RESEARCH INSTITUTE FOR SUSTAINABLE URBAN DEVELOPMENT (RISUD)

News Article for RISUD Emerging Frontier Area (EFA) Scheme

	Name	**Department**
Principal Investigator:	Dr. Sunliang Cao	BSE

Name of EFA: Seashore Zero-Energy Community and Ocean Energy Development

Project Title: Development of the frontier ocean energy technologies to utilize the renewable and storage resources of sea for supporting the seashore residential zero-energy communities

Annual Progress/Achievement

Brief introduction of the project

The zero-energy buildings (ZEBs) and communities (ZECs) are internationally recognized as the ultimate goals to reduce primary energy consumptions and equivalent CO_2 emissions of the building sector. However, most of the applied ZEBs and ZECs are based on the conventional inland renewable and storage resources, whereas the sea-sourced resources were barely utilized for these zero-energy applications. Moreover, the special conditions in the densely-populated coastal regions, such as the intense urbanization and limited above-/under-ground space, further restrict the utilization of the inland resources, whereas the sea-sourced resources present a higher potential. The above conditions hereby stimulate the core research idea of this project, which focuses on the development of the frontier ocean energy technologies in order to fully utilize the renewable and storage resources of sea for supporting the seashore and coastal zero-energy communities.

Research teams in this project

We have a very outstanding and multi-disciplinary team in this project, as shown in Figure 1. The PI of this project is Dr. Sunliang Cao from BSE, while the Co-Is are Dr. Xiaolin Zhu (LSGI), Dr. Yang Xu (LSGI), Prof. Vivien Lin Lu (BSE), and Prof. Shengwei Wang (BSE). Furthermore, there are currently four talented research staffs/students involved in this project with different focuses of the ocean energy system, including Mr. Haojie Luo (Offshore wind turbines and wave energy converters for coastal hotel buildings), Mr. Shijie Zhou (Floating photovoltaics and tidal stream generators for coastal high-rise buildings), Ms. Xinman Guo (Ocean energy supported zero-emission boat and hotel integration and interactions), and Mr. Ming Li (Large-scale ocean energy systems and coastal communities).

We also would like to briefly present some highlighted research progresses as listed below:

(1) Comprehensive and systematic reviews have been conducted for the flexibility and feasibility of the offshore and coastal ocean energy technologies in East and South East Asia.
(2) The state-of-the-art review covers the latest progresses in the academic and industrial communities relating to the wave energy, tidal energy, floating photovoltaics, offshore wind turbines, and sea-sourced heating and cooling technologies in the East and South East Asian counties and regions. We have systematically collected the key features, superiorities, shortages, and problems/barriers for different types of ocean energy technologies. Significant potentials of ocean energy utilizations have also been clearly noticed in the East and South East Asian regions.

(2) We have investigated the techno-economic feasibility of a hybrid wave-wind energy supported coastal hotel building, while the heating/cooling are also supported by the sea-source heat pump/chillers. The research results have shown the advantageous of the hybrid ocean energy system to enhance the matching and economic viability of the zero-energy hotel system, especially regarding the complementary features of the ocean wave and offshore wind energy systems in the summer season.

(3) We have additionally proposed and designed a hybrid system that can support a coastal zero-energy commercial office building, as a comparison to the coastal hotel buildings. As shown in Figure 2(a), this hybrid system consists of a sea-source chiller using ocean thermal energy, an offshore floating PV panel system and a tidal stream generator system. Compared to conventional cooling towers, sea source coolers can be designed to have a slightly better COP. The other two systems are the input sources of power supply, while batteries are added to the system as an energy storage strategy to enhance energy matching. Technical and economic analyses are completed by simulations to assess the feasibility of this system.

(4) We have simultaneously investigated an offshore wind and tidal stream energy supported coastal zero-emission community, comprising clusters of residential and commercial buildings. The system configuration is illustrated in Figure 2(b). Compared to a traditional system, the ocean and solar thermal energy supported system is able to save 26.21% of the annual energy consumption. In addition, 11 groups of ocean renewable energy systems with different generation combinations are analyzed. With the best performing group, 75.28% of the community consumption is covered by the hybrid renewable energy generation, and the community is independent on the electric grid during 59.52% of the time in a year.

(5) We have also further investigated a hybrid zero-emission hotel-electric boat system, which is supported by the ocean energy system (Wave energy converters, Floating PV panels, and boat integrated PV), as shown in Figure 2(c). The electric boat has been functioned as a mobile energy storage, which has proven to be an effective solution to enhance the matching capability between

the highly fluctuated and intermittent ocean generation (hybrid solar and wave energy) and demand sides, mitigating the stress on the electric grid.

Figure 1: The research team in this project.

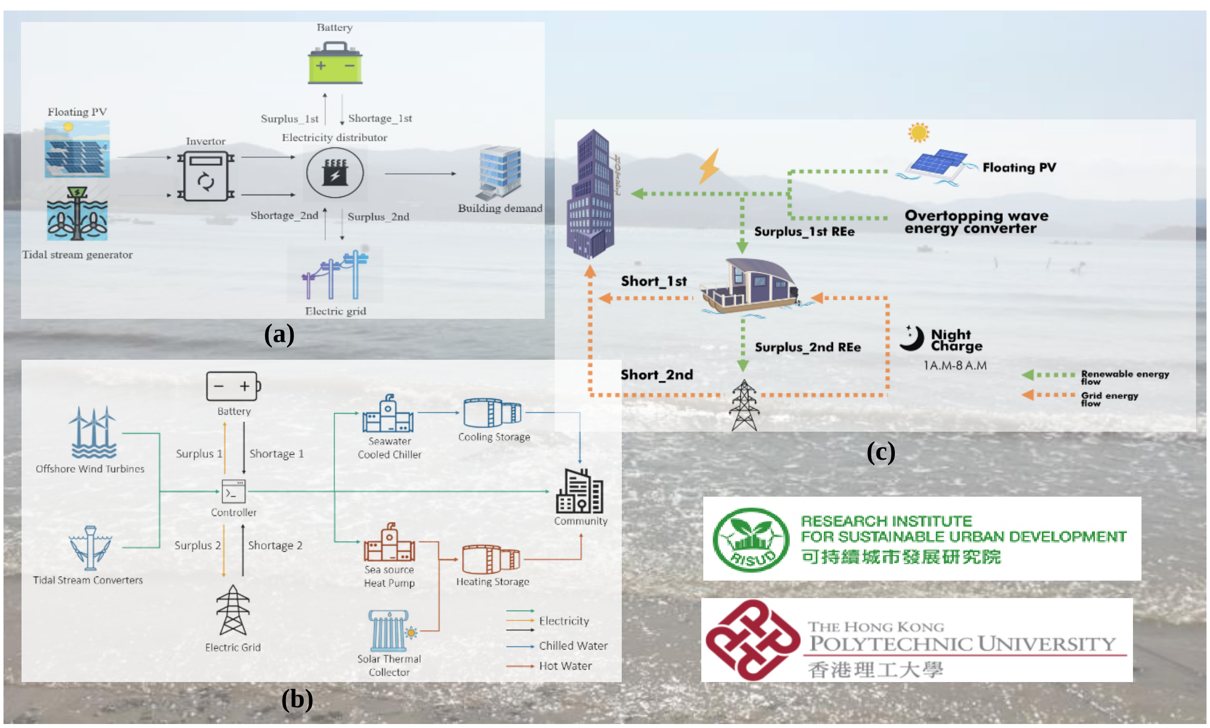

Figure 2: The brief schematic of several studied ocean energy systems.