Marine Policy 57 (2015) 9–17

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Deep waters: Lessons from community meetings about offshore wind resource development in the U.S.

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ARTICLE INFO

Article history:
Received 27 January 2015
Received in revised form
3 March 2015
Accepted 3 March 2015
Available online

Keywords:
Sustainability science
Common-pool resources
Environmental communication
Social science
Citizen-engaged
Gulf of Maine

ABSTRACT

Meeting the United States' offshore renewable-energy goals for 2030 necessitates deploying approximately 9000 wind turbines along U.S. coastlines. Because siting bottom-mounted turbines in most nearshore coastal zones is either impractical or politically difficult, turbine developers are testing floating-platform turbine technologies for deeper waters. Deepwater, floating-platform turbines have the advantages of being sited in the highest quality winds farther offshore, movable if desired, and located beyond the horizon, out of sight from shore. This paper reports on conversations with 103 coastal stakeholders at community meetings regarding development and testing of floating turbines off the coast of Maine, U.S.A. Using naturalistic field methods, this essay reports common questions and concerns of commercial lobstermen, fishermen, and coastal civic leaders. Early-stage conversations suggest that once coastal community members understand the benefits and impacts of wind farm development on their quality of life, many share specific preferences for where offshore developments could be located. Citizens' remarks are sophisticated, nuanced, and innovative and include robust ideas for pairing turbine siting with fishery conservation. Findings imply that when looking to site offshore turbines in public, multiple-use ocean spaces, developers, planners, and coastal communities should engage early and often in two-way conversation rather than one-way outreach.

1. Introduction

Coastal energy infrastructure in the United States is facing formative change. To move the U.S. economy toward domestic and clean energy sources and to mitigate climate change, President Obama's Comprehensive Energy Plan[1] on the U.S. Outer Continental Shelf (February, 2009) seeks to support the establishment of an offshore wind energy industry [14,15,18]. Reaching the goal set by the U.S. Department of Energy and Interior of 54 GW of wind energy by 2030 will require the construction, deployment, and maintenance of nearly 9000 wind turbines in the oceans and Great Lakes with 6 MW turbine technology [14]. Siting thousands of turbines requires that developers, government offices and agencies, resource-dependent communities, and coastal publics work together to locate these technologies in public waters and submerged lands. Typically, these waters function as coastal and marine common-pool resource zones accessed by many types of users and user groups.

Commercially owned wind turbines are granted long-term commercial leases on submerged public lands managed by state and federal agencies. With higher quality wind resources farther offshore (Fig. 1), turbines are likely to be located disproportionately in federal waters within the Exclusive Economic Zone (EEZ), which extends beyond 5.6 km, or 3 nautical miles (nmi), from state shores (except in Texas, Western Florida, and Puerto Rico where the EEZ begins 16.7 km, or 9 nmi, from shore). Locating turbines in federal waters invokes the newly re-organized (ca. 2011) Bureau of Ocean Energy Management—formerly the Bureau of Ocean Energy Management, Regulation, and Enforcement formerly the Minerals Management Service—to coordinate federal regulatory agencies' policies via interagency consultations for determining environmental impacts and make long-term lease decisions [5,15]. As for all federal lands, development in U.S. submerged lands requires that social and environmental impacts are examined according to the National Environmental Policy Act (NEPA). This process includes avenues for public participation.

In the President's Climate Action Plan (June, 2013), President Obama committed to accelerating clean-energy permitting by increasing renewable energy development on these public lands. However, siting wind-farm developments involves satisfying large numbers of stakeholders: 123 million people live (39% of the nation's population) in coastal counties (U.S. Census Bureau, 2011; NOAA,

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[1] Authorized by the Energy Policy Act of 2005; Obama Administration's Goals for Offshore Renewable Energy is 10 GW in outer continental shelf and great lakes by 2020.

http://dx.doi.org/10.1016/j.marpol.2015.03.004
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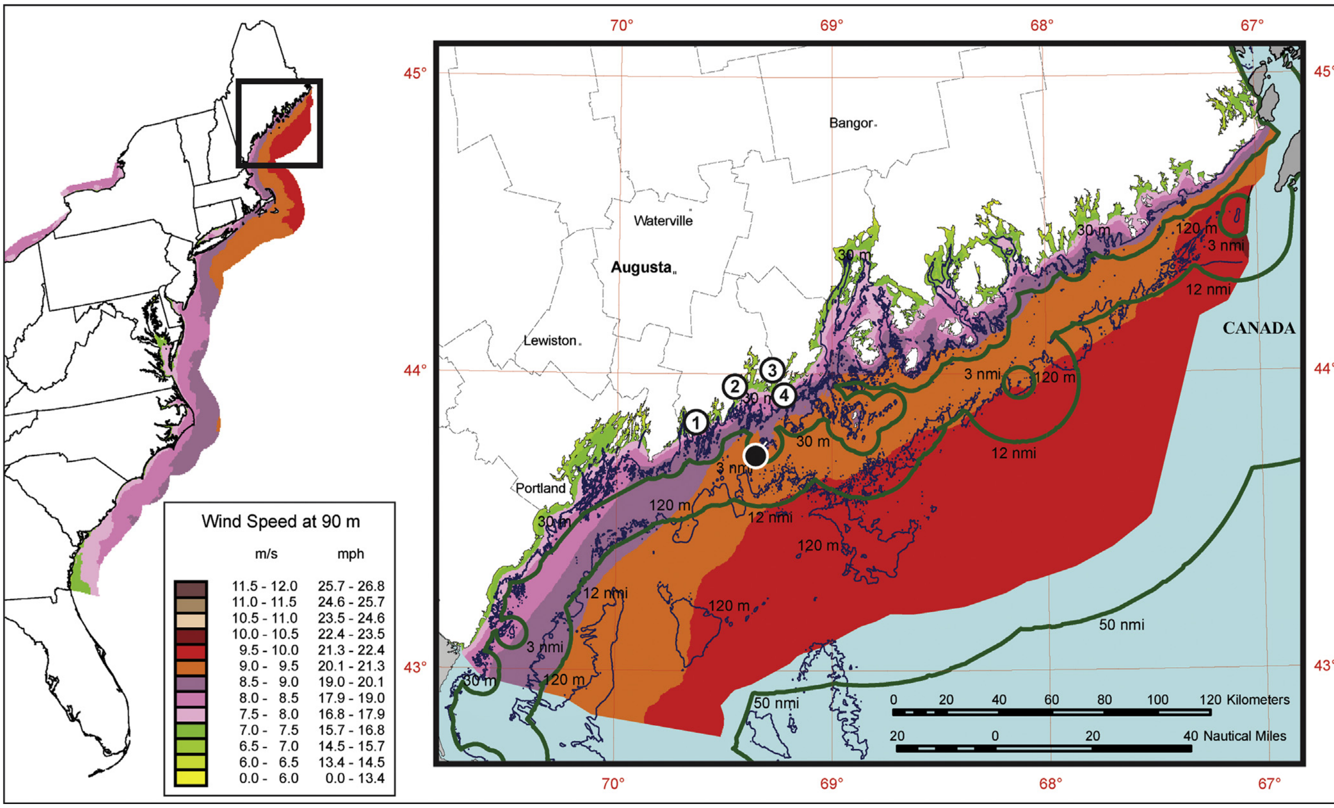

Fig. 1. Maps of annual average offshore wind speed at 90 m for the U.S. Eastern Seaboard and Maine (detail). Bold green contour lines show distance from shore in nautical miles (nmi); fine blue contours show water depth in meters (m). Black dot with white outline shows location of the University of Maine's Deepwater Offshore Floating Turbine original test site, near Monhegan Island. Circled numbers show locations of the coastal community meetings reported here: (1) Boothbay Harbor; (2) Bristol; (3) Friendship; (4) Port Clyde. Annual wind speed estimates were produced by AWS Truepower's MesoMap system and historical weather data. Maps courtesy of the U.S. Department of Energy WINDExchange program and the National Renewable Energy Laboratory (http://apps2.eere.energy.gov/wind/windexchange/windmaps/offshore.asp). (For interpretation of references to color in this figure legend, the reader is referred to the web version of this article.)

2012) and 13.6 million people (8% increase) are expected to move to a U.S. coastal county by 2020 [76,56]. Investing in research toward developing alternative turbine platform technologies can better align the interests of coastal communities to maintain their quality of place—especially in destination locales dependent upon tourism—with achieving federal goals of renewable energy capacity. In this shifting context of new national energy priorities, expedited permitting, existing federal regulatory policies, and the updated jurisdiction of a newly re-organized federal agency, how citizens are engaged in siting decisions for energy infrastructure that will affect lasting alterations to coastal and marine geography is a fundamental open question.

Collated from comments voiced at a series of public outreach meetings, this paper reports coastal community reactions to proposed testing and development of the first deepwater offshore wind turbine deployed in the U.S. for onshore power [53]. The University of Maine Sea Grant initiated the meetings to discuss the temporary installation of a single deepwater offshore floating research turbine in state waters. In 2011, researchers from the Advanced Structures and Composites Center, part of the University of Maine's College of Engineering, visited four coastal communities near the deployment site (Fig. 1) to discuss the research project over the course of eight meetings (two per community). The project is unique for two reasons: first, it constitutes the first offshore wind turbine deployed within U.S. waters to bring power to shore; second, it centers on prototype technology for a floating turbine platform that would enable turbine deployment farther offshore and in deeper waters (cf. [4]). (The research turbine entered the water in June, 2013 [53].) We present these local stakeholder reactions to an offshore wind pilot project as exemplars and as a guide for future projects and public conversations regarding commercial turbine siting conversations, both in the Gulf of Maine and elsewhere.

2. Offshore wind development and local public support

2.1. Lessons from precedents

Globally there are approximately 5.3 GW of installed offshore wind capacity; Europe accounts for 4.993 GW total wind installed capacity at the end of 2012 [55,16,64]. Industry trends include larger turbine sizes, increased distances to shore, and water depths [34,55]. At present there are no commercial-scale wind farms in operation in U.S. waters [57]. However, there are 11 projects in advanced stages of development (Table 1), having conducted baseline or geophysical studies, been awarded a lease, or obtained a power purchase agreement ([55]: xiii).

It is important not to gloss the negative aspects of offshore wind farm development. In addition to the visual disamenities of offshore wind, turbines are disruptive via noise and light, and permanently alter landscapes [25,40,42,46,54,70,75]. People want wind turbines out of sight, just as they do coal-fired power plants, natural gas plants, and waste incinerators. When wind farm developers anticipate public pushback to a proposed project, what seems to matter most is where the turbines will be located. Moving these technologies offshore, where fewer persons can see them, is typically offered as one solution to public opposition to turbines. Deepwater floating platform turbines capitalize on two key natural resources. First, there are much higher wind speeds wind farther out at sea (Fig. 1). Second,

Table 1
United States offshore wind energy projects in advanced development stages (from Navigant, 2013:7–8).

Project name (State)	Proposed capacity (MW)	Turbines (#)	Distance to shore (km)	Average water depth (m)	Projected turbine model	Target completion date
Block Island Offshore Wind Farm (Deepwater) (RI)	30	5	5	22	Siemens SWT 6.0-120 (6 MW)	2015
Lake Erie Offshore Wind Project (Great Lakes) (OH)	27	9	11	18	Siemens SWT-3.0-101 (3 MW)	2015
Fisherman's Energy: Phase I (Atlantic City Wind Farm) (NJ)	25	5	5	11.5	XEMC-Darwind XD115 (5 MW)	2015
Cape Wind Offshore (MA)	468	130	16	10	Siemens SWT 3.6-107 (3.6 MW)	2016
Dominion Virginia Power - Virginia Offshore Wind Technology Advancement Project (VA)	12	2	38	26	Alstom Haliade 6 MW	2017
Fisherman's Energy: Phase II (NJ)	330	66	11	17.5	XEMC-Darwind XD115 (5 MW)	2018
Galveston Offshore Wind (Coastal Point Energy) (TX)	150	55–75	11	14.5	XEMC-Z72-2000 (2–2.75 MW)	2018
Baryonyx Rio Grande Wind Farms (North and South) (TX)	1000	100–200	13	20.5	Siemens SWT 6.0-120 (6 MW)	2019
Garden State Offshore Energy Wind Farm (NJ)	350	58–70	32	27	(5 or 6 MW)	2019
Deepwater Offshore Wind Energy Center (RI, MA)	1000	167–200	32	40	(5 or 6 MW)	2019
NRG Bluewater's Mid-Atlantic Wind Park (DE)	450	150	20	20	3 MW	2020

the natural curvature of the Earth makes offshore activities that are far enough out at sea invisible from beaches and coastal homes. A conservative estimate of this distance of 42 km (22.4 nmi)[2] offshore ensures turbines remain out of sight (and sound) from the shoreline.

Some developers therefore assume that publics overwhelmingly support offshore wind energy because of the environmental merits of the technology and the advantages of locating turbines far from where people live [24]. Moreover, they assume offshore wind farms will avoid the public-opposition controversies of inshore wind farms because offshore turbines are sited further away from houses, communities, and locations of daily life [41]. However, studies in the U.S. (cf. [39,67]) and Europe (cf. [13]) demonstrate the contrary [28,44,43], and suggest that a key aspect of the siting process involves discerning how coastal residents perceive the towns in which they live.

Lessons from the Cape Wind project (Nantucket Sound, MA) show how publics can mobilize to vehemently oppose offshore wind projects when existing user groups are not consulted early enough in siting-process decisions [39,67,19,74,20,59,45]. In addition to overconfidence in the public support for wind technology, Cape Wind developers also failed to appeal to the sensibilities of the Nantucket Sound community and summarily failed to win over powerful landowners early in the process [45]. The Cape Wind project applied for its original permit in 2001, but did not receive state approval until 2009 and federal authorization until 2010. Involving stakeholders in decision making processes has its associated costs, but the costs of poor relationship management can outweigh costs of initiating dialog with impacted communities.

Because offshore wind development is not immune to opposition, development conversations must fit the place, the identity, and activities of residents. In a comparative study of coastal towns in the UK, researchers found differences in technology preference occurring at the town level [13]. Improved communication between developers and publics can lead to a more nuanced understanding of locals' perceptions of their home places when seeking areas suitable for, and suited to, offshore wind farms [12,13].

The character of these conversations between developers and coastal stakeholders is therefore essential to the development process overall. The way deepwater offshore wind projects get framed in the public debate contributes to shaping people's understanding of how problems are defined, of a project's potential benefits and costs, of mitigation measures, and of possible project alternatives. Planners cannot simply rely on the news media to communicate important project details to coastal citizens. In an examination of 110 articles and editorials from three regional newspapers surrounding the planning of the Cape Wind (MA) offshore wind project, Thompson [67] found the newspapers failed to provide meaningful coverage of important environmental, social, and regulatory issues. Instead of seeking local scientific expertise or stakeholder perspectives, the "stories focused heavily on celebrities" and relied on "stock models of cultural conflict to frame their coverage" ([67]:248).

2.2. Maine: developing an industry and an informed public

Since 2009, the state of Maine has hosted pre-scoping, pre-planning public meetings concerning wind farm development in the Gulf of Maine. Facilitators of these conversations include NGOs (Island Institute, Natural Resources Council of Maine, Ocean Energy Council), government agencies (Governor's Ocean Energy Task Force, State Planning Office), and educational institutions (University of Maine, Gulf of Maine Research Institute, Maine Sea Grant, Herring Gut Learning Center). Several of these organizations are assembled as members of the University of Maine-led DeepCwind Consortium, which includes universities, nonprofits, and utilities; a wide range of industry leaders in offshore design, offshore construction, and marine structures manufacturing; firms with expertise in wind project siting, environmental analysis, environmental law, composite materials, and energy investment; and industry organizations to assist with education and tech transfer activities. Of the more than 35 companies, two of Maine's largest builders, Cianbro and Bath Iron Works, are involved. Consortium research receives funding from the U.S. Department of Energy, the National Science Foundation, and others. Its mission is to "establish the State

[2] Visibility to the horizon (in nmi) is calculated as follows. Given the approximate radius (R, in km) of the Earth = 6371 km, 1 km = 0.53996 nmi, and 1 nmi = 6076 ft, for an object of height (h, in ft) at an elevation near sea level, visible distance (d) to the horizon in nmi = sqrt(2Rh) = 1.06 × sqrt(h). For example: a person with a height-of-eye = 6 ft standing on the beach can see 2.60 nmi to the horizon; a turbine with blade-tip height = 350 ft is visible 19.8 nmi from shore; to be over the visible horizon for someone standing on the beach, the turbine would need to be sited at least 22.4 nmi (42 km) offshore.

of Maine as a national leader in deepwater offshore wind technology."

Because the depth of the Gulf of Maine's seafloor limits the feasibility of deploying bottom-mounted turbines, accessing the Gulf of Maine's vast wind resources (Fig. 1) requires deepwater offshore floating wind turbines. With Cape Wind being the only precedent for U.S. offshore wind farm development, new floating-turbine research and development is taking a different approach in informing citizens and garnering support. Something unique about the development of deepwater offshore wind industry in Maine is the role the University of Maine has had in helping pioneer and establish this nascent industry. With a public non-profit educational institute spurring research and development, the University has prioritized a program dedicated to familiarizing coastal communities with the research and testing of floating turbine platforms. Public support and accountability is crucial to the success of a development model led by a public land-grant and sea-grant university; taxpayers are a fundamental source of funding. In 2007, voters approved $50 million in bonds to increase economic development in Maine, which included funding the Offshore Wind Laboratory. As of June 2010, this project has "already brought more than $25 million in research and construction funds to Maine and created 300 construction jobs" [68].

Because the University and Maine's state government are prominent in the research and development activities, details of the industry's evolution have been made transparent and disseminated widely to interested members of the public. One example is the production of the Maine Deepwater Offshore Wind Report [50], a report of more than 500 pages that organizes economics and policy, electrical grid integration, and environmental research (addressing wind, waves, bathymetry, soil, and other aspects of physical setting) into a single reference document for siting turbines in the Gulf of Maine. The report includes research on socio-economics of energy demand, on supply-chain networks, energy infrastructure, and wildlife and fisheries impacts. The document effectively saves potential investors and developers hundreds of hours and thousands of dollars of research. Maine State Senator Chris Rector likened the document to "providing a million dollars worth of research to potential developers" (Rector, 22 March 2011: Port Clyde). He tells the story of attending a meeting with the presidents of two wind energy companies who were impressed with the level of research, one who said he had never seen anything like it (Rector, 22 March 2011: Port Clyde).

2.3. Maine's offshore test turbine and coastal community meetings

The VolturnUS, a 1/8 scale (20 kW capacity) test version of the DeepCwind Consortium's offshore floating wind turbine, was deployed within Maine state waters in Castine Harbor in June, 2013 [53]. Technically, because the project is a noncommercial university research pilot project located in state waters, public outreach for siting the scale-model test turbine was not required. However, after the pilot project was announced in 2010, University of Maine Sea Grant nonetheless initiated public outreach meetings.

In spring and summer of 2011, Maine Sea Grant organized eight evening "community meetings to discuss offshore wind test site" (Table 2). For each event, University project researchers and the Sea Grant state director traveled to peninsular communities near the original pilot project site (Monhegan Island, ME) to inform coastal residents about pilot project deployment details and to answer any questions. Four meetings were convened in the spring; the summer meetings were added later to ensure summer residents were able to attend. Community meetings were advertised by press releases in local newspapers, by emails from the local Sea Grant contact, and by flyers hung at local grocery stores and in post offices. A total of 103 coastal residents—including three Maine state legislators—attended these meetings, which were held in local community spaces (Table 2).

The meetings consisted of four parts. First, the Director of Maine Sea Grant introduced the meeting's purpose: to inform the citizens of Maine about the university's research, and also to create informed stakeholders, so that if or when developers were to show up in coastal communities they would encounter "intelligent and savvy stakeholders." Next, all those in attendance introduced themselves. This was followed by a presentation from a University of Maine project administrator—each with a doctorate in engineering—providing an overview of the 1/8 scale research turbine and long-term study plans. Jake Ward, the Vice President of Economic Development delivered seven of the talks; Bob Lindyberg, the Project Director, delivered the talk on March 22, 2011. The final part of the meeting was reserved for audience questions. (Questions were also encouraged throughout the talk; presenters rarely made it to their second or third slide before the first questions were posed.) At each meeting, Jake Ward explicitly stated, "I'm willing to stay all night to answer questions." Meetings lasted from 70 to 150 min, averaging 109 min per meeting.

3. Method

3.1. Naturalistic inquiry

The first author attended all of these public meetings and took ethnographic field notes (cf., [33,66,17]) during the event, giving particular attention to every voiced question and comment made by citizen attendees. For each question, an attempt to capture verbatim remarks was made.

Citizen questions and comments were transcribed from ethnographic field notes, thematically organized, and compiled into a list of responses [47]. Because the meeting attendees were a self-selected group (they chose to attend a public meeting) rather than a targeted or random sample, we cannot treat citizens' questions as a statistically significant representative sample of a population. As with field research, much was outside of the control of the researchers. For example, the meeting content and audiences changed with each meeting. Presentations comprising PowerPoint slide decks changed between different speakers and were amended between meetings. Therefore, the value (usefulness) of these citizens questions reported here, though driven in part by frequency of occurrence (we provide this measure below), are mostly in the content and quality of the questions and comments themselves.

3.2. Feedback of data to users: an approach for linking knowledge to action in sustainability science

The objective was to capture coastal citizens' reactions and concerns regarding offshore wind turbine testing and the possibility of future offshore wind developments in the Gulf of Maine. Because the community meetings were initiated by Sea Grant staff and meeting content was delivered by trained University of Maine engineers responsible for administering the project, the first author's concern was that public voices regarding the nascent deepwater offshore wind research and young industry would remain undocumented. The first author represented the only social researcher observing these meetings.

Following the four spring meetings, data were fed back to the meetings' speakers to refine the presentation. Each speaker incorporated the feedback and made adjustments to the presentation for the summer meetings. Citizen responses and questions in their entirety were presented to interested citizen, nonprofit, and community organizations. A single-page summary version of the

Table 2
Sea Grant-AEWC 2011 Maine coastal community meetings to discuss offshore wind turbine test site meeting attendance. Town locations shown in Fig. 1.

Location	Date	Total
1. Bristol, ME: Bristol Consolidated School	8 March	6
2. Port Clyde, ME: Herring Gut Learning Center	22 March	16
3. Friendship, ME: Friendship Town Office	12 April	27
4. Boothbay, ME: Boothbay Regional High School Auditorium	26 April	31
5. Port Clyde, ME: Herring Gut Learning Center	9 August	5
6. Friendship, ME: Friendship Town Office	10 August	7
7. Bristol, ME: Bristol Consolidated School	23 August	4
8. Boothbay, ME: Boothbay Regional High School Auditorium	25 August	7
Total		**103**

most representative and pressing concerns was presented to the Maine state legislators and Maine Governor's Cabinet-level members of the BOEM Ocean Energy Task Force approximately three months after the final summer meeting (see Supplement 1). We revised the document several times based on feedback from a former Maine State Senator.

Here, our research is motivated by principles of sustainability science [9,38,51,52]: specifically, to engage in descriptive research to produce data that enable transformational practice [6,32,49,62,71]. Our methodology is driven by considerations of how best to create reliable and useable knowledge in a manner that involves citizens' voices to inform sustainable trajectories [7,22,26]. This research was intended to document the voices of citizens regarding this burgeoning renewable energy technology, and to use those data toward advancing solutions-based sustainability. Sustainability science calls for bridging the boundaries (or gulf) between science, society, and policy, but offers few new methodologies for doing such integrative work [69]. The contextualized research we present here offers one approach for integrating local knowledge with sustainable technology development and policy [30].

4. Results

4.1. Questions and comments from coastal residents: four themes

Over the course of the eight meetings, citizens asked approximately 162 unique questions that were documented in the field notes. Citizens' questions clustered around four themes, which we present here in an approximate order they arose during the meetings (based on general recurrences in questions and emphasis in the public discussions at each meeting). Questions resembled preferences for the development of offshore wind resources (cf., [8,12,27,28,39]). In these results, we preserve the specific language (set off in *italics*) that citizens used at the Maine community meetings, and organize these themes around insights that make them applicable to offshore wind development projects in general.

First, citizens were curious about offshore wind energy infrastructure, turbine technology, and context (20% of the questions). Second, they wanted to know how Maine benefits from deepwater offshore wind testing and development (21% of the questions). Third, they were concerned about the associated risks and sacrifices of offshore wind (51% of the questions); specifically, audiences wanted to understand the impacts upon coastal lives, from the wildlife and fish stocks, to those who work on the water, to those who depend on coastal Maine's tourist economy. Fourth, citizens raised questions regarding possible ways in which this nascent industry could help achieve multiple goals across different resource sectors, identifying, for example, mutual concerns in renewable electricity production and natural resource conservation (8% of the questions).

4.2. Theme 1: Offshore wind infrastructure, turbine technology, and context

Citizens had very basic questions about electricity. For example, *How much is* 1 MW *of power related to what a home uses*? *How does the* [electrical] *grid work*? Meeting presenters answered these questions as they arose, using as exemplars local power-plant names familiar to residents (e.g., the former Maine Yankee nuclear power plant in Wiscasset, Maine, generated approximately 1000 MW). These first-order questions needed to be addressed in order to contextualize the significance of the rest of the presentation.

Similarly, people were curious about the fundamentals of wind turbine technology and how turbines function in the ocean. How do the turbines work? What is the lifespan of one of these turbines out in the ocean? Will the hardware hold up in the marine conditions? For how long? What about salt air and corrosion? Could vertical wind turbines be used?

Questions about the offshore and deepwater wind industry's broader context were common at these meetings. *Is this deepwater wind industry new*? *What have we learned from Norway*? *Are we studying what's happening in Norway*? The mention of Norway refers to the first deployed floating turbine—Hywind—by Norwegian energy company, StatOil, in 2009 in the North Sea (cf. [34,37]).

People asked about the size of wind farms and the physical characteristics of turbines. How many wind turbines are going to be out there? How many towers will be in that area? What will the spacing be between the turbines? What kind of area are we talking about for these wind farms? Where would the farms be located? How far will the tip of the blade be off of the water? Will these towers be lit? Where would the transmission cable go? For the cable, will there be line loss of electricity, must the site be close to land to deal with line loss?

4.3. Theme 2: What's in it for ME?

If coastal Mainers are being asked to approve shared ocean space for industrial-scale development, to alter the view from their beaches, and emplace new obstacles for commercially harvested fish stocks (and the people who harvest them) to navigate, then the question a majority of participants at each meeting wanted to know, *What is in it for Maine*!? These questions and comments took various forms including: *What do Mainers get*? *What is Maine getting out of this*? *How will this benefit Mainers*?

4.3.1. Jobs

Many inquiries focused on revenue and quality jobs. How much of the revenue will actually stay in Maine? How many jobs are going to be out there, based on what we have learned from Norway? What kind of jobs are those? Will the jobs stay here? Do you see any direct profit to [our] town? Are we guaranteed that the transmission cable will come onto the shore in Maine? In Alaska, people get a check for oil development, will that happen here?

4.3.2. Cheaper electricity rates

In related questions, coastal residents consistently wanted to know *if Maine residents would get a better rate on electricity with an offshore wind industry*. This question was raised at all eight meetings, and it took many forms: *Since this project is in Maine's front yard, is there a way that Maine residents can get a better rate on electricity*? *Will this lower electricity prices*?

The spring Port Clyde meeting became heated when this question was asked and attendees became frustrated with the presenter's response that lower electricity prices were an unlikely outcome. Because energy prices are set on a regional market, it is in Maine's best financial interests as a net exporter of electricity to have higher electricity rates to ensure that the State's offshore turbine research, tax revenues, construction, maintenance, and sales are profitable. A lobsterman stood up and said,

> *One good analogy I heard was, what if you had to sell all your lobsters to people only in the state of Maine*? *The reason you make money is because you're shipping lobsters everywhere else. So* [*for renewable-generated electricity*] *it means your revenue stays here, but you're shipping your power out to other people. If it was only sold to Mainers it would be hard to make any money* (*March*, 22, 2011).

4.3.3. Esteem and cultural capital

In addition to material benefits, Maine residents asked how Maine fit into the wind energy industry: *How feasible is this to actually be developed in the state of Maine*? People asked where the University of Maine's research and innovations stood in relation to the greater industry: *So is this cutting edge*, *is this really something different*? *Is the University of Maine developing something different and new*? Meeting attendees were interested in cachet and attention the University and the State garner because of these technological innovations.

4.4. Theme 3: Impacts on coastal lives and livelihoods

People were concerned about trade-offs, evident and hidden, attendant to the development of an offshore wind industry: *What do we have to give up*? *What are the associated risks and impacts*?

4.4.1. Financial benefactors and costs to taxpayers

Coastal citizens consistently asked questions about who is to gain from the offshore industry, if new or existing taxes were spurring research and development, and about the feasibility of development: *Who gains from offshore wind industry*? *Who pays for development*? *How will Maine pay to help to develop this*? *Does the State contribute some money to help do this*? *Is State money involved in making this* [turbine research] *go towards commercial scale*? *How are the potential offshore wind developers going to prove they are financially solvent*? *After the testing*, *what happens when this gets on the market*? *I understand you are doing the testing but what's to stop them from developing the ocean*? *Do Maine people have a say in it*?

Some asked about this project in relation to the Cape Wind project in Massachusetts (cf. Section 2.1): How does this project compare to and relate to the Massachusetts Cape Wind project? How about the litigation going on the Cape [Wind] project? Who's that between? Is that between the fishermen and developer or environmentalists and developers?

At each meeting, residents asked about the visibility and noise of the turbines. Will these wind farms be seen from land? For those near the coast, what is the visibility of these offshore wind turbines? Will the turbines be lit at night? What kind of sound in the air and underwater will occur? What about the vibrations from the wind turbines?

4.4.2. Impacts on coastal life and wildlife

At each of the meetings, attendees raised questions regarding game and non-game wildlife species that offshore turbines have the potential to affect. Concerns focused on the addition of new technological equipment to the water: *What kind of acoustic signatures will be found underwater from these turbines*? *Will whales get entangled in the anchor/tension lines*? *How will they measure the impact on birds*? *What will the impacts be on the underwater cables* [transmission] *that go to shore*? *What about the magnetic fields from the transmission lines*? *Will they* [magnetic fields] *affect crustaceans and their movement*?

4.4.3. Impacts on commercial fishing and the lobster industry

In coastal fishing towns, residents are concerned how this new industry of marine land-use will alter the fishing industry, from loss of bottom to fish to logistical impacts of navigating offshore wind farms [13]. Commercial fishers and lobstermen[3] at the Maine meetings raised several specific questions related to their fishing operations: *Where would the farms be located*? *How many wind turbines are going to be out there*? *What kind of area are we talking about*? *How far will the tip of the blade be off of the water*? *What will the boat traffic look like going out to these sites*? *How often will that* [boat traffic to and from the wind farm] *happen*?

At every meeting, attendees asked questions about fishing access in proximity to the farms: will the wind farm site be permanently closed to fishing activities? What kind of radius from the turbine housing will be considered the exclusion zone? Will the grid patch size be permanently closed to fishing activities? What is the buffer zone size in Europe? What would it be here? How is it being enforced? Will it be enforced? As fishermen, how will we be restricted? Will we be restricted by gear: fixed gear versus towed gear? These questions were another way of inquiring about how much ground they must give up to wind farms: who is going to be asked to give up bottom?

University presenters were also quizzed about the visibility of the equipment in the water. I'm not worried so much about the anchors what about the stabilizing chains, the anchor lines, the tension wires, the tendons and [catenary lines]? How will the anchors and stabilization lines be marked? Can we see it on radar? Will there be lights located on the edges of the platform? Will we be able to see where the catenary cables are with radar and lights? Where would the transmission cable go? Are the cables going to be buried? What about the movement of lobster traps as the tide runs? Could the lobster traps get run into a turbine, or the tension lines or the cabling?

Concerned about the increase in risk of fishing near and traveling near wind farms on the water, commercial fishermen raised important questions about impacts on their insurance rates and how policies may be amended: *with these things in the water*, *how will this effect maritime and lobstermen and fishermen's insurance*? *Will the insurance companies develop their own* [exclusion zone] *distances for fishermen*?

Most inquires related to how specific siting decisions will impact different sectors of the fishing industry. A common fear expressed was: *we are worried that developers don't know where the fish are*. Waterfront commercial fishing communities were concerned about the role of their voices in wind-farm siting decisions.

[3] The preferred term of women and men who fish for lobsters commercially [1].

4.5. Theme 4: Achieving multiple goals within a multiple-use, common-pool resource

At each meeting, attendees' questions steered the subject from the University's deepwater turbine testing to the implications of successful testing and the eventual development of a commercial-scale offshore wind industry in the Gulf of Maine. Indulging the premise of wind resources being harnessed in the Gulf of Maine, attendees from commercial fishing sectors reiterated, *we are worried that developers don't know where the fish are*.

At one meeting, some commercial fishermen responded to the threat of giving up fishing bottom to turbines by suggesting they organize a resistance, but this reaction was isolated. A majority of attendees began to actively problem-solve in the meetings. Comments and questions anticipated how wind farm development could align with local values and leverage local interests and desires.

Recognizing the link between the shared resources of marine wind and the fishery, participants inquired how turbine sites could benefit the health of a fish stock. In-depth conversations migrated into unscripted brainstorming where experts with years of experience working on the water posed suggestions to the design team for how to couple success across industrial, marine common-pool resources. In three separate meetings, participants asked *if the turbine platforms would function as an artificial reefs or preserves for the fishery*. A fisherman from Boothbay Harbor suggested, "Can you put them [turbines] in the fishery recovery areas? Why not put them there? Could the turbines areas act as an artificial preserve for the fishery?" (April 26, 2011). Although not addressed directly in the Maine meetings, studies of offshore turbine hardware [73,72] and of moorings, in general, [63] demonstrate how similar hardware in marine environments promote juvenile fish habitat acting as artificial reefs for fish aggregation.

Fishermen suggested taking a portion of profits from exploiting shared wind resources and using it to establish long-term monitoring of impacts on the fishery. In the spring Bristol meeting, one participant asked, "Could a percentage of the profits [from wind generation] be set aside to pay for fishery monitoring and lobster impacts?" (March 8, 2011). This is a pressing interest to the fishing industry as monitoring under the National Marine Fisheries Service's National Catch Share Program and Stock Assessment has been the target of recent budget cuts [10], forcing the costs of monitoring and observation onto the fishing industry. In New England, local fishermen operating under the catch-share program will be required to share monitoring costs that will disproportionately impact smaller family-owned fishing fleets [10,61].

Citizens raised questions about the public's ability to monitor the wind turbines. An attendee asked, Can you put a webcam out there [on the turbine]? Another asked whether whale-watching vessels could be used to monitor impacts of turbines on wildlife?

5. Discussion and conclusion

The community discussions above were unique in that they focused on university deepwater offshore wind turbine research more than two years prior to actual deployment of the test turbine into Gulf of Maine waters in June 2013. While the research was largely housed within the College of Engineering, the community meetings were initiated, organized, advertised, and funded by Maine Sea Grant. The original topic was university research activities within this nascent industry—deepwater offshore wind—but the community expressed most interest in full build-out scenarios. Below we discuss lessons that may be transferable to similar stakeholder engagement meetings concerning offshore wind or renewable energy siting based on our observations of these meetings and the documentation of citizens' verbatim questions and comments. No formulae can guarantee successful community engagement for communicating research, siting, or deployment of offshore wind technology; however, these data suggest some best practices.

If the offshore wind power industry in the U.S. is to be sustainable—enable the mutual flourishing of economic, ecological, and socio-cultural systems—turbines must be sited in a manner that fits both people and their places. Research can support well-placed wind farms. Examining the social and cultural contexts of the energy transitions can offer managerial strategies for improving practices of developers, governments, and communities ([13,21,30,35,48,65]). Contextual research includes careful attention to established communication pathways, relevant topics, preferred messaging, and the local vernacular of coastal communities (cf. [1,31,30]).

5.1. Recommendations for stakeholder engagement and communicating offshore wind technology

1. Public involvement in natural resource decision making is most beneficial when incorporated early and often [23,11]. People report being surprised by planning decisions [58]. The diversity and sophistication of the questions evidences the importance community meetings have in the planning process (see Section 4.3.3).
2. Outreach events can be designed as a means to systematically listen to and document local residents' voiced concerns and questions that can then feedback to organizers and presenters to improve future communication (see Section 3.2). These public events have a constitutive role in the discourse of renewable energy, meaning they shape the larger conversations about renewable technology, its development, and transitions towards sustainable energy.
3. Involvement of a boundary-spanning organization [7], like Sea Grant or Cooperative Extension, or relevant non-profit organization, which is familiar with the contextual nuances of local communities, the opinion leaders who should attend, the preferred venues, best means of advertising, and most practical day and time of day for hosting such conversations can play a vital role in communicating the technology and its siting procedures to communities. Boundary-spanning groups, like Maine Sea Grant, can ensure that informational meetings effectively benefit constituent communities and match their needs.
4. Attendees asked very basic questions about electricity that had to be addressed before they could participate in a conversation about commercial-scale electricity generation. Meeting organizers must not confuse ignorance of a subject area with incompetence [60]. Planning for an audience to make a transition through requisite knowledge is important to avoid frustrating that audience. For communication with publics, presentations should begin with a respectful discussion of electricity and the electricity grid. A handout that audiences can reference throughout the presentations in language that connects to their existing frames of reference would have helped the above talks. Basic content could include regional or national electricity grid maps and comparisons between kW, MW, and GW in familiar terms related to average regional household-size consumption and locally well-known power plants and numbers (see Section 4.1). Presentations that include targeted, locally relevant explanations of how an electricity market functions could help address citizens' questions such as: *Is there any guarantee that the power will stay in the state of Maine*? *What is the cost of the electricity generated from offshore wind turbines*? *How does this cost compare per kW*

hour with LNG [liquid natural gas] *electricity*? *Would this contribute and provide Maine a way to get off heating oil*? (see Section 4.2.2).

5. Several common misconceptions about the complex system of supply, storage, and consumer cost in grid-based electricity markets must be overcome to explain the attenuated, indirect relationship between a nearby wind farm and a local citizen's electricity bill. Cheaper electricity rates may be beneficial for individual households, but is an issue effectively distinct from the formation of a new energy industry. However, presenters have a real challenge explaining this concept to people under conditions of stress, who are nervous about an abstract threat of change to their daily lives. Time devoted to addressing this complex issue using details familiar to audiences within a specific region would begin to address audiences' common concern of "what's in it for me?" (see Section 4.2.2).
6. In the absence of explicit economic capital gain from sharing rights to ocean territory and lower electricity rates, several questions asked (see Section 4.2.3) reflected the meaningfulness of the esteem value of the cultural capital [3] associated with "cutting-edge" technological innovation and the participation in a nascent avant-garde industry. If residents will pay the same electricity rates, the entire spectrum of benefits to the state, region, local companies, municipalities, and households should be communicated to citizens.
7. Coastal residents and those who work on the water asked many questions about the look and feel of the turbines in the water and how it would impact their livelihood on the water. They want to understand what they will see from shorelines, on the water, and where turbines will be sited. The work on visualizations of wind farms (cf., [42]) may be important for communicating the impacts of wind farms on communities' sense of place. Further, communities and developers may wish to explore options for siting offshore activities beyond the horizon and out of sight as seen from the tourist destination beaches and coastal communities particularly near tourist destinations (see Section 2.1). The cost of the extra length of transmission cable to onshore grid connections could easily become an unambiguous figure within conversations among decision makers, wind farm developers, businesses, and communities.
8. The Gulf of Maine as a shared resource has a legacy of resource users familiar with key spatial details relevant to aligning renewable energy siting, deployment, maintenance, and navigation with community interests in fishery conservation, preservation of coastal amenities for tourism, and others. Those who work on the water have mutually beneficial ideas for sharing space that should be considered by planners to void conflicts between groups of resource users (cf. [29,36]). Encouraging early public participation ensures beneficial ideas are not overlooked (see Section 4.4).
9. To have concerns adequately addressed, fishing interests stand to benefit by ensuring a presence at siting discussions, expressing siting concerns and preferences, and leveraging the strength of a group rather than disorganized individuals. Studying negotiations between European offshore wind farm siting and the displacement of commercial fishing interests could be useful for fishing industry groups [2].

Acknowledgments

This material is based upon work supported by the National Science Foundation under award EPS-0904155.

We wish to acknowledge: the Citizens of Maine; Jake Ward; Paul Anderson; Bob Lindyberg; Elizabeth Viselli; James Passanisi; Sherman Hoyt; Mary Cathcart; Charles Morris, Celeste Lozier; Mellissia Richards; Linda Silka, Laura Lindenfeld; The Island Institute; University of Maine Advanced Structures and Composites Center; University of Maine College of Engineering Renewable Energy Internship Program; Maine Sea Grant; University of Maine's Sustainability Solutions Initiative, Margaret Chase Smith Policy Center, and the Senator George J. Mitchell Center for Sustainability Solutions; and Saint Louis University's Center for Sustainability.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.marpol.2015.03.004.

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