July 2010

DEVELOPMENT OF RENEWABLE ENERGY PROJECTS IN HONG KONG

Hongkong Electric's Experience

RENEWABLE DEVELOPMENT POLICY

- In 2005, the Government announced a renewable development policy to have 1 to 2% of the total electricity generation in HK coming from renewable energy by 2012.
- In September 2010, the Environment Bureau launched a public consultation on Hong Kong's Climate Change Strategy & Action Agenda, in which a target of 3 to 4% renewable energy, including IWMF, by 2020 has been set.
- In recent years, HK Electric has been embarking on developing renewable energy projects in HK, focusing on wind and solar energies.

WIND ENERGY

The “Lamma Winds” Experience

- Developed by HK Electric, the “Lamma Winds” is the 1st commercial scale wind turbine in HK. It is a 800kW wind turbine commissioned in February 2006 as a demonstration project.

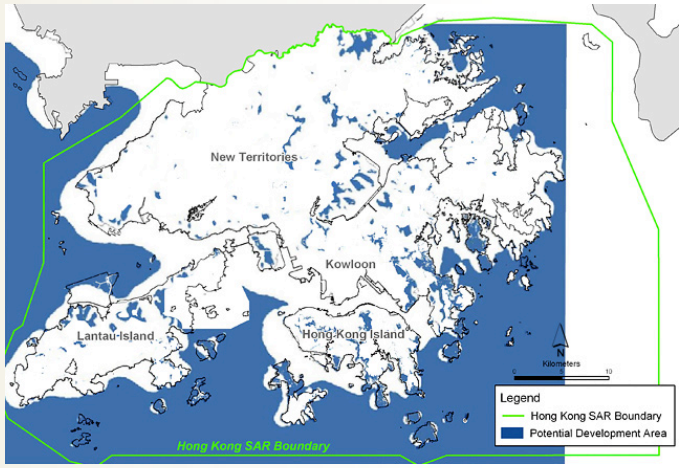
- Average capacity factor (2006 – 2009):

2006	11.6%
2007	12.4%
2008	11.5%
2009	15.7%

Offshore Wind Farm

- The “Lamma Winds” experience reveals the lack of wind potentials in the land terrains in HK.
- Besides, there is also lack of large flat land in HK for development of onshore wind farms.
- Wind potentials of offshore sites are much higher. Feasibility studies were then focused on identifying a suitable offshore wind farm site.

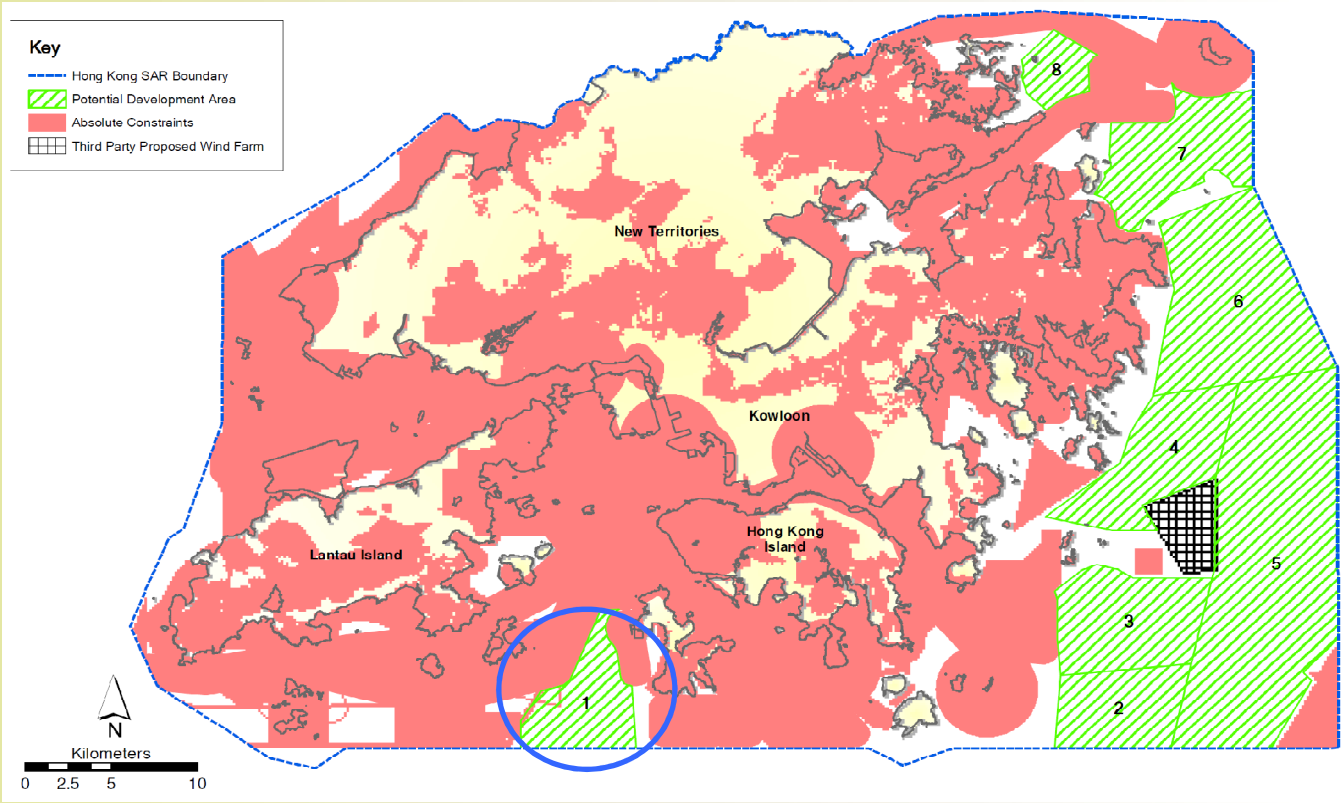
Hong Kong Map



Areas with Adequate Wind Resource for Development of Wind Farm

Site Search

- 8 short-listed offshore sites have been reviewed.
- South West Lamma is the most preferred site for offshore wind farm development.



Advantages of SW Lamma Site

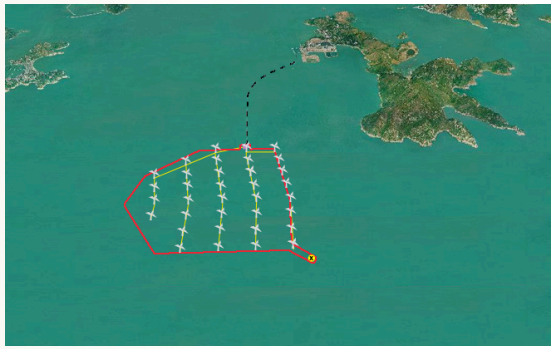
- Least environmental impact
- Merits in technical & geographical aspects:
  - Shorter transmission cable
  - Utilization of LPS for logistics support during construction
  - Shallower water compared with Eastern Offshore sites
- Lower total costs

Environmental Impact Assessment

- Detailed EIA studies on SW Lamma Site commenced in mid 2008
- The studies covered impacts on water quality, terrestrial ecology, marine ecology, landscape and visual, fisheries, and other aspects.
- Report findings:
  Environmental impacts are light to moderate. The impacts are acceptable after suitable mitigation measures are implemented.
- The EIA Report was approved by EPD on 14 May 2010, and an Environmental Permit was issued to HK Electric on 8 June 2010.

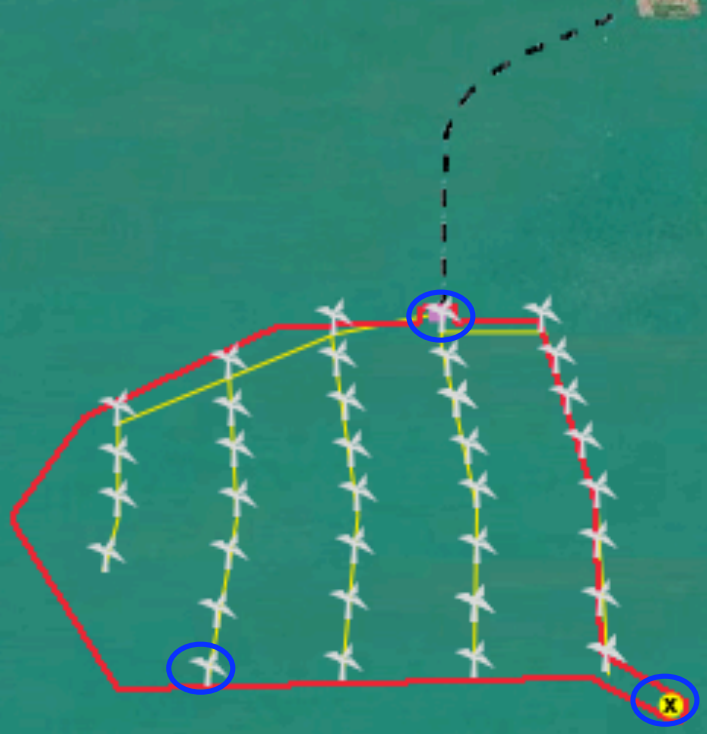
General Information of Offshore Wind Farm

Location	4 km Southwest of Lamma Island
Capacity	About 100 MW
No. of Wind Turbine	28 – 35 nos.
Wind Turbine Capacity	2.3 – 3.6 MW
Hub Height	About 80m above mean sea level
Site Boundary Area	600 Ha
Water Depth	17 – 22 m



Components of Offshore Wind Farm

Wind Turbine



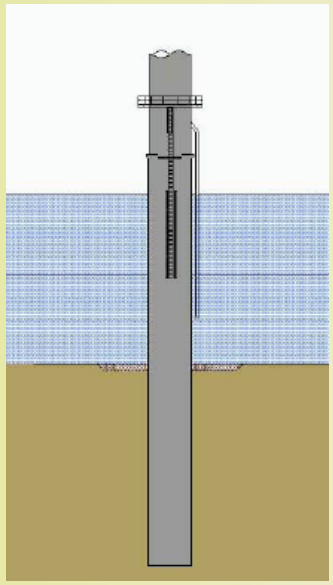
Substation

Wind Monitoring Mast

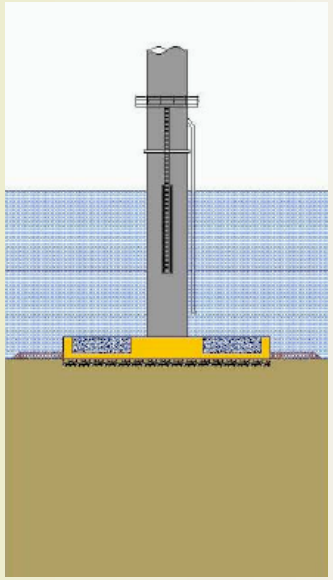
LIDAR System on offshore platform

Wind Turbine Foundation

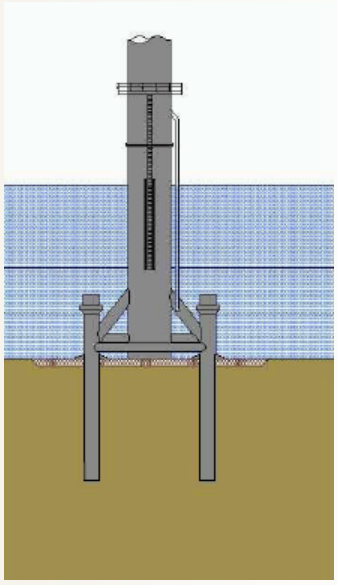
- Following types of foundations are technically available for offshore wind farms:-
- Monopile and gravity based foundations are mostly adopted in existing offshore wind farm installations.



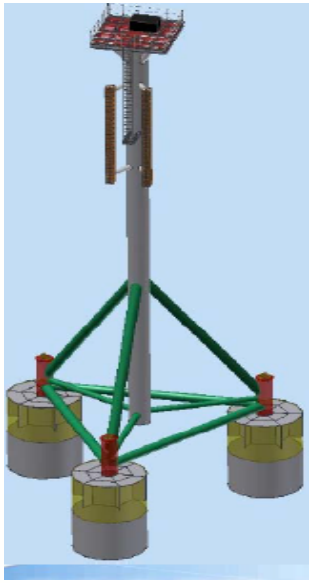
Monopile



Gravity Base



Tripod



Suction Caisson

Wind Turbine Foundation

EIA concludes that mono-pile is an acceptable type of foundation for SW Lamma Offshore Wind Farm

- No waste generated, better environmental performance
- Commonly adopted in other offshore wind farms in Europe
- Proven mitigation measures related to the management of underwater sound impacts
- Shorter construction time

Wind Turbine Size

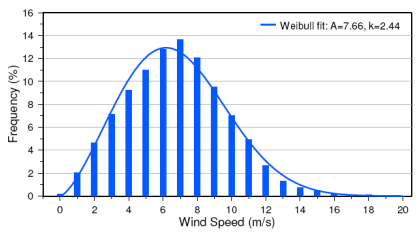
- Sizes of the major offshore wind turbine models are listed below:

Supplier	Model	Capacity (MW)	Rotor Dia (m)	Cut-in / Cut-out / Rated Wind Speed (m/s)
Vestas	V90-3.0MW	3	90	4 / 25 / 15
Siemens	SWT-2.3-82	2.3	82	3.5 / 25 /13
	SWT-3.6-107	3.6	107	3-5 / 25 / 13-14
GE	4.0	4	110	3 / 25-28 / 14
Sinovel	SL3000	3	91.3	3.5 / 25 / 13
RE Power	5M	5	126	3 / 30 / 13

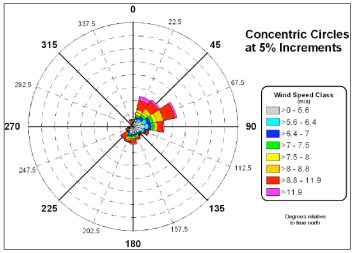
- Offshore wind turbines with capacities in the range of 2.3MW to 3.6MW have been widely installed in Europe and hence is adopted for the EIA study.

Wind Monitoring

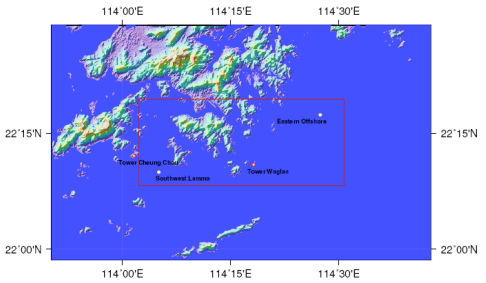
- Desktop studies based on historical wind data archive indicated that the average wind speeds at the wind farm site ranged between 6.8-7.1m/s.
- IEC Class 1A wind turbine models will be adopted to withstand typhoon condition with a maximum gust of 70m/s for a consecutive period of 3 second.
- The next stage is to carry out in-situ wind data collection by installing a LIDAR System at the wind farm site to facilitate detailed engineering design and wind farm optimization.



Wind Speed Distribution



Wind Rose

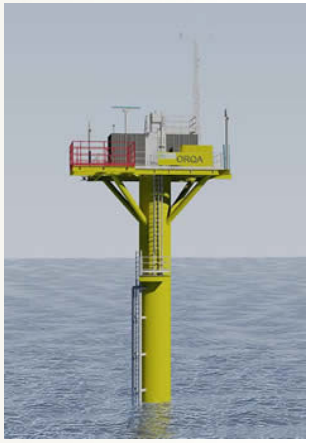


Wind Resource Map

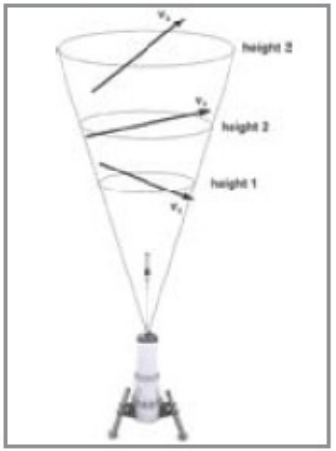
Wind Monitoring – LIDAR System

Advantages of LIDAR System

- Capturing meteorological data by measuring the Doppler shift of the laser beam scattered by microscopic airborne particulates.
- High portability suitable for adopting as temporary installation for 1 year wind monitoring.
- Design requirement for temporary foundation platform will be far less stringent leading to a substantial reduction in foundation cost.



LIDAR System on offshore platform



LIDAR Technology

Wind Turbine Installation

- Pre-assembly in Lamma Power Station
- Jack-up barge for wind turbine installation
- Crane vessel for full assembly installation

Pre-assembly Harbour

Jack Up Barge

Crane Vessel

Wind Farm's Environmental Benefits

- Estimated annual generation of around 170 million units of electricity, enough energy for around 50,000 families in HK
- No fuel required, thus offsetting use of around 62,000 tonnes of coal per annum
- Reduce 150,000 tonnes of carbon dioxide emission per annum
- Reduce 520 tonnes of sulphur dioxide emission per annum
- Reduce 240 tonnes of nitrogen oxide emission per annum

Offshore Wind Farm – Commissioning Schedule

- One-year onsite wind monitoring will start in 2011.
- Tentative commissioning year is 2015.

Lillgrund Wind Farm in Sweden

SOLAR ENERGY

- As a pilot project for the Shenzhen Hong Kong Innovative Circle, DuPont Apollo established a plant in Shenzhen for manufacture of Thin Film Photovoltaic (TFPV) panels in 2008.

- HK Electric is the first customer to place order for a commercial scale TFPV system in November 2009.

The Lamma TFPV System

- 5,500 panels each sized at 1.4m x 1.1m
- Rated output of each panel is 100Wp
- Total capacity 550kW
- To be installed at the Lamma Power Station roofs
- The largest PV system in HK

Advantages of amorphous silicon (a-Si) TFPV

- Less energy use for production

  Energy payback time for a-Si TFPV is about 1.5 year (c.f. about 2.5 years for c-Si module)

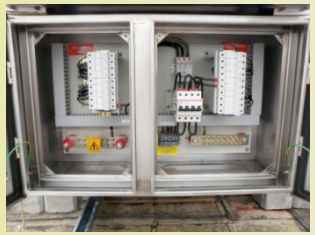
- More suitable in tropical environment

  Temp. coefficient for Pm of a-Si TFPV is about - 0.25% / ºC rise (c.f. about -0.4 % / ºC rise for c-Si module)

- Better weak-light performance

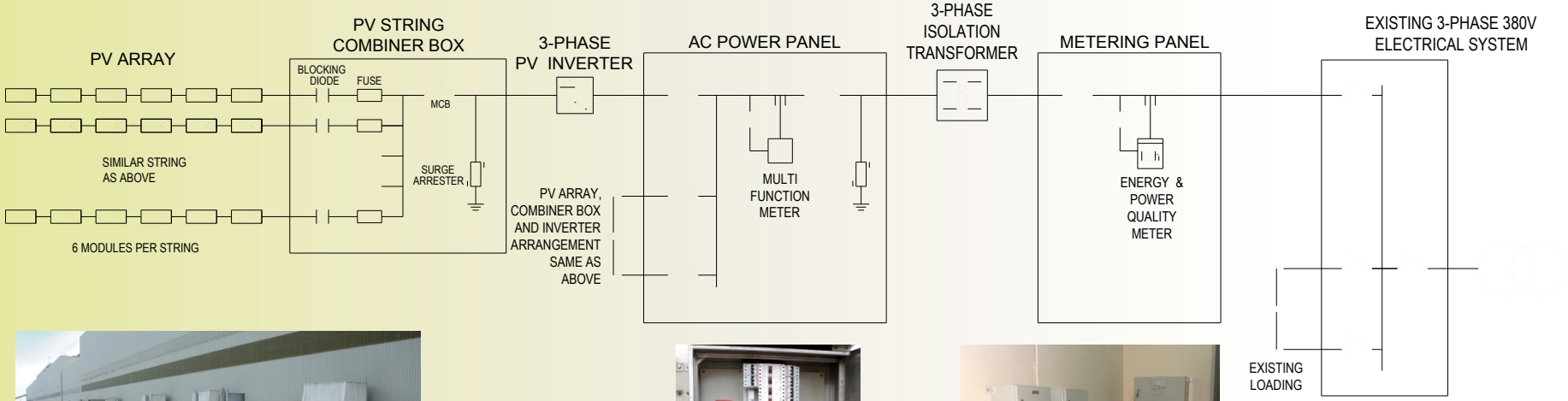
  Naturally, high shunt resistance of a-Si TFPV maintains module efficiency at low irradiance

Major Components of the PV System



- Automatic grid connection
- With Maximum Power Point Tracking (MPPT) control
- Anti-islanding Protection

- Energy Meter
- Power Quality Analyzer



Remote Monitoring System

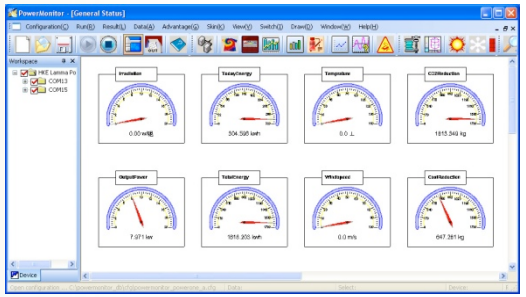
- Solar Irradiance
- Ambient Temperature
- Module Temperature

- PV Inverter Status

- Energy Meter
- Power Quality Analyzer

Remote Monitoring Computer at Central Control Room

PV System Overview



Individual Equipment Monitoring

Construction

100,000 metres of cables and cable supports

47 PV inverters, **47** combiner boxes, **25** Electrical and instrument panels

250 Ton crane for lifting of materials to EL+80.15m roof areas

Construction

Units 1-3 Boiler House Roof

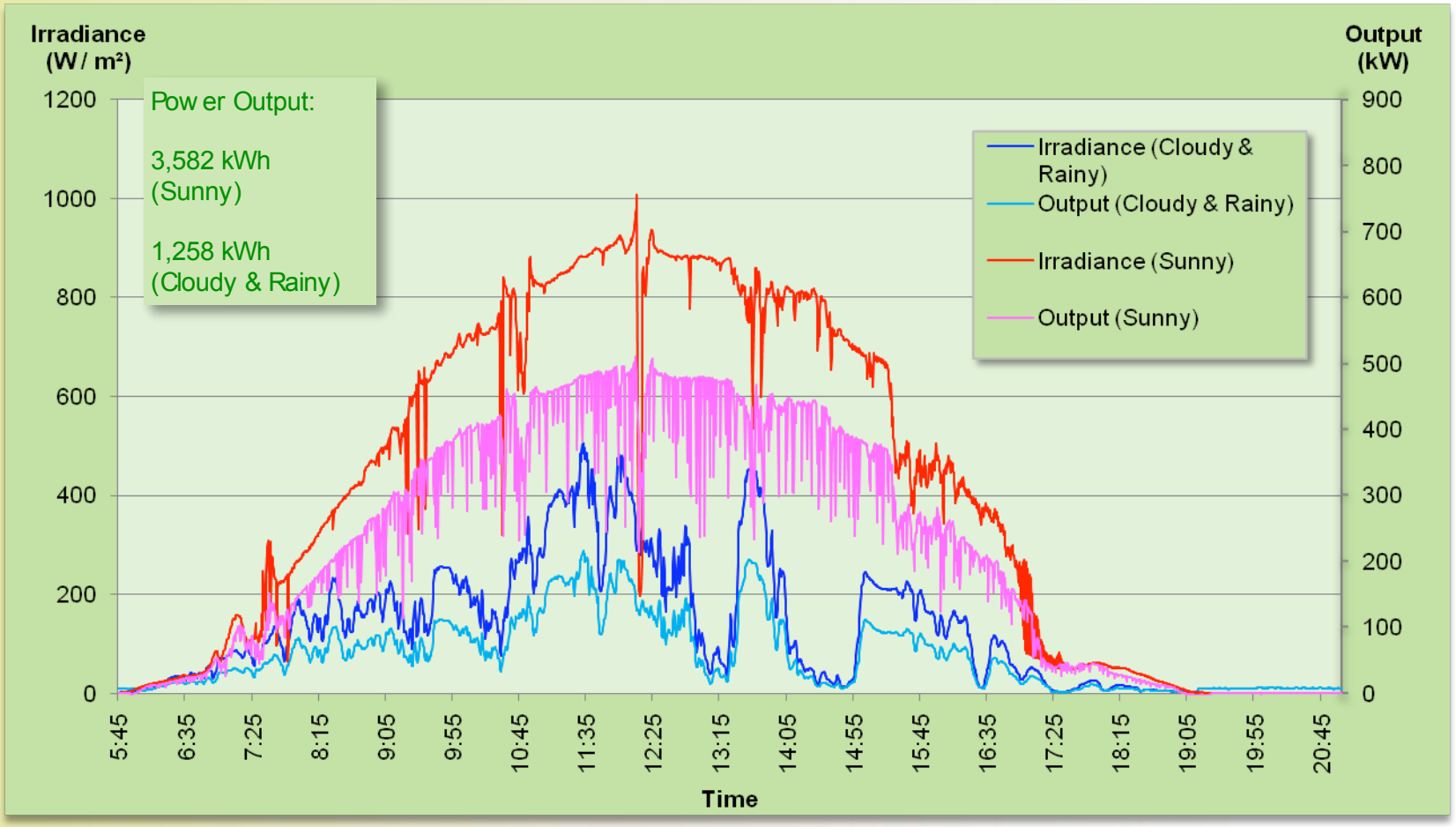
Before

After

Project Programme

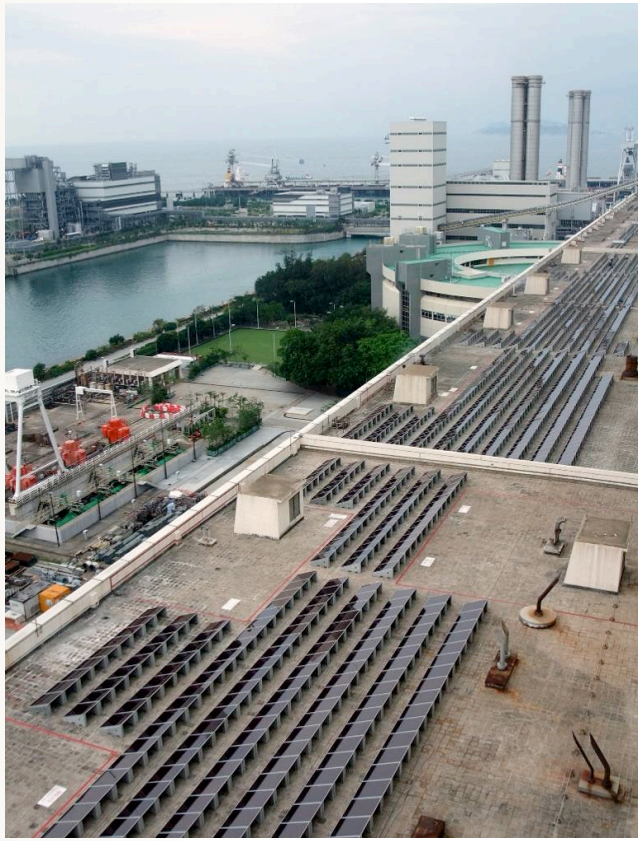
- 4 ~ 9/2009 — Feasibility Study
- 10 ~ 11/2009 — Request for Offer & Assessment
- 12/2009 — Order Placing
- 4 ~ 6/2010 — Construction, testing & commissioning
- End 6/2010 — Total Completion

Power output in response to solar irradiance variation



Plant Performance

	Design	Actual
Capacity	550kW	550kW
Annual Output	620,000kWh(*)	320,248kWh(**)
Capacity Factor	12.9%	18.24%(**)
Design Life	20 years	20 years



(*) Adequate for consumption of 150 families

(**) From 1/7/10 up to 11/11/10

Environmental Benefits

- Zero emissions
- Reduce **520 tons** of **CO_2** per annum
- Equivalent to planting 22,000 trees

Lamma 550kW Solar PV System
– The Largest Solar Power System in HK

Thank You