DEVELOPMENT ASIA
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CASE STUDY

How to Develop Renewable Energy and Water Independence on a Small Island

Developing renewable energy and water systems on small islands present significant challenges. Photo credit: ADB

The keys to success: link education, experience and tourism to create benefits while considering local conditions such as topography and climate.

Published: 31 January 2018

Overview

In order to develop an eco-friendly island, it is necessary to make electricity, heat and water independence using renewable energy as an energy source. The project is aimed at developing a sustainable eco-friendly energy and water-independent community in small island areas. Considering the natural environment and geographical features of the project area, we are developing small villages or communities through eco-friendly energy sources based on a hybrid power system. The hybrid power system consists of a small wind turbine, a photovoltaic panel, a pumped storage hydroelectricity and energy storage system. The renewable energy hybrid system can provide stable electricity and water to the island without greenhouse gas emission by fossil fuels.

Since 2008, Incheon city has been promoting the development of eco-friendly islands centered on Deokjeok-do. Deokjeok-do is at the center of zero carbon island development. Baeka-Do and Ji-Do for example, are small islands that have developed into eco-friendly energy independent villages.

The Korea Institute of Civil Engineering and Building Technology has signed a memorandum of understanding with Incheon City and is participating in the eco-island project centered on Deokjeok-do island.

A local community in Deokjeok-do, Incheon city, was selected in 2013 to be developed as an environmentally-friendly energy and water independent community. A hybrid power system based on a small wind turbine, a photovoltaic panel, a pumped storage hydroelectricity and energy storage system was built. Through this arrangement, electricity is supplied to the community without diesel power generation. Besides eco-friendly energy independence facilities, self-supporting water facilities were also installed. Facilities that use rainwater, valley water and groundwater were developed and built.

In addition, the pumped power generation system uses surplus electricity generated by wind power and solar power to move the water in the lower storage tank to the upper storage tank. By using the water stored in the upper storage tank, it is possible to automatically supply water to the surrounding crops.

Currently, the local community in Erumsil Village produces and uses electricity and water by itself without power and water supplied from the outside sources.

Up to now, installation and research costs have totalled about US$1 million.

Challenges

Many small islands have no electricity supply, and some islands use diesel generators, which are powered by fossil fuels. In order to supply eco-friendly electricity to the island, it is necessary to develop and electricity and water supply systems using the natural environment (wind, topography, etc.). In order to develop an eco-friendly island, it is necessary to produce electricity, heat and water independently with renewable energy as the source. A grid that connects them efficiently is also needed.

In this project, the hybrid power system consists of a small wind turbine, a photovoltaic panel, and a pumped storage hydroelectricity and energy storage system. The renewable energy hybrid system provides stable electricity and water to the island without greenhouse gas emission by fossil fuels.

Solutions

- The development of small-scale decentralized, eco-friendly energy and water-independent villages including the use of information and communications technology.
- Estimation of annual energy production by renewable energy sources and the development of optimum capacity design technology.
- Development of evaluation methods using large-scale numerical analysis.
- Establishment of continuous power supply technology through high-efficiency active control based on linkage to an energy storage device.
- Efficient operation and management technology through information and communication technology linkage between new and renewable energy complex facilities and water self-supporting facilities.
- Development of smart water independent green infrastructure through the establishment of water supply, water conservation, water reuse and water circulation management facilities in connection with renewable energy and taking into consideration installation site conditions.

Project Technical Specifications

- Major specifications for the construction of sustainable hybrid system at Deokjeok-do island:
- Household numbers: 5
- Area including house and crops: 250,000 m^2
- Energy sources: wind turbine (6 kW), solar power (21 kW), hydropower turbine (2 kW)
- Water independence facilities: reuse of rainwater and ground water for agricultural water supply (water tank: total 80 tons)

Results

Construction of eco-friendly hybrid energy system and independent water community:

- 100% supply of environmentally friendly energy on off grid.
- Crop water supply using sprinkler and drip irrigation and drinking water supply.
- Securing water resources using valleys and groundwater, and collecting rainwater using solar panels.destinations.

Using the facility as a place of education and tourism in conjunction with nearby.

Lessons

Providing water and eco-friendly energy self-supporting facilities in small islands improves the lives of residents and protects nature.

Additional information

The project contributes to the expansion of understanding of the global issue of greenhouse gas reduction, following the launch of the new climate system. It also shows the need to develop eco-friendly energy businesses in response to climate change. It also illustrates the establishment of distributed new and renewable energy fusion platforms, such as on islands, and the increased need for eco-friendly energy. The project is an example of water and energy independent village development through links with low impact development.

Resources

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Dr. Choon-Man Jang, with the Korea Institute of Civil Engineering and Building Technology, holds a Doctorate of Engineering from the Department of Mechanical Energy Engineering of Kyushu University. He is an expert in the field of designing hybrid power systems using renewable energy, including the optimal design of turbine blades.

Korea Institute of Civil Engineering and Building Technology (KICT)

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