Input paper: [[1]](#footnote-1) ENG5-10.25

Input paper for the following Committee(s): check as appropriate Purpose of paper:

**□** ARM **X**  ENG **□** PAP **□** Input

**□** ENAV **□** VTS **X**  Information

Agenda item [[2]](#footnote-2) 10

Technical Domain / Task Number 2 TD#2

Author(s) / Submitter(s) Dr. Ju-Seop Han / Korea Association of Aids to Navigation

The Performance of Maritime Hybrid Renewable Energy System in Korea

# Summary

## The most widely used new renewable energy technologies are solar power, wind power, wave power, sea power, and tidal power. Land-based renewable power generation has problems such as large land requirements. A hybrid power generation system which can collect wave energy and solar energy at the same time has been designed and developed in order to solve the problem that the power generation system can only use a single form's marine energy to generate electricity at present. This study provides an analysis of the power generation performance of the hybrid renewable energy systems for offshore. Hybrid renewable energy system was developed with the support of government R&D, performance testing was conducted at sea in order to put into practical application.

# Introduction

## Ships maneuvering without appropriate precautions at sea are at risk of accidents because of shallow shoals and hidden rocks under the surface of the water. There are sailing routes in the ocean just like the roads on land, which enable vessels to achieve safe and efficient navigation, avoiding these hazards. Since the routes at sea are invisible, navigators rely heavily upon nautical charts, a kind of sea map to follow those sailing routes in order to safely maneuver their vessels. In addition to nautical charts, man-made aids to navigation installed on islands, capes, ports, and narrow channels are imperative in helping navigators have the safest and fastest voyage. The Aids to Navigation (AtoN) is a device or system external to vessels that is designed and operated to enhance the safe and efficient navigation of vessels and/or vessel traffic (MOF, 2015). The visual aids to navigation are navigational marks which enable navigators to confirm their locations by identifying the characteristics of lights from the lighthouse. Although the need for additional electronic devices installed in the Light buoy is increased, and the system for supplying electric power to the solar power is limited. The most widely used new renewable energy technologies are solar power, wind power, wave power, sea power, and tidal power. Land-based renewable power generation has problems such as large land requirements (generating power with solar panels requires a great deal of space) and noise (generating electricity with wind power systems creates noise), which have led to a transition to offshore power generation systems (Kwan Jun Jo, 2012).

## A hybrid power generation system which can collect wave energy and solar energy at the same time has been designed and developed in order to solve the problem that the power generation system can only use a single form's marine energy to generate electricity at present. OWC (Oscillating Water Column) type wave generation installed and operated in buoy, produces different output power depending on the radius of water chamber. As it is installed at the ocean, sea algae attachment on the water chamber reduces radius of chamber inlet. The reduced water chamber radius leads to reduced wave generation power output. Figure 1 demonstrates the radius of chamber inlet reduces due to the sea algae attachment on OWC type wave generation.

## 

# Experiments and Results

## The experiments were carried out at Busan New Port route, in order to commercialize wave power generation system based 1 hole (wave power). Light buoy with a diameter is 2,600mm. Light buoy with hybrid power systems are shown in Figure 1. The power system of light buoy was installed combined solar power (160W), wind turbine, and wave generator. The power of wind turbine generator is 40W and that of wave generator is 30W.

1. Photograph of the hybrid renewable energy system

## To maximize restraining of sea algae attachment, multi-channel type AFS (Anti-Fouling System) has been used for the experiment. AFS installs Cu-Anode on the light buoy and remaining currents flow through anode, emitting Cu in order to restrain sea algae attachment.

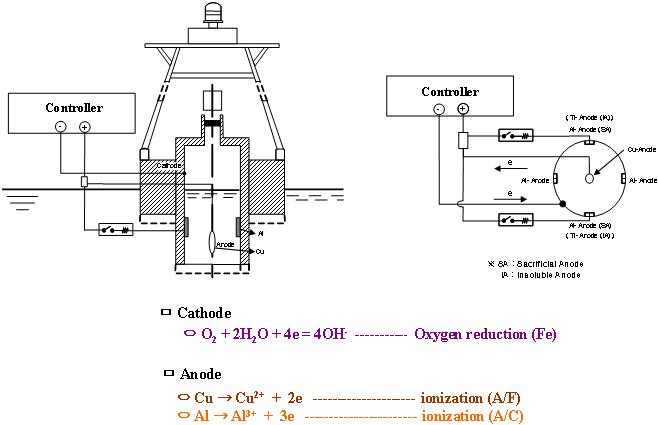
## Through the TRS-based monitoring systems were monitored light buoy status. Light buoy to a second power control device inside the storage system by configuring the memory card. The memory card was replaced by 2 months.

## Figure 2 shows data of hybrid power generation system with wave power generation system based 1 hole. The generated energy of solar power at Light buoy (red color) was up to 358W. That of wave power was up to 95Wand that of wind power has been produced up to 118W. The daily maximum power generation of hybrid power system was 691W with high wave weather. The generated energy of solar power at Light buoy (green color) was up to 276W. Also, that of wave power was up to 148W. The daily maximum power generation of hybrid power system was 424W. On Cloudy Day, the generated energy in 93% increase in solar power output during testing compared to the solar power system.

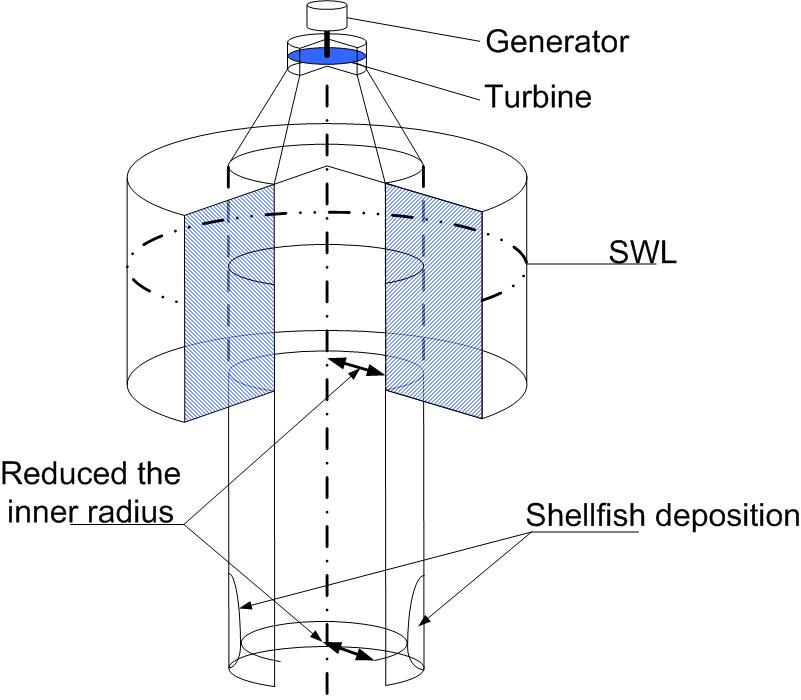
## EMB000012d028df

1. The data of hybrid power generation system

OWC(Oscillating Water Column) type wave generation installed and operated in buoy, produces different output power depending on the radius of water chamber. As it is installed at the ocean, sea algae attachment on the water chamber reduces radius of chamber inlet. The reduced water chamber radius leads to reduced wave generation power output. Figure 3 demonstrates the radius of chamber inlet reduces due to the sea algae attachment on OWC type wave generation.

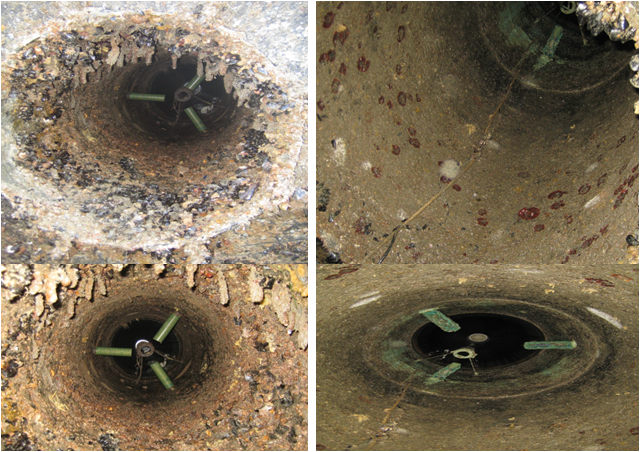


1. The anti-fouling system for buoy with OWC type wave power generator

EMB000014145539

1. The Schematic of control system for anti-fouling

To maximize restraining of sea algae attachment, multi-channel type AFS(Anti-Fouling System) has been used for the research. AFS installs Cu-Anode on the light buoy and remaining currents flow through anode, emitting Cu in order to restrain sea algae attachment. Figure 3 demonstrates sea algae attachment over the 6 month period of experiment took place in the ocean.



1. The results of AFS experiment(Left : inactive AFS , Right : active AFS)

The generated energy of hybrid power system at light buoy was increased up to 93% compared to the solar power system. The importance of the buoy and the safety facility for marine transportation is needed for the voyage near a port. Thus, such stability and reliability for the electric power system of the safety facility for marine transportation will be important. The reason of buoy’s malfunction is caused mostly by the power system. Therefore, improving the power system is essential to ensure the normal operation of the buoy system. Stability of the power system in the ocean safety facility is secured through the development of hybrid power generation system.

1. Input document number, to be assigned by the Committee Secretary [↑](#footnote-ref-1)
2. Leave open if uncertain [↑](#footnote-ref-2)