Investigation on the Possibility of Wave Energy into Electricity in the Coast of Thailand

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Abstract: Energy conservation has been an important policy for the Thai government since the enforcement of the Energy Conservation Promotion Act in 1992. Recently, an economy in Thailand has been increasing. Due to this reason, the energy consumption in Thailand increased continuously at an annual average rate of 4.4%. Although there has been continuous discovery of oil and gas in Thailand, the domestic demand for energy still has been growing resulting in the shortage of energy. Alternative energy is, therefore, highly necessary. These make Thailand renewable energy potentials are at a very good opportunities to be promoted as energy sources and create the promising country energy security. From the previous researches, it was found that the highest wave height in the Gulf of Thailand (GoT) can be found in September with the height of 2.6 m. The average significant wave height is 0.9 m. However, there is still no existing ocean wave energy generator in Thailand whereas the neighboring countries are trying to use this kind of energy. Then, the aim of this study is to study the possibility of promoting wave energy in the coastal zone of Thailand.

Keywords: Wave energy, Gulf of Thailand, Andaman Sea, SWAN Model, Thailand.

1. Introduction

Currently, the energy consumption in Thailand is rapidly growing up and is causing the insufficient energy supply. Although the energy resources from the neighboring countries are imported to solve this problem, with the value of 1,125 billion baht a year, but it is not enough. Therefore, the renewable energy is necessary to support the energy demand and to reduce the import amount of energy resources. It is realized that in Thailand, there are potentials of natural energy resources in all parts of Thailand, for example solar energy, wind energy, hydropower, etc. These make Thailand renewable energy potentials are at very good level with opportunities to be promoted as energy sources and to create the promising country energy security. Renewable energy would be a target fuel expected to substitute natural gas for power generation.

There were 3 important policies from governments that lead a strategic development of renewable [1]. However, after Thailand has changed the energy policies in 2014, there are some improvement of these three policies releases.

i) From Thailand Power Development Plan 2010-2030 (PDP2010: Revision 3), it is expected that at the end of 2030, total capacity of renewable energy will be around 20,546.3 MW (or 29 percent of total generating capacity in the power system) comprising total existing capacity amounting 6,340.2 MW, total added capacity of renewable energy of 14,580.4 MW and deduction of the retired capacity of renewable energy totaling 374.3 MW. After 2014, Thailand Power Development Plan 2015-2036 (PDP2015) is released. The main idea for this policy is to manage the energy under the energy security, economy, and ecology. The goal for renewable energy in Thailand at the end of 2036 is 15-20% includes hydropower [2].

ii) The 20-Year Energy Efficiency Development Plan 2011-2030 (EEDP 2011-2030) is targeting on 25 percent reduction of energy intensity (ratio of energy consumption to GDP) of the country within 20 years (2011-2030), resulting in the decrease of country's power demand projection on account of energy saving programs and energy efficiency promotions [3]. The present 20-Year Energy Efficiency Development Plan 2015-2036 (EEDP 2015-2036) is released with the main goal of to reduce, at least, the energy demand of 30% in 2036 compare with the year 2010. The using of energy resources should be done under the maximum efficiency. However, there is no specific policy on renewable energy [4].

iii) For the Alternative Energy Development Plan: AEDP 2012-2021, it is regarded to use renewable energy and alternative energy by 25 percent instead of fossil fuels by 2021. It is also committed to the development of low-carbon society. The present policy for the Alternative Energy Development Plan: AEDP 2015-2036 focus on the increase of using renewable energy from 8% in the present to 20% in 2036. Therefore, the power from renewable energy should be 19,634.4 MW [5].

For all policies about renewable energy mentioned above with an expected potential in commercial development for the future, there are six strategic issues to be proposed as follows;

i. Promoting the community to collaborate in producing and consuming renewable energy.

ii. Adjusting the incentive measure on investment from private sector.

iii. Amending the laws and regulations which do not benefit to renewable energy development.

iv. Improving the infrastructure system including a development towards Smart Grid System.

v. Public relations and building up comprehensive knowledge for the people.

vi. Promoting the research work to develop the integrated renewable energy industry.

In order to support these strategies, the research work is the important issue. If the new type of renewable energy is needed to be promoted and installed, the new technology will costs a lot. Therefore, the feasibility of potential of wave energy is needed to be studied in that specific area. Wave energy is one kind of renewable energy that is interesting to be promoted in Thailand because there are Gulf of Thailand (GoT) and Andaman Sea press on two sides of Thailand coastal zone. In addition, the advantages of wave energy are the ability of electricity generation that can be produced without the limitation of time and has less environmental impact. However, the use of wave energy is still limited because of high production costs. This research, then, aims to study the possibility of promoting wave energy in Thailand.

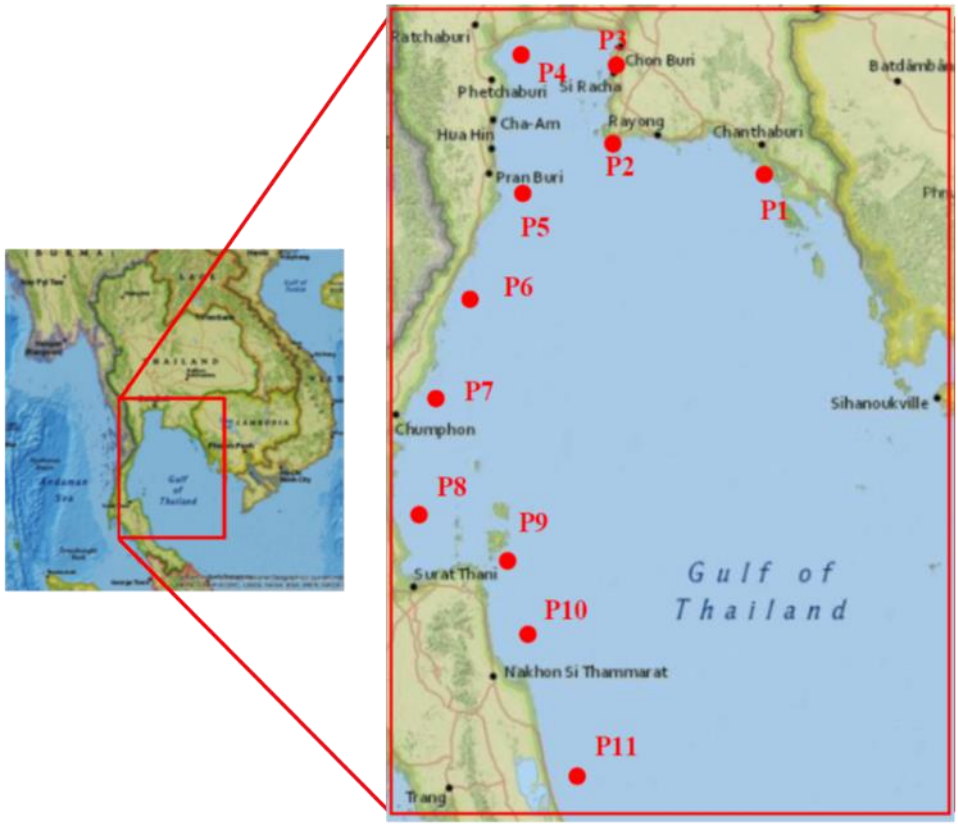

Figure 1. Study area in the Gulf of Thailand (GOT).

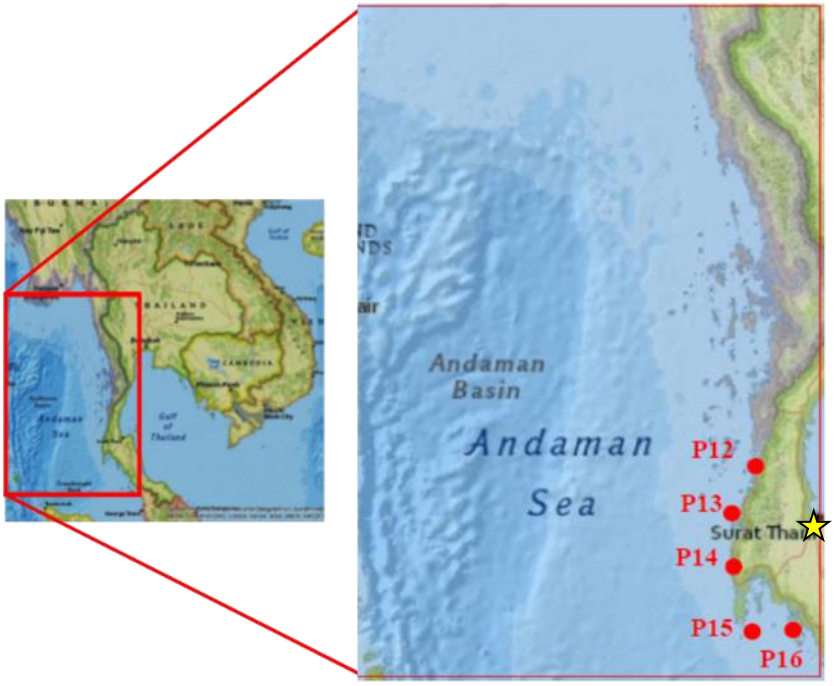

Figure 2. Study area in the Andaman Sea.

2. Numerical model and Methodology

In this study, the Simulating Waves Nearshore (SWAN) model were used to determine the wave characteristic for wave simulation and appropriate location for study wave power generation. The input data are the wind data and bathymetry data in GoT and Andaman Sea. The wind data is provided by USGODAE. They are called NAVGEM and NOGAPS data. Secondly, wind and bathymetry data are used as an input data in SWAN model. A Joint North Sea Wave Observation Project, JONSWAP, gives a boundary condition in this study. The boundary condition from JONSWAP means this model needs a time to spin up the wave in boundary area. Wave properties, dissipation due to depth-induced wave breaking, bottom friction, white capping, quadruplet, and triad wave interaction are activated as nonlinear interaction for deep and shallow waters.

Lastly, calibration and validation with the observed data are done. The results from SWAN model is compared with the observed data which collect from satellite data, Jason-2. Jason-2 operates by two different radar frequencies. First is in the Ku-band (13.6 GHz) and the other is in the Cband (5.3 GHz). On this study, the significant wave height from Ku-band is selected as an observed data. The observed data from Jason 2 which has track number 179 and 242 through GoT and track number 27, 90 and 103 through Andaman Sea were used. The altimetry method provides snapshots of wave height and wind speed across large areas. This measurement produces a useful information data that can be used for range of applications. The altimetry data are used to compute wave velocity and wave height in the present study.

4. Conclusions

For the results in the Gulf of Thailand, to consider on overall average wave power in all seasons, the results show that station P5 is the best station to provide the wave power. The nearest mainland shore of this station is the nature recreation area in Kui Buri district, which is a district in the northern part of Prachuap Khiri Khan Province. Station P4 and P11 also provide high wave power. The nearest mainland shore of station P4 is Queen Sirikit Park in Mueang Samut Songkhram district, Samut Songkhram Province. The nearest mainland shore of station P11 is in Muang-Ngam sub-district, Singhanakhon district, Songkhla Province.

For the results in the Andaman Sea, the highest average significant wave height and wave power are found at the station P12 whereas stations P13 and P14 show the second rank. Station P12 provide wave power of 2.97 kW/m, 5.12 kW/m, and 3.25 kW/m in summer, rainy, and winter seasons, respectively. The nearest mainland shore of this station is the nature recreation area in Mueang Ranong District, Ranong Province. This area includes national park and mangrove forest.

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