BAMS
Meeting Summary

Co-Producing Qualitative Storylines for Resilient Renewable Energy Scenarios Amid Climate Uncertainty

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KEYWORDS:
Climate models;
Numerical analysis/modelling;
Climate services

A Foresight Analysis Workshop for the Renewable Energy Transition

What: Twenty-two experts with different disciplinary and experience backgrounds participated in this workshop to generate qualitative storylines to support the development of scenarios for resilient renewable energy systems. The study responds to the efforts to find climate decision-making-relevant applications of high-resolution Earth system model (HR-ESM) outputs, as well as to incorporate broader perspectives into scenario modeling. HR-ESMs are at the low technical readiness phase, but workshop attendees saw a big potential for their use in supporting complex decision-making under climate change uncertainty, especially for the case of (renewable) energy systems and its interplay with national policy.

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The world is witnessing a rapid transition toward decarbonization, with countries adopting renewable energy (RE) sources and implementing policies to reduce greenhouse gas emissions, aiming to combat climate change and create a sustainable future. Decarbonization goals have been spurred by supranational processes such as in the context of the Integrated Energy and Climate Plans mandated by the European Union to member states. These plans envisage ambitious CO_2 reductions by 2030 and 2050. Energy and electricity models are a tool that currently supports national-level policy-making on how best to increase the uptake of renewable energy (Gatto 2022). While such models provide guidance to policy-makers on the best combination of energy resources, they also face weaknesses: they do not generally take into account the expected impacts of climate change on resource availability, and reliability of supply or demand, nor do they account for the socio-political realities of the country, despite these elements being highlighted as key for enabling energy transitions (Süsser et al. 2022; Fodstad et al. 2022).

In recent years, climate information has seen an increase in quality with several initiatives which aim at developing Earth system models at finer spatial and temporal scales (Hoffmann et al. 2023), which are scales that could support energy modeling (Fodstad et al. 2022). However, despite the increase in quality, the use of climate information has not followed suit—what is known as the "usability gap" (Dilling and Lemos 2011; Raaphorst et al. 2020). The workshop described in this paper is part of a study that explores applications of societal relevance of the expected model outputs in transdisciplinary efforts to reduce this gap, signifying a first step for linking energy, climate, and societal factors in scenario modeling. Scenarios start with a qualitative framing—a storyline. The foresight analysis workshop co-produced these qualitative departure points with stakeholders in response to exploring the two following research questions: (i) What alternative renewable energy transitions are envisaged when a wider plurality of perspectives are involved? (ii) How are these alternative futures constrained or enabled by the expected climate evolution in the midterm?

Studies have shown how the decarbonization discourse may lead to a narrow envisaging of possible policy solutions (Bressand and Ekins 2021), and the use of co-produced storylines with stakeholders from different perspectives and representing several narratives can imply an effort in opening up the range of alternatives for national energy transitions (Sgouridis et al. 2022; Baulenas et al. 2023b). In the field of renewables, and given their important role in the energy transition (Sovacool 2014), co-production should be seen as a *sine qua non* step. Moreover, movements such as the labeled NIMBY (Not in My Backyard), have raised worldwide a challenge to the deployment of renewable energy at the speed needed. Studies to unpack these movements have shown that they are a complex amalgamation of several narratives, including voices for biodiversity protection, land use competition, compatibility with local and rural production systems, or requests for more democratic forms of decision-making in RE deployment decisions (Batel 2020). A co-production approach allows taking these narratives into account. To implement this research, we chose Spain as a case study and its 2023 revised national energy and climate integrated plan, which served well the purposes of this research due to the presence of these narratives as well as

the renewable energy current state of affairs (Alonso et al. 2016; Mercado-Sáez et al. 2022; Fernández-Vázquez and Sancho-Rodríguez 2020).

We next detail the efforts led by science-policy scholars to conduct the workshop held in the Universidad Complutense de Madrid (Spain) on the 31 May 2023. Twenty-two experts, including scientists from different disciplines, public and private representatives as well as the third sector, were invited to the event. The workshop was organized as part of the EU-funded project NextGEMS (Rackow et al. 2022) and the Spanish-funded project GLORIA, both seen as an important step toward building global coupled model simulations of the atmosphere and oceans at a high-resolution scale. The simulations have been run in development cycles and have been improved during hackathons, which are the platforms that hosted the foresight analysis workshop, as well as the preparatory work to conduct it.

Workshop methodology

The workshop preparatory steps and conduction is based on participatory methodologies and the knowledge co-production framework presented in Bojovic et al. (2021). According to the authors, co-production is understood as an "iterative, interactive and collaborative process that brings together a plurality of knowledge sources to mutually define problems and develop usable products to address these problems" (p. 2). The products in this case are the storylines from which the scenario modeling will later on depart (Baulenas et al. 2023b). As the interlinkage between climate, energy and society requires considering a diverse range of expertise and perspectives, the preparatory steps before the actual workshop were also a key element of the process.

Preparatory steps. For the link between climate and energy, the NextGEMS project scientists coordinated a meeting with energy experts and users to explore the variables that would be of interest to obtain from NextGEMS climate models. The list of these variables was used for a brain-storming session conducted with the NextGEMS scientific community in the context of the 2nd Hackathon in Vienna (Austria) with the aim of incorporating the societal perspective. The theme of the 2nd Hackathon was renewable energy with special focus on solar and wind resources, and thus many of the participants had some background or interest in the topic. The brain-storm centered around the research question of how to optimize the design of a regional renewable energy system and how best to extract this information from global storm-resolving models. Around 30 people from the project community turned out. Participants were asked to assume the role of research, policy, business, and society, and propose challenges and needs to renewable energy from that perspective. Table 1 shows the main results of the initial discussion. The second part of the brain-storming session centered around the list of variables and asked participants for each variable the cues "for whom," "for what," and if they saw feasible their production in the context of NextGEMS.

After this co-exploration phase, conducting a more systematic literature review led to identifying the type of discourses that social sciences see present at the climate–energy–society interface. The keywords shown in Table 1 helped the identification of the literature. The color scheme of the table shows the cell inputs which were mentioned by each stakeholder role in order (e.g., "Forecasting power generation" was mentioned three times by members of the "research" role, one time by "policy," and two times by the "business" role). Similarly, as the case study was Spain, revising the gray literature from the country helped understand better the context and existing narratives. The gray literature also helped with stakeholder mapping, conducted following the guidelines from Baulenas et al. (2023a). The main stakeholder categories were set in the following groups: governmental bodies, resource managers, data-related stakeholders, NGOs, private sector, academia, networks or umbrella organizations, media, and disseminators. The stakeholder mapping gave a list of 50 people who positively responded to

Table 1. Results of the brain-storming in the co-exploratory phase to prepare the workshop.

Research	Policy	Business	Society
Forecasting power generation (3, 1, 2)	Local community acceptance (1, 2, 3)	Energy stability/ security (3, 1, 1)	Energy price (1)
Energy efficiency (2, 2)	Environmental impact (3, 1)	Environmental impact (1, 1, 1)	Local community acceptance (1)
Variation of power (2)	Energy price (5, 6)	Integration costs (3)	Energy consumption reduction (1)
Power availability (1)	Grid stability, planning (2, 1, 1)	Power availability (1, 1)	Transition to a more horizontal production of energy (1)
Environmental impact (1)	Energy stability/ security (2, 1)	Fast-enough deployment (1)	
Risk assessment (1)	RE location (1, 1)	Impact of climate change on RE distribution on retrofitting/relocation of plants with 10+ years (1)	
Long-term planning of local generation	Just distribution, energy transition		

the interview invitation. The interviews focused on four main aspects: explain the study, ask about the main topics that interviewees found relevant to consider, ask for further resources, and invite participants to the foresight analysis workshop to co-produce the storylines. These unstructured interviews ranged from 15 to 45 min. Out of the 50 interviewed stakeholders, 25 agreed to participate and finally 22 attended the workshop.

Workshop. The work described in the preparatory phase helped design a workshop, which presented three very broad storylines: (i) the actual, (ii) the integrative, and (iii) the distributive scenarios. Participants were encouraged to challenge and, if needed, change the three storylines. The discussions first centered on the pros and contras of each storyline as if they were the reality of the country. The stakeholders that felt comfortable about models were encouraged to provide feedback also on how best to operationalize them for the quantitative part of the scenarios. The materials provided to stakeholders were the following: the brief description of storylines, the empty tables with a matrix of pros and contras at the short and long terms. They had a list of ideas to facilitate brain-storming, which consisted of cues such as potential stabilities or instabilities of the system (social, economic, institutional or financial); aspects related to society such as just transition, inequality, conflicts, acceptance, or green consciousness; aspects related to energy such as demand patterns, security, or efficiency; models of transitions (from degrowth to green growth); and sectoral considerations (synergies, trade-offs, policy integration, silos). The stakeholders were divided into three groups with two facilitators in each, while a moderator explained the session. The groups had representation of the different perspectives depending on role and narrative orientation. They were allocated 30 min in the first discussion of a storyline (one group per storyline). The groups rotated, and they had 20 minutes in each of the remaining storylines (two) to add on to the discussions of the previous group. The workshop was conducted in 2.5 h.

Figure 1 summarizes the methods deployed for the pre-workshop and during the workshop. As the figure displays, on the same day of the workshop, the steps of "networking and stakeholder presentations" and "presentation of HR-EM case studies for renewable energy" took place during the morning before the workshop. As we explain in the next section, these optional activities were organized to allow the stakeholders to meet each other as well as know more about the project before the foresight participatory analysis workshop.

Main findings

Participants opted to maintain and expand the three proposed storylines. The discussion about pros and contras for each yielded between 25 and 40 arguments distributed in short

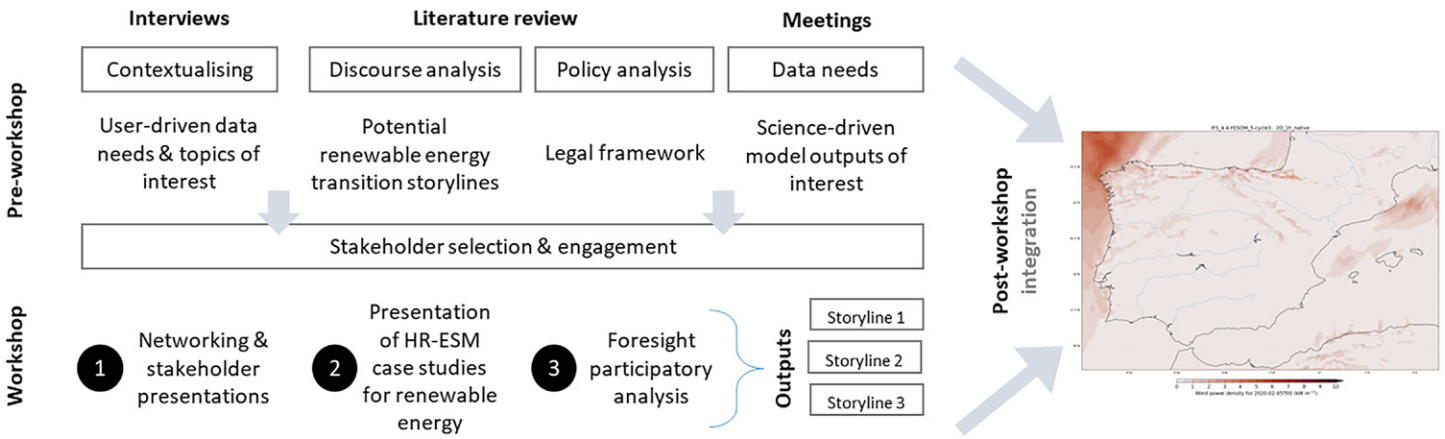

Fig. 1. Summary of the activities conducted across workshop phases.

term and midterm. The majority of the arguments in all three storylines fell in the "contra–short" spectrum, and the majority of the midterm spectrum were also seen as possibly impacting the shorter time horizons in the "distributed" case. The follow-up groups that discussed the results of the first round tended to agree on 30%–40% of the statements. The most divergence and discussion appeared in the "distributive" scenario, which some groups saw more feasible than others. The flow of the discussion indicated that participants could easily depart from the storyline to start the conversation. Still, in the "integrated" and "distributed" cases participants highlighted the need for adapting policy, while the "actual" scenario was already responding to the current state of affairs. Participants provided suggestions on how best to adapt policy to allow for the feasibility of the storylines.

At the end of the discussion rounds, participants were asked to assess the storylines. First, each participant voted for 5 out of 10 criteria proposed by the organizers plus 2 additional criteria proposed by stakeholders. Figure 2 shows the 5 criteria with the highest score. Participants proceeded to rate them vis-à-vis each storyline.

Among the main lessons learnt obtained for preparing a robust workshop, the main suggestions are the following:

- *Knowing your stakeholders*. The stakeholder mapping included a multi-attribute analysis of the stakeholders. The importance of this step is that it gives information on the perspectives that the participant brings in, knowledge type, and preferences in broader terms with regards the topic. The mapping aimed at having a representation of the debates identified in the literature but also in the field with the revision of gray literature. Societal representatives were included as well as big companies, which had very different positions. These positions were also aimed at being represented in the three groups in which stakeholders were divided and helped avoid leaning toward a certain perspective, in case certain positions were underrepresented or to discourage coalitions among participants and give the space for everyone to share their points of view
- *Facilitating personal rapport among stakeholders*. Renewable energy transitions is a heated debate, and an initial informal gathering may support participants getting to know each other being detached from their role as stakeholder and thus facilitating personal rapport. This can help in decreasing the chances of escalating discussions and generate a constructive environment for the workshop. In this regard, stakeholders were invited in the morning and given the space to share their work as well as have lunch together to establish cordial relationships.
- *Front-load efforts*. Workshops are very intense forms of gatherings, and the time in which they are organized is a very important decision. The suggestion is to, once a joint

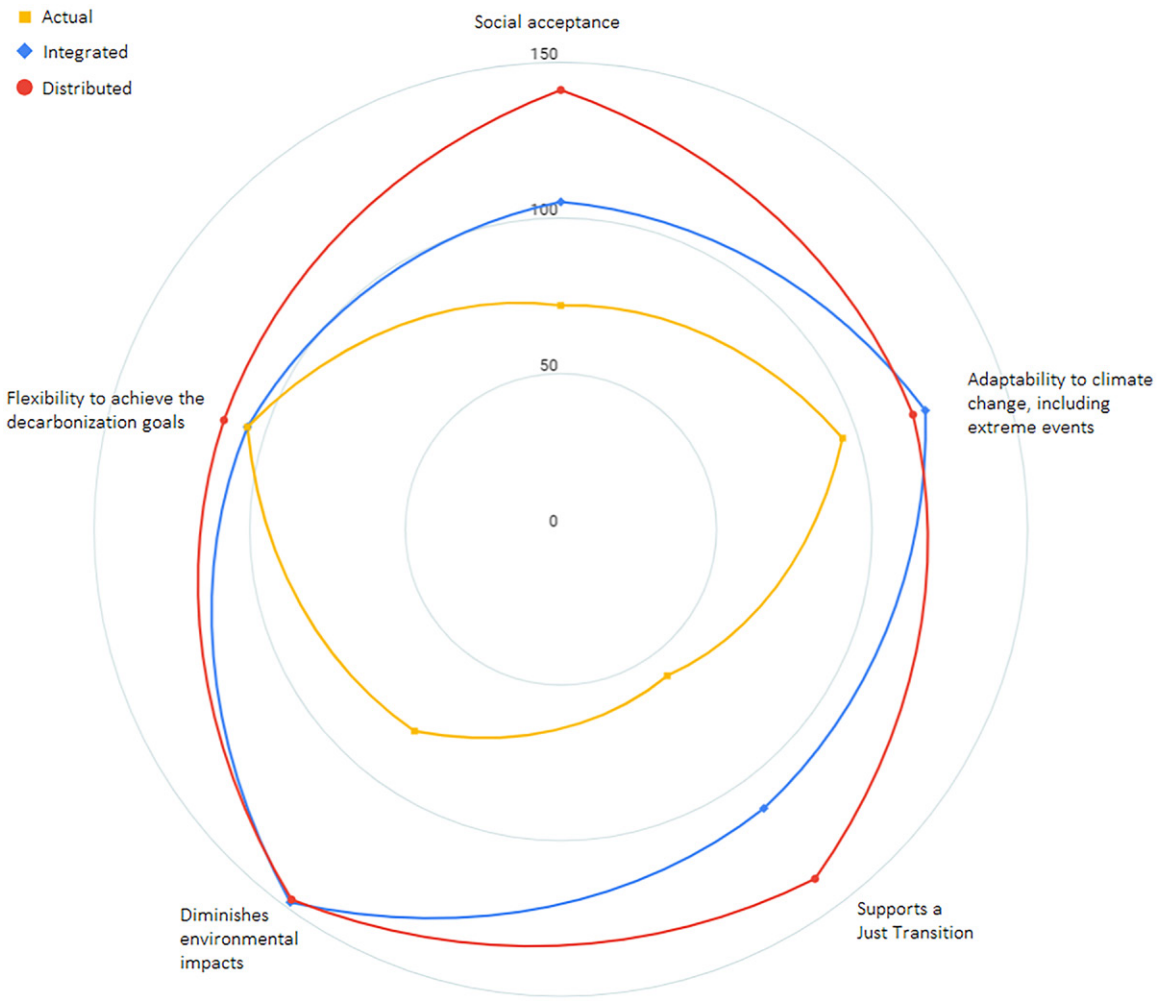

Fig. 2. Storylines assessment by stakeholders on five co-decided criteria.

understanding of the task is ensured, allow for the most intense discussions to come in first. With this in mind, the three groups started with more time allocated to discuss one storyline more deeply, and after, they changed table and topic, but only feedback was requested to build on what the previous group had decided, but which required lower intensity efforts.

- *Facilitators team*. The workshop had two facilitators per table who had knowledge about the topic and had received training to conduct the workshop. Facilitators are key figures in workshops and they have to be given the required tools as they can make or break the outcomes of the workshop. The main tasks included facilitating effective participation, controlling the timings and discouraging the deviation from the main topic, as well as ensuring a comfortable climate and all the voices to be heard.
- *Giving back*. Stakeholder burnout is an aspect recurrently discussed in the participatory literature and incentives are a form for workshop organizers to give something back to stakeholders for their time and expertise. While the project could not pay stakeholders, their commutes and diets were covered. Similarly, the morning allocated time served for networking and to allow participants to identify synergies among them and establish potential collaborations. During the initial interviews, stakeholders were also asked to propose non-monetary back payment, and as a request, certificates were also issued signed by the scientific officer of the project NextGEMS and GLORIA—both being recognized figures in the field of climate science and present during the day and the workshop.
- *Pre and post communication as key*. Beforehand, stakeholders had received all the information with regards to the workshop including background information, the detailed agenda

of the day and the workshop, as well as a list of the affiliations of the participants and logistics. After the workshop, the initial results were sent, together with all the material used, and the contact details of participants (upon everyone's consent). All the material, including the presentations, were designed with the same branding—inspired by the project branding—and helped give a sense of professionality during the gathering.

Final remarks

In conclusion, the workshop held at the Universidad Complutense de Madrid marked a significant step toward linking energy, climate, and societal factors in scenario modeling for renewable energy transitions. The shift toward decarbonization is a global priority, and this workshop's scientific context and motivation addresses national efforts toward this goal. Energy and electricity models play a crucial role in guiding policy-making, but they have limitations in accounting for climate change impacts and socio-political realities. By integrating climate information and co-producing storylines with diverse stakeholders, this workshop sought to broaden the range of alternative futures for national energy transitions. The participants engaged in constructive discussions, presenting pros and contras for each storyline, and providing feedback to optimize policy adaptations for each storyline's feasibility. In general, the use of "storylines" as a methodological approach in climate-related science is seen as a very welcomed tool to bring climate closer to the decision-making context, as the literature also emphasizes as one of its strengths (Baulenas et al. 2023b).

The workshop's methodology proved to be effective in promoting knowledge co-production and inclusivity. By involving a diverse group of experts, stakeholders from different sectors, and representatives from the public, private, and third sectors, the workshop encompassed a wide range of perspectives and knowledge sources. The preparatory steps, including stakeholder mapping, personal rapport facilitation, and front-load efforts, played a vital role in ensuring a constructive and efficient event. Overall, the workshop's outcomes and lessons learned highlight the importance of participatory methodologies in addressing complex challenges such as energy transitions, and its success sets a precedent for future transdisciplinary efforts to tackle climate change and create a sustainable future for all.

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