Hong Kong Offshore Wind Farm in Southeastern Waters

Project Profile

April 2006

WIND PROSPECT

Prepared with the assistance of
BMT Asia Pacific Limited

Cover Photos:
Top left – Maintenance on a turbine nacelle, (courtesy of Vestas)
Top right – Nysted 165MW offshore wind farm, Denmark (courtesy of EnergiE2)
Bottom left – Specialist wind turbine installation vessel (courtesy of Elsam)
Bottom right – Maintenance staff arriving at Horn Rev offshore wind farm, Denmark (courtesy of Elsam)

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1 BASIC INFORMATION

1.1 Project Title

Hong Kong Offshore Wind Farm in Southeastern Waters.

1.2 Purpose and Nature of the Project

1.2.1 Purpose

HK Offshore Wind Limited, a 100% subsidiary of Wind Prospect (HK) Limited is proposing to install a wind farm in offshore Southeastern Waters of Hong Kong as a source of renewable energy.

The proposed Wind Farm will provide benefits in addressing the following issues:

Combating Climate Change

"*One of the great challenges facing mankind is the increasing temperature of the planet. This increase is believed to be associated with the production and consumption of carbon based fuels – coal, oil and gas*" – BP* [oil major]

- The 1990s were the warmest decade globally over the past millennia.†
- Global carbon dioxide concentrations have risen by 30% since the 18th century and are now increasing by 1% per year.‡

Evidence indicates that the recent rises in global temperature are a result of the increase in greenhouse gases like carbon dioxide in the atmosphere and that these increased levels of carbon dioxide are due to human activities, principally the burning of fossil fuels for electricity and transport. The use of renewable energy (RE), along with cleaner sources of traditional energy, can help slow down climate change.

Wind power is a clean source of electricity generation, there are no emissions produced by a wind turbine during its generation of electricity. Therefore when electricity is produced by a wind turbine an equivalent amount of electricity is not produced using traditional power generation methods which would emit greenhouse gases. The energy required to build a

* *http://www.bp.com/sectiongenericarticle.do?categoryId=9002327&contentId=3072035*

† *Presentation by Dr. David Viner, Climate Research Unit, University of East Anglia, February 2002*

‡ *Presentation by Dr. David Viner, Climate Research Unit, University of East Anglia, February 2002*

wind farm is typically recovered in the first year of its operation, so it has a clear net positive effect on greenhouse gas emissions.

For *every year* of operation, the proposed Offshore Wind Farm would offset approximately 188,000 tonnes of carbon dioxide.* This would be equivalent to some 3.7 – 4.6 million tonnes of carbon dioxide over its 20-25 year lifetime, or a saving of approximately 100,000-125,000 lorry-loads of coal equivalent carbon dioxide.

Every year of wind farm operation would also offset approximately:†

- 595 tonnes of Sulfur Dioxide
- 265 tonnes of Nitrogen Oxides
- 22 tonnes of particulate material

Energy Diversity and Security

"*It is a global wish and common responsibility to take right action to cope with challenges posed by environment and energy as well as to achieve sustainable development*" – Hu Jintao, President of the People's Republic of China, November 2005.

In recent years the Hong Kong utilities have diversified from coal and oil into natural gas and nuclear power. This diversification of power sources has improved long term energy security and given Hong Kong one of the most reliable electricity supplies in the world. This is very important because Hong Kong's reputation, quality of life, and ability to attract investment depend on having uninterrupted and affordable power. As Hong Kong is limited in its natural resources, offshore wind power can play a significant role in increasing the diversity of power generation.

Wind Energy is a secure energy source as there is no need to import raw fuel material, and it is totally renewable. Wind power can be an important source of electricity generation even though the wind itself cannot be controlled in an instantaneous fashion. This is because, until the penetration level of wind on an electricity network reaches 10% or more, it can be readily absorbed by most networks‡.

Supporting Government Policy and Sustainable Development

"*We are willing to take up our share of responsibility in combating climate change*" – Dr Sarah Liao, Secretary for the Environment, Transport and Works HKSAR, January 2005.§

** Based on CLP carbon intensity in 2004, CLP Annual Report 2004*

† Based on CLP emission intensities in 2004, CLP Annual Report 2004

‡ www.bwea.com

§ http://www.info.gov.hk/gia/general/200501/25/0125247.htm

The First Sustainable Development Strategy for Hong Kong was released in May 2005 and was produced by the Council for Sustainable Development, Chaired by the Hon. Donald Tsang, Chief Executive of Hong Kong.

After a comprehensive analysis of what sustainable development meant for HK, including investigating potential for RE deployment, it concluded that a strategic objective for HK would be to aim for between 1% and 2% of Hong Kong's total electricity supply to be met by power generated from renewable sources by the year 2012.

By aiming to generate approximately 0.7% of HK's electricity requirements using RE before 2012, the proposed development is very much in line with the Governments Sustainable Development Strategy and would be a significant boost to HK's chances of meeting this objective.

In early 2005 China adopted a new Renewable Energy Promotion Law to encourage increased use of RE in China. In November 2005 Mr. Zeng Peiyan, Vice Premier of the State Council, P.R.China announced that the Government had set a target of achieving 15% of power generation to be from RE by 2020[*]. RE development is therefore also a wider policy aim in the region.

Increasing Investment Opportunities

"*Goldman Sachs believes that wind and other renewable forms of energy will become an increasingly important part of the world's energy mix*," Henry M Paulson Jr, Goldman Sachs' chairman and CEO, April 2005.

The proposed development would represent a major investment in the local economy and would create many jobs during both the construction phase and during the 20-25 year life of the project.

Renewable Energy is the fastest growing power generation technology in the world. Aside from the investment of the project itself, the development could stimulate the creation of renewable energy related industries and services in Hong Kong.

Increasing Community Awareness & Meeting Expectations

Local interest in RE development has risen sharply in recent years, much as it has throughout the world. HK based environmental groups and the general public have been very supportive of efforts to promote RE in the region. For example, Friends of the Earth

** Mr. Zeng Peiyan, Vice Premier, State Council, P.R.China, Key note remarks at Beijing International Renewable Energy Conference 2005,* (HK) has led on the formation of a Renewable Energy Network for HK, whilst Greenpeace China has recently commissioned "Wind Guangdong", a comprehensive study of wind potential in the province.

CLP and HongKong Electric have also promoted RE in the region and have demonstrated regional leadership in the field. This is reflected in the single turbine projects that have been undertaken in HK to locally pilot this technology, and CLP's ambitious voluntary target of sourcing 5% of their generation worldwide from RE by 2010; an unprecedented commitment in the region.

Unfortunately, HK has a relatively poor onshore renewable energy resource, and land is either: already developed, protected from development, or simply ill suited to RE technology on a large scale. Offshore there is more usable space; and of the technologies available offshore, wind power is the most commercial that would allow development on a large scale; although challenges associated with offshore wind power development exist.

By having an offshore wind farm Hong Kong would benefit in the following ways:

1. *Energy Diversity and Security*: A large offshore wind farm would diversify Hong Kong's energy supply, and as its penetration on the electricity network would be below 10%, it would not affect the current world-class level of reliability.

2. *Environmental Benefits*: The offshore wind farm would not produce any emissions during its operation, and would offset emissions from existing thermal power plants. This would contribute to improvements in local and regional air quality.

3. *Project Development Schedule*: An offshore wind farm located within Hong Kong enables defined project development under a single jurisdiction with clear policy and regulations applicable to infrastructure built in HK.

4. *Economic Benefits and Job Creation*: Constructing an offshore wind farm in Hong Kong would comprise a major investment in Hong Kong and would, additionally, provide a significant number of construction and engineering jobs for Hong Kong. It could also serve as a platform for Hong Kong to position itself at the forefront of one of the fastest growing technology sectors in the world.

1.2.2 Nature

The Hong Kong Offshore Wind Farm will consist of up to fifty turbines, each with a rated capacity of approximately 3MW. This will provide a maximum output of approximately 150MW of electricity.

The Wind Farm will be linked by collection cables that collect electricity from the various turbines, and via an offshore transformer, for transmission to shore.

1.3 Name of Project Proponent

The project proponent is HK Offshore Wind Limited, a 100% subsidiary of Wind Prospect (HK) Limited.

Wind Prospect (www.windprospect.com) is a leading international vertically integrated wind farm development, construction and operation company that has worked on over 25 wind farms around the world; including an offshore wind farm. Through its subsidiary, Ocean Prospect, Wind Prospect is also one of the worlds leading wave power developers.

Wind Prospect has been working in Hong Kong since 2004.

1.4 Location of Project and History of Site

1.4.1 Site Selection Overview

In order to identify a site for the wind farm it was first necessary to undertake a site selection process where key design parameters, screening criteria and site issues were identified. The site selection included four main tasks as detailed below:

Definition of Site Parameters

Broad site requirements for the offshore wind farm were initially defined. These parameters were chosen to strike a balance between ensuring the site would maximise its economic and technical potential, whilst maximising the chances of finding suitable sites to consider. Three key parameters were defined:

- The site had to be large enough for a contiguous array of 50 turbines, spaced a minimum of 560m apart. This is equivalent to 50 x 3MW turbines, giving a total potential capacity of 150MW
- The water depth had to be less than 30m
- The site had to be at least 2 km from the nearest island mass. This was to minimise potential coastal related influences and effects.

Identification of Screening Criteria

A selection of key planning, social, technical, physical and environmental criteria were identified which could have an impact on the siting of a wind farm. These included:

- Water depth
- Proximity to islands
- Physical Infrastructure, including:
  i. Bridges and tunnels
  ii. Proposed reclamation areas
  iii. Undersea pipelines & cable routes (existing and proposed)
- Constrained water-spaces including:
  i. Proposed marine parks and fisheries protection areas
  ii. Dumping grounds
  iii. Restricted areas
  iv. Artificial reef deployment areas
  v. Marine fish culture zones
  vi. Log ponds
- Shipping lanes, Fairways and Anchorage areas, including:
  i. Knowledge of ocean going vessel traffic patterns
  ii. Knowledge of local vessel traffic patterns
  iii. Proximity to marine radar installations
- Areas of medium to high fisheries production
- Marine parks and Ecologically valuable sites including:
  i. Core area for Chinese white dolphins
  ii. Core area for Finless Porpoise
  iii. Fisheries spawning areas
  iv. Horseshoe crab areas
  v. Areas of high coral value

Analysis

All of the constraints identified were plotted on a Geographic Information System (GIS) where it was possible to analyse issues and deduce potential areas for wind farm development. Where appropriate, buffers were added to some selection criteria.

Identify Potential Sites

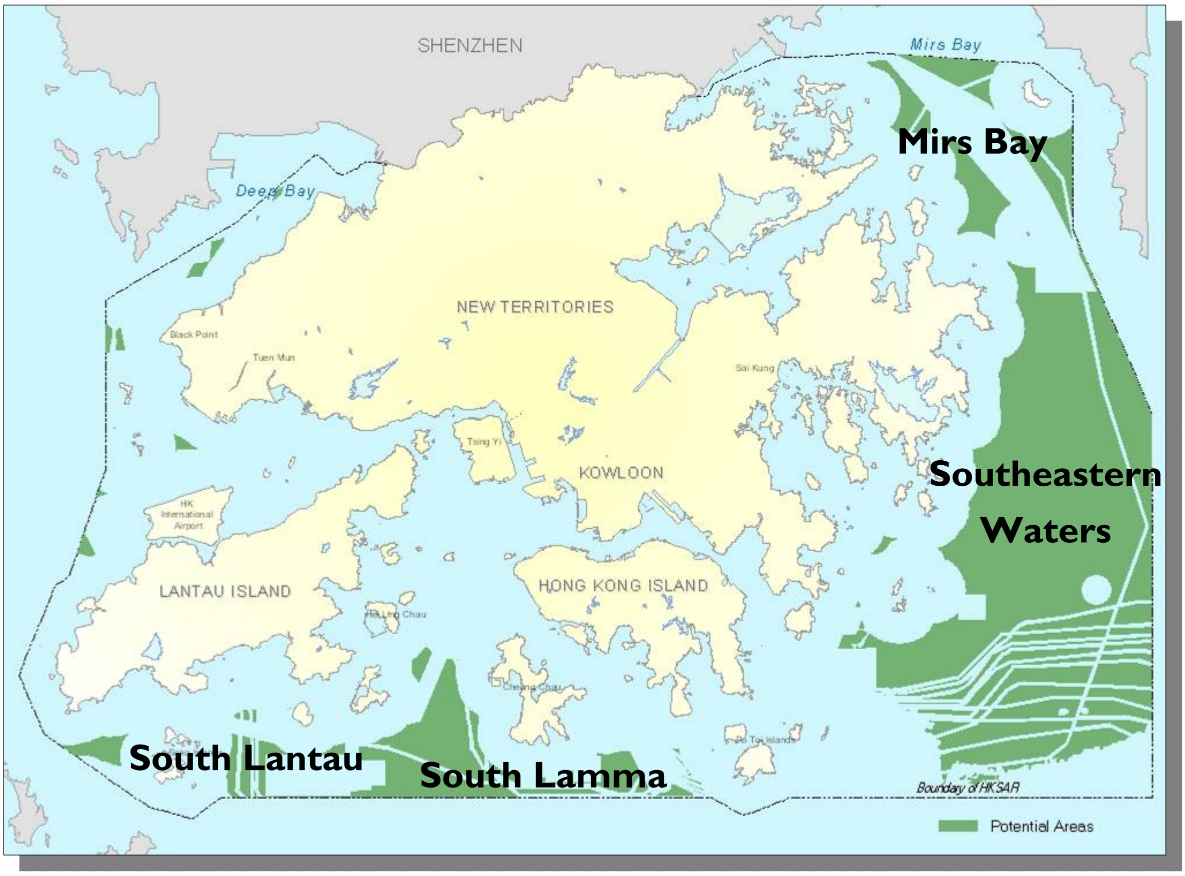
Areas found to be relatively free of absolute constraints after the above analysis were compared against the desired site parameters and subjected to further analysis in order to identify potential 'show stoppers' that would render a site un-workable. This included discussion with the Civil Aviation Department to take into account aviation safety considerations in HK.

1.4.2 Site Selection Results

Figure 1.1 below shows the result of the analysis phase. The Figure shows there were four broad areas relatively free of absolute constraints, to which more selective screening criteria could be applied:

- South Lamma
- South Lantau
- Mirs Bay
- Southeastern Waters

Figure 1.1 – Areas for potential wind farm consideration



South Eastern Waters

The Southeastern waters promise the greatest potential for a large scale offshore wind farm due to the amount of potential contiguous area and the relative lack of potentially sensitive issues (as considered in our screening criteria).

A fortunate aspect of this area is that the Waglan Island wind data (at the extreme south-east of Hong Kong) illustrates that this area has the highest near sea level wind speeds measured in HK, and therefore this area probably has the best wind resource offshore in HK.* Wind resource is important as the amount of clean electricity produced by the proposed wind farm increases with wind speed. Maximising this positive environmental impact is therefore a high priority.

In order to narrow down to a specific area of the south eastern waters a few aspects were considered in more detail. Namely:

1. Grid connection: Following discussion with CLP Power it was decided that the most likely place for a grid connection would be in the Tseung Kwan O area. This area would allow a connection in a part of HK that was of lower potential environmental sensitivity, and the route from coast to wind farm was also through an area of lower potential sensitivity. Proximity to the grid connection is an important environmental, technical and economic issue and therefore areas closest were considered most attractive from this point of view;
2. Fishing: Areas around the Ninepins and near the east coast of the New Territories are of relatively good fishing value and therefore these areas were avoided;
3. Known shipping traffic patterns: Areas of known high traffic patterns were avoided to reduce potential impact on marine safety and navigation;
4. Location of Marine radars: Minimising potential for radar shadow by aligning wind farm in sympathy with known radar facilities on Waglan Island and East Peng Chau;
5. Visual amenity: Trying to design the array such that it had a reduced potential size on the horizon, and site it as distant from sensitive receivers as possible to reduce potential visual influence onshore;
6. Predominant wind direction: Locating array such that it could take advantage of the prevalent winds;
7. Avoiding Victor Rock (the single marine outcrop in this area of known ecological/recreational value).

* *Wind Statistics in HK in Relation to Wind Power, Technical Note (Local) No 77, Hong Kong Observatory, 2002*

1.4.3 Site Location

After considering all of the issues described above, a conceptual layout for the proposed wind farm was prepared as displayed by Figure1.2 overleaf.

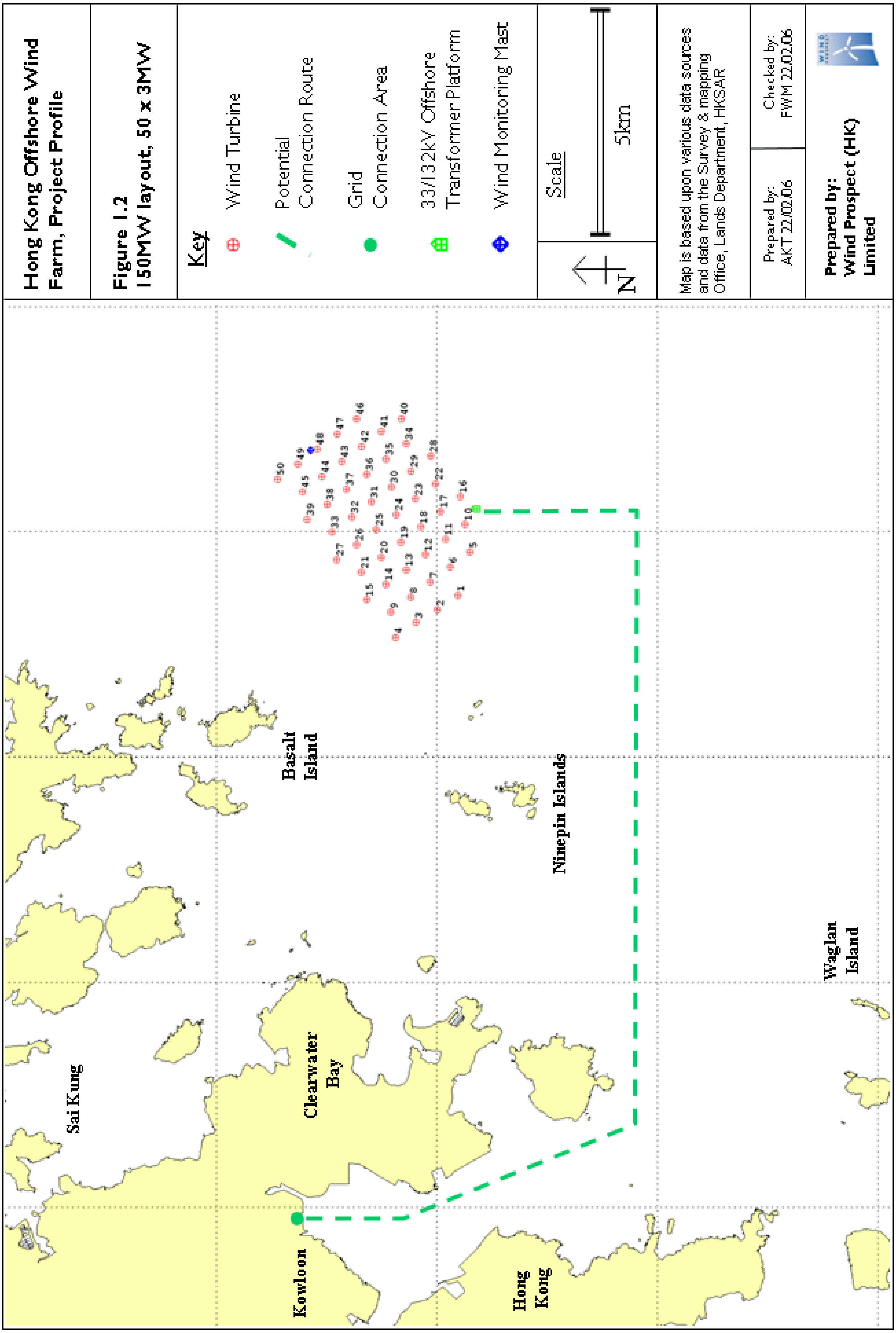
It is important to note that the proposed layout and undersea cable transmission route may be further refined as further consultations and studies are undertaken. Whilst the layout below is representative of the proposed project, it could vary in numbers and size of turbines as well as in the exact cable route chosen to better match any constraints and opportunities developed within the EIA process.

This is typical in wind farm development projects as technology is constantly improving and in the time between starting an EIA and finishing it new technology or results from the EIA itself may allow for an improvement in the proposed project. As a consequence the proponent would look to cover an area in the EIA larger than the area currently being considered for the wind farm/cable to ensure any proposed changes are subjected to the necessary study at the outset.

1.4.4 History of Site

The site was previously used as a firing range and has been subjected to extensive trawling over the years.

Adjacent areas of seabed to the southwest around East Ninepin have been used for open sea (clean) mud disposal.


Hong Kong Offshore Wind Farm, Project Profile
Figure 1.2
150MW layout, 50 x 3MW
Key
Wind Turbine
Potential Connection Route
Grid Connection Area
33/132kV Offshore Transformer Platform
Wind Monitoring Mast
Scale
5km
N
Map is based upon various data sources and data from the Survey & mapping Office, Lands Department, HKSAR
Prepared by: AKT 22.02.06
Checked by: FWM 22.02.06
Prepared by: Wind Prospect (HK) Limited
Basalt Island
Ninepin Islands
Waglan Island
Sai Kung
Clearwater Bay
Kowloon
Hong Kong

1.5 Scale of Project and Infrastructure

1.5.1 Wind Turbine Components

Figure 1.3 shows a typical modern offshore turbine consisting of a steel tower, nacelle and three blades – of the type being considered for this Project.

Whilst wind turbines generally look very similar they differ in size, rated output and particular generator and blade technology. Offshore turbines are designed to be more reliable, hard wearing and productive than normal onshore wind turbines.

Figure 1.3

A 3MW Vestas turbine from the recently commissioned Kentish Flats windfarm in the UK

The turbine hub height is 70m and the rotor diameter is 90m, giving a maximum tip height of 115m, and a minimum tip height of 25m above sea level (sufficient to clear the mast of almost all local craft).

©Elsam

The key components of a Wind Turbine are as follows:

- Tower: a hollow tubular steel tower.
- Nacelle: contains the generator and control equipment.
- Rotor: turbine blades on offshore turbines are always designed to feather independently to gain greater control and increase efficiency. They capture more wind at low wind speeds and spill wind to protect themselves during very high winds.
- Anemometer: measures wind direction and strength and feeds information to the control computer to adjust the blades and nacelle to extract maximum power.
- Controller: a computer controls all aspects of wind turbine operation without human input. Wind farms are typically unmanned, with the controller allowing remote access and control.

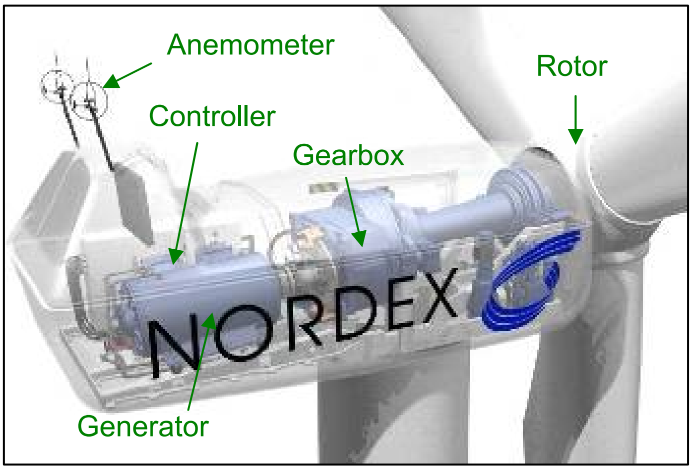


Figure 1.4

Inside a typical nacelle

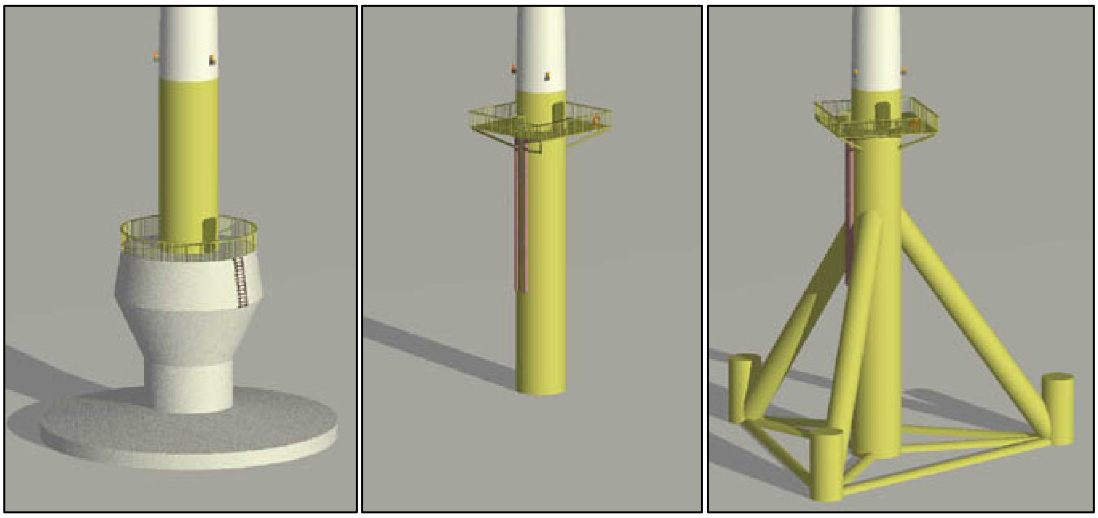
© Nordex

1.5.2 Foundations

The appropriate foundation type for an offshore wind turbine is very site specific. Design options considered to date include: steel monopiles driven into the seabed; concrete gravity foundations that use their weight to keep the turbines upright, or caisson type foundations as an intermediary of the former two options.

Other hybrid solutions and new concepts under development exist, such as tripods. The preferred foundation option shall be identified and subject to detailed environmental assessment during the EIA Study. Figure 1.5 below highlights some typical foundation configurations.*

Figure 1.5– Typical Offshore Foundations



Gravity **Monopile** **Tripod**

* *Courtesy of (www.offshorewindenergy.org)*

1.5.3 Cables and Connections

Additional components of the Project are the undersea electrical collection and transmission cables, the offshore transformer platform, and an onshore cable connection room.

Electrical cabling is split into two functions: collection and transmission. The collection cables connect a series of turbines together and are operated at a distribution level voltage (such as 33kV). These cables then connect into a small offshore transformer platform. This platform acts as a collection point and also houses a transformer to increase the voltage to 132kV for transmission to shore via one or more cables.

Installation options considered so far for the cable to shore include ploughing, jetting and trenching. The best option shall be identified through the EIA Study and subject to detailed impact assessment. Where the cable comes ashore there will be a cable room and potentially some ancillary equipment and minor works.

Figure 1.6 – Cable Laying

Figure 1.7 – Offshore Transformer Platform*

Figure 1.8
Offshore wind
monitoring mast

* Both images courtesy of Elsam (http://uk.nystedhavmoellepark.dk), © Elsam

A meteorological mast will also be required, as this plays an important role in the project development process and during the operational life of the wind farm. The mast is erected to collect on-site wind resource and other environmental data (air and water temperature, wave heights and periods, current, etc.). This data is a valuable source of independent information that can be used during the operational life of the wind farm to optimise site production and study site conditions.

1.5.4 Wind Farm Layout

There are four primary drivers of a wind farm's layout:

- Physical Location: Mean wind speed, water depth, seabed characteristics, sub-surface geology, coastal processes, seascape and landscape assessment.
- Biological Environment: Protected areas, habitat type and character, and marine life (benthos, fish, bird, mammals, etc.).
- Human Environment: Electrical infrastructure, economic development opportunities, tourism / leisure, archaeology, navigation, fisheries, port facilities, civil and military aviation industry, radar facilities.
- Performance: Turbine spacing, array alignment, infrastructure optimization, turbine selection.

Figure 1.9 below shows a typical offshore wind farm layout (the 60MW North Hoyle project in the UK).

Figure 1.9 – Typical Offshore Wind Farm layout

1.5.5 Wind Farm Construction and Decommissioning

Offshore wind farm construction typically takes between one and two years, from first foundation being installed to full commissioning. Construction typically occurs in phases: first the foundations are laid, next the electrical cabling is installed, and finally the wind turbines are erected.

When possible, infrastructure is prepared prior to taking it to the site, but at the site, specialist vessels are employed to safely and efficiently install the plant. The largest vessels at the site are the purpose built installation platforms that have jack-up capability in order to operate regardless of the sea-state (Figures 1.10 and 1.11).

Wind turbines are designed for a 20-25 year working life.

Decommissioning is a mirror image of construction, and it is possible to remove all traces of the wind farm. A wind farm produces no dangerous emissions or residue to clean up after decommissioning, so there is no legacy cost of its siting.

Figure 1.10 – Turbine Installation*

Figure 1.11 – Foundation Installation

1.5.6 Wind Turbine Operations

Wind turbines are controlled by computers and are largely autonomous, indeed most wind farms are unmanned with no on-site permanent staff. They do occasionally require repairs,

* Both images courtesy of Elsam (www.kentishflats.co.uk), © Elsam

and all turbines get a yearly service. The offshore transformer platform and the individual wind turbines will not be permanently manned, but each will have emergency facilities for temporary accommodation. Control of the wind farm will be from a land-based location.

1.6 Name, Position and Telephone Number of Contact Persons

Mr. Alex Tancock, General Manager, Wind Prospect (HK) Limited

T – 2922 1792

1.7 Number and Types of Designated Projects covered by the Project Profile

The following elements of the Project addressed in this Project Profile are classified as Designated Projects under the Environmental Impact Assessment Ordinance (Cap. 499) (EIAO):

- Construction and operation of an offshore wind farm for the purpose of generating clean renewable energy (item D.1 of Part I of Schedule 2 of EIAO).

- Installation of a submarine power cable connecting the wind farm with the onshore electrical infrastructure in the Tseung Kwan O area on Kowloon (item C.12 of Part I of Schedule 2 of EIAO).

Onshore activities relating to the project grid connection into the electricity network will be applied for separately and are not covered by this project profile.

2 OUTLINE OF PLANNING AND IMPLEMENTATION PROGRAMME

The project programme outlined below is indicative, depending on the outcome of this application, subsequent applications and the results of the EIA and other studies:

- EIA Study: Q2 2006 – Q3 2007
- Site Works: Commence 2009
- Commissioning and first generation: 2010/2011

Subject to the results of the EIA, technical studies and supportive Government policies the commissioing date could be brought forward.

3 MAJOR ELEMENTS OF THE SURROUNDING ENVIRONMENT

3.1 General Environs

The proposed wind farm would be located such that the nearest turbine would be approximately 7.5km east of Clearwater Bay peninsula and 7.5km southeast of High Island Reservoir (with the furthest turbines being approximately 12.4km and 11km away respectively).

The closest Islands to the proposed Project location are Basalt Island and East Ninepin which are approximately 3.2km to the northwest and 2.2km to the west, respectively.

3.2 Immediate Environs

The proposed site has been reviewed with respect to local marine traffic in Hong Kong's Eastern waters. It is sited east of the traffic route associated with "Rivertrade" activity between Yantian Port in Shenzhen, and Hong Kong's central harbour area, and west of the principle north-south route used by large ocean-going vessels approach and departing Yantian.

Approximately 900m to the northeast of the wind farm area there is an underwater rock formation referred to as Victor Rock on admiralty charts. Victor Rock does not break water

Approximately 500m to the south of the site there is a spoil dumping ground comprising a site of approximately 2.7km^2.

4 POSSIBLE IMPACTS ON THE ENVIRONMENT

4.1 Air Quality

The project site is located in Southeastern offshore waters where there is no existing development, although there are local emissions from marine vessels. The nearest general air pollution monitoring stations of the Environmental Protection Department are at Sai Wan Ho and Tap Mun, and these averaged an Air Pollution Index (API) of just over 42 during 2005 (i.e., Medium - High).

Construction Phase

There will be only temporary and highly localised emissions from the marine vessels used to install the turbines. These emissions would not have any significant or lasting impact on ambient air quality.

Operational Phase

Wind turbines produce electricity without producing any harmful emissions. Daily visits to the wind farm by light maintenance craft will take place, with occasional larger vessels for major work. These visits would not have any significant impact on air quality.

4.2 Noise

The ambient background noise at the site is typical of open offshore waters. The nearest Noise Sensitive Receiver(s) (NSR) to the proposed site are located well over 3km away, confirming that noise is not a key issue for this Project.

Construction Phase

Noise would arise from vessel movements and turbine / cable installation, but this would be temporary and highly localised. Given the distance separation between the Project and the closest NSR, construction noise is not a key issue for the Project. Submarine cable-laying activities will not generate significant noise impacts.

Underwater construction noise impacts upon Finless Porpoise are not anticipated to be significant. While the Project area is within the range of the Finless Porpoise (albeit not a core area*), prefabricated turbine components will be used while the available foundation options may preclude the need for marine piling activities. However, this shall be subject to an initial development options assessment and a detailed impact assessment in the EIA Study.

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* *http://www.afcd.gov.hk/conservation/con_e.htm*

Operational Phase

Wind turbines produce aerodynamic noise as a result of blades moving through the air. There is also limited noise caused by mechanical equipment operating inside a wind turbine nacelle. However, given the distance separation between the Project and the closest NSR is several kilometres, operations noise is not a key issue for the Project.

4.3 Waste Management

The proposed site comprises open marine waters. There is no existing development in the immediate area, with the closest works area being the natural gas pipeline between Shenzhen (Cheng Tou Jiao) to Lamma Island that is located approximately 5.5 kilometres to the east at its nearest point.

With reference to the latest data from EPD's routine sediment quality monitoring station ('MS14'), sediments in the area of the Project are "uncontaminated".

Construction Phase

Construction waste will be minimal as the foundation and turbine installation activities produce insignificant volumes of waste. Marine sediment will be laterally displaced during foundation works with no solid waste generation, or only minimal volumes would be generated should bored piling be adopted. Likewise, should caisson foundations be installed, interstitial water would be extracted during installation by suction into a holding barge for solids settlement before pre-approved marine discharge. Short-listed development options shall be assessed and the preferred options shall be subject to detailed assessment under the EIA Study.

There will be no or only minimal construction waste or other solid wastes generated from cable installation works.

Solid waste from all construction works will be largely related to personal litter and consumables, packaging and material. This shall be disposed of as required under Government legislation when vessels return to shore, with no adverse impact.

Operational Phase

There is no continuous waste outflow from a wind turbine. Operational waste would include used components, fluids and litter. These would be collected during routine maintenance activities and shall be stored / disposed in full accordance with waste management legislation with no significant adverse impacts.

4.4 Water Quality

The proposed site is located in the Mirs Bay Water Control Zone (WCZ), in the Southeastern Waters of the HKSAR. The nearest of EPD's routine marine water quality monitoring stations is 'MM14'. The entire Mirs Bay WCZ achieved 100% compliance with *Water Quality Objectives* during the year 2004.

The hydrodynamics in the area is characterised by offshore oceanic currents from the southwest in the dry season and the northeast in the wet season.

Construction Phase

Marine works will be required for turbine foundations and cable installation works. The turbine foundations may require minimal pre-dredging to facilitate installation, although foundation type will be subject to an engineering feasibility study. Subject to an initial options assessment, cable installation to the required depth may involve some dredging works.

In terms of potential water quality impacts, seabed disturbance may release sediment into the water column resulting in localised elevations in suspended materials. Marine works at the Wind Farm are not anticipated to generate significant water quality impacts as, despite the presence of oceanic currents, deep water at the site (~ 27m) supports only weak seabed currents. This fact, along with the small scale and footprint of marine works and the distance from water sensitive receivers, will preclude significant effects.

Likewise, transmission cable laying works are not anticipated to generate any significant adverse water quality impacts due to generally weak currents, the anticipated nature of the installation works and the distance from sensitive receivers. Calculations for pipeline installation through Eastern Waters using the jetting technique predicted a mixing zone of around 400m from installation.* The closest water sensitive (aquatic ecology) receiver to the collection cables would be Victor Rock at 900m, with South Ninepin being the closest receiver to the indicative transmission cable route at ~2km.

There will also be minimal standard discharge from marine vessels. However, these considerations would be temporary and would not lead to any significant adverse impact on water quality.

Operational Phase

The small scale and footprint of the works will not result in any significant hydrodynamic change that may result in water quality impacts on sensitive receivers.

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* EIA Study Report for 1,800MW Gas-Fired Power Station at Lamma Extension. ERM, 1999.

The operational wind turbines are inert in terms of water quality impact, while discharges from marine vessels used to access the site for routine maintenance would be insignificant.

4.5 Ecology

4.5.1 Cable landing point

The anticipated land-based grid connection site will be onto an area of entirely reclaimed land at Tseung Kwan O. There are no natural ecological resources in the immediate vicinity that may be impacted.

4.5.2 Offshore / Marine ecology

In general, the isolated islands and submerged rocks of the eastern waters support some of the most diverse and locally important coral habitats in Hong Kong.* This includes the coral habitats found at the Ninepins group of islands (with East Ninepin located about 2.1 km to the southwest) and Victor Rock, the submerged rocky pinnacle, about 0.9 km to the northeast.

East Ninepin and Victor Rock are characterised by diverse communities of hard and soft coral, gorgonians, sponges, holothurians, sea urchins, sea fans and fish species. Both sites are noted as having a "high conservation value".†

The Bluff Island and Basalt Island SSSI has been designated primarily due to its unique grassland community, although the ecological value of the rocky shore communities on both islands is graded as high.

The benthic habitat in the general area of the proposed wind farm is characteristic of soft sediments, and regular trawling activity has resulted in a uniformly disturbed habitat. An evaluation of the soft bottom habitat in the vicinity of the Wind Farm has concluded it to be of "low" ecological value (low species diversity and low abundance) due to this disturbance.‡

The Project area is outside of the range of Chinese White Dolphin. The distribution data on the AFCD web-site suggests a very low density of Finless Porpoise activity in the area, with the core area for this species understood to be in Southern Waters, off Southwest Lamma Island. It is understood that complete data on the distribution and abundance of Finless Porpoise in Hong Kong waters has recently been collected on behalf of AFCD.

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* *ERM-Hong Kong Ltd (1998) Environmental Impact Assessment, of Backfilling marine Borrow Areas at East of Tung Lung Chau. Civil Engineering Department, Hong Kong Government.*

† *Binnie Consultants Limited (1995) Fill Management Study - Phase IV Investigation and Development of Marine Borrow Areas: Marine Ecology of Hong Kong: Report on Underwater Dive Surveys Oct 1991 – Nov 1994 Vol I. Civil Engineering Department, Hong Kong Government.*

‡ *EIA Study Report for 1,800MW Gas-Fired Power Station at Lamma Extension. Hongkong Electric Co. Ltd. ERM, 1999.*

The offshore Project area is not of any known significance as a bird habitat or migration route.

Construction Phase

As a result of extensive trawling activities in the area, the ecological baseline value of the soft bottom habitat is low. As such, significant adverse impacts upon this habitat type are not anticipated in general, while more specifically the cumulative area of permanent habitat loss under the turbines is small – most likely less than 400 square metres. Impacts from cable installation will be temporary only, and are not anticipated to be significant.

In terms of water quality-induced impacts, elevated levels of suspended solids can be expected as highly localised occurrences. However, the small footprint of marine works is not anticipated to cause any significant adverse impacts. The habitat and species at Victor Rock are some 0.9 km to the northeast, and this is too remote to be adversely affected by highly localised events. Subject to finalised alignment, the distance from transmission cable installation works to ecological sensitive receivers is an even greater distance ('Water Quality' section refers).

As referred under the 'Noise' section, the effects of underwater noise on Finless Porpoise are not anticipated to be significant. However, this shall be assessed using quantitative techniques using available data.

The offshore Project area is not of any known significance as a bird habitat or migration route due to its distance from coastal areas. However, bird survey requirements and impact assessment protocol shall be discussed with AFCD in advance of the EIA Study, as necessary. This task shall be supported by literature review and consultations, as appropriate.

Operational Phase

Given the small scale of the project footprint, it can be concluded that the proposed Wind Farm would not induce any significant changes in the hydrodynamic regime or lead to water quality-induced ecological impacts. There are no soft-shore inter-tidal habitats nearby that may be adversely affected by a changed hydrodynamic regime, while the scale of the Project in any case precludes such a scenario.

4.6 Fisheries

The fisheries significance of the Eastern Waters is generally low compared to other fishing areas in Hong Kong waters, while those areas of highest productivity tend to be restricted to inland areas around islands. Figure 4.1 indicates the distribution of fish productivity (adult & fry fish) in Eastern Waters, with data from AFCD's Port Survey 2001/2002.

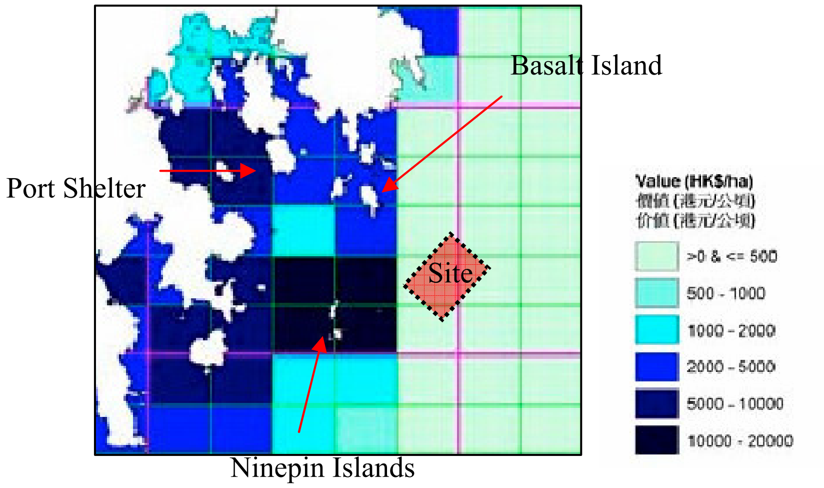

Figure 4.1
Fish Productivity in Eastern Waters of Hong Kong

Trawl catches at Ninepins, Basalt Island are characterised by high biomass of commercially valuable Grouper, Yellow Croaker and Pomfret species. Purse seine vessels are based mainly in ports in the eastern waters of Hong Kong where their activity is concentrated.*

Port Shelter is also recognised as a nursery area for commercial fish species, and includes a number of fish culture zones. The HKSAR's largest Artificial Reef was deployed at Outer Port shelter in 2001-03.

Construction Phase

Given the scale of works, the highly localised nature of water quality impacts during marine works, the low fisheries value of the area and its distance from areas of fisheries importance, the Project is not anticipated to generate significant adverse fisheries impacts.

Operational Phase

For the reasons described above, the Project will not lead to any adverse impact on fisheries. However, there is potential for positive impacts on local fisheries by managing trawling in the area in conjunction with enhancement and management measures such as artificial reef systems and fisheries protection areas. Consultation shall be conducted with relevant stakeholders during the EIA Study to explore this issue further.

4.7 Landscape & Visual

According to the Explanatory Notes† of the recently published Landscape Character Map of Hong Kong, the proposed development is in an Offshore Water Landscape.

* *Fisheries Resources and Fishing Operations in Hong Kong Waters; Agriculture & Fisheries Department, Hong Kong Government. ERM, 1998.*

† *Planning Department, Hong Kong, September 2005*

Construction Phase

The construction phase impacts are of a temporary nature and due to the distance from shore unlikely to be a significant impact.

Operational Phase

The turbines would be up to 135m high and although some distance from shore, could still be seen from various locations around Hong Kong on days of good visibility. They would also be visible to leisure craft transiting near the area. Whilst the visual impact of turbines is largely subjective and 'in the eye of the beholder', this issue will be explored further during the EIA Study.

4.8 Cultural Heritage

The offshore area is not known to include any known important archaeological issues. Given the small scale of works, the highly localised nature of potential impacts during marine works, the widespread disturbance / damage from trawling and the distance from coastal areas, the proposed project is not anticipated to lead to any significant adverse impacts during construction or operation.

As some flexibility in Wind Farm layout exists, turbine locations may be refined as required. Advantage shall be taken of any suitable geophysical survey data collected to support the detailed design to ensure no adverse cultural / historical impacts occur.

With regard to inshore water around Tseung Kwan O, reference has been made to recent marine geophysical / archaeological investigations conducted for further reclamation and coastal infrastructure development.[*] As these surveys / investigations did not identify any artefacts in the vicinity of the indicative transmission cable alignment, no adverse impacts are anticipated.

4.9 Hazard to Life

The existing site area is open sea, with no permanent local population and sparse fishing activity. During construction of the project, marine vessels and "jack-up" rigs may be deployed at site, with specialist vessels mobilised for the cable installation. Temporary safety zones will be established around wind farm construction operations when required, these activities will be notified to Mariners through Marine Department Notices in the usual manner.

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* *EIA Study for Further Development of Tseung Kwan O Feasibility Study. Maunsell, 2005.*

During construction and once operational, the Project has the potential to impact the safety of 3rd party navigation in a number of ways: through relocation of marine traffic, impact on radar and communications, and changes to Search & Rescue response.

Recent guidance developed in the UK (DTI, 2005*) has provided a framework for the quantitative review of navigational risks for offshore wind farms. In the absence of such detailed and relevant guidance for Hong Kong it is intended that this methodology is adopted to review the potential impacts of the proposed facility to the commercial and recreational vessel communities. The initial siting of the wind farm has taken into account local marine patterns, and the location of this site in the relatively low traffic area of Hong Kong Southeastern waters is not anticipated to adversely impact vessel operation. The navigational safety of the site will be closely scrutinised within an assessment consistent with the DTI guidance.

The impact of the turbines on marine radar (Marine Department and shipborne) will be reviewed "*Predictions from modelling and reports from radar installations affected by turbines indicate significant variability in the level of distortion between radar sites and across operating conditions. Many radar installations may not suffer degradation at all*" (DTI 2003).†

At present the site is under the surveillance of two land-based marine radar on Waglan and East Peng Chau, and no additional radar shadows are anticipated. Worldwide experience of existing installations will be identified to review any impacts. It is noted that trails at offshore sites in Europe have identified that there is no degradation of GPS (Global Positioning System) or AIS (Automatic Identification System) signals that play an increasing role in ship navigation. VHF direction finding equipment and radio are similarly unaffected.

The minimum distance between turbines is expected to be approximately 560m. It is expected that local craft will navigate adjacent to the wind farm turbines, indeed many recreational sailors may use the project as a turning mark during cruising and races. Contacts and strandings within the windfarm may arise and Search & Rescue (SAR) operations may be required. Recent trials (MCA 2005+) have identified the key issues impacting SAR operations within these areas. While challenges are created by the new operating environment it is considered that SAR operations, conducted in co-operation with the wind farm control station, can be readily accomplished.

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* *Department of Transport & Industry, UK (2005) Guidance on the Assessment of the Impact of Offshore Wind Farms: Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms.*

† *Department of Transport & Industry, UK (2003) Feasibility of Mitigating the Effects of Windfarms on Primary Radar*

\+ *Maritime and Coastguard Agency, UK (2005) Offshore Wind Farm Helicopter Search and Rescue – Trials Undertaken at the North Hoyle Wind Farm*

Apart from the potential impact to maritime users, the wind farm could impact on aviation interests. Consultation with the Civil Aviation Department has been an important part of the initial design process and consultation during the EIA process will continue

5 ENVIRONMENTAL PROTECTION MEASURES TO BE INCORPORATED IN THE DESIGN AND ANY FURTHER ENVIRONMENTAL IMPLICATIONS

5.1 Air Quality

Insignificant emissions to air will be generated from project construction and operation, including from maintenance activities.

Indeed, the proposed HK Offshore Wind Farm would offset approximately 188,000 tonnes of carbon dioxide annually*; or 3.7-4.6million tonnes of carbon dioxide over its lifetime. This would be the equivalent of approximately 100,000-125,000 lorry loads of coal equivalent carbon dioxide. In addition to carbon dioxide offsets, the proposed HK Offshore Wind Farm would also offset approximately:†

- 595 tonnes of Sulfur Dioxide annually
- 265 tonnes of Nitrogen Oxides annually
- 22 tonnes of particulates annually.

5.2 Noise

Construction Phase

The worst case noise level generated from the construction of the project will comply with the L_{eq} 75 dB(A) limit contained in government guidelines, and no adverse construction noise impact is anticipated.

Operational Phase

Insignificant noise will be generated from project operation, including from maintenance activities.

5.3 Waste Management

No significant environmental issues are anticipated. Best practice guidelines will be implemented during construction and operation, including:

- Barges should be fitted with water tight seals to their hull in the event that excavated material / water is to be collected / transported

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* *Based on CLP carbon intensity in 2004, CLP Annual Report 2004*

† *Based on CLP emission intensities in 2004, CLP Annual Report 2004*

- Excavation / pumping shall not be undertaken if there are signs of material leakage, and any leakage shall be repaired promptly, as appropriate
- All waste materials are to be stored, handled and transported in an agreed and appropriate manner that complies with the Waste Disposal Ordinance (Cap 354) and subsidiary regulations such as the Waste Disposal (Chemical) (General) Regulation

5.4 Water Quality

No significant environmental issues are anticipated. Best practice guidelines will be implemented during construction and operation, including:

- Control of dredging / excavation rates, as appropriate
- Conducting marine works during the wet season

5.5 Ecology

5.5.1 Terrestrial Ecology

No significant environmental issues are anticipated.

5.5.2 Marine Ecology

Construction Phase

No significant environmental issues are anticipated. All sensitive marine habitat areas will be avoided. Best practice guidelines will be implemented during construction and operation as for water quality control.

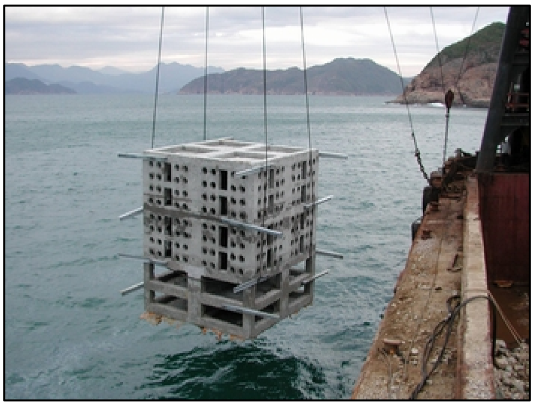
Should marine piling be used for the turbine foundations the programme shall be optimised to minimise work duration with the following precautionary measures to be adopted prior to and during the works:

- Visual monitoring of an exclusion zone around the installation area; and
- Daily time-outs for installation works.

Marine vessel movements (construction and operation) to the proposed site will be routed to avoid passage close to areas of high ecological value, such as the Ninepin group SSSI.

Operational Phase

There are potentially positive implications on local marine ecology from the development of artificial reef structures associated with the turbine foundations, dedicated (stand-alone) AR systems such as those varieties implemented and studied by AFCD through the AR Programme, and also through the potential to support controls on trawling practices in Eastern Waters to encourage fish spawning and nursery areas. Examples of current AR systems deployed in Hong Kong waters are illustrated in Figures 5.1 and 5.2 below.



Figures 5.1 and 5.2
Examples of artificial reefs currently deployed in HK

While the spacing of the turbines will not pose a constraint to small craft it is anticipated that trawling and large vessel transit activities within the Wind Farm area may require special management (due to the specific risks of net snagging and collisions that these vessels pose). A consequence of this is that AR reefs of all types could be viable, and the opportunity exists to develop a significant AR system within the proposed site.

5.6 Fisheries

Construction Phase

No significant environmental issues are anticipated. Best practice guidelines will be implemented during construction and operation as for water quality.

Operational Phase

The same positive implications for the marine ecosystem from the adoption of AR systems in the Project area will also benefit fishsreies ('Ecology' section refers).

5.7 Landscape & Visual

The potential landscape and visual influence of the proposed project will be studied during the EIA study using computer generated visual influence diagrams and by producing around six to seven photomontages from potentially sensitive/representative locations.

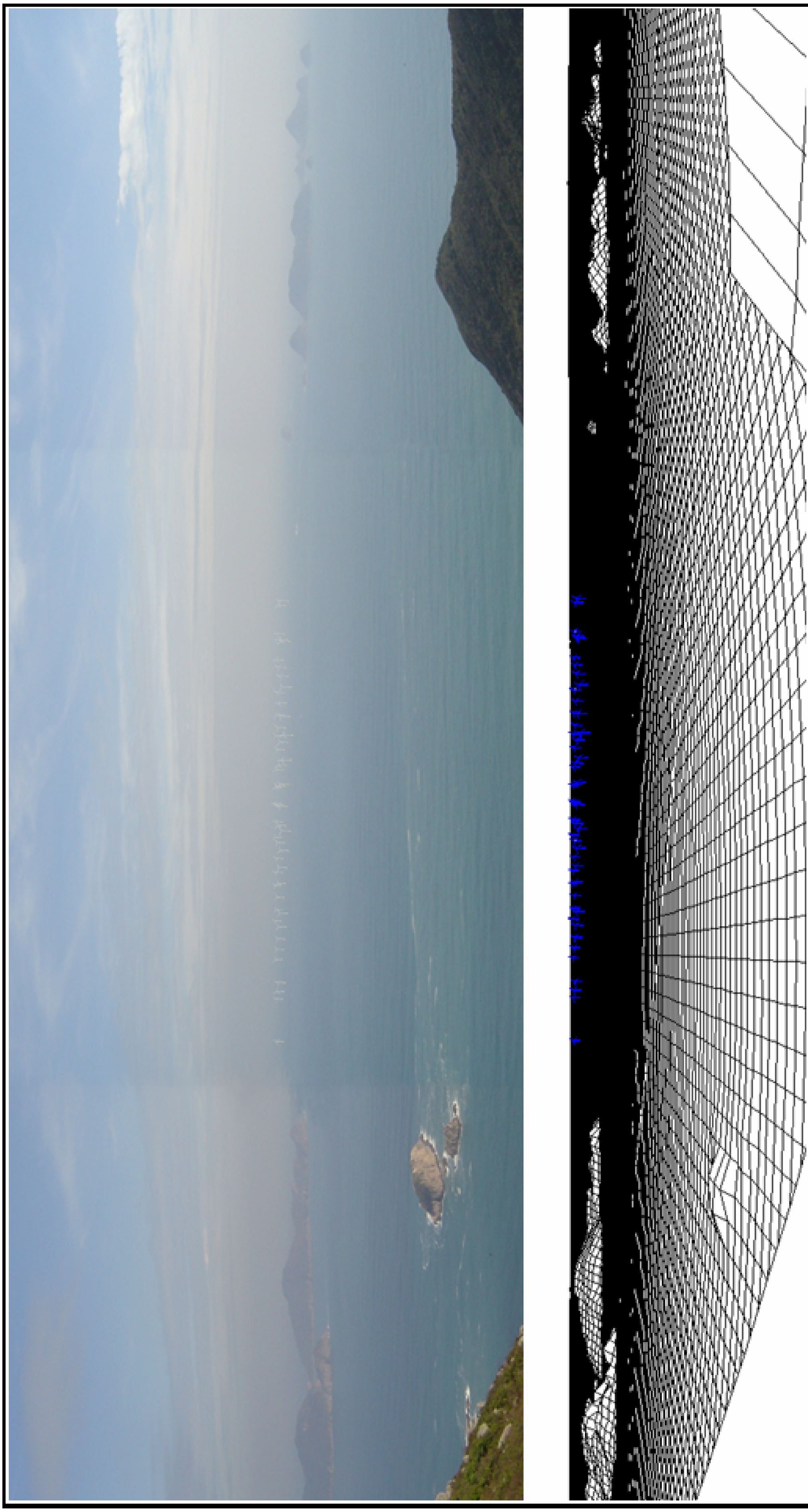
During the site selection stage the proponent has been careful to incorporate project features to reduce potential visual and landscape impact. Considerations have included:

- Being a good distance from shore and known areas of dense housing
- Designing a site that was orderly and pleasing by using a regular array
- Designing the site to minimise its size on the horizon
- Selecting large turbines with slower moving rotor blades
- Using paint and colour schemes which balance visual considerations with safety considerations

Figure 5.3 overleaf displays a representative photmontage of the proposed Project.

5.8 Cultural Heritage

No significant issues are anticipated. Suitable data from Wind Farm geophysical survey(s) shall be subject to marine archaeological interpretation to confirm the absence of any historical / cultural artefacts in the area, as appropriate.



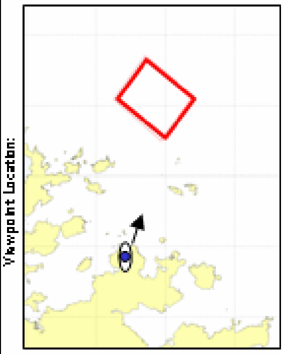
HK Offshore Wind Farm, Project Profile

Figure 5.3: Photomontage

LOCATION: Clearwater Bay Country Park

GRID REFERENCE	849330E 817640N
DISTANCE TO NEAREST TURBINE	8.5km
VIEWPOINT ELEVATION:	291m
NUMBER OF HUBS VISIBLE	50
NUMBER OF TIPS VISIBLE	50

Viewpoint Location:



NOTES:

Number of Turbines: 50
Hub Height: 80m
Maximum Tip Height: 135m
Camera Height: 2m above elevation

Date: 22/02/2006	Project: HKOFF	Prepared by: AKT
Dwg Ref: n/a	Version No.:	

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6 USE OF PREVIOUSLY APPROVED EIA REPORTS

6.1.1 Reference has been made to the EIA Study Report for "A 1,800MW Gas-Fired Power Station at Lamma Extension", dated February 1999 (particularly Part D, "The Gas Pipeline"):

http://www.epd.gov.hk/eia/register/report/executive/english/eia_00998.pdf

6.1.2 Reference has been made to the EIA Study Report for "Further Development of Tseung Kwan O Feasibility Study" dated July 2005:

http://www.epd.gov.hk/eia/register/report/eiareport/eia_1112005/index.htm

6.1.3 Reference is also made in the Project Profile to various other studies (non-EIA) conducted in the vicinity of the proposed Project.