have been the challenges and how have these been addressed in ULTIMATE?	The water needs to meet certain quality standard (composition should be useful for use as irrigation water), it should be safe for reuse (for plants and employees) and the price should be acceptable.	In ULTIMATE treatment of wastewater is studied. Once the water leaves the compound of individual farmers, for the regulators it officially becomes a waste product. Once something is a waste product it cannot be reused – it has to lose its waste status (so called end-of-waste status). This needs to be addressed in order to make water reuse possible.	Primary challenge is the management of sodium content in the water. Separation technology that allows recycling of water and nutrients but selectively removes sodium is required. If only water needs to be reused, ultra-pure water could be produced by RO. However, costs are too high (need for high pressure) and a waste stream (concentrate or brine) is produced. There is a need for technology that is less costly and/or produces less brine.
2. What progress has been made and what have you	A survey has mapped needs and drivers for farmers. The	None – there have been no discussions with regulators	Development of electrodialysis as a new

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Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
learned so far?	different ways to collectively work on reuse and the status in various collectives in The Netherlands has been discussed in a CoP meeting. Besides this, focus has been on making sure water of appropriate quality and/or composition can be produced.	and/or legislators at this point.	treatment technology for the horticulture sector has started. Pilot plant to be operational by the end of 2022.

G.3. Case Study 3 - Rosignano, Italy

Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
1. What have been the	Water reuse has a key role	For water reuse by industry,	› Material reuse: reuse of

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Questions	Topic		
	Acceptance of water reuse by industry	Regulatory barriers for water reuse by industry	Technologies/innovations for water reuse
challenges and how have these been addressed in ULTIMATE?	for Solvay. The acceptance is related to the quality of the water delivered. The main challenge is connected to salinity and COD of the water. Through ULTIMATE and Early Warning system is being developed to monitor seawater intrusion along the sewer network; a study is being done on the possibility of having a smart equalisation of the inlet water to ARETUSA WRP. The replicability of the water reclamation plant and ULTIMATE solutions is being explored in other industrial	there is no specific regulatory framework. The main challenge to address is related to the private agreement between the water utility and the industrial partner related to the quality parameters that must be achieved and the corresponding price of the reclaimed water. However, there is no standard scenario: it is very specific and connected with industrial and/or local needs. In the ARETUSA case, the symbiosis is working well and within the ULTIMATE project the focus is on increasing the quality of the water to guarantee the fulfilment of the	by-products in water treatment is strictly connected to the local context where the application is being developed. The difficulty is in finding recovered materials that are locally useful (e.g., bentonite, limestone, hydrochar, etc.). Numerous tests have been performed on a laboratory scale to address this issue and finally some useful materials have been identified. › Sewer system models and monitoring: There have been some difficulties related to delay of material supply. In

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Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
	districts in Tuscany. Furthermore, the acceptance of water reuse in agriculture is the other challenge that needs to be analysed at the local level.	quality requirements.	general, the heterogeneous sewer networks complicate probes installation and as such some issues related to the signal transmission of sensors in the coastal area have been experienced. Furthermore, detailed technical information related to the sewer networks are difficult to obtain. To address these difficulties specific inspections and case-to-case analysis have been done. › Fit-for-purposes water: within ULTIMATE other possible uses of the water outside SOLVAY will be

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Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
			analysed (e.g., agriculture or other local industries) through the realisation of a functional matchmaking platform. Potential end-users and barriers about water reuse in agriculture are being analysed. If a real application is going to be planned the main barrier will be the missing infrastructure, but this is beyond the scope of the ULTIMATE project.
2. What progress has been made and what have you learned so far?	Acceptance has been addressed through the CoP meetings in June and December 2021. In the coming months a focus group will be organised with	Communication with the partners and technical competences to analyse barriers and to find compromises at cost-benefit level is very important.	Technologies/innovations are discussed in the CoP meetings, focussing on Waste/by-products Framework Directive with experts and analysing local industries and experiences

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Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
	the interested water utilities and industrial partners to show what is being done.	In terms of progress, the approach to water industrial symbiosis is being disseminated and shared, even with other water utilities through the CoP meetings.	on reuse. Some progresses has been made in terms of laboratory analysis on local materials gathered and some other opportunities are under investigation (e.g., Hydrochar). In the meantime, with the CoP meetings, a network of local relationships with industries, other water utilities and rural districts is being created to discuss and address the widespread issues/needs related to water and material reuse, monitoring strategy, etc.

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G.4. Case Study 4 - Nafplio, Greece

Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
1. What have been the challenges and how have these been addressed in ULTIMATE?	Industries are a bit sceptical regarding the reuse of water. Stakeholders such as farmers are afraid of using reclaimed water as they strongly believe that this will affect crop yields.	Greece is one of the countries with an existing water reuse regulation. Unfortunately, the percentage of water that is reused is extremely low. In fact, the cases where water has been reused are from previous research programmes. During the ULTIMATE project a CoP meeting was organised focussing on water reuse regulation.	The current water reuse regulation sets certain limitations with regards to water quality. The quality limits were not easily reached. As such, there is a need to introduce technologies to comply with these limits. This is done in CS4.
2. What progress has been made and what have you learned so far?	Industries and stakeholders that have joined the CoP meeting have indicated their willingness to use reclaimed water.	The second CoP meeting was dedicated on water reuse regulation in which representatives of public water authorities and	Although the proposed technology unit has been installed at one of the partner sites (Alberta), most of the results are from lab experiments. This was due to

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Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
	Farmers did not join the meetings and are still sceptical regarding reclaimed water. The third CoP meeting will consist of an on-site visit in which famers will be engaged.	industries participated. The need for transition towards water reuse and circular economy models was clear to participants, as well the regulatory context. Unfortunately, lack of readiness, lack of personnel and lack of financing were issues stated by several stakeholders. Participants also believed that Greece does not have the infrastructure to support this transition. Participants asked that the information collected in the CoP meeting be shared national entities that should lead the transition to circular models (i.e., Ministry of	some delays at the site, largely related to Covid-19. The combination of technologies such as coagulation, AOP and SPB have been proven to achieve the desirable limits. The stakeholders that have joined the CoP meeting were positive about the presented technologies, and some are willing to install units in their respective sites.

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Questions	Topic		
	Acceptance of water reuse by industry	Regulatory barriers for water reuse by industry	Technologies/innovations for water reuse
		Environment).	

G.5. Case Study 5 - Lleida, Spain

Questions	Topic		
	Acceptance of water reuse by industry	Regulatory barriers for water reuse by industry	Technologies/innovations for water reuse
1. What have been the challenges and how have these been addressed in ULTIMATE?	Acceptance of water reuse does not appear to be an issue since the stakeholders and end-users that Acqualia is working with are familiar with water reuse. The brewery sector is willing to reuse water: there are at least 5 cases of direct reuse, (i.e., produced beer which	Water reuse is well defined in Spain by means of a Royal Decree (RD): 1620/2007. The new regulation for water reuse for agriculture may add a costly requirement, specifically in terms of BOD (<10 mg/L). This parameter requirement may limit the use of several tertiary treatment	The risk of not achieving the water reuse requirements of microorganisms or turbidity exists. In order to minimise this, a double-barrier approach has been proposed in CS5: two membrane technologies working parallel. Growing of algae and filamentous organisms in the

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Questions	Topic		
	Acceptance of water reuse by industry	Regulatory barriers for water reuse by industry	Technologies/innovations for water reuse
	contains reused water).	technologies.	pipelines may clog pipelines, prefilters or pumps, even in nano-filtered water. Therefore, an intermediate disinfection via chemical addition may be needed. But the use of reverse osmosis makes it impossible to use chlorine-based disinfectants, since they damage reverse osmosis membranes. Alternative disinfectants such as bisulphite, are accepted by reverse osmosis membranes, but are toxic and not accepted in high concentrations in water reuse. As a result very precise dosing of bisulphite chemicals is required, which adds complexity and sophistication to the demo-

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Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
			scale plant.
2. What progress has been made and what have you learned so far?	Engagement and participation of the water end-user is essential for a successful experience. It warrants the commitment of the end-user and provides value to the solution. There is a lack of promotion for water reuse strategies in the industrial sectors (food and beverage).	Legionella or Nematod eggs have been absent in 20 samples of the secondary treated wastewater. Are they really representative parameters of health risk derived from water reuse?	Dark tanks and prefiltering of incoming water have shown to be effective measures to avoid algae and filamentous organism proliferation. Simplicity and robustness of solutions are essential for a fast, feasible, acceptable and easy implementation.

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G.6. Case Study 6 - Karmiel and Shafdan, Israel

Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
1. What have been the challenges and how have these been addressed in ULTIMATE?	This is not a challenge in CS6. Technology will not change the final effluent that has been in use for irrigation.	The main barrier is agreeing to how to mix agro-industrial (olive mill) wastewater with domestic wastewater. This issue results in a high legal risk rate.	There are several challenges regarding technologies and innovations: › Maximal ratio mixing of olive mill wastewater and domestic wastewater: This has been addressed by testing the effects of different ratios of olive mill wastewater discharged into domestic wastewater in the summertime vs. wintertime. › Extraction of polyphenols prior to the mixing of the olive mill wastewater with domestic wastewater: This has not yet been tested at the demonstration-scale. Most

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Questions	Topic		
	Acceptance of water reuse by industry	Regulatory barriers for water reuse by industry	Technologies/innovations for water reuse
			likely, it will be tested next year.
2. What progress has been made and what have you learned so far?		In the first CoP meeting invited representatives of the Ministry of Environmental Protection, Water utilities, Water Authorities, Engineers, and public representatives. In the meeting, regulatory barriers were seen as a minor risk.	› For mixing ratios, a ratio of about 0.5% olive mill wastewater with domestic wastewater can be mixed without a negative effect on the biological process. › For the extraction of polyphenols, optimal design parameters were obtained based on lab-scale experiments (GtG).

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G.7. Case Study 7 - Tain, Scotland

Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
1. What have been the challenges and how have these been addressed in ULTIMATE?	In the context where the industry is treating and recycling its own water, water reuse is an accepted practice. However, acceptance usually relies on actual demonstration of the technological options in real conditions.	There is no barrier as such because industrial reuse is accepted but there is no specific regulations for the applications. This can make the implementation of such schemes difficult. In the food and beverage industry, companies will generally rely on the Drinking Water Directive as well as the Private Water Supplies Regulations in the UK for water reuse. To set permits, Industry and regulators will also rely on the Industrial Emissions Directive and the Best Available Techniques (BAT) Reference documents.	Technologies have already been demonstrated for a range of industries and reuse applications but it remains critical to demonstrate and ascertain the applicability for specific cases as industrial effluents vary significantly between industries as well as between sites within a sector. In CS7, there is to date limited evidence of the applicability of the technology for reuse in the whiskey industry, especially following on from anaerobic treatment. The demonstration as part of ULTIMATE will provide the proof of concept and strengthen acceptance.

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Questions	Topic		
	Acceptance of water reuse by industry	Regulatory barriers for water reuse by industry	Technologies/innovations for water reuse
2. What progress has been made and what have you learned so far?		There has been limited progress on this but the plan is to bring all stakeholders together including the regulators to discuss the current limitations and drive change for the future.	There are very limited lessons learned to date as the system is only now being installed.

G.8. Case Study 8 - Saint Maurice L'Exil, France

Questions	Topic		
	Acceptance of water reuse by industry	Regulatory barriers for water reuse by industry	Technologies/innovations for water reuse
1. What have been the challenges and how have these been addressed in ULTIMATE?	We question the advantages and disadvantages of manufacturing a material that complies with the current product criteria (REACH	It is difficult to be sure to take into account all the applicable regulations (end of waste regulations, products regulations, impact on current	

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	regulations) or rather to reach a technical and economic agreement with a user.	authorisation, etc.).	
2. What progress has been made and what have you learned so far?		We know that regulations are constantly evolving regarding the control of potential trace pollutants.	

G.9. Case Study 9 - Kalundborg, Denmark

Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
1. What have been the challenges and how have these been addressed in ULTIMATE?	The food/pharma industry has a strong non-acceptance and reluctance to even discuss water reuse. Despite efforts to show how this is not the case in other EU counties, there has been little success. There has been considerably	The Danish regulatory barriers focus on the source of the water and not the quality of water. This is a very significant barrier. Direct contact with relevant actors in the national administration is being established to explain how the local administration	The lack of knowledge of the available technologies in Denmark has been a major concern. This issue has been addressed in bilateral contacts and CoP meetings where information is shared during presentations (even beyond ULTIMATE and with

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Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
	more success in discussions and co-creation with the petrochemical industry segments. In this case it has been extremely helpful to be able to draw on the experience and knowledge of other partners which for years have supplied reused water to these industry segments. Currently, concrete technical and economic solutions are being worked on, and testing how these can meet the wishes of end-user (also regarding a high degree of supply certainty) with these new solutions (at least new in Denmark).	can assist in making the regulation more reasonable and less destructible. Furthermore, the CoP meetings are being used to spread relevant information on how these matters are handled in a more reasonable way in other EU countries.	people with influence outside of the Kalundborg area. It has been a major advantage to have the direct participation and support from several of the ULTIMATE partners. Partners from the Tarragona case study have been very helpful. In fact, the engagement from Tarragona has played a major role improving the dialogue with the petrochemical industry. It has also been a major advantage that Anne Kleyböcker has been able to identify other CS's relevant to the Kalundborg case and enabling contact with the right individuals.

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Questions	Topic		
	Acceptance of water reuse by industry	**Regulatory barriers for water reuse by industry**	**Technologies/innovations for water reuse**
2. What progress has been made and what have you learned so far?	*Please see above* Danish industry are conservative and adhere to present regulations. Concrete examples from other countries open doors and understanding. Direct personal contact with no-nonsense, precise and direct information pays off.	*Please see above* Very little progress has been made, where some have at least been able to mention the issues. Widespread ignorance of the situation on this matter in other EU countries. Reluctance to change a long freshwater tradition in Denmark. A strange split between a very conservative administration and politicians/the general public that seems to be more in favour of reuse of rainwater, than other untraditional water	*Please see above* Concrete well-documented examples of the use of technologies from other countries open doors and willingness to engage in co-creation of technological solutions. Fast and precise response to relevant information and trustworthy information on technologies from other partners plays a major role. It is a major advantage to have good partners willing to interact together in an EU project.

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Questions	Topic		
	Acceptance of water reuse by industry	Regulatory barriers for water reuse by industry	Technologies/innovations for water reuse
		reuse possibilities.	

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Annex H: Overview of CoP meetings

	CoP meeting	# of participants	Type of organisations engaged	Meeting objective(s)	Gender diversity (%)	
					M	F
CS1	1	7	Research institutes, end-users (Tarragona Industrial Companies Association), water industry (AITASA) and external stakeholders	• Dissemination of ULTIMATE activities • Definition of the approach and objectives of the CoP	43	57
	2	16	Authorities, research institutes, end-users (Tarragona Industrial Companies Association), water industry (AITASA) and external stakeholders	• Dissemination of ULTIMATE activities to the Catalonia Administration • Definition of the legal approach in case AITASA scales up ULTIMATE solution in its facilities	56	44
CS2	1	13	Research institutes, end-users, representatives of Glastuinbouw Nederland and external stakeholders	• Get to know each other • Share experiences with organising cooperative water treatment in horticulture • Identify topics of interest for the CoP and topic for next CoP meeting. Identify additional parties to be invited to CoP	77	23
	2	9	End-users, representatives of Glastuinbouw Nederland and external stakeholders	• Present the results from ULTIMATE aimed at the requirements from De Vlot (water and nutrient recovery using ED)	100	0

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	CoP meeting	# of participants	Type of organisations engaged	Meeting objective(s)	Gender diversity (%)	
					M	F
				• Reflection and discussion on the results		
CS3	1	35	Public authorities, engineering companies, representatives of other sectors, research institutes, end-users, water industry and external stakeholders	• Learn more about our Stakeholders and introduce the ULTIMATE CS3 Partners • Introduce the Stakeholders to the project, showing some details, explaining the importance of the “Work Package-WP” system • Explain the meaning and the potential benefits to be part of a Community of Practice • Validate the composition of the Community and the Roadmap, even presenting the potential topics to face during the next meetings • Co-define with stakeholders their level of involvement and their kind of specific expertise as added value for the ULTIMATE Project • Co-define with stakeholders the mission and interests of the CoP, considering short- and long-term value and impact	71	29
	2	40	Public authorities, engineering companies, representatives of other	• Analyse current legislations about quality requirements for treated	77	23

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	CoP meeting	# of participants	Type of organisations engaged	Meeting objective(s)	Gender diversity (%)	
					M	F
			sectors, research institutes/universities, end-users/industry, water utilities and external stakeholders	wastewater reuse in irrigation and further purposes • Analyse regulation strategy and discuss on planning opportunities / alternatives to encourage water reuse • Deal with critical aspects through local-regional water reuse experiences and start with the exploration of governance scenarios locally available • Start analysing ARETUSA Governance from a multi-purpose point of view: consider integrating industrial reuse with other ones (basically agricultural reuse)		
	3	50	Public authorities, engineering companies, representatives of other sectors, research institutes/universities, end-users/industry, water utilities and external stakeholders	• Analyse current legislations about the definition of a “by-product” and the requirements regarding the End-Of-Waste procedure, to enhance material reuse through circular systems • Analyse regulation strategy and discuss on planning opportunities / alternatives to encourage material reuse • Deal with critical aspects through local-regional material reuse experiences	74	26

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	CoP meeting	# of participants	Type of organisations engaged	Meeting objective(s)	Gender diversity (%)	
					M	F
				and start with the exploration of scenarios locally available • Inform the Community about the progress in ULTIMATE project and introduction about AcquaSPICE project to show the importance of the relationship between local issues to solve, European research program H2020 and an engineering-based approach		
	4	21	No data	• Living Lab meeting organised with Water Europe • Meeting to lay the foundations for a concrete comparison between the various administrations and potential users through the sharing and exchange of experiences/good practices with the objective of stabilising water quality and quantity and safeguarding the water resource in Cornia Valley	No data	No data
	5	41	Public authorities, engineering companies, representatives of other sectors, research institutes,	• Analysis of the legislation on the wastewater reuse in agriculture, highlighting territorial opportunities through the application of the new EU	63	37

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	CoP meeting	# of participants	Type of organisations engaged	Meeting objective(s)	Gender diversity (%)	
					M	F
			end-users, water industry and external stakeholders	regulation 741/2020 in Italy (new dpr) to enhance water reuse through circular systems • Deal with critical aspects through local water reuse for industrial purpose experiences (Val di Cornia (Livorno)) and illustration of synergies with the Ultimate project; in particular, highlight the contribution that Consorzio Aretusa is promoting at environmental level in the European scenario thanks also to Solvay's concrete commitment to reduce water consumption for industrial use • Presentation of the predictive model of the quality of wastewater in the sewer network, in order to optimise the performance of the water reclamation plant and consequently the quality of the effluent • Inform the Community about the progress in ULTIMATE and AcquaSPICE projects to show the importance of the relationship between local issues to solve, European		

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	CoP meeting	# of participants	Type of organisations engaged	Meeting objective(s)	Gender diversity (%)	
					M	F
				research program H2020 and an engineering-based approach		
CS4	1	23	Authorities, engineering companies, research institutes, end-users, water industry, representatives of other sectors and external stakeholders	• Identify all the stakeholders and to co-set the scene regarding the number of meetings, the possibility of formatting focus groups	65	35
	2	25	Authorities, engineering companies, research institutes, end-users, water industry, representatives of other sectors and external stakeholders	• Present the water reuse regulation in Greece & EU and to identify barriers	60	40
	3	18	Authorities, research institutes, end-users, water industry, representatives of other sectors and external stakeholders	• Demonstrate the unit • Involve stakeholders from the local community • Present the progress of the project • Motivate and inspire the stakeholders by showcasing examples of industrial symbiotic systems and water reuse installations in a larger scale and different sectors	67	33

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	CoP meeting	# of participants	Type of organisations engaged	Meeting objective(s)	Gender diversity (%)	
					M	F
CS5	1	13	Engineering companies, research institutes, end-users and water industry	• Dissemination of ULTIMATE activities	77	23
	2	9	Authorities, engineering companies, research institutes, end-users and representatives of other sectors	• Interchange experiences and different views between water sector shareholders (belonging to different areas of the chain value) specialists or with experiences on water reclamation • Dynamise sectorial networking between attendees • Understand the view, the drivers, the particularities and the uncertainty to be dealt with of the shareholders around water reclamation	78	22
	3	18	Authorities, research institutes, end-users, water industry, biogas/biomethane industry and hydrogen industry	• Interchange experiences and different views between water sector stakeholders (belonging to different areas of the chain value), specialists or with experiences on water reclamation • Dynamise sectorial networking between attendees • Understand the view, the drivers, the particularities and the uncertainty to be dealt with of the stakeholders around energy in the water cycle	78	22

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	CoP meeting	# of participants	Type of organisations engaged	Meeting objective(s)	Gender diversity (%)	
					M	F
CS6	1	37	Authorities, engineering companies, research institutes, water industry	• Present the ULTIMATE project • Provide an overview of the problem of dumping untreated agro-industrial waste into the central wastewater treatment system • Outline the ULTIMATE technologies by the technology providers • Review the existing regulations related to this issue • Provide a platform for end users, water corporations, generators of agro-industrial waste, regulators, engineers and others to exchange ideas and suggestions face to face • Share knowledge and discuss the steps for successful design and implementation of water-related technologies and innovations	73	27
CS7	1	10	Engineering companies, research institutes, end-users and water industry	• Introduce the ULTIMATE project, the case study and some of the initial results • Discuss with the stakeholders the potential and limitations in the	70	30

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	CoP meeting	# of participants	Type of organisations engaged	Meeting objective(s)	Gender diversity (%)	
					M	F
				implementation of industrial symbiosis and circular economy in this context		
CS8	1	14	Upstream customer, economic interest group, transport and trading of secondary raw material	• Presentation of the project (European context, ULTIMATE project, CS8 objectives, resources and planning) • Presentation of CoPs (definition, objectives, benefits, etc.) • Building our CoPs (members, objectives, organisation)	57	43
CS9	1	44	Food/biotech & pharmaceutical industries, authorities, water industry, and representatives of other sectors	• Introduction to ULTIMATE and CoPs • Water Reuse and the water smart industrial Symbiosis in Tarragona • Overview of the present situation in EU in relation to the results in the Kalundborg case • Results of the Pilot Installations in Kalundborg	66	34
	2	32	Food/biotech & pharmaceutical industries, authorities, water industry, and representatives of other sectors	• The latest from the 9 cases of ULTIMATE • Next steps in the Kalundborg pilot plants • Supply of Petro-chemical Industry with the right water quality	59	41

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	CoP meeting	# of participants	Type of organisations engaged	Meeting objective(s)	Gender diversity (%)	
					M	F
				• Reused water as municipal drinking water (with perspectives from Sweden where this is already a reality)		
	3	47	Food/biotech & pharmaceutical industries, authorities, water industry, and representatives of other sectors	• Kalundborg Utility and water supply and consumption in the coming years • Overview and present status of the ULTIMATE project • Latest results and update of the 9 cases In ULTIMATE (focusing on those specifically relevant to Kalundborg)	64	36
	4	28	Food/biotech & pharmaceutical industries, authorities, water industry, and representatives of other sectors	• ULTIMATE and status of its case studies • Production of fit-for-purpose water in Kalundborg • Experience on operating a full-scale water reclamation plant in Belgium	64	36
	5	49	Food/biotech & pharmaceutical industries, authorities, water industry, and representatives of other sectors	• Update on the ULTIMATE activities in Kalundborg • Perspectives from Koyambedu Water Reclamation Plant in India • Experience on Operating a full-scale water reclamation plant in Rosignano in Italy	57	43

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	CoP meeting	# of participants	Type of organisations engaged	Meeting objective(s)	Gender diversity (%)	
					M	F
	6	54	Food/biotech & pharmaceutical industries, authorities, water industry, and representatives of other sectors	• Final results from pilot plant operation for water reclamation in Kalundborg • Microbial health risk assessment of water reuse scheme in Kalundborg • Tackling the development of regulatory frameworks for water reuse in Malta through the EU Water Reuse Regulation	67	33
	7	29	Food/biotech & pharmaceutical industries, authorities, water industry, and representatives of other sectors	• Main outcomes of the 9 ULTIMATE case studies • Life cycle assessments of selected case studies • ULTIMATE's added value for the Industrial Symbiosis Kalundborg and Kalundborg Utilities • Insight in the plans for the Horizon Europe project "Recreate" which is Kalundborg Utility's follow-up project on water reclamation, water reuse and new water technologies	63	37

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Annex I: First result of the WOLL assessment analysis

I.1. Case Study 1 - Tarragona, Spain

The figure shows the first results of the benchmarking mapping phase for CS1 including the data collection, metrics, and foundational elements scores, and final overall score.

WoLL Harmonisation Cube scoring Tool	User Involvement						Service Creation						Infrastructure						Governance						Innovation out come						Methods and Tools						
	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						**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						**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.						
	UO-Metrics		UC-Metrics		UT-Metrics		SO-Metrics		SC-Metrics		ST-Metrics		InfraO-Metrics		IC-Metrics		IT-Meytrics		GovO-Metrics		GC-Metrics		GT-Metrocs		INNO-Metrics		INNOC-Metrics		INNOT-Metrics		M&TO-Metrics		M&TC-Metrics		M&TT-Metrics	
Set up	UO 1	Y	UC 1	Y	UT 1	Y	SO 1	N	SC 1	N	ST 1	N	InfraO 1	Y	InfraC 1	Y	InfraT 1	Y	GovO 1	N	GovC 1	Y	GovT-1	Y	INNO 1	Y	InnoC 1	Y	InnoT 1	Y	M&TO 1	N	M&TC 1	Y	M&TT 1	N
Sustainability	UO 2	Y	UC 2	Y	UT 2	Y	SO 2	Y	SC 2	N	ST 2	N	InfraO 2	Y	InfraC 2	Y	InfraT 2	Y	GovO 2	Y	GovC 2	Y	GovT-2	Y	INNO 2	Y	InnoC 2	Y	InnoT 2	Y	M&TO 2	N	M&TC 2	Y	M&TT 2	N
Scalability	UO 3	Y	UC 3	N	UT 3	N	SO 3	Y	SC 3	N	ST 3	Y	InfraO 3	N	InfraC 3	Y	InfraT 3	N	GovO 3	N	GovC 3	Y	GovT-3	Y	INNO 3	Y	InnoC 3	Y	InnoT 3	N	M&TO 3	Y	M&TC 3	N	M&TT 3	Y
	100%		67%		67%		67%		0%		33%		67%		100%		67%		33%		100%		100%		100%		100%		67%		33%		67%		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)		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)		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	78%						33%						78%						78%						89%						44%						Total Score

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I.2. Case Study 3 - Rosignano, Italy

The figure shows the first results of the benchmarking mapping phase for CS3 including the data collection, metrics, and foundational elements scores, and final overall score.

WoLL Harmonisation Cube scoring Tool	User Involvement						Service Creation						Infrastructure						Governance						Innovation out come						Methods and Tools						
	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						**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						**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.						
	UO-Metrics		UC-Metrics		UT-Metrics		SO-Metrics		SC-Metrics		ST-Metrics		InfraO-Metrics		IC-Metrics		IT-Meytrics		GovO-Metrics		GC-Metrics		GT-Metrocs		INNO-Metrics		NNOC-Metrics		NNOT-Metrics		M&TO-Metrics		M&TC-Metrics		M&TT-Metrics		
Set up	UO 1	Y	UC 1	Y	UT 1	Y	SO 1	N	SC 1	N	ST 1	Y	InfraO 1	Y	InfraC 1	N	InfraT 1	N	GovO 1	Y	GovC 1	N	GovT-1	N	INNO 1	N	InnoC 1	N	InnoT 1	Y	M&TO 1	N	M&TC 1	N	M&TT 1	N	
Sustainability	UO 2	Y	UC 2	Y	UT 2	N	SO 2	N	SC 2	N	ST 2	Y	InfraO 2	N	InfraC 2	N	InfraT 2	N	GovO 2	N	GovC 2	N	GovT-2	N	INNO 2	N	InnoC 2	Y	InnoT 2	N	M&TO 2	N	M&TC 2	N	M&TT 2	N	
Scalability	UO 3	Y	UC 3	Y	UT 3	N	SO 3	N	SC 3	N	ST 3	N	InfraO 3	Y	InfraC 3	Y	InfraT 3	N	GovO 3	N	GovC 3	Y	GovT-3	N	INNO 3	N	InnoC 3	N	InnoT 3	N	M&TO 3	N	M&TC 3	N	M&TT 3	N	
	100%		100%		33%		0%		0%		67%		67%		33%		0%		33%		33%		0%		0%		33%		33%		0%		0%		0%		
	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)		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)		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)		**30%**
METRICS SCORE	78%						22%						33%						22%						22%						0%						**Total Score**

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I.3. Case Study 4 - Nafplio, Greece

The figure shows the first results of the benchmarking mapping phase for CS4 including the data collection, metrics, and foundational elements scores, and final overall score.

WoLL Harmonisation Cube scoring Tool	User Involvement						Service Creation						Infrastructure						Governance						Innovation out come						Methods and Tools						
	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						**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						**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.						
	UO-Metrics		UC-Metrics		UT-Metrics		SO-Metrics		SC-Metrics		ST-Metrics		InfraO-Metrics		IC-Metrics		IT-Meytrics		GovO-Metrics		GC-Metrics		GT-Metrocs		INNO-Metrics		NNOC-Metrics		NNOT-Metrics		M&TO-Metrics		M&TC-Metrics		M&TT-Metrics	
Set up	UO 1	Y	UC 1	Y	UT 1	Y	SO 1	N	SC 1	Y	ST 1	Y	InfraO 1	Y	InfraC 1	N	InfraT 1	Y	GovO 1	N	GovC 1	N	GovT-1	N	INNO 1	N	InnoC 1	Y	InnoT 1	N	M&TO 1	Y	M&TC 1	N	M&TT 1	N
Sustainability	UO 2	Y	UC 2	Y	UT 2	N	SO 2	N	SC 2	N	ST 2	N	InfraO 2	Y	InfraC 2	N	InfraT 2	N	GovO 2	N	GovC 2	N	GovT-2	N	INNO 2	N	InnoC 2	N	InnoT 2	N	M&TO 2	N	M&TC 2	N	M&TT 2	Y
Scalability	UO 3	Y	UC 3	N	UT 3	N	SO 3	N	SC 3	Y	ST 3	N	InfraO 3	N	InfraC 3	Y	InfraT 3	N	GovO 3	Y	GovC 3	N	GovT-3	N	INNO 3	N	InnoC 3	N	InnoT 3	N	M&TO 3	N	M&TC 3	N	M&TT 3	N
	100%		67%		33%		0%		67%		33%		67%		33%		33%		33%		0%		0%		0%		33%		0%		33%		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)		Infra- Organizational Metrics (InfraO-metrics)		Infra Contextual Metrics (IntraC Metrics)		Infra Technological Metrics (InfraT-Metrics)		GOV Organizational Metrics (GovO-Metrics)		GOV Contextual Metrics (GovC-Metrics)		GOV Technological Metrics (GovT-Metrics)		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)		**31%**
METRICS SCORE	67%						33%						44%						11%						11%						22%						Total Score

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I.4. Case Study 5 - Lleida, Spain

The figure shows the first results of the benchmarking mapping phase for CS5 including the data collection, metrics, and foundational elements scores, and final overall score.

WoLL Harmonisation Cube scoring Tool	User Involvement						Service Creation						Infrastructure						Governance						Innovation out come						Methods and Tools						
	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						**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						**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.						
	UO-Metrics		UC-Metrics		UT-Metrics		SO-Metrics		SC-Metrics		ST-Metrics		InfraO-Metrics		IC-Metrics		IT-Meytrics		GovO-Metrics		GC-Metrics		GT-Metrocs		INNO-Metrics		INNOC-Metrics		INNOT-Metrics		M&TO-Metrics		M&TC-Metrics		M&TT-Metrics	
Set up	UO 1	N	UC 1	Y	UT 1	N	SO 1	Y	SC 1	Y	ST 1	N	InfraO 1	Y	InfraC 1	Y	InfraT 1	Y	GovO 1	Y	GovC 1	Y	GovT-1	Y	INNO 1	Y	InnoC 1	Y	InnoT 1	Y	M&TO 1	Y	M&TC 1	N	M&TT 1	Y
Sustainability	UO 2	N	UC 2	N	UT 2	N	SO 2	Y	SC 2	N	ST 2	Y	InfraO 2	Y	InfraC 2	N	InfraT 2	Y	GovO 2	N	GovC 2	Y	GovT-2	Y	INNO 2	Y	InnoC 2	Y	InnoT 2	Y	M&TO 2	Y	M&TC 2	N	M&TT 2	Y
Scalability	UO 3	Y	UC 3	N	UT 3	N	SO 3	N	SC 3	Y	ST 3	Y	InfraO 3	N	InfraC 3	N	InfraT 3	N	GovO 3	N	GovC 3	N	GovT-3	Y	INNO 3	Y	InnoC 3	N	InnoT 3	Y	M&TO 3	N	M&TC 3	N	M&TT 3	N
	33%		33%		0%		67%		67%		67%		67%		33%		67%		33%		67%		100%		100%		67%		100%		67%		0%		67%		
	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)		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)		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)		57%
METRICS SCORE	22%						67%						56%						67%						89%						44%						Total Score

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Annex J: Case Study Owner / Support Group Evaluation

Case Study Owner Evaluation Questionnaire

To incorporate the insights from the Water-kennis IMX and gather lessons from other case studies, such as CS3 (L'acqua per Tutti) and CS9 (ULTIMATE Life of Water), a structured questionnaire is provided to gather relevant feedback effectively from the Case Study owners and support group

A. General Information

- Name of Case Study
- Name of Respondent
- Role/Position
- Date of Submission

B. IMX Experience Feedback

1. Overall Engagement:
    a. On a scale of 1-5, how engaging did you find the IMX experience? (1 = Not Engaging, 5 = Very Engaging)
    b. What elements do you think contributed to the engagement level of the participants? (Open-ended)
2. Preparation and Planning:
    a. How adequate was the planning and preparation for the IMX? (Scale: 1 = Poor, 5 = Excellent)
    b. What could have been done differently in terms of preparation? (Open-ended)
3. Technical Aspects:
    a. How would you rate the technical setup for the IMX? (Scale: 1 = Poor, 5 = Excellent)
    b. Did participants encounter any technical issues? If so, please specify. (Open-ended)
4. Interaction Design:
    a. What interaction modes were used in your IMX?
    b. (Multiple choice: Quick mode, Comprehensive mode, Group mode, Individual mode)
    c. How effective were these modes in enhancing participant engagement? (Scale: 1 = Not Effective, 5 = Very Effective)

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5. Group Participation:
    a. Did your IMX encourage group participation? (Yes/No)
    b. If yes, how did it influence engagement?

C. Specific Lessons Learned

1. Key Takeaways:
    a. What are the three key lessons learned from the IMX experience?
2. Participant Feedback:
    a. What feedback did participants provide regarding their experience? (Open-ended)
3. Improvements:
    a. Based on your experience, what improvements would you recommend for future IMXs? (Open-ended)

D. Comparison with Other IMXs

1. Cross-Case Insights:
    a. Based on your observations, how does your case study's approach compare with others, like Water-kennis, L'acqua per Tutti, and ULTIMATE Life of Water? (Open-ended)
2. Shared Strategies:
    a. Are there any strategies from other IMXs that you believe should be adopted in your case study? (Open-ended)

Below are responses from the three (3) case studies to the IMX CS Evaluation, which provide feedback and insights on the IMX platform's implementation and use across the different case studies. This evaluation aims to assess various factors, including engagement, technical aspects, interaction design, and group participation, while also capturing lessons learned and suggestions for future improvements.

IMX Case Study Owner / Support Group Experience Evaluation: CS2

General Information

- **Name of Case Study**: CS2

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- **Respondents**: Joep van den Broeke and Raül Glotzbach
- **Role/Position**: CS2 Support Group
- **Date of Submission**: 30 08/2024

IMX Experience Feedback

1. Overall Engagement

- **Engagement rating**: 3
- **Contributing factors**: The interactive challenges (searching for objects, navigating the maze), going from one site to the other.

2. Preparation and Planning

- **Planning rating**: 3
- **Challenges**: Planning for the meetings in which the IMX was to be used was sufficient. However, the difficulties in getting meeting participants to interact with the IMX, in conjunction with social activities, was underestimated. Therefore, the interaction would have benefited from a different approach.
- **Suggested improvements**: Reserve a specific slot for IMX introduction, interaction, and reflection in the meeting agenda. The experience can be streamlined by sharing installation instructions for the app associated with the IMX prior to the meeting, ensuring users bring a mobile device to the meeting that is prepared. Alternatively, downloading and installing the app could be part of the group activity and included in the IMX slot in the agenda.

3. Technical Aspects

- **Technical setup rating**: 4
- **Technical issues encountered**: Impatient users who failed to read all the information presented missed instructions. As there was no ‘back’ button, it was not possible to review this information. Additionally, a few users encountered technical issues (not being able to complete certain actions), but these could not be reproduced and might have been device-specific.

4. Interaction Design

- **Interaction mode**: Individual, comprehensive mode.

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- **Effectiveness rating**: 4
- **Effectiveness**: The mode's effectiveness differed for various user groups. For the audience of researchers, the comprehensive mode was highly effective (rating of 5), and although it was an individual mode, it was completed as a group with each person using their own device. For the user group of interested laypeople, the comprehensive mode presented too much information and was less effective (rating of 3).

5. Group Participation

- **Group participation**: Yes, this was not the intended purpose, but it naturally happened, which we were pleased with in the end.
- **Influence on engagement**: Discussions among participants about the provided information and challenges enhanced engagement.

Specific Lessons Learned

1. Key Takeaways

i. Participants responded positively to the IMX. Participants had fun using the IMX.
ii. For some people, too much information is presented.
iii. The time required to complete the IMX is too long.
iv. Ensure the interactions are 'easy' and 'simple' to avoid frustrations.

2. Participant Feedback

- Various feedback was received. From the researcher user group, enthusiastic responses were received, including suggestions for improving or correcting the information presented. From the layperson user group, positive responses were received, but an information overload was also reported.

3. Improvements

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- See above – quick mode, more focus on interactivity, and reduce the presentation of static information.
- Involve the target audience more closely in the development (this was attempted but not successful in CS2).
- Struggles with the mobile application; consider something different or more physical.

IMX Case Study Owner / Support Group Experience Evaluation: CS3

General Information

- **Name of Case Study**: CS3
- **Respondents**: Alessio Biso / Camillo Palermo
- **Role/Position**: CS3 support group
- **Date of Submission**: 17/09/2024

IMX Experience Feedback

1. Overall Engagement

- **Engagement rating**: 3
- **Contributing factors**: The interactive elements contributed positively, but the experience could be improved. Many adults were unfamiliar with the IMX system, and technical errors led to disengagement. However, younger participants enjoyed the experience and were more motivated.

2. Preparation and Planning

- **Planning rating**: 3
- **Challenges**: Preparation was insufficient due to changes in material from aluminum to wood for the tabletop. This change, made to reduce costs, led to misunderstandings and delays. Additionally, communication about replicating the model used in the lab was unclear, affecting efficiency.
- **Suggested improvements**: Ensure smoother communication, especially when replicating components. Reserve a specific time for IMX setup and interaction during meetings. Better planning could streamline the experience and minimise delays.

3. Technical Aspects

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- **Technical setup rating**: 3
- **Technical issues encountered**: Minor placement errors (e.g., placing objects outside the designated circular cue) led to system failures. The precision required was challenging for non-expert users, and without detailed instructions, participants struggled. Though a super-user was helpful, improvements are needed for standalone operation.

4. Interaction Design

- **Interaction mode**: Group and individual modes
- **Effectiveness rating**: 3
- **Effectiveness**: While both modes were somewhat effective, complexity in the app and familiarity with the sensors affected engagement. Users familiar with technology fared better, while others struggled. Simplifying the system could improve effectiveness for a wider audience.

5. Group Participation

- **Group participation**: Yes
- **Influence on engagement**: Group participation, especially with younger students, significantly enhanced engagement. This mode worked well for engaging younger users, making it one of the IMX's strengths.

Specific Lessons Learned

1. Key Takeaways

i. Young students were the best users due to their adaptability and quick learning.
ii. Precision installations are not suitable for non-expert users. Small errors in object placement often led to system failures.
iii. The system's high precision, while necessary, conflicts with the creative goals of an art installation.
iv. Clear instructions and simplifying the experience would improve engagement, particularly for non-expert users.

2. Participant Feedback

- Young students enjoyed the experience, but adults found it overly complex. This suggests the need for a simpler interface to accommodate less tech-savvy participants.

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3. Improvements

- The system's sensitivity to minor errors should be reduced to prevent failures caused by small inaccuracies in object placement. Developing a more robust, user-friendly system and creating a standalone version would enhance the experience and expand the target audience.

IMX Case Study Owner / Support Group Experience Evaluation: CS9

General Information

- **Name of Case Study:** CS9
- **Respondents**: Nadejda Ulstrup-Hansen / Hasse Milter
- **Role/Position**: Project manager/chief advisor
- **Date of Submission**: 26/09/2024

IMX Experience Feedback

1. Overall Engagement

- **Engagement rating**: 4
- **Contributing factors**: A highly motivated group of participants who were directly involved in wastewater treatment practices. The IMX was tailored to the local environment and operations, increasing relevance and engagement.

2. Preparation and Planning

- **Planning rating**: 4
- **Challenges**: Although there was sufficient planning for using the IMX in the field, there were minor issues with incorporating it into pre-established schedules at the site.
- **Suggested improvements**: Allow more time for introductory sessions and clear integration of the IMX into site operations and technical activities.

3. Technical Aspects

- **Technical setup rating**: 5

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- **Technical issues encountered**: There were no significant technical problems. The IMX functioned smoothly across various devices used by the participants, and the installation was successful with no reported glitches.

4. Interaction Design

- **Interaction mode**: Collaborative group mode.
- **Effectiveness rating**: 5
- **Effectiveness**: The collaborative mode, combined with the practical, hands-on activities, was highly effective. Participants worked together and contributed ideas and strategies, which enhanced the overall learning experience.

5. Group Participation

- **Group participation**: Yes, actively encouraged as the IMX was designed for collaborative work within the specific setting of a wastewater management facility.
- **Influence on engagement**: Strong. Group discussions and hands-on applications of the IMX within the operations site sparked debates and collaborative problem-solving.

Specific Lessons Learned

1. Key Takeaways

i. Group dynamics enhanced the IMX's functionality and effectiveness.
ii. Technical fluency with the tools was not an issue, but time management was essential for optimal integration.
iii. Some tasks could be shortened or modified to fit tighter timeframes without losing value.
iv. Engagement could be increased by integrating competitive elements or score-based interactions.

2. Participant Feedback

- Feedback was overwhelmingly positive. Participants found the IMX highly relevant to their daily work and appreciated its hands-on, problem-solving approach. Some minor suggestions were made regarding reducing the complexity of certain tasks to make the IMX more approachable for new or less experienced team members.

3. Improvements

- Introduce shorter sessions for participants with tighter schedules.
- Integrate a feedback loop within the IMX to adapt challenges in real-time based on participants' progress.

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- Consider using an adaptive mode for varying levels of experience within the same team.

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