

Investigation of Potential Sites for Deep Ocean Water Development in Taiwan

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ABSTRACT

Deep ocean water (DOW) is commonly referred to the water below 200 meters in the ocean that is typically cold, clean, stable, and rich in nutrients and minerals. Japan and the United States have been exploiting the DOW for applications in water, pharmaceutical, cosmetic, and fishery industries for many years. The sea bed topology in eastern Taiwan has a natural advantage that the water depth can reach 500 meters just several kilometers off shore, making it rather unique and thus economically exploitable for deep ocean water resources. The Water Resource Agency (WRA) of Taiwan has started the planning for the exploitation of the deep ocean water resources since 2000. The history and previous planning such as selection criteria for the sites for DOW in Taiwan was summarized in the papers. During 2005~2006, we conducted a comprehensive field investigation, including seabed bathymetry and DOW quality, on six most possible sites for development. The site near He-Ping has a steepest continental slope that it can reach a depth of 750 meters just 1700 meters off shore, indicating that DOW can be extracted very economically. More than 60 water quality parameters were analyzed and compared to surface waters. These parameters include heavy metals, herbicides, chlorinated compounds, dioxins, as well as essential trace elements. The results indicated that the DOW in several sites along Taiwan's eastern coast has several advantages over traditional water resources, such as not contaminated with anthropogenic compounds, rich in nutrients, and having a temperature difference close to 20 degree Celsius compared to surface waters.

KEY WORDS: Deep Ocean Water (DOW), ocean thermal energy conversion (OTEC), nutrients, temperature difference, anthropogenic compounds, essential trace elements

INTRODUCTION

Deep ocean water (DOW) has been commonly referred to the ocean water that lies beneath the thermocline where the temperature changes rapidly with depth. Sunlight is typically absorbed in the first few tens of meters of water. Since it barely reaches the deep ocean, the phytoplankton is relatively sparse and the photosynthesis process in the DOW is therefore limited. DOW consists poorly mixed and well stratified layers of water whose interaction with surface environment is minimal. With these environmental characteristics, DOW possesses several interesting properties: relatively low in temperature, stable, rich in nutrients, and less suspended particles and pathogens in comparison

to the water of the surface layer (Watanabe, Ohtsu, and Otsuki, 2000). DOW was initially developed for ocean thermal energy conversion (OTEC) in the United States and Japan during the energy crisis in 1970s (BOE, 1992). OTEC is a technology to generate electricity utilizing the temperature difference of ocean water at different depths. Due to the high power generation costs compared to the established fossil fuel plants, commercial OTEC plant has never been materialized. Since OTEC appeared to be economically infeasible, Japan started to channel DOW into other profitable uses in the late 1980s (WRA, 2000). DOW has now emerged as a new industry with great economic values in Japan. In the United States, utilization of DOW is in Hawaii where DOW can be economically extracted from just several kilometers offshore. In 2003, Natural Energy Laboratory of Hawaii Authority (NELHA) finished the world's deepest intake pipe that produced 38 million gallons per day from a depth of 915 meters (Shuster, 2003). NELHA has been focusing on developing and commercializing bottled drinking water, cold season vegetables and crops, aquaculture, pharmaceutical, nutraceutical, and cosmetic products using DOW after OTEC was stalled in the 1980s (NELHA, 2005; TCG, 2004; Daniel, 1994). Taiwan is a mountainous continental island that perches on the southeastern rim of the Eurasian plate. Lying on the edge of the continental slope, the east coast of Taiwan borders some of the deepest oceans in the Pacific. The terrain is precipitous on the east coast and it deepens abruptly into the Pacific Ocean, dropping to a depth of 4,000 meters only 50 kilometers offshore (see Fig 1). The special seabed bathymetry in the east coast of Taiwan makes it one of the few places in the world other than Japan and Hawaii that can exploit DOW for economical use from just a few kilometers offshore. DOW development in Taiwan began with the OTEC during the second oil crisis in 1980s (BOE, 1992). However, the attempt for OTEC has gradually faded out and the attention for DOW was diverted to other type of uses. The success experience of DOW in Japan and the United States has greatly influenced the DOW development and stimulated interests from various sources in Taiwan, including both governmental sectors and other private stakeholders. During the past few years, Taiwan's government has started the evaluation and planning for the exploitation of the deep ocean water resources (MOEA, 2006; WRA, 2000, WRA, 2005a and 2005b; Executive Yuan, 2005; TCG, 2004). DOW is now recognized as a new and valuable water resource in Taiwan. The current proposed capital investment up to 2010 is estimated at approximately 5 billion Taiwan's dollars (\$155 millions) (MOEA, 2006).

Fig 1 shows several locations in Taiwan's eastern coastal area that has a