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water mining
value for society

Deliverable 2.3

Best practices of stakeholder engagement

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Author(s)	Gonzalo Gamboa, Berta Roset-Pérez
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[1] **R**=Document, report; **DEM**=Demonstrator, pilot, prototype; **DEC**=website, patent fillings, videos, etc.; **OTHER**=other

[2] **PU**=Public, **CO**=Confidential, only for members of the consortium (including the Commission Services), **CI**=Classified

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Executive summary

The present deliverable is associated with Task 2.3, social learning and best practices for stakeholder engagement. The goal of this task is twofold: i) to assess the model of social learning, and ii) to provide a set of guidelines for best practices for stakeholder engagement in the complex context of innovations with socio-technical wastewater management systems.

Based on the activities of T2.3, this deliverable aims at the following:

- To assess the use of Communities of Practice (CoPs) to develop and transfer WATER MINING knowledge.
- To develop a model of social learning dealing with impact, institutional and moral uncertainties.
- To provide guidelines for best practices for stakeholders' engagement in the process of design and implementation of Circular Economy (CE) water technologies.

To meet these objectives, this document describes and analyses the implementation of the Communities of Practice (CoPs) as stakeholder engagement and participatory research environments for technological innovation. For the WATER MINING project, the participatory process encompassed a context-sensitive design exercise (Work Package or WP2), which informed a market system analysis and business model development (WP9) and policy packaging processes (WP10).

This document starts by analysing different concepts related to public participation and participatory research: such as social learning, co-creation and the management of uncertainties (Section 2). This is done to subsequently analyse and evaluate the approach to participatory research adopted in WATER MINING.

Participatory processes may go from information, to consultation, participation, and empowerment, implying increasing degrees of stakeholder engagement, commitment and responsibility. Co-creation is understood as a collaborative process involving different actors through the steps of Co-definition, Co-production and Co-dissemination. Social learning is understood here as more than just cognitive learning. It encompasses changes in attitude, beliefs, and behaviour, with a critical reflection on the assumptions and limitations of our knowledge. It requires discussion and deliberation among counterparts, dealing with conflicting values in society, to ultimately find ways of institutional change and collaborative action. Impact, institutional and moral uncertainties in technology development processes refer to multidimensional impacts of new technologies, the adequate institutional arrangement to embed new technologies in society, and the diverging values and moral questions emerging from the development of these new technologies, respectively.

Section 3 is aimed at describing the establishment of CoPs and their implementation as participatory research environments. It starts by critically analysing the concept of Communities of Practice in the context of participatory research for technology development. Second, the establishment and implementation of CoPs are described: aims, structure and frequency of CoP meetings. Third, the participatory research processes implemented in WATER MINING – policy packaging, market analysis and context-sensitive design – are portrayed.

Section 4 is aimed at evaluating the CoPs from the perspective of the stakeholders and according to the conceptual frameworks of participatory research, co-creation, and the management of impact, institutional and moral uncertainties.

The participatory research approach adopted in the context-sensitive design process can be located between consultation and participation. Co-design is limited due to the characteristics of the project: for instance, high TRLs determines the type of contributions made by stakeholders. Co-defining the problem at hand and the solution is not possible since the technologies to be developed are already defined. Stakeholders can make some proposals regarding the use of a product (e.g. Kaumera) or the production chain resulted from coupling different technologies at large scale. These proposals made by stakeholder are further distilled by researchers, who ultimately decides what to implement.

Regarding the treatment of impact, institutional and moral uncertainties, the context-sensitive design process aimed at explicitly identifying societal values and value tensions and, based on that, discussing potential impacts of full-scale implementation of emerging technologies. Despite that there will be always uncertainty and ignorance in the potential impacts of an emerging technology, it provides good prospects to reduce *hypocognition* and deal with impact uncertainty. Moral uncertainty has been partially addressed: a wide range of social values are identified, but actual implementation of emerging technology will always entail the emergence of moral questions and dilemmas.

Institutional uncertainty could have been addressed by the policy and market analyses. These applied an approach based on expert knowledge, with limited interaction with stakeholders beyond project partners and mainstream circles of policy and market experts. Participatory research in these instances can be characterized as consultation, and co-creation is substantially limited. Regarding the management of uncertainties, potential new institutional arrangements are framed within mainstream narratives and imaginaries. Little room is left to alternative ways of framing the problem at hand, with less possibilities of imagining and developing institutional arrangements for unexpected scenarios.

From the analyses performed in the previous sections, a set of criteria of best practices are presented in Section 5, together with the following recommendations:

1) Establishing a participatory research community
    a) To establish CoPs in the context of stakeholder engagement and participatory research for technological innovation process is to bring together people who have different practices and interests, which requires building trust and confidence among participants by means of building and sharing information, knowledge and experiences. Also, gathering the right people is more important than their quantity
    b) This process requires time. Communities are not created but are shaped as a result of a process in which content is created and shared, trust is built, and collaboration is encouraged. It would be difficult that a CoPs is going to start big and engaged; it starts small and builds up overtime.
    c) Lack of time and resources make it difficult to define, together with stakeholders, the mission and the vision of the CoPs, the governance system, convening scheme, roles and responsibilities in the very first meeting. All these steps are needed to generate a feeling of ownership of the community and, therefore, foster engagement.

d) Budget allocated to social sciences within technology driven projects should be adequate for the necessary resources and skills required to facilitate and manage stakeholder engagement activities.
e) According to this, it would be important to be clear that the establishment of a community wouldn't take place at the first meeting, but at least in the second one when all stakeholders are aware of the scope, purposes and objectives of the project and of the technology developed.
f) Be clear on the scope, purpose, objectives and steps of the research process and on the expected role of participants, providing detailed information about the projects or products under discussion. Also, be clear to what extent the participation of stakeholders may influence the development of the new technology. Make explicit the roles in the *co-creation* approach and the approach chosen for *co-production* to avoid unfulfilled expectations and frustration. The role of stakeholders in co-creation can be varied. There is no best approach.
g) Transparency and openness seem to be key factors to develop empowerment, motivation and a sense of ownership in stakeholders. Public research could provide a more adequate space for these practices. On the other hand competitive advantage given by confidential knowledge and patents may hinder stakeholder involvement in a co-creation process.
h) Time is also important in meetings. To foster empowerment and sense of ownership; provide stakeholders with the space and time to reflect on the discussed issues. This requires good planning and choosing the adequate participatory methods.
i) Existing participatory structures should be considered when setting up a community. These types of environments call for flexibility and building synergies. The existing structures may help to maintain the community beyond the project lifespan. On the other hand, power relations and agendas must be considered when integrating different voices and viewpoints a benefit when dealing with complexity but possibly leading to conflict
j) Dissident voices (that may be not present in existing structures) should be integrated by different means. If divergent voices are not considered, then the purpose of substantive and normative approaches to participation is hindered. Diversity is desired to better grasp complexity and to consider different and legitimate viewpoints is society.

2) Implementing criteria of best practices
   a) Provide information about objectives, agenda and any relevant information (e.g., videos, summary of the project) to stakeholders well in advance. If there are newcomers in subsequent meetings, provide all relevant information for them to feel welcome as the rest of participants.
   b) Avoid being ambitious regarding the agenda of the meeting. Reflection and discussions require time, and usually take more than expected. Include time or activities for networking among participants.
   c) Choose adequate meeting venue to facilitate the attendance of stakeholders, in terms of accessibility, size, spaces and equipment required for the planned activities.
   d) Facilitation should allow all participants to raise their voice and concerns and foster constructive discussions. Small groups usually allow more people to participate and get deeper discussions. Good facilitation skills are of upmost importance. Take care of configuring small groups in a way to avoid power imbalances among participants.
   e) Participatory methods should be coherent with the objectives of the activity.

f) At the end of the meetings, be sure to summarise the main discussions and conclusions, and to inform participants about the next steps in the project and in the participatory research process. Send, right after the meeting, a written summary and all the committed information.

3) Dealing with uncertainties
   a) The Communities of Practice environment, as originally conceptualized and as it has been applied in WATER MINING, partially deals with impact, institutional and moral uncertainties. The original conceptualisation of CoPs is limited to a group of people sharing a common practice. There is no explicit consideration of different practices and of contrasting, or even conflicting, and legitimate points of view regarding an issue. This is of key importance to identify a wide range of non-equivalent description of a complex phenomenon (social incommensurability) and the existence of multiple identities descriptive models (technical incommensurability)
   b) Social research methods are of key importance to identify social values and value tension regarding the implementation of innovative technologies. Adequate skills to deploy these methodologies are required. This means that technical partners have to be trained in these methods or incorporate skilled people in their teams
   c) Identification of societal values are the basis to deal with impact uncertainty. It would be interesting to apply specific methodologies to develop future scenarios, explore technology implementation paths and identify potential unexpected outcomes.
   d) Partners should be fully coordinated across different WPs for an adequate stakeholder engagement and participatory research process. Those in charge of market and policy analysis, for example, should participate or have access to the outcomes of the future scenarios workshops to identify potential institutional arrangements for unexpected outcomes. Policy and market analysis should not be based mostly/only on expert knowledge, and the incorporation of stakeholder’s knowledge should go beyond consultation to avoid being framed within mainstream narratives.

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1 Introduction

This deliverable is associated with Task 2.3, social learning and best practices for stakeholder engagement. The goal of this task is twofold: i) to assess the model of social learning, and ii) to provide a set of guidelines for best practices for stakeholder engagement in the complex context of innovations within socio-technical wastewater management systems.

Water resource management is characterized by uncertainty and complexity, where end-of-pipe-solutions become unsatisfactory and increasingly expensive. The water sector needs an innovative transformation, increasing flexibility and adaptability of the system to face uncertainty and risk. A transformation in which the human dimension would play a key role for transformation, innovation and change (Pahl-Wostl, 2002)

These changes require coupling technological, social, organisational and institutional innovations. A step further than just a technological shift; a socio-technical system innovation targeting cultural change (Ceschin & Gaziulusoy, 2016; Schot & Steinmueller, 2018).

Stakeholder engagement is crucial to achieve these transformations in water resource management. It would foster the integration of an array of different values, perspectives, and experience, but also to increase the commitment to search for new, sustainable, and improved solutions for a changing system (Carter, 2006; Fulgenzi et al., 2020; Reed, 2008; Schot & Steinmueller, 2018; von Korff et al., 2012). Stakeholder engagement would also foster social learning, which encompasses cognitive learning, and changes in attitude, beliefs and behaviour. It implies finding ways of institutional change and collaborative action, to enhance the ability to deal with conflicting values in society (Garmendia and Stagl, 2015).

Based on the activities of T2.3, this deliverable is aimed at the following:

- To assess the use of Communities of Practice (CoPs) in developing and transferring WATER MINING knowledge.
- To develop a model of participatory research fostering social learning and dealing with impact, institutional and moral uncertainties,
- To provide guidelines for best practices for stakeholder engagement in the process of design and implement Circular Economy water technologies.

To meet these objectives, the present document describes and analyses the implementation of the Communities of Practice as **stakeholder engagement and participatory research environments for technological innovation**. CoPs were established at the beginning of the project and used to carry out a participatory process encompassing the following WATER MINING research branches and scopes:

- Context-sensitive design (WP2). Identification of social values and value tensions, development and evaluation of technical scenarios, discussion of trade-offs of emergent societal issues when implementing innovative technologies at full-scale.

- Market system mapping (WP9) to identify market actors, and policy and business enabling environments (barriers and enablers), and to devise the desired market system to successfully deploy the water-mined products.
- Policy packaging process (WP10) to enhance the institutional and regulatory environment to foster the deployment of WATER MINING technologies.

The deployment of CoPs as participatory research environments is analysed under the lens of participatory research, co-creation and social learning. Learned lessons are derived from this analysis and a set of recommendations of best practices of stakeholder engagement are proposed. This includes an update of the frameworks used to evaluate stakeholder engagement (CoPs meetings and social learning). For instance, one of the most important learned lessons is the fact that one cannot expect to establish a CoP as participatory research environment at the beginning of a project. A community requires time to build trust, engagement and commitment.

The process to set up a Living Lab, applied in WATER MINING, is also reviewed. The Living Lab (LL) approach was implemented in two Case Studies (CS) (Plataforma Solar de Almería (PSA) and Floating Farm (FF)) and followed a structured process of defining their scope, mission, vision, target stakeholders, and business and governance models. The aim of these activities was to set up a proactive learning and innovation ecosystems at the end of the project. The purpose of including the analysis of the implementation of the Living Labs is to complement the previous analysis of CoPs as participatory research environments for technological innovation and to derive learned lessons from the whole process of establishing a Living Lab.

The outcomes of this deliverable are the following:

- An improved model for social learning dealing with impact, institutional and moral uncertainties.
- An improved set of criteria of best practices for stakeholders' engagement.
- Guidelines for best practices for stakeholders' engagement in the process of design and implementation of CE water technologies.
- An improved evaluation framework for CoPs.
- A social learning evaluation framework.

This document starts by framing the WATER MINING approach to stakeholder engagement within a wide arrange of approaches to public participation, participatory research and co-creation. The document continues by describing the different aspects characterising social learning, both at the individual and societal levels. It follows with the conceptualisation of impact, institutional and moral uncertainties faced when developing and implementing innovative technologies.

The document also presents an analysis of the implementation and deployment of CoPs. It starts by discussing and questioning the conceptualisation of the CoPs and the adequacy of the original CoPs concept in the framework of participatory research. It follows a review of the use of CoPs for developing market maps and policy packaging, and to carry out a context sensitive design process. Finally, the evaluation of the WATER MINING CoPs is presented, and some learned lessons are summarised.

2 Public participation and technology innovation

Different approaches to public participation exist. According to Fiorino (1990), we can distinguish between the normative, substantive, and instrumental approaches to participation. The *normative* approach aims at encouraging social and individual learning and involvement, which betters and empowers both society and citizens. The *substantive* approach would aim at encouraging the incorporation of multiple perspectives on the issue at hand, improving the understanding and the grasp of complexity, the knowledge on the problem at hand and the selection of its appropriate solution. There is also the *instrumental* approach to participation, which is characterized by informing or consulting stakeholders.

These categories can be further disaggregated in what Arnstein (1969) called the “rungs on a ladder” characterisation of public involvement, where different degrees of participation can be identified: from manipulation to citizen control (Arnstein, 1969; Blackstock et al., 2007; Videira et al., 2006). Arnstein’s theory and further studies on participation highlight that these processes can go from purely informative to being controlled by stakeholders or decision-makers (Davison 1998; Carter, 2006; Videira et al., 2006; Luyet et al., 2012; Anggraeni et al., 2019).

The following Table 1 presents an attempt to make a parallel between different approaches to participation.

Table 1: Approaches to participation.

<table>
<tr><th>Fiorino (1990)</th><th colspan="2">Arnstein (1969)</th><th colspan="2">Davison (1998)</th></tr>
<tr><td rowspan="2"></td><td rowspan="2">Non-participation</td><td>Manipulation</td><td rowspan="2" colspan="2"></td></tr>
<tr><td>Therapy</td></tr>
<tr><td rowspan="3">Instrumental</td><td rowspan="7">Tokenism</td><td rowspan="3">Informing</td><td rowspan="3">Information</td><td>Minimal communication</td></tr>
<tr><td>Limited information</td></tr>
<tr><td>Good quality information</td></tr>
<tr><td rowspan="4">Substantive</td><td rowspan="3">Consultation</td><td rowspan="3">Consultation</td><td>Limited consultation</td></tr>
<tr><td>Customer care</td></tr>
<tr><td>Genuine consultation</td></tr>
<tr><td>Placation</td><td rowspan="3">Participation</td><td>Effective advisory board</td></tr>
<tr><td rowspan="5">Normative</td><td rowspan="5">Citizen control</td><td rowspan="2">Partnership</td><td>Partnership</td></tr>
<tr><td>Limited decentralized decision-making</td></tr>
<tr><td>Delegation</td><td rowspan="3">Empowerment</td><td>Delegated control</td></tr>
<tr><td rowspan="2">Citizen control</td><td>Independent control</td></tr>
<tr><td>Entrusted control</td></tr>
</table>

WATER MINING has set the level of participation of stakeholders to **co-create** and foster **social learning** (Grant Agreement), which would entail the adoption of an approach that goes beyond informing stakeholders about the state and details of technology development (*instrumental* approach to participation) and situated between incorporating multiple perspectives to understanding the grasp of complexity (*substantive* approach), and to encourage empowerment of society and individuals (*normative* approach).

To characterize and assess the participatory research approach adopted in WATER MINING, it is necessary to previously conceptualise co-creation and social learning, and specify what these concepts mean and entail in terms of stakeholder engagement. This is the aim of the following subsections.

2.1 Co-creation

Co-creation, co-production, co-development, or co-design are concepts that give an idea of a collective and collaborative process in which something is created, produced, developed, or designed. Some authors use co-creation and co-production interchangeably to explain the same processes (e.g., Fulgenzi et al., 2020; Galende-Sánchez and Sorman, 2021, Wehn et al. 2018). Co-production, for instance, "*embraces multiple ambitions, engaging multiple actors (researchers, decision-makers, citizens etc.) to produce new knowledge and new ways of integrating this knowledge into decision-making and action; ultimately producing new outcomes*" (Galende-Sánchez and Sorman, 2021, p. 2). In a similar vein, co-creation "*emerges as a key mechanism for involving societal actors in shaping innovation*" (Ruess et al., 2023, p. 435).

Co-production or co-creation of knowledge would emerge from a space of equality and reciprocity between scientific expertise and stakeholder knowledge, these being, for example, citizens or practitioners (Fulgenzi et al., 2020; Reed et al., 2018; Ruess et al., 2023). These processes aim at building knowledge that has high scientific quality while also being socially acceptable and robust (Galende-Sánchez and Sorman, 2021; Reed et al., 2018; Ruess et al., 2023).

In this sense, Funtowicz and Ravetz (1992) differentiate between internal and external quality of any human production (e.g. knowledge, technology). Internal quality refers to the different skills required to perform an activity (e.g. dexterity is required to solve exercises, craftsmanship is necessary for problems and creativity is required to deal with challenges). The internal quality of scientific task is evaluated according to criteria that are relevant within the field of practice. External quality refers to the *fitness for purpose* of that human production, which is defined by the relationship of the knowledge developed with a broader community of users (society), its reliability and economy. The incorporation of and extended peer-community beyond the usual circles of scientific and expert knowledge proposed by Funtowicz and Ravetz (1993) would be aimed, among other objectives, to ensure the external quality of scientific practice. For instance, the different technologies developed in WATER MINING should be technically feasible, and also socially relevant and economically viable. The Kaumera extraction system should be able to produce a bio-polymer meeting certain physio-chemical characteristics. However, to be deployed as a substitute of fossil-based polymers, a socially relevant use should be found, for which it is reliable and economically feasible. Thermal desalination is a quite mature technology meeting internal criteria of quality, and it is socio-environmentally relevant as it has the potential of dealing with the two major challenges of conventional desalination technologies: energy consumption and brine release. Thermal desalination should still prove to be economically viable and reliable to reach zero liquid discharge.

Co-production or co-creation is also expected to democratise research, to expand knowledge-making beyond the boundaries of the "scientific and expert world", incorporating different voices in a transdisciplinary approach (Fulgenzi et al., 2020; Galende-Sánchez and Sorman, 2021). These authors differentiate between *participation*, *co-production in science* (knowledge-making beyond the scientific "bubble") and *co-production in policy* (design of public goods and services like urban policies). They have set co-production at higher levels of the "ladder" and define these processes as going beyond consultation and engagement (Figure 1).

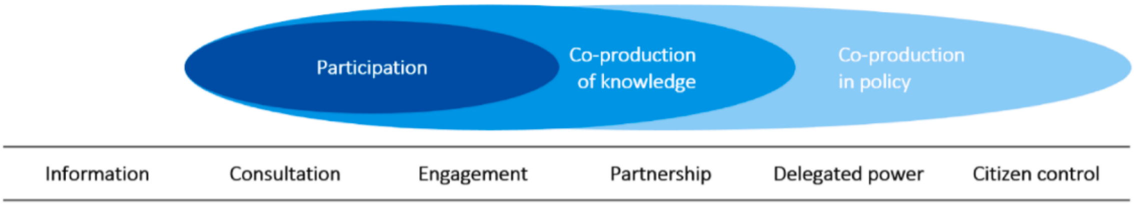

Figure 1: Representing co-production across the ladder of participation. Source: Galende-Sánchez and Sorman, 2021.

Until here, co-creation and co-production have been used indifferently. However, some authors make a clear distinction between these concepts, locating co-production as a phase within a co-creation process. Suhari et al. (2022) define co-creation, in the context of a project development, as a cycle of *co-design* (a joint effort between scientists and practitioners to define the research problem), *co-production* (the joint creation of knowledge between scientist and stakeholders) and, finally, *co-dissemination* (the stage in which the results are made available and accessible to a broad range of users). Van Buuren et al. (2019, p.371) define co-creation as the whole cycle of "*co-producing and co-delivering public goods and services in which society, stakeholder groups and governmental actors have joint responsibility and their collaboration results in public value*".

In the literature on marketing research, co-production[3] is defined as "*a collaborative new product development activity in which customers actively contribute and/or select the content of a new product offering"* (O'Hern and Rindfleisch, 2017, p.86).

In this research field, it is argued that a more active role of customers would provide greater input and control over the development of new products, which brings several advantages such as creativity, speed, reduced development costs and marketplace success. Also, it is argued that incorporating customers in the new product development would bring corporate growth and profitability (Prahalad and Ramaswamy 2000; von Hippel 2005). Co-production would also reduce knowledge asymmetry: i.e., the distance between information about customer needs (held by customers) and information about how to satisfy these needs (held by the firm).

In the co-production phase of co-creation, two stages can be identified: 1) the contribution of novel concepts and ideas, and 2) the selection of ideas to be pursued. Based on the control over these two stages by the different agents involved in this process, O'Hern and Rindfleisch (2017) develop a typology of co-production that can be useful to frame stakeholder engagement and participatory research for technological innovation (Figure 2).

[3] These authors refer to co-creation to what Suhari et al. (2022) or Van Buuren et al. (2019) call co-production. From now on, we refer to co-creation as the overall process and co-productio as one of the phases of co-creation.

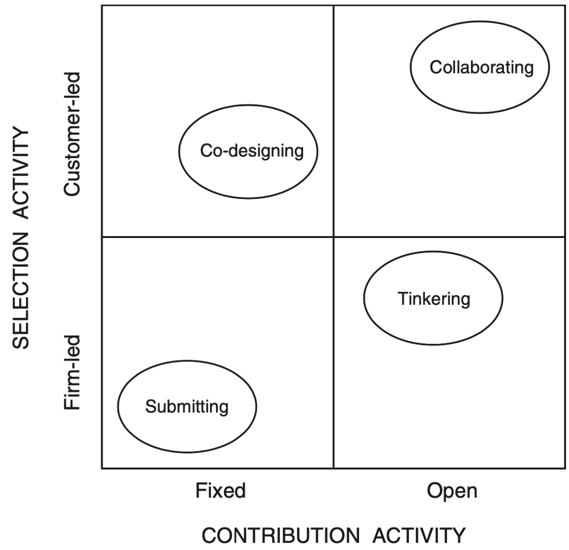

Figure 2. Co-creation typologies according to degrees of ideas contribution and selection. Source: O'Hern and Rindfleisch (2017).

Collaborating is a process in which customers have greater power to contribute with and select ideas to be incorporated in the new product, either in core components or underlying structure. This is the case of open-source software, for instance. This process requires highly skilled participants able to understand and work with the underlying structure of the product, discouraging laypeople who may have also interesting ideas. In the field of technology innovation and development, *collaborating* would apply to open-source technology (e.g., wikifactory), where the core components or underlying structure of technology are shared openly.

Tinkering is about leaving customers the freedom to make modifications to a commercially available product. This approach has been implemented by computer games industry, where customers have access to development tools but not to the source code, limiting the range of potential contributions. Therefore, customers contribute with new ideas and the firm decides whether these ideas are incorporated into future product releases. This process requires people with both a high level of skills and knowledge.

Co-designing is a process in which content and ideas contribution is limited to a small group of customers. Then, a larger group of interested people evaluate and select the more appealing ones for them. Finally, the company selects which products are viable or the features to be incorporated in the final product. In co-design, contributions are usually restricted to a template previously defined by the company. On the other hand, customer autonomy to select features to be incorporated would be in between collaborating and tinkering. This approach is open to people with high and low levels of skills, both in the process of contributing and selecting ideas.

Submitting is the approach that provides less customer autonomy in terms of proposing and selecting. Customers develop tangible ideas about new products by developing well-defined product and process proposals, and firms have full control of the selection of these ideas.

According to the concepts discussed above, Table 2 shows how co-creation and co-production have been used differently in the analysed literature. We propose the following nomenclature (first column of Table 2): *Co-creation* is the process that goes from *co-defining* (instead of O'Hern and Rindfleisch's co-designing) the problem at hand, to *co-producing* (which is called *co-creation* in the marketing research field) and *co-disseminating* knowledge (being it in the form of a product or technology).

Table 2: Co-creation and co-production used differently by different authors, and proposal of nomenclature.

<table>
<tr><th colspan="2"></th><th>Suhari et al. (2022)</th><th>Van Buuren et al. (2019)</th><th>Galende-Sánchez and Sorman (2021)</th><th>Ruess et al. (2023)</th><th colspan="2">O'Hern and Rindfleisch (2017)</th></tr>
<tr><td colspan="2">Co-creation</td><td>Co-creation, in the context of project development, as a cycle of the following steps:</td><td>Co-creation of public goods and services in which society, stakeholder groups and governmental actors have joint responsibility and their collaboration results in public value. The process is made of the following steps:</td><td>Co-creation as co-production of knowledge in science or in policy.</td><td>Co-creation in policy discourse for innovation.</td><td colspan="2">Co-creation as a collaborative new product development.</td></tr>
<tr><td rowspan="4"></td><td>Co-definінition</td><td>Co-design when there is a joint effort between scientists and practitioners to define the research problem.</td><td></td><td></td><td rowspan="3">Co-design and co-production as processes of innovation that consider democratic and socially robust practices as well as matching the users' needs and the design of the product.</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Co-production</td><td rowspan="2">Co-production as the joint creation of knowledge between scientist and stakeholders.</td><td rowspan="2">Co-production when there is an involvement of users and public in the design of services, or management or evaluation, among others. This involvement may not be voluntary.</td><td rowspan="2">Co-production of new knowledge by engaging multiple actors (researchers, decision-makers, citizens etc.) in a transdisciplinary way, and new ways of integrating this knowledge into decision-making and action; ultimately producing new outcomes.</td><td>Co-design</td><td>Collaborate</td></tr>
<tr><td>Submitting</td><td>Tinkering</td></tr>
<tr><td>Co-dissemination</td><td>Co-dissemination as the stage in which all parties involved make available and accessible the results of the process to a broad range of users.</td><td>Co-delivering as the action taken by all parties involved making the public services available.</td><td></td><td></td><td colspan="2"></td></tr>
</table>

2.2 Social learning

The definition of social learning is contested (Muro and Jeffrey, 2008; Reed et al., 2010) and many authors have taken different theories and stances to interpret this phenomenon. Current conceptualisations of social learning derive from the double loop learning framework (Argyris and Schon, 1996), which refers to feedback loops in the learning process. In this framework, the first level (single-loop learning) implies an improvement of the already established actions without questioning the established assumptions. It implies to an instrumental change in strategy within the constraints given by overall norms and beliefs, learning about the consequences of specific actions. The second level (double-loop learning) is a change in the frame of reference as well as these assumptions underlying our actions. A third level (triple-loop learning) came from a later conceptualisation (Tosey et al., 2012), refers to a transformation where the values and beliefs of the person are reconsidered and the world view changes (Johannessen et al., 2019; Pahl-Wostl, 2009). According to Reed et al. (2010) social learning can be defined as a change in understanding (perceptions and/or beliefs) of an individual through social interaction and within social networks. According to these authors, to consider this change in understanding as social learning, it should be situated in a wider social units or communities of practice, which learn as social unit, through collective reflection and problematization.

Following this definition and the original conception of social learning developed by Bandura (1977), some authors argue that social learning also entails a convergent change in perspective between individuals, as a product sharing expectations and points of view, deliberating, observing and imitating others (van der Wal et al., 2014; Teodoro et al., 2021).

The existence of convergence in social learning (Collins and Ison, 2009) is a critical one, we believe. There are, at least, two aspects to consider. On one hand convergence does not necessarily occur towards more sustainable patterns. The role of stakeholders is shaped by its power, legitimacy and urgency (Mitchell et al., 1997). Power refers to a relationship among actors in which one can make other to do something that the other would not have otherwise done. Power can be coercive, utilitarian or normative. Legitimacy refers to the generalized perception that the actions of a stakeholder are appropriate within the social system of norms and values. Urgency refers to the degree to which stakeholder claims call for immediate attention. A powerful and legitimate stakeholder claiming for immediate attention may have a strong influence in a participatory process, fostering convergence towards its worldview and ideas, which might not be sustainable. In other words, social learning not necessarily leads to the raise of pro-environmental positions (Caspersen, Smeby, and Olaf Aamodt, 2017).

On other hand several authors have emphasised the role of dissent in the pursuit of sustainability. Some argue that socio-environmental conflicts may trigger social innovation, i.e., "*a reconfiguration of social relations that leads to new forms of action to meet collective needs and opportunities*", whose main outcome is the creation of an improvement in the capacity of collective action, social cohesion, and sense of belonging (Vercher, 2022, p.4). Others argue that socioenvironmental conflicts may act as sustainability forces, in which, for example, environmental justice movements can question, politicize, and confront unsustainable resource use, fostering transitions to ecological sustainability and social justice (Scheidel et al., 2018). Under these perspectives, conflict and the absence of convergence would trigger social innovation and change for sustainability, which somewhat contradicts the idea of social learning as a process of convergence to shared understanding and consensus. Instead, the "irreducible plurality of standpoints" calls for participatory processes combining consensus-oriented cooperation in the pursuit of a common interest and compromise-oriented negotiation aiming at the adjustment of particular interests (van den Hove, 2006).

Moreover, what is considered sustainable can be a matter of disagreement as well. For instance, from the eco-optimism industrial ecology approach increasing energy efficiency is considered sustainable. That is, increasing the output per unit of energy input in a production process would be considered a sustainable path. From the point of view of societal metabolism, increasing efficiency just increases the option space of socioeconomic complex adaptative systems to expand and even increase energy consumption in the long term, putting more pressure on the environment (Giampietro and Mayumi, 2018).

Garmendia and Stagl (2010, p.3) define social learning in the context of deliberative stakeholder participation for sustainability, as follows: "*a learning process that happens among different elements and at different levels; it is going* ***beyond the acquisition of new factual knowledge*** *by individuals and includes* ***changes in the frames of reference*** *– assumptions and values – while creating capacity for* ***dealing with conflict*** *ridden issues and for finding ways for* ***joint action****. It also implies* ***gaining capacity for systems thinking****, notably about* ***complexities and uncertainties****, and* ***perceiving oneself as part of a whole****, notably* ***recognizing future generations and non-human species***". This definition acknowledges the existence of conflicting values and interests, and calls for joint action.

Therefore, social learning is considered here as more than just cognitive learning. It encompasses changes in attitude, beliefs, and behaviour, with a critical reflection on the assumptions and limitations of our knowledge. It requires discussion and deliberation among counterparts, dealing with conflicting values in society, to ultimately find ways of institutional change and collaborative action.

2.3 Uncertainties in technology development and implementation

In a context of high uncertainty, and even ignorance, expert knowledge is not enough to decide whether the consequences of implementing innovative technologies at large scales (Giampietro, 2002). That iswhy Funtowicz and Ravetz (1993, p. 748) call to extend the peer-community beyond the usual circles of scientific and expert knowledge when making public decisions in a context where "*facts are uncertain, values in dispute, stake are high and decisions are urgent*". IN WATER MINING, the extension of the peer communities was done through the implementation of the CoPs, which were aimed at incorporating stakeholders from a variety of sectors and points of view and type of knowledge.

The introduction of new experimental technologies can be considered as social experiments (van de Poel, 2016), which are characterised by large uncertainties, unknowns and indeterminacies. Consequently, social benefits and risks of introducing such technologies at full-scale cannot be knowns based on experience. According to this author, these experiments are done *in* society (opposed to be done in a laboratory or another in a confined and contained setting), *on* society (social consequences, risks, societal embedding and normative dimensions) and *by* society (in the process of implementing the new technology).

In the case of WATER MINING, some potential examples of social experiments are the production and commercialization of Kaumera (CS3) or the deployment of thermal desalination with ZLD and recovery of resources to produce irrigation water (CS2). These, as with other social experiments, would present several challenges such as the prediction of benefits and hazards of new technologies, how to successfully embed technology in society (develop adequate new institutional and regulatory frameworks), and recognise and deal with new moral questions and relevant ethical issues (van de Poel, 2017).

For example, in the case of Kaumera some agricultural tests have been carried out to evaluate the biostimulant and water retention capacity of Kaumera, which have produced promising results. However, there will be still some uncertainties about the performance of Kaumera at large scale and the consequent successful marketisation of Kaumera (e.g., its price compared against its benefits in agricultural terms). Other uncertainties regarding the performance of Kaumera are related to the following questions: If plant growth is stimulated and accelerated, would production cycles be shortened? What would be the requirement of soil nutrients in this new scenario? What alternatives to recover soil nutrients would be applied? Would these scenarios consume higher or lower amounts of water and energy in the medium-long term?

In the case of thermal desalination, there are some uncertainties about operation parameters, such as the real efficiency of the nanofiltration system (to effectively remove only divalent ions) or the efficiency of the Multiple-Effect Distillation (whether it can reach the theoretical operation conditions). Other uncertainties are related to whether the availability of new water sources would foster agricultural expansion and increase in water consumption in the long-term (i.e. rebound effect).

Some of these uncertainties may be due to long-term, cumulative or interactive effects, which are hard to forecast. Moreover, social systems are nonlinear and present emergent behavior, which make it difficult to predict human behavior. Consequences due to ignorance could also be overlooked

Van de Poel (2017) proposes to differentiate between impact, institutional and normative (or moral) uncertainties. *Impact uncertainty* relates to the social, environmental and economic impacts of these novel water management systems: What will be the impact on resource consumption? How much waste will be recovered from the water? What is the value of this waste?

Institutional uncertainty relates to the governance mechanisms needed to support the introduction of novel wastewater management systems. What regulations support these innovations? Which laws and regulations are a barrier? What market models are suitable for a successful implementation of these innovations? Also, what are the organizational and institutional forms appropriated for technology? How should a technology be adjusted to fit within existing institutions and norms?

Moral uncertainty relates to the desirability of these wastewater systems in relation to the diverging values and worldviews of relevant stakeholders. It is related to moral questions that would arise from the deployment of emerging technologies (e.g., related to privacy, safety, justice, freedom, and other normative issues) and about what is desirable for society. For instance, some stakeholder may have different perspectives on how to prioritize the values of environmental protection, social benefits and economic gain, which would lead to different factors affecting social acceptance across stakeholders.

These uncertainties are related to what Munda (2004) calls *social* and *technical incommensurability*. The former comes from the existence of legitimate and contradictory, and even conflicting, values and interests in society, which lead to different perceptions and non-equivalent descriptions of the same phenomena. The last comes from the multidimensional characteristic of complex system and refers the existence of multiple identities in descriptive models (Munda, 2004). The author calls for public participation and an extended-peer community (Funtowicz and Ravetz, 1991), and multi/interdisciplinary work to deal with these uncertainties respectively.

Following Palmeros-Parada et al. (2018), WATER MINING proposed performing a Value Sensitive Design (Friedman et al., 2017) in the technology development process (which we now call *context-sensitive design*). By involving stakeholders from the business (industry and agriculture), public administration, academic and societal spheres the usual peer-communities of experts were expanded. Societal values and perceptions have been elucidated through social research and used to generate specific technical design propositions, and alternative system configurations. These were the basis of discussing emerging societal issues when implementing the technologies at full-scale. This exercise was also aimed at reducing the uncertainty in early stages of technology development by anticipating the consequences of full-scale implementation and explicitly incorporating societal aspects into emerging technologies, potentially avoiding risks and negative impacts of emerging technologies.

However, anticipation has proved to be unable to reduce all uncertainties (van de Poel, 2016). Some impacts can be predicted, while others are shaped by high degrees of uncertainty and ignorance. In this sense, the production of scientific information about any complex system entails a compression process: the complex issue is interpreted through a set of narratives delimiting the problem at hand. Then, a formalized description of the system is done by using a finite set of attributes, data and models, which unavoidably incorporates some information and leaves aside other information not pertaining to the model or measurement scheme (Giampietro, 2004; Giampietro et al., 2006). Indicators used to formally represent a system are the "*final result of a series of decisions on what to observe and how*", which depend on the narratives adopted in the pre-analytical steps of the research process (Kovacic and Giampietro, 2015, p.54). As highlighted by Stiglitz (2011, p.594), "*models by their nature are like blinders. In leaving out certain things, they focus our attention on other things. They provide a frame through which we see the world*", which may draw our attention from relevant issues (van de Poel, 2016).

This compression process generates "hypocognition" (Lakoff, 2010): i.e., the risk of the tunnel-vision effect generated by the adoption of a given frame of analysis [Ibid]. Hypocognition and the choice of a given narrative may entail ignoring relevant *known knowns* (i.e., alternative problem framings), to miss relevant *known unknowns* (i.e., dealing with uncertainty) and a poor handling of *unknown unknowns* (i.e., dealing with ignorance). If narratives are not contrasted or validated, and the problem framing is not challenged, the use of more data and more complicated models would only increase the levels of ignorance and uncertainty, keeping untouched the level of hypocognition. In other cases, some information has to be ignored for the model to remain operational, which Rayner (2012) calls a phenomenon of "socially constructed ignorance".

Laws and regulations, for example, tend to lag behind technological development. Technologies may have not foreseen impacts unexpected consequences that require new institutional arrangements. Some impacts of new technologies can be predicted, and adequate regulations anticipated. For instance, increasing water availability may increase water consumption in the long terms due to the rebound effect. This would require the adequate policies to avoid overconsumption fostered by the implementation of new and more efficient technologies. However, successfully embedding technology in society requires a mutual adaptation of technology and institutions, which only takes place with time.

In this sense, van de Poel (2016) distinguishes between epistemological uncertainty (due to lack of knowledge) and indeterminancy (i.e., because causal chains towards the future are open). Epistemological uncertainty can be (sometimes) reduced by more research. But we cannot reduce indeterminancy. To deal with this, an alternative to trying to anticipate is the gradual and experimental introduction of a technology into society, which has been proposed as *governance by experimentation* (Asveld, 2016) or *responsible experimentation* (van de Poel, 2017). These approaches would allow for gradual social learning, and it would be important that technologies can always be reversed.

Unfortunately, experimentation is not possible in a research project moving between high TRLs, such as WATER MINING. To be aware of this problem (i.e. hypocognition, epistemological uncertainty, indeterminancy) suggests moving beyond the dominating style of *evidence-based policy,* which aims to indicate "the best course of action" based on a set of simplified narratives looked at through the lenses of e.g. cost benefit analysis, life cycle assessment, or mathematical modelling. On the contrary, it requires checking what can go wrong by considering simultaneously as many narratives and perspectives as possible in the assessment process (Saltelli and Giampietro, 2017). Good practices of stakeholder engagement fostering co-creation and social learning are required for this. This would not reduce indeterminancy, but it would increase the range of options and perspectives when analysing the impact of emerging technologies, the potential institutional arrangements and the normative issues to be discussed.

The following section analyses, among other issues, to what extent the participatory research process carried out within the framework of the CoPs was able to unveil and deal with impact, institutional and moral uncertainties.

3 Communities of Practice for Stakeholder engagement

This chapter is aimed at describing and analysing the CoPs as a participatory research environment. First, the conceptualisation of Communities of Practice is critically analysed in the context of participatory research. Second, the process of establishing a CoPs is contrasted against the theory and the steps required for a successful implementation. Third, the use of the CoPs as participatory research environment is analysed. For that, the market system analysis and policy packaging processes are reviewed and analysed in terms of interaction with stakeholders and the ability to identify and deal with moral and institutional uncertainties. Then, the context-sensitive design process is scrutinised as a co-creation environment, and as a mean to identify and deal with impact, institutional and moral uncertainties. Fourth, the evaluations of the CoPs meetings performed by stakeholders are presented, to finally derive some learned lessons from the establishment and implementation of the CoPs as participatory research environments.

3.1 Communities of Practice in the context of participatory research

According to the Grant Agreement, WATER MINING sets the level of participation of stakeholders to **co-create** and foster **social learning**. To this end, CoPs have been mainly used as a knowledge exchange space to implement a participatory research process across CSs.

In general terms, participatory research entails collaboration among researchers and stakeholders to either (a) the generation of new ideas, theories, methods, or techniques; or (b) the review, verification, adaptation or refining of existing ideas, theories, methods, or techniques through empirical studies. In these processes, it is expected that researchers and participants co-create and share multiple understandings of an issue, promoting social learning through a transformative process leading to social change (Blackstock et al., 2007). Participatory research would entail public involvement in some or all stages of research, implying that different, even contrasting, points of views regarding (in this case) the WATER MINING technologies would exist, and where an *extended peer community* is required to identify and deal with uncertainty and value tensions (Funtowicz and Ravetz, 1991).

Originally, Communities of Practice are defined as "*social learning systems that bring together people who share a concern or a passion for something they do and learn how to do it better as they interact regularly*" (Wegner-Trayner and Wegner-Trayner, 2015). Theoretically, CoPs bring together people who share a concern or a passion for something they do (Domain) and learn how to do it better (Practice) as they interact regularly (Community). In other words, community members have a shared *domain* of interest, which creates common ground and inspires members to participate, giving meaning to their actions. In fact, members would be actual practitioners in their domain of interest, so they build a shared repertoire of resources and ideas that they can take back to their practice. As a community, a CoPs would create the social fabric for enabling interaction, sharing knowledge and collective learning.

However, this definition was developed in the context of situated knowledge, where concerns and passion leaded to informal meetings aimed at sharing experiences between practitioners of the same field. In fact, CoPs are characterised by a common trade, professional practice or working conditions of its members (Henri and Pudelko, 2003). However, in a context of stakeholder engagement and participatory research for technological innovation, stakeholders with different and even contrasting points of views regarding an issue may be part of the "community".

Henri and Pudelko (2003) define *extended goal-oriented community of interests* as a community that is created to solve a particular problem and/or carry out a project, comprising a group of people with different types of complementary knowledge and expertise, which are unable to completely comprehend the problem at hand individually. This definition brings the idea of complementary knowledge from different disciplines and the context in which people come together: a particular problem or project.

Putting these definitions together, and acknowledging the potential existence of different and contrasting viewpoints, CoPs would be understood as ***social learning systems that bring together people from different backgrounds and perspectives, with different types of complementary knowledge and expertise, who share a concern to solve a particular problem and/or carry out a project for the development of particular technological innovations and learn how to do it better as they interact regularly***.

In this perspective, the aim of the CoPs is to address differences and tensions that emerge when different kinds of knowledge and expertise come together to collaboratively carry out participatory research for technological innovation, as well as gathering information to better grasp complexity, and promote social learning and empowerment.

3.2 Establishing the CoPs

According to the Grant Agreement, the establishment of the CoPs was planned for month 14. Before that, the facilitator and moderator of the CoPs were defined, (technical) partners in charge of a CoP were trained in stakeholder engagement tools, and stakeholders were identified and mapped. Also, some in-depth interviews to key informants were held to identify societal values and to develop the preliminary market maps.

Regarding the resources needed to facilitate CoPs, it is important to notice that partners in charge of technology development have limited skills and limited resources allocated to stakeholder engagement. As the facilitation of CoPs is mostly done by partners in charge of case studies, engineers/technology developer partners may not feel up to the task due to the difference in skills applied to social and technoscientific fields. Moreover, in some cases social sciences are seen as less relevant from the point of view of technology developers, with consequences such as lack of motivation and dedication to stakeholder engagement activities. This first CoP meetings were aimed at presenting the project and the CSs, identify missing stakeholders, establish the CoPs, and present and validate the outcomes of the first year of the project (i.e., social values and value tensions in WP2 and the preliminary outcomes of the market analysis of WP9). However, due to time constrains, it was very difficult to perform the 8-steps to correctly establish a CoP (See Box 1).

Box 1. The 8-steps to establish a CoP

According to Catania et al. (2021), the successful implementation of CoPs depends on defining, in a participatory way, the following 8 steps:

1) The vision of the CoPs: objectives and purpose.
2) The governance system: decision-making processes to meet needs, purpose and values of the CoPs. It would require defining membership and the surrounding ecosystem.
3) The leadership: core group, and required responsibilities and resources.
4) The convening scheme: events that work for the community, types of gatherings and convening events that encourage connections and communication, bridging interactions within inside and outside the community.
5) The collaboration and cooperation scheme: how to combine and apply methods for strategic coordination and co-creation, to enrich common practice and create knowledge.
6) The community management roles: organizer, convener/catalyst, knowledge manager, and define mechanisms to make shared knowledge visible, circulated and acted upon regularly.
7) The user experience: what tools and ways of working that meet the needs and interests of members, and what support is needed.
8) The measurement framework: define tools, processes and resources to evaluate achievements, incorporation of feedbacks, addressing challenges, and keep vision and mission in track.

Then, the second CoP meetings were mainly aimed at identifying market barriers and enablers, the second step of the market analysis. The third CoPs meeting was aimed at presenting and discussing the technical scenarios – the second step of the context-sensitive design approach (CS1, CS2, CS5), and to validate the policy packages developed in WP10 (CS1, CS2, CS5). This CoP meeting also served to further discuss the barrier analysis and policy solutions, and to understand the prospects of the business case and inspire discussion on exploitable outcomes (CS6) and visit the plant and test the AR tool (CS2, CS4 and CS5).

As the main activities of the project are related to technology development, together with the relative lack of resources allocated to social sciences in technology driven projects, regular interaction with stakeholders would mean meeting once a year between project partners and stakeholders. Actually, 19 CoPs meeting were held in WATER MINING. These meetings were organized and facilitated by the project partners in charge of the CS, with the support of WP2 leader, UAB, and KWR.

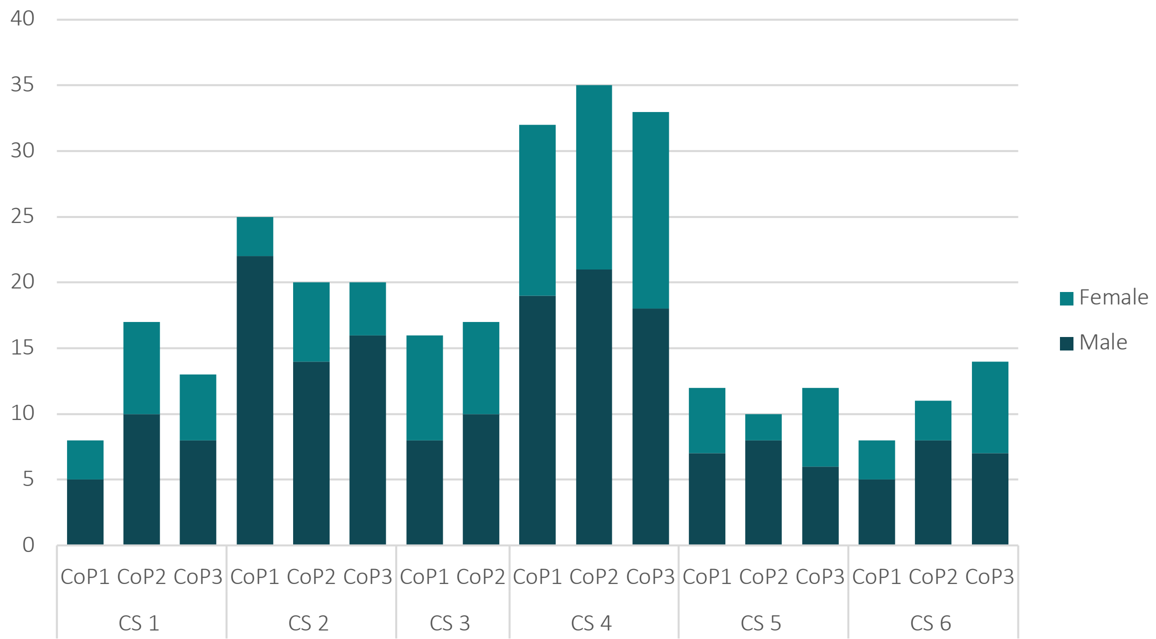

Figure 3: Number of participants per each WATER MINING CoPs.

Regarding the structure of the CoPs meetings, oral presentations by experts dominated the form in which information was communicated. Some exceptions were the following: the first meeting of CS5, in which participatory dynamic was used to discuss and validate social values and value tensions; the second CoPs meeting in all cases, in which the market mapping was developed based on an active exchange of information between project partners and stakeholders; and almost all meetings of CS2 and CS3, in which moderated groups were arranged to discuss and reflect on the information provided by means of oral presentations.

3.3 CoPs as stakeholder engagement and participatory research environment

In WATER MINING, CoPs were used as the participatory research space to interact with stakeholders to develop market maps (WP9), to validate policy packages (WP10) and to carry out a context-sensitive design process (WP2 with the support of WP8 and WP9).

The following sections explain the approaches taken in the market analysis, the policy packaging and the context sensitive design processes. After this, section 4 presents the evaluation of the CoPs from the stakeholders point of view, and as a participatory research environment and their ability to deal with impact, institutional and moral uncertainties.

3.3.1 CoPs and the validation of policy packages

A policy package refers to a "*synergic combinations of policy tools geared to effectively achieve chosen policy goals, while minimizing unintended deleterious policy effects, and enhancing the package's* *legitimacy and feasibility*" (Naftali and Dodick, 2020, p.6). The process implemented in WATER MINING comprises the following steps:

1. Designing the Basic package. Definition of objectives and targets, create an inventory of measures and perform a policy gap analysis, then assess the effectiveness and implementability of measures.
2. Designing the Effective package. Assess the interrelation among measures and neutralised unintended and rebound effects.
3. Designing the Viable package. Assess the social and political acceptability of the measures.

The former two steps are mainly expert based processes, led by WP10 leaders and participated by project partners. Project partners were split in sea, urban and industrial mining working groups. These phases of the process were developed by project partners and no direct interaction with stakeholders took place.

In parallel, between February (Month 29 of the project) and May (M33) 2023 the third CoPs meeting took place. Issues discussed in these instances were varied and were reported in the CoPs meeting reports and in the different deliverables of WP2. Policy packages were presented and discussed in CS1 and CS5, while technical scenarios were brought to discussion in the CoPs meetings of CS1, CS2 and CS5. In CS4 the economic evaluation of the proposed system was presented and discussed and in CS6 the discussion focused on the barriers analysis and understanding the prospects of the business case.

Partners of WP10 had the opportunity to review the meeting reports and deliverables D2.6 and D2.7, which described the context sensitive design process and its preliminary outcomes and derive and/or improve some policy recommendations. These processes resulted in the improvement and complementation of policy packages according to stakeholders' insights (See Box 2 and Table 7 of Annex 1).

Box 2: Incorporating stakeholders' insights in the policy packaging process. The case of thermal desalination.

In CS2, stakeholders express their concern about increasing water availability in the region. If adequate policies are not implemented, larger water availability would foster increasing water consumption and water scarcity in the long term (due to rebound effects). According to this, stakeholders from CS2 proposed the following measures:

- Desalinated water should substitute and not complement water withdrawal from aquifers.
- Water withdrawal from aquifers should be forbidden until they are recovered.
- Priorities in water use should be well defined (drinking, irrigation, leisure...)
- Implement labelling systems to identify decarbonized desalinated water or the (sustainable) source of recovered resources (e.g., NaCl)

Similar concerns were expressed by stakeholders of CS4. The increasing water availability, in quantitative and qualitative terms, would incentivise farmers to switch to more profitable crops (also less sensitive to water salinity), which would increase water consumption in the medium and long terms.

These concerns were translated into policy measures by WP10's partners:

- Mandate that the supply of water be controlled by restricting drilling/pumping permits, to prevent over-consumption of fresh-water, and that above a specified limit, desalinated sources should be used.
- Mandate that EU support is given in regions or Member States on the condition that significant conservation measures are being implemented.
- Provide (short-term) government funding so that EU Member States can improve their water conservation.
- Mandate the use of Block pricing (i.e., tired pricing for water being used) which penalizes overuse.

During the last phase of the policy packaging process, policy proposals were presented one-by-one to CSs' stakeholders to discuss, validate and improve policy packages. This meant that the validation of policy measures took time and effort. In some stakeholder meetings, no dedicated and adequate participatory method was applied, and the time needed to discuss policy measures took an important amount of the available time. This may reduce the motivation of stakeholders to participate in meetings, which can be reinforced by the fact that not all stakeholders participating in a CoPs meeting have the knowledge and interest in policy packaging process, and by the level at which policy proposals are discusses (i.e., mostly EU level).

3.3.2 CoPs and the market mapping process

As part of WP9, Task 9.2 focused on the market system analysis (MSA) for new technologies and products that were developed and demonstrated in the case studies of WATER MINING.

Market System Mapping is designed as a qualitative, participatory research tool for analysing markets for scaled-up implementation of technologies. It consists in analysing the market system by mapping (1) (current or potential) market actors, (2) the policy and business enabling environment (barriers and enablers) and (3) supporting services.

The aim was to elaborate on the desired market system to successfully deploy the sea- or wastewater products. Comparing the desired and current market systems would enable us to identify factors that need to be improved, such as barriers or obstacles that must be cleared for increased competitiveness of sea- or wastewater products.

WP9 partners highlighted the contribution of a vast amount of practitioners' knowledge and market insights into the research. Very valuable information on how to improve market systems for water-mined products (D9.2) was incorporated from stakeholder knowledge. It allowed the identification of showstoppers for technology deployment and to locate market actors and beneficial factors that can support the deployment and diffusion of WATERMINING technologies into markets.

The market mapping process took the following steps:

1. **Scope of the analysis**. Definition of the products to focus on, performed by WP9 and case study partners.

2. Introductory **training session** hosted to familiarise case study partners with the market system analysis process. The market system analysis was to be carried out by Case Study partners given their familiarity with Case Study market contexts, stakeholders active in the markets and ability to communicate with stakeholders in the national languages.
3. **Preliminary version of a market system map**, which was drafted by the case study owners and facilitators based on their expert knowledge.
4. **Validation of preliminary market system maps**. Former maps were improved and validated with small groups of key informant stakeholders towards advanced market system maps.
5. **Identification of market barriers** that could hamper the eventual deployment of WATER MINING products and technologies. Barriers included market competitors, relationships between market actors, lack of policy incentives, legal barriers or knowledge gaps.
6. **Validation of advanced market maps**, with wider groups of stakeholders in the second CoPs meeting. This resulted in the final market system maps, showing a picture of what markets should look like to be ready for deploying and diffusing WATER MINING products and technologies.

The following Table 3 shows some of the outcomes of the market system analysis.

Table 3: Barriers, enablers and policy recommendations from market System Analysis.

Barriers	Enablers
• The relatively high costs of a new technology that is being developed from research and development towards market deployment. These costs may decrease over time though, due to learning effects and reaping of economies of scale. • Environmental damage from conventional systems has not yet been fully addressed by environmental costs, which undervalue environmental benefits that WATER MINING technologies can bring • New products mined from the sea- or wastewater needto gain trust among market actors, in terms of product characteristics and quality. • Current EU legislation stills considers some water mined products as waste, which hinders the deployment of a potential market for them. • In general, unclarity about permits and licenses are considered an important barrier for the operationalization of the cases studies' technology systems. • Limited collaboration between research institutes and water treatment companies, as well as the lack of engagement by the national government, which slows down the improvement of products, procedures, and cost- effectiveness of WATERMINING solutions.	• Growing concern about water scarcity. This strengthens the need for producing water for consumption and uses in industry and agriculture from sources such as sea or wastewater. • Increasing awareness of the potential environmental impacts of conventional treatment of sea- and wastewater and the potential contribution of Water Mining technologies, which could justify paying higher prices for these and generally give rise to positive social perceptions in terms of sustainability. • The market value of environmental benefits can be further strengthened by formulating stricter legislation on the use of conventional products. • Currently, there is already a rather long list of potential EU policies and policy instruments that could potentially incentivize circular sea and water treatment. The policy momentum seems to be growing with the introduction of the EU Green Deal and other EU funding opportunities.

Policy recommendations
• Regulating the origin and quality of (irrigation) water, use of desalinated water in sectors other than agriculture and stimulating use of renewable energy sources in water treatment. • Renewable energy investment support, pricing negative environmental externalities (such as CO_2-eq. emissions by conventional water treatment), • Stricter monitoring of illegal water catchment, • Stricter legislation on the use of conventional, linearly produced substances, • Efforts for increased public awareness of the need for sustainable, circular water treatment. • Water-mined products are often considered waste by EU regulations, which increases uncertainty about the business model of mining Kaumera and phosphates from wastewater. • Foster the status of end-of-waste to nature-based substances, to be applied as alternatives to conventional, linearly produced substances. • Stricter EU legislation could be considered on the use of conventional products, e.g., a ban on seed-coatings made of microplastics in fertilizers.

Following the market system analysis, Task 9.3 was aimed at developing circular business models for WATER MINING technologies. In D9.3, business models are considered as as "*the rationale of how an organization creates, delivers, and captures economic, social, and other forms of value*" (Osterwalder et al., 2005; Osterwalder and Pigneur, 2010), which maps the functional relations among the firm's value creation, delivery and appropriation mechanisms and the underlying activities. Circular business model refers as that one that creates value in a manner that enables regeneration of finite natural resources, and keeps products, components and materials at their highest value and utility, while reducing waste.

WATER MINING circular business models were developed following the seven steps presented in Table 4.

Table 4. Steps to develop the circular business models

Step	Description
Desk research	The research team reviewed the available information on the cases: description contained in the project proposal and explanatory videos elaborated in WP2.
Literature review	Literature review on business models in the water and wastewater sector.
Questionnaire to case study partners	A complete questionnaire was applied to understand, in each case study, each of the blocks that make up the business model. The questionnaire is divided into three layers: the economic or entrepreneurial dimension of a business model, and the social and environmental dimension of the cases.
Discussion meetings	The first phase of the research focused on the economic dimension. For this, a structured online questionnaire was designed based on the original questionnaire and answered by the CS operators (CSOs) and CS facilitators (CSFs). Afterwards, bilateral meetings were held to clarify the answers and to have an open discussion to gain a better understanding of the potential business models associated with the demonstration projects.
Assessment of the business models	Business models were assessed in environmental and social terms, based on available sources of information from the research carried out in WP2, WP8 and Task 9.2.

Development of preliminary business models	With the gathered information, the preliminary version of three circular business models were developed
Validation	The preliminary versions of the business models were discussed and validated with policy and market experts in a workshop organized by WP10 in Brussels. Feedback was incorporated to the final version of the circular business models.

Three business models were developed, considering the following aspects: 1) Value proposition (Products and Services, Customer Segments, Customer Relationships), 2) Value creation and delivery (Key Partners, Key Activities, Key Resources, Channels), Value capture (Revenues, Costs), and Circular value. More information about the circular business models can be found in Pereira et al., (2023)

3.3.3 CoPs and a context-sensitive design of technologies

WATER MINING implemented a "context-sensitive design" approach (Palmeros-Parada et al., 2023) to CSs, with a Responsible Innovation perspective (Marques Postal et al., 2020). These processes were developed using the CoPs as a space of discussion and knowledge exchange between researchers of the project and stakeholders.

The Responsible Innovation perspective aims at making the innovation process more anticipatory, reflexive, and responsive by promoting a strong participation of stakeholders (Marques Postal et al., 2020). The context-sensitive design (Palmeros-Parada et al., 2023) was aimed at consciously incorporating societal aspects into emerging technologies, which are often developed in processes that are blind to the context and the stakeholders' realities (Palmeros-Parada et al., 2017). The approach incorporated elements of Value Sensitive Design (VSD) literature (Davis and Nathan, 2015; Friedman et al., 2017), sustainable design (Palmeros Parada et al., 2020, 2018) and participatory assessments (Gamboa et al., 2016).

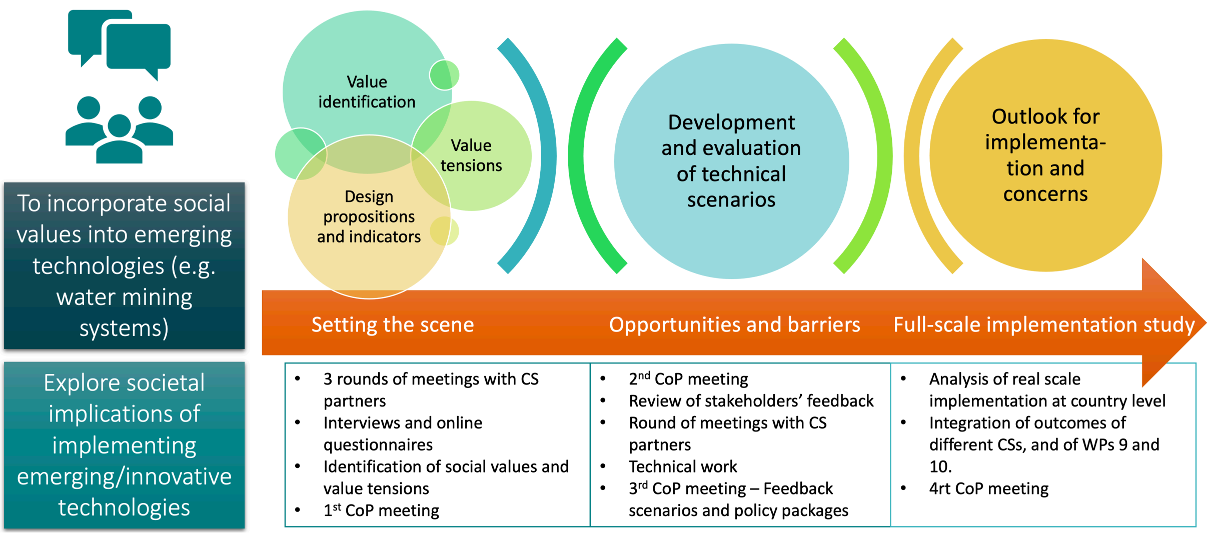

Figure 4: Communities of Practices and Context-sensitive design approach.

To carry out this context-sensitive design approach, the following steps were implemented (Figure 4) (See D2.6, D2.7 and D2.2 for a detailed description of this process)

First, societal values and value tensions were identified through literature review and interviews to project partners and key informants. Based on that, a set of technical scenarios were developed in each CS, as well as a set of multidimensional indicators to evaluate the socioeconomic and environmental performance of the scenarios.

Technical scenarios explore different technical configurations to respond to the identified value tensions. The scenarios are tools to explore different technology development pathways, allowing to anticipate potential impacts, and explore and discuss the identified tensions more concretely (Palmeros-Parada et al., 2023). Technical configurations were developed considering four main variables: 1) process and technology, 2) product and by-products, 3) scale and supply chain, and 4) raw materials and utilities (Palmeros-Parada et al., 2018).

It should be noticed that the aim of this work was not to design the optimal full-scale implementation scenarios of WATER MINING technologies, but to use the design of such a system to explore its societal implications with explicit recognition of emerging tensions between societal values around it.

As a result of implementing these processes, interesting discussions and analyses derived from the development of technical scenarios have taken place in CoPs meetings. The feedback collected from stakeholders have been of key importance to identify critical issues that go beyond the reach of technological development, such as discussing the limits of Circular Economy when providing scarce resources, such as water, to highly resource-demanding and growth-oriented industries. For instance, in CS1 the recovery of salts was questioned considering the available land and renewable energies in the island. In CS2, it has been questioned whether supplying desalinated water to the export-oriented agro-industry is sustainable even if it is powered with thermal energy, considering the context of a water-stressed region where aquifers are already highly degraded. Similar discussions have taken place in CS5, where increasing upstream water consumption may reduce water availability downstream, despite a full circular water economy being implemented upstream. In CS4, the feedback of stakeholders led the researchers to test the feasibility of implementing the WATER MINING technologies without the Nano Filtration.

The following boxes present how CS2 (Box 3) and CS3 (Box 4) incorporated stakeholders' concerns in the process of technology development.

Box 3: Incorporating stakeholders' concerns in technology development at high TRLs. The case of thermal desalination.

Case study 2 of WATER MINING was implemented by CIEMAT in the Plataforma Solar de Almería, Tabernas (Spain). The largest solar thermal open-air lab in Europe. This case study proposed a thermal desalination system composed by a Nano-filtration (NF) unit, followed by a Multi-Effect Distillation (MED) system and Thermal Crystallizer (ThCryst). The NF would remove divalent ions of seawater, allowing the MED to operate a higher temperature (90°C instead of 70°C) and reaching higher recovery rate (86% instead of 38%). The recovery rate is the portion of the seawater that is obtained as distilled water. Then, the brine of the MED would pass through the ThCryst, which would recover NaCl, producing an additional amount of distillate water and reducing the amount of brine to almost zero. Finally, part of the NF reject would be mixed with the distillate to produce irrigation water.

From the discussion with stakeholders several social values and value tensions were identified. One of these tensions is related to the issue of Zero Liquid Discharge and land use: Thermal seawater desalination would be the only way to reach ZLD. This raises some tensions between land use (of thermal energy) and the use of fossil fuels-based electricity (and CO_2 emissions) to desalinate water with conventional systems (such as a Reverse Osmosis (RO)).

To deal with this issue, one of the technical scenarios considered to the thermal desalination system after a conventional RO system, which has a recovery rate of about 50%. The idea would be to treat the RO brine and achieve a Zero Liquid Discharge (ZLD). However, VSD researchers realized that if the RO brine passes by the NF unit, then the salinity of the brine would reach very high values, which would be an obstacle for the operation of the ThCryst.

Therefore, the VSD researchers decided to disregard the NF unit and treat the RO brine with a MED operating at 70°C and a recovery rate of 36% and the ThCryst, with a performance close to ZLD (Palmeros-Parada et al., 2023).

This example shows how concerns expressed by stakeholders can be incorporated into the development of the technological system and adapted by technical partners having in mind the viability of the proposal.

The following conclusions can be drawn from this case:

- In this case, project partners from WP2 and CS2 translated social values and concerns into technical configurations. This participatory approach would be in between Consultation ad Participation (Table 1)
- High level of skills is required to directly contribute to the design of desalination systems. Therefore, few stakeholders were able to provide technical inputs regarding the development of technical scenarios.
- As the stakeholders were able to make some proposals and project partners have full control of selecting the submitted ideas, the *co-production* approach is closer to *Submitting* (Figure 2).

Box 4: Incorporating stakeholders' concerns in technology development at high TRLs. The case of Kaumera.

Case study 3 of WATER MINING was implemented by TUDELFT (The Netherlands), Águas do Algarve (WWTP Faro-Olhão, Portugal), Acciona, Lenntech, RHDHV and Wetsus. This case study proposed to optimize a Kaumera extraction installation in a warm climate. As mentioned before, Kaumera is a biopolymer extracted from aerobic granular sludge generated in a Nereda® wastewater treatment plant.

Nereda® sewage treatment process purifies water with little or no chemicals, by using a patented aerobic granular sludge technology. Compared to conventional activated sludge installations, the Nereda® aerobic granulation technology reduces energy costs with a much smaller physical footprint for municipal and industrial wastewaters.

To produce Kaumera, the granular sludge passes through a first extraction reactor, which operates at high temperature and alkaline environment. Then, a centrifuge separates the residual sludge and sends the concentrate to a precipitation reactor, which operates at ambient temperature and acid environment. Next, a centrifuge separates Kaumera from residual concentrate.

The aim of the research was to optimize the Kaumera extraction installation to warm climate regions, analyse the characteristics of produced Kaumera and do application tests with it.

From an iterative process of feedback between researchers and stakeholders, several research topics were identified and included in the research agenda of the WATER MINING team. Kaumera can be used for several applications in agriculture, construction and industry. During the interviews with key informants and in the first CoPs meeting, stakeholders expressed their interest in studying the agricultural applications of Kaumera as combined bio-stimulant and water absorber. Agriculture and horticulture are very important activities in Algarve, and water shortage a very pressing issue. Therefore, the research team together with stakeholders have chosen the most promising application based on the local needs. This leads to the first change in the design of Kaumera extraction installation: the use of sulphuric acid instead of hydrochloric acid to avoid the presence of Cl in water and the soil in the application of Kaumera. The presence of Cl in water is usually not a problem for the Kaumera extraction process, but in Faro Olhão there is already Cl in the inflow due to the seawater intrusion in the sewer.

Then, some stakeholders expressed their interest in knowing the nutrient content and the salinity of Kaumera: two important characteristics for agricultural applications. In fact, salinity of wastewater can be considered a usual situation incoastal cities like Faro. As well, some stakeholders expressed some concerns regarding the content of heavy metals and emergent pollutants in Kaumera. All of this leaded to the analysis of Kaumera's composition to answer the questions of concerned stakeholders.

As well, agricultural trials to evaluate the performance of Kaumera as bio-stimulant in relevant crops for the Algarve and nearby regions (i.e. citrous and corn) were incorporated in this case study. Trials, which were not considered when writing the WATER MINING project, but requested by stakeholders, were performed by Portuguese Catholic University and deliver very interesting and positive results. Initial tests using Utrecht Kaumera applied to corn cultivation showed plant growth promotion and about 30% lower irrigation water needs. While this report is being written, further trials are being performed in citric orchards and using Faro Kaumera by the University of Algarve to evaluate the contribution of Kaumera as soil improver, as biostimulant and to water absorption.

This example shows how concerns expressed by stakeholders can be incorporated to the development of the technology/product and on the production process to achieve the qualities required by end-users. Some lessons learned from this case are the following:

- Stakeholders' concerns and expectationswere included in the research agenda. For a successful incorporation of stakeholders needs in the research agenda, researchers' willingness to collaborate is essential. In this case, researchers considered the research process easier and more pleasant: "stakeholders set the agenda and researchers follow it".
- It makes technology development relevant to the context and keep participants motivated to participate and contribute to the research process

- The willingness of researchers to receive and incorporate stakeholders' priorities, expectations and concerns in the research agenda creates a cooperation atmosphere between all actors involved.
- Stakeholders' participation and inputs help researchers have a better grasp on complexity. For instance, it was important for stakeholders to know how the product can be applied: Can these be dissolved and applied to the drip fertigation system? Mixed with soil in young plants growing in greenhouses? Can these be dried, maintaining their properties, so that it has much lower transport costs and can be more easily handled? Practical concerns such as those listed here, as well as some doubts, also guided research on the characteristics of the product to be delivered to end-users.
- The inclusion of stakeholders when writing the proposal would be important to better define the research topic, research process and the budget to implement it.
- Even though the product was already defined (i.e., to produce a bio-polymer from granular wastewater sludge), the end-use to be researched was decided based on the inputs from stakeholders. This approach is close to *Partnership* with *limited decentralized decision-making* (Table 1).
- As the stakeholders were able to make proposals and project partners have full control of selecting the submitted ideas, the *co-production* approach is closer to *Submitting* (Figure 2)

4 Evaluating the CoPs

4.1 This section starts by presenting the evaluation of the CoPs by stakeholders, who also made some recommendations of improvements. Then, CoPs are evaluated as participatory research environments: first, Stakeholder's evaluation

To measure the success in terms of output and the functioning of the CoPs over time, an evaluation of CoPs has been done. The evaluation approach adopted in WATER MINING is based on Fulgenzi et al. (2020) to measure the CoPs maturity, structures and process that support the success of CoPs according to the following dimensions:

1. Interaction and engagement of stakeholders (community)
2. Stakeholder's awareness of their own role and those of others (domain)
3. Changes in stakeholder issue frames (practice)

And for each dimension, the following 6 key success factors (KSF) to be assessed are proposed:

1. Organisational aspects
2. Atmosphere
3. Stakeholder inclusion and representation
4. Convergence towards shared perspective
5. Identification opportunities and challenges
6. Generation of knowledge

The KSFs would enable CS partners to identify which aspects are sufficiently incorporated in the CoPs and which aspects deserve more attention based on a set of indicators (or statements). The assessments allow CS partners to implement changes to the CoPs meetings to improve their overall added value, as well as draw overall lessons on successful co-creation in CoPs. As such, the evaluations have helped with continuous learning and improvement of the CoPs within WATER MINING by identifying best practices. These insights are also useful for the implementation of CoPs in future EU projects. The evaluation has been transferred into an online survey, using Survey Monkey, and translated into multiple languages including English, Spanish, Catalan, and Portuguese.

On average, participants across CSs evaluated the CoPs meetings as very valuable (4/5), see figure below. Participating stakeholders found the CoPs meetings to be informative and a good opportunity to engage with a diverse group of stakeholders.

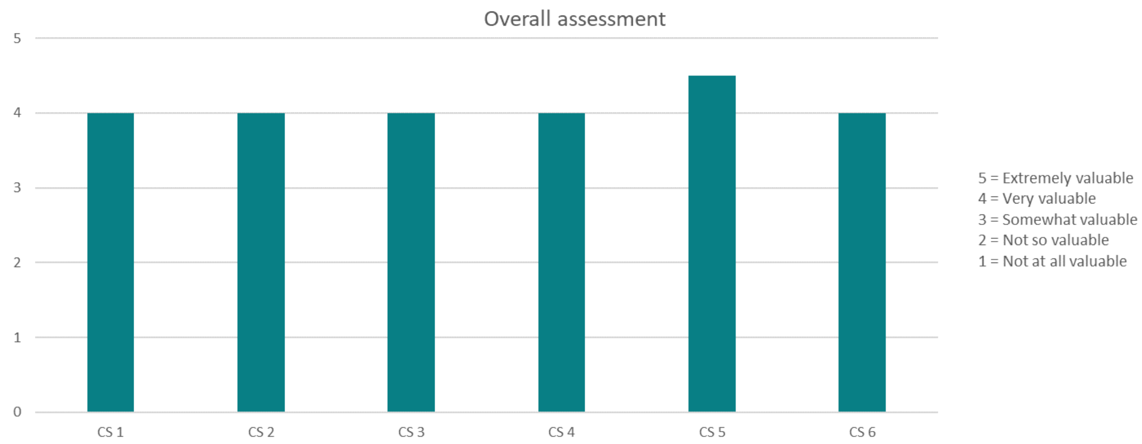

Figure 5: Overall assessment according to WATER MINING evaluation questionnaires of CoPs.

Assessing the maturity, structures and process of CoPs observing the three key elements of CoPs: community, domain, and practice, we have seen that in general the CoPs have been successfully implemented. The exceptions being on the **diversity of stakeholders represented** in the CoPs (domain) which across the CSs scored a 3.78 and **providing stakeholders with the space and time to reflect** on their collective experience and functioning as a group scoring a 3.75. On this last point, we can highlight the fact that oral presentations by experts dominated the form in which information was communicated. If time is not well managed, this practice usually leaves little time to raise and discuss issues relevant for stakeholders beyond the limited questions and answers.

Looking at the written feedback from participating stakeholders, several valued the CoPs meetings for their real-world relevance and the sharing of experiences among participants. These meetings provided excellent networking opportunities, bringing together a diverse array of stakeholders from various sectors, which facilitated the exchange of ideas, opinions, and knowledge. Participants appreciated the well-organised and interactive format of most meetings, which stimulated in most cases productive discussions and collaborative problem-solving. The sharing of technical and non-technical knowledge was particularly beneficial, allowing participants to learn about new technologies and methodologies, as well as the overall project objectives. The diverse participation and constructive dialogue were key in addressing and solving issues collectively, making these meetings a significant platform for knowledge sharing and professional growth.

Despite their many benefits, the CoPs meetings faced several challenges, primarily related to **time management and participation**, and as most CoPs meetings were held online, several faced technical difficulties. Many CoPs meetings suffered from **limited time to cover all topics in depth**, reducing the scope of discussions and working group activities. Additionally, some stakeholders did not participate actively, and important sectors such as industry (CS1, CS5) or agriculture (CS5), environmentalist (CS2), public health (CS5) were in some cases underrepresented or not present. Online meetings encountered technical difficulties, including poor internet connectivity and the challenges of virtual interaction, which hindered effective communication. Moreover, **meetings sometimes lacked clear and objective information about the projects or products being discussed**, leaving participants without a comprehensive understanding of the implications and benefits. These issues impacted the overall effectiveness and engagement of the meetings, although not significantly.

To enhance the effectiveness of future CoPs meetings, several improvements were suggested by stakeholders. For example, **extending the duration of meetings** and **allocating more time for discussions and working groups** to ensure all topics are adequately covered. Putting more time and attention to **ensuring the active participation of all relevant stakeholders** and **improving the dissemination and involvement of local communities and underrepresented sectors**. Conducting **face-to-face meetings** where possible can enhance interaction and relationship-building, and **technical tools should be tested in advance** to avoid issues during virtual sessions. Meetings **should start with a clear overview of roles, expected contributions, and motivations of participants**, and **provide detailed, comparative, and objective information about the projects or products under discussion**. **Focusing each meeting on one or two main topics** can allow for more in-depth discussion, and **smaller group formats can facilitate better communication and more in-depth discussions**. **Encouraging participants to share their expectations and contributions** can further enhance engagement. These recommendations are in line with the worst evaluated aspects of the meetings: the representation of stakeholders and having enough time and opportunities to reflect (See Figure 7 and Figure 8). Section 5.2 Recommendations for best practices delas with these issues and proposes ways to improve them.

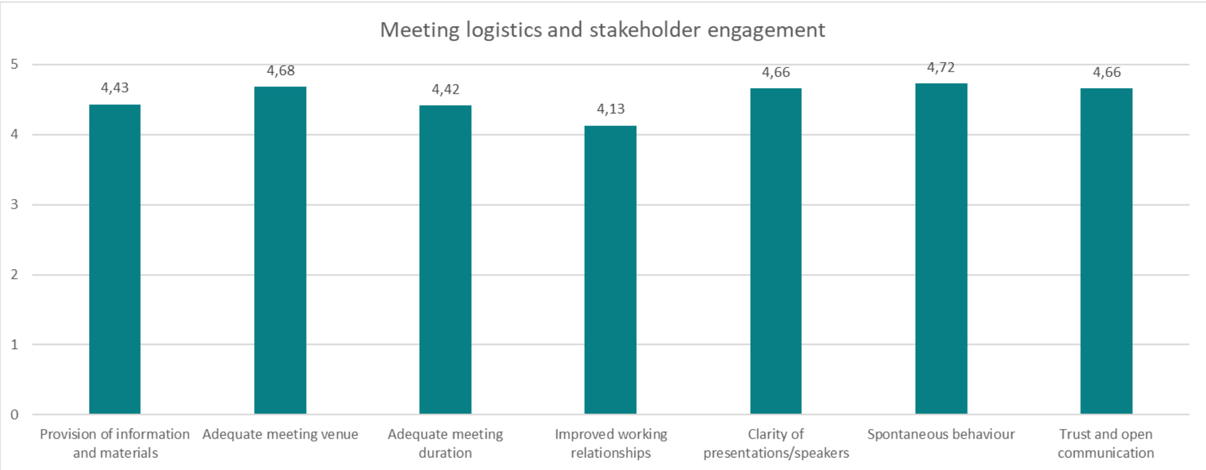

Figure 6: Measured meeting logistics and stakeholder engagement according to WATER MINING evaluation questionnaires of CoPs.

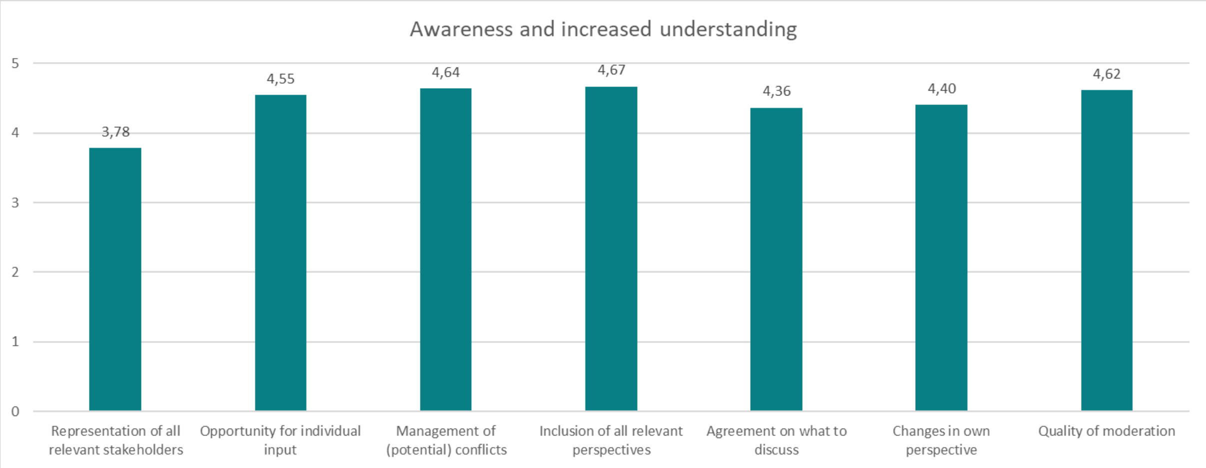

Figure 7: Measured awareness and increased understanding according to WATER MINING evaluation questionnaires of CoPs.

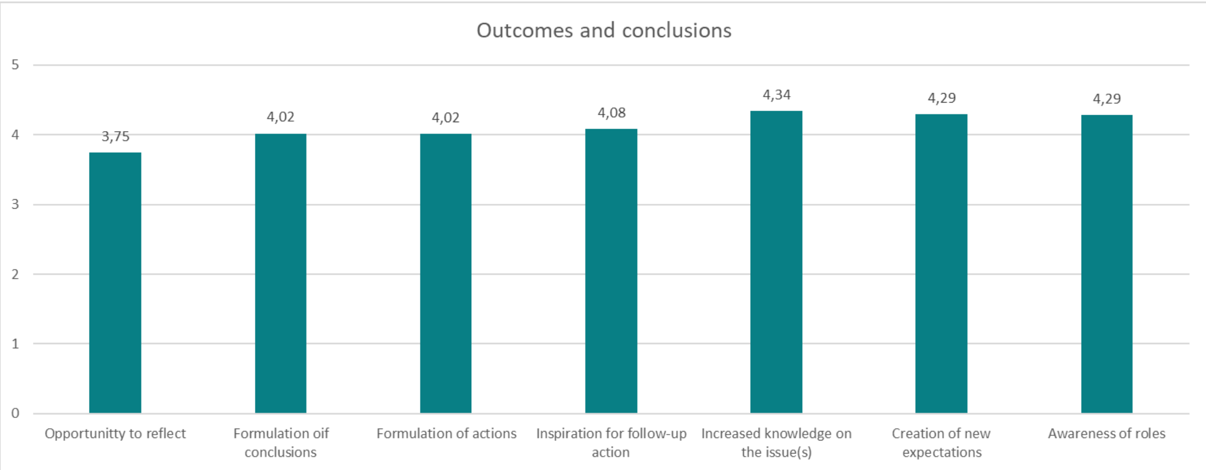

Figure 8: Measured outcomes and conclusions according to WATER MINING evaluation questionnaires of CoPs.

Although guidance has been provided with recommendations on best practices for the stakeholder evaluation survey circulation to try reach an adequate response rate, one of the main problems experienced in WATER MINING has been the **low rate of responses, which decreased with time**. This might in part be due to survey fatigue, but also because the online survey is often sent the day (or days) after the meeting by email. Having identified this issue by the CS partners, **paper copies** of the survey were distributed to participants to provide their feedback before leaving the meetings (this was also highly recommended in the guidance documents for CoPs implementation).

Other ways of dealing with the low rate of responses could be to consider simplifying the evaluation form to make it easier and quicker to answer, for instance, by reducing the number of questions directed at participants as much as possible and transferring some questions to the CoPs facilitators. The format in which the survey is distributed could also be further explored. Furthermore, the way we accommodate the needs and preferences of stakeholders must be considered to reduce participation barriers. The implications on the assessment process of the collected feedback would need to be considered as well (i.e., multiple approaches would require transferring all data into one system for seamless analysis, which will require additional resources and time). Furthermore, **dedicating time in**

the agenda to complete the evaluation (i.e., as an activity of the meeting) might contribute to an increase in the response rate. Also, by clearly communicating why the survey is necessary and how stakeholder feedback will be used to make improvements helps stakeholders see their input as vital and impactful. After collecting survey responses, a summary of the findings and detailing the specific actions taken as a result will show that their input has been acknowledged and addressed.

4.2 CoP as participatory research environment and co-creation

In WATER MINING, different approaches to participatory research and to co-creation were adopted. While the context-sensitive design process was framed under a *normative* approach to participation, located in between *participation* and *empowerment* (Table 1), the market analysis and policy packaging processes took a *substantive* approach to participation (close to *consultation*).

In the policy packaging process, CS facilitators and WP2 leader perform as a communication bridge between stakeholders and the policy packaging team. Stakeholders were informed and queried, to validate the policy package proposals and get feedback for their improvement. This process is considered dense in information, long in its timeframe, and one that needs multiple steps to validate and integrate the results from all the debates. Adequate participatory methods are necessary to perform a dynamic and engaging discussion on policies in stakeholder meetings. Alternatively, in-depth interviews with policy experts and/or interested parties (e.g., industrial associations, environmental groups or NGOs) seems more adequate than the approach used to integrate stakeholders' opinions in the WATER MINING policy packaging process

The market analysis gave a step forward in terms of participatory research, being located between *participation* and *placation*. Here, stakeholders built together with project partners the market analysis, allowing the incorporation of different types of knowledge in the development of the market environment in which WATER MINIG technologies would be deployed. Practitioners' knowledge was of fundamental importance when identifying market actors, policy and business enabling environment and the supporting services.

Business models development, as the policy packaging process, was based on expert knowledge. Feedback to the preliminary models was limited to project partners and policy and market experts.

Regarding *co-creation* in technology development projects, technology readiness level (TRL) is an important issue that would affect the degree of stakeholder engagement in a co-creative participatory research process. First, the issue definition is usually closed, which means the relevant problem to be solved has been identified/defined in previous steps of the research process. Therefore, there is little room for *co-defining*. Even if some stakeholders manifest that the issue definition is different than the one defined by the project, the project will develop a specific set of technologies to solve an already defined problem. Depending on the TRL of the project, the concept and application has been formulated (TRL 2), it has been tested at lab scale (TRL 3) or even a large prototype is ready for being tested in an intended environment. This would also reduce the space for co-*production*.

In cases of high TRLs (e.g., WATER MINING TRLs went from level 5 to 7 across CSs) inputs from stakeholders are constrained in different ways. Participatory co-creation research seems to be located under the *Consultation* and *Participation* approach to participation (Table 1) and between *Submitting* and *Co-design* approaches to *Co-production* (Table 2). In the context of a context-sensitive design process, *Co-designing* would entail that researchers collect content and ideas from the participants in the CoPs. Then, ideas are distilled by researchers according to the technical viability of proposals, and a discussion and reflection about emergent societal issues can be carried out with a wider audience. In *Submitting, the same approach can be applied, but the role of stakeholders would be more restricted than in Co-designing, and the discussion about emergent societal issues would not necessarily take place (See Box 3 and* Box 4 for examples).

Collaborating and *tinkering* would hardly take place. This would be possible if core components and/or the underlying structure are open access, and it would require technically skilled participants in the CoPs.

Table 5: Technology Readiness Levels (TRL) in technology development.

TRL	Description
0	Idea. Unproven concept, no testing has been performed
1	Basic research. principles postulated and observed but no experimental proof available
2	Technology formulation. concept and application have been formulated
3	Applied research. First laboratory tests completed, proof of concept
4	Small-scale prototype built in a laboratory environment.
5	Large scale prototype tested in intended environment
6	Prototype system tested in environment close to expected performance
7	Demonstration system operating in operational environment at pre-commercial scale
8	First of a kind commercial system. Manufacturing issues solved.
9	Full commercial application, technology available for consumers.

Openness and transparency towards contributing stakeholders are important features adopted by researchers and technology developers to increase sense of ownership. This may imply sharing the details of the core components and structure of the product, or even property rights. However, when industrial knowledge over some products and processes provides competitive advantage over other industries, this knowledge is strictly confidential to actors that are external to the firm. Within WATER MINING project, this potential conflict between confidentiality and stakeholder engagement was raised and discussed during the annual meeting in Palermo, on September 19th, 2022. During the ethics session, to the question of whether 'The ethical aspects of openness and transparency are important for science and technology' partners answered in the following way: 35 agree, 8 somewhat agree and 1 disagree. Some of the ideas expressed by respondents included the following:

- Being open and transparent would vary between the (foreseen) product and the process, mostly in the context of patents.
- Being open and transparent is very context-dependent and is also dependent on the specific type of technology.
- Openness and transparency can have a backlash.
- Democratization of science and technology is necessary.

Tension between these values were expressed in the discussion. On one side, there was a partner very much in favour of patenting, who was convinced that often information does not need to be shared as it is very specific and detailed. It was argued that for WATER MINING, for instance, not all technical details are necessary for the other work packages to do their research. On other side, technical scenarios were not developed in two CSs, because some technical details were not shared due to confidentiality (Asveld et al., 2024). This tension may pose some constrains to carry out a fully transparent stakeholder engagement and participatory research for technological innovation and development. In these cases, *Submitting* and *Tinkering* seems to be more appropriate.

To develop these processes, stakeholders' motivation and engagement are of key importance. According to O'Hern and Rindfleisch (2017), motivation may decrease as empowerment and involvement decreases in co-creation processes. Therefore, lower levels of participants involvement may require explicit recognition of co-creators (e.g., financial rewards), while higher levels of involvement may foster higher levels of intrinsic motivation and psychological ownership that would foster voluntary involvement in the co-creation process.

The role of stakeholders in co-creation can be varied. There is no best approach. It would be good to make clear, from the beginning, what is the role of stakeholders in the co-creation process to avoid unfulfilled expectations and frustration. If the type of participation is not made explicit beforehand and not communicated clearly to the participants, there is the risk that the process looks like a co-creation and hence legitimize certain technological development. Not all participatory research can be called co-creation.

4.3 Dealing with uncertainties

In general terms, the identification of moral and institutional uncertainties was done indirectly thanks to the context-sensitive design process, which was aimed at identifying societal values and value tensions surrounding the deployment of WATER MINING technologies. Based on that, discussions about the potential impacts of full-scale implementation of emerging technologies took place. Even though there will be always uncertainty and ignorance in the potential impacts of an emerging technology, it provides good prospects to reduce hypocognition and deal with *impact uncertainty*. *Moral uncertainty* has been partially addressed. A wide range of social values are identified, but actual implementation of emerging technology will always entail the emergence of moral questions and dilemmas.

Institutional uncertainties should have been tackled by the policy packaging and market analysis processes. The policy packaging process was explicitly aimed at developing *policy recommendations to advance the widespread implementation of the case- studies technologies and business models*.

Researchers performing the context-sensitive design process acted as a communication bridge between stakeholders and policy packaging team. Moral uncertainties (e.g., trade-offs between aquifers conservation and economic benefits from exporting highly intensive agriculture in CS2) were identified in the context-sensitive design process and were transferred to the policy packaging process, then translated into proposed policy measures (e.g., to substitute groundwater extractions with desalinated seawater).

Some institutional uncertainties were identified in this process. However, the technocratic approach with limited interaction with stakeholders or beyond mainstream circles of policy experts, and the focus on paving the way to WATER MINING technologies without giving special attention on potential unexpected consequences of deploying WATER MINING technologies, limits the potential identification of necessary institutional arrangements to embed new WATER MINING technologies in society.

In comparison to the policy packaging process, the market system analysis explicitly looked for moral and institutional uncertainties in the form of market barriers and enablers.: e.g. values that would drive consumers to choose between water-mined and conventional products (price, environmental impact, circularity) were identified as barriers and enablers. New institutional arrangements in the form of market mechanisms and business models were developed and proposed.

However, in both cases, potential new institutional arrangements were built within mainstream narratives and imaginaries. Little room is left for alternative ways of framing the problem at hand, with less possibilities to imagine and develop institutional arrangements for unexpected scenarios.

In general terms, more and better coordination between work packages in charge of stakeholder engagement, policy packaging and market analysis is needed, explicitly deploying adequate participatory research methods. This is required to increase the relevance of stakeholder engagement in developing the adequate institutional arrangements to deal with emerging and unexpected scenarios.

5 A model of stakeholder engagement and participatory research for technological innovation

In the WATER MINING project, participation took place within the framework of stakeholder engagement and participatory research for technological innovation. This process has been deployed within the Communities of Practice.

As it has been reviewed throughout the deliverable, stakeholder participation, among others, would foster social learning, empowerment, and personal and institutional transformation, while it enhances the transparency, accountability, and legitimacy of decision-making, as well as its perceived fairness and democratic qualities (Anggraeni et al., 2019; Blackstock et al., 2007; Carr et al., 2012; Díez et al., 2015; Englund et al., 2022; Fulgenzi et al., 2020; Grant and Curtis, 2004; Luyet et al., 2012; Pahl-Wostl, 2002; Reed, 2008; Roque et al., 2022; Thoradeniya and Maheshwari, 2018; Videira et al., 2006; von Korff et al., 2012). While participation has been positively reviewed as a process, it has limitations and disadvantages that must be recognized, such as the time-consuming aspect of its development as well as the cost, and the possible reinforcement of previously existent power dynamics and mistrust (Carr et al., 2012; Díez et al., 2015; Grant and Curtis, 2004; Luyet et al., 2012; Reed, 2008; Roque et al., 2022).

Not all participatory processes produce these expected outcomes. As we have seen in Section 2, different approaches to participation exist, from *minimal communication* (informing within an instrumental approach) to *entrusted control* (citizen control within a normative approach). Also, different approaches to *co-creation* exist, in which stakeholders can have different roles in *co-defining*, *co-producing* and *co-disseminating* new technologies. Therefore, depending on the participatory research approach and how it is implemented, different degrees of social learning, empowerment and transformation can be achieved, and impact, institutional and moral uncertainties can be addressed to different extents.

The aim of this section is to develop a set of criteria of good practices in participatory research, which can deal with impact, institutional and moral uncertainties, and fostering social learning.

The criteria of good practices of the water-oriented CoPs are found in Fulgenzi et al. (2020), which have been implemented in WATER MINING. To update these set of criteria Blackstock et al. (2007), who explicitly develops an evaluation framework for participatory research, have been considered as a starting point. Then, by applying a forward snowballing process, additional literature developing criteria of good practices of participatory research was identified. Forward snowballing refers to review citations of the documents in the start set (Wohlin, 2014). From here, the reference list expanded and included references such as Carr et al. (2012), Englund et al. (2022), Luyet et al. (2012), Cuppen (2012) or Díez et al. (2015).

A second round of literature search was done to ensure that the key literature was well rounded. So, a new search in Scopus, WoS and Google Scholar was done using key words such as "participatory process", "participatory research", "water", "technology innovation". Abstract of references found were reviewed and relevant literature was incorporated to the list.

The analytical process followed to identify criteria of good practices was as follows:

1. The criteria for evaluating participatory processes and CoPs were extracted from the following selected literature:
    a. Blackstock et al. (2007).
    b. Carr et al. (2012).
    c. Díez et al. (2015).
    d. Cuppen (2012).
    e. Englund et al. (2022).
    f. Fulgenzi et al. (2020).
    g. Kelly et al. (2007).
    h. Luyet et al. (2012).
    i. Wittmer et al. (2006).
2. A preliminary list of criteria of good practices was created. Redundancy was used to select them, meaning that only those criteria that were not already in the list from another paper were put forward.
3. Then those criteria that were related or complementary were combined to make the list more comprehensible and shorter. Redundancy was used again here as the benchmark to put together certain criteria.
4. The final list that was compiled consisting of 24 criteria divided in in the following 5 dimensions: Logistics that facilitates participation; Meeting atmosphere and adequacy of participatory methods for facilitation; Identity and representativeness of relevant stakeholders and interest groups; Democratic quality of the decision-making; and Outcomes and safeguard of new knowledge generated.

The resulting set of best practice criteria was shared and discussed with WP2 partners involved in Task 2.3, best practices for Stakeholder Engagement. To this end, a workshop aimed at defining the relevance of dimensions and criteria was organized in June 2023. During the workshop the limitations to stakeholder engagement, using as an example and context the WATER MINING project, were discussed.

5.1 Criteria of best practices for CoPs as stakeholder engagement and participatory research environments for technological innovation

Table 6 presents the criteria of best practices for stakeholder engagement under each dimension. These criteria and dimensions are used to design an evaluation scheme to assess participatory research community meetings.

Table 6: Criteria of best practices for stakeholder engagement (with and example question).

Criteria	Description
1. Logistics that facilitates participation	
1.1. Support for effective collaboration	The agenda, deadlines, milestones, research plan, objectives of the meeting are clearly communicated to participants with enough time to prepare the meeting, to facilitate the collaboration and make the meeting more effective. It also refers to whether participants get any kind of support for/to attend the meeting (economic or otherwise).
1.2. Provision of resources such as information and materials	Whether participants have adequate access to information (in quantity and quality) and materials needed for the meeting beforehand. It also includes a reference to the summary of the project and its advances to update participants and newcomers.
1.3. Definition and adequacy of the meetings	The agenda of the meeting and the issues discussed are coherent, and the duration of the meeting is adequate to discuss all topics of the agenda.
1.4. Accessibility of the meeting venue	Adequacy of the venue in terms of closeness and accessibility (e.g., transportation to the meeting venue, access for people with reduced mobility), which facilitates the participation of stakeholders. It also considers whether the venue is adequate in terms of size, spaces, required equipment.
2. Meeting atmosphere and adequacy of participatory methods for facilitation	
2.1. Interaction and network development	Related to existing relationships and new connections, leads to greater interaction and awareness of each other's activities, raises connectivity as capacity for knowledge exchange, engagement and working with each other.
2.2. Communication within the group	It is related to the clearness of the speakers in their presentations, as well as the understandability of points and arguments exposed. It is also related to the dynamics within the group, which may affect spontaneous interventions and the trust between participants.
2.3. Constructive management of conflict	It is related to the existence of an explicit constructive method for conflict resolution. This refers to a process in which participants confront each other's claims with their own claims, unravel argumentations, make (implicit) assumptions explicit, and jointly develop new ideas that are more robust. Also evaluate whether the process leads to discussion between participants who had previously refused to discuss together. Discussion is essential for identifying shared positions or conducting negotiations.
2.4. Space of exchange, dialogue, and power dynamics	It refers to a space where all ideological orientations can be expressed, and all participants are heard. The distribution of power among participants and its management (institutional arrangements support or promote it), and whether there was an active/effective way of dealing with power asymmetries is also included here. Also, it refers to whether the meeting was inclusive for everyone (e.g., adjustments for deaf or mute people).

Criteria	Description
2.5. Facilitation	This refers to whether facilitation is impartial and dynamic, whether the facilitator was experienced. A good facilitation would define goals, tasks, ground rules, responsibilities from the beginning of the meeting/process. Good facilitation include time tracking and adequate time allocation to cover the agenda and formulate conclusions of the meeting. Participants should leave the meeting with clear information about conclusions and decisions.
2.6. Adequate methods for participatory research/processes	The participatory methods used in the meeting were adequate to meet the objectives of the meeting.
3. Identity and representativeness of relevant stakeholders and interest groups	
3.1. Representation and inclusion of all relevant stakeholders and interest groups	It is related to the representation of all relevant stakeholders and interest groups and inclusion of all relevant perspectives in the discussion as well as the participation and inclusion of newcomers.
3.2. Presence of (responsible) leadership	The facilitator is responsible in terms of being on time and having prepared for the meeting. The person tasked with the leadership have the specific technical knowledge for the development of such task.
3.3. Opportunity for involvement and influence	Referring to the participant's opportunity to influence (e.g., enough time; involved early enough; access to policy makers and leaders; organisational structure), timing of involvement (e.g., public is involved at a stage when value judgments become important, involvement is considered from the onset of the project or program, and involvement is continuous), and the opportunity for participation and provide input.
3.4. Inclusion of all types of knowledge	Refers to the inclusion of all types of knowledge and perspectives (multi-inter-trans disciplinary, and expert, lay and traditional knowledges), either in the discussion and/or decisions made. Also, it refers to whether there were participatory methods to integrate different types of knowledge (not only dominated by presentations and discussion). It would also consider explicit recognition of uncertainty and ignorance.
4. Democratic quality of the decision-making	
4.1. Transparency, legitimacy and quality of the decision making	Related to transparency (i.e., referring to both internal, whereby participants understand how decisions are made; and external, whereby observers can audit the process), to a legitimate decision making (i.e., based on the norms agreed by participants at the establishment of the CoPs). Legitimacy refers to decisions that are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, or definitions: i.e., those defined within the CoPs framework. Quality refers to the establishment and maintenance of agreed standards of decision making.
4.2. Agreement for the discussion and reflective sharing	It refers to whether there is an agreement on what will be discussed in the meeting, or whether participants can propose issues to be deal with in the meeting. It also refers to whether there are good opportunities to reflect and talk about collective experiences through the research process.

Criteria	Description
4.3. Self-awareness and in relation to others	It refers to the role of the participants and the impacts on the meeting. It is related to be aware of the diversity within the group, in terms of the political, social, cultural, historical, environmental context in which the process occurs, and whether this diversity affects the development of the meeting and the interaction of participants.
4.4. Participants' ability to influence	Referring to the participant's ability to influence the decisions made in the meeting/process.
4.5. Accountability	Related to how the process facilitates responsibility and accountability to its participants.
5. Outcomes and safeguard of new knowledge generated	
5.1. Quality and ethics of the outputs	It refers to the existence of tangible outcomes of the project, and their quality in terms of legitimacy, transferability, credibility, comprehensiveness, and robustness. It also refers to outcomes adhering with ethical and confidentiality standards.
5.2. Safeguard of new knowledge generated	It refers to safeguarding mechanism actively and effectively instituted to protect the acquired knowledge such as a registry of the decisions and steps taken. It also refers to the ability of participants to access this information.
5.3. Support and endurance of outcomes	It refers to the existence and clear identification of a responsible person of the process/meeting (accountability), as well as to the ownership and future implementation of outcomes (whether there is an enduring and widely supported outcome). This includes how well the knowledge of how to perform a specific skill or task, or the knowledge related to methods, procedures, or operation of equipment, is acquired, and accounted for within the approach.
5.4. Cost effectiveness	It refers to what extent the outcomes of the process/meeting are compensated by the cost of the process (in terms of human and economic resources).
5.5. Distributive justice	Related to distributive justice, which refers to the distributive dimension of the costs and benefits associated with the outcomes.

Based on these criteria of best practices and the definition of social learning, evaluation questionnaires have been developed to assess participatory research environments (such as CoPs) for technological development (see Annex 2 and Annex 3).

5.2 Recommendations for best practices

This section presents a set of recommendations to overcome the deficiencies found in the deployment of CoPs as stakeholder engagement and participatory research environments for technological innovation and meet the criteria of best practices of stakeholder engagement.

5.2.1 Establishing a participatory research community

- The establishment of CoPs takes time. It is not necessary to establish a community in the very first meeting. This meeting can be used to present the project, the case study, the technology and create a common knowledge base among participants. Also, it can be used to know each other and identify missing stakeholders.

- Be clear on the scope, purpose, objectives and steps of the research process and on the expected role of participants, providing detailed information about the projects or products under discussion. Also, be clear to what extent the participation of stakeholders may influence the development of the new technology. Make explicit the roles in the *co-creation* approach and the approach chosen for *co-production*.
- Ask stakeholders their motivations, expected roles and contributions - these can further enhance engagement.
- Keep communication alive between the first and the second meeting. Provide information about the advances of the project, to keep stakeholders updated.
- The 8-steps for establishing a CoPs proposed by Catania et al. (2021) can be used as a guide to define the main institutional arrangement within a participatory research community.
- Take advantage of existing participatory structures and avoid duplicating participation spaces. However, roles and power relations within the group may bias the participatory research process according to the interests and agenda of the most powerful actors.
- Relying on existing participatory structures also has its disadvantages. Dissident voices (that may be not present in existing structures) should be integrated by different means. If divergent voices are not considered, then the purpose of substantive and normative approaches to participation is hindered. Diversity is desired to better grasp complexity and to consider different and legitimate viewpoints is society.
- The reflexivity of the researcher is encouraged. Questioning what biases, judgements and ideas we bring as, mostly, leaders of these participatory processes may help in understanding the influence and power roles that scientists have.

5.2.2 Implementing criteria of best practices

- Provide information about objectives, agenda and any relevant information (e.g., videos, summary of the project) to stakeholders well in advance. If there are newcomers in subsequent meetings, provide all relevant information for them to feel welcome as the rest of participants.
- Avoid being ambitious regarding the agenda of the meeting. Reflection and discussions require time, and usually take more than expected. Include time or activities for networking among participants.
- Choose adequate meeting venue to facilitate the attendance of stakeholders, in terms of accessibility, size, spaces and equipment required for the planned activities.
- Facilitation should allow all participants to raise their voice and concerns and foster constructive discussions. Small groups usually allow more people to participate and get deeper discussions. Good facilitation skills are of upmost importance. Take care of configuring small groups in a way to avoid power imbalances among participants.
- Participatory methods should be coherent with the objectives of the activity. A recommendation of participatory methods for different purposes is provided in Annexes of D2.1 (Andrews et al., 2021)
- At the end of the meetings, be sure to summarise the main discussions and conclusions, and to inform participants about the next steps in the project and in the participatory research process. Send, right after the meeting, a written summary and all the committed information.

5.2.3 Dealing with uncertainties

- Social research methods are of key importance to identify social values and value tension regarding the implementation of innovative technologies. Adequate skills to deploy these methodologies are required. This means that technical partners have to be trained in these methods or incorporate skilled people in their teams
- Identification of societal values are the basis to develop technical scenarios, and to define attributes and indicators to evaluate them, and deal with impact uncertainty. It would be interesting to apply specific methodologies to develop future scenarios, explore technology implementation paths and identify potential unexpected outcomes.
- Partners should be fully coordinated across different WPs for an adequate stakeholder engagement and participatory research process. Those in charge of market and policy analysis, for example, should participate or have access to the outcomes of the future scenarios workshops to identify potential institutional arrangements for unexpected outcomes. Policy and market analysis should not be based mostly/only on expert knowledge, and the incorporation of stakeholder's knowledge should go beyond consultation to avoid being framed within mainstream narratives.

6 Bibliography

Alegre, H., Coelho, S. T., Feliciano, J. F., and Matos, R. (2015). Boosting innovation in the water sector - The role and lessons learned from collaborative projects. Water Science and Technology, 72(9), 1516–1523. https://doi.org/10.2166/wst.2015.362

Andrews, L., Mooren, C., Munaretto, S., Gamboa, G. and Palmeros Parada, M. (2021). Communities of Practice Roadmap and Facilitation Guidance. Deliverable 2.1 WATER MINING Project.

Anggraeni, M., Gupta, J., and Verrest, H. J. L. M. (2019). Cost and value of stakeholders participation: A systematic literature review. Environmental Science and Policy, 101, 364–373. https://doi.org/10.1016/j.envsci.2019.07.012

Argyris, C., and Schon, D. A. (1996). Organizational Learning II: Theory, Method, and Practice. Addison-Wesley.

Arnstein, S. R. (1969). A Ladder Of Citizen Participation. Journal of the American Institute of Planners, 35(4), 216–224. https://doi.org/10.1080/01944366908977225

Asveld, L. (2016). The need for governance by experimentation: The case of biofuels. Science and engineering ethics, 22, 815-830.

Asveld, L., Polyportis, A. and Gamboa, G. (2024). Ethical report. Final update. Deliverable 1.8 WATER MINING project.

Bandura, A., & Walters, R. H. (1977). Social learning theory (Vol. 1, pp. 141-154). Englewood Cliffs, NJ: Prentice Hall.

Barreteau, O., Bots, P. W., & Daniell, K. A. (2010). A framework for clarifying “participation” in participatory research to prevent its rejection for the wrong reasons. Ecology and Society, 15(2).

Beaudoin, C., Joncoux, S., Jasmin, J. F., Berberi, A., McPhee, C., Schillo, R. S., and Nguyen, V. M. (2022). A research agenda for evaluating living labs as an open innovation model for environmental and agricultural sustainability. Environmental Challenges, 7. https://doi.org/10.1016/j.envc.2022.100505

Blackstock, K. L., Kelly, G. J., and Horsey, B. L. (2007). Developing and applying a framework to evaluate participatory research for sustainability. Ecological Economics, 60(4), 726–742. https://doi.org/10.1016/j.ecolecon.2006.05.014

Carr, G., Blöschl, G., and Loucks, D. P. (2012). Evaluating participation in water resource management: A review. Water Resources Research, 48(11). https://doi.org/10.1029/2011WR011662

Carter, C. (2006). The Power and Pitfalls of Participatory Processes (Aberdeen Discussion Paper Series: People, Environment and Development). https://www.researchgate.net/publication/242365844

Caspersen, J., Smeby, J. C., & Olaf Aamodt, P. (2017). Measuring learning outcomes. European journal of education, 52(1), 20-30.

Catania C., Debremaeker I., Szkola S., Williquet F., 2021. The Communities of Practice Playbook. A playbook to collectively run and develop communities of practice. European Commission, Joint Research Centre (JRC). Available online: https://op.europa.eu/webpub/jrc/communities-of-practice-playbook/assets/cop_online_version_light.pdf

Ceschin, F., and Gaziulusoy, I. (2016). Evolution of design for sustainability: From product design to design for system innovations and transitions. Design Studies, 47, 118–163. https://doi.org/10.1016/j.destud.2016.09.002

Collins, K., & Ison, R. (2009). Jumping off Arnstein's ladder: social learning as a new policy paradigm for climate change adaptation. Environmental policy and governance, 19(6), 358-373.

Compagnucci, L., Spigarelli, F., Coelho, J., and Duarte, C. (2021). Living Labs and user engagement for innovation and sustainability. Journal of Cleaner Production, 289. https://doi.org/10.1016/j.jclepro.2020.125721

Cuppen, E. (2012). A quasi-experimental evaluation of learning in a stakeholder dialogue on bio-energy. Research Policy, 41(3), 624–637. https://doi.org/10.1016/j.respol.2011.12.006

D2.2. (No date). Value-sensitive design report (including gender analysis). Deliverable 2.2 WATER MINING Project.

D9.2. (No date). Report on innovative CE business models & green financing for mobilizing investments. Deliverable 9.2 WATER MINING Project.

D9.3. (No date). Framework agreements. Deliverable 9.3 WATER MINING Project.

Davidson, S. (1998). Spinning the wheel of participation. Planning, 1262(1415.15)

Davis, J., & Nathan, L. P. (2015). Value sensitive design: Applications, adaptations, and critiques. Handbook of ethics, values, and technological design: Sources, theory, values and application domains, 11-40.

Díez, M. A., Etxano, I., and Garmendia, E. (2015). Evaluating Participatory Processes in Conservation Policy and Governance: Lessons from a Natura 2000 pilot case study. Environmental Policy and Governance, 25(2), 125–138. https://doi.org/10.1002/eet.1667

Englund, M., André, K., Gerger Swartling, A., and Iao-Jörgensen, J. (2022). Four Methodological Guidelines to Evaluate the Research Impact of Co-produced Climate Services. Frontiers in Climate, 4. https://doi.org/10.3389/fclim.2022.909422

Ernst, A. (2019). Research techniques and methodologies to assess social learning in participatory environmental governance. Learning, Culture and Social Interaction, 23. https://doi.org/10.1016/j.lcsi.2019.100331

Fiorino, D. J. (1990). Citizen participation and environmental risk: A survey of institutional mechanisms. Science, Technology, and Human Values, 15(2), 226-243

Friedman, B., Hendry, D. G., & Borning, A. (2017). A survey of value sensitive design methods. Foundations and Trends® in Human–Computer Interaction, 11(2), 63-125.

Fulgenzi, A. (2019). A framework for evaluating communities of practice for the diffusion of circular water solutions.

Fulgenzi, A., Brouwer, S., Baker, K., and Frijns, J. (2020). Communities of practice at the center of circular water solutions. Wiley Interdisciplinary Reviews: Water, 7(4). https://doi.org/10.1002/wat2.1450

Funtowicz, S. O., & Ravetz, J. R. (1991). A new scientific methodology for global environmental issues. Ecological economics: The science and management of sustainability, 10, 137.

Funtowicz, S. O., & Ravetz, J. R. (1993). Science for the post-normal age. Futures, 25(7), 739-755.

Funtowicz, S. O., and Ravetz, J. R. (1991). A new scientific methodology for global environmental issues. Ecological economics: The science and management of sustainability, 10, 137

Galende-Sánchez, E., and Sorman, A. H. (2021). From consultation toward co-production in science and policy: A critical systematic review of participatory climate and energy initiatives. Energy Research and Social Science, 73. https://doi.org/10.1016/j.erss.2020.101907

Gamboa, G., Kovacic, Z., Di Masso, M., Mingorría, S., Gomiero, T., Rivera-Ferré, M., & Giampietro, M. (2016). The complexity of food systems: Defining relevant attributes and indicators for the evaluation of food supply chains in Spain. Sustainability, 8(6), 515.

Garmendia, E., and Stagl, S. (2010). Public participation for sustainability and social learning: Concepts and lessons from three case studies in Europe. Ecological economics, 69(8), 1712-1722

Giampietro, M. (2002). The precautionary principle and ecological hazards of genetically modified organisms. AMBIO: A Journal of the Human Environment, 31(6), 466-470.

Giampietro, M. (2003). Multi-scale integrated analysis of agroecosystems. CRC press.

Giampietro, M., & Mayumi, K. (2018). Unraveling the complexity of the Jevons Paradox: The link between innovation, efficiency, and sustainability. Frontiers in Energy Research, 6, 26.

Giampietro, M., Allen, T. F., & Mayumi, K. (2006). The epistemological predicament associated with purposive quantitative analysis. Ecological Complexity, 3(4), 307-327.

Grant, A., and Curtis, A. (2004). Refining evaluation criteria for public participation using stakeholder perspectives of process and outcomes. Rural Society, 14(2), 142–162. https://doi.org/10.5172/rsj.351.14.2.142

Hassenforder, E., Ducrot, R., Ferrand, N., Barreteau, O., Anne Daniell, K., and Pittock, J. (2016). Four challenges in selecting and implementing methods to monitor and evaluate participatory processes: Example from the Rwenzori region, Uganda. Journal of Environmental Management, 180, 504–516. https://doi.org/10.1016/j.jenvman.2016.05.019

Henri F., and Pudelko B. (2003). Understanding and analysing activity and learning in virtual communities. Journal of Computer Assisted learning 19, pp. 474-487

Hothorn, T., Hornik, K., van de Wiel, M.A., and Zeileis, A. (2006). "A Lego system for conditional inference." The American Statistician, 60(3), 257-263. doi:10.1198/000313006X118430.

Johannessen, Å., and Hahn, T. (2013). Social learning towards a more adaptive paradigm? Reducing flood risk in Kristianstad municipality, Sweden. Global Environmental Change, 23(1), 372–381. https://doi.org/10.1016/j.gloenvcha.2012.07.009

Johannessen, Å., Gerger Swartling, Å., Wamsler, C., Andersson, K., Arran, J. T., Hernández Vivas, D. I., and Stenström, T. A. (2019). Transforming urban water governance through social (triple-loop) learning. Environmental Policy and Governance, 29(2), 144–154. https://doi.org/10.1002/eet.1843

Katika, T., Karaseitanidis, I., Tsiakou, D., Makropoulos, C., and Amditis, A. (2022). Augmented Reality (AR) Supporting Citizen Engagement in Circular Economy. Circular Economy and Sustainability, 2(3), 1077–1104. https://doi.org/10.1007/s43615-021-00137-7

Kelly, G. J., Blackstock, K. L., and Horsey, B. L. (2007). Limits to learning for developing a sustainable region: Lessons from North-East Queensland. Australasian Journal of Environmental Management, 14(4), 231–242. https://doi.org/10.1080/14486563.2007.10648721

Lakoff, G. (2010). Why it matters how we frame the environment. Environmental communication, 4(1), 70-81.

Landström, C., Sarmiento, E., and Whatmore, S. J. (2023). Stakeholder engagement does not guarantee impact: A co-productionist perspective on model-based drought research. Social Studies of Science. https://doi.org/10.1177/03063127231199220

Lieu, J., Martínez-Reyes, A., Groome, P., Mangalagiu, D., Pearce, B. J., Witajewska-Baltvilka, B., and Møller, R.-E. D. (2023). Inclusive stakeholder engagement for equitable knowledge co-production: Insights from the EU's Horizon 2020 programme in climate change research. GAIA - Ecological Perspectives for Science and Society, 32(1), 138–143. https://doi.org/10.14512/gaia.32.1.11

Luyet, V., Schlaepfer, R., Parlange, M. B., and Buttler, A. (2012). A framework to implement Stakeholder participation in environmental projects. Journal of Environmental Management, 111, 213–219. https://doi.org/10.1016/j.jenvman.2012.06.026

Marques Postal, A., Solidario de Souza Benatti, G., Palmeros Parada, M. D. M., Asveld, L., Osseweijer, P., & Da Silveira, J. M. F. (2020). The role of participation in the responsible innovation framework for biofuels projects: Can it be assessed?. Sustainability, 12(24).

Mastelic, J. (2019). Stakeholders' engagement in the co-design of energy conservation interventions: The case of the Energy Living Lab.

Munda, G. (2004). Métodos y procesos multicriterio para la evaluación social de las políticas públicas. Revibec: revista de la Red Iberoamericana de Economia Ecológica, 1, 031-45.

Muro, M., and Jeffrey, P. (2006). A review of participatory test and evaluation approaches for water management. [conference paper]. Water Science and Technology: Water Supply, 6(5), 1–8. https://doi.org/10.2166/ws.2006.829.

Muro, M., and Jeffrey, P. (2008). A critical review of the theory and application of social learning in participatory natural resource management processes. Journal of Environmental Planning and Management, 51(3), 325–344. https://doi.org/10.1080/09640560801977190

Naftali and Dodick (2020). Policy packaging and its applicability to the water mining project. A summary of a concept and methodology. Deliverable 10.5 WATER MINING Project.

Nguyen, H. T., and Marques, P. (2022). The promise of living labs to the Quadruple Helix stakeholders: exploring the sources of (dis)satisfaction. European Planning Studies, 30(6), 1124–1143. https://doi.org/10.1080/09654313.2021.1968798

O'Hern, M. S., & Rindfleisch, A. (2017). Customer co-creation: a typology and research agenda. Review of marketing research, 84-106.

OHern, M.S. and Rindfleisch, A. (2010), "Customer Co-Creation", Malhotra, N.K. (Ed.) Review of Marketing Research (Review of Marketing Research, Vol. 6), Emerald Group Publishing Limited, Bingley, pp. 84-106. https://doi.org/10.1108/S1548-6435(2009)0000006008

Osterwalder, A., & Pigneur, Y. (2010). Business model generation: a handbook for visionaries, game changers, and challengers (Vol. 1). John Wiley & Sons.

Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. Communications of the association for Information Systems, 16(1), 1.

Pahl-Wostl, C. (2002). Towards sustainability in the water sector-The importance of human actors and processes of social learning. Aquat. Sci, 64, 394–411

Pahl-Wostl, C. (2009). A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. Global Environmental Change, 19(3), 354–365. https://doi.org/10.1016/j.gloenvcha.2009.06.001

Palmeros Parada, M., Asveld, L., Osseweijer, P., & Posada, J. A. (2018). Setting the design space of biorefineries through sustainability values, a practical approach. Biofuels, Bioproducts and Biorefining, 12(1), 29-44.

Palmeros Parada, M., Asveld, L., Osseweijer, P., & Posada, J. A. (2018). Setting the design space of biorefineries through sustainability values, a practical approach. Biofuels, Bioproducts and Biorefining, 12(1), 29-44.

Palmeros Parada, M., Asveld, L., Osseweijer, P., & Posada, J. A. (2020). Integrating value considerations in the decision making for the design of biorefineries. Science and Engineering Ethics, 26(6), 2927-2955.

Palmeros Parada, M., Gamboa, G. And Bouchaut. B. (2023). Optimalisation infosheet Quick-scan VSD-2. Deliverable 2.7 WATER MINING Project.

Palmeros Parada, M., Osseweijer, P., and Posada Duque, J. A. (2017). Sustainable biorefineries, an analysis of practices for incorporating sustainability in biorefinery design. Industrial Crops and Products, 106, 105–123. https://doi.org/10.1016/j.indcrop.2016.08.052

Palmeros, M. and Gamboa, G. (2021). Infosheet quick scan VSD for case studies. Deliverable 2.6 WATER MINING Project.

Parada, M. P., Randazzo, S., Gamboa, G., Ktori, R., Bouchaut, B., Cipolina, A., ... & Xevgenos, D. (2023). Resource recovery from desalination, the case of small islands. Resources, Conservation and Recycling, 199, 107287.

Pereira M.A., Turnes J.A., Nogueira E., 2023. Innovative circular economy business models and green financing. Deliverable 9.2, WATER MINING project.

Prahalad, C. K., & Ramaswamy, V. (2000). Co-opting customer competence. Harvard business review, 78(1), 79-90.

Rayner, S. (2012). Uncomfortable knowledge: The social construction of ignorance in science and environmental policy discourses. Econ. Soc., 41, 107–125.

Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. Biological Conservation, 141(10), 2417–2431. https://doi.org/10.1016/j.biocon.2008.07.014

Reed, M. S., Evely, A. C., Cundill, G., Fazey, I., Glass, J., Laing, A., Newig, J., Parrish, B., Prell, C., Raymond, C., and Stringer, L. C. (2010). What is Social Learning? Ecology and Society, 15(4). http://www.ecologyandsociety.org/volXX/issYY/artZZ/

Reed, M. S., Vella, S., Challies, E., de Vente, J., Frewer, L., Hohenwallner-Ries, D., Huber, T., Neumann, R. K., Oughton, E. A., Sidoli del Ceno, J., and van Delden, H. (2018). A theory of participation: what makes stakeholder and public engagement in environmental management work? Restoration Ecology, 26, S7–S17. https://doi.org/10.1111/rec.12541

Roque, A., Wutich, A., Quimby, B., Porter, S., Zheng, M., Hossain, M. J., and Brewis, A. (2022). Participatory approaches in water research: A review. Wiley Interdisciplinary Reviews: Water, 9(2). https://doi.org/10.1002/wat2.1577

Ruess, A. K., Müller, R., and Pfotenhauer, S. M. (2023). Opportunity or responsibility? Tracing co-creation in the European policy discourse. Science and Public Policy, 50(3), 433–444. https://doi.org/10.1093/scipol/scac079

Saltelli, A., & Giampietro, M. (2017). What is wrong with evidence based policy, and how can it be improved?. Futures, 91, 62-71.

Scheidel, A., Temper, L., Demaria, F., & Martínez-Alier, J. (2018). Ecological distribution conflicts as forces for sustainability: an overview and conceptual framework. Sustainability science, 13, 585-598.

Schmidt, L., Falk, T., Siegmund-Schultze, M., and Spangenberg, J. H. (2020). The Objectives of Stakeholder Involvement in Transdisciplinary Research. A Conceptual Framework for a Reflective and Reflexive Practise. Ecological Economics, 176. https://doi.org/10.1016/j.ecolecon.2020.106751

Schneider, F., and Rist, S. (2014). Envisioning sustainable water futures in a transdisciplinary learning process: combining normative, explorative, and participatory scenario approaches. Sustainability Science, 9(4), 463–481. https://doi.org/10.1007/s11625-013-0232-6

Schot, J., and Steinmueller, W. E. (2018). Three frames for innovation policy: RandD, systems of innovation and transformative change. Research Policy, 47(9), 1554–1567. https://doi.org/10.1016/j.respol.2018.08.011

Siccama and Penna. (2008). Enhancing Validity of a Qualitative Dissertation Research Study by Using NVIVO. https://www.emerald.com/insight/content/doi/10.3316/QRJ0802091/full/pdf

Simon, H. A. (1976). From substantive to procedural rationality. 25 years of economic theory: Retrospect and prospect, 65-86

Stiglitz, J. (2011). Rethinking macroeconomics: what failed, and how to repair it. Journal of the European Economic Association, Vol. 9, No. 4, pp.591–645.

Suhari, M., Dressel, M., and Schuck-Zöller, S. (2022). Challenges and best-practices of co-creation: A qualitative interview study in the field of climate services. Climate Services, 25. https://doi.org/10.1016/j.cliser.2021.100282

Teodoro, J. D., Prell, C., & Sun, L. (2021). Quantifying stakeholder learning in climate change adaptation across multiple relational and participatory networks. Journal of Environmental Management, 278, 111508.

Thoradeniya, B., and Maheshwari, B. (2018). Strategies and Frameworks for Effective Stakeholders Engagement for Water Governance Leadership: A Review. New Water Policy and Practice, 4(2), 19–55. https://doi.org/10.18278/nwpp.4.2.3

Tosey, P., Visser, M., and Saunders, M. N. K. (2012). The origins and conceptualizations of "triple-loop" learning: A critical review. Management Learning, 43(3), 291–307. https://doi.org/10.1177/1350507611426239

van Buuren, A., van Meerkerk, I., and Tortajada, C. (2019). Understanding emergent participation practices in water governance. International Journal of Water Resources Development, 35(3), 367–382. https://doi.org/10.1080/07900627.2019.1585764

van de Poel, I. (2016). An Ethical Framework for Evaluating Experimental Technology. Sci Eng Ethics 22, 667–686.

Van de Poel, I. (2017). Society as a laboratory to experiment with new technologies. In Embedding New Technologies Into Society (pp. 61-87). Jenny Stanford Publishing.

Van den Hoven, J., Vermaas, P. E., and Van de Poel, I. (2015). Design for values: An introduction. Handbook of ethics, values, and technological design: Sources, theory, values and application domains, 1-7

Van der Wal, M., De Kraker, J., Offermans, A., Kroeze, C., Kirschner, P. A., & Van Ittersum, M. (2014). Measuring social learning in participatory approaches to natural resource management. Environmental policy and governance, 24(1), 1-15.

Vercher, N. (2022). Environmental conflicts and social innovation on the Balearic Islands (Spain). Sustainability, 14(9), 4994.

Vervoort et al. (2024a). Evaluation report of two Living Labs. Deliverable 2.4 WATER MINING Project.

Vervoort et al. (2024b). Replicability study. Deliverable 2.5 WATER MINING Project.

Vervoort, K., Konstantinidis, E., Santonen, T., Petsani, D., Servais, D., De Boer, D., Spagnoli, F., Onur, O., Bertolin, J., Trousse, B., Desole, M., and Bamidis, P. (2022). Harmonizing the evaluation of living labs: a standardized evaluation framework. https://vitalise-project.eu/

Videira, N., Antunes, P., Santos, R., and Lobo, G. (2006). Public and stakeholder participation in European water policy: A critical review of project evaluation processes. European Environment, 16(1), 19–31. https://doi.org/10.1002/eet.401

Von Hippel, E. (2005). Democratizing innovation: The evolving phenomenon of user innovation. Journal für Betriebswirtschaft, 55, 63-78.

von Korff, Y., Daniell, K. A., Moellenkamp, S., Bots, P., and Bijlsma, R. M. (2012). Implementing participatory water management: Recent advances in theory, practice, and evaluation. Ecology and Society, 17(1). https://doi.org/10.5751/ES-04733-170130

Wehn, U., Collins, K., Anema, K., Basco-Carrera, L., and Lerebours, A. (2018). Stakeholder engagement in water governance as social learning: lessons from practice. Water International, 43(1), 34–59. https://doi.org/10.1080/02508060.2018.1403083

Wenger-Trayner E., and Wenger-Trayner, B. (2015). Communities of Practice—A brief introduction. Retrieved from https://wenger-trayner.com/wp-content/uploads/2015/04/07-Brief-introduction-to-communities-of-practice.pdf

Wittmer, H., Rauschmayer, F., and Klauer, B. (2006). How to select instruments for the resolution of environmental conflicts? Land Use Policy, 23(1), 1–9. https://doi.org/10.1016/j.landusepol.2004.09.003

Wohlin, C. (2014). Guidelines for snowballing in systematic literature studies and a replication in software engineering. In Proceedings of the 18th international conference on evaluation and assessment in software engineering (pp. 1-10)

Annex 1. Outcomes of the policy packaging and market analysis

Table 7: Examples of changes in policy proposals derived from stakeholder's feedback.

Package	Original measure	Space in which it was discussed	Comment by stakeholders	Improved measure
Sea-Mining	PM 33: Implement a traceability of water use (sources) in commercial products.	Sea-Mining validation presentation (Implementing Water Innovations: Policy Innovation, management, and Business Models Workshop – University of Palermo, Italy). 20.09.2023	After the discussion at the Palermo consortium,PM 33 was rewritten.	PM 33: Create a labelling system that certifies the source of water used in commercial products (to avoid the drawing of freshwater resources).
Sea-Mining	PM 6G: Mandate that all EU member-states formulate a regulatory plan for sustainable production and usage of water that takes into account regional demand, season etc.	Business and Policy-makers Workshops (Brussels) (Sea-Mining, Urban-Mining and Industrial-Mining sub-sectors). 07-.08.02.2023	Possible linkages to Water Framework Directive, also individual member state River Basin Management plans. In general, Policy measures proposed by the project should be made relevant for such existing and ongoing EU level policy framework processes. This makes the project more concrete for EU-level policy making. Important to keep an eye on the Drinking Water Directive which is currently being revised via delegated acts (i.e. non-legislative act adopted by the Commission to supplement or amend certain non-essential elements of a legislative act. The Commission also consults experts, including experts designated by each member state, before adopting such acts). Thanks to these suggestions, PM 6G was reformulated.	PM 6G: Mandate that all EU member-states formulate a regulatory plan for sustainable production and usage of water that guides municipalities and regions, while also taking into account water stress.

Urban – Mining	PM 98: Mandate Material Safety Data Sheets are developed, certifying the safety of the materials (water / solids / chemicals) that are recovered from wastewater. PM 25: Mandate minimum standards for the quality of fertilisers that are recovered from water (such as humidity levels, minimum P concentration, contaminants, such as pathogens, metals etc.) for different types of crops.	Sea-Mining validation presentation (Implementing Water Innovations: Policy Innovation, management, and Business Models Workshop – University of Palermo, Italy). 20.09.2024	One participant noted with regards to PM 98 and PM 25 that the suggested measures are already addressed by the revised Fertiliser Product Regulation and that it was not sensible to introduce a new legal tool. As a response to this feedback PM 98 was deleted. PM 25 was advanced to stage 3 as it was considered important to emphasize this in the Urban-Mining package to establish a market for products specifically reclaimed from wastewater.	PM 25: Mandate minimum standards for the quality of fertilisers that are recovered from water (such as humidity levels, minimum P concentration, contaminants, such as pathogens, metals etc.) for different types of crops.
Urban – Mining	PM 70a (70 in stage 2): Provide funding for improving circularity in UWW infrastructure (for reclaimed water, other materials and biogas).	Business and Policy-makers Workshops (Brussels) (Sea-Mining, Urban-Mining and Industrial-Mining sub-sectors). 07-.08.02.2023	Under the UWWT Directive, EU MSs have to report on their activities and this could include the use of e.g. a new generation fund for circular treatment of urban wastewater. They would have to show that they are adapting their facilities to circularity; this will allow for greater funding. This can be inserted into the UWWTD. It should also be noted that in the case of GI / MB measures, financial support is not always continuous; incentives may be temporary until the market and efficiencies have been established so that the products can compete with conventional materials. The granting of money must be done efficiently, with the proper mix and using next generation funding tools. New PM 70a merges former PM 70 with PM 39, being rewritten after the workshop was done.	PM 70a: Provide funding and/or subsidies for improving circularity in UWW infrastructure (for reclaimed water, other materials and biogas). This financial support is dependent on the UWWT infrastructure reaching targeted efficiency levels.

Industrial-Mining	Two interconnected solutions were suggested: • Early involvement of regulators and municipalities in the development process • Specify building standards for industrial applications/installations These suggestions resulted in the following policy: PM 16: Create either a separate EU unit or new competencies to an existing department that aids the industry in receiving permission to install and operate IWWT technology.	Rotterdam CoPs (CS6 – Industrial-Mining sub-sector). 24.11.2023	Regarding PM 16, this policy was validated by the participants as being necessary for accelerating the granting of IWW permits. It was rewritten and advanced to stage 3. Participants also suggested integrating the Circular Economy Action Plan into the REPowerEU plan. This good suggestion is beyond the scope of the policy packages. Finally, as part of the discussion of the suggested policies, stakeholders mentioned that a national/EU-wide strategy for circular IWW treatment could support the implementation and deployment of innovative technologies in this sector In response the policy team reiterated a new policy: PM 6.	PM 16: Expand EU support to industrial plants’ efforts in receiving permission to install and operate IWWT technologies. PM 6: Mandate that the EU creates (with the cooperation of EU MS states) an EU-wide strategy for circular IWWT.

Annex 2. Evaluation questionnaires for CoPs

The framework to evaluate *CoPs as stakeholder engagement and participatory research environments for technological innovation* has been developed from the criteria of best practices of stakeholder engagement (Section 5.1). These communities can have different purposes and objectives, and the role of stakeholder may vary according to the approach to participation and co-creation is adopted. Moreover, the approach to participation may vary as time passes by and the communities becomes more mature. At the beginning of a project, the leading role rest (mainly) on the project partners and the approach to participation may easily fall within the *instrumental* approach to participation (i.e., informing). When the community evolves, it would be easier to apply the *substantive* and *normative* approaches to participation. According to this, the set of evaluation questions has been tailored for each stage of the participatory process.

Next, adequate questions under each dimension and criteria were defined. Questions to capture the subjective experiences of participants (Kelly et al., 2007; Thoradeniya and Maheshwari, 2018) are included, and combined with questions aimed at evaluating criteria in a more objective way. Other aspects considered to define the questions that will comprise the evaluation are the following:

1. Distribute questions between the facilitator and the participants. This was done to reduce the number of questions to participants. Especially in those cases one answer is enough to evaluate the meeting. For instance:
    - *How much time in advance was the invitation to the meeting and the agenda sent to participants?*
2. Combining questions that can be affected by perceptions or personal feelings with more objective questions.
    - Ask participants: *Did you have enough opportunities to provide inputs to the discussion?*
    - Ask facilitator: *What participatory methods did you use in the meeting? (Multiple choice: Only presentations, Q&A, Post-its on the wall, discussion groups)*
3. Ask complementary questions to the facilitator and the participants:
    - Ask participants: *Did you feel rushed in discussing some topics?*
    - Ask facilitator: *Were you able to discuss all topics in the agenda according to the planned time allocated to them?*
4. Avoid using concepts that can be understood in different ways.
    - *Were all communications within the group appropriate?* Not clear what 'appropriate' means for each person.
    - *Were all communications within the group clear?* Which would depend on the knowledge of each person.
    - *Were all communications within the group relevant?* This depends on the priorities of people.

Stakeholder evaluation 1st CoPs

We would be very grateful if you, as participant of the 1st CoP meeting, fill in the following evaluation form.

It will take you no more than 5 minutes.

1. <u>Please indicate the CS that hosted the CoP you just attended:</u>

   CS1

   CS2

   CS3

   CS4

   CS5

   CS6

2. <u>Regarding the agenda of the meeting:</u>

   There was enough time to discuss all the topics of the agenda

   I felt rushed to discuss some topics

   The time allocated was not enough to cover all important issue

3. <u>The presentations and speakers were clear and understandable.</u>

According to your opinion, rate this statement from Strongly disagree (0) to Strongly agree (10)

0	1	2	3	4	5	6	7	8	9	10

4. <u>I have a better understanding of the perspective of other stakeholders.</u>

According to your opinion, rate this statement from Strongly disagree (0) to Strongly agree (10)

0	1	2	3	4	5	6	7	8	9	10

5. <u>I had enough opportunities to provide input to the discussion.</u>

According to your opinion, rate this statement from Strongly disagree (0) to Strongly agree (10)

0	1	2	3	4	5	6	7	8	9	10

6. <u>During the meeting, I felt safe to behave spontaneous and unfiltered.</u>

According to your opinion, rate this statement from Strongly disagree (0) to Strongly agree (10)

0	1	2	3	4	5	6	7	8	9	10

7. <u>My trust in the group increased after the meeting.</u>

According to your opinion, rate this statement from Strongly disagree (0) to Strongly agree (10)

0	1	2	3	4	5	6	7	8	9	10

8. <u>There were conflicting points of view around some issue(s) during the meeting.</u>

According to your opinion, rate this statement from Strongly disagree (0) to Strongly agree (10)

0	1	2	3	4	5	6	7	8	9	10

9. <u>The conflict escalated during the meeting.</u>

According to your opinion, rate this statement from Strongly disagree (0) to Strongly agree (10)

0	1	2	3	4	5	6	7	8	9	10

10. <u>I felt there was a powerful participant that dominated the discussion.</u>

According to your opinion, rate this statement from Strongly disagree (0) to Strongly agree (10)

0	1	2	3	4	5	6	7	8	9	10

11. <u>The facilitator allowed all people to participate.</u>

According to your opinion, rate this statement from Strongly disagree (0) to Strongly agree (10)

0	1	2	3	4	5	6	7	8	9	10

12. <u>The facilitator motivated all people to participate.</u>

According to your opinion, rate this statement from Strongly disagree (0) to Strongly agree (10)

0	1	2	3	4	5	6	7	8	9	10

13. My opinion was heard and considered in the discussions.

According to your opinion, rate this statement from Strongly disagree (0) to Strongly agree (10)

0	1	2	3	4	5	6	7	8	9	10

14. I was able to understand all discussions held in the meeting.

According to your opinion, rate this statement from Strongly disagree (0) to Strongly agree (10)

0	1	2	3	4	5	6	7	8	9	10

15. The decisions or conclusions of the meeting were clearly communicated before the meeting ended.

According to your opinion, rate this statement from Strongly disagree (0) to Strongly agree (10)

0	1	2	3	4	5	6	7	8	9	10

16. I contribute to the project by:

Circle your answer or answers

Providing technical information

Providing information about policies

Providing information about market issues

Providing information about societal issues

Providing information about institutional issues

Validating proposals

Checking the quality of the work done

Learning from the work done

Disseminating results of the project

Other

17. If you answered Other in the previous question, please, specify what:

18. Please, provide any additional insight or comment you may consider relevant to improve the next meeting.

Thank you very much for your contribution.

Facilitators’ Evaluation 1st CoPs

Thank you for facilitating the meeting, it is a pleasure having you leading the CoP.

We would like to know your opinion on the organization and development of the meeting to recollect your opinions and recommendations. Please, *answer the following questionnaire and send it to the reference person with the participants’ surveys attached*.

1. Please indicate your CS.

   CS1

   CS2

   CS3

   CS4

   CS5

   CS6

2. How far in advance have you sent the meeting invitation?

   More than one month

   Between one month and 3 weeks

   Between 2-3 weeks

   About a week

3. If you answered Other in the previous question, please, specify what:

4. **Was the meeting venue accessible by public transport?**

   Yes

   No

5. **Was the meeting venue accessible by people with limited mobility?**

Yes

No

6. **Was the meeting venue adequate to carry out planned activities (in terms of size, spaces for working groups and coffee break, required equipment, etc.)?**

Yes

No

Why not?

7. **Was the meeting venue accessible by people with limited mobility?**

Yes

No

8. **Was there a space for networking (coffee break, lunch)?**

Yes

No

9. **Was there a professional facilitator in the meeting?**

Yes

No

10. **Do you have facilitation skills (e.g., it's easy for you to engage people or keep communication channels open with them)?**

Yes

No

11. What information have you sent with the invitation? [*Check boxes*]

Agenda	
Objectives of the meeting	
Summary of the project description and objectives	
Summary of the advances of the project	
Presentations of the meeting	
Relevant reports and/or deliverables	
Other [*Specify*]:	

12. The objectives of the meeting were the following: [*Check boxes*]

Purely informative	
To know each other	
Create common ground, introduce the project	
Informative and we asked feedback from stakeholders	
Collect proposals from stakeholders	
Look for solutions with stakeholders	
Make some decisions with stakeholders	
Other [*Specify*]:	

13. What methods did you use in the meeting? [*Check boxes*]

Presentations	
Ice-breakers techniques	
Questions and answers in plenary	

Participatory activity to collect feedback (post-its, brainstorming, write-down ideas, etc.)	
Small group discussion (implies discussion and deliberation)	
Decision-making participatory technique.	
Other [*Specify*]:	

14. Who has defined the agenda? [*Check boxes*]

Exclusively by project partners, participants were not consulted	
Participants were consulted but no issue was proposed	
Participants proposed issues to be included in the agenda, which were included	
Participants proposed issues to be included in the agenda, but they were not included	
Other [*Specify*]:	

15. **Have you been able to discuss all topics in the agenda adequately?**

Yes

No

16. **Have you sent a summary of the meeting discussions and conclusions to participants after the meeting?**

Yes

No

Annex 3. Social learning questionnaire

When it comes to evaluate social learning, Ernst (2019) reviewed the different methods for assessment applied in the social learning literature for participatory environmental governance. Among them, the author reported a myriad of techniques, from qualitative to quantitative as well as mixed methods, with each their own advantages and limitations. Furthermore, the timing of the evaluation was also highlighted: the assessment can be ex-ante, mid-term, or ex-post (Muro and Jeffrey, 2006).

In relation to the methods used, quantitative surveys provide a chance to measure learning through structured questions or statements. Although they are limited in the depth of information that can be collected, they can provide a comparable breadth of information through the years that may show change over time. This technique can used to measure any element of social learning, from acquisition of knowledge and information to participation process output or cognitive, relational, or technical change. On other hand, qualitative evaluations (e.g., interviews or focus groups) could provide more in-depth understanding of the components and detailed data, meaning a close observation of social leaning (Ernst, 2019). This method would also facilitate gathering those elements that were not considered in the definition of the evaluation framework, for example, the behaviour of the participants or the environment in which the process takes place (Hassenforder et al., 2016).

Social learning encompasses the following aspects:

- Change in knowledge within an existing frame of reference (i.e., adoption of new facts), finding answers about either:
    - How the system works.
    - How to achieve a particular objective by means of adopting different options.
    - How different options meet a particular goal with different effectiveness.
- Change in values and assumptions and increasing the understanding of the perspectives of others.
    - Changing the perception of the problem (i.e., the issue definition).
    - Expanding one's view from the individual to the collective.
    - Changing attitudes towards others, including future generations and non-human species.
- Dealing with conflicting and legitimate values in society.
- Refining views about complexities and uncertainties of the systems under study.
- Finding ways of institutional change, joint and collaborative action.

Therefore, under the umbrella of stakeholder engagement and participatory research for technological innovation, the evaluation of social learning, as an outcome of a participatory process, would be based on assessing the aspects mentioned above as a mid-term and ex-post assessment by means of a questionnaire.

In the WATER MINING project, a questionnaire has been developed and tested in the last CoPs meeting of CS2 was carried out to identiy some learned lessons. The social learning evaluation questionnaire was constructed following Garmendia and Stagl (2010), and it was adapted to the themes present in the workshop on desalinated water for irrigation held on February 21st, 2024, at the University of Almería by the Plataforma Solar de Almería (Living Lab of the WATER MINING project and CS2).

The questionnaire (Annex 3) was given to the participants and 27 people answered. No information was taken from the participants regarding their gender, race, class, or other intersectional factors for a later analysis. This should be done in the case there is time and resources for a more in-depth analysis of social learning.

The questionnaire was done in two phases: before and after the workshop, in which three presentations on the topic of desalinated water for irrigation were given with a posterior co-creation space to debate the implementation of desalinated water for irrigation in the Almería region. The notes of this co-creation space were collected to complement the statistical analysis of the social learning questionnaire.

The main takeaway from this exercise is that the design of the questionnaire should also consider the attendees of the meeting. In this case, most of questions were answered with higher values in the pre-meeting round, reflecting a high level of experience and knowledge on the subject by participants. While the workshop may have brought new information for them, they didn't necessarily perceive it as a big cognitive change on the topic. What is also important to remember is that for some questions having a lower score in the post-workshop part than in the pre-workshop part may not mean that learning did not take place. Social learning is not only about a net growth of knowledge and that cannot only be measured with higher scores afterwards. Since opinions are being analysed, a lower perception on a topic after the workshop can also mean that social learning took place.

Furthermore, the workshop commented on and debated only certain topics. The lack of debate on certain points may have also influenced what people acquired knowledge on. In other words, anticipating the content of the workshop and topics debated is helpful in having a successful questionnaire. What this also means is that social learning evaluation is heavily context-dependant and cannot be implemented blindly from one environment to another.

Additionally, there is a measured higher interest in opportunities for joint action among stakeholders, meaning that not only actual knowledge was acquired but also the possibility of collaboration between them may have originated.

All these ideas take the conclusions to the same place: considering the people that come to the workshops is key for developing questionnaires that are context-dependent and successful. For example, having different questionnaires for different types of people, based on their knowledge (e.g.), could be interesting. This would lead to a stratified sample and may yield more statistically significant results. However, there is little knowledge of people's knowledge about an issue before asking them.

The responses of the pre- and post-meeting questionnaires were analyzed using the Wilcoxon test. It is a non-parametric test aimed at comparing the medians of two groups and determine whether there are differences between them. In this case, no statistical differences were found between the pre- and post-meeting questionnaires. This would indicate that no social learning took place, maybe due to the knowledge already held by participants. This can also mean that questionnaires and other quantitative methodologies may not fully appreciate the breadth of change that social learning aspires to, and information may be lost in the process of evaluation (Ernst, 2019).

A more complete statistical analysis is needed here, and in the case of social learning the comparison of means may not be the most adequate. General lessons can still be extracted from this exercise. One of the most important would be the need for a more in-depth analysis of social learning using mixed methods. This can take more time and resources than a survey, so a budget allocated for this in projects similar to WATER MINING is key.

Evaluation questionnaire of the workshop on desalinated water for irrigation in the CoPs of the Plataforma Solar de Almería

CS2 of the WATER MINING Project

It has been a pleasure to have you at this meeting. With this survey, we will evaluate the progress of the workshop in relation to the presentations and discussions that have taken place. This survey consists of two parts, one to be completed before the workshop and the other at the end. Each part should not take more than 5 minutes of your time.

Thank you for your cooperation.

(Optional) Please enter

Your name ______________________ Your organization _________________________

A3.1. Part 1: Do it before the workshop.

1. Are you familiar with the role that desalinated water for irrigation can play in the Almería region in the coming years? (Please mark from 1, not at all, to 5, very much)

1	2	3	4	5

2. How familiar are you with the following impacts of using desalinated water for irrigation in the Almería region? (Please mark from 1, not at all, to 5, very much.)
    a. Environmental (For example, increased concentration of salt in the soil))

1	2	3	4	5

    b. Technical (For example, need for changes in infrastructure))

1	2	3	4	5

    c. Social (For example, positive reaction to change in used water))

1	2	3	4	5

d. Economic (For example, increase in crop prices due to changes in used water))

1	2	3	4	5

e. Political (For example, change in the legal framework for irrigation water standards))

1	2	3	4	5

f. others:

3. To what extent do the following factors affect the implementation of desalinated water for irrigation in the Almería region? (Please mark from 1, not at all, to 5, very much)
   a. Economic factors

1	2	3	4	5

b. Social factors

1	2	3	4	5

c. Technical factors

1	2	3	4	5

d. Political factors

1	2	3	4	5

e. Others:

4. To what extent do the following actors affect the implementation of desalinated water for irrigation in the Almería region? (Please mark from 1, not at all, to 5, very much)
   a. Scientists

1	2	3	4	5

b. Engineers

1	2	3	4	5

c. Politics

1	2	3	4	5

d. Society members like citizens or NGOs, etc.

1	2	3	4	5

e. Others:

5. To what extent do the following aspects support increasing the use of desalinated water for irrigation in the Almería region? (Please mark from 1, not at all, to 5, very much)
    a. Economic interests

1	2	3	4	5

b. Political interests

1	2	3	4	5

c. Water conservation

1	2	3	4	5

d. Agriculture sectors' interests

1	2	3	4	5

e. Others:

6. How relevant are the needs of future generations when deciding whether to increase the use of desalinated water for irrigation in the Almería region? (Please mark from 1, not at all, to 5, very much)

1	2	3	4	5

7. Are the consequences of increasing the use of desalinated water for irrigation in the Almería region uncertain? (Please mark from 1, not at all, to 5, very much)

1	2	3	4	5

8. Do you consider that the current public and private institutions are sufficient for the transition to the use of desalinated water in agriculture in the Almería region? (Please mark from 1, not at all, to 5, very much)

1	2	3	4	5

9. If there were conflicts regarding the use of desalinated water for irrigation, how could they be best addressed? (Please mark from 1, not at all, to 5, very much)
    a. Provide better information

1	2	3	4	5

    b. Find a consensus solution that everyone agrees on

1	2	3	4	5

    c. Find a solution where everyone gives a little, find a compromise

1	2	3	4	5

    d. Manage conflicts so that they are a source of new ideas

1	2	3	4	5

    e. Others:

10. What considerations would you have regarding the implementation of desalinated water for irrigation in the Almería region that have not been mentioned in this questionnaire? (Open question)

A3.2. Part 2: Do it after the workshop.

11. Are you familiar with the role that desalinated water for irrigation can play in the Almería region in the coming years? (Please mark from 1, not at all, to 5, very much)

1	2	3	4	5

12. How familiar are you with the following impacts of using desalinated water for irrigation in the Almería region? (Please mark from 1, not at all, to 5, very much.)
    a. Environmental (For example, increased concentration of salt in the soil))

1	2	3	4	5

    b. Technical (For example, need for changes in infrastructure))

1	2	3	4	5

    c. Social (For example, positive reaction to change in used water))

1	2	3	4	5

    d. Economic (For example, increase in crop prices due to changes in used water))

1	2	3	4	5

    e. Political (For example, change in the legal framework for irrigation water standards))

1	2	3	4	5

    f. others:

13. To what extent do the following factors affect the implementation of desalinated water for irrigation in the Almería region? (Please mark from 1, not at all, to 5, very much)
    a. Economic factors

1	2	3	4	5

    b. Social factors

1	2	3	4	5

c. Technical factors

1	2	3	4	5

d. Political factors

1	2	3	4	5

e. Others:

14. To what extent do the following actors affect the implementation of desalinated water for irrigation in the Almería region? (Please mark from 1, not at all, to 5, very much)
    a. Scientists

1	2	3	4	5

b. Engineers

1	2	3	4	5

c. Politics

1	2	3	4	5

d. Society members like citizens or NGOs, etc.

1	2	3	4	5

e. Others:

15. Do you see opportunities for joint action among the workshop participants for the implementation of the use of desalinated water for irrigation in the Almería region? (Please mark from 1, not at all, to 5, very much)

1	2	3	4	5

16. To what extent do the following aspects support increasing the use of desalinated water for irrigation in the Almería region? (Please mark from 1, not at all, to 5, very much)
    a. Economic interests

1	2	3	4	5

    b. Political interests

1	2	3	4	5

    c. Water conservation

1	2	3	4	5

    d. Agriculture sectors' interests

1	2	3	4	5

    e. Others:

17. How relevant are the needs of future generations when deciding whether to increase the use of desalinated water for irrigation in the Almería region? (Please mark from 1, not at all, to 5, very much)

1	2	3	4	5

18. Are the consequences of increasing the use of desalinated water for irrigation in the Almería region uncertain? (Please mark from 1, not at all, to 5, very much)

1	2	3	4	5

19. Do you consider that the current public and private institutions are sufficient for the transition to the use of desalinated water in agriculture in the Almería region? (Please mark from 1, not at all, to 5, very much)

1	2	3	4	5

20. If there were conflicts regarding the use of desalinated water for irrigation, how could they be best addressed? (Please mark from 1, not at all, to 5, very much)
    a. Provide better information

1	2	3	4	5

    b. Find a consensus solution that everyone agrees on

1	2	3	4	5

    c. Find a solution where everyone gives a little, find a compromise

1	2	3	4	5

    d. Manage conflicts so that they are a source of new ideas

1	2	3	4	5

    e. Others:

21. What considerations would you have regarding the implementation of desalinated water for irrigation in the Almería region that have not been mentioned in this questionnaire? (Open question)

22. Of those participants with whom you disagree, to what extent are you most familiar with their reasoning? (Please mark from 1, not at all, to 5, very much)

1	2	3	4	5

23. How would you rate your overall experience during the workshop? (Please mark from 1, bad, to 5, good)

1	2	3	4	5

Annex 4. Living Labs' mentoring programme

Task 2.4 was aimed at setting up two real test benches; experimental environments where users and producers can co-create innovations in a small setting: the Living Labs. In WATER MINING two organizations carried out a series of activities and tasks as Living Lab candidates: the Floating Farm in the Netherlands and the Plataforma Solar de Almería in Spain.

The Living Labs are conceived to "*catalyse the development of user-centric solutions for complex environmental issues by exploring, co- creating, testing, and evaluating innovations within real-world contexts*" (Beaudoin et al., 2022, p. 1). Within the WATER MINING project, Living Labs are understood as *real-life test and experimentation environments that foster co-creation and open innovation among the main actors of the Quadruple Helix Model, namely: Citizens, Government, Industry and Academia* (www.enoll.org). Living Labs are problem driven environments, tackling wicked problems of the whole society. They operate as orchestrators/intermediaries between citizens, government agencies, companies, and research organizations, focusing on interdisciplinary collaboration.

In this model, the citizens are considered along with universities, industries, and governments to co-create innovation using LLs as a platform (Compagnucci et al., 2021; Nguyen and Marques, 2022). Per their defined working model (**¡Error! No se encuentra el origen de la referencia.**), LLs engage users through active involvement as well as the dissemination of information regarding innovation processes developed within??? (Compagnucci et al., 2021).

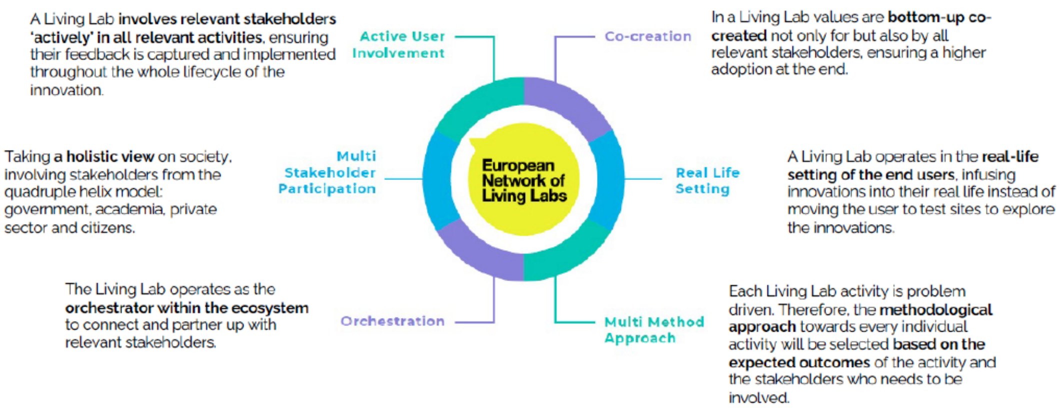

Figure 9: Six building blocks of a Living Lab according to the European Network of Living Labs (ENoLL) from Vervoort et al. (2022).

Within a wide variety of Living Labs, those relevant for WATER MINING are the Water-oriented Living Labs (WoLLs), defined as "*real-life, water oriented and demo-type and platform-type environments with a cross-sector nexus approach, which have the involvement and commitment of multi-stakeholders and provide a real-life 'field lab' to develop, test and validate a combination of solutions as defined in the SIRA, which include technologies, their integration as well as a combination with new business and governance models, and innovative policies based on the value of water*"[4].

[4] Extracted from https://watereurope.eu/water-oriented-living-labs.

WoLLs facilitate water-oriented interventions with a cross-sector nexus approach in real world and/or realistic environments, operate as proactive learning and innovation ecosystems with R&D continuity and reproducibility. Their open and local multi-stakeholder governance structures are supported by democratic control systems, with context specific needs.

Four branches of work were developed within Task 2.4. Subtask 2.4.1 was aimed at performing a process of Value Sensitive Optimization of the Floating Farm. This includes identifying aspects deemed to be improved, propose some improvements, and evaluate them. To this purpose the methods deployed in WP8 were adapted and applied to the Floating Farm.

Subtask 2.4.2 considered the PSA to become a networking point for public authorities and policy makers, both from the regional and the national government. As well, end-users and other social actors (such as the main irrigation communities, greenhouse producers and farmer's associations) were involved in a series of events focused on the use of solar energy and desalination in the greenhouse sector of SE Spain (Water-Energy-Food nexus).

Subtask 2.4.3 was aimed at developing an evaluation framework for Water Oriented Living Labs, which was applied to evaluate the degree of maturity of both Living Lab candidates. Before applying the evaluation framework, ENoLL worked closely with both organizations developing a process to become Living Labs: i.e., to map relevant stakeholders, define a portfolio of activities, match stakeholders and activities, develop the business and governance models. It followed the application of the expert-based quantitative and qualitative evaluation of the LL candidates.

Finally, subtask 2.4.4 was aimed at developing a replicability study based on the outcome of subtask 2.4.3.

A structured mentoring program existing out of 11 steps to become a Living Lab

A4.1. Mentoring programme

A4.1.1. Explaining the Living Lab concepts, actors and principles

The start of the mentoring programme was an online webinar to explain the basic Living Lab concepts, layers, processes, and methodologies to stakeholders of both WATER MINING Living Labs. In a 2-hour session ENoLL explained these different aspects to guarantee a common understanding about them and to kickstart an open discussion with PSA and FF.

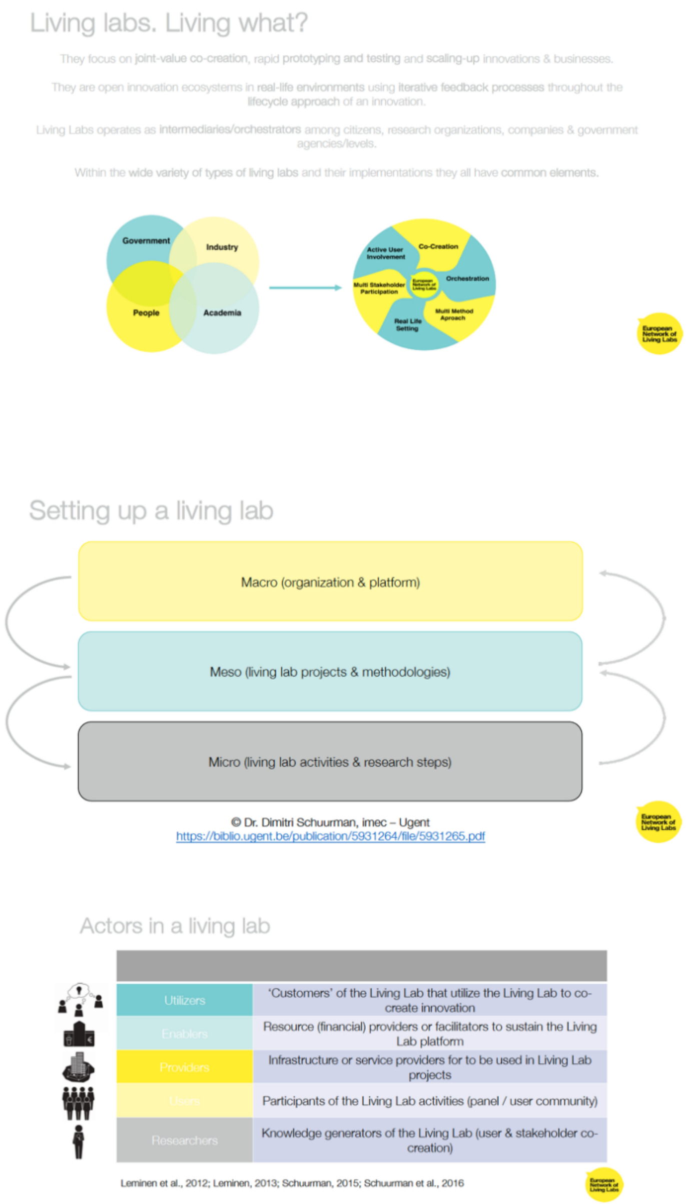

Figure 10: screenshots from Living Lab webinar.

A4.1.2. Stakeholder mapping

After the introduction of the Living Lab concepts separate online workshops were organized with both PSA and FF to support them to identify the relevant stakeholders present/needed within their ecosystems. Making use of a MIRO board this step focused on matching the activities described in the grant agreement of the WATER MINING project with the purposes of the individual Living Labs, identifying different stakeholder groups in relation to these activities and ambitions.

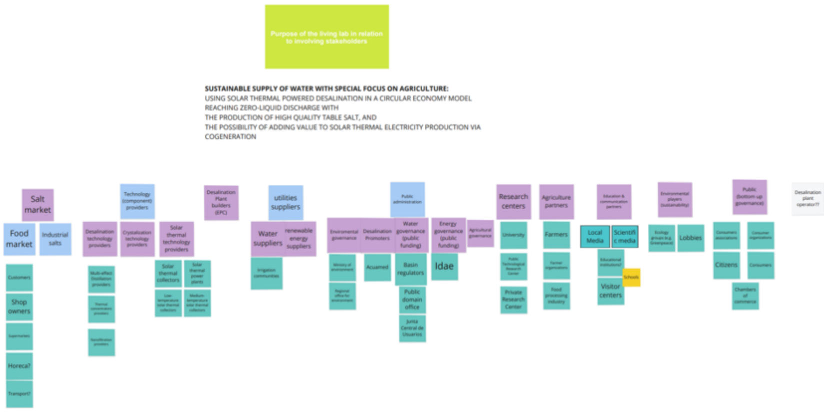

Figure 11: example of identified stakeholder groups in relation to the purpose of the PSA Living Lab.

A4.1.3. Stakeholder engagement plan

Next, a stakeholder engagement approach was co-developed with both PSA and FF individually, starting with a second webinar on Stakeholder management, followed by additional online co-creation workshops to match the identified stakeholder groups with the foreseen activities. Within this step, panel squares were created to provide a visual overview of the stakeholders within their ecosystems. Following this, a panel matrix was co-created to support PSA and FF to keep an overview of their stakeholder engagement plan.

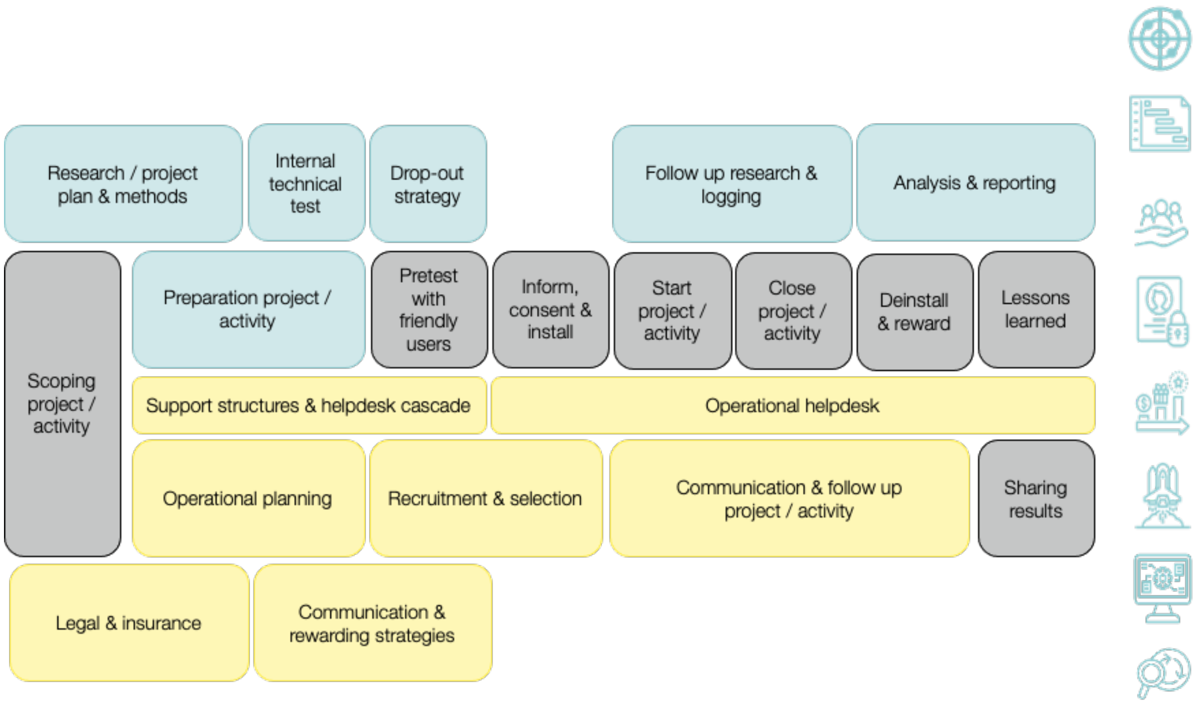

Figure 12: a structured approach for stakeholder engagement - Koen Vervoort (Sync The Dots).

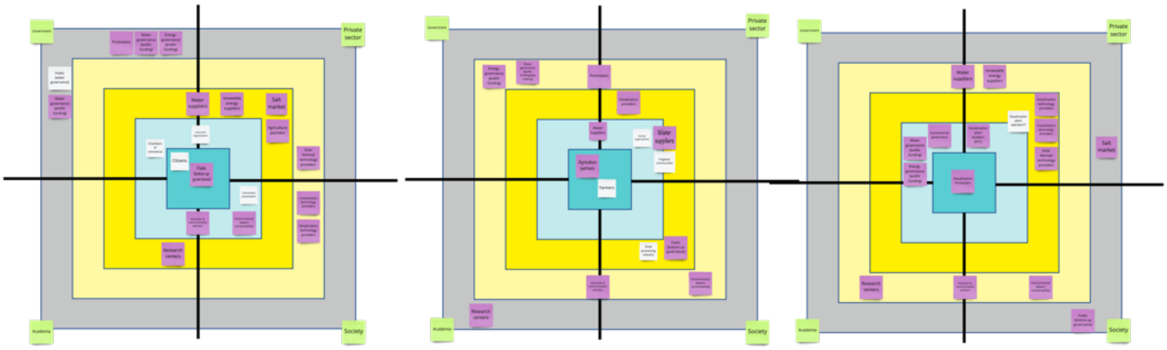

Figure 13: examples of created panel squares.

A4.1.4. Introducing supporting Living Lab tools

During an on-site training day at the venues of the Living Labs, ENoLL introduced two supporting tools to help the LL teams to organize their activities aligned with the Living Lab principles: the Living Lab Integrative Process and the Living Lab Mapping Canvas.

The Living Lab Integrative Process, adapted from Mastelic (2019), describes all the different steps within a Living Lab project to be considered concerning the involvement of different stakeholders.

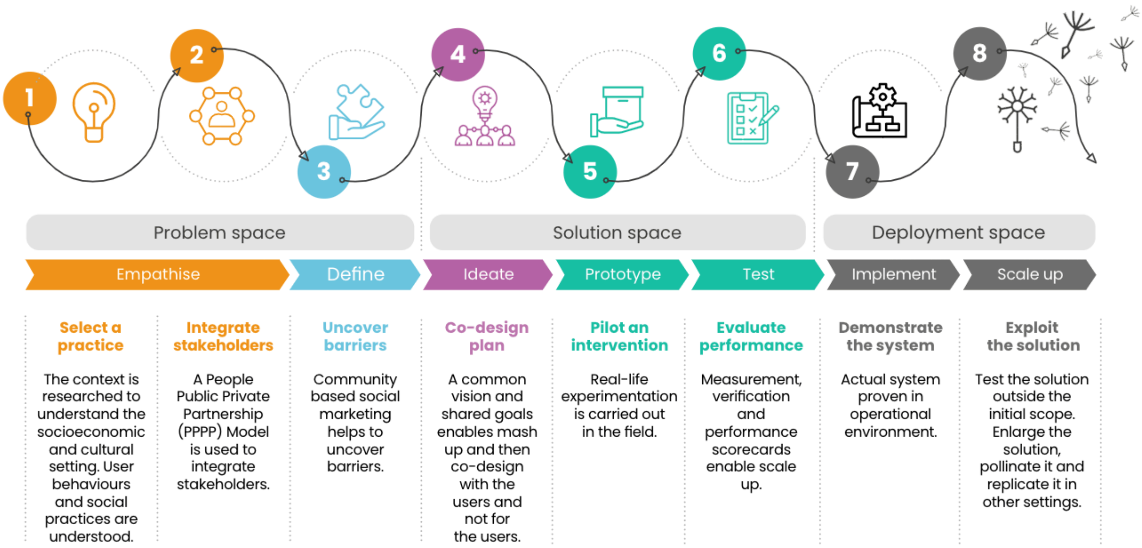

Figure 14: The LLIP adapted from Mastelic (2019).

The Living Lab Mapping canvas is a tool to keep a centralized overview of all the different aspects of a Living Lab like the mission, the context, the stakeholders, the organization, the business approach (revenues and costs), etc.

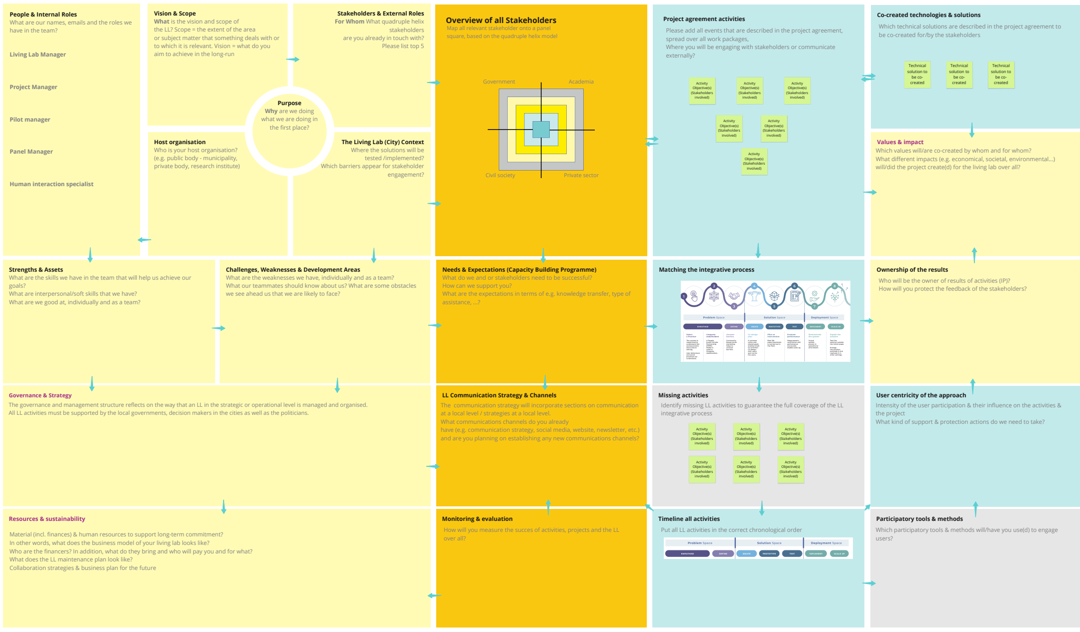

Figure 15: The Living Lab Mapping canvas - ENoLL (©2022).

A4.1.5. Creating a support structure of the Living Lab

In addition to the introduction of the supporting tools, during the on-site training a co-creation session was organized to define the necessary support questions to be considered by the LL team throughout the WATER MINING project. Focusing on installing a Single Point of Contact (SPOC) for stakeholders within the ecosystems of the Living Labs, questions were mapped in relation to the purpose and the foreseen activities of the two Living Labs, based on the standard helpdesk structure provided by ENoLL.

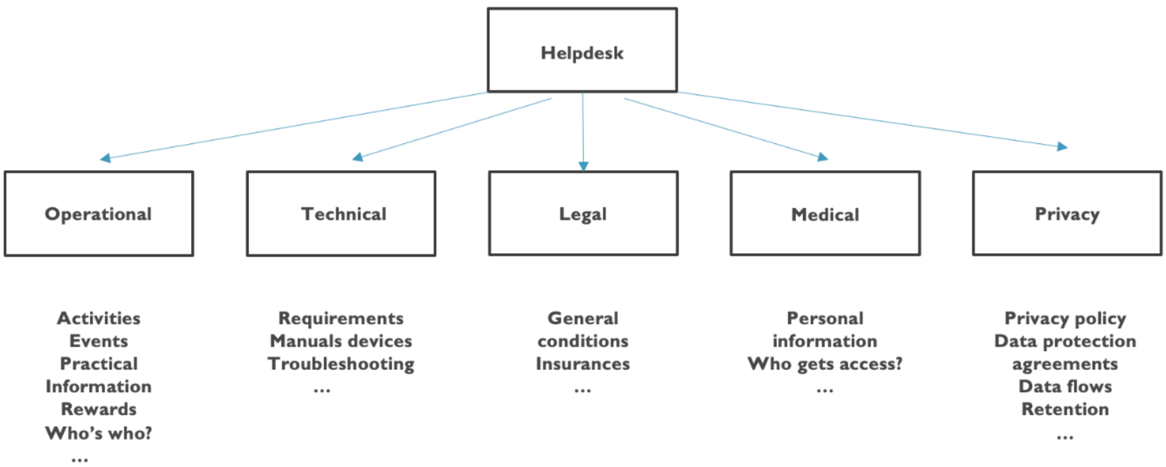

Figure 16: Standard helpdesk structure – ENoLL.

A4.1.6. Defining an operational Living Lab team

Identifying all the possible questions from different stakeholders of the Living Lab was taken as the starting point to discuss the assignment of internal roles and responsibilities within the two Living Lab teams who are in charge of operationally running the Living Lab. Together with the participants of the on-site training responsibilities for each of them were co-identified and assigned.

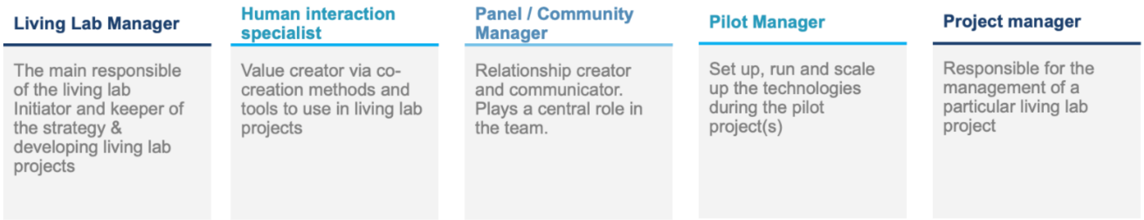

Figure 17: Internal roles of an operational Living Lab team – ENoLL.

A4.1.7. Creating an analysing a SWOT of the Living Lab

Following the previous step, the focus of the mentoring program shifted more to the long-term aspects of running a Living Lab beyond the scope of an individual Living Lab project like for instance WATER MINING. To identify possible ways forward for the two Living Labs a SWOT analysis was made by both Living Lab teams and discussed with ENoLL to detect future Living Lab projects hosted by both PSA and FF, together with steps needed to be taken to overcome identified barriers.

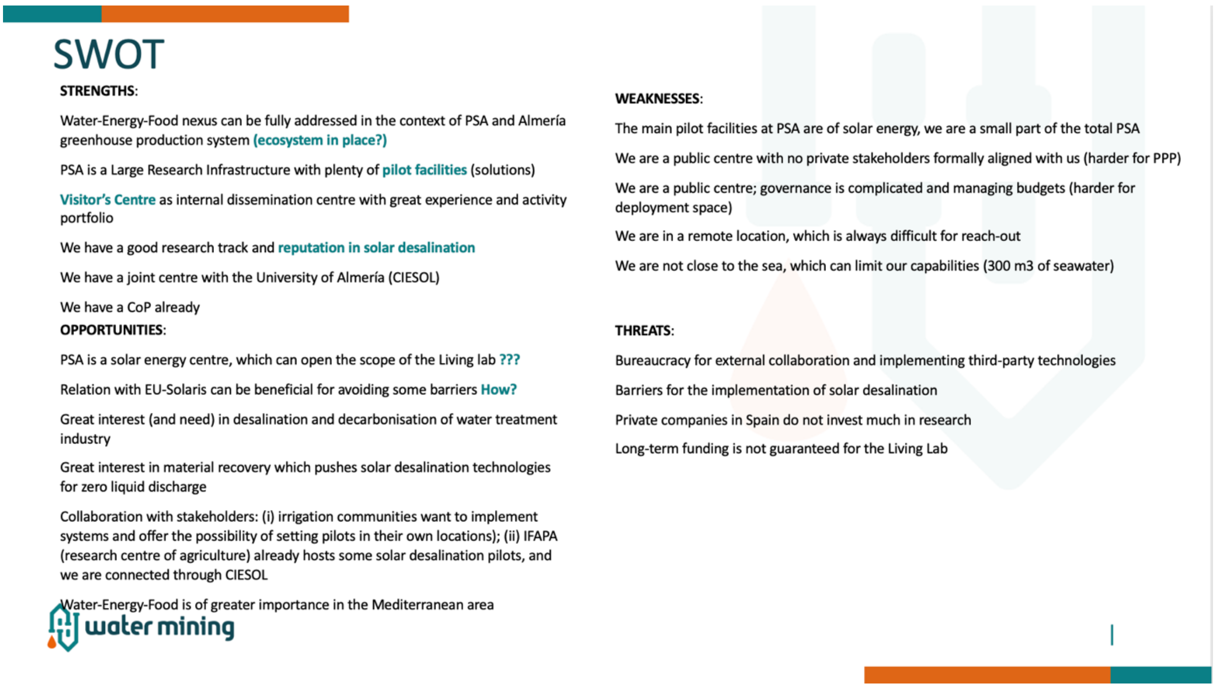

Figure 18: Outcomes of the SWOT analysis of PSA.

A4.1.8. Sustainability of the Living Lab

Based on the SWOT analysis both PSA and FF were challenged by ENoLL to think about questions considering the long-term sustainability of their Living Labs:

- What is the shared vision/mission of the Living Lab beyond the WATER MINING project?
- Based on that mission/vision, what are the long-term strategic goals of the Living Lab?
- Which (already existing) projects can support these strategic goals?
- Is the stakeholder matrix developed within the WATER MINING project valid for these goals or does it need to be expanded?
- What are the needs of the stakeholders in relation to the long-term strategic goals of the Living Labs?
- How will the Living Lab monitor results and returns on investments?

A4.1.9. Bi-monthly mentoring sessions

After the opening of both Living Labs at the end of 2022, bi-monthly mentoring session are being organised with each of the two Living Labs to tackle current needs of the Living Lab teams concerning running their Living Labs. These sessions are demand driven, meaning ENoLL is there to respond and support questions arising from the daily work of the Living Lab teams of PSA and FF. The sessions will be continued until the end of the WATER MINING project.

A4.1.10. Recommendations for further growth of the Living Lab

Based on the harmonised evaluation framework for all diverse types of Living Labs an evaluation and assessment of the maturity of the two WATER MINING Living Labs was executed, focusing on providing both Living Labs with recommendations to further increase their maturity (beyond the scope of the WATER MINING project. Each of the Living Labs was evaluated by three independent Living Lab experts and all outcomes were compiled in feedback reports for each of the two Living Labs. Extended and detailed information about these assessments and recommendations can be found in D2.4.

A4.1.11. Scaling-up of Living Lab solutions, services, and products

Currently, as a last step of the mentoring program within the scope of WATER MINING, both Living Labs are supported to identify best practices concerning technical solutions, stakeholder engagement and other Living Lab outcomes. These best practices will be evaluated by multiple mature Living Lab organisations from the ENoLL network to identify which best practices could be replicated to other Living Labs in Europe and beyond. All the identified best practices and the evaluation of them will be reported in D2.5 which is due by August 2024

A4.2. Evaluating Living Labs

The evaluation strategy is key for determining best practices, ensuring that all building blocks of a Living Lab are present in its organization and development. Through the work done by Vervoort et al. (2022) **a new harmonized framework** to enable the assessment of different types of Living Labs was born. This evaluation framework is made of **six general Living Lab 'chapters', fifteen general criteria and thirty-four general KPIs (Key Performance Indicators)**. According to the authors, this "*provides a stronger emphasis on the macro-level of a Living Lab to support them in becoming more impactful and stable beyond the scope of individual Living Lab projects (meso-level)*".

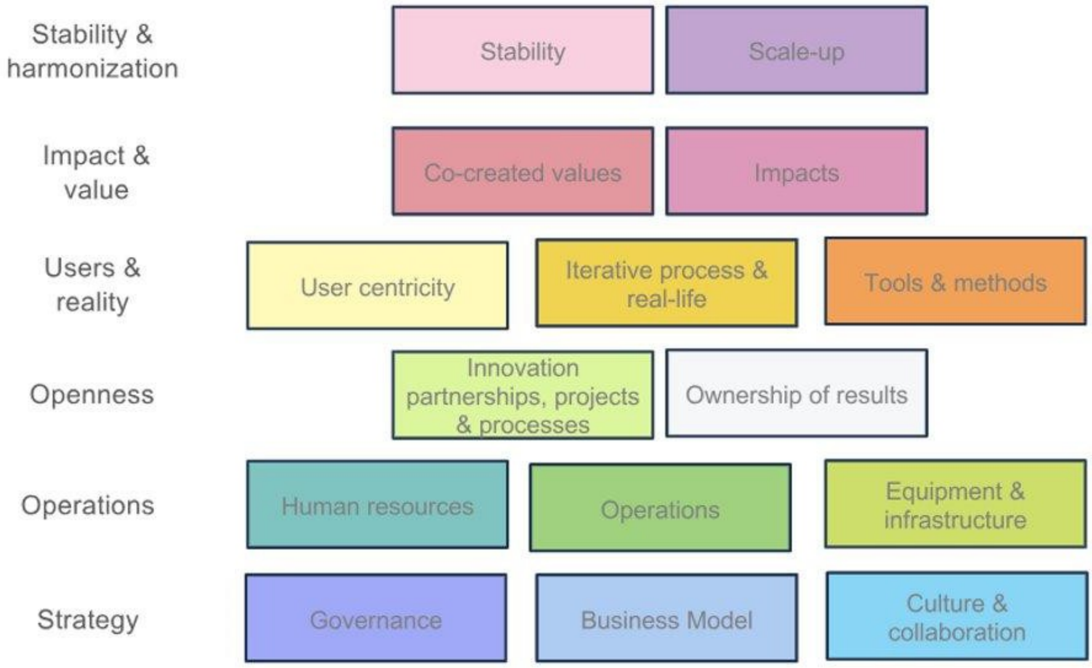

Figure 19: Chapters and criteria of the harmonized evaluation framework of Living Labs, Vervoort et al (2022).

As a summary[5], the different blocks of this evaluation are:

1. **Strategy chapter** which focuses on the macro-level of a Living Lab, considering the multi stakeholder participation and the orchestration role of the Living Lab, looking at their collaboration strategies, while investigating the business model of the Living Lab as well. Within this chapter three general Living Lab criteria are included:
    a. **Governance**: the Living Lab governance is strong if it includes all the major actors of the quadruple helix (academia-industry-government-community), along with a systematic participative approach (rules and processes), in a shared vision and mission which can impact the Living Lab strategy and the projects for better outcomes, and a clear collaboration management (a clear definition of each actor's roles).
    b. **Business Model**: a sustainable Living Lab business model enables the Living Lab to strengthen its status and service portfolio via active stakeholder partnerships and financial engineering.
    c. **Culture and collaboration**: the culture of a Living Lab empowers internal collaboration and communication strategies and strengthens external collaborations within an open and solid innovation culture.
2. **Operations chapter** covers all levels of a Living Lab, looking at the way the Living Lab manages its operations, considering the necessary equipment and infrastructure and human resources of the Living Lab. Within this chapter three general Living Lab criteria are included:

[5] The development and implementation of this evaluation framework is described in depth in Vervoort et al. (2024a).

   a. **Human resources**: the Living Lab has clearly defined internal roles and assigned people to these roles in a flexible and sufficient way.
   b. **Operations**: the Living Lab shows experience in executing projects and activities supported by recurrent self-monitoring processes to monitor the overall performances of the Living Lab.
   c. **Equipment and infrastructure**: the Living Lab has sufficient access to the equipment (hard- and software) and infrastructure (facilities, networks) they need to run their Living Lab and its main activities.
3. **Openness chapter** deals with the openness of a Living Lab from a macro-, meso- and micro-level perspective by focusing on the processes, the partnerships, and the feedback and Intellectual Property (IP) protection. Within this chapter two general Living Lab criteria are included:
   a. **Innovation partnerships, projects and processes**: the Living Lab has the needed processes in place to safeguard an ethical approach and to make sure they work in a reflective and iterative way.
   b. **Ownership of results**: the Living Lab has monitored and transparent processes and agreements to protect stakeholders' feedback and deal with property rights (IPR).
4. **Users and Reality chapter** indicates the ways of collaboration with users and the levels of engagement and participation by focusing on the implementation of an iterative Living Lab process in real-life contexts and investigating the quality of used tools and methods. Therefore, it relates to all three levels of a Living Lab. Within this chapter three general Living Lab criteria are included:
   a. **User-centricity**: a user-centric Living Lab has an active and diverse group of users, that represents the ecosystem of the Living Lab, influencing the innovation processes.
   b. **Iterative process and real-life**: the Living Lab actively engage and involves users in every phase of the innovation process/project using realistic real-life contexts of the users.
   c. **Tools and methods**: the Living Lab has strong engagement strategies, supported by transparent and tailored communication processes, using a range of tools and methods to interact with their users and stakeholders, relevant to specific phases of the innovation cycle.
5. **Impact and Value chapter** assesses the co-created values (e.g. knowledge sharing, capacity building, network building) by whom but even more importantly for whom. Furthermore, it investigates different impact aspects of the Living Lab (e.g. societal, economic, environmental, regulatory, academic...). Therefore, this chapter is related to all levels of a Living Lab. Within this chapter two general Living Lab criteria are included:
   a. **Co-created values**: the Living Lab co-creates values for all types of stakeholders (including users) in their value chain by sharing knowledge and building capacities of their stakeholders.

b. **Impacts**: based on their strategies, the Living Lab assesses (long-term) impacts within one or more of the following aspects of their ecosystem: societal, environmental, economic, regulatory, academic.

6. **Stability and Scale-up chapter** delivers insights on the (financial) stability of the Living Lab from a macro-level perspective, considering different needed aspects like service offerings and strategy plans. Aligned with this, this chapter looks at the level of harmonisation of these strategic and operational building blocks beyond their own Living Lab since this will increase the sustainability of the Living Lab. Within this chapter two general Living Lab criteria are included:
   a. **Stability**: the stability of a Living Lab is enhanced by strong relationships with partners and customers, the development of value propositions and a mature, balanced, and diversified set of funding and revenue streams.
   b. **Harmonisation and scale-up**: the Living Lab can replicate and scale-up products, solutions (including infrastructures) and services by participation in initiatives/projects based on harmonised knowledge, skills, standards, methods, tools, and processes.

Logically, a Living Lab that attains all these criteria is an entity that ensures best practices, not only of stakeholder engagement but also of short and long-term development.

Furthermore, the two WATER MINING Living Labs have the potential to become a sustainable Living Lab over time, though they will have to invest in (Vervoort et al., 2024a):

- strengthening their operational Living Lab teams to safeguard that at least one person is full-time dedicated to take care of all the Living Lab projects and activities.
- developing their own Living Lab services for clients of the Living Lab to increase the balance of their revenue streams and not being solely dependent on project funding and /or private funding.
- exploring and implementing more advanced and diverse types of participatory tools and methods to interact with users/participants of their Living Lab activities.

In D2.5 (Vervoort at al., 2024b), the recommendations for improvement are concluded after the evaluation of each WATER MINING Living Lab.