# ULTIMATE

## WATER SMART INDUSTRIAL SYMBIOSIS

# D3.5

## (Preliminary) results and insights from co-creation exercises in ULTIMATE CSs

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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, 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 (T3.2 and T3.3) across its nine (9) case studies (CS). Stakeholders are engaged through co-creation exercises for the design of multi-use play spaces, Communities of Practice (CoP), and through Living Labs (LL). These activities are implemented in the context of WP3. Deliverable (D) 3.5 provides preliminary insights and results from co-creation exercises (Subtask 3.2.2 and T3.3) in three (3) CSs (CS 2, 3 and 9) and from CoP (Subtask 3.2.1) across the nine (9) CSs.

The insights and results show the value of co-creation exercises and CoPs to stimulate knowledge sharing, learning and exchange across and among stakeholder groups. ULTIMATE benefits from the co-creation exercises and CoP process 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, for example, co-creation and CoPs, 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.

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

# List of Abbreviations

ACA: Catalan Water 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

CE: Circular Economy

COD: Chemical Oxygen Demand

CoP: Community of Practice

CPTM: Consorzio Polo Tecnologico Magona

CS: Case study

D: Deliverable

EU: European Union

GA: Grant Agreement

GtG: Greener than Green Technologies

IS: Industrial Symbiosis

iWWTP: Industrial wastewater treatment plant

KSA: Kalundborg Symbiosis Association / Industrial Symbiosis Association

KSF: Key success factor

KWR: KWR Water Research Institute

M: Month

MD: Membrane Distillation

MSM: Mahou San Miguel

NEB: New European Bauhaus

NTNU: Norwegian University of Science and Technology

PPP: Public Private Partnership

RD: Royal Decree

RO: Reverse osmosis

SME: Small and medium-sized enterprise

Solvay: Solvay Chimica Italia

SPB: Single-Pass Biofilter

T: Task

UF: Ultrafiltration

WP: Work Package

WSIS: Water Smart Industrial Symbiosis

WWRP: Wastewater reuse plant

WWT: Wastewater treatment

WWTP: Wastewater treatment plant

ZLD: Zero liquid discharge

# Disclaimer

This publication reflects only the author's views and the European Union is not liable for any use that may be made of the information contained therein.

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# 1. Introduction to the report

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.

Within the context of ULTIMATE, 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 (CS 9), France (CS 8), Greece (CS 4), Israel (CS 6), Italy (CS 3), Scotland (CS 7), Spain (CS 1 and 5) and The Netherlands (CS 2).

Successful uptake and acceptance of technologies and strategies for symbiosis solutions requires the active engagement of relevant stakeholder groups and citizens. 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 and innovation co-creation (T3.2 and T3.3) across its nine (9) CSs. Stakeholders are engaged through co-creation exercises for the design of multi-use play spaces, Communities of Practice (CoP), and through Living Labs (LL). These activities are implemented in the context of Work Package (WP) 3.

## 1.1. Purpose of the deliverable

The purpose of Deliverable (D) 3.5 is to provide preliminary insights from two main subtasks in WP3:

- Subtask 3.2.2 (and T3.3.) on co-creation exercises in three (3) CSs (CS 2, 3 and 9) and from
- Subtask 3.2.1 on establishing and implementing CoPs across the nine (9) CSs.

These approaches are used to promote active innovation co-creation through stakeholder engagement to ensure that the knowledge produced is capable of addressing the complexities inherent in symbiotic arrangements.

## 1.2. Structure of the deliverable

D3.5 consists of two main (2) parts:

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

- Part II – Preliminary Results 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 preliminary results of the implementation.

# PART I – PRELIMINARY INSIGHTS: ULTIMATE CO-CREATION EXERCISES

# 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 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 (CS 2, 3 and 9) are presented as a best practice in Task (T) 3.3 (citizen engagement). The insights are shared in this part of D3.5.

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 (validated and analysed immersive narratives for citizens, M46).

## 2.1. Co-creation

Co-creation[1] 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.

Co-creation is practiced using methods and tools in engaging various stakeholders in a playing field. Through co-creation, all participants can come together with others to find common ground and potential solutions on issues that they identified and defined together through an open dialogue, and reflection of each other's unique perspective.

Following a co-creation process, a report with suggestions for future actions can be drafted to provide an early prototype needed for future development of a service, action, or an intervention and to begin conversations with decision-makers.

The ULTIMATE project can benefit from the co-creation process because it could positively change and create new forms of community action, social engagement, and citizen involvement. Locally relevant stakeholders including citizens are invited 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. Co-creation is utilised throughout the project development process to ensure that the new ideas or solutions generated serve their intended purpose.

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[1] https://www.interaction-design.org/literature/topics/co-creation

By investing in this approach, we envision ULTIMATE CSs increase in the capacity and velocity to generate ideas. In this way innovation is ensured, risk is reduced, and a sense of community is built as well as project ownership and engagement. People involved in co-creating ideas and solutions are more likely to agree and support its implementation. By co-creating the envisioned future actions and doing so in synchrony with those who are part of the issue to begin with, various ideas can be generated and accommodated, risks accounted for before they happen, and create solutions that are optimal for those who are involved.

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

The ULTIMATE Co-creation approach aims to be clear, agile and re-usable, which will help to easily realise and design solutions together in a physical (multi-use playspace) or combined online space. It is guided by the concept of a "place by design". Place by design is a process of determining where and how to play and win in the implementation of a proposed site-specific action or intervention. It involves identifying the place where intervention or play will live, the local context and the needed structures that support choices in the environment, the local audience, and the neighbourhood networks. The result of our co-creation will lead to co-designed interventions or immersive media experiences in the selected CS locations.

## 2.2. Place by Design Playbook

ULTIMATE stakeholder engagement using playbook (D3.7) in co-creation activities aims to bring together designers, strategists, developers, and citizens from various backgrounds in a team. The playbook, and supplementary toolkits, are used in this team setting to guide stakeholders through an engagement process. The playbook helps the CSs and partners start conversations around complex topics that are hard to grasp at first, thereby closing the differences and gaps that exist in a multi-stakeholder collaboration practices. Using the playbook as a tool makes it possible to design and implement stakeholder engagement in the form of co-creation activities for three (3) CSs selected based on four (4) guiding principles (see section 3): CS 2 (The Netherlands), CS 3 (Italy), and CS 9 (Denmark).

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.

# 3. Co-creation methodology

The co-creation process started in WP3 by identifying and mapping the selection of the CSs. The activities of the nine (9) CSs were examined initially through their online presence. Internet search, online project reports and literature reviews were gathered. The presentation materials with CS project partners were also jointly analysed and one-on-one interviews with qualifying CSs conducted. Four (4) guiding principles were used as the selection criteria (see D3.4 section 3.2): co-creation, sense of community, openness, and change-making. Appendix A provides more information on the CS criteria considered for co-creation engagement and development of an immersive narrative installation, which ultimately resulted in the selection of the three (3) CSs:

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

After the selection of the CSs, their business activities were examined and visualisation of their transactions created. By understanding the CSs, their activities and potential player activity systems, the appropriate tools for the CSs were decided. The lessons learned from previous experiences[2] in the co-creation process and in earlier implementations of multi-use playspaces, place by design and immersive experiences were revisited to provide a new dimension in solving challenges in stakeholder engagement applied in water-oriented cases. Selected tools from previous projects were adopted and tested through workshops with a diverse team of artists, scientists, researchers, designers, and architects at the Sense-IT[3] Lab at the Norwegian University of Science and Technology (NTNU). A human-centred design thinking in the co-creation framework was used. Through this methodology, three (3) tools to facilitate the co-creation process were provided and distributed to the CSs:

- Onboarding Kit: Contains tools that welcomes and guides a new participant into the project and the team.

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[2] NTNU has a long experience in collaborating with several other faculties and had a diverse team of artists, scientists, researchers, designers and architects working on tools related to the concepts of multi-use playspaces, place by design and narrative experiences. We have implemented all these concepts in a public space called Adressaparken in Trondheim and on an EU project called +CityxChange.

[3] http://www.iet-multimedialabs.org/

- 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.

All the methodologies and tools used in the co-creation practice are documented in the ULTIMATE playbook. The co-creation framework has been designed by stages (see figure 1). The framework stages are also described in more detail in the playbook and in the facilitator's slide deck.

| STAGES | PROCESS | PLAYS | OUTPUTS |
|---|---|---|---|
| **Plan** | Scope and onboard Case Study team | One on one meetings<br>Community Concern Mapping | Selection & Onboarding of CS<br>Stakeholder / Participant`s Map<br>Defined Community-related Issues |
| **Understand** | Engage and know your co-creation team (citizens and stakeholders)<br>Find out who the audience are and what they say, do, feel, and think<br>Immerse the team in the environment where the intervention will live | Team Building & Alignment<br>Empathy Mapping<br>On-site Experience Safari & Shadowing | Filled Team Alignment Canvas<br>Audience Empathy Map<br>On-site data collection and User Journey |
| **Imagine** | Imagine stories, scenarios and journeys on how to make the idea tangible<br>Plan the strategy you will follow to put the intervention in place | Problem Solving Game<br>Results Ideation<br>Communication Scenario | Documentation of game activity<br>Outcome of Results Ideation<br>Defined Communication Tone |
| **Build** | Sketch and demonstrate your idea<br>Build the initial prototype | Discuss , Sketch, & Show<br>Prototype | Discuss, Sketch, & Show Outcome<br>Paper / Digital Prototype |
| **Reflect** | Listen to what people have to say about your prototype<br>Reflect on your learnings | Prototype Appraisal<br>Reflection | Prototype User Feedback and Team Reflection<br>Reflection of Lesson`s Learned |
| **Analyze** | Synthesize all inputs together to determine the final design of the intervention | Innovation Playground Strategy Mapping<br>Impact Analysis | Mapped Innovation Playground Strategy<br>Filled Impact Analysis |
| **Legacy** | Envisioning the future of the project and making a plan for lasting impact | Inspiring Stories<br>Champion`s Recognition | Inspiring Stories Documentation<br>Distributed Participation Certificate |

*Figure 1 Co-creation framework stages*

The Kirkpatrick Model[4] has been adopted to evaluate the success of the co-creation exercises focusing on the participant's satisfaction, knowledge retention, and skills shared and gained. The Kirkpatrick Model is a four-level approach to evaluating learning effectiveness that can be applied in many different forms of learning programs (see table 1).

| | 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. |

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

The approach assesses both formal and informal learning methods, and rates them against four 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:
    o Was the co-creation exercise worth your time?

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

- o What are the things you learned from the exercises?
- o Was your co-creation exercise successful?
- o 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.

  The following questions are asked:
  - o What did you learn or miss in training?
  - o 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:
  - o Do the participants know about their improvement after the co-creation?
  - o Did the participants use the knowledge and skills they gained from the co-creation sessions to their roles?
  - o 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?

The result of the co-creation as a best practice will lead to the development of an immersive narrative experience in D3.6 (validated and analysed immersive narratives for citizens, month (M) 46). 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. Preliminary insights from co-creation exercises

## 4.1. Internal workshops

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 in June 2022) 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.

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 ULTIMATE Lab at the NTNU, 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 of brainstorming, 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 is 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.

In the ULTIMATE workshop during the Festival of the New European Bauhaus (NEB), the *results ideation* exercise was directly carried out because of time constraint. The

participants of the NEB workshop were local people and some international event visitors with little to no knowledge of the concept of immersive narrative experiences. Drawing from the feedback from the first internal workshop at NTNU, several examples and interactive demonstrations of immersive narrative experiences were added before proceeding to the actual *ideation* play. Two ideation challenges were provided to participants:

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

With some pre-filled elements to quickly provide participants information about the ideation challenge, participants were able to create their own immersive narrative intervention rapidly. In addition, digital audio-visual materials and an immersive tool called EyeJack[5] were provided to bring forward their ideas to life without going through the process of user/audience research (see figures 2 and 3). EyeJack, is in fact an Augmented Reality (AR) tool to help with the visualisation of the immersive narrative.



*Figure 2 Pre-filled narrative ideation template used in the NEB workshop*

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An EyeJack Creator desktop app is an editor that allows creators to bring their stories to life with animations and sound with three simple steps... 1) Upload art materials. 2) Upload animations. 3) Test new AR art with the EyeJack mobile app.
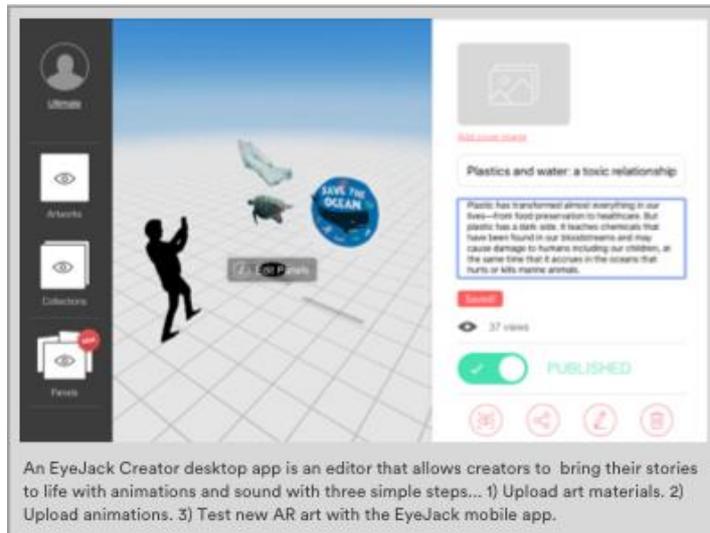
*Figure 3 The EyeJack Augmented Reality app co-created with the participants of the NEB workshop*

In a workshop in June 2022, during the ULTIMATE Annual Meeting at KWR Water Research Institute (KWR) in Nieuwegein (The Netherlands), participants were also shown several examples and interactive demonstrations of immersive narrative experiences before proceeding to the actual *ideation* play. Due to time constraint, instead of providing a tool to enable participants to play and create an immersive intervention, an explanation of the scenario and the resulting immersive experience that the participants played and co-created during the NEB workshop in Brussels was provided. Participants were asked to focus on ideating the narrative content and story lines that could be added to a number of story panels of the immersive narrative app created in EyeJack.

The last two workshops conducted turned out with positive outputs. Participants were able to complete their tasks within a limited amount of time. Participants indicated that they were able to understand how co-creation works and got a clearer idea of what an immersive narrative intervention is. Based on the results of these three workshops, the first version of the Place by Design Playbook was revised. The improvements introduced in the second version of the playbook were done by observing and analysing the behaviour of the workshop participants and the tangible output that were produced. For example, in the *imagine* stage of the playbook a play called *narrative ideation* was introduced. This play brings forward three main variables that participants can ideate together to come up with an initial immersive intervention concept, leading to a rapid prototype:

1. Framing and reframing of the community challenges
2. Intervention concept

3.  Narrative story content

In the updated version of the playbook, a section called 'extra plays' was added where participants can choose to engage in more plays. This is especially relevant for citizen engagement where elements of fun and team building are very important. The 'plays' section provides the recommended plays for the CSs. In the *imagine* stage, the *narrative ideation* play section is also added to simplify the initially recommended *ideation* play. The current *ideation* play brings together stakeholders to brainstorm on different elements to spark fresh intervention ideas and innovation. The previous play in the *ideation* phase (the *results ideation*), now becomes an optional play. Updates on the 'plays in action' section in the *build* stage of the playbook were also provided, showing some of the co-creation efforts made within the various ULTIMATE workshops and dissemination activities (e.g., the Festival at the NEB in Brussels and the ULTIMATE Annual Meeting at KWR) (see figure 4).
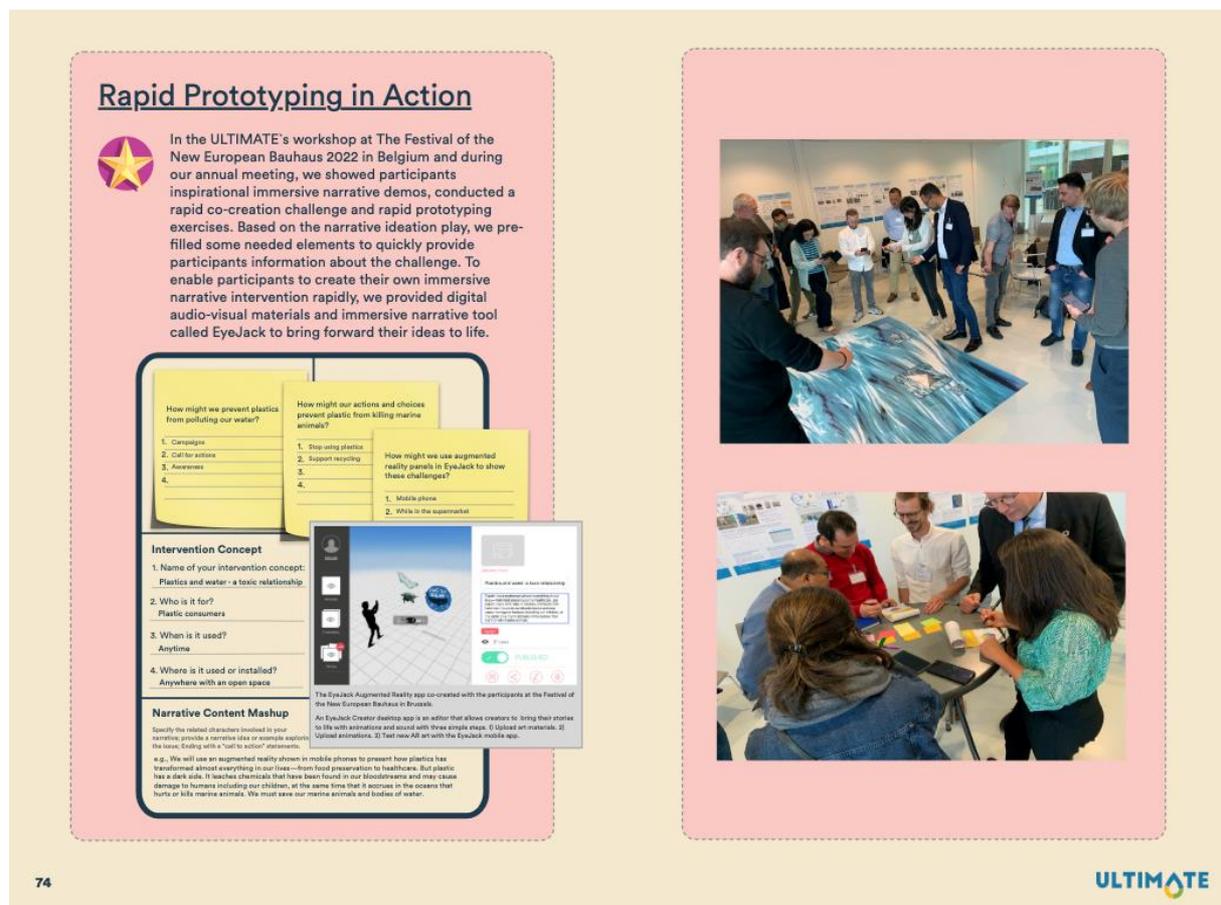


*Figure 4 Prefilled template used at the Festival of the New European Bauhaus in Brussels and photos showing the rapid co-creation workshop in the ULTIMATE Annual meeting at KWR in Nieuwegein*

CS 2, 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 by M46.

# 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.

*Figure 5 Co-creation scenario and immersive intervention site research work with KWR (Nieuwegein, The Netherlands) where the CS 2 team and our team of experts from the NTNU explore the potential immersive intervention sites and understand their potential community challenges*

*Figure 6 Co-creation scenario and immersive intervention site research work with Consorzio ARETUSA (Rosignano, Italy) where the CS 3 team and our team of experts from the NTNU explore the potential immersive intervention sites and understand their potential community challenges.*
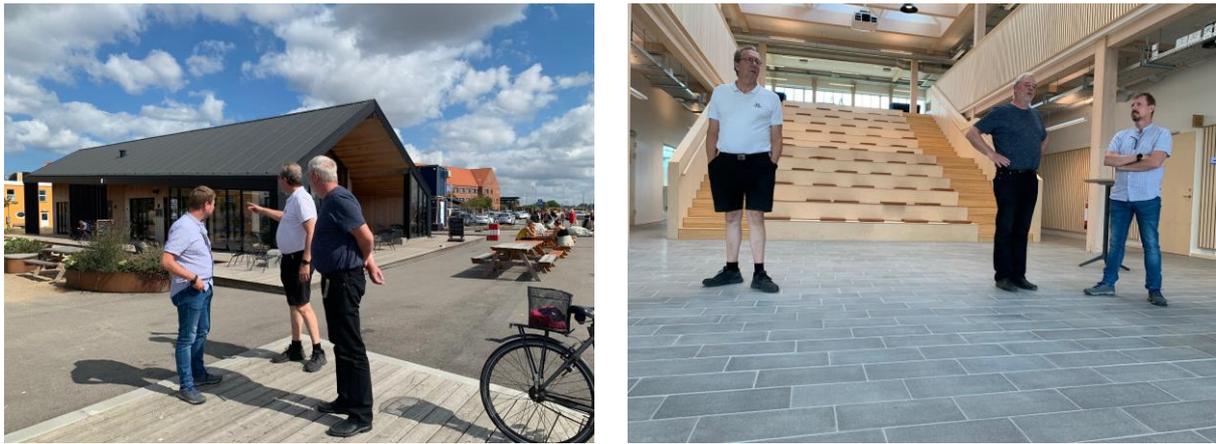
*Figure 7 Co-creation scenario and immersive intervention site research work with Kalundborg Forsyning (Denmark) where the CS 9 team and our team of experts from the NTNU explore the potential immersive intervention sites and understand their potential community challenges.*

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

### 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 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 CS 2*

*Figure 9 Selected co-creation output from CS 3*
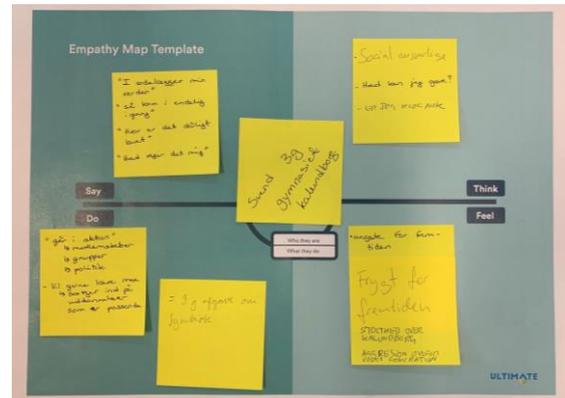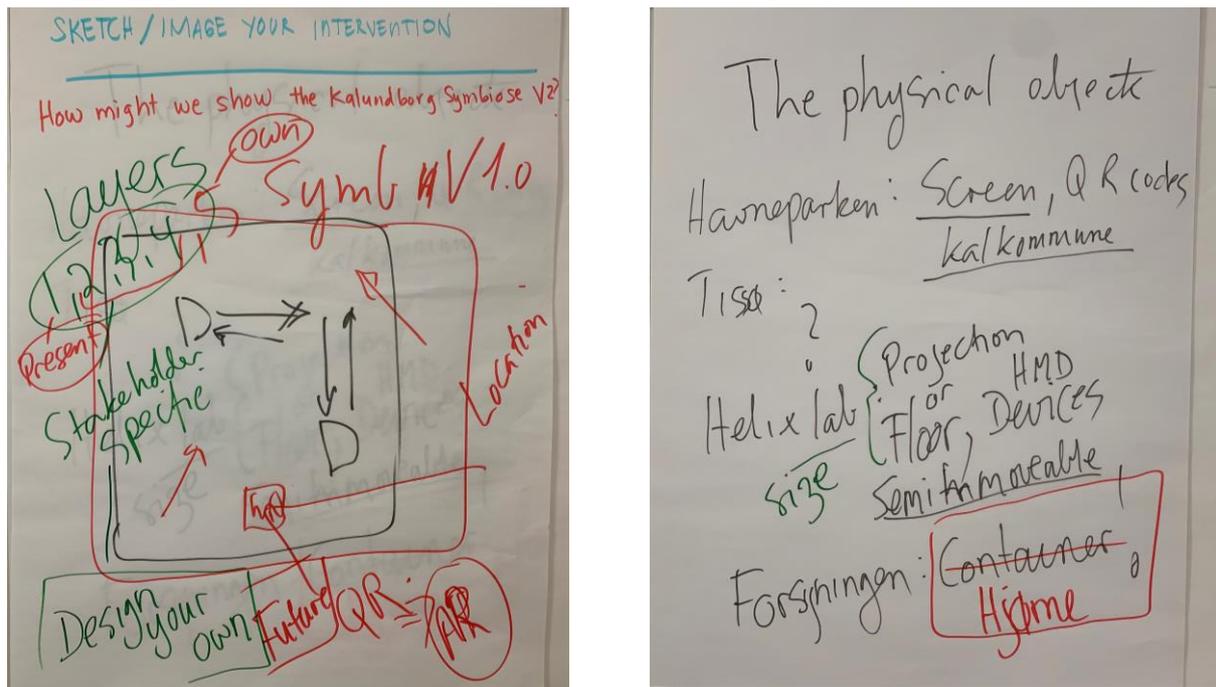
*Figure 10 Selected co-creation output from CS 9*

### 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 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 (Table 2) provides an overview of co-creation excerceises held across the three (3) CSs.

| | # of co-creation plays completed | Average # of participants | Type of organisations engaged | Average Gender diversity (%) | |
|---|---|---|---|---|---|
| | | | | M | F |
| CS 2 | 7 | 8 | Research institutes and end-users | 70 | 30 |
| CS 3 | 5 | 9 | Research institutes, end-users, and water industry and external institutions | 70 | 30 |
| CS 9 | 6 | 8 | Research institutes, end-users, water industry, representatives of other sectors | 70 | 30 |

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

## 4.2.2. Case study 2 - KWR, The Netherlands

### 4.2.2.1. Context

The initial plan was to involve horticultural industries as co-creation stakeholders however, KWR as CS 2 leader saw that it is not always easy to engage or reach all types of stakeholders in the ULTIMATE activities – e.g., local authorities, farmers. With the increasing energy prices, engaging the farmers in CS 2 has been even more challenging as their priority channels towards ensuring the continued operation of their business. With the difficulty of getting the desired stakeholders together, it was agreed that a team with broad expertise would be assembled by KWR to engage in the co-creation process – their entry point was the Watershare Associates who consist of PhD students at KWR working on EU projects as well as KWR early career colleagues. With their fresh perspectives on Circular Economy (CE) and wastewater, this group can represent the views of the targeted audience, in this case local students, KWR visitors and relevant researchers.

### 4.2.2.2. Case study 2 co-creation exercise

Using Kirkpatrick's model to evaluate the success of the co-creation exercises, the CS 2 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.

- 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.

- 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.

## 4.2.3. Case study 3 - Consorzio ARETUSA Rosignano, Italy

### 4.2.3.1. Context

CS3 is collaborating 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). In this development and expansion, ARETUSA, is a public private partnership (PPP) between ASA (as the municipal water utility), Solvay (as the industrial company that uses reclaimed water) and Termomeccanica Ecologia (as the technology provider). The aim is to treat municipal wastewater for industrial reuse and reduce the industrial consumption of high-quality groundwater which should be used solely as a drinking water in the community.

Other partners such as Università Politecnica delle Marche, West Systems Srl and Consorzio Polo Tecnologico Magona (CPTM) contribute with CS 3 on this collaborative change and further increase circularity in the water and chemical industry.

### 4.2.3.2. Case study 3 co-creation exercise

Using Kirkpatrick's model to evaluate the success of the co-creation exercises, the CS 3 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 organized 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 CS 3 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 valorization 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.

**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 CS 3'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 CS 3 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.

## 4.2.4. Case study 9 - Kalundborg Forsyning, Denmark

### 4.2.4.1. Context

Kalundborg Forsyning have an excellent collaboration with the Kalundborg Symbiosis Association (KSA) by supporting the development and integration of the newcomers (e.g., new industries, etc.) into the existing Industrial Symbiosis. CS 9 also aims to expand its internal cooperation with KSA to stimulate an increase in energy efficiency of plant operation and reducing chemical consumption. This can be achieved by locating and incorporating future users of the produced water, the recovered energy, and the recycled material.

Kalundborg Forsyning intend also to take on the role as the "catalyst" connecting Horizon 2020 knowledge and the new industries establishing themselves in the "Greenfield" area, and thereby making the new Kalundborg Industrial Area a truly sustainable part of a Water Smart Industrial Symbiosis (WSIS) integrated with optimised streams of material and energy.

The Municipality of Kalundborg handles the process of selling land to interested companies. One major challenge that the co-creation exercises are investigating is the integration of an impact assessment visualization and interactive game that will provide ideas on how to handle water and wastewater, energy, and material management in their expansion plans.

### 4.2.4.2. Case study 9 co-creation exercise

Using Kirkpatrick's model to evaluate the success of the co-creation exercises, the CS 9 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?
  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 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.

# PART II – PRELIMINARY INSIGHTS: ULTIMATE COMMUNITIES OF PRACTICE

# 5. 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 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

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., CS 9 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.

Due to the Covid-19 pandemic, most engagement with stakeholders across the CoPs have 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.

# 6. Establishing and implementing Communities of Practice

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

KWR has outlined an eight (8) step guideline to assist 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 (see D3.4 for more details on the steps to preparing and implementing a CoP):

- 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 with the intention to engage locally relevant stakeholder. Engagement with stakeholders has been facilitated across most CSs, with the exception of CS 7 (Tain, Scotland; more details in section 7.8), 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 base on their specific needs and circumstances. These can be defined using, for example, a CoP roadmap.

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

- 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 not a required activity in ULTIMATE. It is 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), with the exception of CS 2 (Farmer's water reuse, The Netherlands), CS 5 (Lleida, Spain), CS 7 (Tain, Scotland), CS 8 (St. Maurice L'Exil, France), and CS 9 (Kalundborg, Denmark). Where roadmaps are available, these have been included in the CS specific sections of Part II of the report.

The roadmaps provide an overview of when CoP meetings and focus group meetings will take place. However, these are 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 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 to 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.

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 CS 9 is made, as the Kalundborg case offers a unique perspective on the engagement with stakeholder within the context of industrial symbiosis.

# 7. Communities of Practice implementation across case studies

## 7.1. Overview of Communities of Practice

The table below (Table 3) 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.

| | # of CoP meetings held | Average # of participants | Type of organisations engaged | Average Gender diversity (%) | |
|---|---|---|---|---|---|
| | | | | M | F |
| CS 1 | 2 | 12 | Authorities, research institutes, end-users, water industry and external stakeholders | 50 | 50 |
| CS 2 | 1 | 13 | Research institutes, end-users and representatives of Glastuinbouw Nederland | 77 | 23 |
| CS 3 | 3 | 42 | Public authorities, engineering companies, research institutes, end-users, water industry and external stakeholders | 74 | 26 |
| CS 4 | 2 | 24 | Authorities, engineering companies, research institutes, end-users, water industry, and representatives of other sectors | 63 | 37 |
| CS 5 | 1 | 13 | Engineering companies, research institutes, end-users and water industry | 77 | 23 |
| CS 6 | 1 | 37 | Engineering companies, research institutes, water industry | 73 | 27 |
| CS 7* | 0 | N/A | N/A | N/A | N/A |
| CS 8 | 1 | 14 | Upstream customer, economic interest group, transport and trading of secondary raw material | 57 | 43 |
| CS 9** | N/A | N/A | Food/biotech & pharmaceutical industries, authorities, water industry, and representatives of other sectors | N/A | N/A |

*See section 7.8 for more information
**See section 7.10 for more information

*Table 3 Overview of CoP meetings across case studies*

## 7.2. Case study 1 - Tarragona, Spain

### 7.2.1. Context

Located in Tarragona (Spain), in an industrial area hosting a petrochemical complex, CS 1 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. 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 will combine advanced reverse osmosis and membrane distillation. This will be initially tested at pilot-scale in the existing wastewater reclamation plant and later introduced in the future iWWTP.

### 7.2.2. Community of Practice meeting(s)

There have been a total of two (2) CoP meetings prepared and implemented with stakeholders in Tarragona, with a third to be held in late November 2022.

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 with stakeholders information on the ULTIMATE project, the activities in CS 1 and to define together an approach and 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 CS 1.

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 CS 1 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 strong support given to AITASA's ambition to increase reclaimed water production capacity from an environmental point of view.

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



*Figure 11 1st online CoP meeting in CS 1*

### 7.2.3. Stakeholder experience and learning

Drawing insights from the evaluation survey of the first CoP meeting[6], the participation and engagement of stakeholders was successful. The participating stakeholders generally found the CoP meeting to be extremely valuable[7], showing a good level of interest and willingness to learn.

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[6] Responses from participating stakeholders are not available from the second CoP meeting.

[7] 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).

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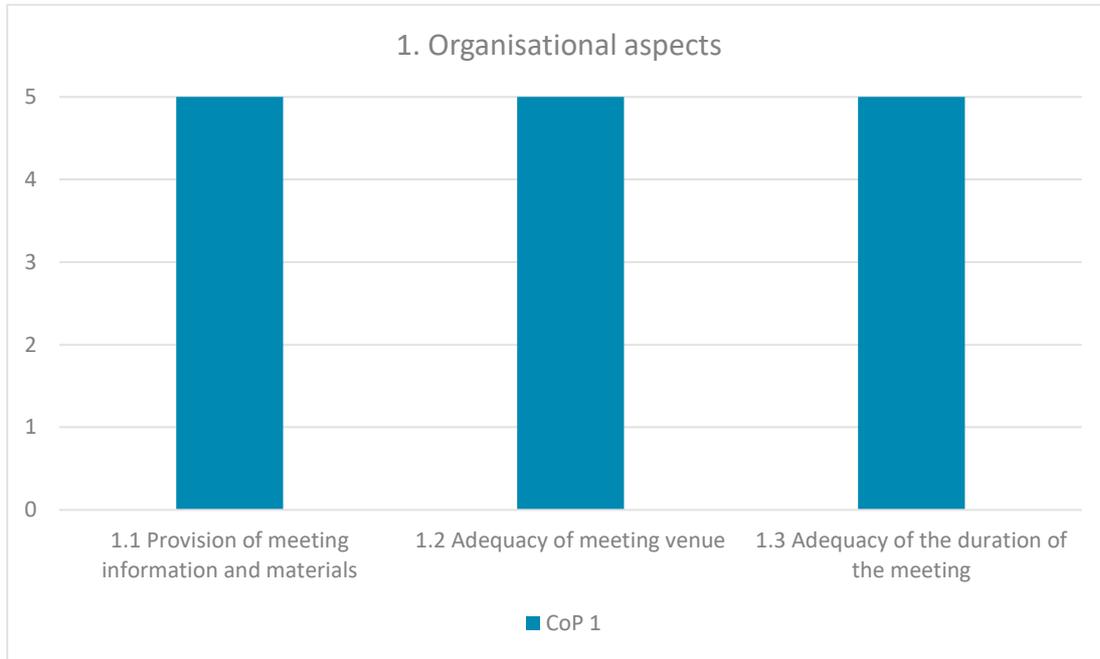


*Figure 12 Meeting logistics and stakeholder engagement: Organisational aspects (CS 1)*

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[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.
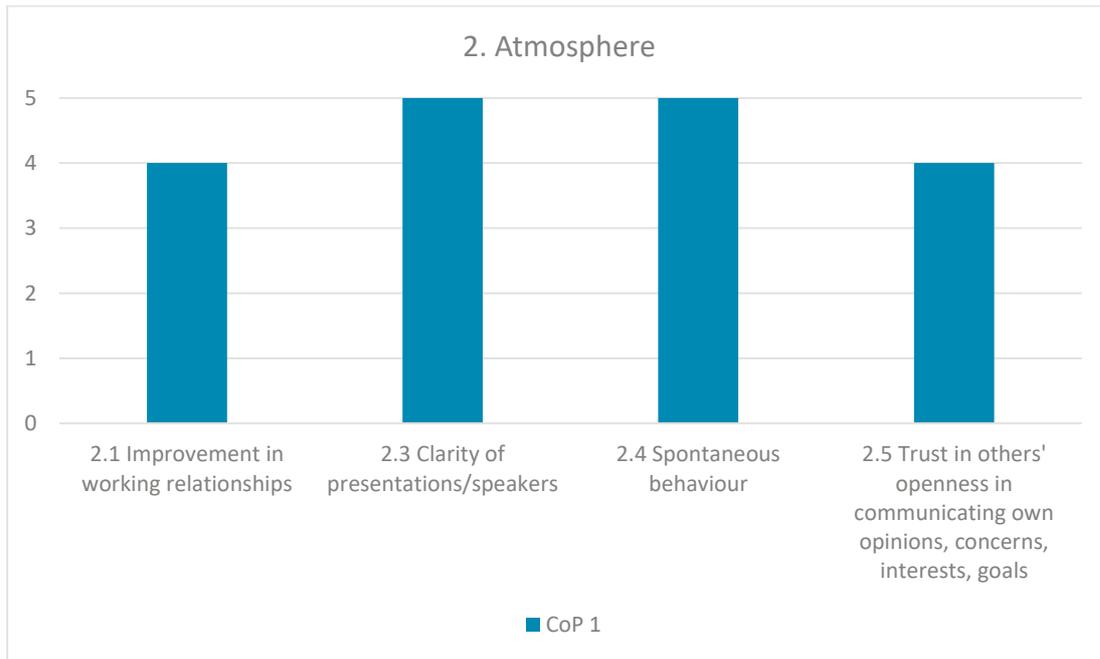
*Figure 13 Meeting logistics and stakeholder engagement: Atmosphere (CS 1)*
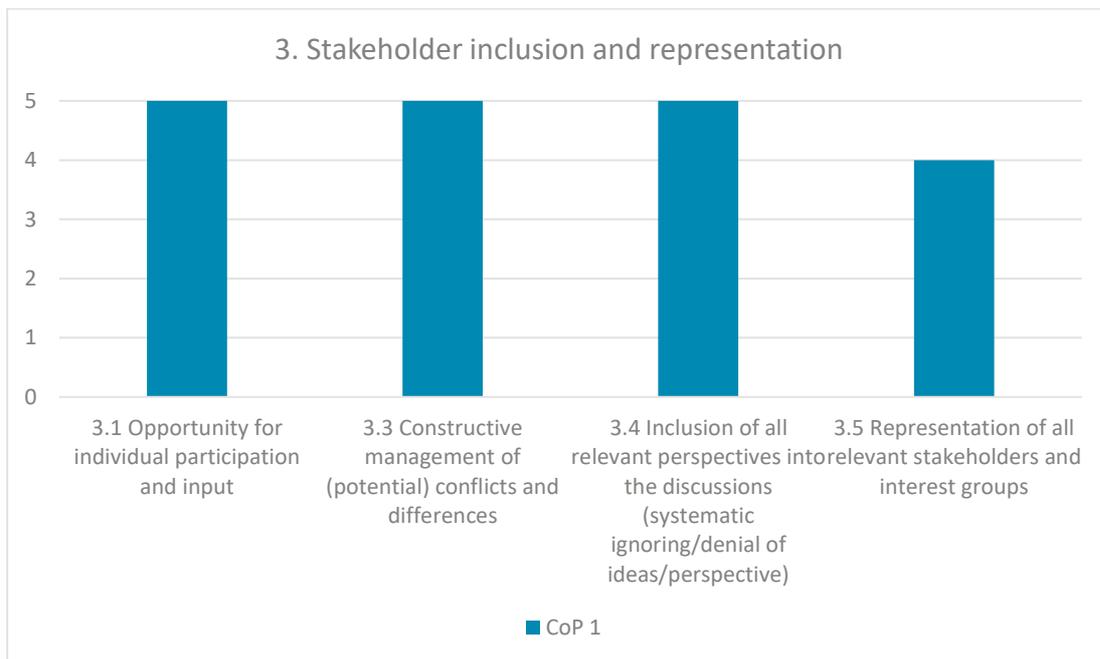


*Figure 14 Awareness and increased understanding: Stakeholder inclusion and representation (CS 1)*
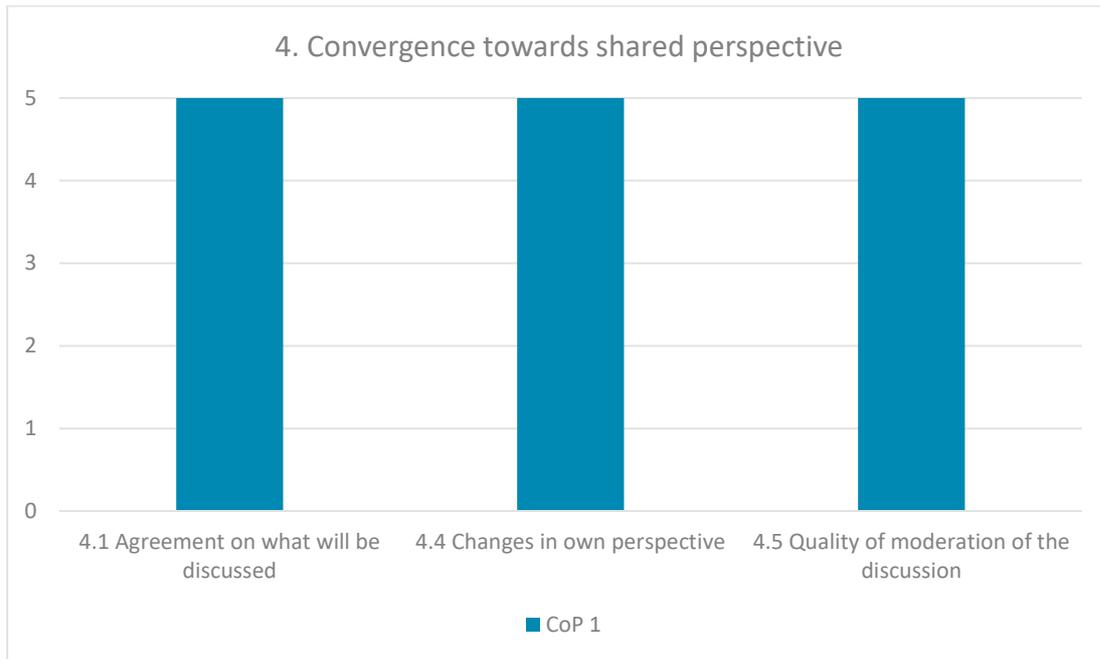
*Figure 15 Awareness and increased understanding: Convergence towards shared perspective (CS 1)*
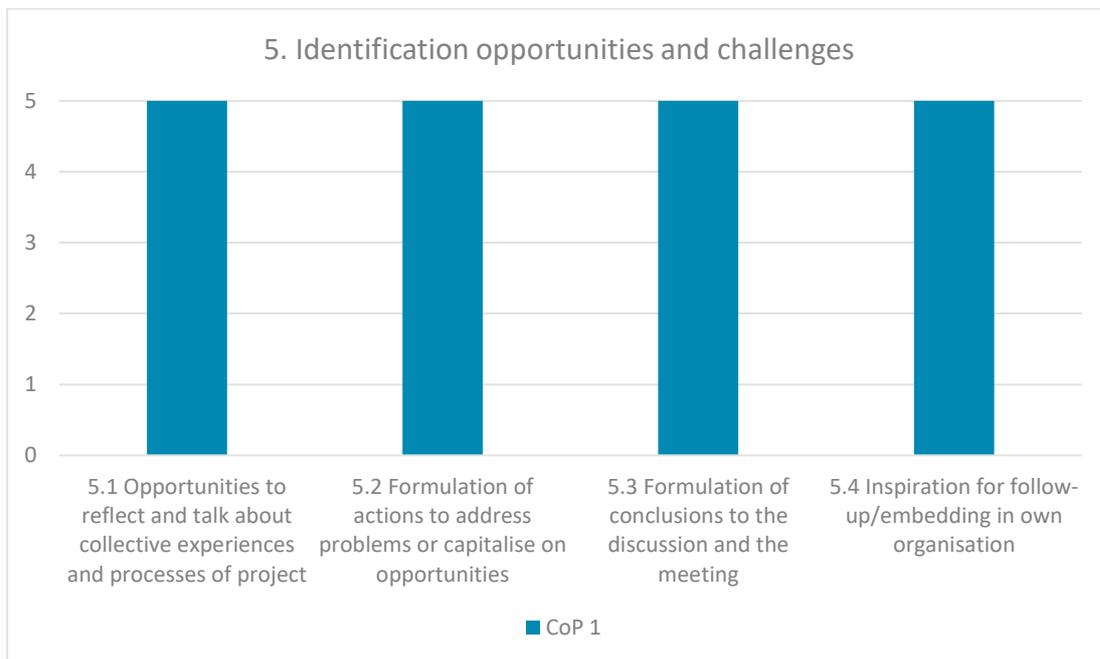


*Figure 16 Outcomes and conclusions: Identification opportunities and challenges (CS 1)*
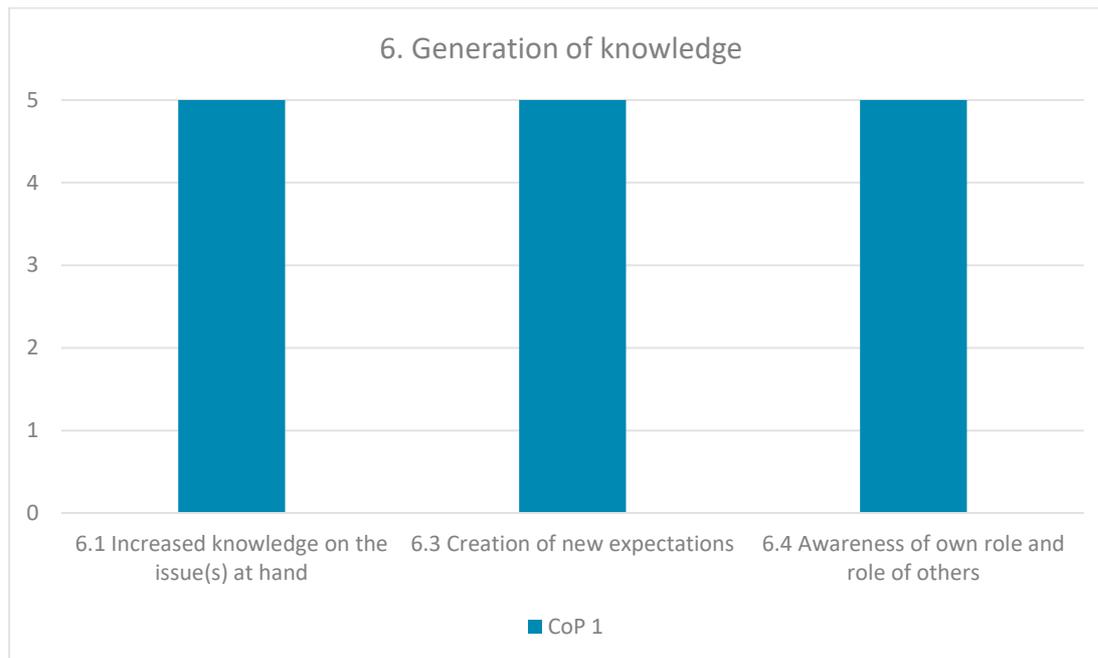
*Figure 17 Outcomes and conclusions: Generation of knowledge (CS 1)*

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.

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.

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

### 7.3.1. Context

Located in the west of The Netherlands, CS 2 is in a region known for its greenhouses growing vegetables and flowers with a state-of-the-art technology, and for its continuous innovation development. The area is organised around 60 greenhouses arranged in a cooperative sharing a common WWTP. CS 2 focusses on closing the water, energy, and material loop, looking at the reliable removal of pesticides and plant pathogens for water reuse in horticulture and heat recovery for greenhouse heating from wastewater treatment (WWT).

To optimise the work of the greenhouses, the cooperative is looking into different opportunities for water 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.

### 7.3.2. Community of Practice meeting(s)

There has been a total of one (1) CoP meeting prepared and implemented with stakeholders in CS 2. The CoP meeting, which took place on 2 February 2022, convened research institutes, end-users, representatives of Glastuinbouw Nederland and the entrepreneurial network in the Dutch greenhouse horticulture sector. The meeting had the ambition to initiate, stimulate, and facilitate collective knowledge development and sharing in order to improve the networks 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 CS 2 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 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.

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



*Figure 18 1ˢᵗ online CoP meeting in CS 2*

### 7.3.3. Stakeholder experience and learning

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

The following figures provide the average scores across the KSFs, 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 an average 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. CS 2 discussed the possibility of a physical meeting, however many stakeholders indicated a preference to engage online. The willingness to continue participating online, in spite the challenges, can be 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.
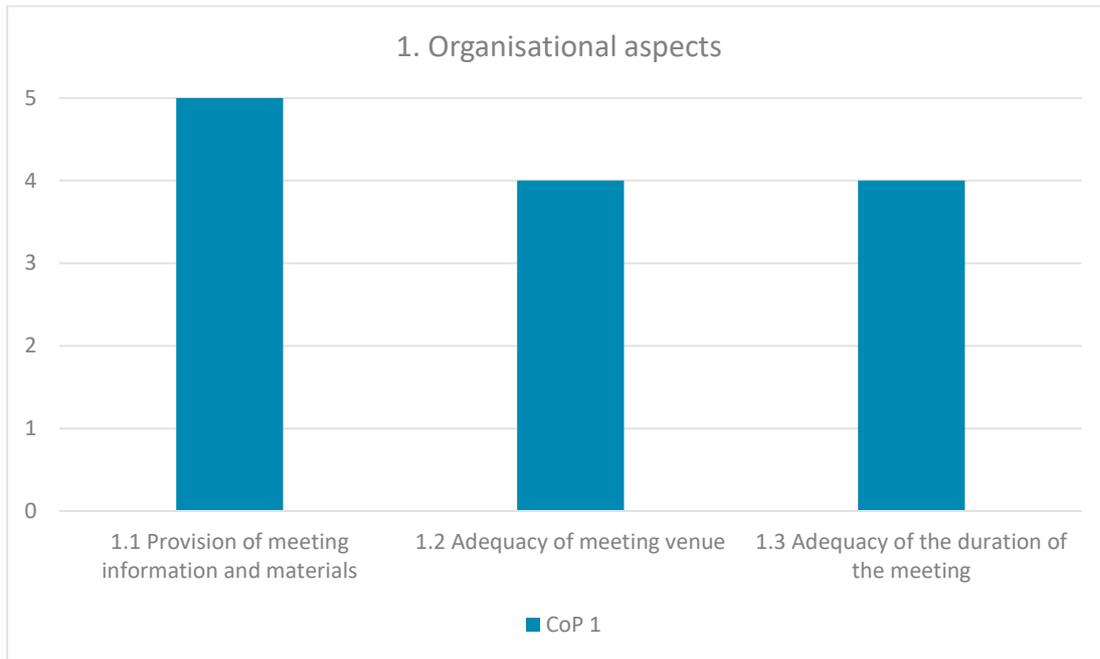
*Figure 19 Meeting logistics and stakeholder engagement: Organisational aspects (CS 2)*
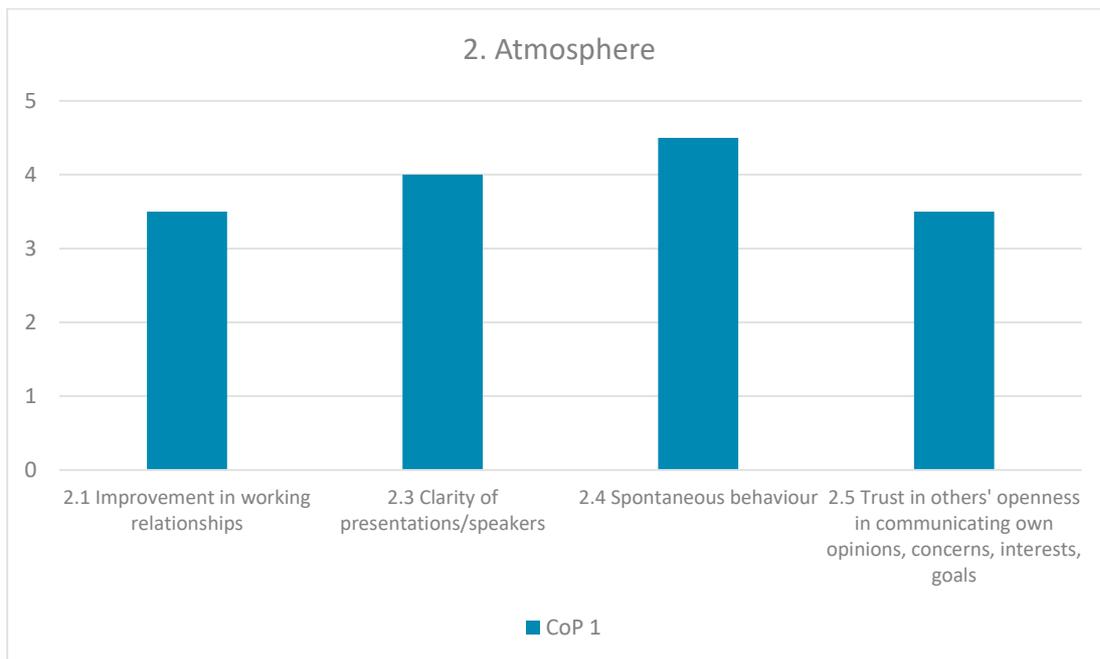


*Figure 20 Meeting logistics and stakeholder engagement: Atmosphere (CS 2)*
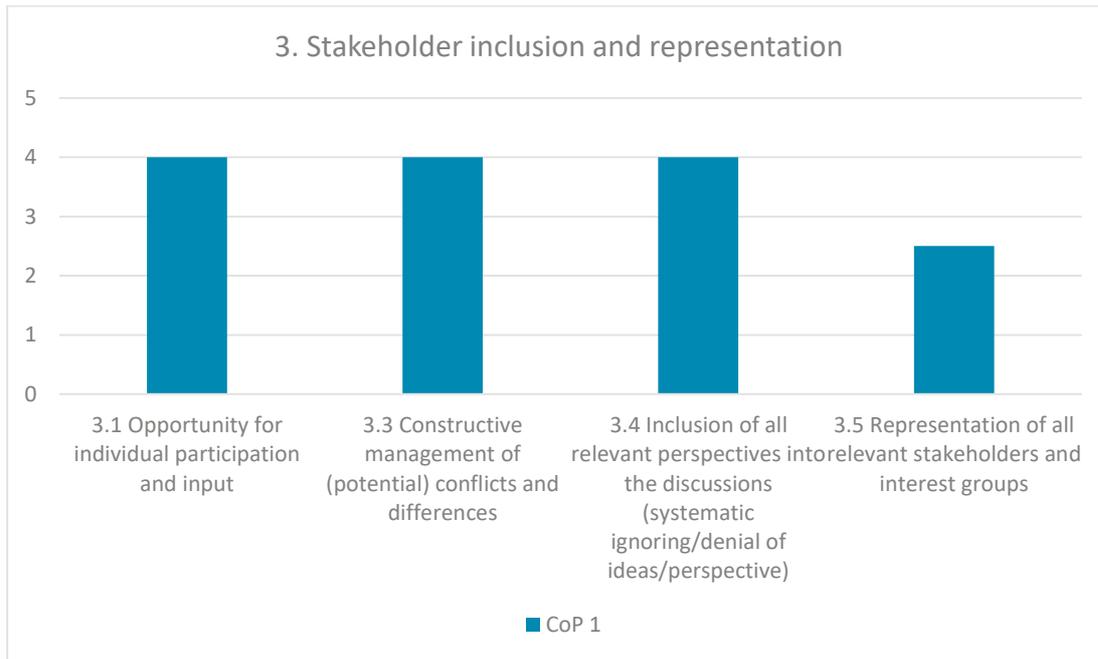
*Figure 21 Awareness and increased understanding: Stakeholder inclusion and representation (CS 2)*
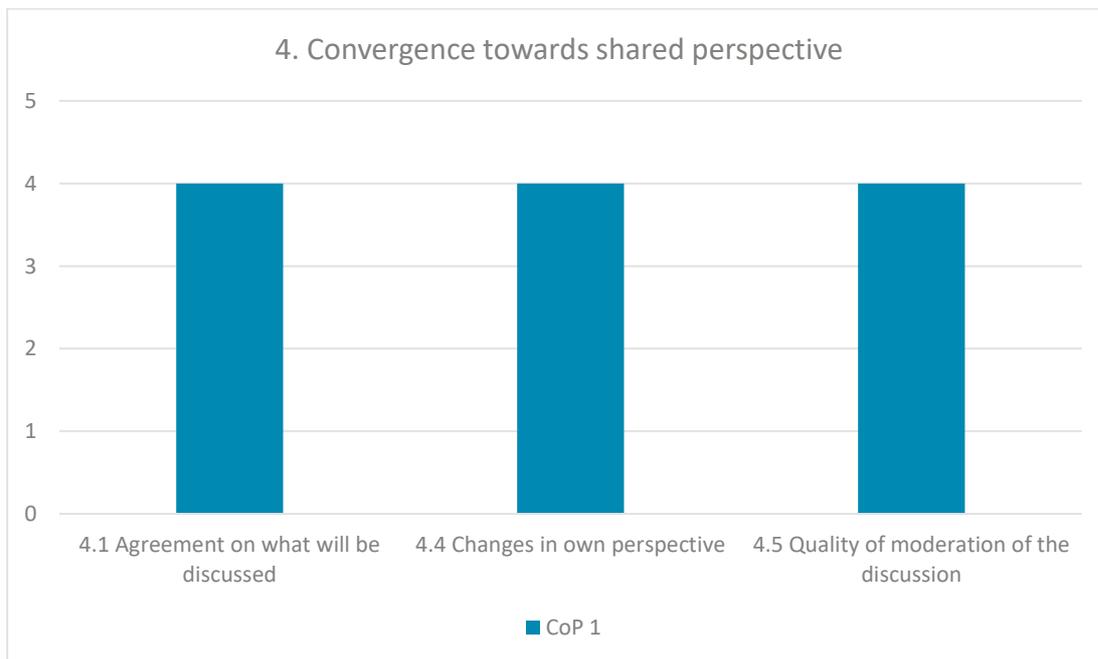


*Figure 22 Awareness and increased understanding: Convergence towards shared perspective (CS 2)*
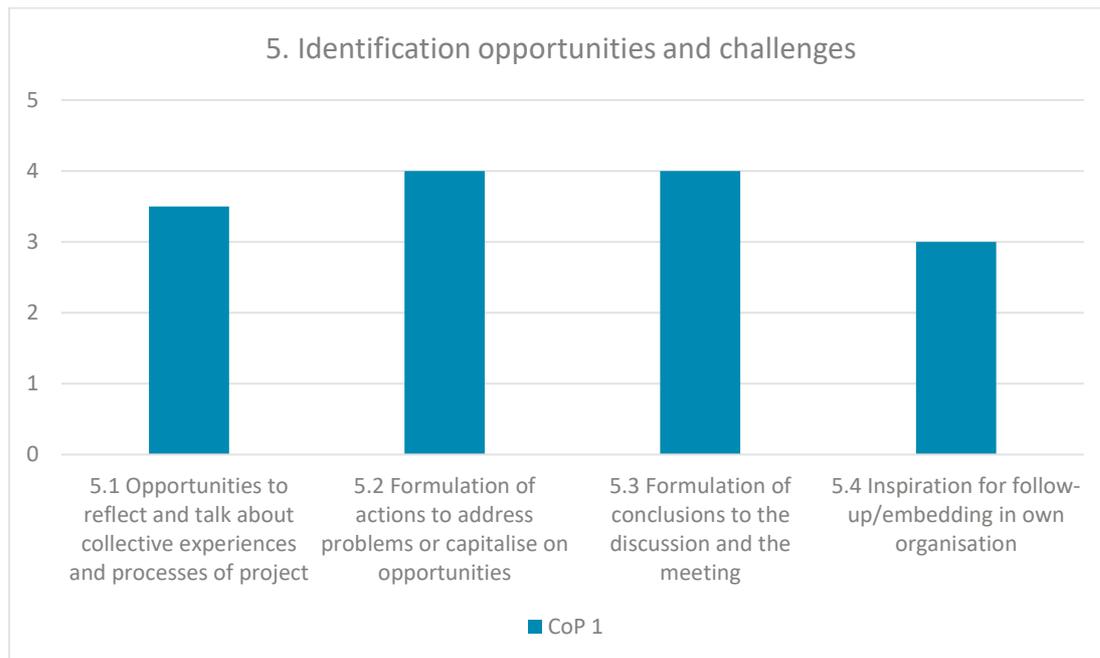
*Figure 23 Outcomes and conclusions: Identification opportunities and challenges (CS 2)*
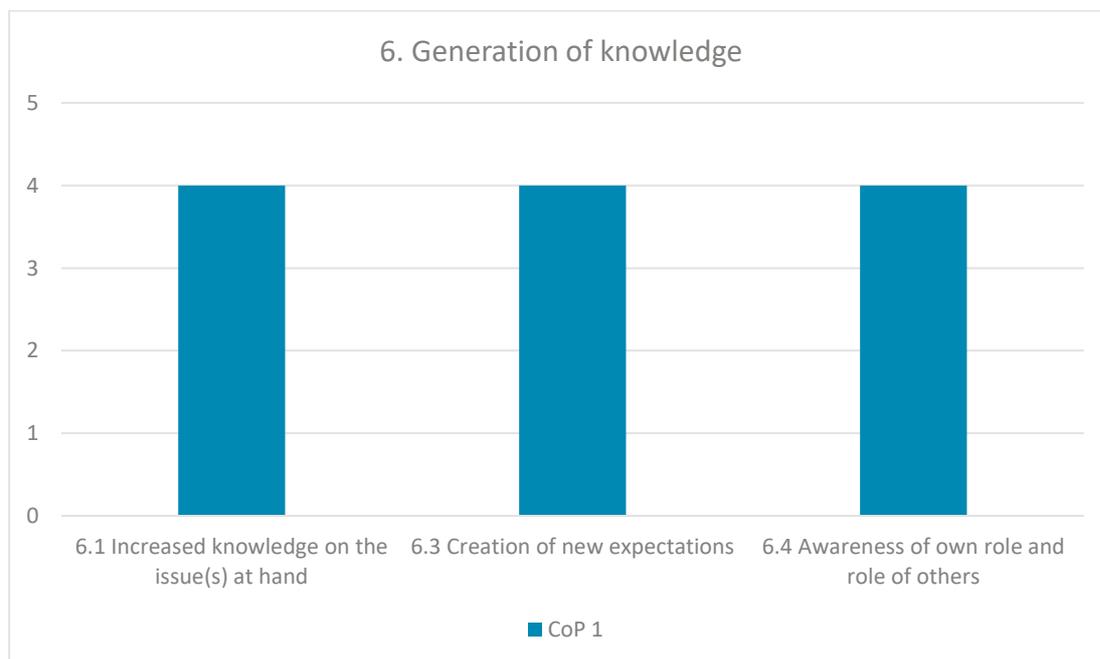


*Figure 24 Outcomes and conclusions: Generation of knowledge (CS 2)*

# 7.4. Case study 3 - Rosignano, Italy

## 7.4.1. Context

Located in Rosignano (Italy), CS 3 works 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).

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 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 and supply from various sources (water reuse, groundwater and surface water).

## 7.4.2. Community of Practice meeting(s)

A total of three (3) CoP meetings were prepared and implemented with stakeholders in CS 3. A forth meeting will be held on 14 December 2022.

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 CS 3. 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 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.

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



*Figure 25 Site visit of Solvay's Rosignano plant*
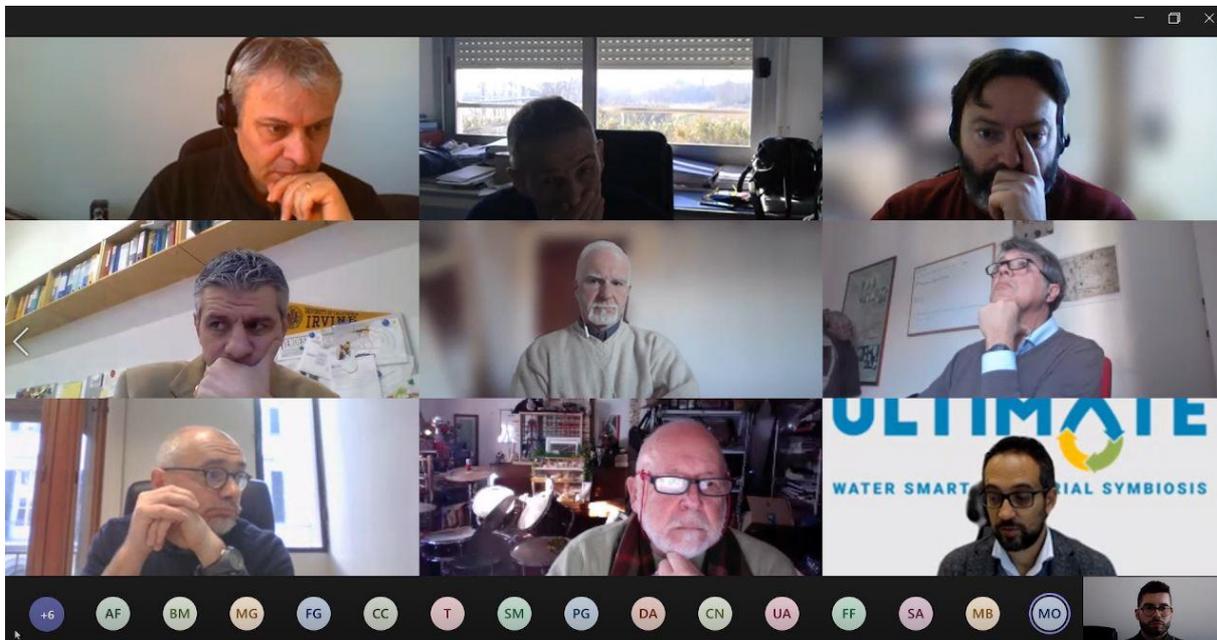


*Figure 26 2nd online CoP meeting in CS 3*

### 7.4.3. Stakeholder experience and learning

Drawing insights from the evaluation survey of the CoP meetings held in CS 3, stakeholders generally found the CoP meeting to be extremely valuable.

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).
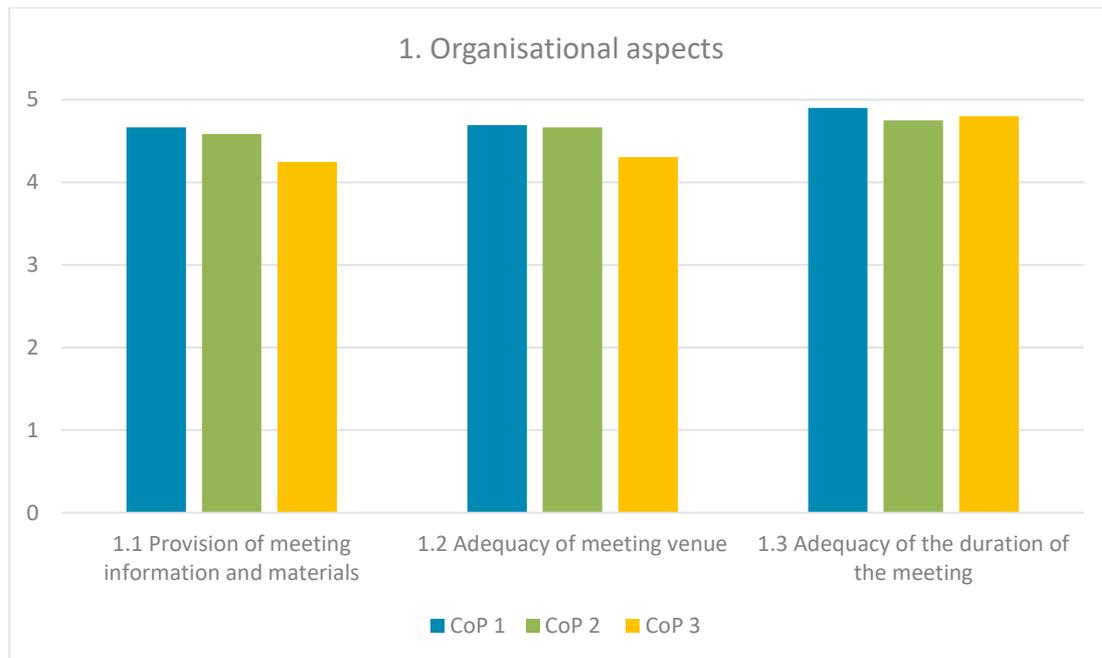


*Figure 27 Meeting logistics and stakeholder engagement: Organisational aspects (CS 3)*
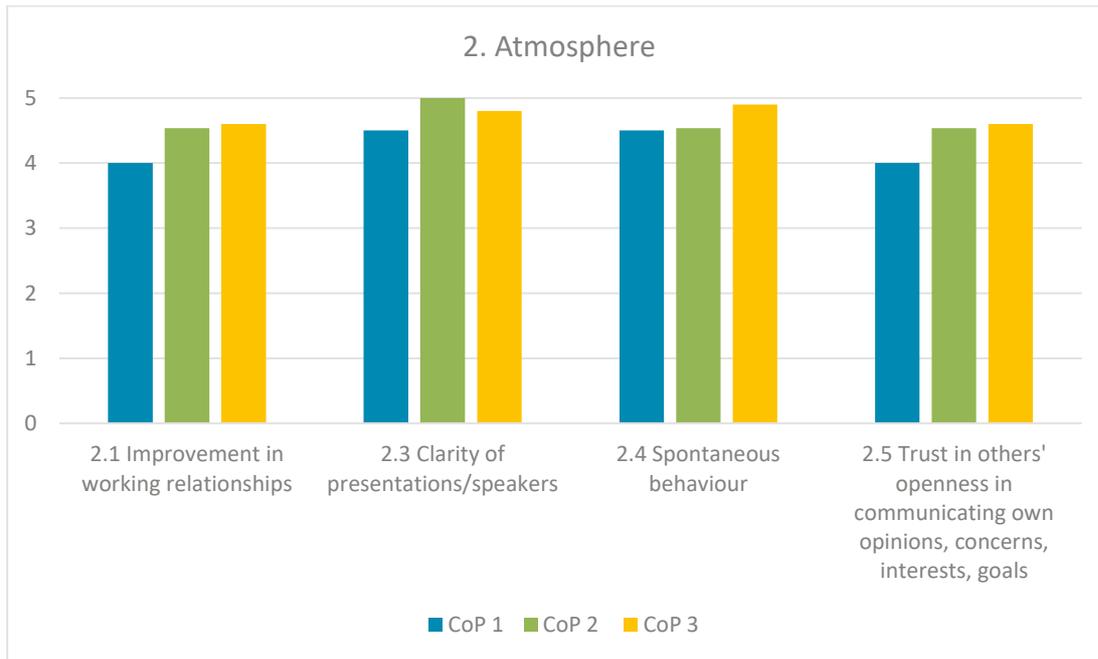
*Figure 28 Meeting logistics and stakeholder engagement: Atmosphere (CS 3)*
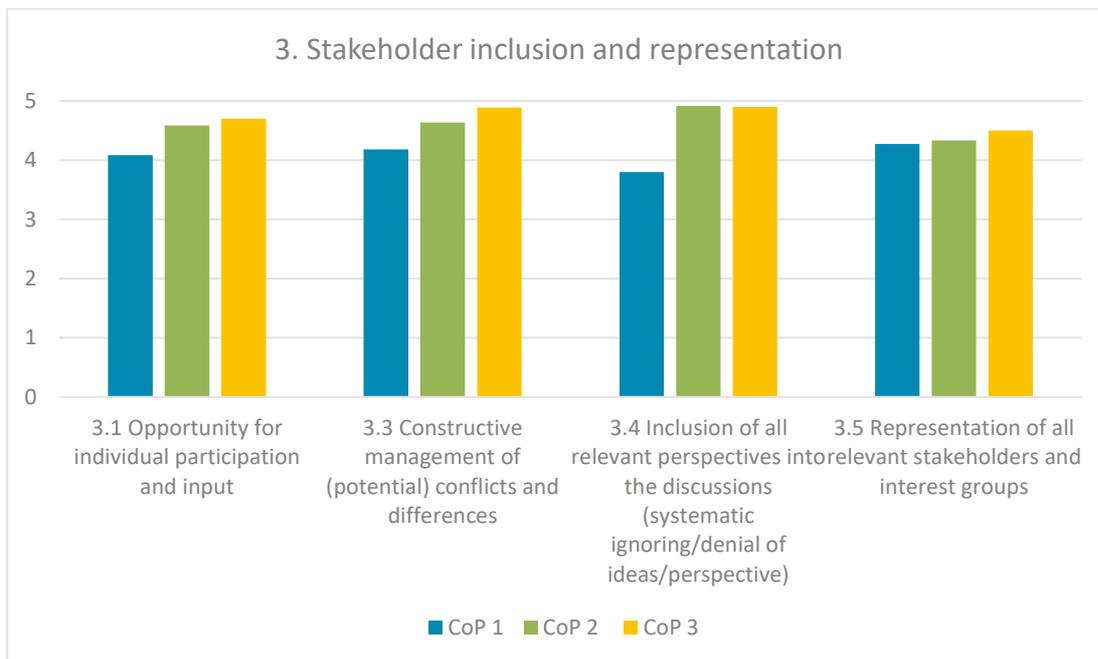


*Figure 29 Awareness and increased understanding: Stakeholder inclusion and representation (CS 3)*
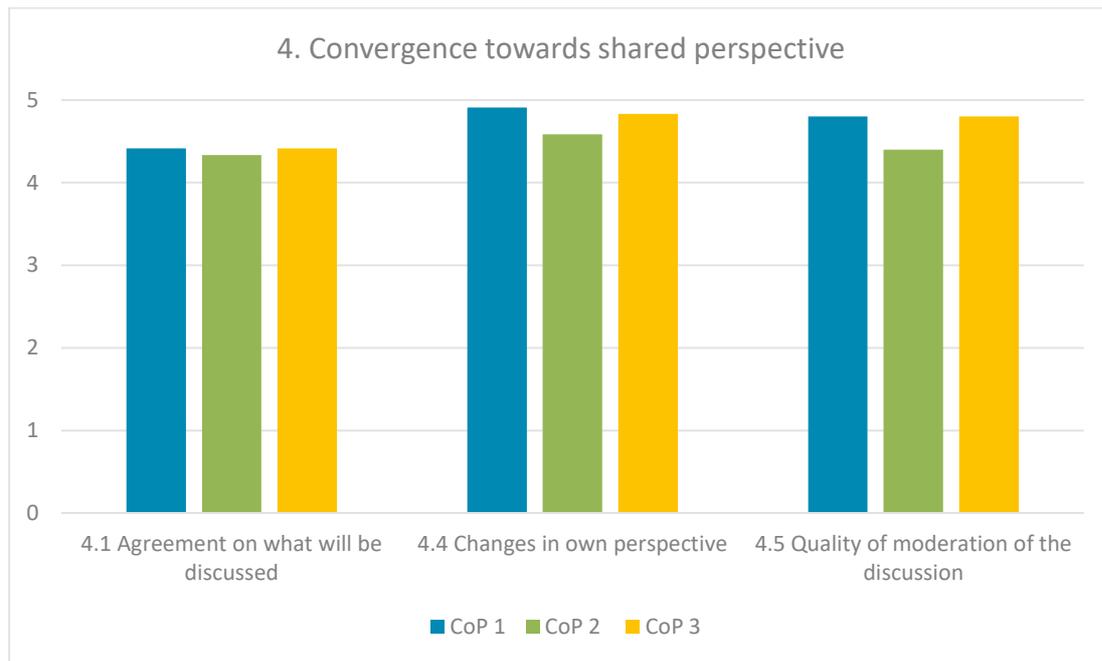
*Figure 30 Awareness and increased understanding: Convergence towards shared perspective (CS 3)*
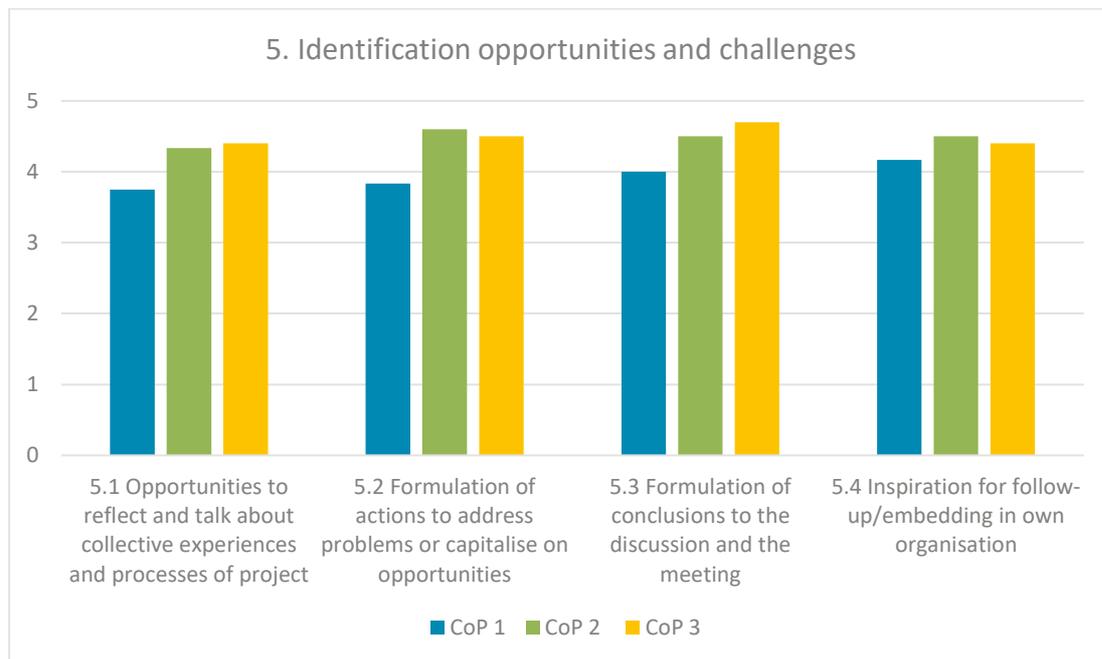


*Figure 31 Outcomes and conclusions: Identification opportunities and challenges (CS 3)*
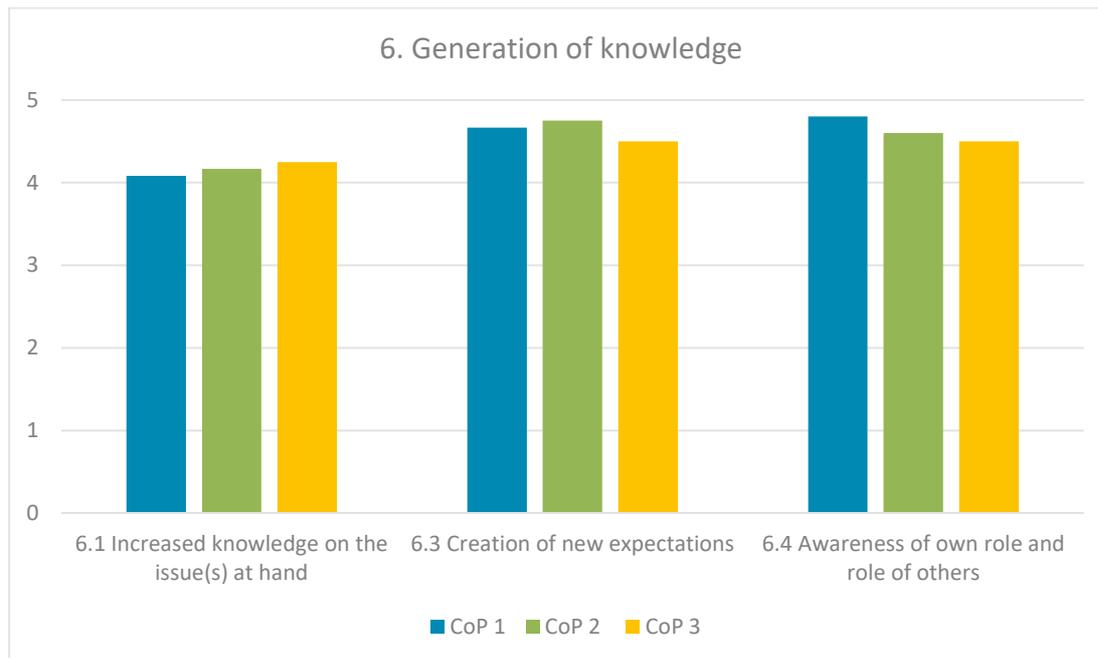
*Figure 32 Outcomes and conclusions: Generation of knowledge (CS 3)*

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 information shared, in particular for the first CoP meeting. However, over the course of the second and third CoP 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). Through the CoP, stakeholders reported that there is a growing recognition of the many circular realities and best practices already in development in the local area.

All of the CS 3 CoP meetings have been held online. Stakeholders across the three (3) CoP meetings have expressed a need for face-to-face meetings to stimulate better engagement in the CoP.

# 7.5. Case study 4 - Nafplio, Greece

## 7.5.1. Context

Located in Nafplio (Greece), a highly productive citrus fruit region, CS 4 looks at the 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 salt water intrusion. For the moment, there is no symbiosis established between the different stakeholders that would enable water reuse or recovery of any valuable resource.

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.

## 7.5.2. Community of Practice meeting(s)

There have been a total of two (2) CoP meetings prepared and implemented with stakeholders in CS 4. A third CoP meeting will be prepared for December 2022 with a focus on CE.

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 agreed to meet two (2) times per year (preferably face-to-face), with at least one site visit (to make engagement more attractive). In terms of content, topics identified for focus groups 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.

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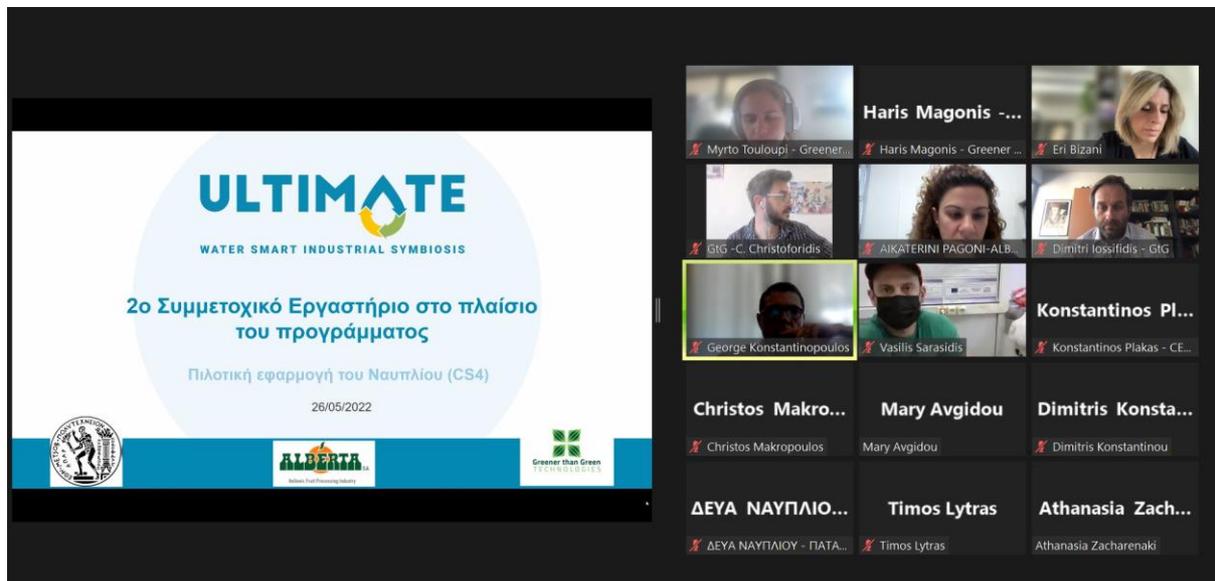


*Figure 33 2nd online CoP meeting in CS 4*

### 7.5.3. Stakeholder experience and learning

On average, stakeholders in CS 4 scored the first and second CoP meeting "very" and "extremely" valuable, respectively, finding the meetings to be very informative and vivid. The figures below provide the average scores across the KSFs showing positive feedback from the CoP stakeholders over the two (2) CoP meetings. The lowest scores given by the CoP stakeholders were on the representation of all relevant stakeholders and interest groups (such as the wineries and farmers). While stakeholder perception about the CoP process improved in the second meeting, stakeholders felt that more effort should be made to bring more and diverse stakeholder groups within the CoP.

As for content, stakeholders would welcome presentations on results as well as the opportunity to see pilots in operation. In many instances, stakeholders also indicated 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.
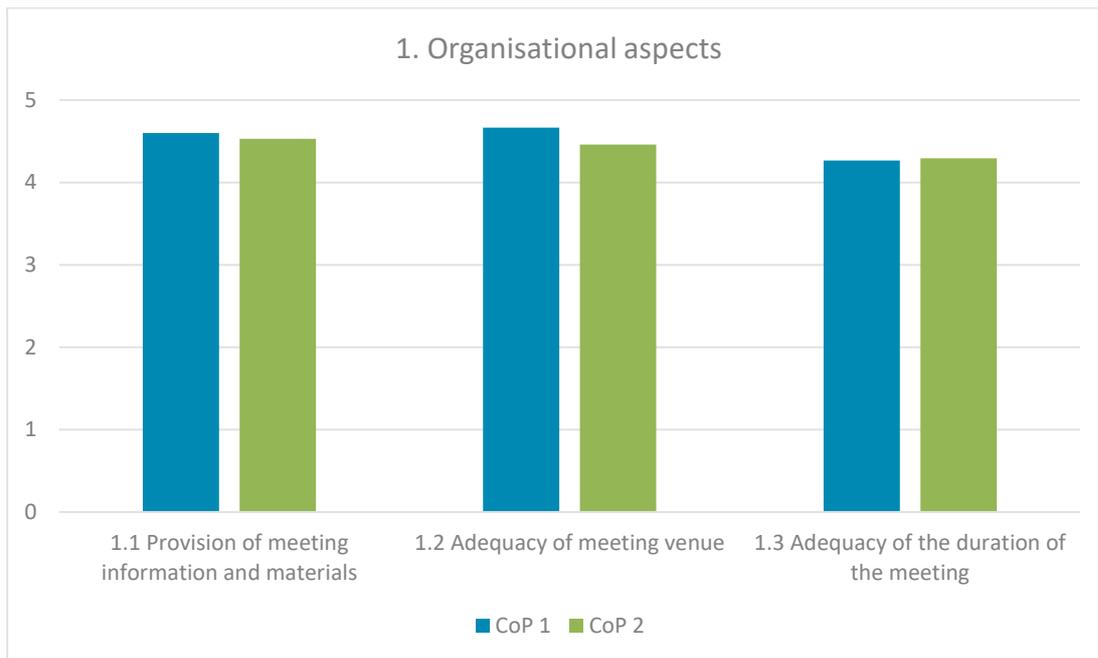
*Figure 34 Meeting logistics and stakeholder engagement: Organisational aspects (CS 4)*
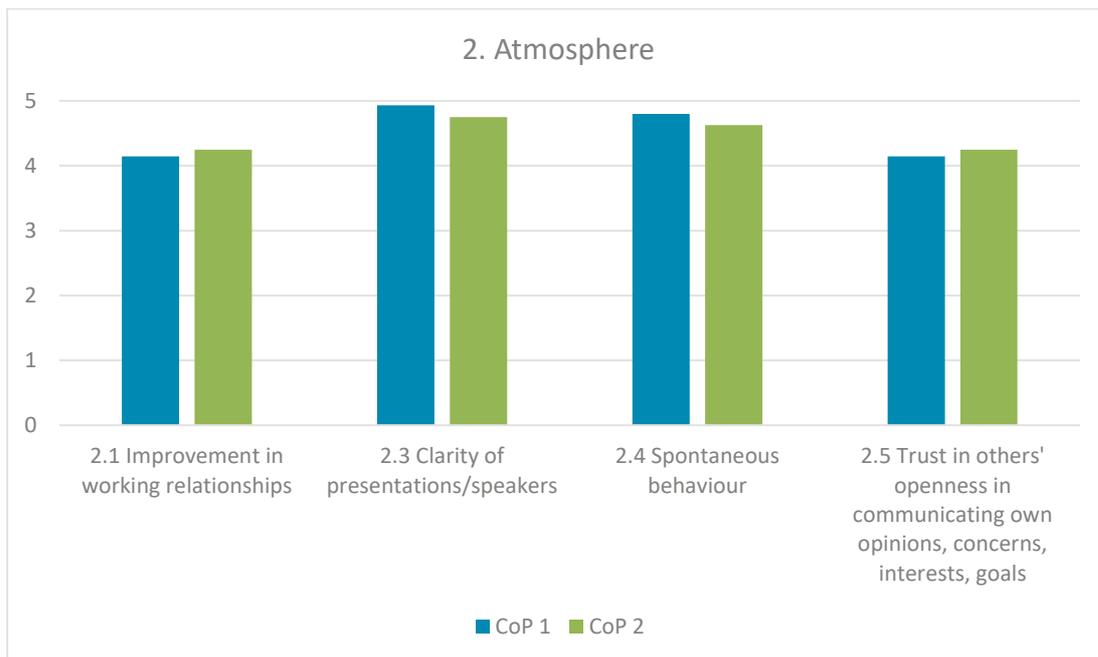


*Figure 35 Meeting logistics and stakeholder engagement: Atmosphere (CS 4)*

*Figure 36 Awareness and increased understanding: Stakeholder inclusion and representation (CS 4)*
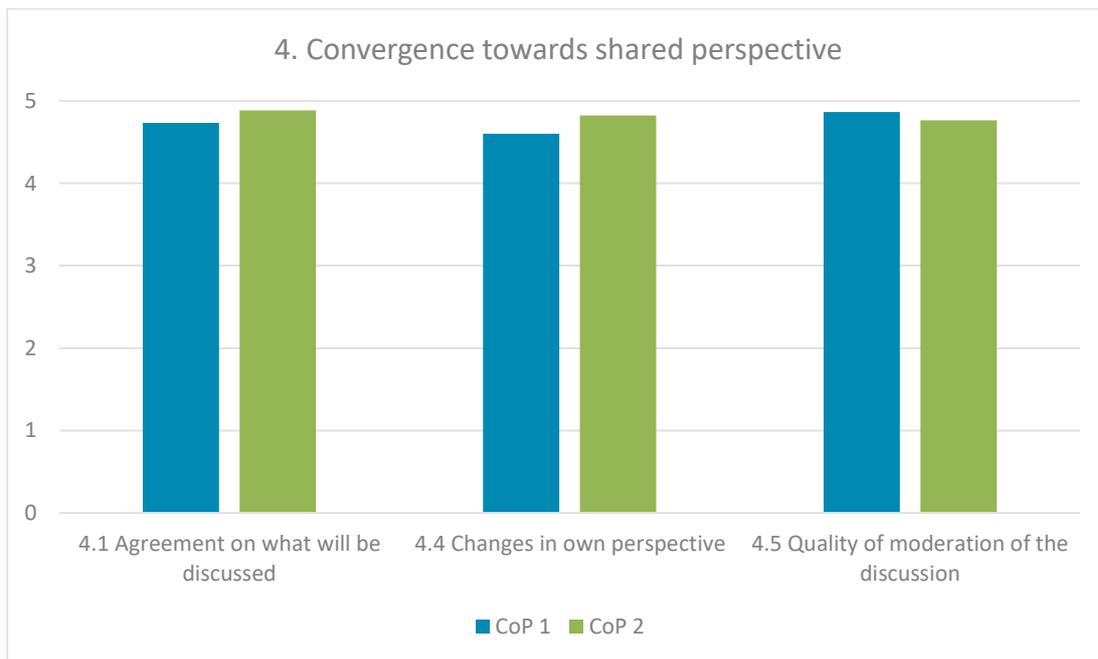


*Figure 37 Awareness and increased understanding: Convergence towards shared perspective (CS 4)*
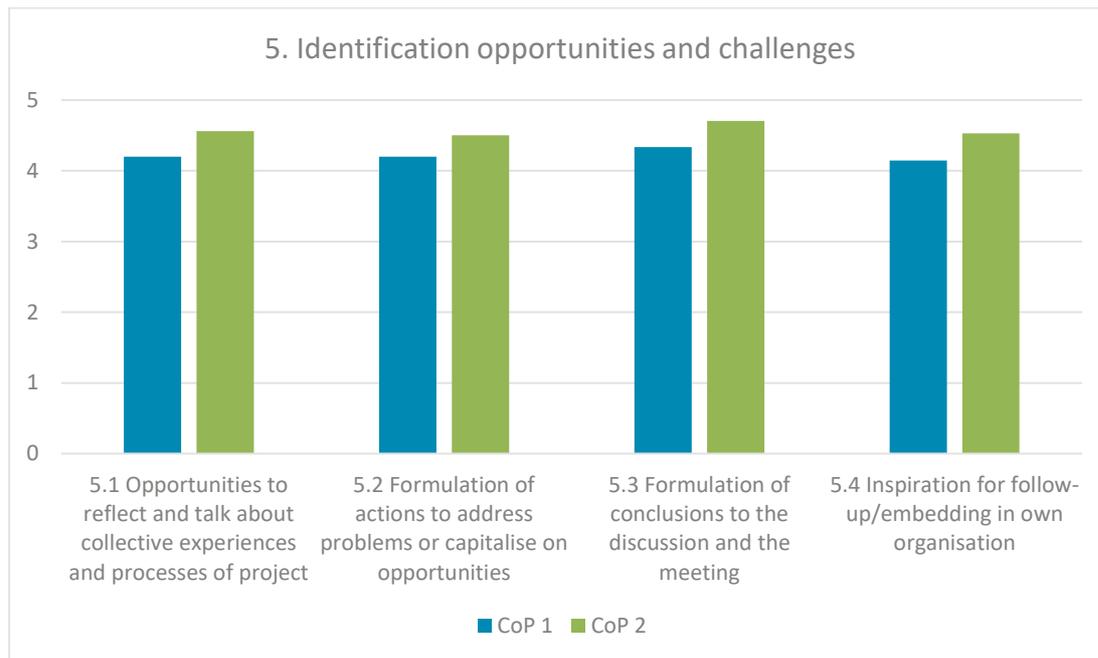
*Figure 38 Outcomes and conclusions: Identification opportunities and challenges (CS 4)*
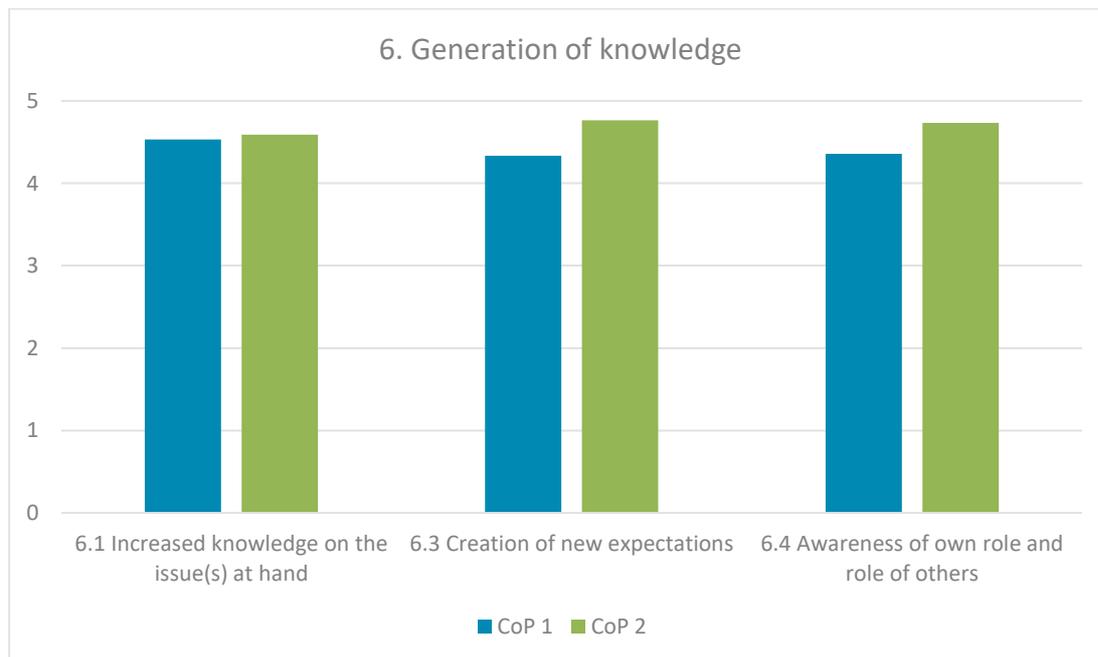


*Figure 39 Outcomes and conclusions: Generation of knowledge (CS 4)*

# 7.6. Case study 5 - Lleida, Spain

## 7.6.1.Context

Located in Lleida (Spain), CS 5 focusses on the relationship between the Mahou San Miguel (MSM) brewery, a multinational utility Aqualia, the local municipal utility of

Lleida and the Catalan Water Agency (ACA). CS 5 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.

To achieve circularity the current symbiosis between the parties involved need to produce water for industrial reuse. This should reduce the consumption of fresh water for industrial uses. To this purpose, wastewater from the brewery is envisaged to be used for cooling towers, anaerobic treatment methods will be applied to recover green energy in biogas, nutrients will be recovered from treated wastewater to produce fertiliser, and a solid oxide fuel cell fed with biogas will be used to create electricity as well as heat.

## 7.6.2. Community of Practice meeting(s)

There has been one (1) CoP meeting prepared and implemented with stakeholders in CS 5, with a second meeting to take place towards the end of November.

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 ULTIMATE and the relevant activities for CS 5, 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 CS 5. 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 CS 5. As such the distribution of a simple 'newsletter' with project updates will be implemented. Furthermore, CS 5 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.

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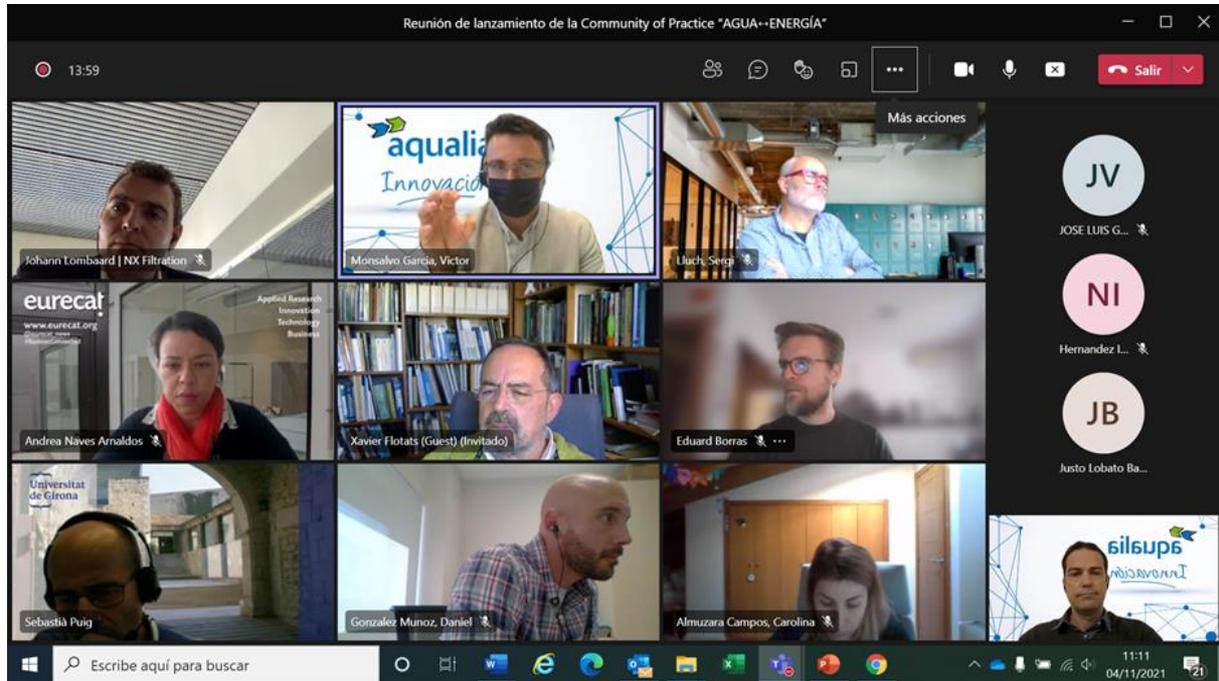


*Figure 40 1st online CoP meeting in CS 5*

### 7.6.3. Stakeholder experience and learning

Stakeholders participating in the CoP meeting found the CoP 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 exposure for demonstration projects.

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. This, for them, also means discussing both barriers and opportunities for market replication and implementation.

The following figures provide the average scores across the KSFs.
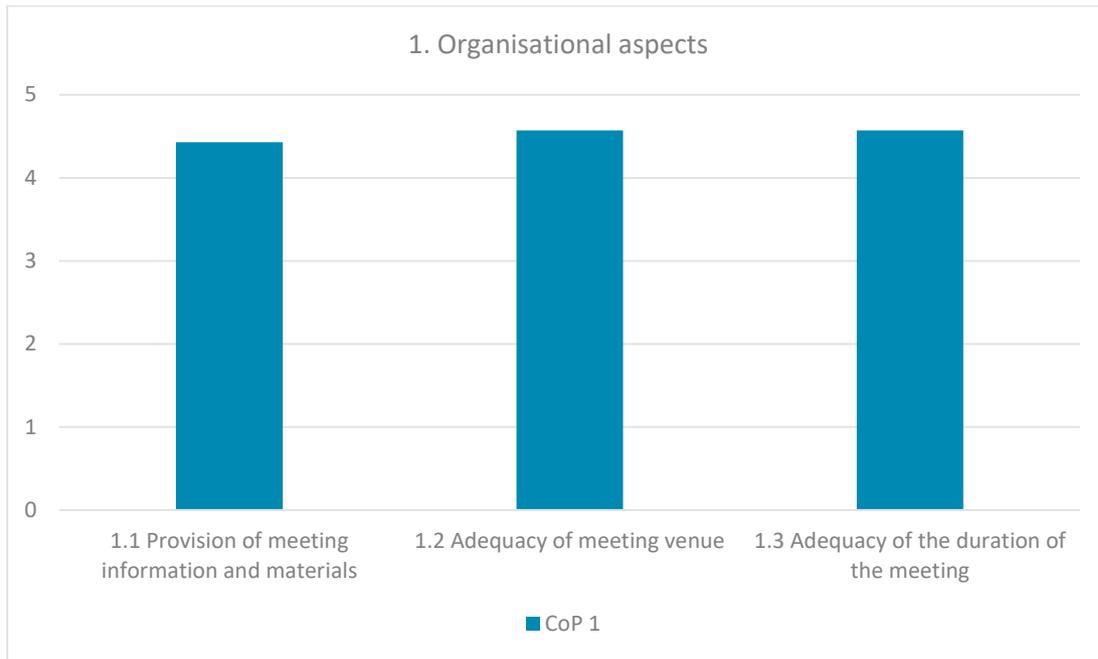
*Figure 41 Meeting logistics and stakeholder engagement: Organisational aspects (CS 5)*
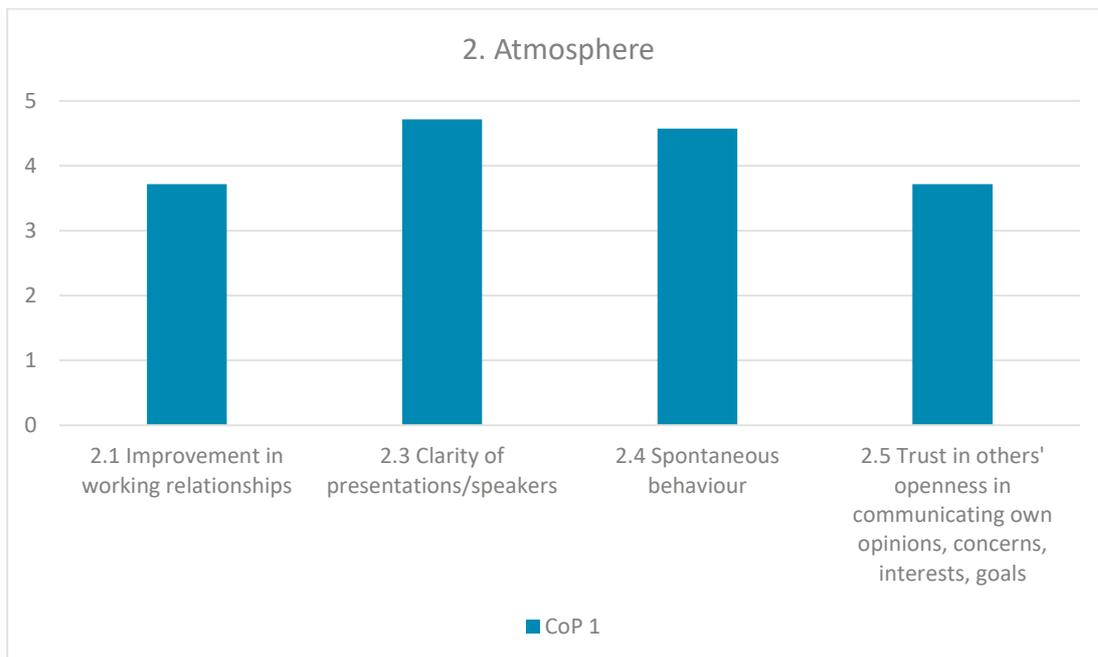


*Figure 42 Meeting logistics and stakeholder engagement: Atmosphere (CS 5)*
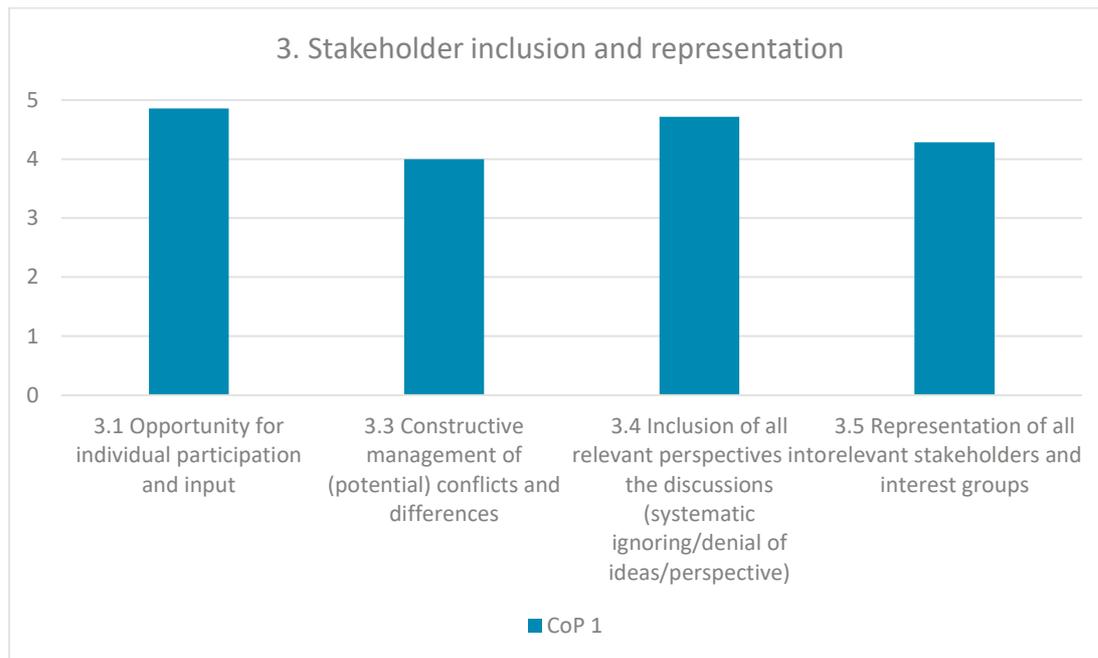
*Figure 43 Awareness and increased understanding: Stakeholder inclusion and representation (CS 5)*
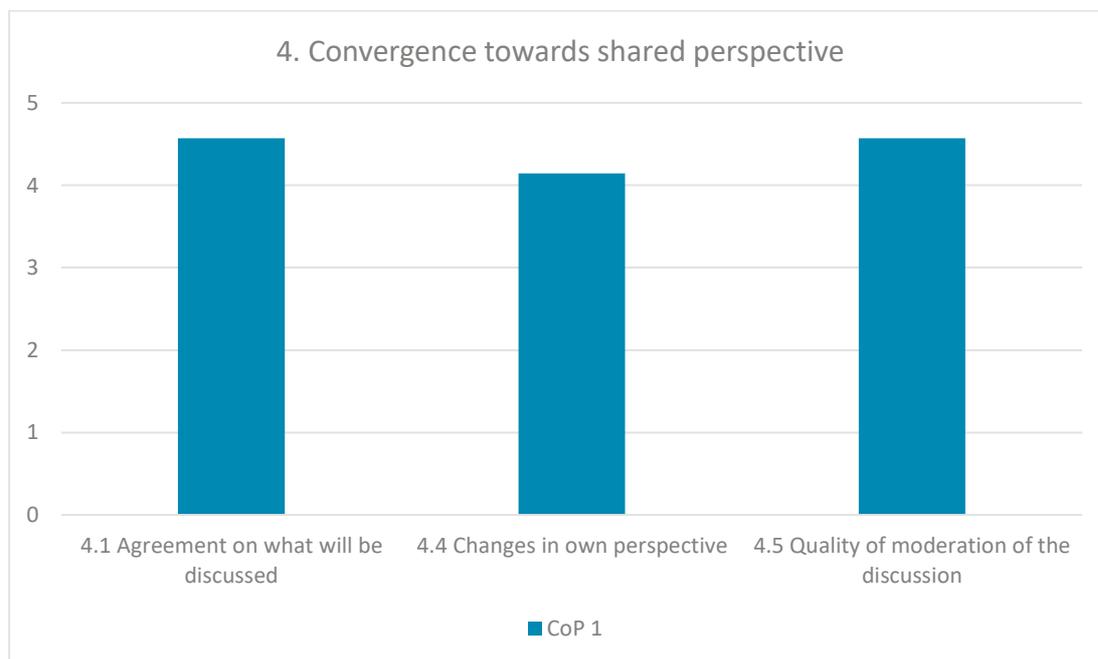


*Figure 44 Awareness and increased understanding: Convergence towards shared perspective (CS 5)*
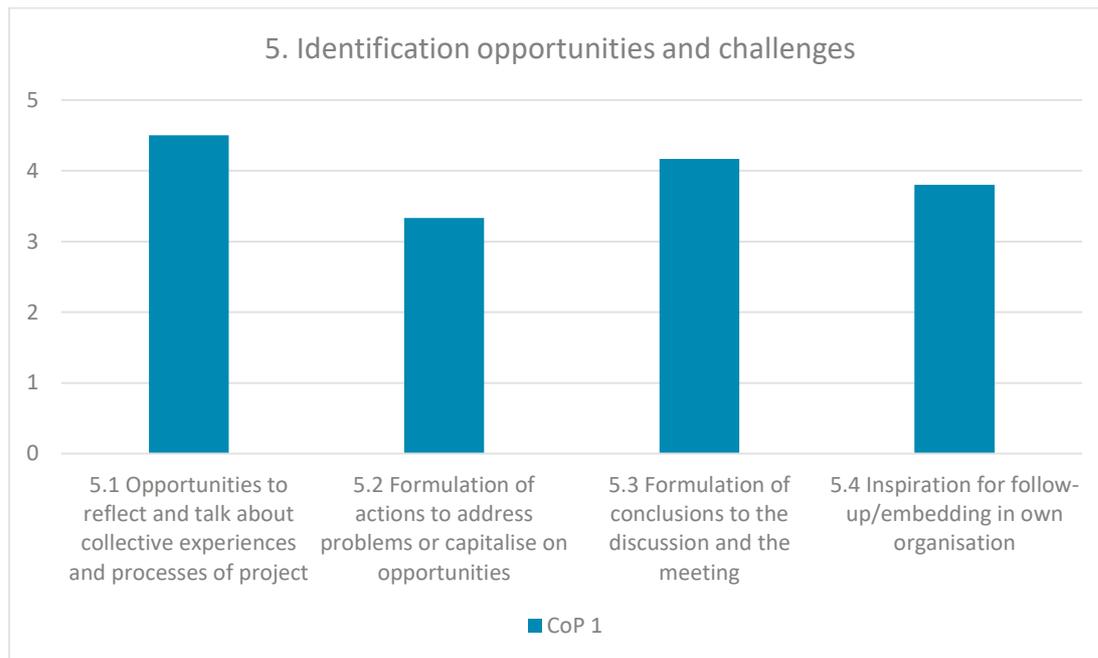
*Figure 45 Outcomes and conclusions: Identification opportunities and challenges (CS 5)*
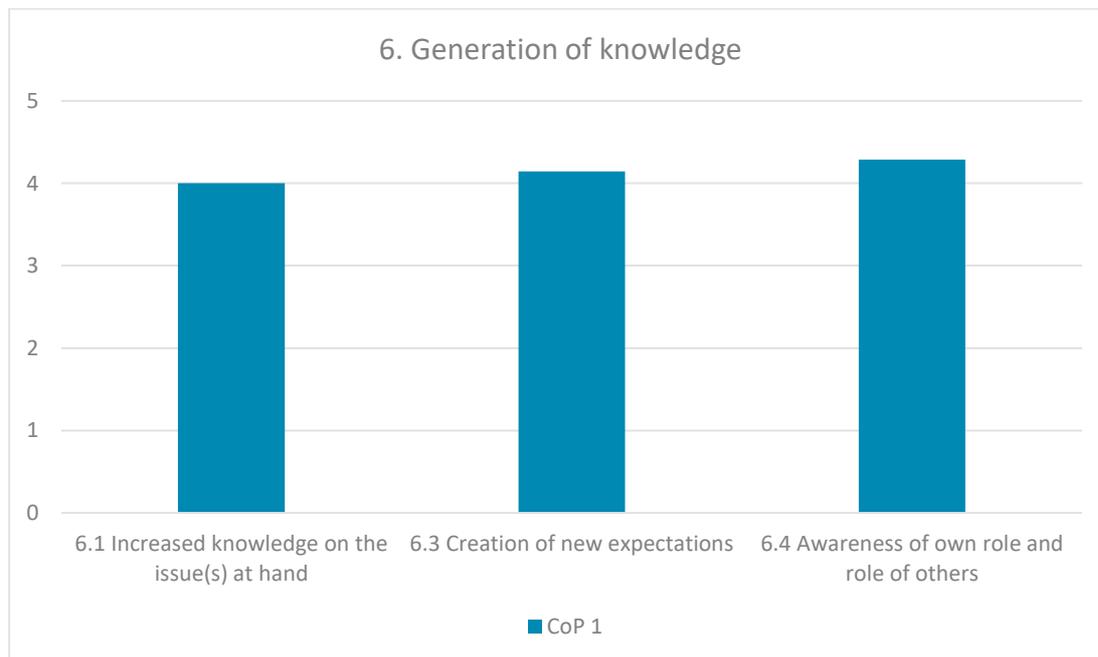


*Figure 46 Outcomes and conclusions: Generation of knowledge (CS 5)*

CS 5 partners summarised the different viewpoints of several stakeholder groups in the CoP as follows. The academic sector has very clear ideas about the needs and the challenges associated with the implementation of technical solutions in the water sector. The discussion focussed on the existing challenges and the narrow perception of the end-users around the real cost of innovation. Similarly to the academic

stakeholders, the suppliers who aim to spread their technologies and innovations in the market, feel that there are still many challenges to overcome for the implementation of innovative technologies, and in particular to show the benefits of the different solutions. Pilot plants are expensive and slow and do not always show effectively the potential of the technology. Costs (CAPEX) seem to be a dominant issue, even where low OPEX technologies are proposed. End-users, such as Aqualia, MSM and ACA, have a pragmatic view and provided clear insights about the knowledge needs. Technological maturity is an issue of concern for them too. The CoP recognised the need to also get the insights from the agro-food industry, which would require identifying the relevant stakeholders to engage in the CoP.

Understanding the perception of different stakeholder groups was a first important step to facilitate engagement and dialogue between stakeholders in order to work towards a common objective, and to improve the experience and learning among the CoP stakeholders. The CoP also agreed that depending on the topic of future meetings, good consideration should be put on who to invite to ensure productive discussions.

Finally, CS partners also observed stakeholders to be relaxed and comfortable, willing to fully immerse themselves in the CoP process. They appreciated the stakeholders suggesting approaches to stay informed on progress in ULTIMATE (e.g., a newsletter or something similar), and indicating their interest in seeing results from pilots in operation.

# 7.7. Case study 6 - Karmiel and Shafdan, Israel

## 7.7.1. Context

Located in both Karmiel and Shafdan (Israel), CS 6 will work to improve and increase the capabilities of the urban WWTP of Mekorot (the national water company), and make it fit to receive agro-industrial effluents. Mekorot provides diverse types of water related services including urban and industrial WWT.

The focus areas revolves mostly around the agro-industrial sector including agriculture, food industry, olive oil mills and water treatment. To shelter the WWTPs of Karmiel and Shafdan from sudden shocks deriving from agro-industrial wastewater and at the same time allow recovery of high added value products like polyphenols, the symbiotic relationship between the small and medium-sized enterprises (SMEs) and the public wastewater utility needs to be expanded.

## 7.7.2. Community of Practice meeting(s)

One (1) CoP meeting has been prepared and implemented with stakeholders in CS 6. A second CoP meeting is scheduled for March 2023. The CS 6 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 is to have data from the two pilots latest February 2023 and to share it with the CoP stakeholders in March.

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.

The CoP meetings aim to offer a platform for end-users, water industries, generators of agro-industrial waste, regulators, engineers and others to exchange ideas, share knowledge and discuss the steps for successful design and implementation of water-related technologies and innovations to address waste disposal from the agro-industry sector.

Despite different stakeholder groups were represented, CS 6 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 CS 6 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 CS 6 on the acceptance, regulatory barriers and technology/solutions to enable water reuse by industry are presented in Annex F.6.



*Figure 47 Stakeholders of the 1st hybrid CoP meeting in CS 6*

*Figure 48 1st hybrid CoP meeting in CS 6*

### 7.7.3. Stakeholder experience and learning

Despite the missing stakeholders, which resulted in a low score on the stakeholders inclusion and representation (see figure 51), input from the evaluation of the first CoP meeting showed that stakeholders found the CoP meeting to be very valuable. Future CoP meetings should focus on engaging all relevant stakeholders groups to ensure the right discussions are stimulated and actions agreed and taken with all stakeholders.

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.
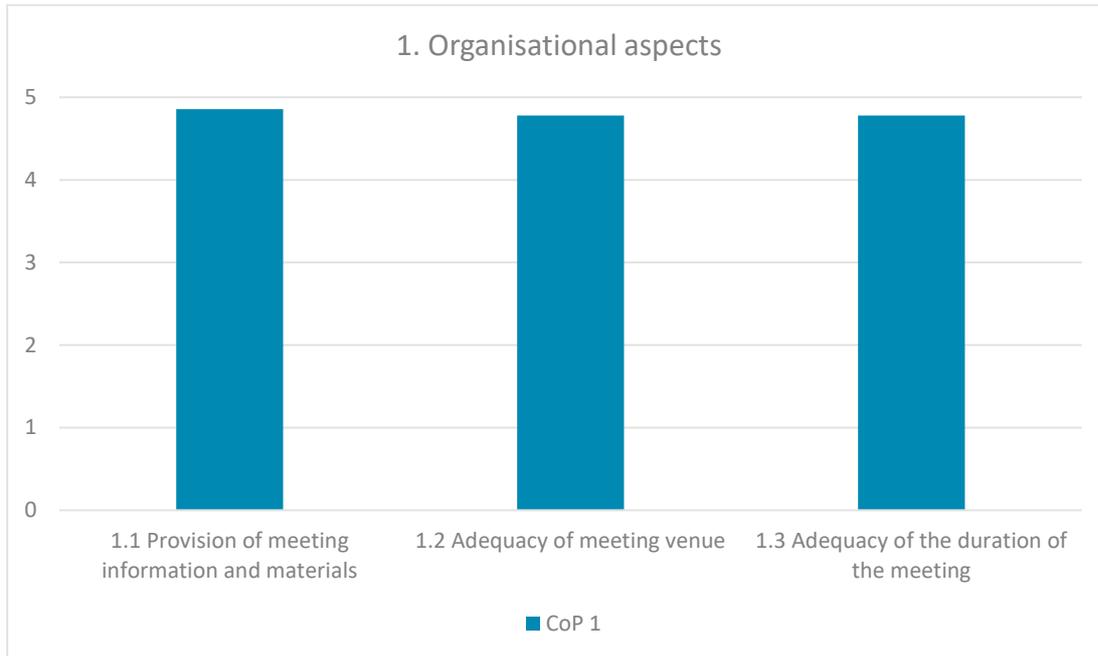
*Figure 49 Meeting logistics and stakeholder engagement: Organisational aspects (CS 6)*
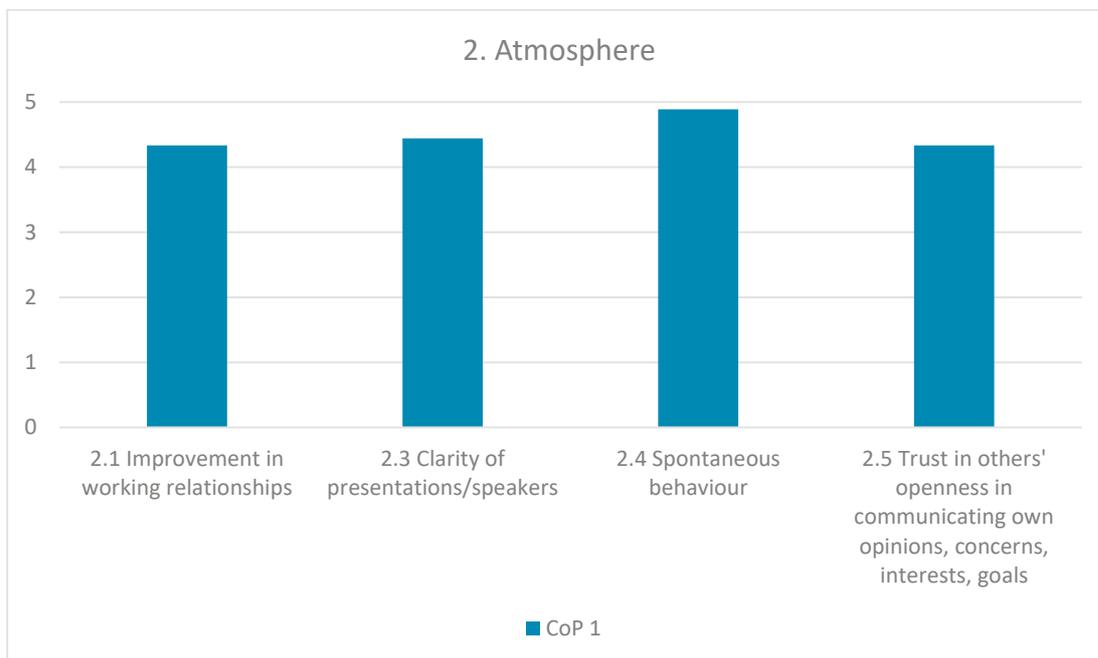


*Figure 50 Meeting logistics and stakeholder engagement: Atmosphere (CS 6)*
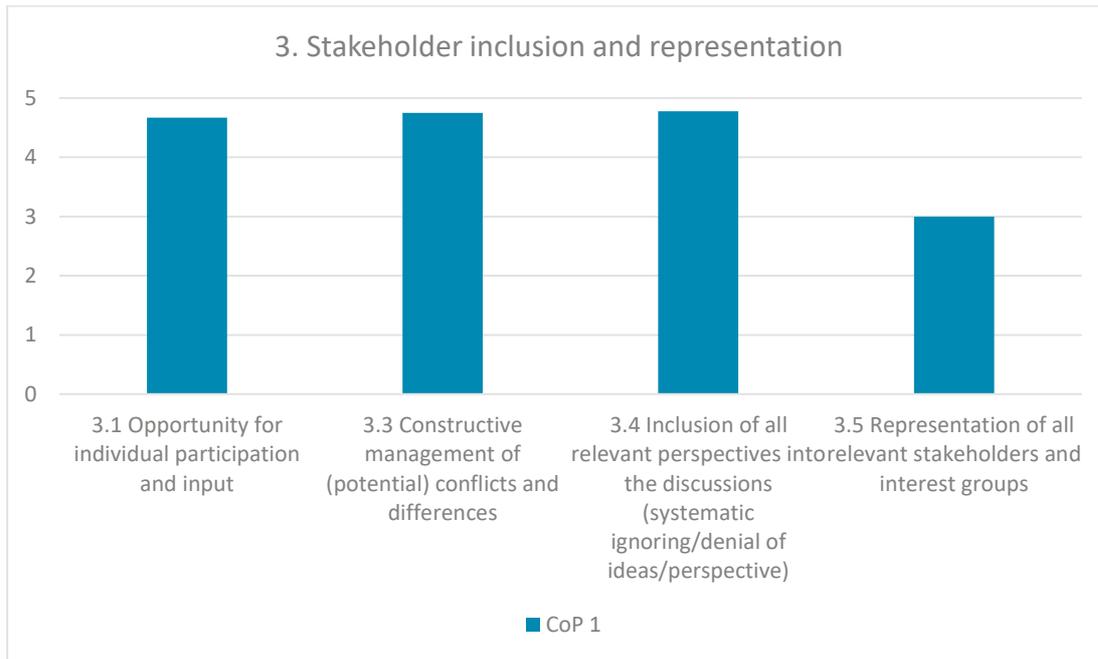
*Figure 51 Awareness and increased understanding: Stakeholder inclusion and representation (CS 6)*
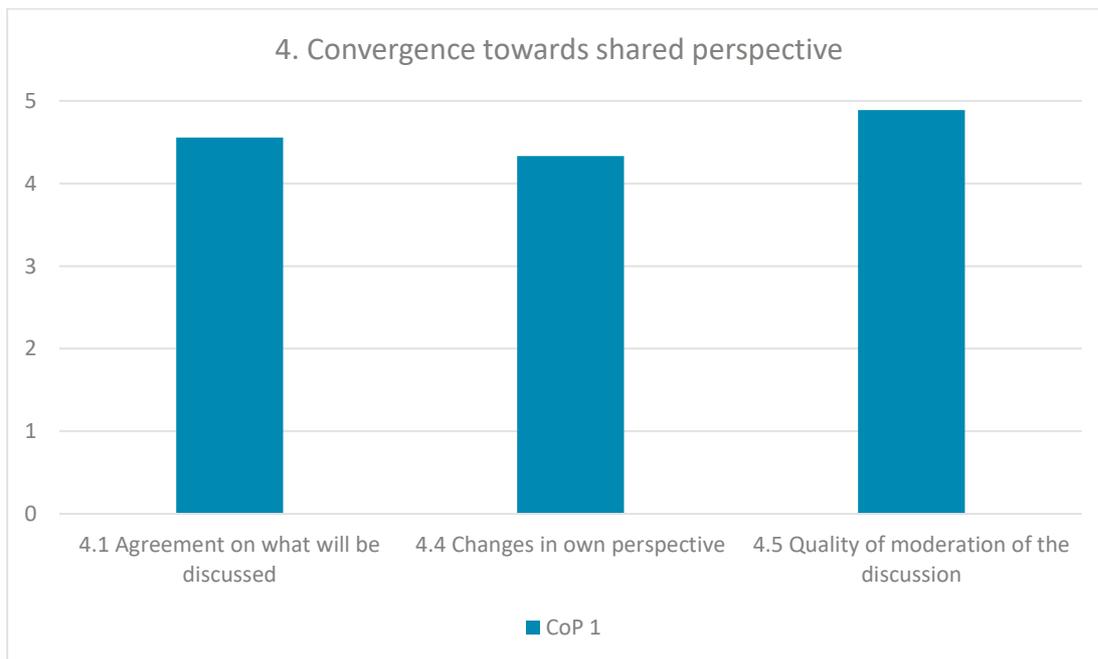


*Figure 52 Awareness and increased understanding: Convergence towards shared perspective (CS 6)*
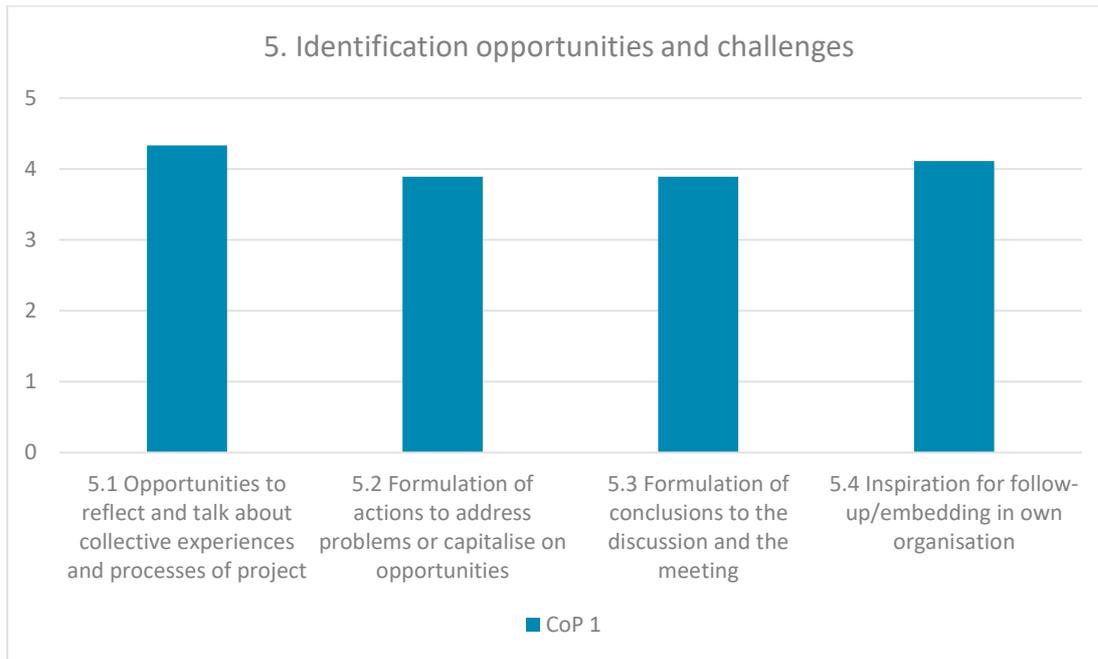
*Figure 53 Outcomes and conclusions: Identification opportunities and challenges (CS 6)*
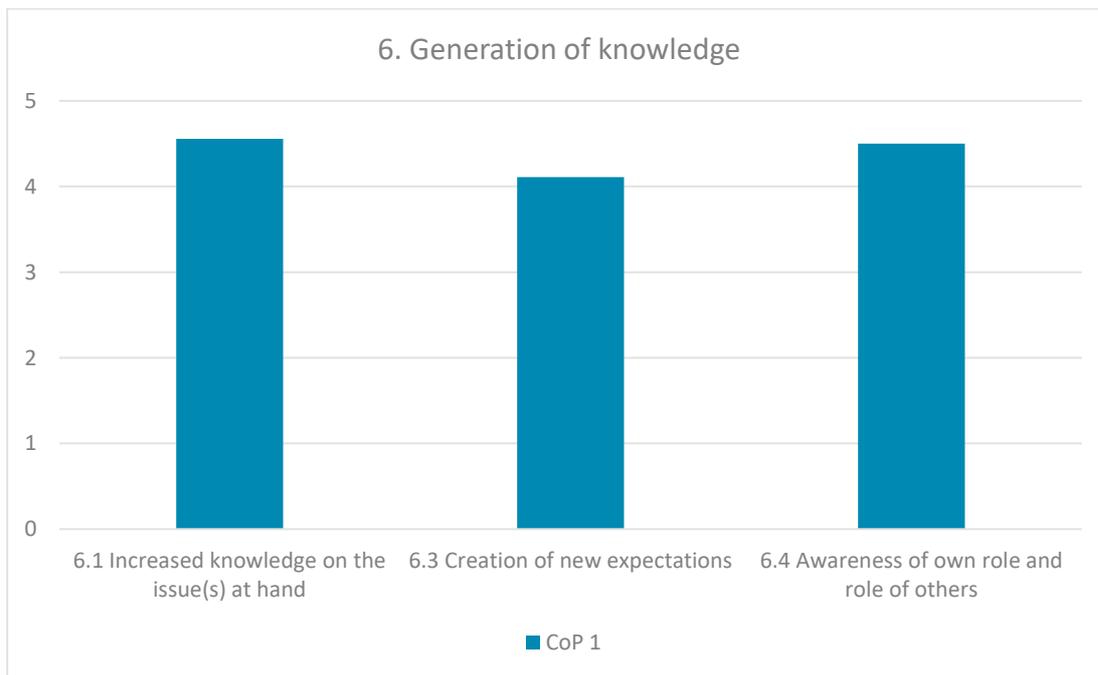


*Figure 54 Outcomes and conclusions: Generation of knowledge (CS 6)*

## 7.8. Case study 7 - Tain, Scotland

### 7.8.1. Context

Located in Tain (Scotland), CS 7 activities contribute to an improved circularity of the WWT process of the Grenmorangie whiskey distillery (the industrial stakeholder in the project). Aquabio 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, 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.

### 7.8.2. CoP meeting(s)

No CoP meetings have been held in CS 7 so far, despite preparations for a CoP meeting on 7 October 2021 took place. Due to delays in designing the demonstration system, CS 7 had to cancel the CoP meeting in 2021 and prioritise the technical work in order to have all necessary part to build and commission the system before the turn of the new 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. CS 7 has been engaging in bilateral conversations with relevant stakeholders to secure their engagement in the CoP before setting the date of the CoP meeting. However, more recently, new challenges have led to interrupting the communication between the project partners and the distillery, which has affected the ability to plan a CoP meeting. The ULTIMATE CS 7 partners are currently working to re-establish the communication with the onsite partners to implement the first CoP meeting while maintain the establishing link with the already engaged stakeholders. While there is no minimum project requirements for the set up and implementation of CoPs, WP3 will continue to closely monitor and support CS 7 to ensure that locally relevant stakeholders are engaged within the framework of ULTIMATE.

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

### 7.8.3. Stakeholder experience and learning

As there has been no CoP meeting with stakeholders in CS 7, there is no reflection from stakeholders to be shared at this point in time.

## 7.9. Case study 8 - St. Maurice L'Exil, France

### 7.9.1. Context

Located in Saint Maurice l'Exil (France), CS 8 focuses on the Roches-Roussillon chemical platform. The platform, which engages 15 chemical companies, operates an incineration facility for hazardous and non-hazardous liquid waste. Additionally, there is a biomass recovery unit that provides 15% of the steam requirement of the chemical industries.

The CS aims to reduce the pollutant load in flue gas cleaning water of the incineration facility. The water is sent to a WWTP on site. The CS will work towards the improvement of the environmental footprint, including improving the operation of the industrial WWTP by recovering metals, sulphates, and gypsum, as well as thermal energy from the liquid waste. Furthermore, advanced data-driven techniques will be integrated in real-time monitoring of WWTP for automatic diagnosis, predictive analysis, and intelligent alarms.

### 7.9.2. Community of Practice meeting(s)

One (1) CoP meeting was prepared and implemented on 1 December 2021 with stakeholders in CS 8. 14 participants took part in the first CoP 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 CS 8 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. CS 8 partners recognised the need for face-to-face meetings as well as the need to set more targeted agenda topics.

### 7.9.3. 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 CS 8, the improve working relationship between stakeholders scored low (see figure 56), 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.
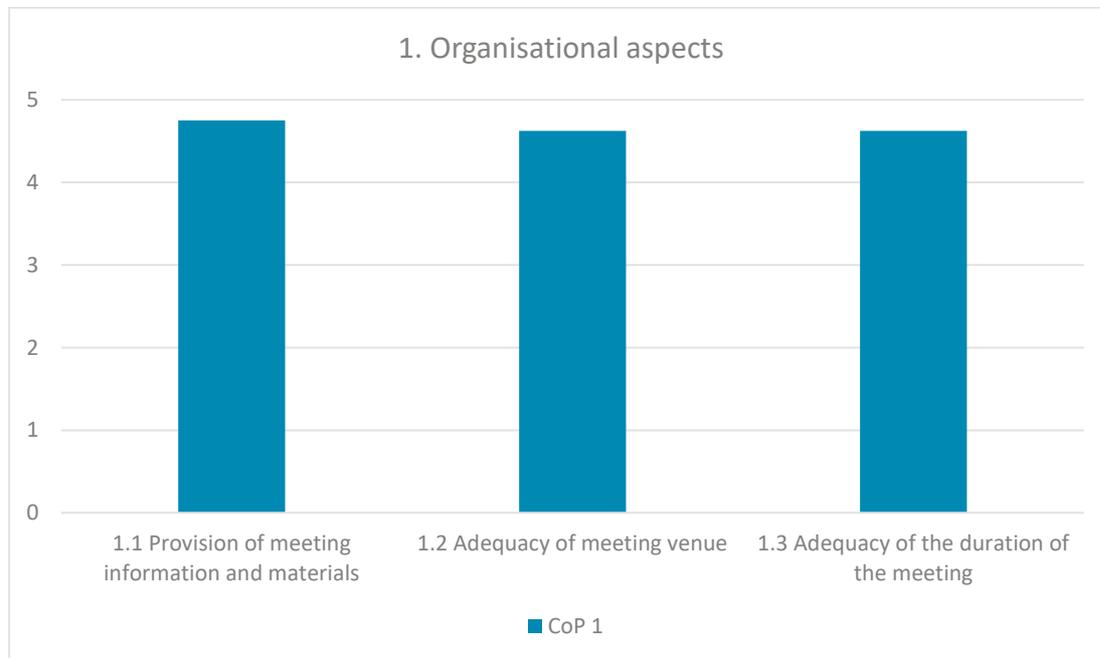


*Figure 55 Meeting logistics and stakeholder engagement: Organisational aspects (CS 8)*
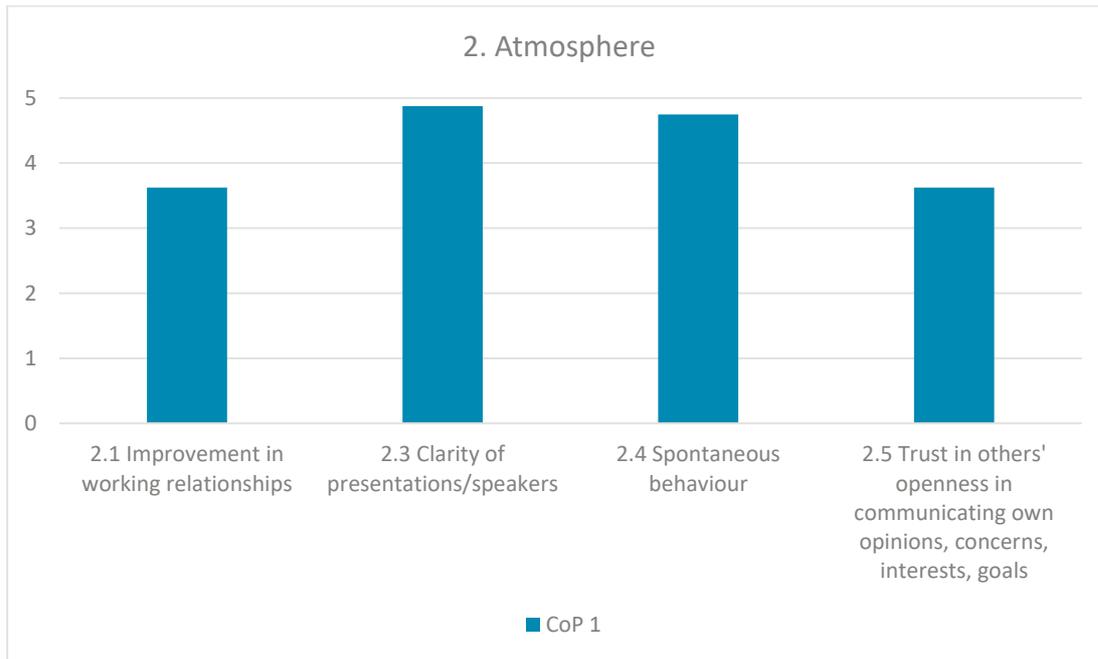
*Figure 56 Meeting logistics and stakeholder engagement: Atmosphere (CS 8)*
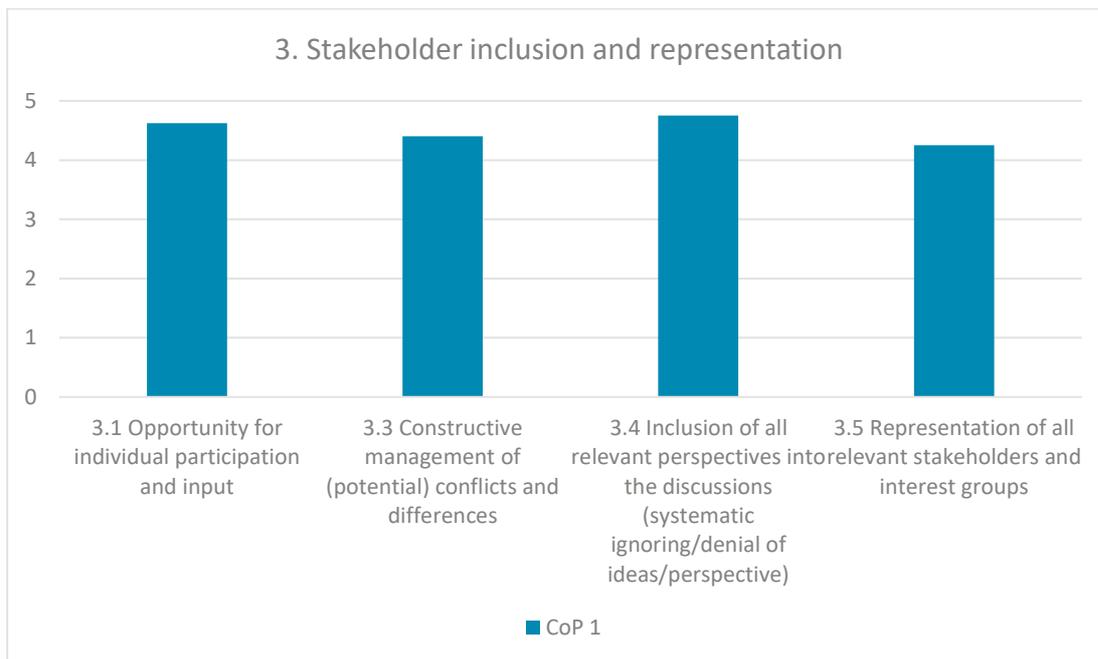


*Figure 57 Awareness and increased understanding: Stakeholder inclusion and representation (CS 8)*
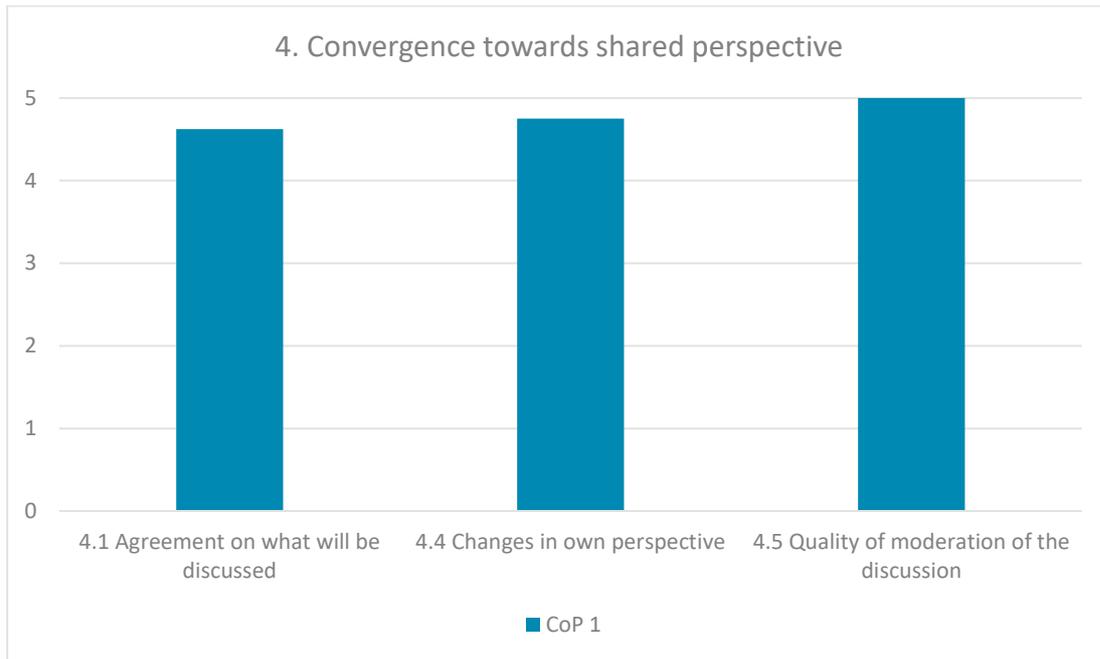
*Figure 58 Awareness and increased understanding: Convergence towards shared perspective (CS 8)*
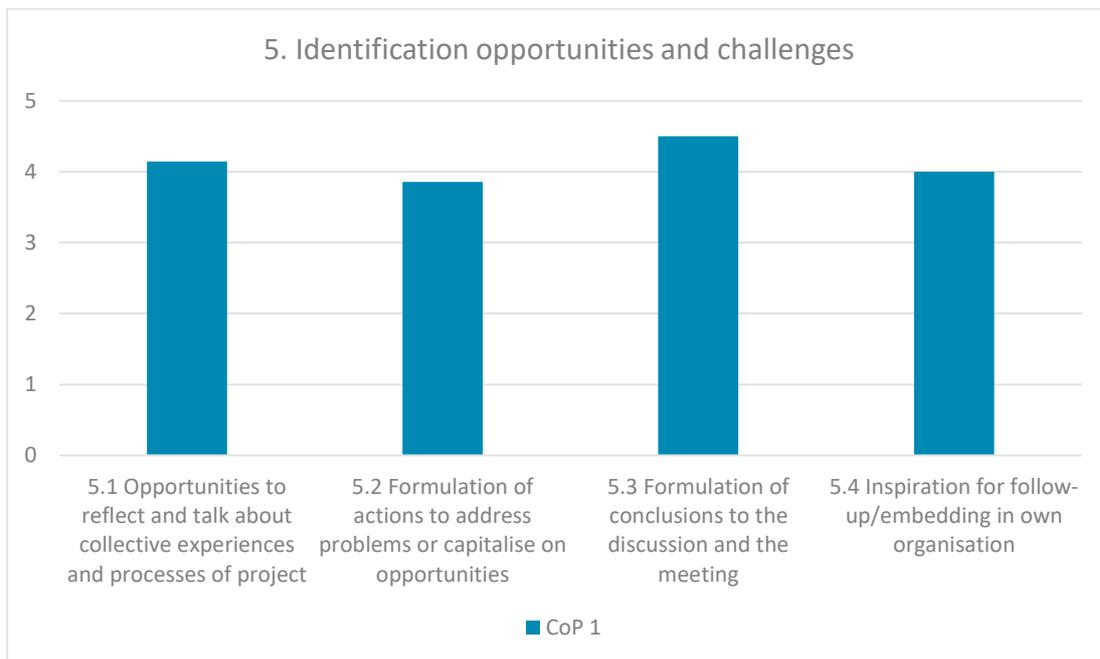


*Figure 59 Outcomes and conclusions: Identification opportunities and challenges (CS 8)*
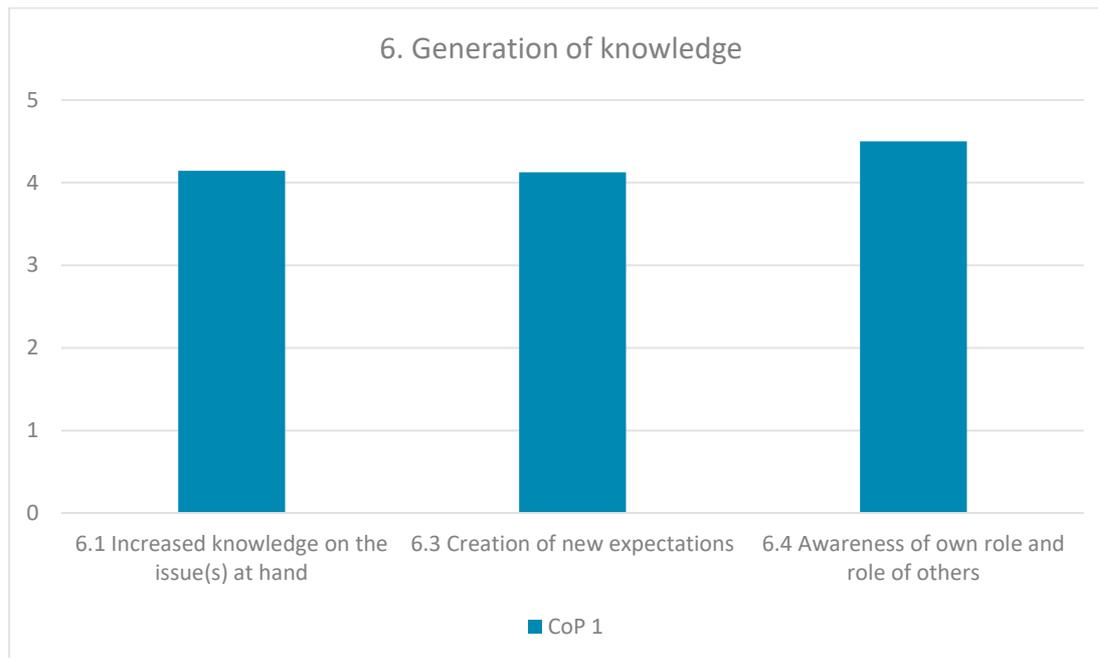
*Figure 60 Outcomes and conclusions: Generation of knowledge (CS 8)*

## 7.10.  Case study 9 - Kalundborg, Denmark

### 7.10.1.  Context

Located in Kalundborg (Denmark), CS 9 focuses on the KSA that connects the public and private sector. 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 Kalundborg Industrial Symbiosis (IS) already recovers and reuses different types of material, water and energy, there are opportunities to further improve towards a full circular system. Aspects that can be improved include energy efficiency, reduction of chemical consumption and wastewater treatment for water reuse by industries in the symbiosis. Wastewater treatment is currently done by two companies in the symbiosis, Novozymes and Kalundborg Forsyning (the latter is the municipal WWTP). The main difficulty faced with wastewater reuse in the production processes of the food, pharma and biotech industries are related to the Danish and European laws.

Accordingly, CS 9 has two main goals: 1) to expand the internal cooperation of the KSA to stimulate an increase in energy efficiency of plant operation and reducing chemical consumption. This would be achieved by locating future users of the produced water, the recovered heat, and the recycled material in close proximity to one another and design their installation for the exchange of water, energy and materials; 2) to investigate solutions for wastewater treatment of the effluents from the industrial and municipal WWTPs to a quality that allows reuse for cooling and steam

production, cleaning and flushing purposes and explore the potential of wastewater reuse by the Kalundborg industries.

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 CS 1) to replicate in Kalundborg relevant wastewater treatment schemes and circular approaches already in operation.

## 7.10.2. Community of Practice meeting(s), stakeholder experience and learning

In Kalundborg, the establishment of a CoP was different than in the other CSs. This is because an existing symbiotic ecosystem has existed in Kalundborg for over 60 years, with some 32 to 34 bilateral agreements established between public and private companies and an active and fruitful stakeholder engagement process and community operating for decades, the KSA (see section 7.10.3 for in depth discussion). It was therefore decided to not establish a new stakeholder engagement group that might disrupt the existing well-functioning ecosystem, but rather discuss the ULTIMATE project topics in the context of the existing KSA and its working groups. The KSA and related groups are therefore considered the CoP for CS 9.

The CoP meetings discussion 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. The discussion of these two topics will continue in the context of the ULTIMATE project. Insights from CS 9 on the acceptance, regulatory barriers, and technology/solutions to enable water reuse by industry are presented in Annex F.9.

## 7.10.3. The experience of the Kalundborg (case study 9) symbiosis on 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 CS 9 and who is leading the ULTIMATE stakeholders discussion in the KSA. The information collected with this interview and here below summarized will be integrated with interviews with stakeholders from the Kalundborg symbiosis in the update of this report (due by the end of the project).

In 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

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 numerous 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 a local partnership, partners are able to share and reuse resources, saving both money and minimising waste (see figure 61).
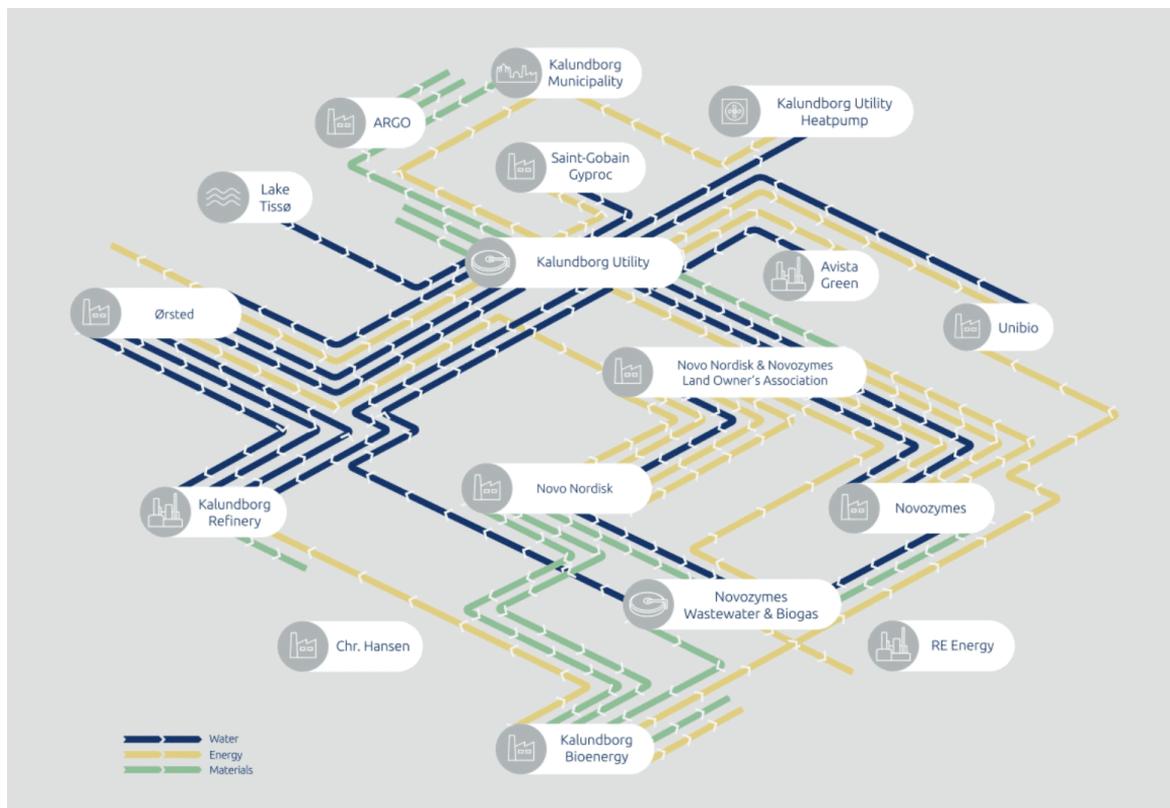


*Figure 61 Material flows within the Kalundborg Symbiosis in which companies exchange water, energy and materials*

The KSA is a 60 years old year arrangement that took time to mould into the symbiosis of today, currently consisting of 32-34 bilateral agreements between companies. Over the 60 years, the organisational framework has changed. Until few years ago, there was no formal organisational structure in place for the industrial symbiosis. Instead, the engagement between companies was facilitated by a Danish NGO (voluntary organisation) bringing together between eight (8) and ten (10) company directors around a non-legal statute (something like an informal board of directors).

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.

About four (4) years ago, 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 for the symbiosis to be more sustainable. His goal was to build a sustainable community of industries with Novo Nordisk leading the process. This change would not disrupt the basic arrangements around the exchange of water, energy and materials achieved through the bilateral agreements. Instead, it was meant to build a more structured process to continue the discussions already taking place in the assembly of 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, four (4) years ago, of the KSA as a legal entity registered at the chamber of commerce and with capacity to operate on behalf of the associated companies. Currently, the KSA has a small (4 people), independent secretariat that carries out specific activities as per the agenda agreed in the meetings of the now institutionalized board of directors. The secretariat, hosted by the municipality, is now independent, funded partly by the participating industries 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 set up a number of permanent groups to deal with strategic

matters and issues related to for example new technologies. These groups, under the direction of the secretariat, meet regularly and often with strategic managers of industries and technical staff participating, depending on the topic of the discussion.

## ULTIMATE within the framework of the Kalundborg symbiosis

The ambition of the ULTIMATE project is to establish a CoP in each CS. This is expected in the Grant Agreement (GA). Accordingly, the responsible project partner (KWR) initiated the process with the CS 9 partners. However, given the history of the KSA, the initial attempt was not successful and actually risked to jeopardize the existing collaborations in the symbiosis. The attempt of Kalundborg Forsyning to establish a new stakeholder group in parallel to the KSA was perceived as the company trying to take over control, raised a number of questions in the KSA and created unnecessary tensions, lengthy discussions and reluctance of stakeholders to engage. It soon became clear that the CoP approach would not work in Kalundborg. Therefore, it was decided to engage with the KSA to leverage the existing relationships and collaboration to achieve the goals of the ULTIMATE project for Kalundborg.

To secure engagement a number of issues 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. However, it was clear that such a commitment should occur in the form of bilateral agreements, to remain aligned with the symbiosis approach and that no multi-industry agreements were to be sought. Furthermore, directly talking about wastewater reuse was clearly not an option as wastewater reuse is a sensitive issue 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.

Accordingly, first common ground among different companies in the symbiosis was sought around their 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 found, the discussion about ULTIMATE was focussed on learning from other ULTIMATE case studies experiences about technologies and circular approaches to address the water supply challenges. This approach made it easier to engage with the KSA and the industries because of their interest and long lasting experience of exchanging on technologies and learned lessons 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 usual symbiosis approach. For example, in the context of ULTIMATE, Kalundborg Forsyning and the Kalundborg refinery are currently exploring the supply of reclaimed water during a drought situation to ensure the refinery would not need to shut down due to lack of water. 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 is meant to function as a platform for sharing new concepts and technologies around water reuse for the future development of Kalundborg.

Currently, Kalundborg Forsyning runs a CoP meeting every second month with interested symbiosis partners, universities, and political representatives, as well as those with an interest in new water treatment technologies. The agenda is set by CS 9 partners (KWB, Pentair, Kalundborg Forsyning and Novozymes) for a one 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 though 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 WP 5 on replicability of the ULTIMATE solutions. Furthermore, engaging with ULTIMATE connects Kalundborg with an 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
In sum, the establishment of the KSA and its working groups is a story of long lasting self-organized, 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.

# 8. Lessons learned and way forward

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.

## 8.1. Co-creation exercises

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.

## 8.2. 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).

It is important to remember that CoPs are made of people. As a result, people need to experience, for example, a sense of belonging, respect, diversity, flexibility, motivation, and trust. This can help to motivate stakeholders to join, contribute, engage, share, and learn through the CoP. Having well defined objectives and goals gives the CoP a purpose based on a shared vision for the future. Setting these objectives and goals beyond just the context of ULTIMATE can help sustain the relevance of the CoP beyond the lifetime of the project.

CoP roadmaps, when implemented, helped CSs to give structure to the CoP process and a plan for the project lifetime. This in turn may contribute to maintain commitment of stakeholders to the CoP. However, insights across the CSs have shown that a degree of flexibility is required to accommodate different contexts, institutional arrangements and needs. A one-size-fits-all approach is therefore not realistic when it comes to preparing and implementing a CoP.

Documenting the preparation and implementation of the CoP is useful for continued learning and improvement of the CoP. Evaluating the CoP, as such, is not only necessary to measure its success in terms of output, but also to measure its functioning over time in terms of the 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, structures and processes over time that support their success. Despite the importance of the evaluation survey, response rates are not always high across the CSs. This may in part be due to stakeholder fatigue. WP3 recommended CSs to allocate time during the CoP meetings to complete the evaluation survey. However, this is not always done due to usually a very dense CoP meeting agenda. A point for consideration is therefore whether the current evaluation of the CoP can be done differently or complemented with for example interviews with selected CoP stakeholders. The interview approach will be applied in CS 9 to capture the insights of stakeholders in the context of the regular KSA meetings.

Finding the right balance between the project needs and the local circumstances for the operationalisation of the CoPs is necessary. The design and testing of knowledge, technologies, and innovations in ULTIMATE require input from the CSs and the local stakeholders in order to ensure their adoption in practice. For project monitoring and reporting purposes, such demands can be overwhelming and sometimes difficult to understand for stakeholders and CSs. This is for example the case of the CoP monitoring, reporting, and evaluation. Sometimes CS partners and stakeholders find it difficult to understand why this is needed. Within the context of the project, these aspects will be observed to ensure sufficient monitoring, reporting, and evaluation is taking place across the CSs. Based on this, appropriate steps will be discussed and implemented to adjust the monitoring, reporting, and evaluation approach.

Moreover, 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. As a result, sometimes establishing a CoP as a new stakeholder group is not the best solution if similar stakeholder groups already exist. Similarly, conducting a stakeholder evaluation may not be appropriate when internal group dynamics are tense. 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. In this regard, CS 9 provided a clear example of how a good understanding of the existing local conditions was crucial to strategically position the CoP for the benefit of both the stakeholders and the project.

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 encouraged and will continue to remind 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.

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 takes time and a tailored approach whereby a balance between flexibility and structure is needed. Across the CSs, the CoPs have been initiated as a space to facilitate the exchange of information and knowledge. The goal is for them, when locally relevant and appropriate, to eventually develop into a permanent structure such as living labs (see D3.2 for more details) to share best practices and continue to exchange and learn beyond the local context.

# 9. 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 immersive media experiences in multi-use play spaces, CoPs and living labs.

D3.5 provided preliminary insights and results from the implementation of co-creation exercises in CS 2, CS 3 and CS 9 (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). Living labs are not subject of this report because they have not been established yet. Living labs are expected to be the consolidation of some CS CoPs into a permanent structure by the end of the project (see D3.2 for more details).

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.

CS 2, 3 and 9 have successfully implemented parts of their co-creation exercises guided by plays defined in the ULTIMATE playbook (see D3.3). 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.

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. Co-creation will continue to be utilised throughout the project development

process to ensure that the new ideas or solutions generated serve their intended purpose.

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 safe space for learning and exchanging ideas, and discussing problems and solutions with a broad and diverse group of interested parties.

Due to the Covid-19 pandemic, most of the CSs held CoP meetings online. Despite CS partners finding creative and appropriate ways to involve and engage their stakeholders online, there is a general agreement among CSs and stakeholders that face-to-face meetings would be more effective in stimulating knowledge sharing, learning and exchange.

CoPs are an important tool of the ULTIMATE project to support knowledge development, sharing and stakeholder acceptance of symbiosis solutions. As such, all CSs will continue with CoP meetings until the end of the project, in spite being envisaged in the project proposal their ending in M30.

WP3 will continue to collect insights and results from the co-creation exercises and CoPs until the end of the project. Lessons will be drawn and reported in a final deliverable where best practice for stakeholder co-creation and CoP engagement will be discussed for continuous improvement of such practices in future projects.

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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 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? How well can you identify your organisation addressing not just organisational but also community issue at large? | The potential access, sense of belongingness and responsibility to their neighbourhood community was considered across the CSs. |

| | | |
|---|---|---|
| **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?<br><br>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?<br><br>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. |

# Annex B: Roadmap

## B.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

- 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* <br> *Validate with stakeholders the composition of the community and fill any gaps (are we missing any important stakeholder?)* <br> *Co-define with stakeholders short and long-term value and impact of CoP* <br> *Co-define with stakeholders the specific ways the CoP will operate: decision-making procedures, communication strategy 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*<br>*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*<br>*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* |

## 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*<br>*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*<br>2. *Future of CoP/outputs – beyond the project*<br>3. *Other as needed* |
| **Related WP:** | *Indicate which WPs/ Living Labs will add content to this meeting.*<br>*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.
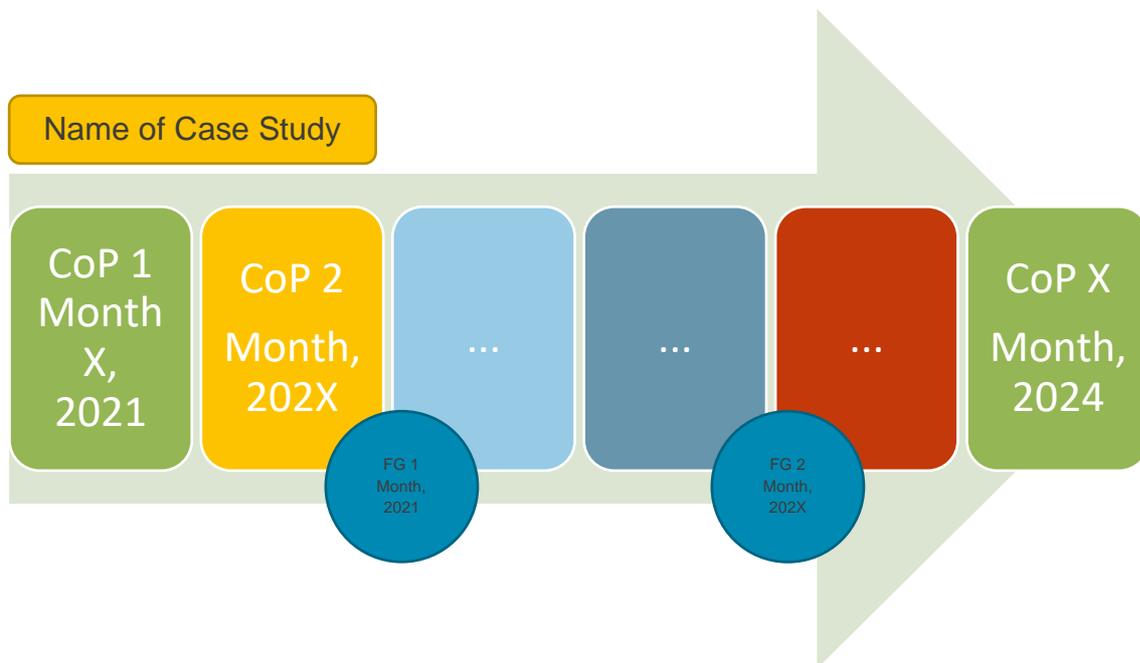
## B.1. Case study Community of Practice meeting roadmap infographics

### Case Study 1 - Tarragona, Spain
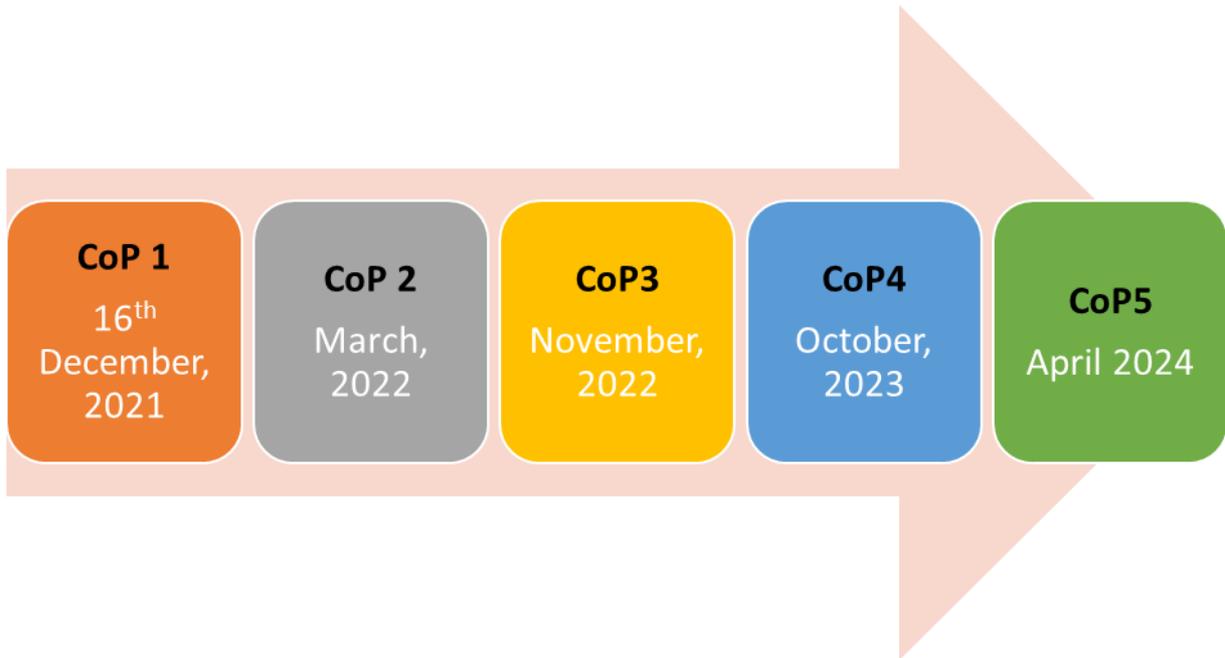
| CoP 1 16th December, 2021 | CoP 2 March, 2022 | CoP3 November, 2022 | CoP4 October, 2023 | CoP5 April 2024 |

### Case Study 3 - Rosignano, Italy

| CoP 1 8th June, 2021 | CoP 2 14th December, 2021 | CoP3 8th June, 2022 | CoP4 14th December, 2022 | CoP5 8th June, 2023 | CoP6 14th December, 2023 |

## Case Study 4 - Nafplio, Greece

**CoP 1** 14th October, 2021 | **CoP 2** 2022 | **CoP3** June, 2022 | **CoP4** December, 2022 | **CoP5** June, 2023 | **CoP6** December, 2023

## Case Study 6 - Karmiel and Shafdan, Israel

CoP 1 Dec 16, 2021 | CoP 2 Sep 2022
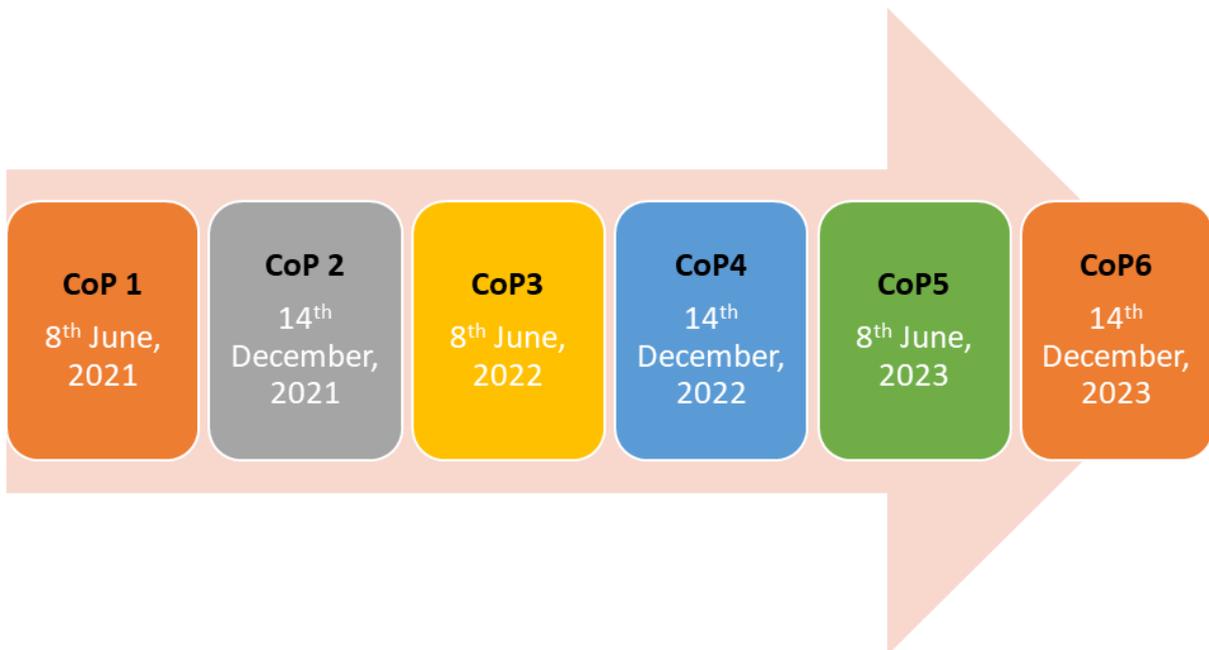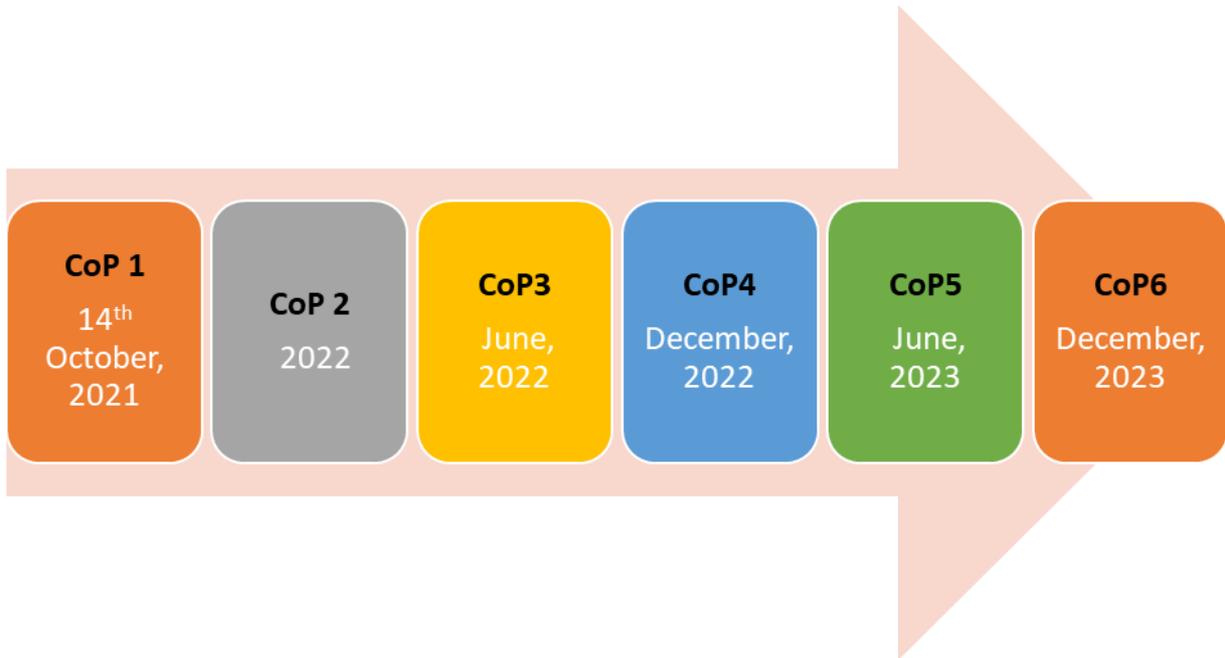
# Annex C: Consent form

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

# Annex D: 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.<br><br>Thank you for your collaboration! |
| 1. Please enter your name (optional) |
| 2. Your organisation  (optional) |
| *3. What was the date of the CoP meeting?<br><br>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)<br><ul><li>I received the information about the meeting and materials well in advance</li><li>The venue was adequate for the purpose of the meeting</li><li>The meeting had the right duration in time</li><li>During the meeting I improved or made new connections for my professional network</li><li>The presentations and speakers were clear and understandable</li><li>During the meeting, I felt safe to behave spontaneous and unfiltered</li><li>I believe others were communicating openly with me</li></ul> |
| 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)<br><ul><li>I had sufficient opportunities to provide input to the discussion</li></ul> |

- Differences and (potential) conflicts among us were addressed in a constructive manner
- 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?

# Annex E: Meeting report template

## E.1. Community of Practice meeting

### CoP meeting reporting
### Case Study:

<div style="background-color:yellow">

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

</div>

**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** | |
| **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
- xxx

Cons:

---

| |
|---|
| • xxx<br>• xxx<br>• xxx |
| What suggestions for improvement do you have for future workshops?<br><br>• xxx<br>• xxx<br>• xxx |

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

# E.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

**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.).

# Annex F: 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.

## F.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.<br><br>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 |

| | | | |
|---|---|---|---|
| | 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.<br><br>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.<br><br>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. |
| 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 | Legal restrictions can stop or limit technological and economically feasible solutions which can increase reclaimed water availability. | The next step is to start trials at the industrial pilot plant site. Experimental results will show if the proposed technologies are technically |

| | | | |
|---|---|---|---|
| | 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. | For scaling up purposes in AITASA, clarity on the legal framework is needed in CS 1.

If necessary, consultations will be held at EU level. | 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. |

## F.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 | 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 |

| | | waste status (so called end-of-waste status). This needs to be addressed in order to make water reuse possible. | 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 learned so far? | A survey has mapped needs and drivers for farmers. The different ways to collectively work on reuse and the status in various collectives in The Netherlands has been discussed in a CoP meeting.<br><br>Besides this, focus has been on making sure water of appropriate quality and/or composition can be produced. | None – there have been no discussions with regulators and/or legislators at this point. | Development of electrodialysis as a new treatment technology for the horticulture sector has started. Pilot plant to be operational by the end of 2022. |

## F.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 challenges and how have these been addressed in ULTIMATE? | Water reuse has a key role for Solvay. The acceptance is related to the quality of the water delivered.<br><br>The main challenge is connected to salinity and COD of the water.<br><br>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.<br><br>The replicability of the water reclamation plant and | For water reuse by industry, 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.<br><br>However, there is no standard scenario: it is very specific and connected with industrial and/or local needs.<br><br>In the ARETUSA case, the symbiosis is working well and within the ULTIMATE project | › Material reuse: reuse of 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.<br>› Sewer system models and monitoring: There have |

| | | |
|---|---|---|
| ULTIMATE solutions is being explored in other industrial districts in Tuscany.<br><br>Furthermore, the acceptance of water reuse in agriculture is the other challenge that needs to be analysed at the local level. | the focus is on increasing the quality of the water to guarantee the fulfilment of the quality requirements. | been some difficulties related to delay of material supply. In 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.<br>› Fit-for-purposes water: within ULTIMATE other possible uses of the water outside SOLVAY will be 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.<br><br>In the coming months a focus group will be organised with the interested water utilities and industrial partners to show what is being done. | Communication with the partners and technical competences to analyse barriers and to find compromises at cost-benefit level is very important.<br><br>In terms of progress, the approach to water industrial symbiosis is being disseminated and shared, even with other water utilities through the CoP meetings. | Technologies/innovations are discussed in the CoP meetings, focussing on Waste/by-products Framework Directive with experts and analysing local industries and experiences 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).<br><br>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. |
|---|---|---|

## F.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 | 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 |

| | | research programmes.<br><br>During the ULTIMATE project a CoP meeting was organised focussing on water reuse regulation. | CS 4. |
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| 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.<br><br>Farmers did not join the meetings and are still sceptical regarding reclaimed water.<br><br>The third CoP meeting will consist of an on-site visit in which famers will be engaged. | The second CoP meeting was dedicated on water reuse regulation in which representatives of public water authorities and industries participated.<br><br>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. | 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 some delays at the site, largely related to Covid-19.<br><br>The combination of technologies such as coagulation, AOP and SPB have been proven to achieve the desirable limits.<br><br>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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| | | 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 Environment). | |

## F.5. Case Study 5 - Lleida, Spain

| Questions | Topic | | |
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| | **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 Aqualia is working with are familiar with water reuse.<br><br>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.<br><br>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 CS 5: two membrane technologies working parallel.<br><br>Growing of algae and filamentous organisms in the |

| | 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-scale plant. |
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| 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 | Legionella or Nematod eggs have been absent in 20 samples of the secondary treated wastewater. Are they | Dark tanks and prefiltering of incoming water have shown to be effective measures to avoid algae and filamentous |

| warrants the commitment of the end-user and provides value to the solution.<br><br>There is a lack of promotion for water reuse strategies in the industrial sectors (food and beverage). | really representative parameters of health risk derived from water reuse? | organism proliferation.<br><br>Simplicity and robustness of solutions are essential for a fast, feasible, acceptable and easy implementation. |

## F.6. Case Study 6 - Karmiel and Shafdan, Israel

| Questions | Topic | | |
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| | **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:<br><br>› Maximal ratio mixing of olive mill wastewater and domestic wastewater: This has been addressed by testing the effects of different ratios of olive mill |

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| | | | wastewater discharged into domestic wastewater in the summertime vs. wintertime. <br>› 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 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. <br>› For the extraction of polyphenols, optimal design parameters were obtained based on lab-scale experiments (GtG). |

## F.7. Case Study 7 - Tain, Scotland

| Questions | Topic | | |
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| | **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. |

| 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. |

## F.8. Case Study 8 - St. Maurice L'Exil, France

| Questions | Topic | | |
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| | **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 regulations) or rather to reach a technical and economic agreement with a user. | It is difficult to be sure to take into account all the applicable regulations (end of waste regulations, products regulations, impact on current authorisation, etc.). | |

| | | We know that regulations are constantly evolving regarding the control of potential trace pollutants. | |
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| 2. What progress has been made and what have you learned so far? | | | |

## F.9. Case Study 9 - Kalundborg, Denmark

| Questions | Topic | | |
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| | **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 more success in discussions and co-creation with the petrochemical industry | 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 can assist in making the regulation more reasonable and less destructible. Furthermore, the CoP | 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 people with influence outside of the Kalundborg area.  It has been a major |

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| | 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.<br><br>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). | meetings are being used to spread relevant information on how these matters are handled in a more reasonable way in other EU countries. | 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.<br><br>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. |
| 2. What progress has been made and what have you learned so far? | *Please see above*<br><br>Danish industry are conservative and adhere to present regulations.<br><br>Concrete examples from other countries open doors and understanding. | *Please see above*<br><br>Very little progress has been made, where some have at least been able to mention the issues.<br><br>Widespread ignorance of the situation on this matter in | *Please see above*<br><br>Concrete well-documented examples of the use of technologies from other countries open doors and willingness to engage in co-creation of technological solutions. |

| | Direct personal contact with no-nonsense, precise and direct information pays off. | other EU countries.<br><br>Reluctance to change a long freshwater tradition in Denmark.<br><br>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 reuse possibilities. | Fast and precise response to relevant information and trustworthy information on technologies from other partners plays a major role.<br><br>It is a major advantage to have good partners willing to interact together in an EU project. |