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Engaging the public with CCUS: reflection on a European project approach

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Abstract

The aim of this paper is to share our approach for a societal engagement and participation process that is implemented as part of two sequential research projects on CCUS. The two projects are both funded under the European Union's (EU) Horizon 2020 research program. The first one, STRATEGY CCUS (2019-2022), develops strategic development plans for eight regions in South-East Europe; the second, Pilot STRATEGY (2021-2026), partly builds on the first project; Pilot STRATEGY aims at enabling three of the eight regions to start developing their storage resources concretely and to support two further regions in continuing to explore CCUS as an option. Both projects were designed in a way that they integrate geological, technical and economic research with social sciences, with a focus on the regional level. The paper provides an overview on the concept, objectives and the methodologies for the engagement process. It further includes reflections identifying room for improvement and provides recommendations for other projects. Overall, we find that the situation is characterized by low levels of awareness regarding CCUS, but some openness to discuss it. Specific expectations vary and the societal view is not always in line with the current scientific knowledge and the technological development. Important recommendations include building strong interdisciplinary teams that also implement processes for self-reflection.

Keywords: CCUS; engagement; public acceptance; project experience

1. Introduction

While CCUS technology is (still) largely unfamiliar to the broad public in Europe, CCUS implementation projects have encountered a lack of societal support in several contexts and in some regions. Currently, under the impression of rising concern around climate change and increasing ambitions to mitigate climate change, CCUS is considered to

be an important technological option to reach the goals of the Paris Agreement. However, to find out if the anticipated potentials hold, experimenting with the technology and developing it further also outside the laboratory are an important step to inform societal decision making on the potential contribution, costs and benefits of CCUS. In the past, CCUS projects have been met with opposition [1]. Thus, finding strategies to engage society with CCUS projects that allow for an open discussion is an important challenge. Therefore, in CCUS research there is a high interest in the conceptualization of engagement strategies [2] and also in insights about actual implementation [3].

The aim of this paper is to share our approach for such an engagement and participation process that is implemented as part of two sequential research projects on CCUS. The two projects are both funded under the European Union's (EU) Horizon 2020 research program. The first one, Strategy CCUS (2019-2022), develops strategic development plans for eight regions in South-East Europe [4]; the second, PilotSTRATEGY (2021-2026), partly builds on the first project and aims at enabling three of the eight regions to start developing their storage resources more concretely and supporting two further regions in continuing to explore CCUS as an option. Figure 1 below provides a map showing the initial eight regions from the StrategyCCUS-project as well as the further selections from these eight for PilotSTRATEGY. Both projects were designed in a way that they integrate geological, technical and economic research with social sciences, with a focus on the regional level.



Fig. 1. Overview on the regions under study. Organizations from all countries named are part in the project consortia.

In the next sections we will provide an overview on our approach in a consecutive way: first we provide more details on our approach in both projects. Then we summarize experiences and selected findings from the activities implemented so far. In the end we reflect them critically to allow for drawing conclusions.

2. Rationale for participation and engagement

From a conceptual point of view, our social science approach combines academic research to enhance the knowledge on societal perceptions of CCUS with direct interaction activities with society and its stakeholders. Content-wise the focus moved from broadly exploring social acceptance to more specifically engaging the regional communities during the progress of the two projects. We designed explorative phases especially at the beginning of the projects as well as engagement activities for a constant dialogue between the research projects and (regionally affected) societies.

2.1. Approach in STRATEGY CCUS

According to the project plan of STRATEGY CCUS, a specific work package (WP) was dedicated to societal engagement. This WP was led by a team of two research groups specialized in research on social acceptance, human

behavior and societal transitions with academic backgrounds in a variety of social sciences such as sociology, psychology or political sciences. However, for each of the regions at least one of the technical partners involved in the consortium also participated in the WP. An overview of the process is given in Figure 2.

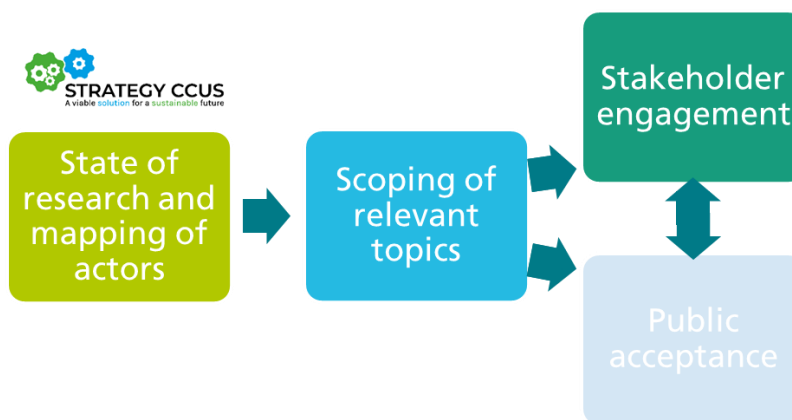


Fig. 2. Process of engagement and acceptance research in STRATEGY CCUS.

Activities on engaging with society began with a workshop at the Kickoff meeting. In this workshop the scientists leading the activities provided an overview on the planned tasks and collected input from all partners regarding external actors to be involved in the different tasks, important topics to be raised in the engagement process as well as expectations and concerns from the overall consortium in relation to the participation and engagement activities.

The first analytic step in the project consisted of an exploratory step that combined two approaches, namely a review of the social acceptance literature around CCUS as well as identifying potentially relevant actors through discussions with projects partners from the country and systematic research on the internet [5]. To inform the process of identifying actors a scheme derived from the literature on technical innovation systems was applied and adapted to the context of the study [6,7].

This step provided input to the second step, namely the scoping of relevant topics in the countries and regions under study in relation to CCUS. From a methodological point of view, the scoping consisted of an interview study [8]. The interviews were semi-structured following a guideline based on inputs from the previous steps but allowed interviewees bringing up topics they consider as relevant. Topics included stakeholders' overall evaluation of CCUS technologies, their level of acceptance of CCUS developments in their regions, sources of concern, perceived benefits and costs of the development of CCUS to the region, conditions for acceptance, perceived barriers and enablers to the development of CCUS in the study regions and preferences and expectations for energy futures. The sample of interviewees was selected building on the actor research from the step before, also applying again the actor categories from the innovation system approach to ensure heterogeneity in views.

This scoping step prepared the grounds for engagement with the regions which were channeled by establishing regional stakeholder committees (RSC) [9]. RSC consisted of key stakeholders from the regions, sometimes also from the national level. The RSC met at least three times in every region over the course of the project lifetime. They were identified applying again the stakeholder categories and using contacts and knowledge about potential participants from the previous steps. The number of stakeholders per RSC ranged between 6 and 20 participants per meeting and industry stakeholders were usually the biggest group. Established stakeholder engagement and problem structuring methods from the social sciences were applied to ensure reliable and scientifically high-quality outcomes. For a constant monitoring, after each RSC workshop, the stakeholders were asked to complete a short evaluation questionnaire. The first workshop aimed at getting familiar with stakeholders as well as giving them a first opportunity to engage with the STRATEGY CCUS project and its research team. The second RSC workshop aimed at strengthening the stakeholder network and receive their first opinion on CCUS scenarios developed by the project consortium for the respective region. Here, a visioning exercise was implemented. The third RSC workshop, presented

and discussed the final scenarios with the stakeholders including the economic assessment of a potential CCUS implementation. For the preparation, implementation and documentation of the RSC, we established a constant exchange and strong cooperation between the WP leads as well as partners from the countries. While the WP leads provided the framework such as the agenda and methods for facilitating the workshops, country partners implemented them, usually in the national language (except in Romania). To provide a safe space for every stakeholder to speak up and state its opinion regarding the implementation of CCUS in the region appropriate facilitation methods were used e.g., where every participant had the opportunity to provide input also using polls or brainstorming boards. Furthermore, data protection measures and informed consent forms ensured confidentiality.

In parallel and towards the end of the project lifetime questionnaire based surveys were undertaken in two of the regions [10]. Budget constraints were the main reason for not implementing the surveys in all of them. The survey design included a comparison of the national and the regional level in France (Rhône Valley) and Spain (Ebro Basin). Each of the four samples that were recruited based on online panels consisted of around 1300 respondents. The questionnaire asked participants about their self-rated familiarity with CCUS, provided them with information about the technology and then measured beliefs and acceptance as well as preferences on other options for the energy transition as well as trust in stakeholders. As CCUS is fairly unknown to the public, providing survey respondents with information has been established as a standard methodology to receive more valid responses [11].

Finally, in a concluding step, learnings and conclusions for future engagement processes were summarized in a report [9].

2.2. Approach in Pilot STRATEGY

In Pilot STRATEGY the focus is on CO₂ storage and on developing regional plans further towards starting the implementation of storage pilots in the main regions in Portugal, Spain and France. For the secondary regions it aims at enhancing the knowledge of CO₂ storage options in West Macedonia in Greece and Upper Silesia in Poland. Thus, in comparison to STRATEGY CCUS the focus is on CO₂ storage and not on the full chain including capture and transport nor on CO₂ use. In addition, the aims of the research are nearer to implementation as in the main regions it is the goal to provide all information necessary to start the actual implementation process if projects results support the feasibility from a technical, economic, regulatory and societal perspective and if the decision is taken to move forward by political and industrial bodies. Thus, participation and engagement activities as well as the analysis of social acceptance are even more relevant in this project.

Here also a specific WP was included for engagement and participation. Further related activities are included in the project management. Due to the rising relevance the team of partners with a background in social sciences was extended to have experts from this field as partners in all countries with main regions. Again, for each of the regions teams were formed with the respective technical partners involved in the consortium. An overview of the process is given in Figure 3.

As an over-arching activity a trans- and interdisciplinary dialogue is included as part of the project management and is led by two of the social science partners. This dialogue consists of a variety of interactions among the different scientific disciplines (engineering, natural sciences, social sciences) and institutions (private research bodies, universities, companies) involved in the consortium of PilotSTRATEGY. By providing time and resources for such a dialogue the goal is to increase the understanding of the different perspectives, promoting mutual understanding. Through dedicated sessions at each periodic consortium meeting, the process of an internal dialogue tries to identify and clarify assumptions among the project group, assessing starting points, perceptions, attitudes and socio-technical imaginaries related to the potential development of geological storage sites. These are to feed back in a deliberative process to stakeholder-facing project activities. As a first outcome of this process the consortium documented its understanding of the project in a short manifesto that describes the project identity. It explicitly values the different perspectives involved but also defines its scope towards society and a potential implementation of CO₂ storage in the regions:

“The European Union (EU) research project “CO₂ Geological Pilots in Strategic Territories” (PilotSTRATEGY) supports future decision making by developing detailed insight on how geological CO₂ storage sites could potentially take their place in five regions across Europe. PilotSTRATEGY, in harmony with recommendations from the Intergovernmental Panel on Climate Change (IPCC), will help add CCUS to the

feasible climate mitigation options available to policy makers across all levels, to local industries, and to local communities.” (p. 2 of the Pilot STRATEGY manifesto, unpublished document)

In the subsequent consortium meeting the manifesto was discussed now from the perspective of the different WPs which made visible different perspectives within the consortium on the desirability of CO₂ storage and thus the hopes connected to project outcomes.

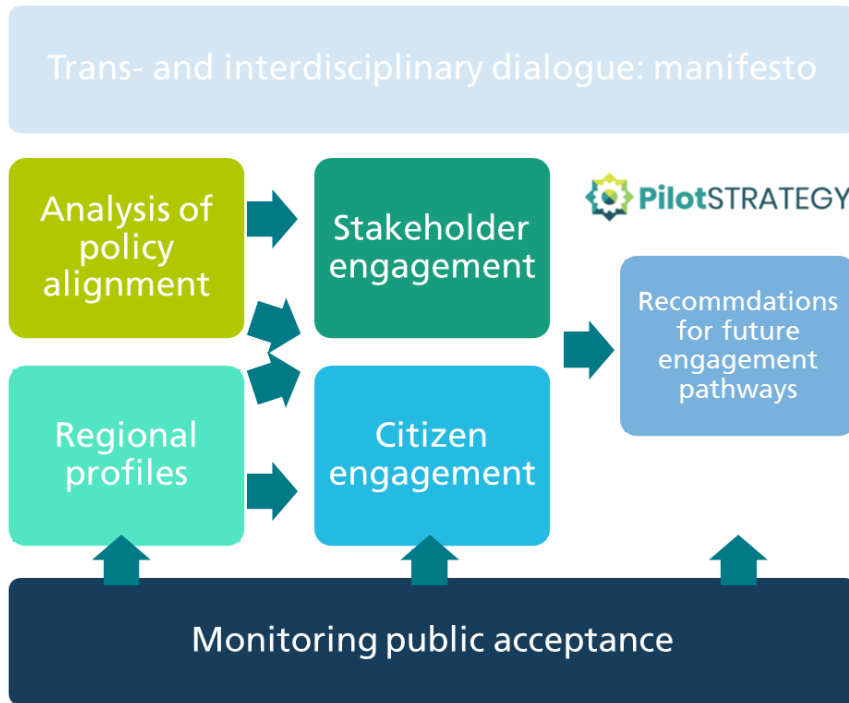


Fig. 3. Process of engagement and acceptance research in STRATEGY CCUS.

Its society-directed activities started with an analysis of the policy framework in seven Member States, including the countries under study, and the UK and examined its alignment with the European level [12]. The motivation for this analysis was to check the regulatory and legislative framework as a precondition to a potential implementation of CO₂ storage. The countries studied comprise the PilotSTRATEGY countries (Portugal, Spain, France, Poland and Greece) and in addition the Netherlands as a Member State and the UK, both as countries more advanced on developing frameworks for CCS. The report highlights the role of EU legislation in the context of development of CCS projects in the Member States. In addition, it analyses the transposition of EU legislation into national law and provides information on further national legislation or support instruments relevant in the context. Towards the end of the project the analysis will be updated to check for any progress or changes.

In parallel, the development of profiles of the regions was started. This included several methodological approaches such as (a) a document analysis including the identification of the affected region, (b) media-analyses for the main countries involving print media, google search outputs and Wikipedia articles as well as (c) a series of interviews with societal stakeholders. These steps aim at getting to know the regions on a detailed level and to anticipate their level of knowledge, prior experiences and possible expectations for CCS development.

In addition, monitoring public acceptance was carried out by means of regional surveys. The surveys are implemented with online questionnaires in Poland, Greece and France and as phone surveys in Spain and Portugal. The aim is to assemble representative samples to get an account of current perceptions and acceptance. Later in the project, a second survey round will take place in the main countries to monitor the development.

Both steps, the regional profiles and the first survey round will be integrated into a comprehensive assessment of community acceptance and will inform the next steps, i.e., designing engagement strategies. Engagement strategies

contain two elements. Firstly, stakeholder engagement through continuing the RSC. However, their composition and the workshop design and content will be adapted to the focus of Pilot STRATEGY and take into account the learnings from the scoping analysis. Secondly, a public engagement strategy will be developed and implemented. It is supposed to take into account local culture and traditions as explored by the profiles. Furthermore, the goal is to reach out to citizens who are heterogeneous in terms of gender and ideally income and age groups. In particular, their perceptions of the costs and benefits of CO₂ storage, their impacts, any changes impinged upon their daily lives (for better or worse) will be investigated. Based on the evidence gathered in the previous steps, the most suitable engagement method will be designed and implemented in the different regions in the third year of the project.

The final step consists of developing a local stakeholder and citizen engagement strategy for each region outlining the current situation, anticipated challenges in case of moving forward with the implementation of a CO₂ storage pilot as well as a preliminary list of stakeholders and groups to be involved.

3. Findings and learnings

The STRATEGY CCUS project started in 2019 and was completed in 2022. Thus, all the activities described are implemented, analyzed and documented. Pilot STRATEGY started in 2021 and will run until 2026. From the activities described above, the first round of the policy alignment analysis [12] is completed and the activities for the development of profiles of the regions were started and will be completed before end of 2022. At the time of writing of this paper the first survey is in the field. Thus, findings from Pilot STRATEGY are just coming up, but as activities were intensive in the first months of the project, some first reflections can be shared.

3.1. STRATEGY CCUS

The literature review in the exploration phase at the beginning of the project pointed out that the awareness of CCS and CCU technologies in the broader public continues to be low and that acceptance levels are found to be moderate on average. CCU is evaluated more positively than CCS [13–15]. On a national level, some variety in social acceptance was found. While in the past community acceptance for CCS was found to be lower than on the national level e.g., for Germany, more recent research in the UK detected also more positive evaluations on the local level [15]. While a few studies have looked into different groups of stakeholders and experts, the majority of social acceptance research focuses on the broader or the local public. Regarding stakeholders, most studies so far involve only very small samples and a differentiation between stakeholder categories is therefore difficult to draw. Furthermore, some studies in the past were implemented in Spain [16–18], however, the other countries were usually considered if at all as part of bigger cross-country studies [19,20]. Thus, less is known about the specific context factors in the countries under study (except for Spain). The research for stakeholders identified actors and institutions for all categories from the innovation system but it also turned out that, that the number of CCUS actors from industry is limited [5]. The number of CCUS related stakeholders varied strongly between the countries. For instance, in Spain a number of governmental bodies that deal with CCUS related topics could be identified, while this was not the case in some of the Eastern and South-Eastern European countries.

The scoping of topics through the interviews thus had an important role in learning more about the specific regions under study. The overall number of interviewees was 102, consisting of 10 to 12 representatives in each of the study regions, an additional three key informants at the national level in each country and finally four EU-level interviews. Most of the stakeholders consulted in the regions expected that the implementation of CCUS technologies would help in climate change mitigation and decarbonization by significantly reducing emissions in the industry. In countries such as Spain and Portugal, interviewees emphasized the potential role of CCUS in reducing CO₂ emissions from the process industries (cement, steel and glass). In France as well as in other countries, interviewees emphasized that CCUS should be considered as one among the many options to reduce CO₂ emissions. Overall and in line with research on public acceptance, we found a more favorable attitude towards CCU relative to CCS, although some interviewees perceived CCU as promising in the long term but currently insufficient to result in significant reductions in CO₂ emissions. Stakeholders in the eight regions outlined the environmental global benefits (climate change mitigation) as well as the potential regional benefits of developing CCUS projects. The socioeconomic benefits of implementing CCUS technologies were a key topic of discussion in the eight regions. Overall, there was the perception, shared by

some but not all stakeholders, that CCUS technologies would bring potential regional benefits in terms of job creation and the generation of new industries in the region. As for the potential costs and risks of implementing CCUS in the regions, economic considerations as well as the potential risks for the environment were raised by stakeholders in all the studied regions. The societal impacts of carbon capture and storage were also considered by the stakeholders. Overall, most of the interviewees in the eight regions were rather positive about the development of CCUS technologies. Support for the deployment of CCUS in the regions was based on a favorable attitude towards CCUS technologies as well as on a recognition of the potential socioeconomic benefits of CCUS projects for the region. Only a minority of stakeholder representatives were opposed about the introduction of CCUS projects in their region. These interviewees reported a negative attitude towards CCS, preferred alternative technologies to reduce CO₂ emissions and were skeptical about the potential regional benefits of CCUS projects. As conditions for acceptance, interviewees from the regions mentioned the need to consider the costs (financial viability), acceptance issues (adequate information and engagement), and support from the government (new and adequate legislation). In Spain, Croatia and Romania, lack of support and interest from authorities, political actors, and administration was considered a critical barrier. Lack of technological know-how as well as limited CO₂ storage possibilities were further barriers mentioned in countries such as Romania and Poland. Regarding the enablers for the development of CCUS projects, interviewees in the various regions generally pointed out to the existence of process and petrochemical industries potentially interested in implementing CCUS technologies as well as to the onshore geological storage capacity.

RSC made up of key stakeholders were established in each of the eight regions of STRATEGY CCUS as main approach to engage them. Stakeholders from all identified stakeholder categories were part of the RSC. The number of stakeholders per RSC ranged between 6 and 20 participants with most stakeholders from the industry. In some countries, it was difficult to include NGOs, researchers, support organizations and interest groups. For the preparation, implementation and documentation of the RSCs, we established a constant exchange and strong cooperation between the WP lead, the regional teams as well as the technical team. This was necessary for the successful implementation of the RSC workshops and to implement them with the flexibility needed during the COVID 19 pandemic*. The first workshop had some methodological challenges caused by the shift from a face-to-face design to an online format due to the pandemic. However, the online RSC workshop was successfully conducted as indicated by the RSC members' evaluations. As results of the first RSC workshop, the main drivers of CCUS implementation expressed by the RSC members in the regions were the existence of CCUS-relevant industry in the region as well as the positive reduction of CO₂ emissions. As main barriers, the stakeholders mentioned the economic feasibility and the impact for the environment as well as the lack of clear regulations and distribution of responsibilities. Overall, the first RSC workshop was perceived as a great opportunity to connect with other CCUS-related stakeholders.

In the second RSC workshop, a first version of the potential CCUS scenario for the region was presented and discussed. Besides this, the second workshop aimed to strengthen the network between the stakeholders. Most RSC members in most regions liked and confirmed the presented scenarios, they found them interesting and a good starting point. Most stakeholders highlighted that the scenario needs to be developed further by including additional information - especially on the economic assessment. Thus, in most countries, there was a discussion of the economic feasibility as well as on the (expected/anticipated) social acceptance (mostly with a focus on the social acceptance of storage). The RSC members also highlighted the importance of implementing a pilot as a starting tool for technical, institutional, social, environmental and financial feasibility. Their views of the future of CCUS differed between a key role in decarbonization and a secondary role limited to industrial processes where no other option to decarbonize is available.

The results of the third RSC workshop validated and deepened the results from the two other RSC workshops: Although there were minor region-specific discussions, most RSC members across the regions considered the economic feasibility, the social acceptance from the public, the environmental impact as well as the required political and regulatory framework as main problems for the scenarios. The economic evaluation of the scenarios was the most discussed aspect. Overall, the scenarios from the project were perceived as rather realistic and interesting. Some RSC

* The pandemic began in 2020 and strongly affected public and private life in European countries and outside Europe. For example, personal meetings were limited in terms of the number of people that were allowed to attend. At the time of writing this paper restricting measures in Europe have been revoked for the summer months of 2022.

members expressed ideas for some adjustments or had specific opinions about decisions for refinement, most stakeholders had questions about the economic evaluation.

Public acceptance was measured in the surveys in France and Spain. Most respondents reported not having heard about CCUS technologies before participating in the study. Only around one out of ten respondents reported being familiar with CCS or CCU technologies. There were no significant differences in levels of familiarity between study populations. After being informed about the main features of CCS and CCU technologies, respondents in the four study populations provided a more positive evaluation of CCU compared to CCS. On average, more positive emotions towards CCU than towards CCS were stated. CCU was perceived as more innovative, necessary, economic, safe, less tampering with nature and more beneficial for the regional and national economies by respondents relative to CCS. At the national level, more than half of respondents would accept the development of CCUS technologies in their country. Acceptance levels were higher for CCU (60 percent) relative to CCS (50 percent). Acceptance was higher in Spain (65 percent for CCU and 54 percent for CCS) compared to France (56 percent for CCU and 46 percent for CCS). Regarding the local acceptance of CCS and CCU projects, acceptance ranged from around 60 percent for CCU to 48 percent for CCS. Acceptance levels were higher for CCU projects (62 percent in both regions) compared to CCS projects (45 percent in France and 49 percent in the Ebro Basin). The main individual-level predictors of acceptance of CCS and CCU included the perception about the economic impacts of CCUS developments as well as prior pro-technology beliefs.

Overall, the implemented process worked well and the consecutive steps could made good use of the preceding ones. Some topics were confirmed throughout the process, such as a preference from the public and societal stakeholder for CCU instead of CCS. Partly this is at conflict with the technological development as so far CCU does not seem feasible without implementing CO₂ storage in parallel as CO₂ utilization options are still on lower levels of development and as the quantities of CO₂ do not match. This poses a tension to future developments and societal discussions. In the early phase of the project, it seemed challenging in some countries to identify industry representatives and the innovation system did not appear to be strong in this regard. However, for the stakeholder engagement this did not turn out to be a real challenge and it was sometimes more difficult to integrate other societal groups. Partly this may also be due to the low levels of societal awareness around CCUS that was also confirmed in all steps of the project. This is in line with earlier findings by Mander et al. [21] who pointed out that the discussion around CCS is taking place in communicative niches. Overall, the participatory formats such as the interviews and the RSC workshops were welcomed. The stakeholders were highly engaged and motivated to express their opinion to contribute to the strategic planning of CCUS in their region. Especially from the RSC several aspects emerged that are important for future activities [9]: Establishing a strong team is key for conducting the workshops regarding social science methodologies, CCUS experts, technical support and a regular exchange with the regional teams conducting the workshops. During the workshops, leaving enough time for discussions and flexibility to allow for region-specific modifications is needed to have participants really engage with the information shared. Given that there is a lack of knowledge and also that researchers from the consortium tend to be keen to share their insights which takes time, this is a potential source for tensions in the planning process. Further, to ensure an eye level engagement process, all activities should be implemented in the local language also to lower barriers to participate. This again supports the structure of forming teams with the local partners and giving them a strong role in the process for all activities. One of the learnings was however, that implementing engagement activities requires several competences and all of them need to be represented during the activities. For instance, the foci of the RSC workshops were impacted by the discipline of the regional teams conducting the workshop. Thus, the involvement of additional social science teams would have enhanced the implementation of participatory formats for stakeholder engagement.

3.2. Pilot STRATEGY

To embed the findings of Pilot STRATEGY it is important to note that this project differs from STRATEGY CCUS as the project focuses on CO₂ storage and is preparing the way for an implementation especially in the main countries.

In Pilot STRATEGY the first step that is also already completed was the analysis of the current regulatory and legislative framework considering the EU level as the countries under study are all EU member states as well as their respective national level legislation [12]. The analysis shows that the EU provides a well-established framework for CCS projects consisting of a clear political willingness to make the EU climate-neutral, regulatory requirements and

financial support instruments. In particular, the EU Commission decided quite early on to develop a common legal framework for CCS activities. On the national level and likely influenced by the developments on the EU level, most of the countries analyzed have introduced or are on their way to introduce a net-zero target by 2050 into national legislation. The examination of this net-zero target have resulted in an examination of the role of CCS in many of the countries. While the outcomes of that process are quite heterogeneous, certain clusters can be identified: In Spain, France and Poland, the economic structure opens up a way for CCS projects being a suitable way to reach climate neutrality. As a result, a certain activity level can be found driven by the private sector and particularly concerned industries. However, in all three countries a clear political signal is missing to date. Hence, neither a dedicated financial support system for CCS projects nor a very much adapted legal framework for the transport and geological storage of CO₂ can be found in these countries. In particular the second one can present a high barrier for the timely realization of CCS projects as it means that, on the one hand, a high level of uncertainty exists on costs and liabilities for such projects and, on the other hand, approval procedures may take a lot of time in cases where specific details have to be clarified along the way. In Greece or Portugal, the structure of the industry sector does not require the development of strong CCS capacities and, so far, strong political signals for the realization of CCS projects are missing. The implementation of the CCS directive was merely a translation of the European law into national law, leaving open questions for project developers that would need to be addressed by the government in the process of realizing a CCS project. As a result of the missing political signals and legal uncertainties, activity levels in those countries are low.

The development of regional profiles is still ongoing, but supports the observation that differences between countries will emerge regarding the expectations and concerns and also in the way the discussion around CCS is taking place e.g., regarding actors involved, awareness on the topic, knowledge available. In the main regions, the country teams were extended to make sure that they include social science partners. This already proved to be valuable and to add additional insights in the learning process such as additional ideas for example as to extend the media analysis that originally did not include the analysis of Wikipedia.

4. Further reflections and concluding recommendations

Coming to conclusions, we derive the following recommendations:

- For CCUS to be considered as an option in regional and national policy strategies for the energy transition, there is still a high need for raising awareness for the benefits and risks around the technology to enable societies to make an informed decision whether or not or to which extent CCUS is a worthwhile pathway. This underlines the need to give a strong role to participation and engagement processes in all types of CCUS projects - those aiming for a more general analysis on the topic, but also those aiming for pilot implementation.
- Whether or not societies will accept CCUS is not clear from our findings at this stage; however, we find that societal stakeholders and the public are open to further discuss the topic. Notably, the differences in perception and acceptance on distant levels like national ones and on local levels of potentially affected areas are currently small. Acceptance for CCUS seems to be conditional (e.g., it depends on the CO₂-source, perceived socio-economic benefits, environmental and safety risks, social trust). This emphasizes that engagement processes are important to find out which options are supported by society (or not) and to enable the emergence of trusted relationships.
- The approach of combining an exploration and scoping phase to learn more about the relevant regions and technological options and also to make an early first step towards the stakeholders has proved valuable and is highly recommended to future projects.
- Many disciplines and a broad knowledge are needed for engagement activities such as the procedural and methodological knowledge and experience from social scientists. However, also technological, geological and economic expertise is relevant to design and implement high quality engagement activities and to be able to respond to the expectations and requests from society. Furthermore, knowledge on the local conditions is important starting with language and organizational issues such as preferred communication platforms, but also more specifically contacts to stakeholders and direct experience with local conditions. Thus, the engagement strategies need to be designed in an integrated way and be supported by resources for all partners.
- Societal engagement is, however, not limited to outreach activities, but also has an important dimension within the consortium. For example, one question is whether the climate crisis should remain in the background or move

to the forefront in order to a) better anchor CCUS in a sense-making perspective and b) move from "research as usual" to responsible and engaged research?

- Repeatedly, discussions within the research consortium came up for example how and what information is shared. This includes varying perceptions also regarding needs and expectations between consortium members such as the roles of engagement activities vs. dissemination and communication. Thus, a platform and formats for a discussion of these topics is needed. In PilotSTRATEGY this was implemented by the trans- and interdisciplinary dialogue. However, resonating this with the project dynamics is sometimes challenging and requires flexibility.

Projects such as StrategyCCUS and its follow-up project PilotSTRATEGY are valuable in this regard: Through the scientific evaluations on the regional level, the debate about CCUS also comes to the regional level. Moreover, these projects put an emphasis on societal involvement. It is important to note that this does not mean to convince stakeholders on (certain options of) CCUS, but to provide a platform to exchange on scientific evaluations, ensure transparency and enable to build trust around the project, as a basis for making political decisions on regional pathways for decarbonization - including CCUS or not.

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