Low Carbon Microgrid Long Case Study

Town Island Renewable Energy Supply Project, Hong Kong

CLP Power Hong Kong Ltd

Project background

Renewable energy (RE) is a clean and sustainable alternative source of energy, but there are huge challenges to the development of a large-scale RE system in Hong Kong. Abundant natural resources – so scarce in Hong Kong – are a prerequisite for developing RE. For instance, sustained strong winds and plenty of land are required to operate wind turbines, while the power generation by solar system needs plenty of sunshine and large areas of land to lay solar panels.

Because of the natural limitations, a traditional power generation system is essential to back up any RE supply. A CLP study found that even if wind turbines were installed across the entire Kowloon peninsula, they would meet only 4% of Hong Kong's total electricity demand.

Despite the challenges, CLP is committed to investigating opportunities for local RE projects. In 2010, CLP set up the first standalone commercial-scale RE system in Town Island, Sai Kung. The system has produced more than 300,000 kWh of electricity since commissioned, equivalent to the monthly electricity consumption of 850 households. The project has successfully met the energy needs on the island and achieved a reduction of over 120,000 kg in carbon dioxide emissions.

CLP has supported the community in developing small-scale RE projects, ranging from schools, rooftops, households and other community facilities. CLP supports these projects by simplifying application procedures to connect to the electricity grid and providing technical consultancy services. By the end of 2015, over 200 small-scale RE systems have been connected to the CLP electricity grid.

Town Island, also known as Dawn Island, is situated off the Sai Kung Peninsula. A non-profit-making organization, Operation Dawn, has run a drug rehabilitation center on the island since 1976 and there are currently around 80 recovering drug users and employees from Operation Dawn living there.

The center used to rely on electricity generated from three diesel generators that would function intermittently for hours a day. Transporting fuel (i.e. diesel) by sea was costly and time-consuming. Hence, CLP looked into possible solutions, involving the supply of power through a submarine cable or an overhead line. However, both options would have impacted upon the island's natural landscape and marine ecology.

Instead, CLP seized the opportunity to create Hong Kong's first standalone RE system. Taking advantage of the increasing maturity of solar power technology and the geography of Town Island, which has large open areas to accommodate solar panels and high winds to make power generation possible, CLP began the Town Island RE Supply Project in August 2009. The first phase of the project was commissioned in January 2010, with the aim of meeting existing electricity demand on the island. As well as being environmentally friendly, the project turned out to be more cost-effective than supplying power through a submarine cable or overhead line.

Technical features

The Town Island RE system is the first commercial-scale system of its kind in Hong Kong. A standalone RE system operates without any interaction with the power grid, making it distinct from grid-connected RE systems.

Work began on the two-phase Town Island Power Supply Project in August 2009. The first phase, commissioned in January 2010, involved installing 100 solar panels and 96 batteries at the Mount Carmel site on the island. With a generating capacity of 20kW, enough to light up the equivalent of 1,000 compact fluorescent lamps, the first phase powers facilities including the center's kitchen, garden and hostels.

The second phase of the project was completed in October 2012. Apart from the Mount Carmel site, the RE system was extended to the Living Spring site on the island. The total RE system now comprises of 672 solar panels, 2 wind turbines and 576 batteries, with a generating capacity of up to 192 kW, enough to illuminate the equivalent of 9,600 compact fluorescent lamps. The electricity generated by the whole RE system meets the power demands of the island and is designed to support its future development.

To ensure a reliable power supply for Town Island, an enhanced RE system utilizing the hybrid sources of solar and wind energies has been adopted. The solar panels used on the island are made of Polycrystalline Silicon, which has long been used in the industry and can withstand wind gusts of over 250 km per hour. In addition, downwind wind turbines have been installed. The blades of the turbines fold up when winds strengthen, reducing the exposure area in high winds. Even at a wind speed of 250km per hour, the turbines can continue to generate electricity normally without a risk of damage.

The RE system also has batteries to store excess energy generated by the solar panels during sunny periods, so that at nighttime or on days with no sunshine, the system can still supply power to the island. The batteries are capable of storing over 1,100kWh of electricity, enough to supply power for around 30 hours.

The RE system produces zero emissions during power generation. Additionally, since the power regenerating units are close to the users, energy loss during the power distribution process is reduced, enhancing energy efficiency.

Because the RE system on Town Island is the first of its kind in Hong Kong, there was no blueprint for its design and the CLP engineering team had to overcome considerable challenges to complete the pioneering project.

As the system is not connected to the grid, the amount of electricity consumed must be meticulously calculated. To ensure an uninterrupted supply of electricity for the island, the RE system is equipped with batteries capable of storing over 1,100 kWh of electricity, enough to supply power for around 30 hours. On days when there is little sunlight, the two wind turbines can provide additional electric power.

The island's remote location makes transporting supplies a logistical challenge. Another complication is that the island is subject to extreme weather, meaning that the design and choice of materials had to take into account the fact that the system would be exposed to a harsher climate than in urban areas.

Key learnings and best practices

By the end of 2015, the RE system on Town Island had generated more than 300,000 kWh of electricity, equivalent to the monthly consumption of 850 households. In addition, it had achieved a reduction of over 120,000 kg in carbon dioxide emissions.

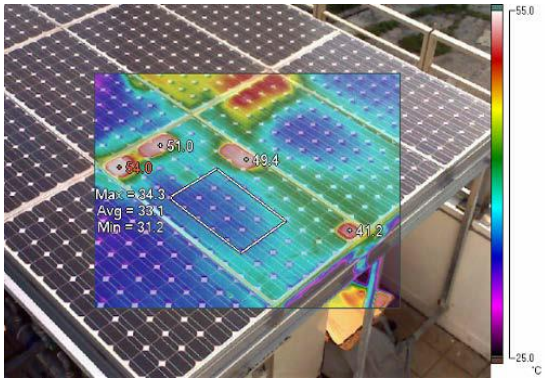
Previously, the drug rehabilitation center on Town Island used to rely on power generated by diesel generators that would function intermittently. Since the first phase of the RE system was commissioned in early 2010, the island has enjoyed a 24-hour uninterrupted electricity supply which powers the air-conditioner, fans, refrigerator and induction cookers, contributing to a marked improvement in the quality of life of the inhabitants.

CLP is confident the amount of electricity generated by the RE system will meet the future power demands of the island and support all the center's facilities, including new facilities being built under a redevelopment due for completion in 2016.

The Town Island project is a ground-breaking initiative for Hong Kong and provides the industry and academics with critical data and field experience of the use of RE in Hong Kong. CLP has worked with the University of Hong Kong and the Hong Kong Polytechnic University to research and analyze operational data from the Town Island system to see how the green technology might be deployed elsewhere in Hong Kong.

Solar Panel Inspection by Infrared Imaging

Solar panels last on average for around 25 years. However, their performance and efficiency can be affected by factors such as dust accumulation or the poor connection of panels. These issues cannot always be identified by visual checks, and the conventional inspection method involves detaching the solar panels which is time-consuming.



Since the completion of the first phase of the Town Island RE Supply Project in 2010, CLP has used infrared imaging (or thermal imaging) technology to carry out inspections of the solar panels. When solar energy is converted to electricity in a solar module in the solar panel, the process absorbs heat, resulting in a lower temperature for operating solar modules compared to malfunctioning ones. By comparing the temperature profiles of different solar cells based on the infrared images, engineers can analyze the conditions of the solar panels effectively and replace the malfunctioning panels where necessary.

Other than the standalone solar panel system on Town Island, the infrared imaging technology can also be applied to small-scale RE installations and grid-connected solar power generation system, making system inspection more convenient and efficient.

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Annex: Milestones of the Town Island RE Supply Project

Date	Event
1999	Operation Dawn applies unsuccessfully for a power supply due to a number of limitations.
2005	Operation Dawn applies for power supply for a second time in a proposal tied to its redevelopment plan.
Oct 2008	CLP decides to deploy RE to provide electricity to Town Island.
Q4 of 2008	Project planning is conducted.
Q1 of 2009	Network design and equipment procurement commence.
Aug 2009	Work begins on site.
Jan 2010	First phase of the project is completed and commissioned.
2010	Operational performance review is conducted.
Q4 of 2010	Planning of the second phase of the project, involving permit application and equipment procurement.
Q3 of 2011	Site work of second phase of the project commences.
Oct 2012	Construction of facilities is completed.
Jan 2013	System testing is carried out.
Apr 2013	Entire Town Island RE Supply Project is completed.
Apr 2013	Town Island project is chosen by The Hong Kong Institution of Engineers as one of the Hong Kong People Engineering Wonders in the 21st Century.
Jun 2013	Town Island project is presented with Platinum Award under the category of green energy development in the 7th Prime Awards for Eco Business 2013.