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Wind Resource Assessment Report, Philippines

Site Acquisition, Installation and Commissioning of Wind Measurement Equipment

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EC - ASEAN Energy Facility

ASEAN Wind 2005

Feasibility Assessment and Capacity Building
for Wind Energy Development
in Cambodia, Philippines and Vietnam

Wind Resource Assessment Report, Philippines

Site Acquisition, Installation and Commissioning of Wind Measurement Equipment

December 2006

Project reference: EuropeAid/119920/C/SV

Document reference: Task1/Philippines/
Version: 060120/PNOC EDC/PN (Final)

RISØ	IED	Mercapto	PNOC EDC	IoE	MIME

ASEAN Wind 2005 - Fact Sheet

Main project data

Full project title:	Feasibility Assessment and Capacity Building for Wind Energy Development in Cambodia, The Philippines and Vietnam
Objective:	The main objective of the project is to promote wind energy development and facilitate investments on wind energy projects in The Philippines, Vietnam and Cambodia through feasibility assessment and capacity building.
Start:	February 2005 End: December 2006
Total effort:	64.5 man-month
Contracting Authority:	EC-ASEAN Energy Facility (www.aseanenergy.org/eaef)
Budget / Support:	€ 1 000 000 / € 500 000 by European Community

Tasks

Task 1:	Wind Resource Assessments	RISO	+ IED; PNOC EDC; IoE	(10.5 MM)
Task 2:	Power System Analyses	RISO	+ PNOC EDC; IoE	(7.5 MM)
Task 3:	Policy & Market Studies	RISO	+ IED; Mercapto; PNOC EDC; IoE	(9.5 MM)
Task 4:	Technical Feasibility Studies	RISO	+ PNOC EDC; IoE	(10 MM)
Task 5:	Economic Feasibility Studies	IED	+ RISO; PNOC EDC; IoE	(7 MM)
Task 6:	CDM Project Studies	Mercapto	+ All	(5.5 MM)
Task 7:	Financial Framework	IED	+ All	(5.5 MM)
Task 8:	Dissemination	RISO	+ All	(4.5 MM)

Project partners

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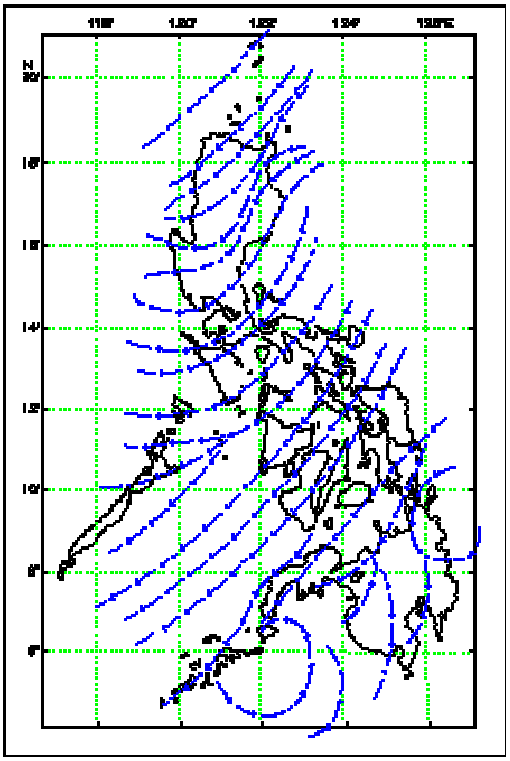
MIME	Ministry of Industry, Mines & Energy	Cambodia	Sovanna Toch	mimedet@forum.org.kh

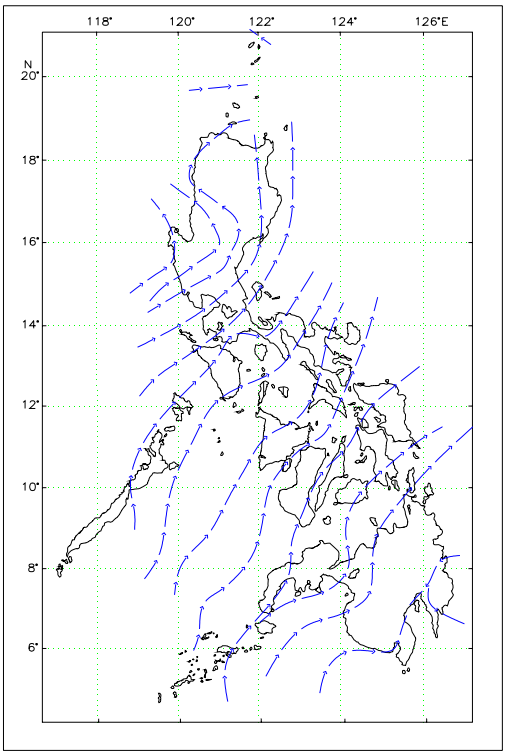
Preface

For the purpose of establishing the wind patterns and determining the wind resource potential for the Philippines on its north eastern part of Luzon and on one of its islands for an off-grid set-up, it is imperative that careful selection of the site and at least one year of continuous wind measurement and monitoring should be conducted.

PNOC EDC explored several sites in the Province of Cagayan, located northeast of Luzon. This area is known to be frequented by strong typhoons or cyclones and falls inside the typhoon corridor. On the other hand, somewhere north off the main Mindanao Island, there is a small island believed to be a good candidate site for and off-grid wind power development. In selecting the particular site on where to install the wind measuring instrument, the site selected must meet the criteria of being plain, without much vegetation and open to both the prevailing wind directions (Northeast and Southwest monsoons).



NORTHEAST MONSOON



SOUTHWEST MONSOON

Table of Contents

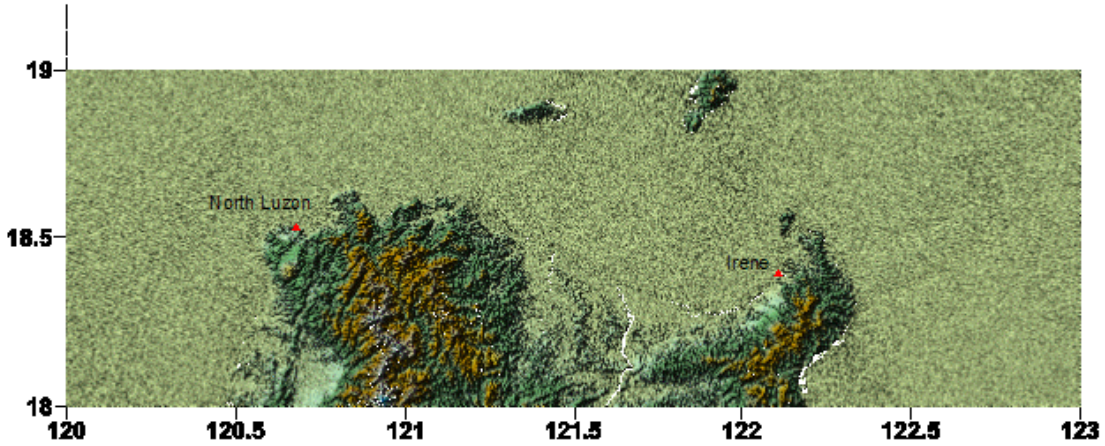


Figure 1: Map of northern Luzon illustrating the surface contours. The axes indicate the longitude and latitude in degrees. Subset of Figure 2 below. (Source: NASA SRTM)

1 Site Investigation and Acquisition in North Eastern Luzon

PNOC EDC will be developing its first wind farm on the north western part of Luzon Island. This 30MW wind power project includes the construction of transmission line to connect to the end of the national grid 42 km south of this project. They are also looking at other wind power projects on this part of Luzon with an aggregate capacity of 116 MW, including the first 30MW.

PNOC EDC believes that the northern part of Luzon is the most promising site for wind power development. However, the eastern part of the said island is frequently hit by typhoon. Much that PNOC EDC wants to consider developing similar wind farms on the north eastern part of Luzon to extend the transmission line loop north of the Philippines from the west end to the east end of the national grid, the available wind turbine generators in the market would not pass the design survival wind speed criteria of the National Structural Code of the Philippines.

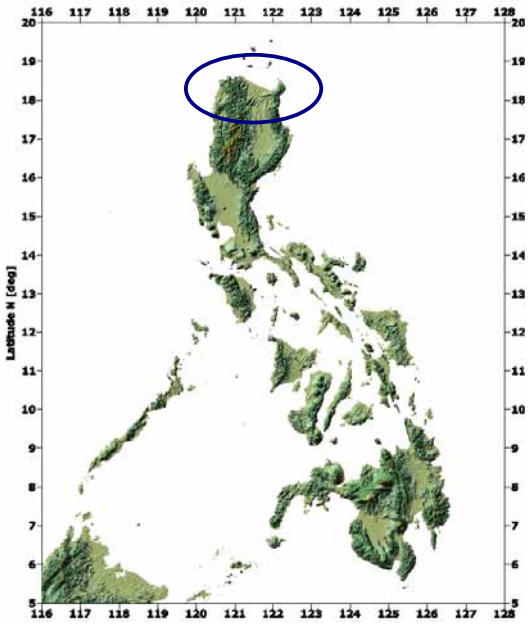
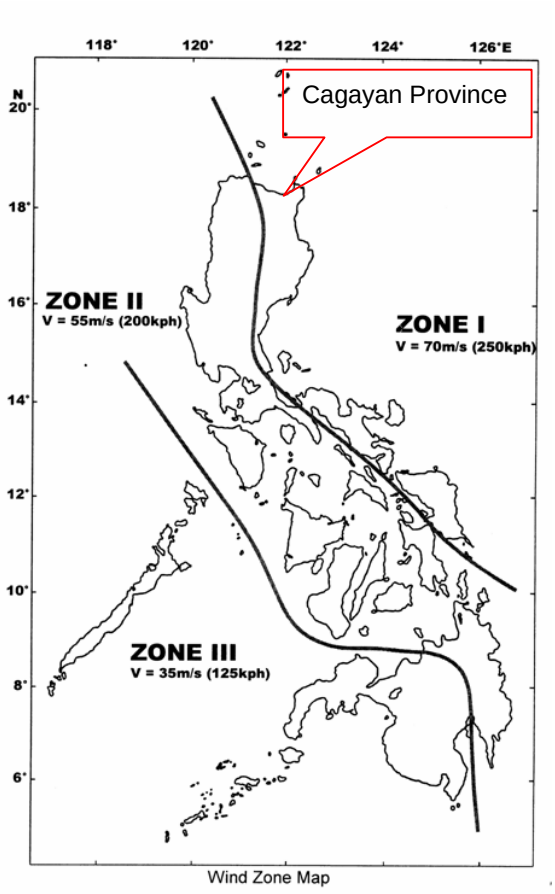


Figure 2: Map of the Philippines illustrating the surface contours. The axes indicate the longitude and latitude in degrees. (Source: NASA SRTM)

For the purpose of the case study, the Cagayan Province was chosen primarily because it is located in Zone I as described in the National Structural Code of the Philippines (see figure to the right). The extreme wind speed design criteria for infrastructure built within Zone 1 starts from 70 meters per second and higher. Aside from being on the eastern side of the Philippines, it is on the typhoon path. It must be noted that the Philippines experiences about 20 typhoons per year on the average.



Wind Zone Map

PNOC Project Engineers searched for appropriate sites in the said province where to install wind measuring equipment for data gathering needed in the study. The prime consideration is that the area must be open to both the Northeast and Southwest monsoons. Furthermore, the area should be relatively flat, clear of obstruction and of vegetation.

Desk study was initially undertaken to identify areas that are open to both monsoon directions and are relatively flat. After which, local residents were consulted for indications of continuous strong winds. The following areas were visited.

1.1 Port Irene

Most of the people from the region always point to Port Irene as a potential site for wind farm development because of the continuous strong winds they observe in the area. This therefore became the first candidate area.

A particular area inside Port Irene, which is very near the pier, was visited by a team composed of PNOC EDC Project Engineers and representatives from RISOE as candidate area. It was later learned from the port authority that there is a planned development in the particular area selected. The port authority, desirous to have the project continue, offered an alternate site, which is also inside the port but as assessed by PNOC EDC Engineers, the main warehouse located adjacent to the alternate site would act as an obstruction thereby adversely affect the measurement activity.

The proposed Port Irene met-mast site seen from East from the pier at the harbour. (Photo: RISO)

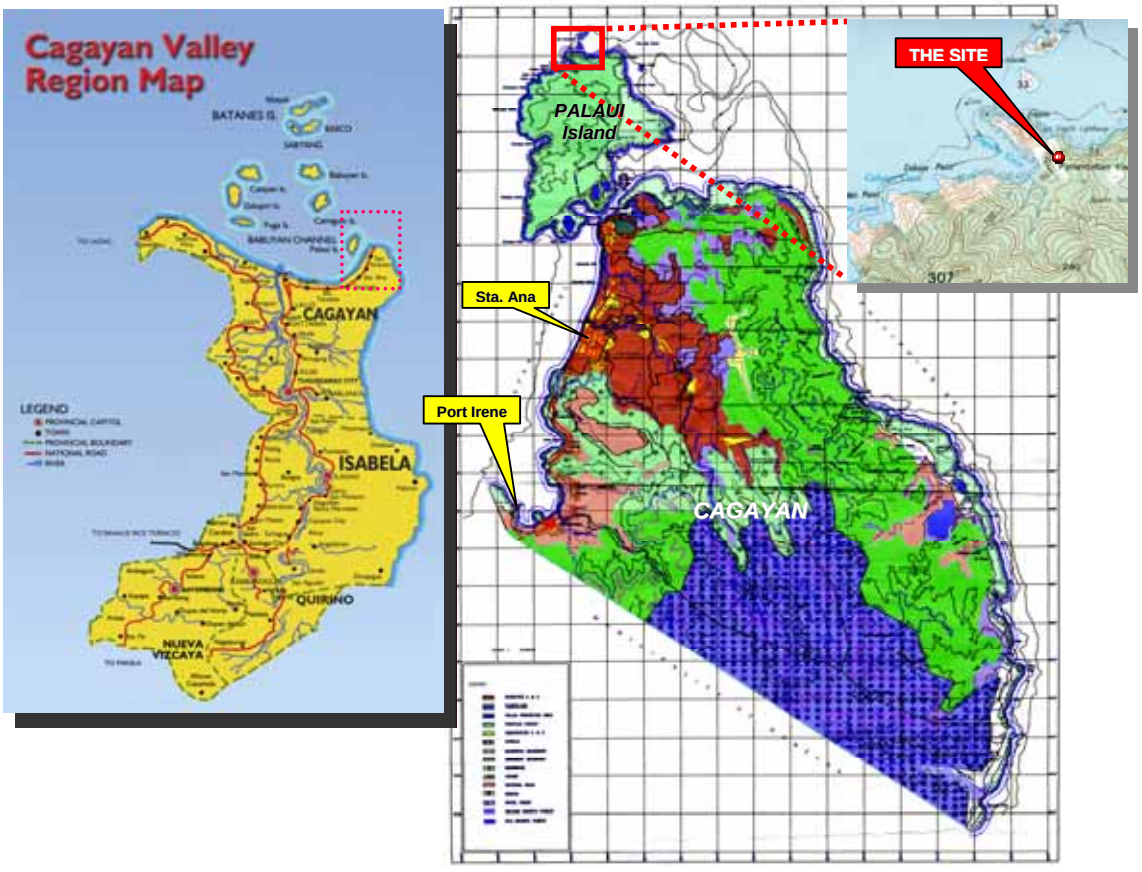
The alternate site recommended by the Port Administrator. (Photo: PNOC EDC)

1.2 Palaui Island

Next to be considered is Palaui Island that is located off the extreme north eastern tip of Luzon. The island is 10 km long by up to 4.5 km wide, and has a maximum elevation of 307 meters. It has an area of inter-tidal mudflats and sand flats with offshore coral reefs. The island provides the first significant area of mudflats for shorebirds crossing the Bashi Channel and Luzon Strait from Taiwan.

The exploration team hired an outrigger boat to get to Palaui Island. The trip took more than one hour, transversing the Pacific Ocean from mainland Sta. Ana, and going around the coral reefs that abound the island.

The exploration team took notice of a ridge in Cape Engaño adjacent to the site of the lighthouse. The site is strategic in the sense that it is the northernmost tip of the island and is therefore the most exposed area to the Northeast winds from the Pacific Ocean and the Southwest winds from the South China Sea. However, the entire island is a protected area under the Philippine National Integrated Protected areas System (NIPAS Act) since 28 August 1994 through Proclamation 447, thus any activity, especially operating a wind monitoring station necessitates a special land use permit through a resolution from the island's Protected Area Management Board. PNOC EDC anticipated that going through the process of securing the required permit would take a long time and decided instead to look for other areas.



1.3 Adeline Point

The PNOC EDC Project Engineers went back to the main island of Luzon to explore for a potential site. Adeline Point was mentioned by local guides. Adeline Point is located off the Eastern side of the town of Sta. Ana. It is exposed to the North East wind from the Pacific Ocean. Access to the site, however, takes longer by land, thus the exploration team hired an outrigger boat to go to the site along the shorelines. The trip took more than an hour from the beaches of San Vicente in Sta. Ana.

The exploration team identified a potentially good site for wind measurement as viewed from the boat. However, it is impossible for the boat to dock at the beach near the identified site because of sharp rocks and corals that abound the ocean floor so the team had to hike approximately a kilometer from the site where the boat could dock. Upon close inspection, the site was indeed clear of obstruction and is very much exposed to the wind and an ideal site for wind measurement.

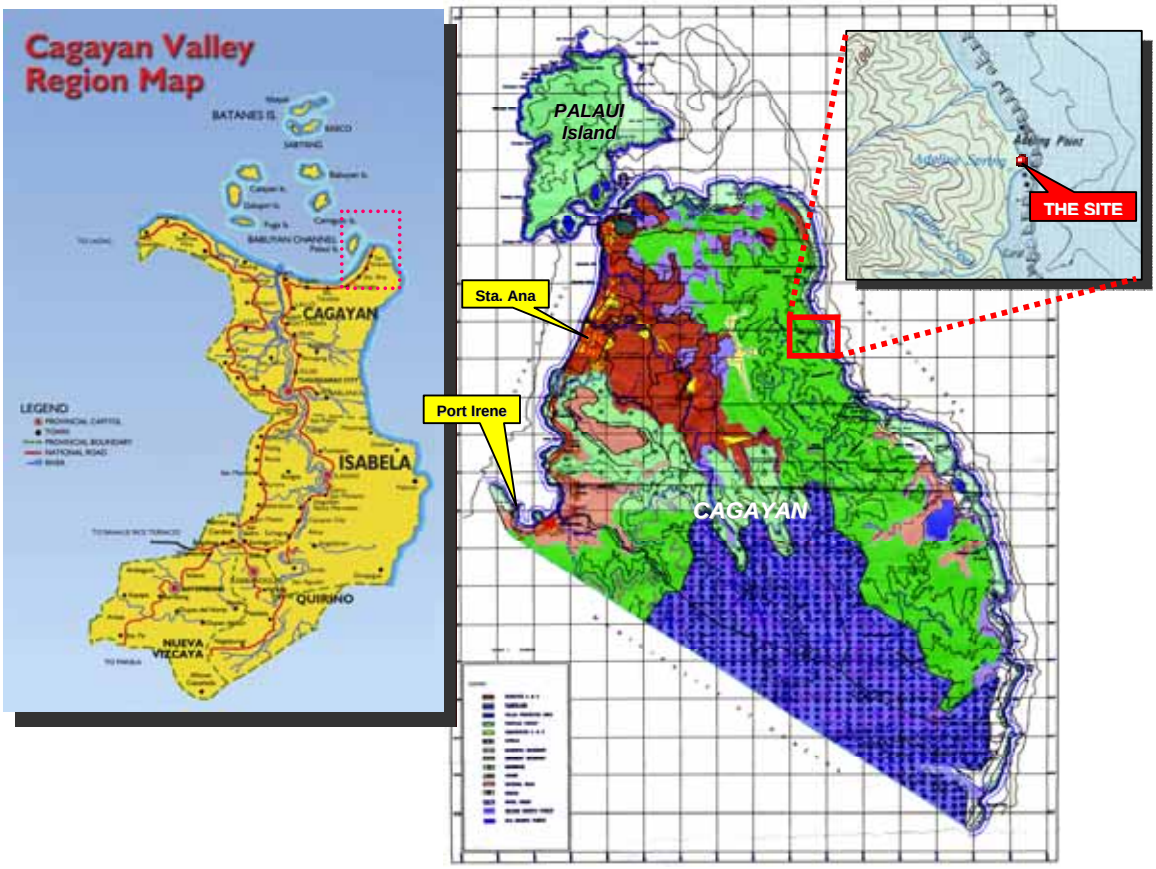
During the preparations for the land acquisition, it was found out that the land is classified as forest zone, thus requiring a special land use permit from the Department of Environment and Natural Resources (DENR). After further assessment, considering the access and the difficulty in securing the permit from the DENR as against the suitability of the site for wind measurement, the Team decided to abandon the area.

Adeline Point as viewed from the boat

The long hike going to Adeline Point

Sharp rocks fronting Adeline Point

View from the site in Adeline Point



1.4 Diora, Sta. Ana

An area in Barangay (small village) Diora was considered because of its accessibility (very near the Municipal Road). Furthermore, the site selected met the criteria of being plain, without much vegetation and open to both the prevailing wind directions. There are some coconut trees but these will not in anyway likely to affect the wind measurement activity for the given area.

The Diora site is very accessible

The Diora site is clear of obstruction

Site acquisition works commenced and the team found out that the selected area in Barangay Diora is owned by the Municipal Government of Sta. Ana. After discussions with the Mayor and the Municipal Council, PNOC EDC was granted permission to install the wind measurement station through a resolution supporting the project. The local government of Sta Ana granted PNOC EDC free access to their land and a permission to install the wind measurement equipment for a year of data gathering.

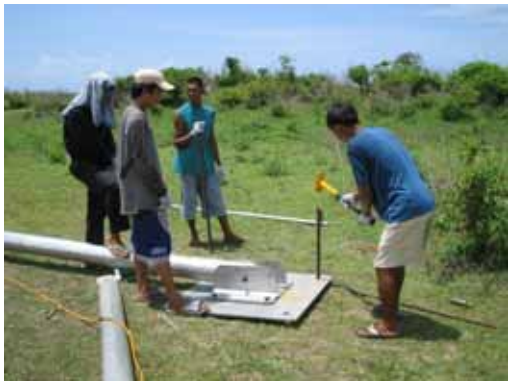
A site was finally secured in Diora, Sta. Ana, Cagayan Province. We will refer to this site as Sta. Ana. All the necessary permits were secured for the equipment installation in Sta. Ana, including the community information drives for local awareness. The PNOC EDC team proceeded with the mast installation.

2 Commissioning of Wind Measurement Equipment in Sta. Ana, Cagayan

Immediately after securing the necessary documents that allowed PNOC EDC to install its equipment at the specified site, PNOC EDC Engineers prepared and mobilized the equipment and engaged the services of six local residents of Sta. Ana to assist in the commissioning activity.

The EC ASEAN Project Team rented an NRG 9200 plus data logger and a 27-meter meteorological mast for use as wind measuring equipment. The equipment was transported to the site via land and installation was supervised by PNOC EDC Project Engineers. The following pictures show how the mast was installed.

Fastening the tower to the base plate



Drilling anchors through the base plate holes

Measuring Anchor Placements

Drilling of Anchors for the guy wires

Drilling of Anchors

Assembling the Tower Segments

Fastening the Guy Wires

Guy wires placed at respective anchors

Manual winch being prepared

Assembling the gin pole

Raising the gin pole

Placing the Instruments at the 27-meter level

Installing the lightning arrester and grounding

Installing the data logger shelter box

Connecting instrument cables to the logger

Raising-up the tower

Manual winch helped by motorized winch

Tower raised 45 degrees from ground level

Adjusting the guy wires tension

Tower almost erected

Straightening of the tower and tensioning of the guy wires


Tower fully erected


Re-tensioning of guy wires and tightening of nuts

Straitened tower

Grounding wires


Construction of security fence around the tower


Construction of security fence around the tower

The instrument was finally erected and the site was coded as Site No. 0201.

Below is the site and wind measuring equipment full specifications.

Site No.:	0201
Site Name:	Sta. Ana
Location:	Diora, Sta. Ana, Cagayan
Coordinates:	408440 2039903
Elevation:	10 meters above sea level
Date Commissioned:	12 September 2005
System Installed:	27-meter meteorological mast equipped with 2 levels of anemometers (27 meters and 10 meters heights) and a wind vane at 27 meters height NRG 9200 plus data logger

Table 1: Wind Measurement Station Data

3 Result of the Wind Measurement Campaign in Sta. Ana, Cagayan

Wind data were collected from the mast on a monthly basis for the period of September 2005 to August 2006. The data were checked for anomalies and the table below shows the months where there are data gaps. Apparently, the data logger registered errors and missed some data in the process. An error message of "Reboot stamp found!) Verify time and date" were found on the months of February, April and May. The instrument engineer in-charge of recovering the monthly data only found this out after the data on the chips were being processed. In his next visit the following month, the instrument was diligently inspected and the chip firmly secured.

Based on EDC's investigation, the problem may have been caused by defective chips as only two sets of two chips were used. The equipment was commissioned on September 13, thus only 62% of the entire month has data. On September 2005, the pair of memory chips installed that time began to have problems as can be seen from the percentage of data recovery and the apparent warning stamped on the chips. The replacement memory chips installed on the month of March did not lose any data. When the deteriorating chips were installed again on April, data loss was severe and even extended until the first few days of May before it was replaced with fresh new memory chips. The suspected memory chips were not used again and data recovery for the succeeding months were very good.

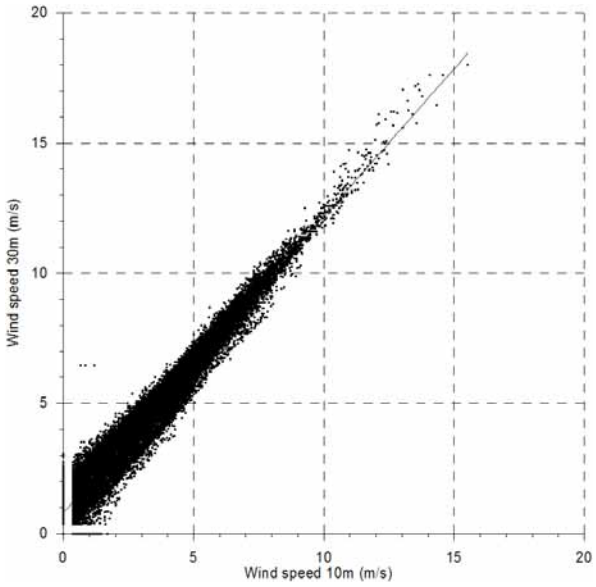
This is the first time PNOC EDC experienced such problem on data gaps that are caused by memory chip defects. The next time PNOC EDC will install memory chips, verification of their integrity must be assured first.

Sta. Ana, Cagayan

Year	Month	Percent Recovery	Remarks
2005	Sep	62.38%	September 13, 2005 Installed
2005	Oct	100.00%	
2005	Nov	99.98%	
2005	Dec	100.00%	
2006	Jan	100.00%	
2006	*Feb*	88.14%	(Reboot stamp found!) error on logger
2006	Mar	100.00%	
2006	*Apr*	29.61%	(Reboot stamp found!) error on logger
2006	*May*	87.59%	(Reboot stamp found!) error on logger
2006	June	100.00%	
2006	July	100.00%	
2006	Aug	100.00%	
2006	Sep	60.00%	
	Approx. total weighted data recovery	**85%**	

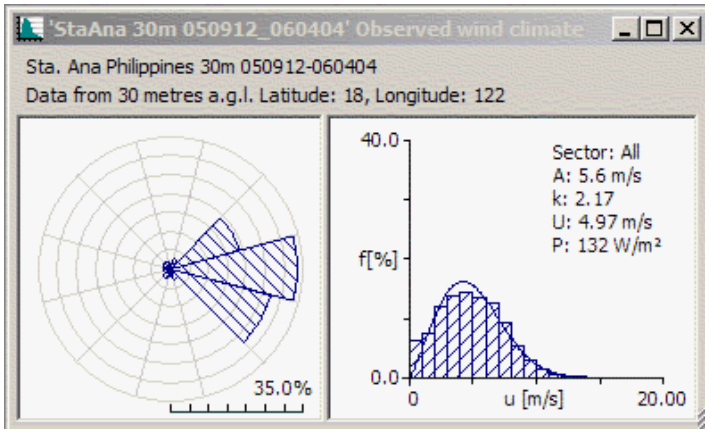
PNOC EDC tried to get data from the nearest weather bureau station but to no success. Therefore, only 85% of the required data were used as input to the WAsP software to arrive at the wind regime in the area.

The following graph shows the quality of the wind data in terms of the correlation between the data obtain from the two measurement heights.



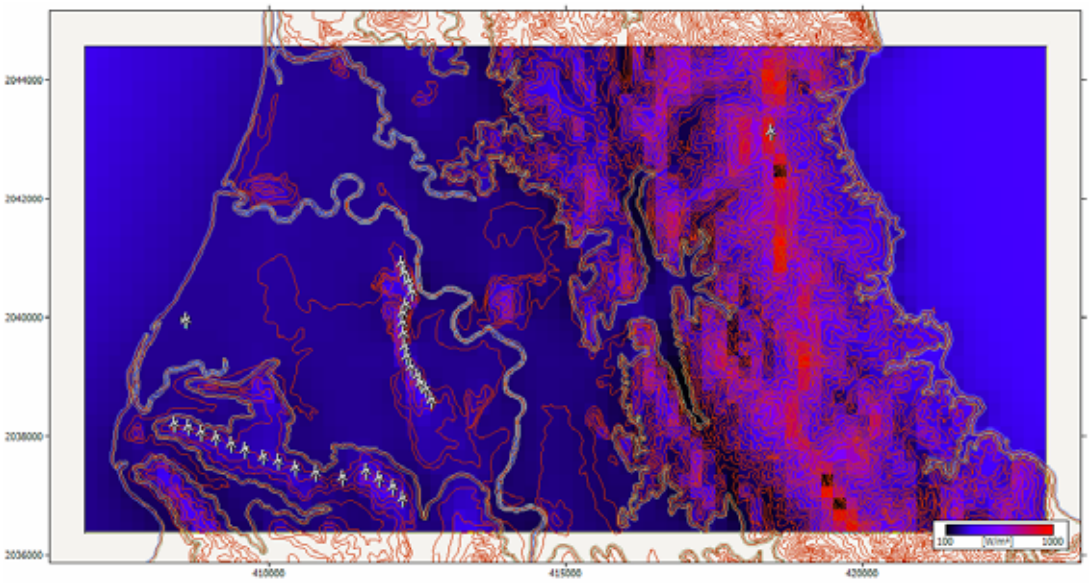
Comparison of wind data from 30 meters and 10 meters height

The wind data collection efficiency of 85% for the period covering September 2005 to August 2006 is somehow a low percentage based on industry standard of 95% data recovery. Loss of data was still experienced considering that the wind measurement equipment was inspected on a regular monthly basis, anomalies usually occurred one or two weeks after the scheduled inspections.



Sta. Ana Observed Wind Climate

Based on the calculations, the annual average wind speed in Sta. Ana is 4.97 m/s. This is low to be considered as a potential site for commercial wind power development. Good wind regimes can be found on top of the mountain ranges east of the location of the mast as can be seen from the graphical result of the Wasp run below. The height of mountain range is about 250 - 300 meters above sea level and the distance to the meteorological mast approximately 10 kilometers.



4 Site Investigation and Acquisition for Dinagat Island

During the course of site selection, PNOC EDC has not undertaken a wind resource campaign on small islands like the Dinagat Island. Though this island is not in the category of small island if one considers the other much smaller populated islands in the Philippines, Dinagat Island is small in terms of its being isolated from the Philippine national grid. The Philippine Wind Atlas prepared by the US National Renewable Energy Laboratory categorizes Dinagat Island as having a good to excellent wind potential. In addition, the island is exposed to the north east monsoon coming from the Pacific Ocean, which is the prevailing wind direction normally experienced in the Philippines. Also known by the local people to have strong winds as evidenced by frequent big and strong waves in the area, Dinagat Island was selected. PNOC Engineers searched for appropriate site in Dinagat for the installation of a wind monitoring station. The prime consideration is that the area must be open as much as possible to both the Northeast and Southwest monsoons. Furthermore, the area should be clear of obstruction, vegetation and is near to potential customers.

Dinagat is a big, seven-town island lying between Southern Leyte and Surigao del Norte, of which it is a part, within the newly formed Caraga region. The Island is about an hour's boat ride from Surigao City's port.

It has a total population based on the 2000 census of 106,951, with an annual growth rate of 1.55 percent in the 2000 census and a total land area of 80,205 hectares.

Around 54,223 hectares of the total 80,205 hectares of Dinagat Island are considered as mineral lands. Among minerals found abundantly are Nickel Silicate ores, Saprolite, and Limonite and Metallurgical Chromite, gold, and silver.

4.1 Rubenian, Basilisa

Rubenian in the Municipality of Basilisa was recommended by the local government authorities of Dinagat Island considering that the area is relatively elevated and open to both prevailing wind directions. However, upon further site assessment, the exploration team noted that the area is considerably far from the load center and access to the site would be a main constraint since the road that leads to the proposed site is unpaved and winding in addition to the rather remoteness of the area.

4.2 Wilson, San Jose

San Jose is one of the seven Municipalities in Dinagat Island which lies along the south-western part of the island. It is envisioned to be the urban center of Dinagat and part of this vision is having a sustainable development through the development of reliable power sources especially those from renewable energy sources. Generally sloping with only patches of lowland along the coast mostly developed into

settlements describes the basic geography of this town. It has twelve Barangays and one of these is Barangay Wilson which is considered to be the most appropriate site for the meteorological mast installation.




The site is appropriate in the sense that it is the most exposed area to the sea in this part of the Island plus the fact the future development and power demand will be coming from this area. An area in Barangay Wilson was then considered because of its accessibility and the site met the criteria of being plain, without much vegetation and open to the prevailing wind directions.

Upon further investigation, the team found out that this area in Barangay Wilson is owned by the Local Government. After some co ordinations with the Local Government Officials, PNOC EDC was granted permission to install the wind measurement station.

After all the necessary permits were secured for the equipment installation in Wilson, which will be referred to as Dinagat, the PNOC EDC team proceeded with the mast installation.

5 Commissioning of Wind Measurement Equipment in Dinagat Island

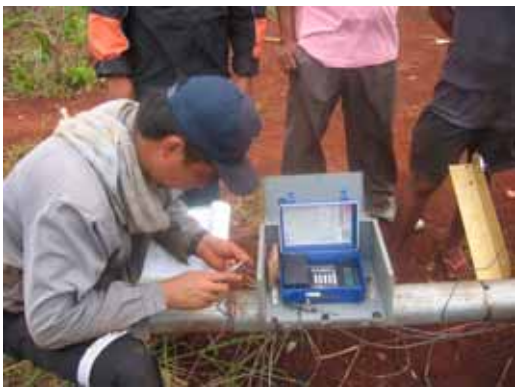
After securing the necessary documents and permits for the transport and installation of the equipment, the PNOC EDC team immediately proceeded to the area for site preparation and coordination with the Local Government of San Jose. As part of the installation strategy, PNOC EDC also engaged the services of eight local residents to assist in the installation and commissioning activities.

The EC ASEAN Project Team rented an NRG Symphonie data logger and a 30-meter meteorological mast for use as wind measuring equipment. The equipment was shipped by sea and installation was supervised by PNOC EDC Project Engineers. The installation and commissioning lasted for 1-1/2 days with no major problems encountered.

Pictures of transportation and installations are shown below.

Transport of Equipment to Boat

Equipment arrival at San Jose port



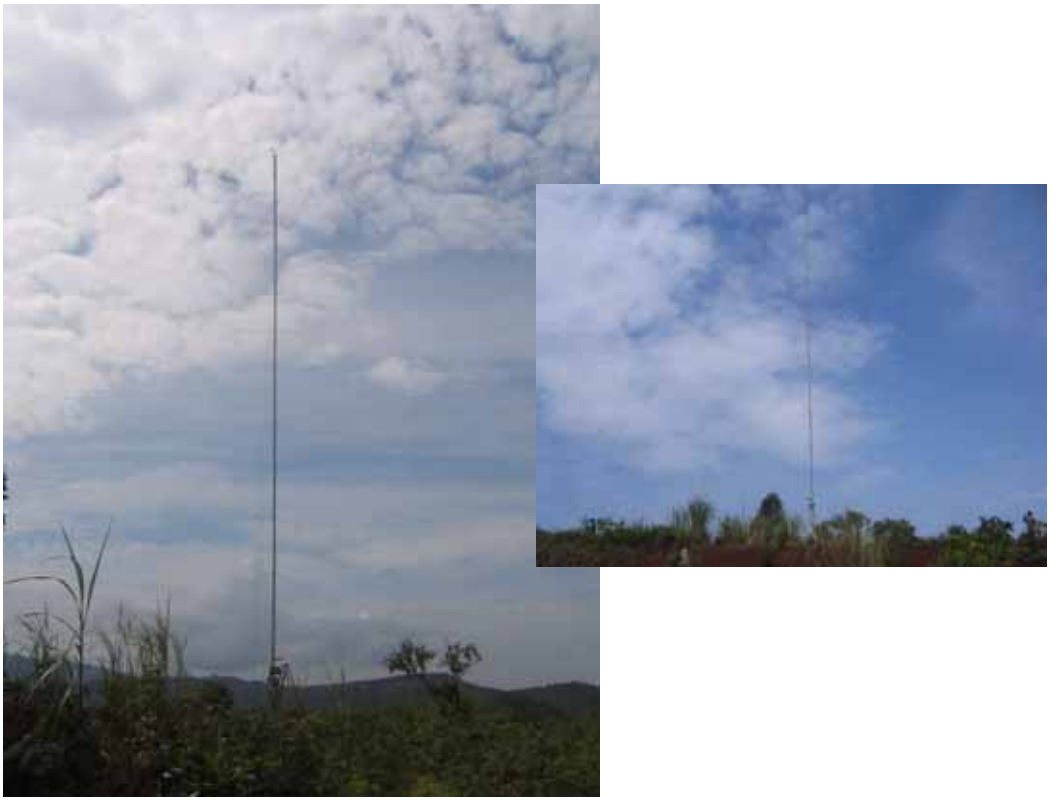
Instrument Installation and Cabling

Erecting the 30-meter Tower

Adjusting the tension of Guy Wires

Straightening Up the Tower

Figure 2: Map of the Dinagat Island showing the location of the installed meteorological mast.



Tower Now Fully Erected and Started Gathering Data

The site and equipment specifications are tabulated below.

Site No.:	0008
Site Name:	Dinagat
Location:	Wilson, San Jose, Dinagat Island, Surigao del Norte
Coordinates:	783679 1110752
Elevation:	159 meters above sea level
Date Commissioned:	12 August 2005
System Installed:	30-meter meteorological mast equipped with an anemometer and a wind vane at 30-meter level, another anemometer at 10-meter level and a pyrometer installed on top of the logger. NRG Symphonie type data logger

Table 2: Wind Measurement Station Data

6 Result of the Wind Measurement Campaign in Dinagat Island

Wind data were collected from the mast on a monthly basis for the period of September 2005 to August 2006. The data were checked for anomalies and were used as input to the WAsP software to arrive at the wind regime in the area.

The wind data collection efficiency for the period covering September 2005 to August 2006 is about 90%. This is somehow a low percentage based on industry standard of 95% data recovery. Loss of data was still experienced considering that the wind measurement equipment was inspected on a regular monthly basis, anomalies usually occurred one or two weeks after the scheduled inspections. Further to that, some form of vandalism happened at the site wherein signal cables from the instruments were cut.

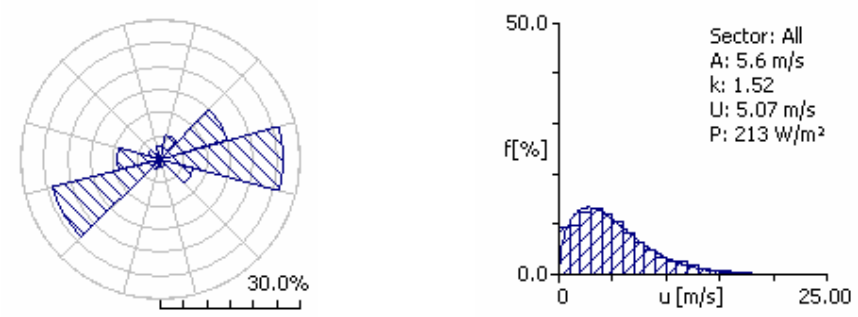
DINAGAT (N 10^0 02' 17.5" E 1250 35' 16.4")

Year	Month	Mean Speed (30m)	Per cent Recovery	Remarks
2005	Aug	4.22	60.01	
2005	Sep	6.23	100.00	
2005	Oct	3.55	100.00	
2005	Nov	3.77	100.00	
2005	***Dec***	***3.57***	***23.50***	*Data Cable Stolen*
2006	***Jan***	***5.20***	***24.15***	*Data Cable Stolen*
2006	Feb	6.96	100.00	
2006	Mar	5.18	100.00	
2006	Apr	4.59	100.00	
2006	May	3.61	100.00	
2006	June	3.11	100.00	
2006	July	7.74	100.00	
2006	Aug	4.56	100.00	
2006	Sep	5.17	88.94	

The data in Dinagat were compared in behaviour to three existing data taken from other PNOC EDC subject areas within the vicinity of Mindanao. One of the three appeared to fit and RISOE instructed PNOC EDC to fill in the gaps using their standard equation based on a mathematical relationship of the two sets of data.

Although the overall average wind speed from all directions is relatively low the annual average wind speeds from the dominating two directions East and Southwest is 5.9 and 5.2 m/s respectively. However, the result was actually lower than what

was expected from the site, considering that the whole island is very much exposed to the wind coming from the Pacific Ocean.



Dinagat Observed Wind Climate