

論文の内容の要旨

論文題目 Evaluation of public acceptance and co-existence strategies of
marine renewable energy development in Japan
(日本における海洋再生可能エネルギーの社会受容性と共存戦略の評価)

氏 名 アルギリヤ ヘーワゲ ティリナ シャーム クララッナ

Marine Renewable Energy (MRE) which consists of offshore wind energy, wave energy, tidal and ocean current energy, etc. has been identified as a key component of global renewable energy production. However, MRE industries are still in the initial phases except for offshore wind energy in Europe. With the increased urgency to avoid from conventional energy sources, Japanese government has given prominence to accelerate the development of MRE industry to commercial level in the last decade. Japan's MRE sector is in transition to the commercial scale thus will create significant impacts to the local marine users in the future. However, on the contrary to European cases, Japan still lacks clear policies regulations which provide guidance and legal assurance for the MRE sector. General public also have a vague perception about the ocean as a source of energy. According to the existing regulations which are complex and scattered, MRE project developers are given the responsibility of getting the consensus of local stakeholders prior to the project initiation. Further, the policy makers are required to obtain the local consensus for a development of long term marine spatial plan and a management strategy which satisfies the requirements of MRE sector. Understanding the public acceptance behavior and creating a sustainable coexistence among stakeholders have been identified as the cornerstones of consensus building for MRE projects. Literature review has shown that there is no universal formula for local acceptance which vary significantly with the local conditions, project management strategies, stakeholder knowledge and perceptions. Further, there is a significant research gap on understanding public acceptance of commercial MRE projects in Japanese context and options to create co-existence between local community and MRE projects. Hence the objective of this study is to 'analyze local stakeholders' MRE acceptance, underlying factors & potential co-existence options for the development of commercial MRE projects in Japan'. Specific research questions focused in this study are; (1). 'What is the current stakeholder acceptance level, trend and underlying factors of MRE acceptance?' , (2). 'What are the options available for creating a win-win situation & co-existence between MRE industry and local community?' , and 3. 'What is the feasibility of

the preferred strategy?' . The thesis is divided into six chapters where the first chapter is dedicated to the introduction to explain the above mentioned background data, research gap and objectives.

Second chapter explains the overall research framework with specific data collection and analysis methodologies used for three research questions. The study used a 'case study approach' where Nagasaki and Kitakyushu MRE developments were selected as the main case studies. Stakeholders in the selected case studies have experienced the early phases of MRE sector which is now in transition from technology readiness phase to the commercial phase. Data collection was done through key informant interviews & focus group discussions, site observations and three questionnaire surveys between 2016 and 2019. Public acceptance factor analysis was done using descriptive statistics and logistic regression analysis. Evaluation of stakeholder preferences of potential co-existence options was done using multi-criteria analysis and Dempster Shafer Analytical Hierarchy Process (DS-AHP). A new computer software tool was developed to run the DS-AHP analysis. Feasibility of the optimum co-existence option was evaluated by technical and economic feasibility study.

Third Chapter evaluates the public acceptance and underlying factors, focusing on the first research question. Nagasaki case study had a higher level of stakeholder interaction activities and about 63% have formed a decision to support MRE projects in contrast to the 40% in Kitakyushu. However majority of supporters have a soft decision or just a tendency which might change with counter-factual information. Supporters are more sensitive to the potential negative project impacts such as adverse effects to marine life, local fisheries, etc. and have a high tendency to reduce existing support. Opponents' decision is more rigid and has less sensitivity to the potential project benefits. Sharing project information with stakeholders, inclusivity of local community interests, and improving stakeholder engagement have significantly improved the local acceptance. However sharing only positive project information also did not improve the level of acceptance in comparison to sharing both positive and negative information. Impacts to marine and bird life as well as local fisheries are sensitive factors of acceptance decision while majority are expecting an adverse impact with respect to those factors. Acceptance trend analysis indicated a reduction in current acceptance level with the development of commercial level MRE projects. Hence the developers are expected to put more effort in consensus building to maintain the current level of acceptance. Strategies which ensure long term commitment and nationwide MRE development such as being first of many projects, government led projects etc. tend to improve the local acceptability. Logistic regression shows that project characteristics and management practices employed such as level of sharing project information etc. have a significant influence on local acceptance than demographic parameters such as gender, education and residence area. Perception of visual impacts and preference over the project location tend to differ from the common literature from the western contexts.

Fourth chapter evaluates the potential local benefit creation and coexistence strategies focusing on the second research question. Three step process of option identification, multi

criteria analysis and preference evaluation was used. Five broader level coexistence options were identified from literature review and expert interviews in the first step namely, (01) sharing in-situ, real time ocean information; (02) using MRE structures as artificial reefs and support structures for commercial fishing; (03) co-location with other industries such as leisure and tourism, aquaculture, etc.; (04) sharing generated electricity for local users at a subsidized rate; and (05) use of local resources to construct and operate the power plant, creating business involvement opportunities. Quantitative and qualitative data relevant to identified options were collected in the second step by key informant interviews based on criteria such as costs & benefits, scalability etc. This multi criteria analysis results were then used for the third step of DS-AHP multi criteria decision making model. DS-AHP preference results show that the main stakeholder, fishery industry generally prefers the option of sharing ocean information which can be generated by MRE projects. Further small and medium scale fishermen who use fishing methods which do not require large sea areas have shown a high preference to the positive environmental impacts created by underwater structures and their capability to act as artificial reefs. However, the general community preferred the fifth option of using local resources to construct and operate the power plant. It was identified that the co-existence option preference is highly dependent on individual impacts. Even within local fisheries, the preference changed according to the fishing method, scale, and area.

Fifth chapter evaluates the feasibility of the optimum co-existence strategy as per the third research question. Fishery being the main stakeholder, their preferred strategy of sharing oceanographic information was further analyzed based on technical and economic feasibility perspectives. This analysis proved that most of the oceanographic information required by fishermen can be generated by the MRE projects' condition monitoring systems (CMS) and supervisory control and data acquisition (SCADA) systems at a minimum additional cost to the developer. Fisheries were willing to pay a significant amount in comparison to additional project costs due to the availability of high resolution, real-time, in-situ data such as depth wise temperature distribution, current velocities etc. Comparison of fishers' Willingness to Pay (WTP) with the estimated additional costs indicated that it is financially feasible to achieve the proposed solution provided that fishers pay the identified WTP amount. Thus it was identified that oceanographic information sharing option has the potential to create a win-win situation between fisheries and MRE developers. Further analysis on the potential impacts and economic feasibility is required due to the uncertainty and unavailability of data, which will be the future work of this study.

As suggested in previous literature, provision of local benefits may lead to a higher public acceptance of renewable energy projects, if they were initiated as a policy requirement rather than a voluntary act by the developers. Hence the policy level implementation of results of this study is discussed in the sixth chapter along with the overall summary of study, generalization of the results, limitations and future research opportunities, as the conclusion of the study.