FORGING

INDUSTRY-ACADEMIA FORUM TO UNCOVER THE POTENTIAL OF EMERGING ENABLING TECHNOLOGIES

Exploring the potential of co-creation in Emerging Technology: challenges and success factors

D1.3 Co-creation on emerging technologies - relevant initiatives and success factors

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Deliverable abstract

The present document, **D1.3 Co-creation on emerging technologies - relevant initiatives and success factors**, is a report gathering the **outcomes of scouting previous experiences of co-creation in the field of emerging technologies**, understanding and capturing the specific features and challenges of engagement and co-creation activities in the context of emerging/low TRL technologies.

It is supportive and preliminary to other tasks of the project, which envisage aspects of integrated by-design values such as T1.2 “Consultation with national and regional initiatives” (Leader: GAC, Participants: ALL) and T1.4 “Develop and refine the innovation journey towards a sustainable future” (Leader: VTT, Participants: INL, STAM, I2CAT, APRE).

Keywords

Co-creation, stakeholder engagement, emerging technologies, social innovation

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1. Introduction

1.1 FORGING overview and context

The potential of technological breakthroughs is immense, especially when combined with enabling technologies. These breakthroughs can be harnessed to address several global challenges, such as climate change, ageing population and well-being. However, in order to truly leverage this potential, considering the potential implications of these technologies from the very beginning is key.

FORGING proposes a new methodology for innovation that is based on value-sensitive considerations. This approach breaks the traditional linear trajectory of innovation and encourages the development of new visions and pathways that are mindful of the environment, society, and human-centered in alignment with Industry 5.0 approach. This approach provides a vision of industry that aims beyond efficiency and productivity as the sole goal, as well as reinforces the role and the contribution of industry to society. It places the wellbeing of the worker at the center of the production process and uses new technologies to provide prosperity beyond jobs and growth while respecting the production limits of the planet.

The FORGING methodology is designed to be deployed in three phases: the technological uncovering, where experts from academia and industry work together to identify early signals of emerging technologies; the societal confluence, which explores the desirability and societal impact of these technologies; and the full-fledged co-creation, where the broader community can contribute to the development of use cases for these emerging technologies.

1.2 Purpose and objectives of Deliverable D1.3

This deliverable, elaborated as result of task 1.3, is aimed at understanding and capturing the features and challenges of engagement and co-creation activities in the context of emerging/ low TRL technologies. Such preliminary exploration serves to better shape co-creation activities in FORGING, including the innovation journey, by suggesting co-creation approaches with proven success.
This activity will better support the existence and sustainability of the FORGING FORUM and the community of interests around these technologies. The task analyses, mainly through desk research, the work and results of previous projects performing multi stakeholder dialogues and engagement in the technological sector.
The analysis considered pros and cons of different methodologies in the specific context, obstacles connected to expert/non-expert dialogue as well as dialogues and activities in situation of unpredictability, as it is the context of emerging technologies.

2. Co-creation in the context of Emerging Technologies

2.1 Definition and concepts

2.1.1 Defining Emerging Technologies

To set the context in which the main results of scouting of previous experiences of co-creation in the field of emerging technologies are presented in this report, it is worth considering the characteristics of this kind of technologies.

Although there is no consensus definition of emerging technologies (ETs), a valuable effort to collect the main characteristics of ETs has been produced by D. Rotolo, D. Hicks, B. R. Martin[1] (2015) who identified these features common to several definitions:

1. radical novelty: the technology arises in discontinuity in terms of method, function and/or use. This can also refer to an existing technology being applied in a different/new domain of application.
2. relatively fast growth, which concerns several dimensions such funding sources, knowledge and results produced, actors involved etc.
3. coherence: what distinguishes ET from those still in a conceptual phase is the fact that they have gained a certain identity and persistence over time.
4. prominent impact: the scientific community seems to share the view that these kinds of technologies have an impact on the socio-economic system. The impact can range from affecting one or a few domains to wider coverage.
5. uncertainty and ambiguity: these two aspects are linked to the fact that the technology is still in a process not being finished yet. This opens the room for uncertainty and ambiguity in terms of production, outcomes, applications as well as potential impacts and consequences (which can be unintended and/or undesirable).

Some of these characteristics are also reflected in the definition adopted by Dr. Philip Brey (2017): *Emerging technologies are technologies that are new, innovative, and still in development, and are expected to have a large socioeconomic impact*[2]. According to this definition, emerging technologies are those that are still in a developmental stage but have a potential major impact and employ new methods and techniques offering better solutions than existing technologies.

[1] D. Rotolo, D. Hicks, B. R. Martin, *What is an Emerging Technology?*, Version: July 7, 2015, Accepted for publication in Research Policy

[2] P. Brey, Ethics of Emerging Technologies. In S. O. Hansson (Ed.), Methods for the Ethics of Technology. Rowman and Littlefield International, 2017

Emerging technologies are typically considered at lower Technology Readiness Levels (TRLs)[3], generally ranging from TRL 1 to TRL 3. At these levels, the focus is on basic research and concept formulation:

- **TRL 1:** Basic principles are observed and reported. This is the earliest stage of technology development where scientific research begins to be translated into applied research and development.
- **TRL 2**: Technology concept and/or application formulated. Here, the basic technological concepts and applications are identified. This is still speculative, with no experimental proof or detailed analysis.
- **TRL** 3: Experimental proof of concept. This level sees the initial proof of concept developed and experimental validation of the technology under controlled conditions.

In these stages, technology is still in its nascent form, often requiring significant research and development to progress to higher levels of readiness for practical application.
The fact that they are still in a research and development (R&D) phase, implies two crucial aspects: i) they require further research to be successful, both in terms of industry uptake and social acceptance ; ii) they are situated in a context of uncertainty since there are no solid data about the consequences of their application on the market, in industry and by society.

2.1.2 Defining Co-creation

Today, it is recognised how innovation in technology can profoundly affect people's quality of life. At the same time, these advances introduce new considerations regarding ethics, sustainability and social value of scientific and technological progress. It has been noted that issues of such complexity cannot be handled solely by policymakers together with scientists and experts. Consequently, a fundamental question emerges as to which actors should decide how and which innovations should be developed and implemented.

In an environment where interactions between technology, science and society are increasingly seen as a process involving a variety of participants and interests, the concept of co-creation seeks to address this issue. Indeed, this concept emerges as a set of methodologies and tools that foster collaboration between researchers, scientific communities, stakeholders and citizens in the innovation process[4].

In the traditional research and innovation model, experts are considered the only legitimate actors able to generate and convey pertinent knowledge in a linear and unidirectional process.

[3] Technology Readiness Levels (TRLs) is a method developed by NASA to assess the maturity of technologies. They use a scale of 1 to 9, where 1 represents the lowest level of technology readiness (basic principles observed and reported), and 9 indicates the highest level (actual system proven through successful mission operations). TRLs are widely used in various sectors to evaluate the readiness and feasibility of new technologies for practical application. https://www.nasa.gov/directorates/somd/space-communications-navigation-program/technology-readiness-levels/

[4] Arnaldi S., Benegiamo M., Crabu S, Magaudda P., Minniti S., Urbano L., Co-creazione e responsabilità nell'innovazione tecnoscientifica dal basso, January 2022

Such an approach has gradually begun to appear more and more inadequate both to face the challenges of an increasingly complex and interconnected world and to respond to the needs of society.

Originally born in the field of management and product design as a new way of generating company growth by the interaction between companies and consumers, the co-creative approach has gone beyond the business sector[5]. Co-creation initiatives have been proved to contribute to more responsible research and innovation (R&I) while improving public perception and understanding of technoscience, aligning it with the specific social needs of citizens. Co-creation approaches can bring to the forefront and address relevant social problems, that are often neglected by public authorities.

Some authors have identified different types of co-creation based on the level of citizen involvement. Voorberg et al. (2014) distinguished between: 1) co-implementer citizens, when they are involved only in the implementation of tasks; 2) co-designer, in which citizens participate in the design of the service; 3) initiator citizens, when citizens are the starters of the initiative/service. In a report dated 2013, the IBM Center for Business[6] elaborated four different categories of roles that citizens can perform when involving in co-creation.

• Citizen as explorer: this profile refers to citizens' ability to be the first to identify certain problems by being personally exposed to specific contexts, which is not the case for government agencies that may not be aware of certain issues or may not identify them promptly. This is also linked to two main factors: • the growing technological connectivity, that allows citizens to share easier impressions and concern, and • the higher level of government transparency that offers citizens the possibility to be informed.

• Citizen as ideator: citizens, in this case, can take on the role of ideators by conceptualizing innovative solutions to well-defined problems without specifying implementation details. Just as customers contribute ideas to improve products in various industries, citizens can provide innovative ideas to address issues in their communities.

• Citizen as designer: citizens are not limited to suggesting ideas but can actively contribute to the development of innovative concepts, translating them into practical solutions. This evolution in citizen participation underscores the potential for collective problem-solving and customization of services to address diverse community needs. This transformation of citizen involvement is facilitated by advanced IT tools that support collaborative idea building and visualization, similar to how customers in the private sector actively engage in the design and development of new products and services.

• Citizen as diffuser: this profile emphasizes citizens' potential to act as change agents in promoting the adoption of new services among their peers. This role draws parallels with the way customers have assisted companies in spreading the word about new products and services

[5] Harmes-Liedtke U., Soledad Gianetti M., The concept of co-creation and related methodologies for generating urban innovations bibliographic systamatization, December 2019

[6] Nambisan S., Nambisan P., Engaging Citizens in Co-Creation in Public Services: Lessons Learned and Best Practices, IBM Center for Business of Government, 2013

in the private sector. This role recognizes that innovation adoption is a social process, where the evaluations and endorsements of opinion leaders within a community, including peer citizens, significantly impact the adoption decisions of others.

A key aspect of co-creation revolves around the importance of involving a wide range of stakeholders in joint endeavors, creating a platform for collaboration, and proactively incorporating diverse participants into the innovation processes[7]. Involving multiple perspectives is crucial to achieve a comprehensive view of the issue, weighing all the different elements.

In order to make co-creation meaningful and successful, dialogue between actors involved needs to be properly guided and managed. There are numerous methods to implement stakeholder engagement through co-creation. This document tries to report those most relevant to FORGING's objectives and select those most promising for the project.

2.2 Potential opportunities and challenges

The above-mentioned specific features of emerging technologies pose both risks and opportunities. While these technologies cannot offer solid data about their future, they offer a unique opportunity to intervene in their early development process since it is still ongoing by definition. An early intervention in the process makes it possible to prevent unintended results and embed those values that can lead to the most positive impact possible in society. The involvement of diverse relevant actors, bringing their related perspectives and experiences, as of the earliest stages is considered crucial in FORGING.

Co-creation stands out as it leverages diverse expertise of various actors, facilitating *inter alia* the sharing of tacit knowledge. The active involvement of stakeholders from the beginning of the innovation process allow to align scientific progress with the needs of both industry and society thus facilitating the successful uptake of the innovation. By including beneficiaries from the start, co-creation initiatives ensure that innovation efforts directly address users' needs, enhancing the likelihood of future adoption[8]. Secondly, co-creation builds legitimacy around the innovation, making the initiatives more successful compared to those perceived as externally imposed. Furthermore, co-creation has the potential to accelerate innovation in areas of disruptive digital technologies like big data analytics, artificial intelligence, and the Internet of Things. The digital age demands collaboration across different sectors and disciplines, often requiring skills beyond traditional and/or purely technical competencies. Co-creation, therefore, becomes a crucial approach to meet these complex and interdisciplinary challenges of contemporary innovation.

More in detail, the benefits of co-creation in the context of ETs/low TRL technologies include:

1. **Exploring and understanding the impacts and implications of these technologies**: Given the uncertainty that often surrounds emerging technologies (as mentioned earlier), a co-

[7] Eckhardt J, Kaletka C, Krüger D, Maldonado-Mariscal K and Schulz AC (2021) Ecosystems of Co-Creation. Front. Sociol. 6:642289. doi: 10.3389/fsoc.2021.642289

[8] OECD, Knowledge co-creation in the 21st Century, A cross-country experience-base policy report, OECD Science, Technology and Industry, policy paper No. 115, June 2021

creative approach can help to consider potential impacts and implications while reducing the risk of unintended consequences. For example, co-creation can help to identify and assess the potential risks and uncertainties associated with a new technology, and to develop strategies for managing or mitigating these risks.

2. **Identifying and addressing societal concerns**: emerging technologies can raise complex ethical and societal questions that may need to be addressed through co-creation processes. For example, the deployment of a new technology may have implications for privacy, security, equality, or other ethical aspects. Co-creation can help to identify and address these concerns by bringing together stakeholders with different perspectives on these issues and facilitating dialogue and debate.

3. **Design ways to correct undesired societal projections:** When examining emerging technologies in light of their impact on different realms of human experience, both positive and negative projections could emerge. Both projections should serve to reflect on the future application of emerging technologies, anticipate possible and probable consequences and conduct them to minimize the risks of conflict or social rejection.

4. **Building trust and ensuring inclusivity:** co-creation can help to build trust among stakeholders and ensure that the development and deployment of the technology is inclusive and takes into account the needs and perspectives of all relevant parties. This can be especially important in the context of emerging technologies, which may be unfamiliar or controversial to some stakeholders. By involving a wide range of stakeholders in co-creation processes, it is possible to build trust and ensure that all relevant perspectives are taken into account.

5. **Fostering innovation and creativity:** co-creation can be a powerful approach for fostering innovation and creativity in the development and deployment of emerging technologies. By bringing together a diverse group of stakeholders with different perspectives and expertise, co-creation can facilitate the generation of new ideas and approaches that may not have been considered otherwise. This can be particularly valuable in the context of emerging technologies, which may require new and innovative solutions to address the challenges and opportunities they present.

On the other hand, the inherent degree of complexity and uncertainty of ETs may pose serious challenges. Some crucial aspects may arise:

Competence and knowledge aspects:

1. **Lack of understanding or knowledge, misunderstanding:** Low TRL technologies may be unfamiliar or not wellunderstood by some actors/stakeholders, which can make it difficult to engage in meaningful dialogue about the technology.

2. **Criticism in the dialogue**: exchanging knowledge and experience on technologies whose concrete application is not precisely known can be very challenging and tiring. Stakeholders may find it difficult to reason about technologies under development without having knowledge of their concrete use.

3. **Speculation and adoption challenges**: The spread of radical and disruptive new technologies in the marketplace and society typically gives rise to a phase of speculation. These speculations can be more or less skeptical or hostile, and negatively affect the expectations of adoption by the market and society.

Stakeholder issues – power, and goals.

1. **Power imbalances:** There may be significant power imbalances among stakeholders in the context of low TRL technologies, which can make it difficult for some voices to be heard or for all stakeholders to participate equally in dialogue. Identify what kind of power imbalances exist between stakeholders in this specific area.

2. **Disagreement or conflict**: Stakeholders may also have conflicting perspectives or goals when it comes to low TRL technologies, identifying application areas and scopes which are widely different (useful to big mass versus niche). This is very much linked to the prioritization criteria used to selecting ET.

3. **Aligning objectives and expectations**: different stakeholders may have different expectations and objectives about the ETs. Some might be more focused on commercial outcomes, while others might prioritize social impact or academic research. Reconciling these differing objectives to arrive at a shared goal can be a complex process.

Timeframe

4. **Time frame**: discussion on ET concerns long-term impacts and application. Something that does not impact stakeholders' life in the immediate. The issue “what’s in it for me” becomes highly relevant, risking to jeopardize the process by impacting on some stakeholders’ interest.

3. Scouting of previous projects

3.1 Screening and selection process

A search on the European Community CORDIS (Community Research and Development Information Service) Platform was performed to identify the research projects focusing on co-creation and engagement in the field of emerging technologies.

The keyword-based retrieval of data from CORDIS and the desk research were adopted as analysis techniques. Some projects were also indicated by the contributing partners to this task. The dataset retrieval was obtained by searching on the CORDIS database the research projects mentioning the following keywords:

o 'TECHNOLOGIES'|' CO-CREATION'| EMERGING TECHNOLOGIES| 'ENGAGEMENT|

The search on CORDIS produced a wide range of results:

- 54 073 results for the two key words 'TECHNOLOGIES' AND 'CO-CREATION'
- 1 469 results for the three key words 'EMERGING TECHNOLOGIES' AND 'CO-CREATION' AND 'ENGAGEMENT'

These results have been further reduced to 259 projects by adding the CORDIS filter starting date "after 2016" and fields of application "society", "environment" and "industrial technologies". Eventually, 14 of these projects were found to be relevant to FORGING's research objectives and therefore further analysed. For these projects, public deliverables related to stakeholder engagement and co-creation (e.g. final reports, engagement plan, etc.) were analysed. The following sections are a tentative to rationalise and categorise knowledge exploited from this search.

The list of the 14 selected projects is reported below in Table 1.

Table 1. List of selected projects

Project acronym	Project title	Start – End year	CORDIS Link
Sea2See	Innovative blockchain traceability technology and Stakeholders' Engagement strAtegy for boosting Sustainable sEafood visibility, social acceptance and consumption in Europe	2022-2026	https://cordis.europa.eu/project/id/101060564
Robotics4EU	Robotics with and for Society – Boosting Widespread Adoption of Robotics in Europe	2021-2024	https://cordis.europa.eu/project/id/101017283
SocKETs	Societal engagement with key enabling technologies	2020–2023	https://cordis.europa.eu/project/id/958277
URBANITE	Supporting the decision-making in URBAN transformation with the use of dIsruptive Technologies	2020–2023	https://cordis.europa.eu/project/id/870338
SONNET	Social innovation in energy transitions: Co-creating a rich understanding of the diversity, processes, contributions, success and future potentials of social innovation in the energy sector	2019-2022	https://cordis.europa.eu/project/id/837498
CO3	Digital Disruptive Technologies to Co-create, Co-produce and Co-manage Open Public Services along with Citizens	2019-2021	https://cordis.europa.eu/project/id/822615

SocialRES	Fostering socially innovative and inclusive strategies for empowering citizens in the renewable energy market of the future	2019-2022	https://cordis.europa.eu/project/id/837758
FETFX	Stimulating effects of Future and Emerging Technologies through communication and outreach	2019-2021	https://cordis.europa.eu/project/id/824753
SISCODE	Society in Innovation and Science through CODEsign	2018-2021	https://cordis.europa.eu/project/id/788217
SCALINGS	Scaling up Co-creation: Avenues and Limits for Integrating Society in Science and Innovation	2018-2021	https://cordis.europa.eu/project/id/788359
IRIS	Integrated and Replicable Solutions for Co-Creation in Sustainable Cities	2017-2023	https://cordis.europa.eu/project/id/774199
SIENNA	Stakeholder-informed ethics for new technologies with high socio-economic and human rights impact	2017-2021	https://cordis.europa.eu/project/id/741716
VIRT-EU	Values and ethics in Innovation for Responsible Technology in EUrope	2017-2019	https://cordis.europa.eu/project/id/732027
EFFECT	Creating effects through communication and engagement in Future and Emerging Technologies	2017- 2018	https://cordis.europa.eu/project/id/737301

3.2 Semi-structured interviews

In addition to the search via CORDIS, a series of semi-structured interviews with Project Coordinators of relevant projects or experts in co-creation approaches in the field of technological innovation were carried out to obtain further insights on the subject. The deeper knowledge gained from the interviews was integrated in the following sessions.

Set of questions asked:

- Why did you perform a stakeholder engagement?
- Which methods have been selected for the dialogue among stakeholders? Why?
- How to facilitate mutual understanding between experts/non-experts and experts from different sectors?
- Which were the main issues, problems or questions brought to stakeholders to discuss?
- Could you briefly outline the main lessons learnt/best practices (i.e. recommendations), specific challenges and how they have been solved?

3.3 Multi-stakeholder dialogue and engagement

3.2.1 Methods for stakeholder engagement

The scouting of stakeholder engagement methods across several projects reveals a variety of approaches tailored according to their specific objectives and contexts. Among the projects identified, stakeholder engagement is seen as multifaceted, creating platforms for continuous dialogue and direct participation of diverse groups in decision-making processes. The engagement strategies of all the projects scouted have the common feature of having been designed to be inclusive and interactive, ensuring that all voices are heard and considered.

Projects like SEA2SEE, Robotics4EU, and CO3 utilized diverse engagement actions to connect with stakeholders. The engagement strategy of SEA2SEE is tailored to specific stakeholder groups recognizing that not all groups can or should be engaged with the same intensity or approach. The strategy aims to ensure that stakeholders perceive their interests as included, fostering a sense of trust and ownership over the outcomes and encouraging active engagement. The project distinguishes three levels of engagement: “informed” stakeholders (that receive information related to the project); “involved” stakeholders (that collaborate directly with the partners throughout the SEA2SEE design process); “cooperative” stakeholders (that drive the research and development of the project solution. Fostering a sense of ownership and belonging among the participants is outlined also in Robotics4EU that proposes a community-centric approach, where stakeholder engagement is facilitated through community-building activities.

Sociotechnical imaginaries are the key tool outlined by the SocKETs project that emphasized cultural conditions for engagement and co-creation, using this method to navigate cultural influences on technology engagement. SocialRES, aimed at bridging gaps in social innovation for sustainable energy, analyzed behavioral aspects of energy consumption, emphasizing the role of consumers in shaping energy practices. SISCODE, focusing on co-creation in policymaking, sought to enlarge opportunities for civic collaboration through a mutual fertilization process involving diverse sectors and stakeholders. It highlighted the reconciliation of bottom-up and top-down approaches, stressing the need for a framework where co-creation can fully thrive. This approach was characterized by a design-driven policy process, integrating creative design to align policy purposes with practical implementation, and emphasizing interdisciplinary collaboration for innovative solutions. The project also considered the roles, functions, structures, and norms influencing co-creation, highlighting the importance of understanding the context in which co-creation occurs.

The importance of practical guides to reach multiple audiences effectively is highlighted in EFFECT that used various methods for engaging stakeholders in public projects. These methods include organizing events like the Meet & Match and European Science Forum sessions, aimed at fostering community awareness and enhancing visibility of scientific research. Another significant method was the organization of major events for policymakers, such as conferences and workshops, to promote the impact of scientific programs.

In addition to traditional tools (i.e. conferences and meetings) most of the projects highlighted the benefit in using innovative techniques. This is the case of SCALING project that stress the

AR/VR visualizations to facilitate stakeholder engagement making their involvement more interactive and immersive.

3.2.2 Dialogue among stakeholders

Stakeholder dialogue is a crucial aspect to take into account when involving different types of actors. Often the stakeholders involved come from diverse sectors and bring with them different perspectives and even differing languages. Simple mutual understanding should not be taken for granted. The dialogue is a pivotal element in all these projects, generally aimed at bridging knowledge gaps and fostering mutual learning. Facilitating dialogue among stakeholders requires a nuanced understanding of the context and needs of different groups.

The SEA2SEE project, for example, involves stakeholders from different segments of the seafood value chain, necessitating a balance between expert knowledge and lay perspectives. URBANITE's approach, which emphasizes the participation of diverse stakeholders beyond consultation, aligns with this by bringing together varied societal sectors. This reflects a growing recognition of the value of non-expert contributions in shaping socially robust and relevant outcomes in projects. The Social Policy Labs are explored as an effective platform for bringing together diverse participants from various sectors.

The CO3 project highlights the shift from a traditional expert-driven approach to a more collaborative model. SISCODE's co-creation process also exemplifies this, as it involves stakeholders in co-designing solutions, promoting a more inclusive approach to innovation. This dialogue is crucial for aligning innovation trajectories with societal values and needs, ensuring that outcomes are not just technologically sound but socially relevant and accepted. This includes creating environments conducive to open dialogue, where stakeholders can share ideas, express concerns, and provide feedback. Techniques like facilitated discussions and collaborative platforms are mentioned as ways to foster a constructive exchange of ideas.

While SEA2SEE and Robotics4EU focus on creating shared understanding and fostering interactive learning environments, projects like SocKETs and SocialRES delve into the cultural and behavioral aspects of engagement. SocKETs uses the concept of sociotechnical imaginaries to facilitate dialogue by considering the cultural backdrop of technology perception, whereas SocialRES employs quantitative data analysis and questionnaires to understand the differences and motivations behind various consumer behaviors in the energy sector. These approaches underline the importance of trust, empathy, and understanding the cultural and socio-economic backgrounds of stakeholders to facilitate meaningful dialogue.

In IRIS collaborative platforms, both virtual (through apps and online platforms) and physical (through workshops and meetings), were used to facilitate exchange of ideas and perspectives.

3.2.3 Features and challenges of engagement

Regarding challenges, each project encounters unique obstacles in engaging stakeholders. SEA2SEE grapples with stakeholder fatigue and cultural diversity, Robotics4EU faces the challenge of societal acceptance of robotics, SocKETs needs to navigate different cultural conditions for effective engagement, and SocialRES deals with understanding diverse consumer behavior patterns in the energy sector. These challenges highlight the complexity of stakeholder engagement, necessitating adaptable and culturally sensitive strategies to ensure effective and meaningful participation of all stakeholder groups. A common feature across these projects is the recognition of cultural diversity and the need to tailor engagement strategies accordingly. For instance, in SEA2SEE, the recognition of stakeholders' fatigue and expectations, as well as cultural diversity, shapes the engagement approach. This is mirrored in URBANITE's attention to the complexity added by social labs' evolving nature, necessitating adaptive engagement strategies that can respond to dynamic societal challenges. However, these projects also face challenges such as bridging gaps between different stakeholder groups, managing expectations, and addressing the inherent complexity in engaging diverse groups with varying levels of power and interest.

Projects such as EFFECT highlight the two-way nature of public engagement, where researchers and the public learn from each other. This method is crucial in raising awareness and collecting diverse viewpoints on scientific projects or new technologies. However, challenges arise in terms of managing diverse stakeholder expectations and ensuring inclusive participation. This necessitates a continuous evaluation and adaptation of engagement strategies, as seen in the SISCODE project, which pays close attention to the multi-level changes in stakeholder networks.

3.4 Most promising co-creation approaches

Each project demonstrates a distinctive approach to co-creation, ranging from structured methods and interactive workshops to innovative activities. SEA2SEE and Robotics4EU emphasize structured workshops and interactive activities, focusing on collaboration in technology development. CO3 distinguishes itself with its use of digital platforms for collaborative design, enabling online idea sharing and feedback. SocKETs introduces a toolkit-based approach, offering resources and guidelines for stakeholder collaboration. SocialRES stands out for its emphasis on culturally sensitive engagement strategies, acknowledging the diversity of stakeholder backgrounds. SISCODE's approach involves stakeholders in co-design workshops and iterative prototyping, ensuring their involvement is integral to the design process. These projects, though different in their methods, all aim to effectively engage stakeholders in diverse, innovative ways.
A table summarising the broad panorama of co-creation tools is provided.

Table 2: Non-exhaustive list of co-creation tools

Approach	Pros	Cons
Futures / Scenario Workshop	Imagining socio-technical futures in a stakeholder dialogue enables creativity, unconventional viewpoints, and forming a shared understanding	A meaningful futures process requires time. It is dependent on the level of engagement of the participants, and creating an

	and social learning on topics that are relevant but seldom raised in the context of innovation, such as hopes, fears, concerns, and expectations.	atmosphere of trust is essential for enabling the expression of unconventional views. Facilitators are challenged to ensure diversity in the discussion.
Participatory Workshop	Encourages free expression, diverse ideas; uses visual aids; adaptable to responsiveness	Needs coordination, facilitation skills; managing diverse opinions can be challenging
Science Café	Suitable for any topic; provokes reactions; creates ethical dilemmas	Requires careful location selection; limited by venue size
Storytelling	Bridges gap between science and public; enhances imagination, understanding	Depends on moderator's storytelling skill; needs structured delivery
Appreciative Inquiry	Focuses on positive potential; involves systematic discovery, imaginative envisioning	May overlook critical issues; needs skill in framing questions, guiding discussions
Fishbowl	Dynamic participation, addresses controversies; reduces speaker-audience distinction	Requires participation management; engaging all audience members equally can be challenging
Solution Focus	Emphasizes solutions over problems; encourages future envisioning without problems	May neglect root cause analysis; heavily reliant on facilitator's ability
Dynamic Facilitation	Suitable for emotionally charged environments; encourages creativity without rigid structures	Can be unpredictable, requires skilled facilitation; may not always produce concrete results
Five-to-Fold	Integrates all perspectives, including minority views; fosters open, honest communication	Time-consuming democratic process; dependent on consensus ability
Open Space Technology	Relies on self-organization, spontaneity; flexible and adaptable	Lacks formal agenda, leading to unstructured outcomes; dependent on participant engagement
Circle Process	Explores many sides of an issue; adaptable to different groups, issues	Requires skilled facilitation; potential for conflict if not managed properly
Social Policy Lab	Engages diverse stakeholders; promotes interdisciplinary collaboration; offers space for experimentation; focuses on systemic solutions; aims to diagnose barriers and design sustainable experiments	Complexity in coordination; dependence on stakeholder commitment; challenges in synthesizing diverse viewpoints
Virtual Policy Lab	Facilitates steady communication; hosts various resources; enables collaborative idea and solution	Challenges in maintaining virtual engagement; dependence on technology; lack of immediacy in

	proposal; supports evaluation and selection of ideas	interaction compared to physical meetings
Quasi-Conversation	Informal and relaxed; encourages open dialogue; accessibility	Lack of structure; variable depth of engagement; limited documentation
On-Premises Visit	Direct observation; rich, firsthand data; personal interaction	Resource-intensive; limited scale; potential intrusiveness
Twitter Hour	Accessibility to a wide audience; real-time interaction; networking	Limited depth due to character limitations; lack of non-verbal cues; fast-paced discussions
Gamification	-Increases engagement and motivation; effective for education; introduces competition	Risk of complexity; superficial engagement; not universally effective

3.5 Results and lessons learnt

These projects underline the importance of tailored, inclusive, and adaptive engagement strategies that consider cultural diversity as well as power dynamics. Furthermore, they highlight the essential role of facilitating meaningful dialogues between experts and non-experts, acknowledging the value that different perspectives bring to addressing complex social challenges. The following aspects can be highlighted as key lessons:

1. **Tailored engagement**: The importance of tailored, inclusive, and adaptive engagement strategies that consider cultural diversity and power dynamics was a common factor among the projects. A fit-for-all strategy is unlikely to make engagement meaningful.

2. **Multi-faceted dialogue**: Effective stakeholder dialogue was essential, requiring nuanced understanding of different perspectives and cultural backgrounds to bridge knowledge gaps and foster mutual learning.

3. **Integration of diverse contributions:** There was a strong emphasis on combining insights from both experts from different sectors and non-experts, acknowledging that inclusive input leads to more robust outcomes.

4. **Diverse co-creation techniques:** Various co-creation techniques, both traditional and innovative methods, were employed to ensure stakeholders played an active role in the design and development processes.

5. **Value of inclusivity:** Inclusive strategies that pay attention to cultural diversity and power dynamics were crucial for meaningful stakeholder engagement and dialogue.

6. **Effective communication:** Maintaining an ongoing, open dialogue that respects diverse viewpoints and cultural nuances was crucial. This approach helped in understanding various perspectives and facilitated mutual learning.

7. **Overcoming challenges:** Projects faced challenges like stakeholder fatigue, managing expectations, and cultural diversity, necessitating flexible and sensitive engagement approaches.

4. Value-based considerations on Emerging Technologies

Integrating value-sensitive considerations into technology design is of paramount importance for creating technology that is beneficial, sustainable, and acceptable to society[9].

Firstly, incorporating value-sensitive design principles ensures that technology aligns with human ethics and values. This alignment is crucial because technology is not developed in a vacuum; it impacts and is impacted by the societal context in which it operates. By embedding values such as privacy, fairness, and accessibility into the design process, technology developers can ensure that their products respect and uphold these principles, thereby fostering trust and credibility among users.

This approach significantly enhances user acceptance and adoption. Technologies that are designed with an understanding of the values and needs of their intended users are more likely to be embraced. This is because they are seen as more relevant, user-friendly, and sensitive to the concerns of the community they serve. For instance, a technology that prioritizes user privacy is more likely to gain traction in a society that values individual rights and data protection.

In addition to human values and societal considerations, environmental sustainability was recognised as an important value to be considered in technological development. Therefore, considerations from sustainability approaches to technology were incorporated into the FORGING value sensitive approach. A well-functioning ecological system is crucial for all human societies. In addition, ecological systems are often seen as having a value of their own, independent of their potential benefits to humans. As human technologies shape and have shaped the ecosystems of the whole planet in the contemporary era, developing technology that seeks to find a balance between human values and preserving the ecosystems is crucial both for humans and all the other species on the planet.

Considering values from the outset helps in anticipating and mitigating potential negative impacts. In the absence of such considerations, technologies might inadvertently perpetuate biases, infringe on privacy, destroy the environment, or have other unforeseen harmful consequences. By incorporating value-sensitive design, developers can identify and address these issues early in the development process, reducing the risk of harm and the need for costly modifications later. In an era where technology has far-reaching implications on various aspects

[9] B. Friedman, P.H. Kahn Jr, A. Borning, Value Sensitive Design: Theory and Methods, UW CSE Technical Report, December 2001.

of life, from personal privacy to democratic processes, it is essential for those creating technology to consider the broader social, ethical and environmental implications of their work.

Furthermore, by proactively addressing value-sensitive issues, technology is better prepared for future challenges and evolving regulatory landscapes. With the rapid pace of technological advancement, new ethical and sustainability related dilemmas are constantly emerging. Designing with a foresight of these challenges helps in creating technology that is resilient and adaptable to future norms and regulations.

In conclusion, integrating value-sensitive considerations in technology design is crucial for ensuring that technological advancements are not only innovative and efficient but also ethically sound, socially responsible, and environmentally sustainable. This approach is essential for creating technology that is not only functionally effective but also beneficial to society in the long term. Technology shapes all aspects of human lives and our interactions with the natural world, and developing these technologies with a mindset that is sensitive for both human and environmental values is the only way of creating a desirable future for humanity.

5. Conclusions

From an overview of the projects analysed in this document, we can conclude that a number of aspects are key when attempting a co-creative approach in the field of technology development and adoption.

First, it is crucial to engage a wide array of stakeholders from various sectors such as academia, industry, government, and the public. This diverse participation ensures a range of perspectives and expertise, leading to more responsible technological solutions.

Effective co-creation also relies on ongoing dialogue and collaboration throughout the technology development process. This continuous interaction helps adapt to new insights and manage evolving risks, ensuring that the final product remains aligned with stakeholders' needs and societal values. The process should be flexible enough to accommodate changes and new insights, which is essential in the rapidly evolving field of emerging technologies.

In the specific case of FORGING, as was emphasised by several experts during the interviews carried out in the framework of this task, the main challenge is to narrow down the field of discussion on ETs. The scenario workshop was stressed as a very suitable tool to address this challenge facilitating the discussion among stakeholders.

Integrating ethical considerations from the outset is vital, addressing not only potential ethical issues related to the technology but also ensuring that the co-creation process itself is ethical. This involves respecting the voices and contributions of all participants.

The co-creation approach should balance expert knowledge with lay perspectives and end-user insights, providing valuable context and practical considerations. This balance helps in developing technologies that are not only advanced but also practical and user-friendly.

Implementing iterative development processes with regular feedback loops allows for continuous improvement and refinement of the technology. This ensures that the emerging technology evolves in response to stakeholder input and real-world applicability.

Maintaining transparency throughout the co-creation process is crucial for building trust among stakeholders. Open communication about goals, processes, and challenges fosters a sense of ownership and commitment to the project. Empowering all stakeholders, especially those who are typically underrepresented, ensures a more equitable co-creation process. This might involve capacity building or providing resources to enable meaningful participation.

In summary, a co-creation approach to be meaningful needs to be inclusive, collaborative, flexible, ethically grounded, balanced in expertise, iterative, transparent, and empowering. This approach leads to more innovative and effective technological solutions and ensures that these technologies align with societal values and needs. Co-creation brings with it inherent complexities, linked to the necessity to manage a variety of participants that bring with them different background knowledge, languages, assumptions, motivations, priorities and objectives. In the context of FORGING such complexity is increased by the uncertainty and unpredictability aspects that naturally characterise the area of emerging technologies. Such aspects will be attentively taken into consideration and addressed at the facilitation level, supported by the instruments and methodologies developed through a co design approach, in order to successfully catalyse integrative thinking and consensus building around a more sustainable technological future.

Annex I: Summary tables of the selected projects

Project	Sea2See
Technology Focus:	End-to-end blockchain traceability model
Stakeholders Involved	The project encompasses a wide range of stakeholders, including aquaculture producers, fishers, representatives from private and public authorities, suppliers, and policymakers.
Engagement Strategies	The engagement strategy is tailored to specific stakeholder groups recognizing that not all groups can or should be engaged with the same intensity or approach. Techniques are identified for different approaches, including traditional engagement tools, like conferences and meetings, as well as digital tools. The strategy aims to ensure that stakeholders perceive their interests as included, fostering a sense of trust and ownership over the outcomes and encouraging active engagement. Diverse levels of stakeholder engagement are foreseen based on: i) objectives of relevant groups, ii) geographical distribution, iii) resource availability. The project distinguishes three levels of engagement: "informed" stakeholders (that receive information related to the project); "involved" stakeholders (that collaborate directly with the partners throughout the SEA2SEE design process); "cooperative" stakeholders (that drive the research and development of the project solution).
Co-creation approach	Co-creation in SEA2SEE is integral to the project design process. It involves three key phases: **Co-design Phase**: Establishing ground rules and principles for stakeholder co-creation, defining stakeholder expectations, and identifying areas of interest. **Co-production Phase**: Collaborative work on the agreed areas of stakeholder interest, including discussion and review of initial results and methodological approaches. **Co-delivery Phase**: Developing and delivering tools and services for the blockchain-based platform, with an emphasis on stakeholder engagement in knowledge discovery and iterative feedback to refine project outcomes.
Challenges Identified	**Stakeholder fatigue**: The project acknowledges that engaged stakeholders are more productive, but fatigued stakeholders tend to underperform and may disengage. To counter this, SEA2SEE keeps stakeholders informed about the evolution of multi-disciplinary technological and innovation activities, catering to each stakeholder's interests. The project sets up a clear timeline for information sharing while empowering stakeholders in decision-making processes. This approach is especially important in countries where similar projects are occurring, where SEA2SEE engages with these projects to organize common events, minimizing stakeholder fatigue. Managing **stakeholder expectations**: Managing stakeholders' expectations is crucial for effective engagement and maximizing project benefits. SEA2SEE addresses this by presenting project objectives, activities, and outcomes to stakeholders, defining their roles across technological and methodological advancements, and iteratively evaluating and adapting to their expectations. **Cultural and operational differences** among stakeholders:

	SEA2SEE recognizes differences in the operational environments of stakeholders (e.g., fisheries, food associations, authorities, aquaculture companies, consumers, suppliers) and the national cultural differences among partners and stakeholders in various countries like France, Spain, Portugal, the Netherlands, Greece, and Bulgaria. **Conflicts between stakeholders**: Conflicts may arise between stakeholders due to different requirements, beliefs, motivations, and expectations. SEA2SEE provides a systematic way to identify stakeholders' concerns, investigate the degree of consensus, and consider that conflict resolution should fit into the cultural norms of the targeted stakeholders. **Concerns over societal benefits** of technological innovation: Some stakeholders might raise concerns about the societal benefits of the technological innovations proposed by SEA2SEE. The project engages to fosters open and transparent dialogue to address these concerns.

Project	**Robotics4EU**
Technology Focus	AI-based robots
Stakeholders Involved	The project involves a wide range of stakeholders, including robotics innovators from companies and academia in healthcare, infrastructure inspection and maintenance, agri-food, and agile production, citizens/users, policymakers, and decision-makers.
Engagement Strategies	Robotics4EU focuses on developing an extensive and inclusive framework for end-user engagement, ensuring that all societal actors, including researchers, industry representatives, policymakers, and civil society, are engaged in a meaningful and beneficial manner. The project has set goals for its Maturity Assessment Model to reach a high Societal Readiness Level (SRL), reflecting the integration of diverse viewpoints and the anticipated societal acceptance of its outcomes.
Co-creation approach	The principles of collaboration and interactivity guide the methodology. Collaboration concerns the engagement between the project and the interested parties and aims at raising awareness, sharing good practices, transferring knowledge as well as at identifying most demanding challenges. Interactivity envisages the approach to communicate the message to the interested parties by engaging event participants in co-creation sessions. Robotics4EU implements various activities including assessing needs and developing a responsible robotics maturity assessment model. This model serves as a practical tool for robotics developers to integrate legal, societal, and ethical aspects of robotics. The project also organizes capacity-building events in different sectors, ensures citizen acceptance of robotics through consultations and assessments of industry ideas with end-users, and engages policymakers through advocacy reports and policy debates.
Challenges Identified	Specific challenges in the context of robotics were found to be: 1. Lack of engagement and empowerment methods: challenge in finding effective ways to engage and empower stakeholders. This issue was particularly highlighted by those outside the robotics community, who were twice as likely to consider "Lack of empowerment" an important issue compared to those within the robotics community.

	2. Inequality in development: This challenge refers to the education sector not keeping pace with current trends, which can lead to disparities in development and understanding of robotics technologies. 3. Insufficient public engagement: Policymakers identified "Insufficient public engagement" as a significant issue, highlighting the need for more inclusive and widespread engagement strategies in the field of robotics.

Project	**SocKETs**
Technology Focus:	Key Enabling Technologies in industry
Stakeholders Involved	Stakeholders include societal actors who either impact or are impacted by the research and innovation process, such as citizens, industry players, governmental entities, NGOs, community organizations, trade unions, and consumer organizations
Engagement Strategies	The project employs a structured approach to societal engagement, including organizing societal engagement events and adapting them to cultural conditions through the study of sociotechnical imaginaries of different countries. The engagement process is focused on considering the priorities and concerns of a broad range of actors, including underprivileged and hard-to-reach groups. There is an emphasis on recruiting not just any citizens but societal actors who are already organized and working towards societal goals.
Co-creation approach	Co-creation in SocKETs is described as a spectrum, ranging from consulting end-users for opinions and ideas to actively involving citizens as co-developers in the innovation process. This methodology is aimed at ensuring that citizens' priorities, expectations, and concerns significantly impact the outcome of the innovation process, aligning it with societal values and concerns.
Challenges Identified	Identified challenges include cultural factors, breaking silos between disciplines, establishing dialogues between business and society, and integrating societal concerns into innovation. The project acknowledges the importance of understanding the societal context and the diverse perspectives of stakeholders. Cultural aspects, such as mistrust in government and industry in certain countries, and differences in sociotechnical imaginaries, play a crucial role in shaping public engagement practices .

Project	**URBANITE**
Technology Focus:	Disruptive technologies such as big data analytics, algorithmic techniques, and simulations. These technologies are explored in the context of their impact on mobility and urban transformation.
Stakeholders Involved	A variety of stakeholders have been involved in the project, including NGOs and NGO lobbying for digital rights. These stakeholders play advisory roles and represent civil society, platform users, and neighborhood associations. The project also involved technology companies, universities, legal advisors in data and mobility, and city strategy representatives.
Engagement Strategies	The project focused on building a community to discuss and enhance dialogue among stakeholders about societal aspects such as trust, attitude, and privacy related to using disruptive technologies in urban settings.
Co-creation approach	The project used the SoPoLabs that are platforms for addressing complex social challenges, characterized by their social nature, experimental approach, and systemic

	focus. The SoPoLabs bring together diverse participants from various sectors (government, civil society, business community) to work collectively. The labs an iterative approach to challenges, prototyping interventions, and managing promising solutions. These labs aim to address the root causes of problems rather than just symptoms, offering a space for observation, reflection, analysis, and triggering actions for proposed solutions.
Challenges Identified	The project recognizes several challenges in stakeholder engagement, particularly in the context of utilizing disruptive technologies in public administration. The challenges include setting up a team of stakeholders, delivering a process that extends beyond conventional methods, creating spaces for engaged participation, diagnosing barriers and obstacles, designing and developing social experiments, reflecting on the process, and capturing the narrative of the engagement's successes and failures.

Project	**SONNETS**
Technology Focus:	Emerging technologies (like IoT, linked-open data, blockchain, big data, and AI) potentially relevant for the public sector
Stakeholders Involved	SONNETS involved both stakeholders external to the public sector (citizens/individuals and businesses) as well as internal ones (civil servants).
Engagement Strategies	Engagement strategies include creating local communities of interest involving different stakeholders and organizing citizen hackathons to improve public service. These strategies aim at harnessing the value of open data through active engagement with citizens and businesses.
Co-creation approach	The methodology involved a shift from hierarchical control to crowdsourced governance. This included using crowdsourcing techniques to give more voice to people, especially SMEs, allowing them to contribute directly to changing regulations in a transparent and user-friendly way. Examples included the UK Red Tape Challenge and the Cabinet Office's Tell Us How scheme.
Challenges Identified	Challenges include financial barriers like shrinking public budgets, legal issues such as the heterogeneity of legal systems, and organizational obstacles like risk aversion and lack of incentives. Additionally, the lack of cooperation due to organizational silos and significant bureaucracy are also highlighted as critical problems.

Project	**CO3**
Technology Focus:	Digital disruptive technologies (including blockchain, augmented reality, geolocation, social networking, opinion formation, and gamification)
Stakeholders Involved	The primary stakeholders involved were public administrations, including municipalities, universities, and other public government bodies. The project also targeted policymakers.
Engagement Strategies	Engagement plans were tailored for each pilot site, considering their unique context. Strategies involved a variety of actions, from face-to-face interactions with early adopters to media presence in national newspapers. The plan includes identifying target groups and specific engagement actions. Engagement actions were designed based on User Stories and points where significant engagement was necessary. These actions are outlined in the Engagement Action Card included in the Toolkit produced by the project.
Co-creation approach	Co-creation included user stories using the developed User Personas and the service plan developed through co-design activities. These user stories, emphasizing the onboarding parts of the service, are visualized using Unified Modeling Language

	(UML) diagrams. This approach ensured a participatory design process, engaging local organizations in creating stories within the service.
Challenges Identified	Ensuring that the target group (« User Personas ») accurately represent the diverse range of users and stakeholders; identifying and selecting the most effective « Engagement Points » in the user journey, which requires a deep understanding of the service and its user; designing and implementing « Engagement Actions » that are effective and resonate with the target audience.

Project	**SocialRES**
Technology Focus:	Technologies related to energy consumption monitoring, data analysis, and renewable energy initiatives
Stakeholders Involved	Various groups involved: participants in energy cooperatives, aggregators, and crowdfunding platforms, as well as a broader public.
Engagement Strategies	Strategies involving quantitative data analysis, surveys, and questionnaires to engage participants.
Co-creation approach	-
Challenges Identified	Challenges in categorizing stakeholders due to variability in behaviors and preferences. It also noted the complexity in engaging diverse stakeholder profiles effectively and the need for nuanced strategies to accommodate a broad spectrum of characteristics. For instance, different stakeholders have varied levels of acceptability towards technologies, which can impact the effectiveness of engagement strategies.

Project	**FETFX**
Technology Focus	Emerging technologies
Stakeholders Involved	Stakeholders range from the FET project coordinators and participants to other researchers, research managers, policy makers and innovation experts in industry, academia and the public sector. In addition, some FETFX activities interested science communication experts, multiplier organisations (such as regional support services), and the public.
Engagement Strategies	Engagement actions in FETFX were implemented through various initiatives focusing on communication potential (journalists in labs), addressing communication gaps in high-risk research, highlighting innovation potential, enhancing FET researchers' communication skills, and fostering the emergence of the FET community.
Co-creation approach	The co-creation approach of the FETFX project included: • Engaging journalists directly in labs to enhance media understanding and reporting of FET research. • Conducting policy workshops and developing a Recommendation Paper to address communication gaps in high-risk research. • Showcasing the potential of emerging technologies through initiatives like the Future Tech Week and FETFX pills. • Improving FET researchers' communication skills through webinars and training sessions. • Building the FET community through events like FET Day and creating a FET Booklet.
Challenges Identified	The engagement strategy suggests that addressing the diverse needs of different stakeholders and effectively communicating complex and high-risk research topics were potential challenges.

Project	SISCODE
Technology Focus:	Focus on integration of society in science and innovation rather than on specific technologies
Stakeholders Involved	Variety of stakeholders, including citizens, local actors, policymakers, and the scientific community
Engagement Strategies	SISCODE employs strategies like design approach, multi-actor dialogue, participatory involvement, and citizen involvement. It stresses the importance of stakeholders' motivations to participate and the inclusiveness of ecosystem structures. The project focuses on creating conducive environments for empowering co-creation and addressing challenges such as social rejection and traditional top-down practices.
Co-creation approach	The process of co-creation was envisioned as an iterative cycle of design with the phases of understanding, ideating, prototyping, and verifying. A set of innovation development support tools was aggregated to each of the phases: tools aimed at stakeholder engagement such as stakeholder mapping, tools for identification of motivations/alignment of intentions (e.g. motivation matrix).
Challenges Identified	Challenges include managing diverse viewpoints and interests, ensuring equal representation and participation, as well as aligning the co-creation process with practical constraints and policy requirements.

Project	SCALINGS
Technology Focus:	Two main technological domains: Robotics and Urban Energy
Stakeholders Involved	The project involved a wide array of stakeholders, including scientists, practitioners, students, firms, civil society, and co-creation consortia.
Engagement Strategies	The focus was on elaborating theoretical frameworks to enable these stakeholders to develop more evidence-based programmatic agendas and to learn from international best practices while acknowledging socio-cultural particularities.
Co-creation approach	The project analysed the implementation, uptake, and outcomes of three co-creation instruments within these domains: Public Procurement of Innovation (PPI), Co-Creation Facilities (CCF), and Living Labs (LL). By using comparative case studies and coordinated cross-country experiments, the project sought to understand if and how these co-creation instruments can be adapted and scaled across different socio-cultural settings. The project approach involved stages of observation, intervention, and exploitation, which includes policy analysis. This process has led to the development of more mature theoretical frameworks, such as "situated co-creation" and "socially robust scaling," to enable stakeholders to develop more evidence-based agendas and mainstream co-creation in various contexts while acknowledging socio-cultural particularities.
Challenges Identified	Among of the key challenges identified is the scalability of innovative solutions that are context specific. It highlighted the difficulty of deploying co-creation more widely while avoiding standardized, one-size-fits-all processes. The project aimed to address these challenges by developing frameworks and methodologies that respect the diversity of socio-cultural contexts and ensure that innovation is aligned with societal values and needs.

Project	IRIS
Technology Focus	ICT solutions in energy and mobility sectors

Stakeholders Involved	Local communities, tenants of apartment buildings, school children and their parents, local schools, and municipalities of Utrecht (NL), Göteborg (SE) and Nice Côte d'Azur (FR) and their Follower cities Vaasa (FI), Alexandroupolis (GR), Santa Cruz de Tenerife (ES), and Focsani (RO).
Engagement Strategies	The project strategy focused on engaging specific groups within the community, each with unique needs and influence. A significant aspect of the engagement strategy was to involve stakeholders directly in the creation and implementation of solutions. The Engagement Ladder model was used to determine the level of citizen influence in decision-making, ranging from no involvement to active control and steering of integrated solutions.
Co-creation approach	Co-creation involves various methodologies, including collaborative platforms, both virtual (through apps and online platforms) and physical (through workshops and meetings).
Challenges Identified	Technical and legal barriers in fully utilizing tools like Min Stad for citizen dialogue due to the lack of mechanisms to incorporate citizens' views into the official planning process and verify the identity of contributors. Handling personal data and processing comments from outside the official consultation process present further challenges, alongside accessing sensitive or proprietary BIM data.

Project	**SIENNA**
Technology Focus:	AI and robotics
Stakeholders Involved	A wide range of stakeholders is identified, including banks, investors, universities, research institutes, science academies, professional organizations in the AI and robotics fields, and advisory and consultancy firms.
Engagement Strategies	The multi-stakeholder strategy underlines the necessity of involving a diverse range of societal actors through various initiatives. This strategy is regarded as an umbrella document that incorporates a series of methods designed to encourage the ethical development and use of AI and robotics.
Co-creation approach	The collaborative approach included various forms of stakeholder engagement, such as written feedback, online discussions, workshops, and public commentary. These interactions ensured a diverse range of viewpoints were considered, facilitating a more comprehensive and inclusive dialogue among stakeholders.
Challenges Identified	Context-specific challenges related to the difficulty of addressing ethical aspects at all stages of development, implementation and use.

Project	**VIRT-EU**
Technology Focus:	Enabling and industrial technologies - Information and Communication Technologies (ICT)
Stakeholders Involved	Technology designers and developers, especially those in startups and small organizations, venture capitalists, accelerators, regulators, and policymakers.
Engagement Strategies	The project employed various strategies for engagement. These included designing workshops, supporting materials, and tools. These resources were targeted at technology designers and developers, and other stakeholders in the broader ecosystem.
Co-creation approach	The co-creation approach involved tools like the Ethical Stack, Privacy Ethical and Social Impact Assessment (PESIA), and various interventions such as curated stories, workshop facilitation scripts, ethical reviews, and educational exercises. These tools

	and methods were designed to translate academic content to real-world problems and facilitate discussions on ethics.
Challenges Identified	One of the key challenges identified was the need for IoT developers to engage with social values within a project-based moral order. Values such as sustainability, flexibility, and creativity were found to be significant across the technology development process. The social milieu of IoT developers presented both opportunities and constraints, as they act on values in relation to business logic absorbed from collective discussions and influential actors like accelerator programs.

Project	**EFFECT**
Technology Focus:	Emerging Technologies
Stakeholders Involved	Range of stakeholders involved in public engagement and co-creation processes, including scientists, researchers, policymakers, business representatives, and the general public
Engagement Strategies	The project produced a « Guide for Stakeholder engagement » that envisages a wide set of methodologies such as: Science Cafés, participatory workshops, storytelling, appreciative inquiry, fishbowl, solution focus, dynamic facilitation, five-to-fold, open space technology, circle process. These methods promote mutual learning and co-creation of knowledge between different stakeholders. The methodologies include simple structures for conversation, dialogue techniques, meetings in circles for peer discovery and learning, and strategic conversations with real needs and clear purposes.
Co-creation approach	The co-creation methodology focuses on collaborative approaches where scientists and the public work together in all aspects of a project. This includes idea generation, project design, data analysis, and dissemination of findings. The methodology aims to ensure that public perspectives are integrated into scientific research and innovation.
Challenges Identified	Balancing diverse viewpoints, ensuring inclusivity, communicating complex scientific concepts to non-experts, and measuring the qualitative impacts of engagement activities like community empowerment.

Annex II: Interviews to Project Coordinators

FORGING

INDUSTRY-ACADEMIA FORUM
TO UNCOVER THE POTENTIAL OF
EMERGING ENABLING TECHNOLOGIES

T1.3 Learning about co-creation and success factors related to emerging technologies.

Interviews to Project Coordinator

Informed Consent

Funded by the European Union

Information Sheet

You are being invited to take part in a virtual interview carried out in the framework of the European funded project FORGING.

Before you take part in this activity, we would like to provide some relevant information.

Please take some time to read all the information carefully.

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About the FORGING Project

FORGING is an initiative funded by the European Commission to assist the growth and manifestation of new technologies from their very beginning, namely those contributing to the transformative vision of Industry 5.0.
FORGING aims at providing a pioneer methodology to assist the growth and manifestation of emerging enabling technologies for industry 5.0 and accelerate their uptake by industry and society.
The FORGING methodology will be deployed in three main phases: (1) technology uncovering through the identification of emerging technologies with expected economic, societal and environmental effects; (2) analysing future societal scenarios for the enabling technologies; and (3) co-creating concrete use cases for the uncovered technologies.
To do so, FORGING will catalyse an active community of stakeholders - the FORUM, which will be engaged through co-creation sessions; future scenarios workshops; and consultation processes.
The FORGING methodology will be developed and implemented over 6 use cases identified in the context of the Industry 5.0 approach.

FORGING consortium consists of 6 European partners: INL – International Iberian Nanotechnology Laboratory, GAC Group, STAM SRL, I2CAT – The Internet Research Centre, APRE – Agency for the Promotion of European Research, VTT – Technical Research Centre of Finland.

Description of Task 1.3 "Learning about co-creation and success factors related to emerging technologies"

This task is aimed at understanding and capturing the very specific features and challenges of engagement and co-creation activities in the context of emerging/ low TRL technologies. Such preliminary exploration serves to better shape co-creation activities, including the innovation journey, by possibly selecting more appropriate co-creation approaches. This activity will better support the existence and sustainability of the forum and the community of interests around these technologies. The task will analyse the work and results of previous projects performing multi stakeholder dialogues and engagement in the technological sector. The analysis will consider pros and cons of different methodologies in the specific context as well as obstacles connected to expert/non-expert dialogue or to dialogues and activities in situation of unpredictability, as it is the context of emerging technologies.

Kind of Data collected

In order to perform the FORGING project activities, some personal information (e.g. name, surname, gender, email, country, working organisation, sector and stakeholder group, as well as opinions and experiences in the field of co-creation) will be collected and then stored in the coordinator's server.

Processing and Storing of your Data

Your data will be processed in accordance with the General Data Protection Regulation (available at https://eur-lex.europa.eu/eli/reg/2016/679/oj/eng). All information collected about you will be kept strictly confidential inside the consortium.
Only the FORGING beneficiaries will have access to the data collected. At the end of the project, your personal data will be destroyed unless you agree to let us continue to use it for other EU projects. If a publication is not finished by this date, the data may continue to be used until the work is finalized.
Processed data might survive the project, as it may become part of publications and other dissemination activities.

Your data will not be sent to third parties nor to countries outside of the European Union. The sole purpose of storing your data is for project activities.

The interview can be electronically recorded for the purpose of the FORGING Project, summarised and, if necessary, transcribed. The recording will be deleted immediately after the summary or transcript has been created. The results of your interview could be used for analysis and policy recommendations in the project.

Dissemination of Results

The data stored will be used for research purposes. Information provided during the interview will be included in the Deliverable "D1.3 Co-creation on emerging technologies" as part of the report.

Supervision

Each FORGING beneficiary has its own ethical rules, taking into account the national legislation.

Data sharing and re-use

The data stored will be used for the activities relating to FORGING. This includes their processing for research purposes and dissemination activities. Your data could be re-used by other relevant EU funded projects. Your data will, under no circumstances, be sold to any third party.

Data Breach

In case of a data breach, each beneficiary will immediately inform the Coordinator. Together they will undertake all steps necessary to minimize any possible negative consequences. You will receive a notification as soon as possible about the nature of the data breach, the information lost and the actions that are being taken to prevent or minimize any possible harm.

Your rights

You have the right to ask for correction and/or deletion of your data at any time and you can restrict the processing of your data, as granted in GDPR Articles 15 -22.

You can also withdraw your consent at any time according to GDPR Article 6(1) and Article 9(2) without any consequences sending an email to privacy@apre.it .

APRE project contact:

Livia Di Bernardini, dibernardini@apre.it

APRE – Agenzia per la Promozione della Ricerca Europea
Via Cavour 71
00100 Rome

Informed Consent

I, _____(name and surname), I acknowledge that:

- ✓ I have read the FORGING Information Sheet, and understand what the project is about. I have been given the opportunity to ask questions and have had them answered to my satisfaction.
- ✓ My personal details will be processed and handled in accordance with European legislation including the General Data Protection Regulation (EU) 2016/679.
- ✓ I am volunteering to be interviewed in the framework of the EU-Horizon Europe Project FORGING.
- ✓ I will be asked to be eventually recorded during the interview.
- ✓ I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason without consequences.
- ✓ I have been given the information about the expected duration of the storage of the data.

In the final publication (the analysis will be anonymised), I give my consent for (please select one):

- ☐ Both my name and organisation name;
- ☐ Only the organisation name;
- ☐ None of the above.

Date: _____

Signature: _____

APRE Contact:

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3 Bibliography

Literature

Arnaldi, S., Benegiamo, M., Crabu, S., Magaudda, P., Minniti, S., Urbano, L., 2019. Co-Creazione e Responsabilità nell'innovazione tecnoscientifica dal basso. En-RRI Project.

Brey, P., 2017. Ethics of Emerging Technologies. In: S. O. Hansson (ed.): Methods for the Ethics of Technology. Rowman and Littlefield International.

Creţu, V., 2016. Co-creating Public Policies or Ways to Bring Citizens into the Process. European Public Sector Information Platform, Topic Report No. 2016/01.

Eckhardt, J., Kaletka, C., Krüger, D., Maldonado-Mariscal, K., Schulz, A.C., 2021. Ecosystems of Co-Creation. Frontiers in Sociology, vol. 6:642289. https://doi.org/10.3389/fsoc.2021.642289.

Evans, G., Durant, J., 1995. The relationship between knowledge and attitudes in the public understanding of science in Britain. Public Understanding of Science, vol. 4, pp. 57-74. https://doi.org/10.1088/0963-6625/4/1/004.

Friedman B., Kahn Jr P.H., Borning A., Value Sensitive Design: Theory and Methods, UW CSE Technical Report, December 2001.

Hochgerner, J., 2017. Empowerment, Co-Creation and Social Innovation Ecosystems.

Mandolfo, M., Chen, S., Noci, G., 2020. Co-creation in new product development: Which drivers of consumer participation?. International Journal of Engineering Business Management, vol. 12, SAGE. https://doi.org/10.1177/1847979020913764.

Nambisan, S., Nambisan, P., 2013. Engaging Citizens in Co-Creation in Public Services: lessons learned and Best Practices. IBM Center for the Business of Government.

OECD (2023), Engaging citizens in Innovation Policy. Why, When and How?. OECD Science, Technology and Industry, OECD Publishing, Paris.

OECD, Knowledge co-creation in the 21st Century, A cross-country experience-base policy report, OECD Science, Technology and Industry, policy paper No. 115, June 2021.

Rotolo, D., Hicks, D., Martin, B.R., 2015. What is an Emerging Technology?. Research Policy, vol. 44, pp. 1827-1843. https://doi.org/10.1016/j.respol.2015.06.006.

Voorberg, W.H., Bekkers, V.J.J.M., Tummers, L.G., 2015. A Systematic Review of Co-Creation and Co-Production: Embarking on the Social Innovation Journey. Public Management Review, vol. 17:9, pp. 1333-1357. https://doi.org/10.1080/14719037.2014.930505.

Project deliverables

A PRACTICAL GUIDE for PUBLIC ENGAGEMENT in Future and Emerging Technologies “the Involvement of Specialists Listening To, Developing Their Understanding Of, and Interacting With, Non-Specialists.” 2017.

A PRACTICAL GUIDE for STAKEHOLDER ENGAGEMENT in Future and Emerging Technologies “the Involvement of Specialists Listening To, Developing Their Understanding Of, and Interacting With, Non-Specialists.” 2018.

Andler, Daniel, et al. Converging Technologies and Their Impact on the Social Sciences and Humanities (CONTECS) an Analysis of Critical Issues and a Suggestion for a Future Research Agenda Final Report. 2008.

Ares, Ref. DELIVERABLE 1.2: CO-CREATION in RRI PRACTICES and STI POLICIES. 2018.

DELIVERABLE 1.3: THEORETICAL FRAMEWORK and TOOLS for UNDERSTANDING CO-CREATION in CONTEXTS. 2018.

Augustijn, et al. DELIVERABLE 1.2 Cultural Conditions for Public Engagement in Key Enabling Technologies in Industry. Mar. 2021.

Calderaro, Marta. Creating Effects through Communication and Engagement in Future and Emerging Technologies D5.3 Recommendations. 30 Dec. 2018.

Creating Effects through Communication and Engagement in Future and Emerging Technologies D5.6 Report on Community Building and Engagement. 30 Dec. 2018.

Creating Effects through Communication and Engagement in Future and Emerging Technologies Deliverable 4.5 Report on Civil Society Engagement Activities. 2017.

Stimulating Effects of Future and Emerging Technologies through Communication and Outreach D1.3 FETFX Communication and Engagement Strategy and Plan. 2020.

Deliverable 3.1 OBSERVE 360° Radar Funded under Future and Emerging Technologies FET OPEN CSA Workpackage WP3 Assessment Deliverable D3.2 OBSERVE Phase 2 Methodology Report Submission Date. 2017.

Grigoleit, Sonja, et al. D4.1-Analysis of the Identified Emerging Technologies Coordination and Support Actions SOcietal Needs ANalysis and Emerging Technologies in the Public Sector Deliverable D4.1 Analysis of the Identified Emerging Technologies. 2017.

Grigolet, Sonja, and Enrico Ferro. Coordination and Support Actions SOcietal Needs ANalysis and Emerging Technologies in the Public Sector Deliverable D4.4 Stakeholder Specific Recommendations. 2017.

Kharas, Mark, et al. Societal Readiness Plan. Jan. 2021.

Kuhn, Rainer, et al. Co-Creation Toolkit a Guidance on the Design, Development and Implementation of Effective Co-Creation in Industry-Citizen Collaboration Settings Deliverable D4.3; Lead Beneficiary: DIALOGIK. Apr. 2021.

Mazorra, Carlos. Innovative Blockchain Traceability Technology and Stakeholders' Engagement StrAtegy for Boosting Sustainable SEafood Visibility, Social Acceptance and Consumption in Europe D1.1-SEA2SEE STAKEHOLDERS' ENGAGEMENT STRATEGY. 28 Dec. 2022.

Mulero, Sofía, et al. Report on Behavioural Aspects of Engagement with Social Innovation Projects. 13 June 2021.

Observing Emergence Fact Sheet Project Information. https://doi.org/10.3030/665136. Accessed 8 Dec. 2023.

Ref, and Ares. Creating Effects through Communication and Engagement in Future and Emerging Technologies D5.1 Analysis of EFFECT Impacts -First Release. 2017.

Resseguier, Anais, et al. D5.4: Multi-Stakeholder Strategy and Practical Tools for Ethical AI and Robotics [WP5 -the Consortium's Proposals] Lead Contributors. 26 Feb. 2021.

Shklovski, Irina, et al. VIRT-EU Values and Ethics in Innovation for Responsible Technology in Europe. 31 Dec. 2019.

Smith, Craig, et al. "Triggering Sustainable Biogas Energy Communities through Social Innovation." 23 Aug. 2017.

SOCIETAL ENGAGEMENT with KEY ENABLING TECHNOLOGIES Fact Sheet Project Information. https://doi.org/10.3030/958277. Accessed 8 Dec. 2023.

Tsardanidis, Gregory, et al. Plan of Engagement of User / Target Groups. 20 Dec. 2019.

Warnke, Philine, et al. Deliverable 1.2 OBSERVE Horizon Scanning Report Funded under Future and Emerging Technologies FET OPEN CSA Workpackage WP1 Horizon Scanning Deliverable D1.2 Horizon Scanning Report. 2016.

Deliverable 1.3 OBSERVE Horizon Scanning Methodology Report Funded under Future and Emerging Technologies FET OPEN CSA Workpackage WP 1 Horizon Scanning Deliverable 3.1: OBSERVE Horizon Scanning Methodology Report. Mar. 2016.

Interviews

Dr Deserti from SISCODE project (1/06/2023).

Dr van Broekhuizen from NANDIODE project (21/06/2023).

Dr Mustafa Ersoz from EngSurfTwin project (5/10/2023).

Dr Damgaard from Danish Institute of Fire and Security Technology (11/10/2023).