Empowering communities to participate in marine energy planning and development

Grace Chang, Benjamin D. Best, and Sharon Kramer

Abstract— **Marine renewable energy (MRE) projects require informed and collaborative project planning to overcome significant sociocultural, ecological and environmental, and economic barriers that may limit responsible and accelerated deployment. This challenge is exacerbated by competing values held within and by a diverse set of communities. The overall goal of this project was to design a community-driven education and communication tool to inform the MRE planning and development process. Specific objectives were to: engage with community members to contribute to design of digital tools for MRE education and communication; develop prototype digital tools as informed by community input; and test prototype digital tools with community members in regions affected by MRE project planning. Ocean multi-use and blue justice concerns are expanding; therefore, conflicts over marine resources and spatial competition between marine industries and the general public are projected to increase. Collaborative planning is critical to any offshore development, as well as for upgrades to existing infrastructure and construction of new infrastructure to support expanding and emerging marine activities. This community-driven story building tool will contribute to effective and equitable offshore development planning processes for a number of maritime sectors, and will benefit sociocultural, ecological and environmental, regulatory, and technological challenges, all of which will contribute to economic benefits to communities while respecting environmental justice issues.**

Keywords—**environmental justice, marine renewable energy, marine spatial planning, ocean multi-use, sociocultural issues.**

I. INTRODUCTION

To meet community priorities and equitable outcomes for all, marine renewable energy (MRE) projects, such as those for marine energy and offshore wind, require informed and collaborative marine spatial planning (MSP) to overcome significant cultural, societal, and economic barriers that may limit responsible and accelerated deployment. Effective MSP brings together multiple users of the ocean to coordinate decision-making for sustainable use of marine resources. The MSP process is becoming increasingly important and complex as the global population continues to rise, and pressures on marine resources are expanding into new and emerging maritime uses such as aquaculture, MRE, and other Blue Economy markets. The United States (U.S.) Department of Energy is committed to applying the principles of environmental justice (EJ) to its programs, policies, and activities. EJ ensures that no group of people, regardless of race, color, national origin, or income, should bear a disproportionate share of negative environmental consequences resulting from industrial, governmental, and commercial operations or policies. It guarantees that people have equal opportunity to voice community concerns, and to participate in decisions about activities that may affect a community's well-being.

The motivating force behind the community-driven, "CStories" project is to give stakeholders a data-driven voice in the MRE planning process. By equipping stakeholders with online tools to perform comprehensive MSP, multiple concerns can be addressed while communicating interests in an informed conversation that

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guides communities toward consensus and mutual understanding.

Gilek et al. [1] reviewed more than 300 scientific articles on MSP published between 2005 and 2020 to examine social sustainability in the MSP processes. They found that very few articles addressed EJ; the MSP process was largely driven by economic and environmental aspects of marine planning and governance with little regard for social issues. Fortunately, the third decade of this century has brought positive change to attitudes on EJ, perhaps spurred by U.S. President Biden's Executive Order on Tackling the Climate Crisis at Home and Abroad (27 January 2021). During the last few years, several MSP studies have identified the critical challenges of equitable MSP and suggested potential pathways for MSP success.

These recent studies emphasize the need to disengage from traditional MSP that may be driven by economic interests, with decision-making accomplished through politics. Rather, MSP should be promoted through public processes that allocate human activities across multiple spatial and temporal dimensions to meet social, economic, and ecological objectives (e.g., McKinley et al. [2]; Schupp et al. [3]; Hoerterer et al. [4]; Pennino et al. [5]; von Thenen et al. [6]). von Thenen et al. [6] emphasize the need for careful consideration of spatial aspects to understand vulnerabilities across different economic and social systems. Pennino et al. [5] stress the importance of supporting EJ and consideration of disadvantaged community interests into the MSP process. The term "blue justice" is discussed by Bennett et al. [7] in the context of necessitating exploration of Blue Economy effects on indigenous communities' historical marine uses and rights, including access rights to food and livelihoods, equity in the distribution of economic benefits, and importantly, inclusivity in MSP and decision-making. Implementation of adaptive governance with continuous integration of new data as marine dynamics and social interactions change over multiple dimensions is suggested for equitable decision-making ([5, 6]). Scientific data access, effective dissemination, and integration with the MSP process would strongly benefit productive stakeholder communications. However, it is crucial for these data to be presented in a manner in which non-technical audiences can interpret status and trends [8].

We have developed a prototype user-friendly digital dashboard in collaboration with community organizations, Redwood Community Action Agency (RCAA) and Santa Barbara Maritime Museum (SBMM), to give communities a data-driven voice in the MRE planning process. The dashboard will empower communities with information and interactive data analysis and visualization tools to promote meaningful stakeholder engagement and communications, and informed decision-making, and will be a significant advancement in ocean multi-use management with MRE.

The key hypotheses related to the CStories project are:
- MSP is currently limited to decision-making entities and developers; many stakeholders are disengaged from the MSP process.
- Many community members (local stakeholders) are intimidated by scientific data and tools currently used for MSP.
- The broadening of scientific data access, effective dissemination, and a collaborative MSP process will promote productive stakeholder communications

TABLE I
COMMUNITY DESIGN WORKSHOPS

Date	Host, Location (USA)	No. of Participants /Moderators
21 September 2022	SBMM, Santa Barbara, CA	21 / 6
29 September 2022	RCAA, Eureka, CA	16 /5
2 February 2023	RCAA, Eureka, CA	18 / 5
8 February 2023	SBMM, Santa Barbara, CA	13 / 3

II.   APPROACH

We developed prototype elements of a digital, community-driven story building tool to inform the MRE and development process that addresses the important themes identified as broadly relevant to a multi-objective MSP process [9]. We developed an online dashboard that enables easy access to information and interactive digital tools to empower communities to engage in meaningful communications with other stakeholders. Because of the recent California (U.S.A.) offshore wind energy lease sales (7 December 2022), CStories project outreach was focused on California offshore wind energy development. Outreach content and results are applicable to MSP in general and can also be extended to marine energy projects (e.g., wave and tidal).

Development of the technical aspects of the dashboard was guided by input from community members along the northern and central California Coast to ensure that products are broadly accessible, understandable, functional, and applicable to all stakeholders [10]. With assistance from community organizations, RCAA and SBMM, we hosted a series of design workshops for community input and feedback (Table 1). The primary goal of the CStories workshops was to establish equality and foster a sense of community through collaborations in the design process. Feedback was solicited for decisions and testing of, e.g., the dashboard digital platform type and accessibility, relevant data, approach for inputting community data of interest, and functionality of interactive infographics and other applications. Importantly, design workshops served a dual function of collaboration and education.

The key technical objectives and achievements for the CStories project were a series of software development goals that were informed, reviewed, and validated by community partner end-users through a series of design workshops. Technical objectives and achievements are summarized below.
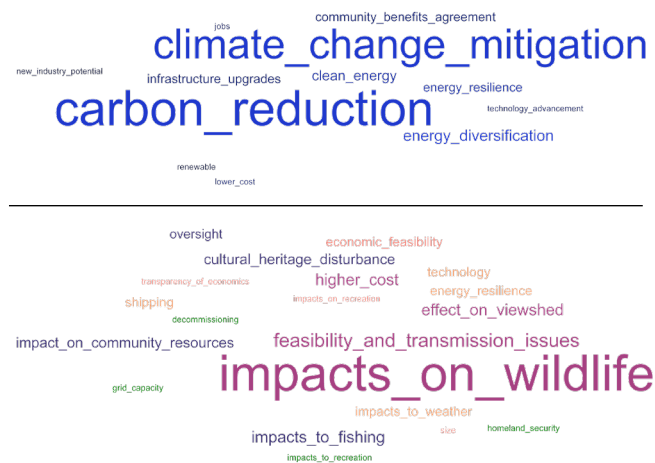
Fig. 1. Synthesis of community member responses to the questions: Top (in blue), "What are the biggest benefits as the result of offshore energy development?" (44 responses) and Bottom (multi-coloured), "What are your biggest concerns with offshore energy development?" (66 responses).

A. Task 1. Initial engagement with community partners

Two CStories project design workshops were held in September 2022 (Table 1). These workshops were focused on providing an overview of the CStories project, presenting a summary of California offshore energy (wind) development activities, and soliciting needs for communities to gain knowledge and communicate concerns about MRE development, i.e., information *IN* (to community members) and information *OUT* (from community members). The content included short presentation materials delivered by project team members, participatory surveys using Poll Everywhere (Fig. 1), and moderated small-group breakout sessions. The CStories workshops attracted participants from the offshore energy industry, consultants, non-profit organizations, regulatory agencies, and the interested public.

The key takeaways from Task 1 outreach activities were:
- The MRE planning process must incorporate stakeholder feedback starting in its early stages (as early as siting). Community benefits must be clearly articulated and quantified.
- Communities generally trust decision-makers/regulators and distrust offshore energy developers. Direct communication with developers would thus not be effective; however communication with regulators and developers together would be useful.
- Participation in MRE planning through existing public process-based mechanisms as part of the U.S. National Environmental Policy Act or other consenting (permitting) processes are intimidating and inconvenient. Community members have difficulty navigating the extensive consenting documents and are oftentimes unable to reach an understanding of complex analysis; therefore, putting

concerns in writing is an intimidating process. Further, public comment periods during meetings are at inconvenient times.
- Community members do not know much about MRE and are eager to learn. The biggest knowledge gaps are MRE device and array characteristics (size, extent, location) and effects of MRE development on the seascape and on wildlife.
- There is too much information available over disparate sources. Community members do not know where or how to search for answers to questions about MRE development in their communities (or elsewhere).
- Community members want to hit the 'Easy Button'. Data need to be digestible and tools need to be easy to use with little technical knowledge or experience necessary.

The outreach activities confirmed the project hypotheses, and guided the development of CStories prototype tools and features.

B. Task 2. Prototype tools development

Four prototype dashboard tools were developed with features focused on information *IN* and *OUT*[1]:

1. Artificial intelligence (AI) driven Marine Energy Chat Bot. This tool directly addresses feedback regarding the need to develop an 'Easy Button'. Several community members expressed the desire to have a means to ask a question and receive an instant response. The Marine Energy Chat Bot operates using Generative Pre-trained Transformer 3 (GPT-3), an autoregressive large language model to provide human-like answers to questions. Questions from users and answers from the Chat Bot are currently logged to a file located on the CStories server. While the Chat Bot operates as intended, it can be subject to digital "hallucinations," [11] meaning answers to questions are not always accurate. Therefore, additional development will be required. This may include human-in-the-loop intervention, where the logged inputs and responses will be reviewed and corrected by MRE experts. Corrections may be reposted to the user account (via Hypothes.is) and used for Chat Bot AI training.

2. Data-driven infographics to communicate relevant topics in a visually engaging and interactive platform [8]. Two prototype infographics were developed:
   - MRE and interactions with baleen whales (Figure 2); data layers currently include:
     o Cetacean sounds
     o Anthropogenic sounds
     o Video – Humpback whales and floating offshore wind farms
     o Video – The Grand Size of Offshore Wind Turbines (from *60 Minutes*)
     o Above and below water floating offshore wind

Whale Interactions
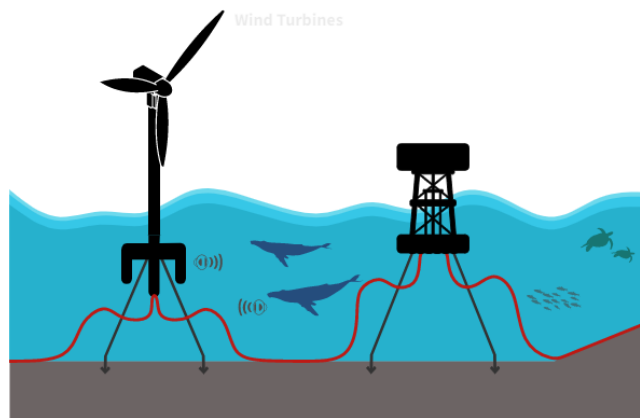
How do baleen whales interact with the cables?

Fig. 2. Screenshot of the interactive infographic for whale interactions. Clicking on various components of the infographic results in the opening of a modal window with content.

> turbine structure characteristics (platforms and turbines)
> o Mooring and subsea cable characteristics
> o Offshore substation information
- Offshore wind development and effects on the seascape/viewshed (Figure 3)
  - o California offshore wind energy lease areas
  - o Visual simulations for California offshore wind energy areas during day and night.
3. Wind energy news found across the internet. The Newsfeed offers the ability to:
  - Quickly digest headlines or read articles in greater detail
  - Sort articles by date, title, or source
  - Filter articles with user-specified keywords.
4. Comment system for users to annotate text throughout the website, including infographics and Newsfeed articles. Users can pose questions and react to other comments (Figure 4). This is facilitated by Hypothes.is and requires a free account (easily setup with an email) before posting. Users may choose to post their comments publicly or only through their own account,

Fig. 3. Screenshot of the interactive viewshed infographic, "How will wind turbines affect your view?". The tabs provide real images of the viewshed with simulated wind turbines.

You're Invited: Gulf of Mexico Proposed Wind Lease Sale Auction Seminar

On February 22, 2023, the Department of the Interior announced a proposed offshore wind lease sale for three proposed lease areas in the Gulf of Mexico off the coasts of Galveston, TX, and Lake Charles, LA. The Bureau of Ocean Energy Management (BOEM) published a Proposed Sale Notice (PSN) in the Federal Register on February 24, 2023, which initiated a 60-day public comment period ending at 11:59 pm ET on April 25, 2023. To comment on the PSN, go to www.regulations.gov and search for docket number BOEM-2023-0021. During the comment period, BOEM will hold an auction seminar for prospective…

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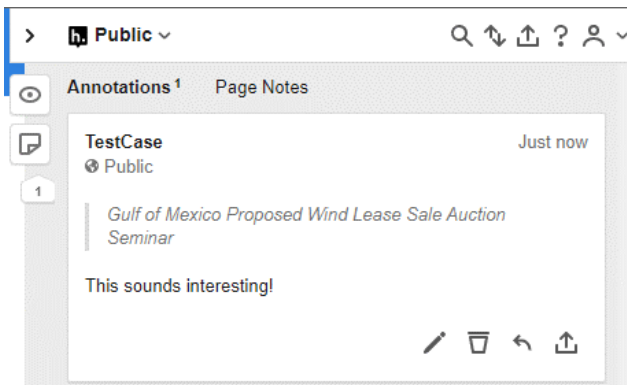Source: Bureau of Ocean Energy Management

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Fig. 4. Screenshot of the newsfeed with posted user comment.

and comments on each page may be shown or hidden by the user (Figure 4).

C. Task 3. Community protype testing and feedback

A second set of community CStories workshops was held in northern and central coast, California in February 2023 (Table 1). The focus of these workshops was to synthesize results from the first set of workshops, present the newly developed prototype digital tools, and solicit feedback from community members on the prototype online dashboard and its tools. Interestingly, only one participant from the initial northern California workshop returned for the second; and all but two participants for the second central California workshop attended the first.

Despite this discrepancy, community member feedback was largely positive and participants were fascinated by the digital tools developed as part of this project. The Marine Energy Chat Bot was of particular interest. Many participants greatly appreciated the infographics as visually appealing educational tools. Several community members were so pleased that they expressed the desire for a "CStories Mobile Trailer" for the project team to present information, ask pertinent questions, and gather feedback around town, i.e., serve as a MRE liaison between stakeholders. Community organizations such as Commercial Fishermen of Santa Barbara (CFSB; California, U.S.A.), are interested in CStories as an educational tool for promoting the use of science for fisheries co-management to protect resources and preserve ocean health. They view CStories as a means to build knowledge and connect stakeholders with regulators. CFSB's mission is in-line with the CStories goals of:
- Connecting community members
- Working toward co-management of the oceans

- Promoting science and monitoring
- Being stewards of the ocean.

Suggested improvements were for the team to guard against Chat Bot hallucinations and to link infographics to local information. One user did not want to create a Hypothes.is account to make comments.

The Newsfeed tool sparked ideas for additional CStories tool development, for example, a filterable calendar of local MRE-related events was requested. Users expressed the need for an interactive, online MRE calendar for coordinating local meetings and events to avoid overlapping and/or missing important events. Participants also suggested additional infographics for community members to communicate EJ concerns in northern California. These concerns include:

- Communities are making sacrifices for offshore wind development yet there is no information on whether the renewable energy source will be made available for local residents.
- There is a lack of information on the development process.
- Recreation in local waters (bay and coastal areas) during and after construction activities may be limited.
- Traffic, noise, waste production and handling, and current infrastructure (e.g., hospitals) may not be sufficient.

III. ANTICIPATED PUBLIC BENEFITS

A data-driven, multi-use decision-support dashboard for MSP, developed in close collaboration with community members, addresses sociocultural, ecological and environmental, regulatory, and technological challenges, all of which will contribute economic benefits to MRE. Ocean multi-use and blue justice concerns are expanding; therefore, conflicts over marine resources are projected to increase. DNV [12] reports intensification of spatial competition between marine industries and predicts that by 2050, offshore wind will grow to account for 50% of ocean capital expenditure and provide nearly as much energy as offshore oil. Further, marine aquaculture output will be comparable to that of reported wild catch. A nine-fold increase in demand for ocean space for aquaculture and energy production is forecasted. Pressures on the shipping industry and its resulting congestion at sea and in ports will continue to increase. Careful and collaborative MSP and management will be crucial. The CStories project products contribute to effective and equitable MSP processes for a large number of maritime sectors. Below is a summary of anticipated benefits of CStories.

Sociocultural: Consideration of socioeconomics of coastal communities including cultural ecosystem services (i.e., non-material benefits such as spiritual enrichment and aesthetics), subsistence fishing, job loss/creation, local tax structures, real estate values, and tourism opportunities; preservation of cultural resources;

protecting interests of commercial and recreational fishers (food supply); increasing ocean literacy and marine citizenship; and maintaining visual appeal.

Ecological and environmental: Awareness and consideration of sensitive habitat and marine species, e.g., essential fish habitat, migration routes, endangered species, cetacean biologically important areas, marine protected areas, Audubon important bird areas, artificial reefs, corals and sponges, etc.

Regulations and policy: EJ and expansion of public participation and interests in MRE planning, siting, and development; and increased efficiency in environmental assessments. Benefits to consenting agencies and applicable to other traditional and emerging marine sectors (e.g., transportation, security, fisheries, recreation, ocean observation, aquaculture, and desalination).

Technological: MRE siting to optimize resources and minimize conflicts; reduction in the time required for consenting projects; assessment of meteorological and oceanographic conditions that may result in risks to deployed technology (e.g., hurricane forces, extreme waves); reductions to the levelized cost of energy. Benefits to MRE developers and operators of MRE test facilities, as well as for other offshore construction activities, deep-sea mining, developers and operators of aquaculture, desalination, ocean observatories, and other blue economy facilities, military operations, and maritime security.

IV. SUMMARY

We developed a user-friendly dashboard that integrates information and interactive data visualization tools to give communities a data-driven voice in the MRE planning and development process. Four prototype tools were developed and tested in collaboration with community members in northern and central California – areas affected by offshore energy (wind) development activities. The technology facilitates meaningful and equitable engagement of community stakeholders in the MRE planning the development process. We have worked closely with community organizations, RCAA and SBMM, through a series of design workshops to ensure that the developed technology meets the needs of communities in terms of relevance and ease-of-use. Community feedback on the tools has been positive and community members expressed the desire for further refinement of existing tools and development of additional digital tools.

the SBMM, and the CStories workshop and survey participants.

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