CLP

More than light

CLP's First Off-grid Commercial RE Supply Project for Dawn Island

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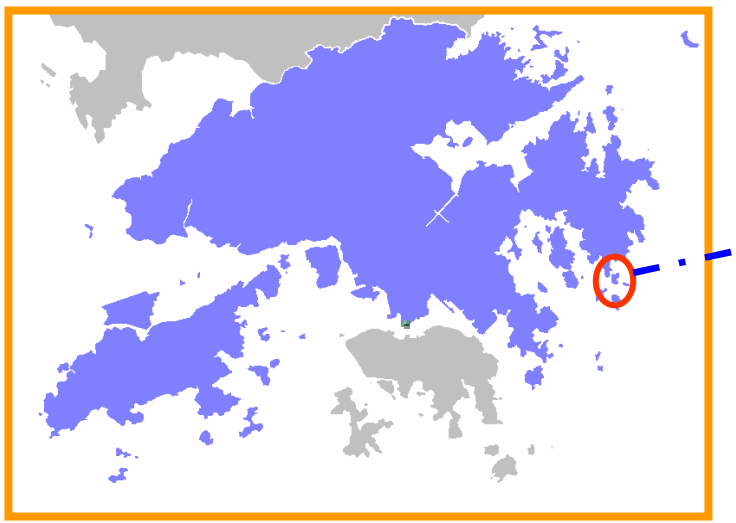
Agenda

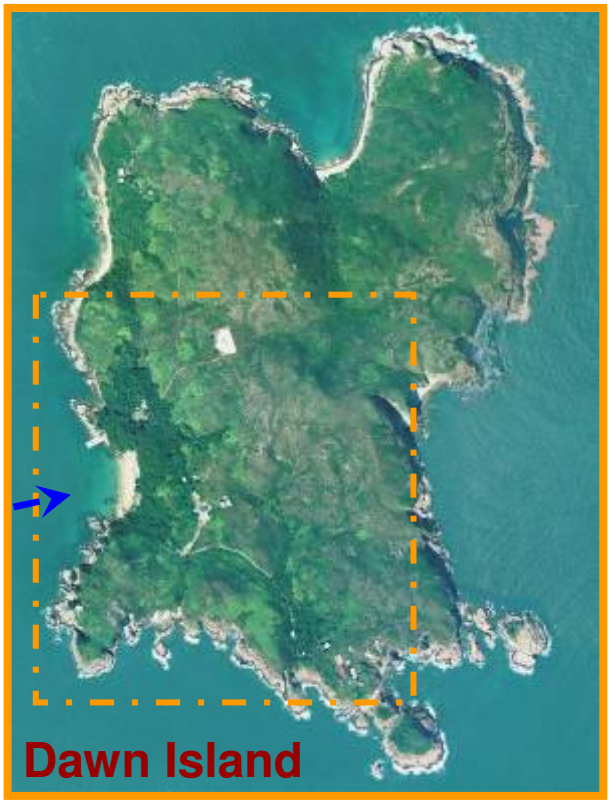
- Background
- Supply options & System Design
- Site Implementation & Safety Management
- Demand Side Management & Energy Efficiency
- Beyond Electricity Supply
- Looking Forward

Background

Where is Dawn Island?

- Also known as Town Island or Fo Tau Fan Chau
- Located at the southeast of Sai Kung High Island Reservoir
- Operation Dawn, a drug rehabilitation centre established there in 1976; they planned to carry out redevelopment to improve living conditions and facilities
- CLP to provide electricity supply to the island which has a known redevelopment plan





Background

- The drug rehabilitation centre provides treatment to 50-70 rehabilitants of different nationalities
- The island was powered by three diesel generators with fuel transported by sea
- When Operation Dawn applied for power supply in 1999, both options of supplying through submarine cable or overhead line could not be pursued due to respective disadvantages

Life without Proper Electricity

Project Objectives

- To uphold CLP's commitment to providing a reliable supply of electricity for every customer who needs it
- To realize CLP's core value of "Cares for the Community"
- To align with CLP's Energy Vision and the core value of "Cares for the Environment" by promoting the use of local RE

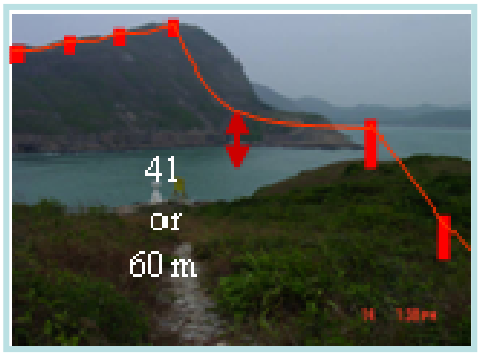
CLP's "Energy Vision"

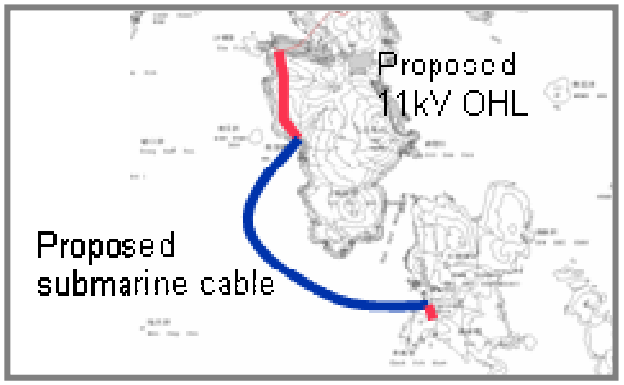
- **CLP outlines its vision for clean energy in "Energy Vision" for the next decade**
- **Major initiatives include**
  - Using more natural gas for local power generation
  - Importing more nuclear energy to meet base load requirements
  - Reducing reliance on coal to further cut emissions
  - Promoting local renewable energy sources
  - Promoting energy efficiency
- **Helping CLP Group achieve the following targets**
  - To increase non-emitting energy sources to 20% of the Group's total capacity by 2010
  - To reduce CLP's CO2 intensity by 75% by 2050

As early as in 2004, CLP set a voluntary target to have 5% of its total generating capacity come from renewable energy sources by 2010 and we have exceeded substantially with RE accounting for over 15% of our generation portfolio as of Jun 30 2010.

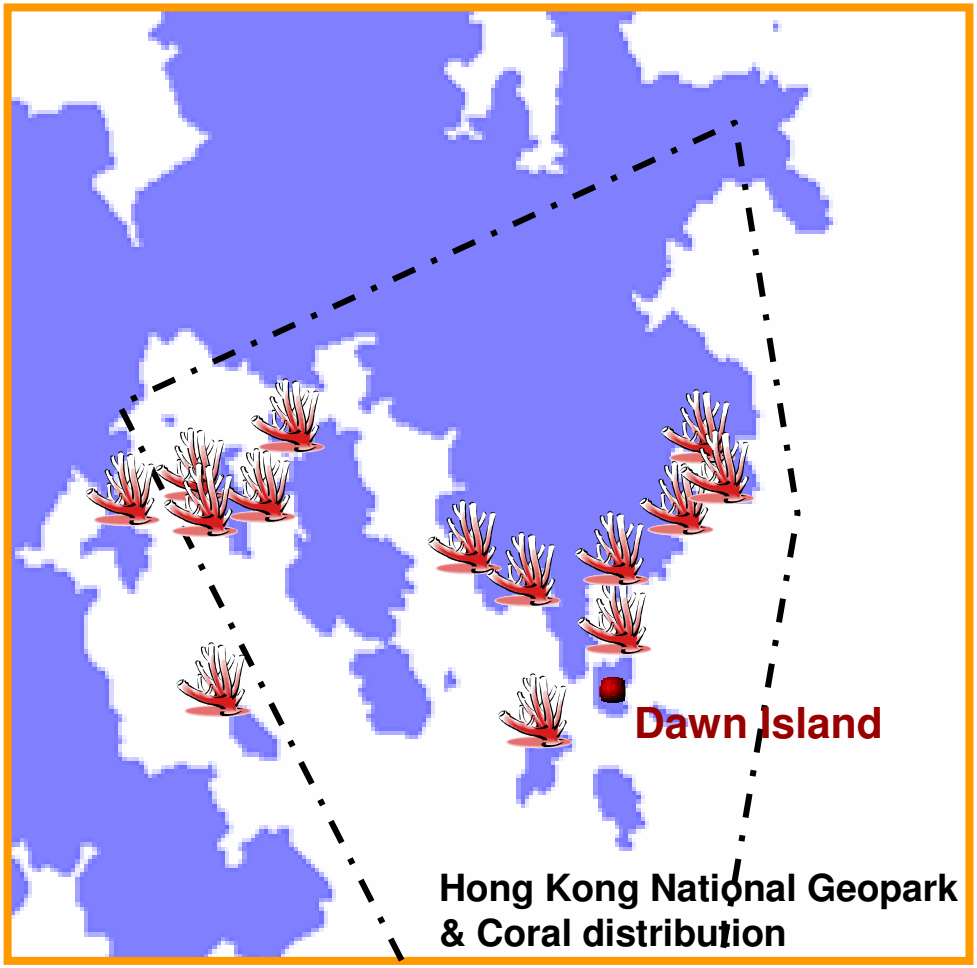
Supply Options

- Overhead line
- Submarine cable
- Bio-diesel generator
- Photovoltaic system
- Wind system
- Ocean





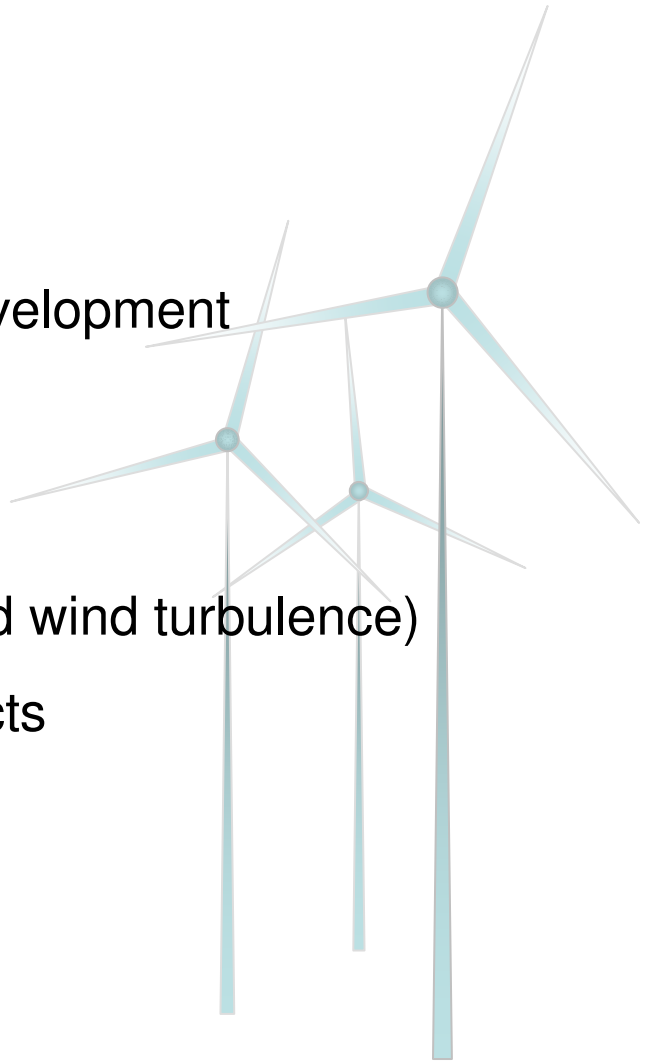
Why Renewable?



- **Submarine Cable Option**
  - Impact on undersea corals
- **Overhead Line Option**
  - Visual intrusion
  - Marine navigation safety
- **Bio-diesel Generator Option**
  - Diesel transportation & storage
  - Monthly maintenance
  - Noise & Air pollution

Renewable Energy System Selection

- **Ocean Option**
  - Limited knowledge on ocean resources
  - Uncertainties with the ocean technology development
- **Wind Power Option**
  - No on-site wind resources data
  - Complex landscape (wind turbine sitting and wind turbulence)
  - Uncertain aviation and environmental impacts
  - Higher maintenance requirement



Why Solar Energy?

- Clean and green energy
- Technology has become more mature
- Ample space on the island favors the installation of solar panels
- No obstruction to sunlight
- Hybrid sources of solar and wind energies could enhance the effectiveness of system and meet the ultimate electricity demand of the island
- More cost effective than submarine cable
- Align with CLP's move towards renewable energy development

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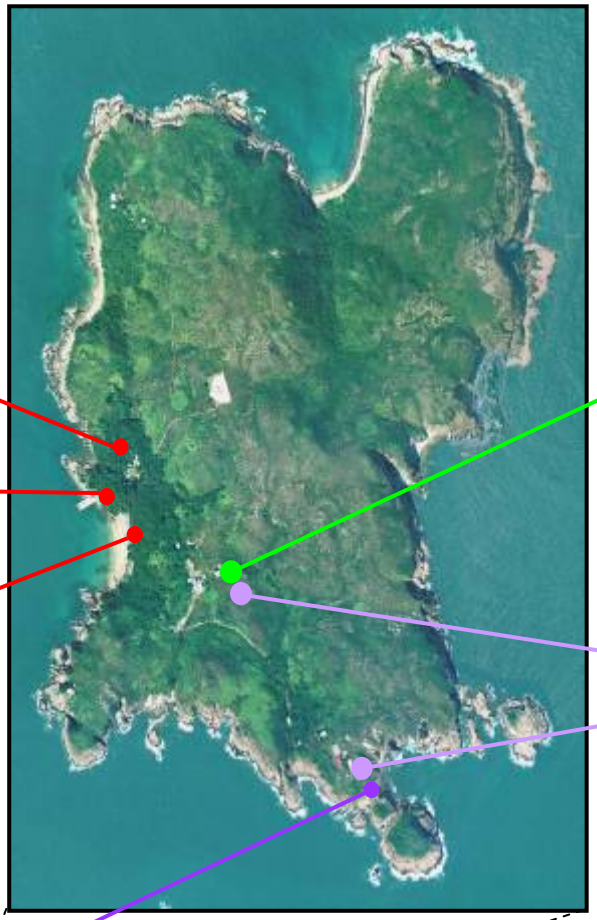
Farmland

Church

Rehabilitation Center



New hostels to be built in Dawn Island Redevelopment Project

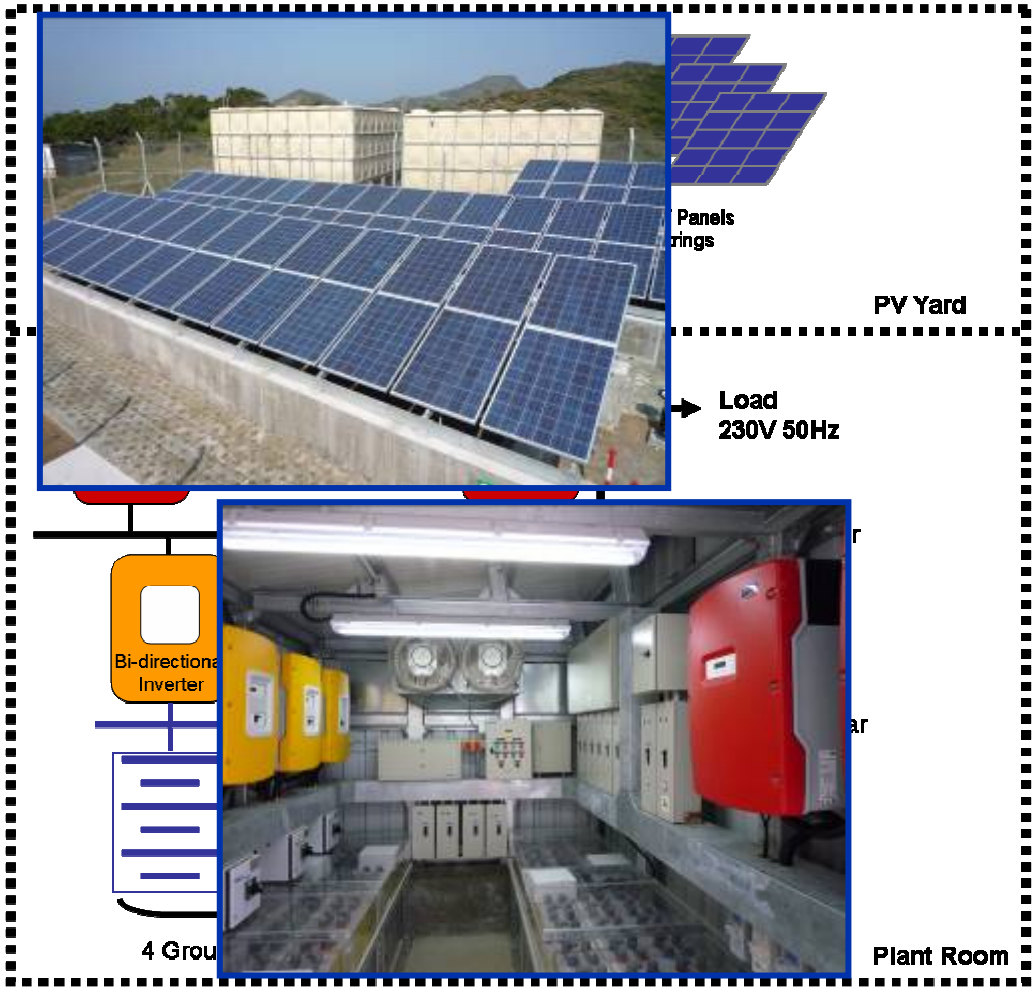
Stage 1:
99 x PV Panels

Stage 2:
Estimated 800 x PV Panels &
2 x Small Wind Turbines

Project Milestones

- Jan 2009 – Project Team & Steering Committee formed
- Mar 2009 – Tendering
- Jun 2009 – Reach Out to EPD and EMSD
- 3 Jul 2009 – Stage 1 Tender Awarded
- 9 Aug 2009 – Stage 1 Work Commence
- Sep 2009 – Erection of PV Panel Foundation
- Oct 2009 – 100 x PV Panel Installation Plant Room Construction
- Dec 2009 – T&C for Stage 1
- 13 Jan 2010 – Power On for Stage 1
- Oct 2009 – Jan 2010 – Voluntary Services to Dawn Island
- Jul 2009 – Environmental Impact Assessment - Stage 2 starts
- Q1 2010 – Stage 2 Environment Permit Application
- Q3 2010 – Stage 2 Land Handover to customer
- Q3 2010 – Tender Award for Stage 2
- Q4 2010 – Stage 2 Building Permits Application
- Q2 2011 – Stage 2 Work Commences
- Q2 2011 – Foundations & Plant Rooms Construction
- Q3 2011 – 800 x PV Panel & 2 x WT Installation
- Q1 2012 – Power On for Stage 2 - Carmel
- Q1 2012 – Power On for Stage 2 - Living Spring

Stage 1



- **PV Panels**
  - 99 units in 6 Strings
  - 200W(peak)
- **System Output (utility standard)**
  - 19.8kW(peak)
  - 220V +/- 6%
  - 50Hz +/- 2%
- **Nominal Battery Capacity**
  - 184kWh

Stage 1

CO2 Reduction since Jan 2010: 7,550 kg

System Performance

Accumulated System Output: 13,480 kWh
System Efficiency: 9.09%

Aligned with plan!

- **Challenges**
  - First installation of this kind in HK
  - Needs system enhancement by fine-tuning the charging cycle
  - Intermittence and unpredictability of solar/wind resources to meet utility reliability standard

Stage 2

Carmel Hostel

- **PV Panels**
  - Total 120kW(peak)
- **Wind Turbine**
  - Total 6kW(peak)

Living Spring Hostel

- **PV Panels**
  - Total 60kW(peak)
- **Wind Turbine**
  - Total 6kW(peak)

Total Output: 192kW(peak)
Expected Annual CO_2 Reduction: 70,000kg p.a.

Civil Design Considerations

- Strong wind loading
- Salty environment
- Site orientation and topography
- Minimum excavation and disposal
- Reduce on site machining and welding
- Use of solar bollard lighting
- Vegetation management
- Recycle and Reuse

Recycle & Reuse – Grass Paving Blocks

Excavated materials during construction

+

Excess grout

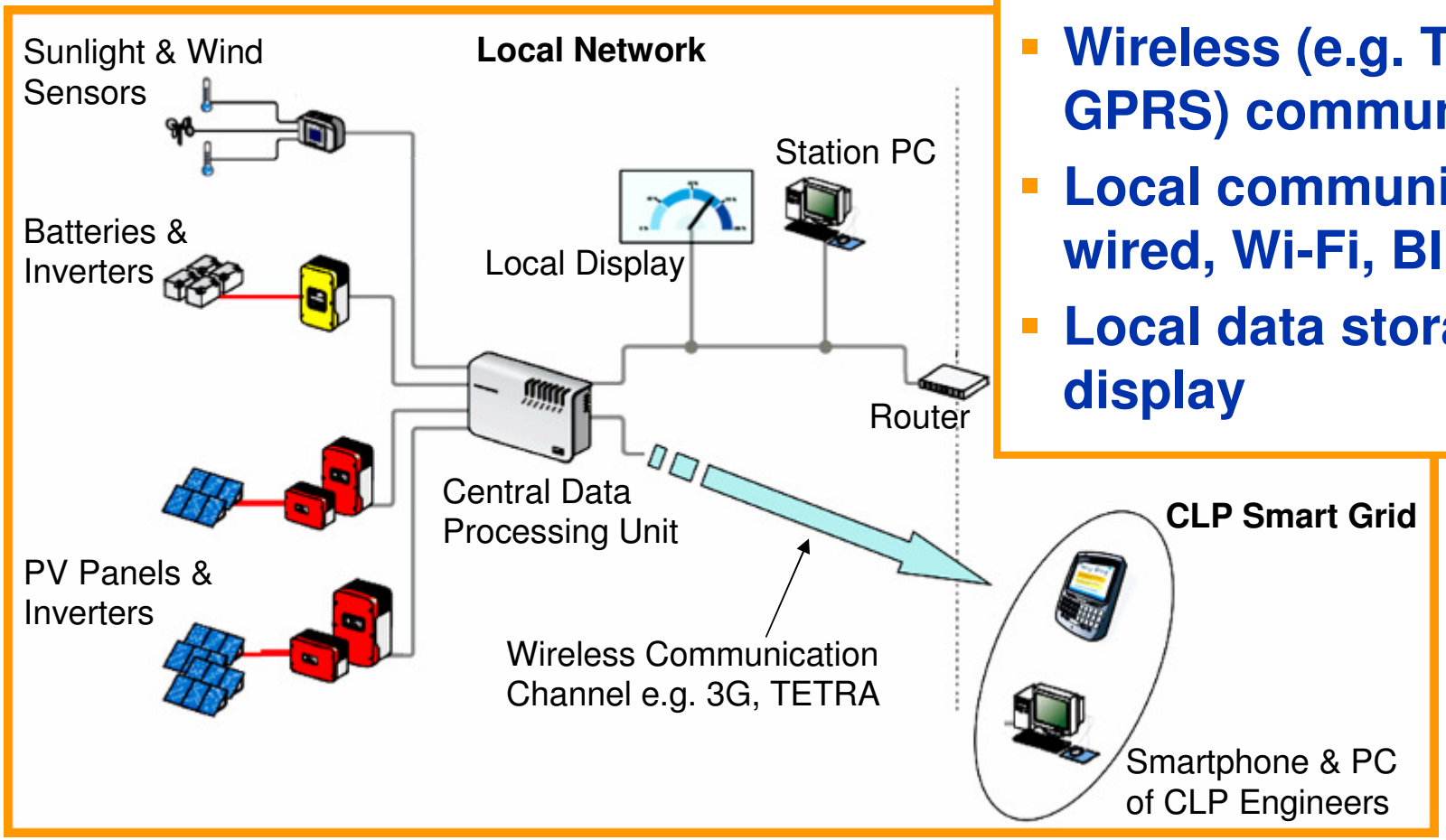
Mixing

Molding

Grass paving block

Telemetry, Remote Monitoring & Control

- Fix-line communication network not available
- Wireless (e.g. TETRA, GPRS) communication
- Local communication by wired, Wi-Fi, Bluetooth
- Local data storage & display



Site Implementation

Site Survey & Material Delivery

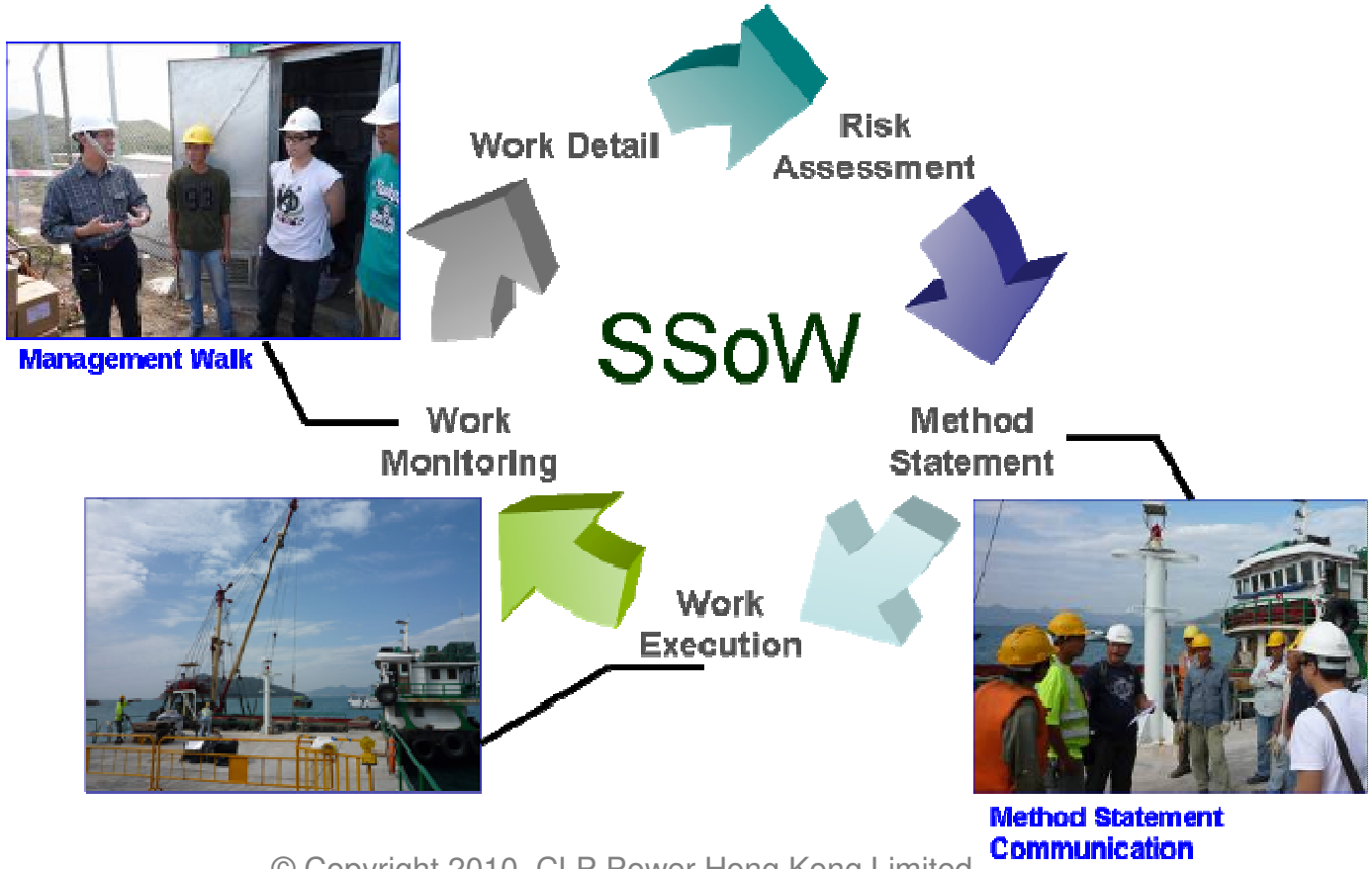
Stage 1 completed in 5 Months

PV Supporting Frame & Plant Room Construction

RE Equipment Installation & Site Testing

Safety Management

- Safety is always our No. 1 Priority
- Implemented the Safe System of Work (SSoW)
- Achieved Zero Incident in Stage 1



Demand Side Management & Energy Efficiency

- **Customer Background**
  - Controlled environment
  - High mobility
  - Self-maintained electric system

- **Difficulties**
  - Electricity using habit change
  - Aged and defective appliances
  - Load growth due to redevelopment

Demand Side Management & Energy Efficiency

- **Objectives**
  - Improve energy efficiency
  - Optimize system performance
  - Improve residents' habit on using electricity
- **Actions**
  - Replacing defective and aged electric appliances
  - Reducing power consumption at night by using timer switches and sensor switches
  - Educating the residents with safety and power-wise tips on using electricity
  - Sending out alert alarms at low battery capacity
  - Providing advices on electric appliances selection for future development

Beyond Electricity Supply
- Corporate Citizenship

- **Care for the Environment - Promote the use of RE**
  - Reduces 70,000kg of CO_2 emission each year
  - Being Hong Kong's first commercial standalone RE project using solar energy as the main power source, the project demonstrates the applicability of RE in the territory
  - Provided a platform whereby experience and data can be collected to support further research into the potential of wider applications of RE in the market
  - Offered a real-life example of renewable energy in practice, which serves as a platform for RE education outside the classroom
  - Promoted demand side management and energy efficiency
  - Full compliance with EIAO

- **Care for the Community**
  - Supported an NGO on drug rehabilitation by providing a low cost, reliable electricity supply
  - Volunteer services on Dawn Island
  - Financed research projects for development of RE system

Research Projects

- Currently supporting three research projects proposed from two local universities
- Research scope cover smart grid modeling, statistical analysis on RE system performances and RE supply option for remote island
- CLP provides funding, data and engineering inputs to these three research projects
- All research projects have started in Sep/Oct 2010 and would last for one to two years
- Research findings would be shared with the public to enhance HK's knowledge on these subjects and facilitate further development of RE in HK

Looking Forward

- Ride on Stage 1's experience, Stage 2 has commenced and will be completed by Q1 2012
- Develop Smart Grid to optimize the system performance
- Explore the opportunity to optimize the energy consumption (Community-based supply system)
- Utilize the RE system for education on CLP's website
- Collect data from the wind turbines installed to look for opportunity for the development of an optimal scale of wind / hybrid energy system

Supplementary Slides

Selection of PV Panels

Selection Criteria

- Cost
- Level of technology sophistication
- Robustness
- Supply availability

Poly Crystalline Silicon solar panels selected

PV Panels installed at Dawn Island

Volunteer Services

- **Scope of service**
  - ➢ Inspect customer installations on the island
  - ➢ Plan and design customer installations to support the operation of the RE system
  - ➢ Work with rehabilitants to improve supply installations
  - ➢ Provide training to the rehabilitants on power safety & basic principles of electricity so that they could apply when they work in society

- **Volunteer background**
  - ➢ 120 volunteers are involved, including CLP staff and their families working on weekends

Stage 1 – Challenges of PV design

- Output voltage balancing among PV panels within a PV array
- Output voltage matching between PV arrays and inverter system

Only MPP Voltage matched

Configuration (Module x String)
= 12 pcs x 8 strings
Total No. of Modules: 96 pcs

PV Peak Power: 19.20 kW
Est. Daily Energy Yield: 49.77 kWh

MPP Voltage, Temp. Coefficients matched

Configuration (Module x String)
= 16 pcs x 6 strings
Total No. of Modules: 96 pcs

PV Peak Power: 19.20 kW
Est. Daily Energy Yield: 66.90 kWh

34.4% Higher!