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Institutional improvement measures for environmental assessment in the pursuit of eco-friendly ocean renewable energy development in South Korea

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ABSTRACT

This paper aims to identify institutional improvement measures to promote environmentally sustainable ocean renewable energy development by analyzing how the environmental assessment systems in South Korea are integrated into this development. The measures identified in the paper include (1) consideration of subjecting ocean renewable energy development to strategic environment assessment in order to assess the adequacy of relevant project plans and the validity of site selection at early stages, (2) new standards, such as the area of occupancy, integrated within the environmental impact assessment at the project implementation stage, (3) integration of the environmental impact assessment with the procedures for Consultation on Utilization of Sea Areas to reduce development cost and delays and (4) reinforcement of post-development environmental monitoring processes to eliminate uncertainty or lack of knowledge about potential impacts on marine environment and habitat caused by development.

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1. Introduction

Growing issues pertaining to climate change and energy security have led to an emphasis on development of renewable

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energy in South Korea as green technology and renewable energy industries continue to receive significant support from the government. By announcing a new version of the "National Energy Master Plan" in 2014, South Korea targets to supply 11% of its total national energy demand from renewable energy by 2035. To date, a significant portion of renewable energy generation in South Korea has been delivered by waste-to-energy and hydroelectricity power plants [1]. However, there are increasing efforts toward making full use of South Korea's geographical characteristics: surrounded by sea on three sides, South Korea is at an advantageous position for ocean renewable energy development, including offshore wind power, tidal range, tidal current, wave power and ocean thermal energy.

South Korea has become more aggressive in its promotion of ocean renewable energy to further sustainable development [2]. South Korea has operated the world's largest tidal range power plant with 254 MW power capacity since 2011 at Sihwa Lake, and several feasibility studies are currently being conducted for other tidal range power sites [3,4]. Furthermore, more than 10 development plans have been proposed for large-scale construction of commercialized offshore wind farms in Korean coastal waters. Although tidal current, wave power and ocean thermal energy developments are still in early stages, there are a number of pilot projects that have been conducted under real sea conditions with the aim to realize power generation.

However, there are growing concerns about environmental and ecological effects of these developments on the marine environment. Because most ocean renewable energy developments are still in early stages, there is insufficient information on the environmental effects of those developments on marine environments and ecosystems. Moreover, as the effects of marine energy devices vary greatly by type and design of device, scale and location of development and animals and habitats presents [5–12], there remain considerable knowledge gaps and uncertainties. While these ocean renewable energy developments promise to assist in the effort to reduce greenhouse gas emission and dependence on fossil fuels, construction plans for tidal range and offshore wind power plants have been suspended in response to resident protests in South Korea [13–15].

Regarding this issue, an increasing number of studies have argued that environmental assessment (EA) could be a potentially effective means for resolving environmental problems as well as creating harmony between ocean energy development and marine environment conservation [16–19]. In particular, EA can play a role in not only strengthening scientific knowledge but contributing a supportive regulatory environment [20,21].

Since European Marine Energy Center developed a set of guidelines for the environmental impact assessment (EIA) process for marine renewable energy projects [22], many European countries have required EIA as a part of the licensing and consenting process through adopting and reforming their own EIA systems [20]. Under the Marine and Coastal Access Act 2009 which provides a framework for the marine licensing regime, all marine renewable energy projects require an EIA and, where required, Appropriate Assessments in the United Kingdom [23]. In October 2013, Portugal released a revised EIA legislation which clarifies the timeline of the licensing procedures and creates a web based "one-stop-shop" facility for the environmental licensing of projects, allowing the digital delivery of documents during the EIA process [24].

Some countries including the United Kingdom and Canada have regularly conducted a government-led strategic environmental assessment (SEA) on ocean renewable energy development plans [25–28]. The SEA process has the opportunity to improve the efficiency of EA by dealing with high level policy issues before individual projects are proposed and designed. It can also help to select proactively sustainable locations for commercial scale wave and tidal energy projects, as well as offshore wind farm.

Meanwhile, there are very few studies in South Korea examining how EA systems are integrated into ocean renewable energy developments or whether they are even being used at all. This paper aims to examine the EA systems deployed in South Korea related to ocean renewable energy development and suggests policy directions and institutional improvement measures for the EA systems in the pursuit of environmentally friendly development. The next section, Section 2, reviews the operational statuses of ocean renewable energy developments in South Korea. Section 3 reviews current procedures and EA systems for ocean renewables. Improvements measures for these systems are then discussed in Section 4. In conclusion, Section 5 highlights some of the key findings and suggests a direction for future studies.

2. Operational status of ocean renewable energy development

Owing to its geographical formation as a peninsula surrounded by the three seas (the East Sea, the West Sea and the South Sea), South Korea has abundant potential ocean renewable energy resources. Energy generation is possible via exploitation of various marine energy resources, including wind, tide, tidal current, wave and ocean thermal energy. However, each energy resource is not evenly distributed across the three seas. The West Sea has favorable conditions for the development of tidal range and tidal current due to its large tidal range, whereas the East Sea has abundant wave and ocean thermal energy resources. Tidal current and wave energy are also found in the South Sea, but the amount is relatively little compared with the other seas [2,15]. Exploitable wind resources exist at nearly every coastal area of South Korea, but the available wind resource data indicate that the South Sea and Jeju Island are the best candidates for wind power [29].

The West Sea, especially the middle region of the western coast of Korea, is one of the most promising places for developing a tidal range power plant (See Fig. 1). The 254 MW class tidal power plant, a total cost of approximately USD 355 million, has been completed during the six years (2005–2010) and operated at Sihwa Lake since 2011, and the annual energy output is expected to be 552.7 GW h [3]. There are development plans for building a 1320 MW, an 838.2 MW, and a 520 MW class tidal power plants at the proposed locations of Incheon, Kwanghwa and Garolim Bay, respectively. However, the plans become uncertain due to the social and environment issues. The construction of new tidal embankments causes social conflicts and marine environment impacts. If existing embankments is used for tidal power generation, then it will be not only environmentally more beneficial to improve water circulation and water quality but economically more feasible than constructing new embankments [30]. The Garolim Bay tidal power plan which required a new embankment caused serious social conflicts and has been postponed.

As tidal current, wave and ocean thermal energy developments are in early stages, real sea pilot projects are being conducted to demonstrate these technologies under realistic operating conditions. A 100 MW pilot device of tidal current is being deployed and tested in the Uldolmok waterway, which is well-known for its shallow water depth and tidal flat with great tidal range since 2009—two full-scale demonstration tests for tidal current devices were completed around the area. The assessment of wave power potential in the East Sea and part of South Sea was performed with 28 rotating body of 750 kW capacity each using significant wave height and peak wave period data. Annual electricity production was estimated to be up to 1207 MW h/year, and the sea far from land has higher wave power potential than the sea near coast [31]. The research of oscillating wave power plant suitable for the