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Successful experience of renewable energy development in several offshore islands

Jhieh-Hao Lin^a, Yuan-Kang Wu^{b*}, Huei-Jeng Lin^a

^aDepartment of Engineering Science and Ocean Engineering, National Taiwan University, No. 1, Sec. 4, Roosevelt Rd., Taipei 10617, Taiwan

^bDepartment of Electrical Engineering, National Chung Cheng University, No.168, Sec. 1, University Rd., Chiayi 62102, Taiwan

Abstract

Islands incur more difficult and expensive energy supplies; many offshore islands, therefore, develop renewable energy to supply energy and reduce CO₂ emissions. However, most of renewable energy sources, such as wind and solar, are intermittent and variable sources of power. To overcome the integration problems, numerous islands have utilized several useful methods. For instance, the island of Gran Canaria applied the pumped storage systems to reutilize energy, and the island of Lolland developed renewable hydrogen community. The operation experience of these islands is extremely worthy to appreciate. This article introduces eight offshore islands and discusses about their present situations, policies, successful experience and challenges about renewable energy development. Those islands include Samso, Reunion, Cyprus, Crete, King Island, Agios Efstratios, Utsira and El Hierro. The successful experience on those islands can provide useful information for other islands for developing renewable energy.

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1. Introduction

Increasing concern about environmental problems and the shortage and rising costs of fossil fuels have promoted a growing interest in massive integration of renewable energy sources (RES) in power systems. Electrical grids in offshore islands are appropriate for the large scale installation of renewable sources because the fuel cost is very high and there are numerous RES that can be exploited in several islands. However, the integration of a large scale of RES would bring many challenges on power system operation [1-3]. Therefore, this article will introduce the

* Corresponding author. Tel.: +886-5-2720411; fax: +886-5-2720411#33232.

E-mail address: allenwu@ccu.edu.tw.

development and successful experience of renewable energy, as well as renewable projects, in several offshore islands. The valuable experience would provide significant references to other islands.

2. The development and successful experience of renewable energy in several offshore islands

Many RES, such as wind, solar, hydro, biodiesel and biomass, have been popularly utilized in offshore islands. Table 1 listed several famous offshore islands that develop renewable energy. This article will introduce the renewable energy development in those islands in detail.

Table 1 Famous offshore islands that develop renewable energy

| Island | Country | Location | Area | Population | Density | Renewable Energy |
|------------------|-----------|-------------------|-----------------------|------------------------|-----------------------|--|
| Samso | Denmark | Kattegat | 112 km ² | 3,806 (as of 2013) | 34.0/km ² | Wind, Solar, Biomass |
| Reunion | France | Indian Ocean | 2,512 km ² | 844,994 (as of 2011) | 336.4/km ² | Wind, Solar, Sea, Hydropower, Biomass |
| Cyprus | Cyprus | Mediterranean Sea | 9,251 km ² | 1,141,166 (as of 2011) | 123.4/km ² | Wind, Solar, Biomass, Bio fuel, Biogas |
| Crete | Greece | Mediterranean Sea | 8,303 km ² | 623,065 (as of 2011) | 75.0/km ² | Wind, Solar, Hydropower, Biomass |
| Agios Efstratios | Greece | Aegean Sea | 43 km ² | 270 (as of 2011) | 6.28/km ² | Wind, Solar, Hydrogen |
| King Island | Australia | Tasmania | 1,098 km ² | 1,800 (as of 2013) | 1.64/km ² | Wind, Solar, Biodiesel |
| Utsira | Norway | North Sea | 6.3 km ² | 206 (as of 2015) | 32.7/km ² | Wind, Hydrogen |
| El Hierro | Spain | Atlantic Ocean | 268.7 km ² | 10,960 (as of 2010) | 40.8/km ² | Wind, Hydropower |

2.1. Samso (Denmark)

The island of Samso has invested heavily on local energy production, including wind, biomass, and solar power generation. The installed capacity of onshore and offshore wind turbines in Sanso is 11 MW and 23MW, respectively, and it achieves 100% renewable energy supply [4-6]. The renewable production not only covers the electricity consumption, but compensates the energy utilized in the transportation sector. The development strategies of Samso are as follows [7]:

- Energy savings and increased efficiency in terms of heat, electricity and transport by the introduction novel energy technologies.
- Expansion of the district heating supply systems using local biomass resources.
- Expansion of individual heating systems using renewable energy.
- Construction of onshore and offshore wind power plants.
- Gradual conversion of the transport sector from petrol and oil power to electrical power and hydrogen.

2.2. Reunion (France)

The island of Reunion has high potentials of RES such as solar, wind, geothermal, sea energy, biomass and hydropower. Two renewable-related projects - PRERURE and GERRI were launched in 2000 and 2008, respectively. They have indeed promoted investments to achieve an energy mix with 100% renewable energy sources by 2025 through incentive mechanisms such as tax exemptions, direct subsidies and advantageous feed-in tariffs [8, 9]. The hydropower with an installed capacity of 146 MW spread over six sites is the main renewable resource of the island. An additional capacity of 50 MW should be deployed by 2020. The biomass potential of Reunion is important. Solar energy is also an abundant energy resource. The current installed capacity of photovoltaic solar energy is 130 MW. The southeast and the northeast regions of the island are suitable for wind power generation. There are two wind farms with the installed capacity of 16.5 MW in Reunion; however, the potential of wind power generation is estimated up to 60 MW [10-12].

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