Journal of Environmental Management 141 (2014) 146–154

Contents lists available at ScienceDirect

Journal of Environmental Management

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

Changing vessel routes could significantly reduce the cost of future offshore wind projects

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ARTICLE INFO

Article history:
Received 12 September 2013
Received in revised form
10 February 2014
Accepted 28 March 2014
Available online 7 May 2014

Keywords:
Offshore wind energy
Cost-effectiveness analysis
Marine transportation
Marine spatial planning
Vessel rerouting

ABSTRACT

With the recent emphasis on offshore wind energy Coastal and Marine Spatial Planning (CMSP) has become one of the main frameworks used to plan and manage the increasingly complex web of ocean and coastal uses. As wind development becomes more prevalent, existing users of the ocean space, such as commercial shippers, will be compelled to share their historically open-access waters with these projects. Here, we demonstrate the utility of using cost-effectiveness analysis (CEA) to support siting decisions within a CMSP framework. In this study, we assume that large-scale offshore wind development will take place in the US Mid-Atlantic within the next decades. We then evaluate whether building projects nearshore or far from shore would be more cost-effective. Building projects nearshore is assumed to require rerouting of the commercial vessel traffic traveling between the US Mid-Atlantic ports by an average of 18.5 km per trip. We focus on less than 1500 transits by large deep-draft vessels. We estimate that over 29 years of the study, commercial shippers would incur an additional $0.2 billion (in 2012$) in direct and indirect costs. Building wind projects closer to shore where vessels used to transit would generate approximately $13.4 billion (in 2012$) in savings. Considering the large cost savings, modifying areas where vessels transit needs to be included in the portfolio of policies used to support the growth of the offshore wind industry in the US.

1. Introduction

Emerging ocean uses, such as offshore wind energy development, tend to increase the crowding of ocean areas and emphasize the need for integrative planning. Development of wind projects often requires repurposing ocean areas that were previously used for other activities. Such reorganization often can produce tensions. In Europe and the US, coastal and marine spatial planning (CMSP) has become one of the major resource management processes utilized to reduce conflicts between existing and new uses and to allocate space for specific activities (Douvere and Ehler, 2009; Douvere et al., 2007; Qiu and Jones, 2013). In the US, CMSP is being implemented through Executive Order 13547 (White et al., 2012). However, CMSP is rarely paired with economic valuation techniques, such as cost-effectiveness analysis (CEA), which could be used to estimate the economic effects of repurposing ocean areas for wind development.

In the recent years, offshore wind energy has been discussed as an important sector to the US economy (US Department of Energy (DOE), 2011). Development of wind energy is thought to diversify the energy mix, help improve air quality, increase energy security, mitigate climate change, and boost domestic manufacturing (US DOE, 2011; Musial and Ram, 2010). This vision is reflected nationally in the goal set by the DOE (2011) to develop 54 GW of offshore wind capacity by 2030. This would involve building thousands of wind turbines. The push to determine optimal locations for these wind projects has been the main catalyst for applying CMSP framework in the US (White et al., 2012; Douvere and Ehler, 2009).

Thus far, several leasing blocks – called Wind Energy Areas (WEAs) – have already been allocated to offshore wind development in the US Northeast and Mid-Atlantic. The US Department of the Interior's Bureau of Ocean Energy Management (BOEM) determines the locations for these leasing blocks. Assuming that the existing WEAs will be filled in the next several years, and assuming the push to meet the goal of 54 GW by 2030, additional WEAs will have to be

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http://dx.doi.org/10.1016/j.jenvman.2014.03.026
0301-4797/

designated. Also, as wind projects become more prevalent, commercial shippers will be compelled to share their historically open-access waters with these projects. In this study, we estimate which locations for future WEAs could be most cost-effective considering possible changes to the current vessel travel routes.

Our study demonstrates the utility of using cost-effectiveness analysis (CEA) to assess tradeoffs between offshore wind power and other uses, such as commercial shipping, within a CMSP framework. The analysis is timely as the US Coast Guard (USCG) is conducting the Atlantic Coast Port Access Route Study (PARS) to assess the potential impacts of offshore wind development on commercial navigation (US Coast Guard, 2011b).

1.1. Connecting offshore wind development, coastal and marine spatial planning and cost-effectiveness analysis

Development of ocean-based renewable energy projects has been one of the main catalysts for the debate on allocation of ocean space (White et al., 2012; Douvere and Ehler, 2009; Firestone and Kempton, 2007). In a very broad sense, CMSP analyzes and allocates marine spaces to specific uses or non-uses to achieve economic, social and environmental objectives that are determined through a political process (Douvere and Ehler, 2009; Ehler and Douvere, 2007). Thus, CMSP facilitates a more integrated resource management process (Lester et al., 2013; Douvere and Ehler, 2008; Jay, 2010), considers the requirements of different ocean sectors, and provides greater certainty for long-term investment decisions (Ehler, 2008). The CMSP framework also helps balance costs and benefits of particular management measures (Ehler, 2008).

However, established ocean users often resist attempts to conduct CMSP analysis as it may require changing the status quo to accommodate new uses (White et al., 2012). Thus far, CMSP has drawn little from resource economics or other economic valuation tools to inform the planning process (White et al., 2012). As a result, CMSP does not explicitly offer economic assessment tools to quantify, monetize and reduce spatial conflicts among different sectors (White et al., 2012; Douvere and Ehler, 2009; St. Martin and Hall-Arber, 2008).

A few studies integrate quantitative analysis within the CMSP framework. Spaulding et al. (2010) use depth, geology, distance, etc. and wind speed to optimize wind project siting off Rhode Island. This analysis was later extended to include social and ecological constraints (Grilli et al., 2013). An ecosystem services approach was used to determine optimal arrangements among wind projects, commercial fishing and the whale-watching sector off Massachusetts (White et al., 2012). But there are only a few studies evaluating the economic effects of vessel rerouting.

Thus far, the studies that consider the economic effects of rerouting vessels concentrate on the cost of avoiding piracy-ridden seas (Bowden et al., 2010) or the cost of reducing the probability of vessel strikes of whales (Kite-Powell and Hoagland, 2002; National Marine Fisheries Service (NMFS), 2008; Betz et al., 2011). Here, we conduct the first study to use CEA as a decision support tool for CMSP and to assess cost savings from altering vessel routes to open areas for wind development.

CEA is widely used as an alternative to cost-benefit analysis (CBA). It is useful when the analysis focuses on estimating which alternative policy achieves the greatest desirable outcome for the cost (Cellini and Kee, 2010). CEA often provides a cost-effectiveness ratio, which is the ratio of the costs of the alternatives and a single quantified (not monetized) effectiveness measure (Boardman et al., 2011). As here the considered alternatives are equally effective in terms of the amount of electricity produced, we calculate the actual cost differential between the alternatives rather than a cost-effectiveness ratio.

1.2. Study area and scope

We focus on the US Mid-Atlantic region as it has a shallow continental shelf, steadily growing power demand (Musial and Ram, 2010), tremendous wind resource potential (Kempton et al., 2007), and several designated WEAs. The area is also a home to the proposed offshore transmission system off New Jersey.

Our analysis does not incorporate all of the existing ocean activities and thus, is not a full-fledged CMSP. We limit the problem to two mutually exclusive ocean uses: commercial shipping and offshore wind energy development. Our analysis evaluates large deep-draft ships traveling between the port areas of New Jersey/New York, Delaware Bay and Chesapeake Bay (Fig. 1). Deep-draft vessels include container ships, bulk carriers, general cargo, tankers and vehicle carriers. Less than 1500 annual vessel transits would be affected. An average increase in the voyage length would be 18.5 km.

We use the CEA framework for our analysis because we are not estimating whether there are benefits from building offshore wind projects instead of other electrical generation. Instead, we assume that offshore wind projects would be built and their locations will be largely determined by vessel traffic. Therefore, we use CEA to calculate which of two scenarios would be more cost-effective if the wind projects are built. The scenarios we consider would produce equivalent amounts of electricity. (The number of wind turbines employed would differ in the two scenarios, as fewer turbines are needed to produce the same amount of electricity farther from shore where winds are stronger). This allows us to make a comparison of total (private and social) costs.

We construct two scenarios where the location of future WEAs is influenced by the paths taken by vessels transiting between the US Mid-Atlantic ports. In the first scenario – "Status Quo" – vessels would continue to transit within a virtual corridor[1] 53 km from shore and wind projects are built beyond the vessel routes far from shore (Figs. 2 and 3). In the second scenario – "Alternative" – vessels would transit within a virtual corridor 74 km from shore and wind projects would be built where vessels used to transit (Figs. 2 and 3). We then apply cost-effectiveness analysis framework to quantify and monetize the effects of this hypothetical vessel rerouting.

As we are evaluating the effects of a hypothetical policy on an existing marine activity, we develop several assumptions. During the next decades, the currently designated WEAs and other nearshore areas with minimal spatial conflicts and water depths of less than 30 m would come to house wind projects. In the Status Quo scenario, to prevent conflicts, developers would then have to build far from shore beyond the existing traffic routes (Fig. 3). For our analysis, we call these wind areas Status Quo WEAs (SQ-WEAs). Without changes in ship traffic patterns, these far-shore sites would need to be developed if the US is to meet its goal of deploying 54 GW of offshore wind capacity by 2030. The SQ-WEAs avoid major existing vessel routes and areas determined unsuitable for wind development by the US Department of Defense (DOD) (Fig. 3). We assume that the SQ-WEAs would be larger than 260 km^2 and located in transitional waters of more than 30 m.

[1] The vessel corridor, referred to as habitual traffic pattern (HTP), represents movements of vessels transiting between the US Mid-Atlantic ports (Figs. 1 and 2). Following Vanderlaan et al. (2009), we define HTPs as areas between ports or traffic separation schemes (TSSs) (which guide vessels in and out of ports) with relatively more vessels than in adjacent areas of the ocean.