NATIONAL INSTITUTE OF WIND ENERGY

WIND RESOURCE ASSESSMENT UNIT

Chennai-600100

REPORT ON WIND MONITORING STUDY AT PULIKKANAM TEA ESTATE, KOTTAYAM DISTRICT, KERALA

Final Report

Prepared for

M/s. Agency for Non-Conventional Energy and Rural Technology (ANERT).,

C-WET Quality System:

Document Reference	: NIWE/WR/CF-026/2017-2018
Project Code	: CWET/WR/CP-461/2012-2013
Report Revision	: Final
Report Status	: Issued
Report Type	: Confidential
Prepared by	: T. Suresh Kumar
Reviewed	: K. Boopathi
Approved by	: Rajesh Katyal
Date Issued	: 24.07.2017

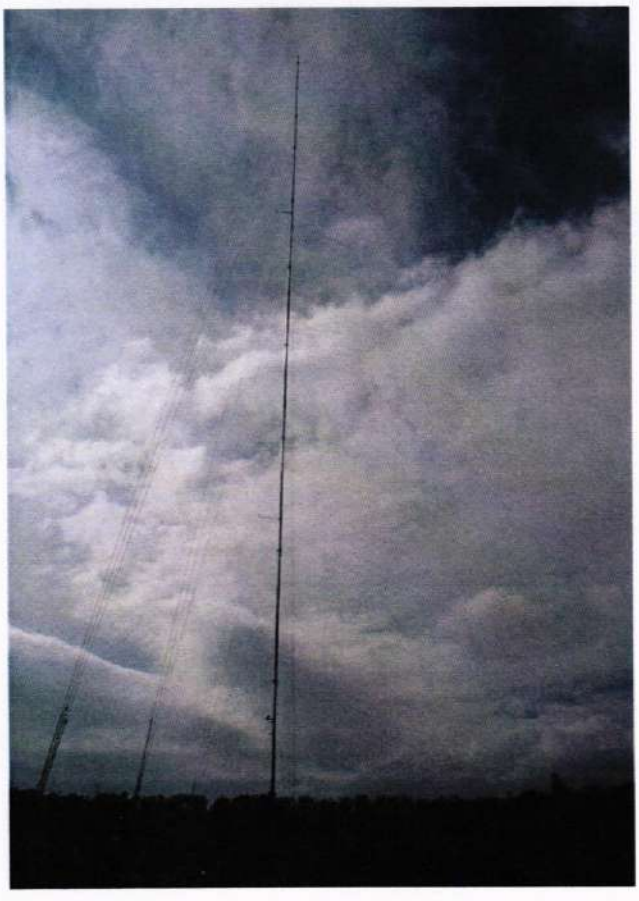
Quality Management System Certified to ISO 9001:2008

REPORT ON WIND MONITORING AT PULIKKANAM TEA ESTATE, KOTTAYAM, KERALA

Final Report

Prepared for

M/s. AGENCY FOR NON-CONVENTIONAL ENERGY AND RURAL TECHNOLOGY, THIRUVANANTHAPURAM



नीवे NIWE
(ISO 9001:2008)

WIND RESOURCE ASSESSMENT UNIT
NATIONAL INSTITUTE OF WIND ENERGY (NIWE)
Chennai 600 100

July 2017

NATIONAL INSTITUTE OF WIND ENERGY

WIND RESOURCE ASSESSMENT UNIT

EXECUTIVE SUMMARY

Agency for Non-Conventional Energy and Rural Technology (ANERT), Trivandrum vide their letter No. 4431/WRA/ANERT/2009 dated 22.11.2011 had approached National Institute of Wind Energy (NIWE), Chennai for taking up Wind Monitoring study at Pulikkanam Tea Estate, Kottayam district, Kerala. This report gives the results of the detailed analysis carried out about the wind characteristics at Pulikkanam Tea Estate, Kottayam district, Kerala.

The location Pulikkanam Tea Estate, Kottayam was selected for the study in may 2012 based on the Indian Wind atlas. The Wind Monitoring station at the proposed location was commissioned on 07.12.2014 with a 80m tall-guyed tubular mast with instrumentations at 80m south, 78m south, 50m and 20m levels. Wind speed sensors (Anemometer) were fixed at all the four levels mentioned above and the wind direction sensors (wind vane) were fixed at 78m & 48m levels. Two year data collection was completed in the month of December 2014 and the data recovery rate is 95.88%.

Based on the analysis of Two year data collected at Pulikkanam Tea Estate, the Mean Annual Wind Power Density (MAWPD) at 80m level for the period from January 2013 to December 2013 is found to be 220.94 W/m² & January 2014 to December 2014 is inadequate data. The predominant wind direction is found to be W for 2013.

Table of Contents

List of Figures

List of Tables & Annexure

REPORT ON WIND MONITORING STUDY AT PULIKKANAM TEA ESTATE, KOTTAYAM DISTRICT, KERALA

1.0. BACKGROUND

M/s. Agency for Non-Conventional Energy and Rural Technology *(ANERT), Trivandrum* vide their letter no. *4431/WRA/ANERT/2009 dated 22.11.2011* - approached NIWE for a proposal to measure wind characteristics by establishing a Wind Monitoring Study at Pulikkanam Tea Estate, Kottayam district, Kerala. Based on their request, NIWE submitted a project proposal on 05.12.2011 for the aforesaid study with 80m tall tubular met mast.

A Wind Monitoring Station was commissioned on 07.12.2012 and data collection was carried out till December 2014. This report gives the results of the feasibility study carried out for Two year.

2.0. OBJECTIVE

- To establish a 80m height wind monitoring station at Pulikkanam Tea Estate, Kerala
- To Collect wind data at various levels for 2 years, analysis of data
- Preparation and submission of wind monitoring study report.

3.0. SITE DESCRIPTION

The site is located at Koottikkal village, Kottayam District-Kerala and is approximately 2.07kms North town from Kolahalamedu. The orography of the site is Highly Complex terrain, on the western edge of Western ghats overlooking the plain and the soil type is known to be Laterite.

The geographical co-ordinates and elevation details of the site are given in the Table 1

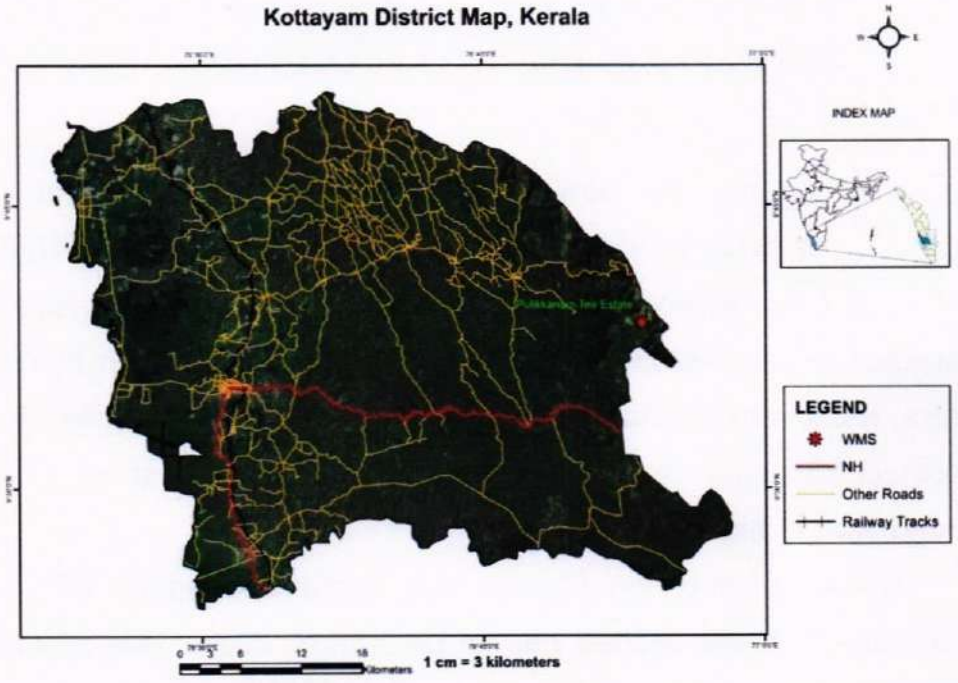


FIGURE 1: DISTRICT MAP OF KOTTAYAM

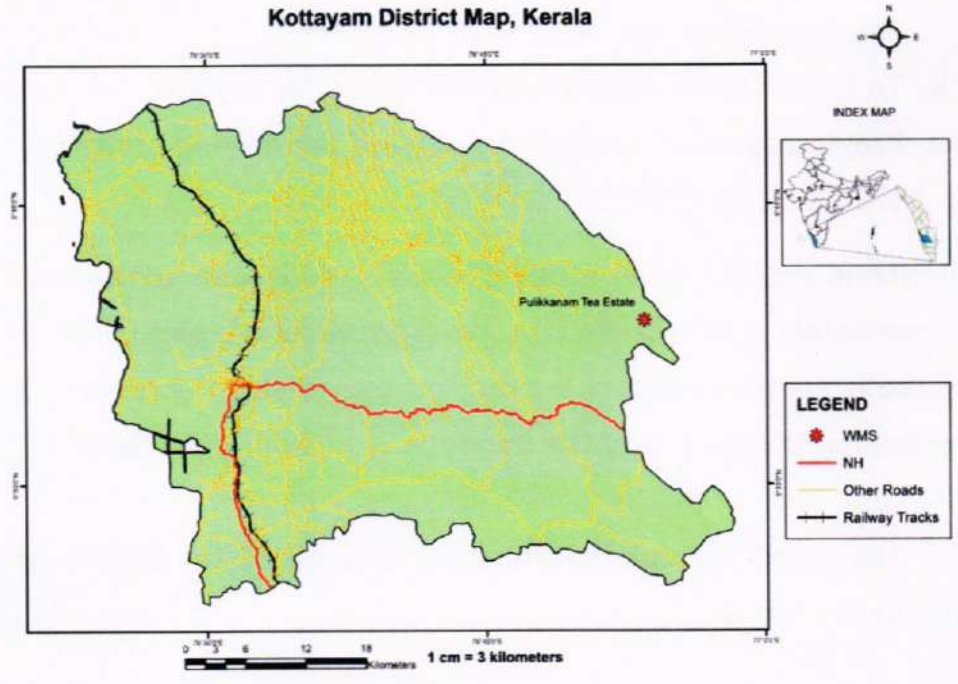


FIGURE.2. MAST LOCATION

TABLE 1: GLOBAL POSITION AND OTHER USEFUL INFORMATION OF PULIKKANAM TEA ESTATE WIND MONITORING STATION

Latitude	09° 39' 11.5" N
Longitude	76° 55' 3.0" E
Elevation	1114 m AMSL SOI Topomap No.58-C14
State	Kerala
District	Kottayam
Taluk	Kanjirappally
Village	Koottikkal
Nearest town	Elappara
Nearest Railway station	Ettumauur
Nearest Airport	Kochi
Orography	Highly Complex terrain, on the western edge of Western ghats overlooking the plain
Soil	Laterite soil
Earthquake	Zone III
Land Use	Open scrub
Physiographic Division	Semi Complex Terrain
Nearest C-WET mast location	KOLAHALAMEDU–2.07kms aerially towards North Latitude-09°40'14.70" Longitude-76°55'12.5"
Nearest wind farm in operation	Nil

4.0. DESCRIPTION OF THE MASTS &INSTRUMENTATION

A 80m tall guyed tubular wind mast was commissioned on 07.12.2012. A picture of the mast mounting arrangements and a panoramic view taken from the site is presented below (Fig 3).

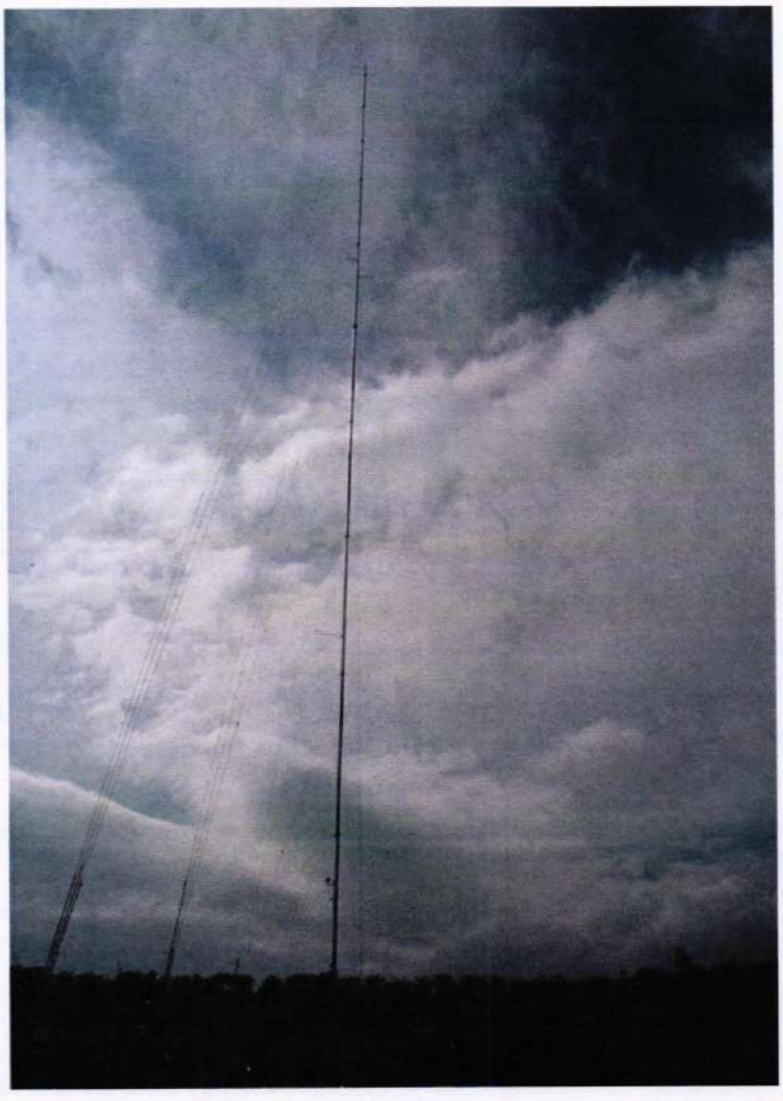


FIG 3. VIEW OF MET MAST

Anemometer (Wind speed sensors) were fixed at 80m south, 78m south, 50m and 20m and the Wind vane (wind direction sensors) were fixed at 78m and 48 m levels. The outputs from the sensors were connected to a sophisticated automatic data logger system that was kept about 1.5 m above ground level in locked weather proof housing. The

data logger used was imported from M/s. Second Wind Inc., USA. The sensors used were imported from M/s. NRG systems Inc, USA and the anemometers used were calibrated at M/s. SOHANSEN.DK. Denmark.

The calibration certificates for the instruments used are given in Annexure 3.

TABLE 2: DETAILS OF WIND SENSORS USED IN THE SITE

Sensors	Height	Sensor serial Number	Slope	offset
Anemometer	80m south	179500166128	0.75947	0.29658
	78m south	179500166130	0.76078	0.27547
	50m	179500166131	0.76073	0.27465
	20m	179500166132	0.75987	0.37450
Wind Vane	78m	601	-	-
	48m	602	-	-
Temperature sensor	10m	001	-	-
Pressure Sensor	8m	18174	-	-

5.0. DATA MEASUREMENT

In the data logger, wind speed and directions were sampled at 1 sec and 10 minutes average values were logged. Analysis was performed with 10 minutes average data as per International Electro technical Commission (IEC) standard. Data was stored in removable storage devices (Compact Flash Card) which were collected once in a month regularly by NIWE along with the battery replacement. Data was manually

validated to remove outlier events due to failed instruments and repeated values. Periodic quality check on the data was also carried out to avoid incorrectness in the computation and analysis. The collected data was compiled and interim report was sent to the client regularly as per the terms and conditions prescribed in the project proposal.

Monthly and Daily Mean Wind Speed values for the four heights (20m,
50m, 78m south and 80m south) are shown in Figure 8 of Annexure-1.

6.0. DETAILS OF DATA ANALYSED

The Wind Monitoring Station was commissioned at Pulikkanam Tea Estate, Kottayam as per the project terms & conditions and Two-year data collection was completed in the month of December 2014. As the data collection at the location was for Two year, the customer had been informed to NIWE in December 2014 that the data collection would be completed and terminates in the month of January 2015.

Analysis of the wind data has been performed using Matlab, MS Excel and Windographer. The data have been checked for quality & correctness, analyzed and details of the analysis/ results are given in Annexure-1. The consolidated annual wind data and wind data summary tables for the wind characteristics at Pulikkanan Tea Estate are given in Table 4 and Table 5 respectively of Annexure-1.

Mean Hourly Wind Speed, Monthly Mean Wind Speed and Monthly Wind Power Density values are shown graphically in Figure 4 to 6 of Annexure-1.

The Mean Hourly Wind Speed tables for the five heights viz., 80m south, 78m south, 50m and 20m are given in Table 6, 6A, 6B, 6C and 6D of Annexure-1. The graphical representations for the same are given in Figure 4, 4A, 4B, 4C and 4D of Annexure-1.

7.0. RESULTS

The data recovery rate is 95.88% for the period of measurement. The comparative details of various parameters are as follows:

Year	Mean Annual Wind Power Density(W/m2)			
	At height 20m (AGL)	At height 50m (AGL)	At height 78m south (AGL)	At height 80m south (AGL)
2012-2013	139.51	195.54	217.02	220.94

Year	Mean Annual Wind Speed (m/s)			
	At height 20m (AGL)	At height 50m (AGL)	At height 78m south (AGL)	At height 80m south (AGL)
2012-2013	4.73	5.37	5.59	5.57

Year	Mean Annual		
	Temperature ^{0} C	Air density Kg/m^3	Power law
2012-2013	20.02	1.050	0.12

7.1. WIND FREQUENCY DISTRIBUTION

A common method for displaying a year wind data is by wind frequency distribution, which shows the percentage of time that each wind speed occurs. Table 7, 7A, 7B, 7C and 7D of Annexure-1 show the month wise percentage frequency distribution for the five measurement heights viz., 20m, 50m, 78m south and 80m south.

Joint frequency distribution is another way to display the data, where the wind is classified by speed and also by direction. Table 8, 8A and 8B of Annexure-1 show the joint frequency distribution for 50m, 80m south and 78m south heights.

7.2. WIND ROSE

Two wind vanes have been installed at the site to measure the 10 minutes mean values of the wind direction. Monthly and Annual wind roses have been calculated to show the predominant wind direction at all the three heights. Figure 7, 7A, 7B & 7C of Annexure-1 show the monthly wind roses at 80m south, 78m south and 50m heights. From the wind roses, it is revealed that the wind is flowing predominantly from West (W) directions.

7.3. WIND SHEAR PROFILE

The wind shear profile at the site is useful to understand the wind speed variation with height. Figure 9 & 10 of Annexure-1shows the daily wind shear and monthly wind shear profiles. The vertical wind shear profile based on the measured data is given in Figure 11 of Annexure-1.

7.4. TURBULENCE INTENSITY (TI):

Turbulence Intensity is the basic measure of the turbulence of wind. Typically, 10% of TI is desired for minimal wear of wind turbine components. The turbulence intensity related graphs are shown in Figure 12 of Annexure-1.

The Mean Turbulence Intensity for the period of January 2013 to December 2013 (at 80m AGL) at 15m/s is 0.19 (19%) and January 2014 to December 2014 is inadequate data.

7.5. LONG TERM DATA FOR THE STUDY AREA

MERRA (The Modern Era Retrospective-Analysis for Research and Applications) data have been made available for the site as Table - 4 and Figure - 3. The latitude and longitude of the MERRA grid point nearby the study site is given below. This information gives the wind pattern during the period of January 2004 to December 2014 at 50m AMSL in the region of interest. This reanalysis data is helpful in understanding the long term variability of wind speed in the region of interest.

Latitude Range: 28°13' 36.8"

Longitude Range: 80°10' 20.9"

**AMSL – Above Mean Sea Level*

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
2004	3.1	3.1	2.9	1.8	4.9	6.7	6.0	6.5	3.7	3.5	3.8	4.0	4.2
2005	2.9	3.0	2.3	1.9	3.2	6.2	6.6	5.7	5.5	2.8	3.2	3.1	3.9
2006	3.6	3.4	1.8	2.1	4.4	5.5	6.9	5.8	4.5	3.2	2.8	4.2	4.0
2007	4.1	3.0	2.4	1.7	4.1	5.7	6.1	5.3	5.1	3.2	2.6	4.1	4.0
2008	3.3	2.7	3.0	2.2	4.4	5.9	5.9	4.8	4.9	2.8	2.8	3.6	3.9
2009	3.5	3.1	2.3	2.9	4.1	6.3	7.0	5.1	5.1	3.2	3.1	3.5	4.1
2010	3.3	2.6	2.7	2.1	3.9	6.0	6.2	5.9	3.9	3.8	2.4	3.1	3.8
2011	3.6	2.7	2.5	2.1	4.1	6.2	6.2	5.9	5.1	2.7	3.2	3.6	4.0
2012	3.3	3.4	2.6	2.3	4.3	6.0	6.0	5.5	4.9	3.2	2.7	4.1	4.0
2013	3.5	3.3	2.8	2.2	4.0	6.8	7.0	5.2	5.0	3.4	2.7	3.4	4.1
2014	3.4	2.6	2.8	2.2	3.2	6.1	6.8	5.5	4.3	2.5	3.3	3.5	3.8
						AVG							4.0

TABLE 3: MERRA REANALYSIS DATA FOR PULIKKANAM TEA ESTATE, KERALA (JANUARY 2004 – DECEMBER 2014)

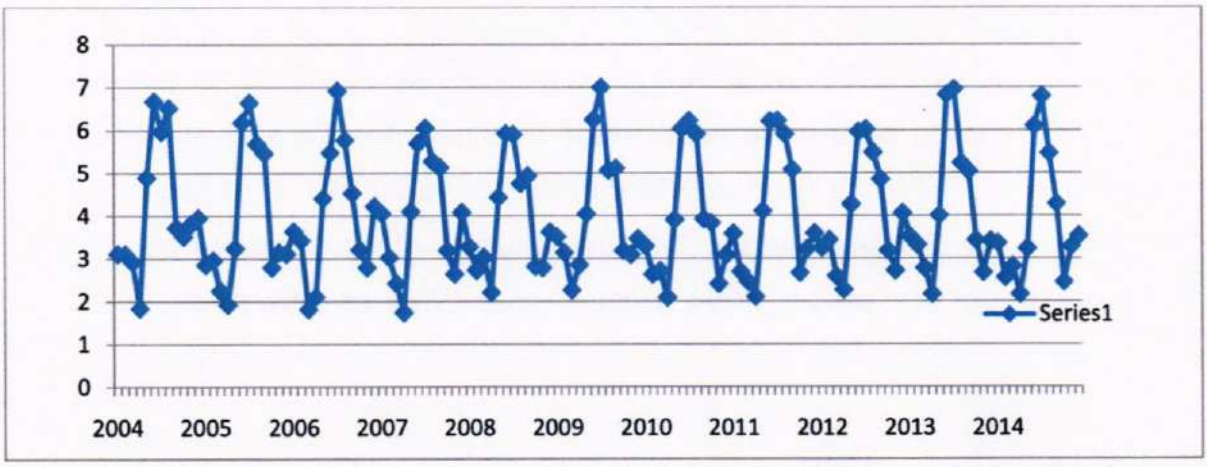


FIGURE.3A. MERRA REANALYSIS DATA FOR PULIKKANAM TEA ESTATE, KERALA (JANUARY 2004 – DECEMBER 2014))

8.0. CONCLUSION

Based on the analysis of Two year data collected at Pulikkanam Tea Estate, the Mean Annual Wind Power Density (MAWPD) at 80m level for the period from January 2013 to December 2013 is found to be 220.94 W/m^2 and January 2014 to December 2014 is inadequate data.

The monthly average wind speed at 80m level for the period from January 2013 to December 2013 is found to be 5.57 m/s and January 2014 to December 2014 is inadequate data. The predominant wind direction is found to be W for 2013.

It has been observed from the analysis and the computation of WPD at 80m level, that the site is having promising wind power potential for the development of large-scale wind power projects at the area of interest.

PULIKKANAM TEA ESTATE 2013 - 2015

Annexure-1

Data (Tables & Figures)

NATIONAL INSTITUTE OF WIND ENERGY

WIND RESOURCE ASSESSMENT UNIT

PULIKKANAM TEA ESTATE

STATE	:	KERALA
DISTRICT	:	KOTTAYAM
TALUK	:	KANJIRAPPALLY
VILLAGE	:	KOOTTIKKAL
LATITUDE	:	09° 39' 11.5" N
LONGITUDE	:	76° 55' 3.0" E
ELEVATION	:	1114M AMSL
INSTRUMENTS USED	:	NOMAD-2
PERIOD OF DATA	:	JANUARY 2013 to DECEMBER 2014
COMMISSIONED ON	:	07/12/2012
MAST HEIGHT	:	80m
MEASURED WIND SPEED AT 80m south AGL (January 2013 to December 2013)	:	5.57 m/s
MEASURED WIND SPEED AT 78m south AGL (January 2013 to December 2013)	:	5.59 m/s
MEASURED WIND SPEED AT 50m AGL (January 2013 to December 2013)	:	5.37 m/s
MEASURED WIND POWER DENSITY AT 80m south AGL (January 2013 to December 2013)	:	220.94 W/m^2
MEASURED WIND POWER DENSITY AT 78m south AGL (January 2013 to December 2013)	:	217.02 W/m^2
MEASURED WIND POWER DENSITY AT 50m AGL (January 2013 to December 2013)	:	195.54 W/m^2

MEASURED WIND SPEED AT 80m south AGL (January 2014 to December 2014)	:	--
MEASURED WIND SPEED AT 78m south AGL (January 2014 to December 2014)	:	--
MEASURED WIND SPEED AT 50m AGL (January 2014 to December 2014)	:	--
MEASURED WIND POWER DENSITY AT 80m south AGL (January 2014 to December 2014)	:	--
MEASURED WIND POWER DENSITY AT 78m south AGL (January 2014 to December 2014)	:	--
MEASURED WIND POWER DENSITY AT 50m AGL (January 2014 to December 2014)	:	--
SOI TOPO MAP NUMBER	:	***58-C14***

1st Year

Jan 2013 - Dec 2013

PULIKKANAM

TABLE 1
CONSOLIDATED TABLE

	JAN-13	FEB-13	MAR-13	APR-13	MAY-13	JUN-13	JUL-13	AUG-13	SEP-13	OCT-13	NOV-13	DEC-13	ANNUAL
Monthly Mean Wind Speed (m/s)													
20m	4.89	4.52	3.75	2.12	2.94	7.98	8.44	5.55	4.84	3.03	3.83	4.90	4.73
50m	5.27	4.87	4.09	2.58	3.65	9.06	9.50	6.32	5.66	3.78	4.30	5.41	5.37
78m S	5.50	5.10	4.33	2.67	3.89	9.36	9.78	6.65	5.81	3.85	4.59	5.59	5.59
80m S	5.41	5.10	4.27	2.51	3.77	9.52	9.92	6.62	5.93	3.91	4.40	5.53	5.57
Monthly Wind Power Density (Watts/Sq.m)													
20m	122.33	107.43	87.55	10.97	24.20	380.52	388.95	165.23	119.55	27.86	92.13	147.41	139.51
50m	154.79	135.32	110.19	15.92	39.37	557.96	556.05	237.23	176.82	46.97	120.59	195.31	195.54
78m S	183.35	157.66	129.46	17.61	47.75	600.53	600.04	265.70	190.97	52.37	140.41	218.35	217.02
80m S	171.03	149.54	121.92	16.94	45.39	640.22	636.92	270.47	202.90	54.09	133.56	208.27	220.94
Power Law Index (PLI)													
	0.07	0.09	0.09	0.12	0.18	0.13	0.12	0.13	0.15	0.18	0.10	0.09	0.12
Energy Pattern Factor													
20m	2.03	2.20	3.16	2.19	1.82	1.41	1.22	1.85	1.99	1.92	3.17	2.37	2.11
50m	2.05	2.23	3.07	1.77	1.53	1.42	1.23	1.79	1.85	1.66	2.94	2.34	1.99
78m S	2.14	2.25	3.04	1.77	1.54	1.39	1.21	1.73	1.84	1.76	2.82	2.36	1.99
80m S	2.09	2.13	2.97	2.03	1.61	1.40	1.23	1.78	1.84	1.73	3.04	2.33	2.02
Air Density (kg/m^3)													
	1.033	1.055	1.052	1.050	1.052	1.058	1.059	1.046	1.056	1.046	1.032	1.057	1.050
Temperature (^{0} C)													
	--	20.89	21.77	21.19	21.14	19.10	18.76	19.01	19.17	19.59	20.20	19.42	20.02
Turbulance Intensity (at 80m agl)													
At 15m/s : 0.19													
Data Availability (Based on 10 Minutes Interval)													
	4464	4032	4464	4320	4464	4320	4464	4463	4320	4459	4320	4464	

Based on Data January 2013 to December 2013

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

PULIKKANAM

TABLE 2
SUMMARY OF WIND DATA

Month	Monthly Mean wind speed (m/s)			Monthly standard Deviation (m/s)			Peak wind speed(m/s) (date/year/Time of occurance)			Prevailing wind Direction	
	(50m)	(80m south)	(78m south)	(50m)	(80m south)	(78m south)	(50m)	(80m south)	(78m south)	(48m)	(78m)
Jan-13	5.27	5.41	5.50	0.68	0.67	0.67	15.00 17-01-2013 4:00	15.45 17.01.20133 4:10	16.00 17.01.2013 4:10	NE	NE
Feb-13	4.87	5.10	5.10	0.73	0.71	0.73	16.00 13.02.2013 11:00	16.04 13.02.2013 11:00	16.56 13.02.2013 11:00	NE	NE
Mar-13	4.09	4.27	4.33	0.68	0.67	0.68	18.39 06.03.2013 1:00	18.93 06.03.2013 1:00	19.45 06.03.2013 1:00	NE	W
Apr-13	2.58	2.51	2.67	0.56	0.56	0.55	11.09 28.04.2013 22:30	11.76 28.04.2013 22:30	11.99 28.04.2013 22:30	W	W
May-13	3.65	3.77	3.89	0.75	0.76	0.73	12.24 31.05.2013 8:40	12.76 31.05.2013 8:40	12.34 31.05.2013 8:40	W	W
Jun-13	9.06	9.52	9.36	1.73	1.72	1.68	20.63 14.06.2013 12:20	21.17 14.06.2013 12:20	20.62 14.06.2013 12:20	W	W
Jul-13	9.50	9.92	9.78	1.92	1.91	1.87	19.19 24.07.2013 10:20	19.61 24.07.2013 10:20	19.11 24.07.2013 10:20	W	W
Aug-13	6.32	6.62	6.65	1.29	1.30	1.30	18.70 01.08.2013 3:30	19.30 01.08.2013 3:30	18.75 01.08.2013 3:30	NW	NW
Sep-13	5.66	5.93	5.81	1.10	1.10	1.09	16.62 17.09.2013 6:20	17.26 17.09.2013 4:30	16.72 17.09.2013 4:30	W	W
Oct-13	3.78	3.91	3.85	0.73	0.73	0.72	11.93 08.10.2013 3:50	12.98 08.10.2013 3:50	12.50 08.10.2013 3:50	W	W
Nov-13	4.30	4.40	4.59	0.64	0.64	0.64	17.97 11.04.2013 10:00	18.51 11.04.2013 10:00	18.59 11.04.2013 10:00	NE	NE
Dec-13	5.41	5.53	5.59	0.68	0.66	0.67	17.01 24.12.2013 08:40	16.85 24.12.2013 08:40	17.34 24.12.2013 08:40	NE	NE
ANNUAL	**5.37**	**5.57**	**5.59**	**0.96**	**0.95**	**0.94**	**20.63 14.06.2013 12:20**	**21.17 14.06.2013 12:20**	**20.62 14.06.2013 12:20**	**W**	**W**

Based on Data January 2013 to December 2013

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 6

PULIKKANAM

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	5.75	5.92	6.54	6.99	7.20	7.41	7.58	7.78	7.66	7.01	6.03	5.07	4.55	4.17	3.96	3.96	3.84	3.59	3.15	3.64	4.11	4.26	4.67	5.02	5.41
FEB	4.69	4.81	5.16	5.54	6.19	6.20	6.57	6.76	6.91	6.80	6.46	5.68	5.15	4.83	4.49	4.51	4.46	4.54	4.07	3.52	3.55	3.66	3.87	4.01	5.10
MAR	3.58	4.16	4.31	4.43	5.31	5.77	5.63	5.58	5.06	4.52	4.05	4.26	4.42	4.95	4.80	4.78	4.30	3.72	3.08	3.18	3.04	3.17	3.16	3.30	4.27
APR	2.37	1.96	1.79	1.80	1.81	1.86	1.70	2.07	1.91	2.15	2.34	2.80	3.25	3.66	3.86	3.82	3.55	3.21	2.68	2.35	2.19	2.46	2.61	2.15	2.51
MAY	3.59	3.49	3.41	3.78	3.89	3.89	3.81	3.46	3.33	3.02	2.78	3.07	3.74	4.05	4.41	4.47	4.37	4.28	4.01	3.98	4.14	3.95	3.91	3.74	3.77
JUN	9.56	9.49	9.67	9.43	9.80	9.61	9.67	9.35	9.30	9.22	9.35	9.33	8.98	9.12	9.46	9.41	9.67	9.22	9.39	9.64	9.85	9.98	10.15	9.79	9.52
JUL	9.93	10.15	10.06	10.51	10.13	10.38	10.32	9.68	9.92	9.78	9.66	9.24	9.32	9.40	9.68	9.67	9.90	9.95	9.91	10.13	10.20	10.19	9.94	9.97	9.92
AUG	7.03	7.10	7.08	7.22	7.03	7.19	6.94	6.48	6.34	6.09	5.99	5.89	6.04	6.16	6.25	6.83	7.21	7.39	7.33	7.01	6.74	6.82	6.84	7.03	6.75
SEP	5.48	5.56	5.57	5.69	5.43	5.81	5.67	5.51	5.48	5.46	5.30	5.67	5.68	6.09	6.56	6.64	6.51	6.57	6.72	6.55	6.49	5.97	5.88	5.96	5.93
OCT	3.77	3.80	3.69	3.67	4.09	4.32	3.98	4.06	3.84	3.43	3.39	3.68	3.92	4.16	4.17	4.38	4.33	4.35	4.32	3.79	3.79	3.43	3.70	3.66	3.91
NOV	4.36	4.79	4.95	4.90	5.14	5.53	5.17	5.32	5.35	5.04	4.32	4.22	3.85	3.79	3.75	3.60	3.24	3.14	3.40	3.95	4.21	4.35	4.61	4.60	4.40
DEC	6.60	6.56	6.20	6.34	6.65	6.62	6.57	6.15	6.02	5.71	5.43	5.08	4.63	4.34	4.26	4.22	4.12	4.02	4.18	4.68	5.10	5.90	6.58	6.79	5.53
Annual	5.56	5.65	5.70	5.86	6.06	6.22	6.13	6.02	5.93	5.68	5.43	5.33	5.29	5.39	5.47	5.52	5.46	5.33	5.19	5.20	5.28	5.35	5.49	5.50	5.59

SENSOR HEIGHT: 80m

Based on Data January 2013 to December 2013

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 6 A

PULIKKANAM

MEAN HOURLY WIND SPEED

MONTH	OO	O1	O2	O3	O4	O5	O6	O7	O8	O9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	5.86	6.03	6.65	7.12	7.36	7.56	7.72	7.93	7.81	7.13	6.12	5.11	4.57	4.17	3.96	3.97	3.86	3.65	3.21	3.71	4.20	4.34	4.77	5.12	5.50
FEB	4.70	4.81	5.19	5.60	6.26	6.25	6.66	6.86	7.02	6.90	6.52	5.70	5.13	4.78	4.41	4.44	4.38	4.48	4.02	3.45	3.44	3.58	3.81	3.98	5.10
MAR	3.66	4.24	4.38	4.54	5.42	5.90	5.76	5.75	5.24	4.63	4.05	4.24	4.38	4.91	4.75	4.73	4.29	3.72	3.10	3.22	3.09	3.22	3.22	3.41	4.33
APR	2.52	2.18	2.08	2.09	2.12	2.16	2.06	2.32	2.13	2.31	2.45	2.84	3.24	3.63	3.82	3.79	3.53	3.26	2.76	2.49	2.37	2.65	2.82	2.40	2.67
MAY	3.78	3.72	3.64	3.99	4.06	4.08	4.01	3.67	3.42	3.15	2.90	3.11	3.77	4.05	4.40	4.48	4.37	4.29	4.10	4.09	4.26	4.06	4.02	3.91	3.89
JUN	9.42	9.35	9.50	9.27	9.63	9.44	9.47	9.16	9.09	9.06	9.20	9.17	8.83	8.96	9.32	9.28	9.52	9.05	9.24	9.49	9.68	9.83	10.00	9.64	9.36
JUL	9.81	10.04	9.95	10.38	9.98	10.24	10.18	9.56	9.78	9.66	9.51	9.11	9.17	9.25	9.52	9.50	9.73	9.80	9.80	10.01	10.09	10.06	9.81	9.85	9.78
AUG	7.08	7.14	7.11	7.24	7.03	7.23	7.00	6.51	6.38	6.14	6.07	5.99	6.10	6.19	6.26	6.81	7.17	7.37	7.33	7.02	6.77	6.87	6.88	7.09	6.78
SEP	5.37	5.42	5.45	5.51	5.30	5.64	5.53	5.39	5.39	5.38	5.27	5.63	5.63	5.99	6.43	6.52	6.40	6.44	6.57	6.41	6.38	5.86	5.75	5.87	5.81
OCT	3.66	3.71	3.58	3.56	3.98	4.20	3.83	3.98	3.83	3.46	3.43	3.70	3.92	4.16	4.16	4.36	4.31	4.32	4.25	3.71	3.68	3.31	3.62	3.54	3.85
NOV	4.66	5.07	5.28	5.18	5.46	5.81	5.42	5.58	5.56	5.20	4.45	4.30	3.92	3.84	3.79	3.64	3.30	3.24	3.55	4.10	4.42	4.61	4.84	4.86	4.59
DEC	6.69	6.65	6.31	6.46	6.78	6.76	6.73	6.28	6.13	5.77	5.49	5.10	4.64	4.33	4.23	4.20	4.10	4.02	4.21	4.71	5.16	5.96	6.65	6.89	5.59
Annual	5.60	5.70	5.76	5.91	6.11	6.27	6.20	6.08	5.98	5.73	5.45	5.33	5.28	5.36	5.42	5.48	5.41	5.30	5.18	5.20	5.30	5.36	5.52	5.55	5.60

SENSOR HEIGHT:78m

Based on Data January 2013 to December 2013

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 6 B

PULIKKANAM

MEAN HOURLY WIND SPEED

MONTH	OO	O1	O2	O3	O4	O5	O6	O7	O8	O9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	5.48	5.66	6.24	6.80	7.03	7.17	7.29	7.44	7.37	6.94	6.09	5.10	4.54	4.13	3.94	3.94	3.84	3.59	3.14	3.54	3.93	4.04	4.46	4.74	5.27
FEB	4.39	4.47	4.81	5.16	5.82	5.83	6.21	6.48	6.57	6.71	6.50	5.63	5.05	4.71	4.33	4.40	4.33	4.39	3.87	3.30	3.24	3.36	3.53	3.70	4.87
MAR	3.37	3.90	4.04	4.20	5.09	5.55	5.38	5.29	4.87	4.53	4.02	4.18	4.30	4.82	4.66	4.64	4.16	3.56	2.94	2.93	2.79	2.87	2.87	3.10	4.09
APR	2.37	1.99	1.95	1.95	1.93	1.98	1.92	2.20	2.06	2.26	2.47	2.92	3.27	3.63	3.83	3.79	3.48	3.18	2.63	2.40	2.28	2.50	2.61	2.25	2.58
MAY	3.44	3.34	3.25	3.65	3.71	3.71	3.63	3.33	3.25	3.07	2.82	3.06	3.67	4.01	4.34	4.37	4.24	4.13	3.84	3.85	4.02	3.79	3.69	3.51	3.65
JUN	9.09	9.02	9.15	8.96	9.30	9.16	9.17	8.81	8.85	8.78	8.97	8.94	8.61	8.79	9.09	9.00	9.23	8.75	8.88	9.20	9.37	9.49	9.66	9.28	9.06
JUL	9.46	9.73	9.61	10.07	9.65	9.93	9.89	9.24	9.47	9.34	9.27	8.86	8.95	9.09	9.33	9.30	9.51	9.53	9.48	9.75	9.75	9.71	9.47	9.56	9.50
AUG	6.63	6.72	6.68	6.81	6.62	6.84	6.58	6.17	6.06	5.87	5.84	5.76	5.89	5.98	6.07	6.57	6.92	7.09	6.98	6.67	6.37	6.46	6.43	6.61	6.44
SEP	5.19	5.26	5.19	5.38	5.13	5.53	5.38	5.18	5.21	5.31	5.15	5.49	5.49	5.87	6.32	6.38	6.23	6.30	6.44	6.26	6.16	5.66	5.56	5.65	5.66
OCT	3.66	3.63	3.57	3.47	3.87	4.04	3.75	3.85	3.71	3.41	3.41	3.68	3.89	4.08	4.09	4.29	4.20	4.25	4.08	3.68	3.65	3.32	3.59	3.56	3.78
NOV	4.33	4.73	4.93	4.85	5.07	5.38	5.07	5.27	5.32	5.10	4.39	4.19	3.78	3.71	3.57	3.39	3.10	2.96	3.19	3.66	3.87	4.26	4.46	4.57	4.30
DEC	6.35	6.33	6.00	6.15	6.44	6.44	6.45	6.06	5.97	5.79	5.57	5.16	4.64	4.34	4.03	4.01	4.08	3.90	4.04	4.50	4.92	5.65	6.36	6.53	5.41
Annual	5.31	5.40	5.45	5.62	5.80	5.96	5.89	5.78	5.73	5.59	5.38	5.25	5.17	5.26	5.30	5.34	5.28	5.13	4.96	4.98	5.03	5.09	5.22	5.26	5.38

SENSOR HEIGHT : 50m

Based on Data January 2013 to December 2013

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 6 C

PULIKKANAM

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	4.94	5.09	5.64	6.26	6.42	6.54	6.62	6.77	6.91	6.66	5.79	4.89	4.40	3.98	3.75	3.80	3.69	3.41	3.06	3.27	3.54	3.61	4.04	4.22	4.89
FEB	3.99	4.00	4.32	4.61	5.19	5.26	5.64	5.91	6.14	6.40	6.21	5.37	4.89	4.48	4.17	4.21	4.15	4.19	3.65	3.10	2.96	3.12	3.27	3.37	4.52
MAR	3.01	3.37	3.53	3.68	4.50	4.95	4.79	4.60	4.47	4.25	3.86	4.05	4.17	4.63	4.50	4.42	4.00	3.43	2.78	2.68	2.55	2.50	2.55	2.74	3.75
APR	1.74	1.33	1.25	1.27	1.30	1.38	1.24	1.46	1.65	1.97	2.38	2.88	3.19	3.47	3.62	3.52	3.19	2.85	2.19	1.90	1.67	1.80	1.94	1.68	2.12
MAY	2.44	2.31	2.29	2.62	2.72	2.73	2.67	2.43	2.59	2.56	2.49	2.84	3.34	3.61	3.90	3.91	3.75	3.54	3.22	3.12	3.24	2.96	2.78	2.45	2.94
JUN	8.02	7.91	7.92	7.94	8.19	7.99	8.03	7.73	7.85	7.84	7.97	7.93	7.64	7.74	8.04	7.92	8.15	7.75	7.79	8.12	8.25	8.27	8.47	8.15	7.98
JUL	8.44	8.63	8.57	9.01	8.57	8.83	8.82	8.20	8.47	8.31	8.26	7.83	7.88	8.04	8.26	8.16	8.43	8.42	8.44	8.64	8.72	8.61	8.49	8.53	8.44
AUG	5.77	5.85	5.84	5.92	5.75	5.96	5.73	5.43	5.30	5.15	5.16	5.07	5.26	5.33	5.37	5.79	6.06	6.25	6.16	5.87	5.65	5.71	5.61	5.71	5.65
SEP	4.38	4.37	4.32	4.46	4.20	4.54	4.44	4.35	4.43	4.58	4.51	4.95	4.88	5.15	5.54	5.59	5.53	5.53	5.63	5.38	5.29	4.82	4.64	4.75	4.84
OCT	2.73	2.64	2.55	2.46	2.74	2.93	2.69	2.82	3.07	2.98	3.08	3.37	3.53	3.64	3.64	3.73	3.58	3.50	3.30	2.95	2.83	2.47	2.69	2.67	3.02
NOV	3.59	4.00	4.23	4.23	4.31	4.56	4.37	4.67	4.91	4.74	4.20	4.08	3.67	3.64	3.55	3.34	2.90	2.67	2.77	3.17	3.36	3.51	3.67	3.90	3.83
DEC	5.62	5.63	5.38	5.45	5.60	5.64	5.68	5.33	5.46	5.43	5.33	4.91	4.42	4.12	3.98	3.95	3.78	3.52	3.64	4.03	4.38	4.99	5.61	5.76	4.90
Annual	4.56	4.59	4.65	4.83	4.96	5.11	5.06	4.97	5.10	5.07	4.94	4.85	4.77	4.82	4.86	4.86	4.77	4.59	4.39	4.35	4.37	4.36	4.48	4.49	4.74

SENSOR HEIGHT : 20m

Based on Data January 2013 to December 2013

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 7

PULIKKANAM

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	ANNUAL
0.0-1.0	5.91	8.66	14.09	25.95	8.65	0.14	0.02	1.08	4.75	13.06	16.30	6.18	8.73
1.0-2.0	9.14	9.10	14.09	20.76	18.41	0.83	0.11	3.43	7.52	14.96	14.98	10.35	10.31
2.0-3.0	14.52	13.96	18.19	25.86	27.58	3.31	0.29	9.70	13.96	23.14	19.58	15.68	15.48
3.0-4.0	12.68	16.32	17.70	20.53	23.88	5.76	1.52	16.51	15.39	22.07	11.39	14.74	14.87
4.0-5.0	11.78	14.06	12.25	6.11	13.15	6.53	3.97	18.51	15.95	14.02	7.66	10.15	11.18
5.0-6.0	12.50	10.76	5.98	0.53	5.82	8.82	8.42	16.80	14.12	8.45	6.55	10.13	9.07
6.0-7.0	10.86	8.09	5.42	0.05	1.39	11.46	12.95	10.44	9.47	3.25	6.67	9.72	7.48
7.0-8.0	8.47	7.02	4.17	0.12	0.69	13.87	16.42	7.01	6.46	0.94	5.51	8.13	6.57
8.0-9.0	6.59	5.16	1.75	0.05	0.18	13.29	17.36	5.04	4.19	0.09	4.68	4.82	5.26
9.0-10.0	2.91	3.03	1.61	0.02	0.25	11.67	13.71	3.34	3.03	0.00	3.13	2.73	3.79
10.0-11.0	2.02	2.16	1.90	0.02	0.00	9.21	10.53	2.69	2.41	0.02	1.74	2.33	2.92
11.0-12.0	1.55	1.07	1.39	0.00	0.00	6.11	8.13	1.86	1.78	0.00	0.90	2.06	2.07
12.0-13.0	0.96	0.37	0.72	0.00	0.00	3.96	4.03	1.73	0.65	0.00	0.37	1.55	1.19
13.0-14.0	0.11	0.12	0.45	0.00	0.00	2.52	1.88	0.87	0.23	0.00	0.30	0.72	0.60
14.0-15.0	0.00	0.12	0.18	0.00	0.00	1.34	0.54	0.69	0.07	0.00	0.21	0.47	0.30
15.0-16.0	0.00	0.00	0.04	0.00	0.00	0.74	0.09	0.27	0.02	0.00	0.02	0.16	0.11
16.0-17.0	0.00	0.00	0.02	0.00	0.00	0.39	0.00	0.02	0.00	0.00	0.02	0.09	0.05
17.0-18.0	0.00	0.00	0.04	0.00	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.01
18.0-19.0	1.23	1.22	0.96	0.00	0.00	5.00	5.94	1.48	1.62	0.02	1.00	1.21	1.64
19.0-20.0	0.78	0.94	0.94	0.02	0.00	4.21	4.59	1.21	0.79	0.00	0.74	1.12	1.28
20.0-21.0	0.94	0.67	0.78	0.00	0.00	3.19	4.59	0.96	0.97	0.00	0.56	0.96	1.14

SENSOR HEIGHT: 20m **Based on Data January 2013 to December 2014**

Range 0--1 Extends from 0 to 0.99 m/s &
1-- 2 Extends from 1 to 1.99 m/s etc.

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 7A

PULIKKANAM

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	ANNUAL
0.0-1.0	6.29	8.23	10.93	12.48	1.81	0.00	0.00	0.65	1.37	4.91	9.40	4.84	5.08
1.0-2.0	8.27	8.21	13.60	19.81	9.36	0.37	0.02	1.41	3.63	9.12	15.51	8.65	8.16
2.0-3.0	11.76	12.57	17.09	29.79	23.39	1.44	0.27	4.95	11.06	20.00	20.16	14.40	13.91
3.0-4.0	11.87	15.05	17.88	24.77	29.17	4.93	0.67	12.73	15.81	23.92	14.03	13.26	15.34
4.0-5.0	10.75	13.72	13.35	11.04	19.51	5.60	1.93	17.61	15.02	18.88	7.11	10.73	12.10
5.0-6.0	12.23	10.94	6.83	1.74	10.60	6.69	5.15	18.91	14.79	11.98	6.62	9.72	9.68
6.0-7.0	10.66	7.54	4.86	0.09	4.03	8.17	9.23	12.86	12.04	6.90	6.55	9.92	7.74
7.0-8.0	8.71	7.84	5.00	0.09	1.14	11.25	12.05	9.12	7.50	3.05	5.49	7.86	6.59
8.0-9.0	8.24	5.73	2.96	0.07	0.58	11.27	14.58	5.44	5.60	1.03	5.07	6.50	5.59
9.0-10.0	4.66	4.32	1.72	0.09	0.18	12.73	15.55	4.59	4.17	0.09	4.24	4.35	4.72
10.0-11.0	2.62	2.55	1.46	0.00	0.16	10.19	13.13	3.02	3.19	0.09	2.82	2.40	3.47
11.0-12.0	1.28	1.81	1.79	0.02	0.04	8.40	10.08	2.53	2.52	0.02	1.20	1.79	2.63
12.0-13.0	1.66	0.92	1.12	0.00	0.02	6.48	7.57	1.75	1.46	0.00	0.79	2.11	1.99
13.0-14.0	0.72	0.30	0.72	0.00	0.00	4.65	5.06	1.25	1.11	0.00	0.37	1.75	1.33
14.0-15.0	0.25	0.17	0.36	0.00	0.00	3.08	2.67	1.43	0.51	0.00	0.23	0.87	0.80
15.0-16.0	0.02	0.07	0.18	0.00	0.00	2.18	1.12	0.85	0.12	0.00	0.23	0.54	0.44
16.0-17.0	0.00	0.02	0.09	0.00	0.00	1.27	0.67	0.65	0.09	0.00	0.14	0.29	0.27
17.0-18.0	0.00	0.00	0.02	0.00	0.00	0.79	0.13	0.16	0.00	0.00	0.05	0.02	0.10
18.0-19.0	1.41	1.34	0.69	0.00	0.09	5.49	7.35	1.77	1.62	0.07	1.48	1.21	1.88
19.0-20.0	1.21	1.22	0.81	0.00	0.07	5.19	5.89	1.32	1.57	0.02	1.34	1.19	1.65
20.0-21.0	0.76	0.89	0.81	0.02	0.02	4.40	5.40	1.39	1.34	0.00	0.79	0.96	1.40

SENSOR HEIGHT: 50m **Based on Data January 2013 to December 2013**

Range 0--1 Extends from 0 to 0.99 m/s &
1-- 2 Extends from 1 to 1.99 m/s etc.

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 7B

PULIKKANAM

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	ANNUAL
0.0-1.0	7.33	8.16	8.65	11.71	1.99	0.00	0.00	1.03	2.20	7.06	7.36	4.53	5.00
1.0-2.0	6.99	7.56	13.17	18.70	7.86	0.30	0.02	1.30	3.66	8.62	14.44	8.11	7.56
2.0-3.0	11.31	12.08	17.18	29.14	20.16	1.09	0.20	3.97	10.19	18.03	18.98	15.28	13.13
3.0-4.0	11.42	13.69	18.17	25.23	25.87	3.68	0.47	9.77	13.94	22.07	15.28	12.57	14.35
4.0-5.0	10.53	14.31	13.73	12.36	21.84	5.58	1.59	15.06	14.26	17.88	8.01	9.63	12.06
5.0-6.0	10.75	10.04	6.94	2.29	12.95	5.83	3.92	17.34	13.40	12.68	6.55	9.25	9.33
6.0-7.0	10.26	7.54	4.91	0.19	6.16	7.20	7.66	16.09	12.99	7.91	5.95	9.99	8.07
7.0-8.0	8.47	7.32	4.37	0.14	1.75	10.76	11.40	10.06	8.96	3.90	6.34	7.82	6.77
8.0-9.0	7.68	6.20	4.48	0.07	0.76	11.92	14.25	7.13	6.37	1.41	4.95	6.65	5.99
9.0-10.0	6.21	5.13	1.81	0.09	0.29	12.80	15.70	5.02	4.26	0.34	4.42	4.88	5.08
10.0-11.0	3.58	3.30	1.48	0.05	0.22	11.09	13.73	3.56	3.43	0.04	3.47	2.89	3.90
11.0-12.0	2.13	2.18	1.28	0.02	0.09	8.89	11.02	2.62	2.62	0.04	1.81	2.04	2.89
12.0-13.0	1.14	1.46	1.70	0.00	0.04	6.97	8.29	2.02	1.76	0.02	1.04	1.86	2.19
13.0-14.0	1.08	0.52	0.92	0.00	0.00	4.81	6.05	1.43	1.16	0.00	0.51	2.02	1.54
14.0-15.0	0.87	0.27	0.74	0.00	0.00	3.87	2.89	1.55	0.51	0.00	0.37	1.28	1.03
15.0-16.0	0.22	0.17	0.20	0.00	0.00	2.27	1.77	0.96	0.25	0.00	0.21	0.63	0.56
16.0-17.0	0.02	0.05	0.16	0.00	0.00	1.53	0.69	0.76	0.07	0.00	0.19	0.47	0.33
17.0-18.0	0.00	0.00	0.04	0.00	0.00	0.60	0.22	0.22	0.00	0.00	0.07	0.11	0.11
18.0-19.0	2.37	1.84	0.78	0.05	0.18	6.34	7.57	1.95	1.88	0.04	1.94	1.61	2.21
19.0-20.0	1.21	1.46	0.76	0.00	0.04	5.53	6.27	1.73	1.55	0.00	1.57	1.28	1.78
20.0-21.0	1.23	1.29	0.58	0.00	0.04	4.35	6.29	1.41	1.18	0.04	1.20	1.14	1.56

SENSOR HEIGHT: 78m **Based on Data January 2013 to December 2013**

Range 0--1 Extends from 0 to 0.99 m/s &
1-- 2 Extends from 1 to 1.99 m/s etc.

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 7C

PULIKKANAM

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	ANNUAL
0.0-1.0	6.92	6.75	10.35	18.17	3.25	0.00	0.00	0.90	1.55	6.72	13.15	5.17	6.08
1.0-2.0	7.08	7.86	11.94	18.01	8.78	0.28	0.02	1.32	3.36	7.93	13.22	7.59	7.28
2.0-3.0	11.31	11.48	16.51	26.06	20.12	1.13	0.20	4.26	9.31	17.94	16.18	14.58	12.42
3.0-4.0	11.98	14.36	17.76	22.52	26.39	3.80	0.52	9.95	14.58	21.68	14.40	12.61	14.21
4.0-5.0	11.25	14.98	14.14	12.34	20.61	5.42	1.64	15.82	14.61	18.91	7.69	10.30	12.31
5.0-6.0	11.00	11.11	7.59	2.27	12.23	6.06	3.97	18.22	13.91	12.66	6.62	9.88	9.63
6.0-7.0	10.15	7.61	4.91	0.21	5.69	6.83	7.59	15.48	12.99	8.15	6.16	10.17	7.99
7.0-8.0	8.74	7.37	4.41	0.16	1.57	10.49	10.98	9.61	8.33	4.03	6.16	7.89	6.64
8.0-9.0	7.62	6.30	4.19	0.09	0.69	10.76	13.49	6.41	6.41	1.41	5.23	6.41	5.75
9.0-10.0	6.14	5.06	1.95	0.07	0.36	12.13	14.65	4.55	4.21	0.43	4.14	4.68	4.86
10.0-11.0	3.07	3.25	1.52	0.07	0.16	10.90	13.84	3.56	3.52	0.07	3.26	2.80	3.84
11.0-12.0	1.79	1.98	1.34	0.02	0.11	9.10	11.00	2.49	2.50	0.04	1.60	1.77	2.81
12.0-13.0	1.21	1.22	1.66	0.00	0.04	7.18	8.45	2.08	2.34	0.02	1.06	2.17	2.29
13.0-14.0	1.21	0.32	0.87	0.00	0.00	5.23	6.63	1.46	1.13	0.00	0.37	1.88	1.59
14.0-15.0	0.43	0.25	0.45	0.00	0.00	4.07	3.36	1.41	0.74	0.00	0.28	1.01	1.00
15.0-16.0	0.11	0.07	0.25	0.00	0.00	2.66	2.35	1.08	0.35	0.00	0.25	0.76	0.66
16.0-17.0	0.00	0.02	0.07	0.00	0.00	1.90	0.76	0.92	0.14	0.00	0.14	0.31	0.36
17.0-18.0	0.00	0.00	0.04	0.00	0.00	0.97	0.43	0.34	0.02	0.00	0.05	0.00	0.15
18.0-19.0	1.93	1.76	0.90	0.07	0.09	6.34	7.06	1.90	1.85	0.02	1.85	1.55	2.11
19.0-20.0	1.14	1.49	0.67	0.00	0.07	5.60	6.92	1.81	1.67	0.04	1.46	1.25	1.84
20.0-21.0	0.99	1.04	0.67	0.00	0.04	4.65	5.47	1.43	1.46	0.02	1.02	0.99	1.48

SENSOR HEIGHT: 80m **Based on Data January 2013 to December 2013**

Range 0--1 Extends from 0 to 0.99 m/s &
1-- 2 Extends from 1 to 1.99 m/s etc.

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 8

PULIKKANAM

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED

Deg/ (m/s)	345-15	15-45	45-75	75-105	105-135	135-165	165-195	195-225	225-255	255-285	285-315	315-345	ANNUAL
0.0-1.0	0.43	0.30	0.29	0.21	0.18	0.25	0.46	0.48	0.55	0.62	0.52	0.46	4.8
1.0-2.0	0.76	0.65	0.61	0.38	0.21	0.20	0.54	0.80	1.25	1.31	0.84	0.59	8.1
2.0-3.0	1.05	0.95	1.40	0.64	0.15	0.19	0.41	0.94	2.61	2.89	1.14	0.83	13.2
3.0-4.0	0.85	0.79	2.23	0.77	0.06	0.04	0.18	0.71	2.80	3.08	1.08	0.84	13.4
4.0-5.0	0.43	0.44	2.99	1.00	0.03	0.02	0.06	0.28	1.55	2.44	1.35	0.96	11.6
5.0-6.0	0.11	0.23	3.44	0.93	0.00	0.02	0.05	0.20	0.78	2.84	2.38	0.80	11.8
6.0-7.0	0.01	0.19	4.15	0.61	0.00	0.01	0.02	0.07	0.84	3.33	1.97	0.27	11.5
7.0-8.0	0.00	0.12	3.64	0.39	0.00	0.00	0.03	0.04	0.54	1.78	1.00	0.06	7.6
8.0-9.0	0.00	0.12	3.15	0.23	0.00	0.00	0.04	0.02	0.38	1.30	0.55	0.01	5.8
9.0-10.0	0.00	0.04	2.26	0.09	0.00	0.00	0.03	0.01	0.40	1.04	0.34	0.00	4.2
10.0-11.0	0.00	0.04	1.63	0.05	0.00	0.00	0.02	0.00	0.28	0.93	0.21	0.00	3.2
11.0-12.0	0.00	0.02	0.91	0.02	0.00	0.00	0.00	0.00	0.21	0.68	0.09	0.00	1.9
12.0-13.0	0.00	0.02	0.59	0.01	0.00	0.00	0.00	0.00	0.19	0.45	0.06	0.00	1.3
13.0-14.0	0.00	0.01	0.45	0.00	0.00	0.00	0.00	0.00	0.14	0.21	0.01	0.00	0.8
14.0-15.0	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.09	0.11	0.00	0.00	0.5
15.0-16.0	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.04	0.06	0.00	0.00	0.2
16.0-17.0	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.1
17.0-18.0	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18.0-19.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19.0-20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Total	3.6	3.9	28.2	5.3	0.6	0.7	1.9	3.6	12.7	23.1	11.5	4.8	100.0

SENSOR HEIGHT: 50m

Based on Data January 2013 to December 2013

Range 0--1 Extends from 0 to 0.99 m/s &
1-- 2 Extends from 1 to 1.99 m/s etc.

TABLE 8A

PULIKKANAM

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED

Deg/ (m/s)	345-15	15-45	45-75	75-105	105-135	135-165	165-195	195-225	225-255	255-285	285-315	315-345	ANNUAL
0.0-1.0	0.59	0.31	0.33	0.21	0.21	0.29	0.39	0.45	0.73	0.71	0.66	0.51	5.4
1.0-2.0	0.68	0.59	0.52	0.38	0.18	0.22	0.40	0.63	1.15	1.22	0.88	0.61	7.5
2.0-3.0	0.85	0.77	1.20	0.65	0.21	0.17	0.42	0.93	2.38	2.58	1.22	0.77	12.1
3.0-4.0	0.65	0.73	1.97	0.84	0.07	0.06	0.18	0.72	2.78	2.92	1.18	0.71	12.8
4.0-5.0	0.43	0.39	2.73	0.87	0.03	0.01	0.08	0.29	1.70	2.20	1.07	0.86	10.7
5.0-6.0	0.21	0.19	3.26	0.93	0.01	0.02	0.05	0.19	0.69	2.06	2.08	1.01	10.7
6.0-7.0	0.03	0.15	3.85	0.61	0.00	0.01	0.03	0.14	0.81	3.33	2.08	0.49	11.5
7.0-8.0	0.01	0.06	3.86	0.39	0.00	0.01	0.03	0.06	0.66	2.21	1.44	0.14	8.9
8.0-9.0	0.00	0.08	3.30	0.24	0.00	0.00	0.04	0.02	0.45	1.37	0.72	0.03	6.2
9.0-10.0	0.00	0.04	2.68	0.10	0.00	0.00	0.03	0.02	0.45	1.15	0.44	0.00	4.9
10.0-11.0	0.00	0.02	1.82	0.04	0.00	0.00	0.03	0.02	0.37	0.91	0.28	0.00	3.5
11.0-12.0	0.00	0.02	1.14	0.02	0.00	0.00	0.01	0.00	0.29	0.70	0.14	0.00	2.3
12.0-13.0	0.00	0.01	0.72	0.01	0.00	0.00	0.00	0.00	0.24	0.42	0.07	0.00	1.5
13.0-14.0	0.00	0.01	0.52	0.00	0.00	0.00	0.00	0.00	0.18	0.22	0.04	0.00	1.0
14.0-15.0	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.12	0.11	0.01	0.00	0.6
15.0-16.0	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.07	0.05	0.00	0.00	0.3
16.0-17.0	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.00	0.00	0.1
17.0-18.0	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.0
18.0-19.0	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19.0-20.0	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Total	3.5	3.4	28.5	5.3	0.7	0.8	1.7	3.5	13.1	22.2	12.3	5.1	100.0

SENSOR HEIGHT: 78m

Based on Data January 2013 to December 2013

Range 0--1 Extends from 0 to 0.99 m/s &
1-- 2 Extends from 1 to 1.99 m/s etc.

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 8B

PULIKKANAM

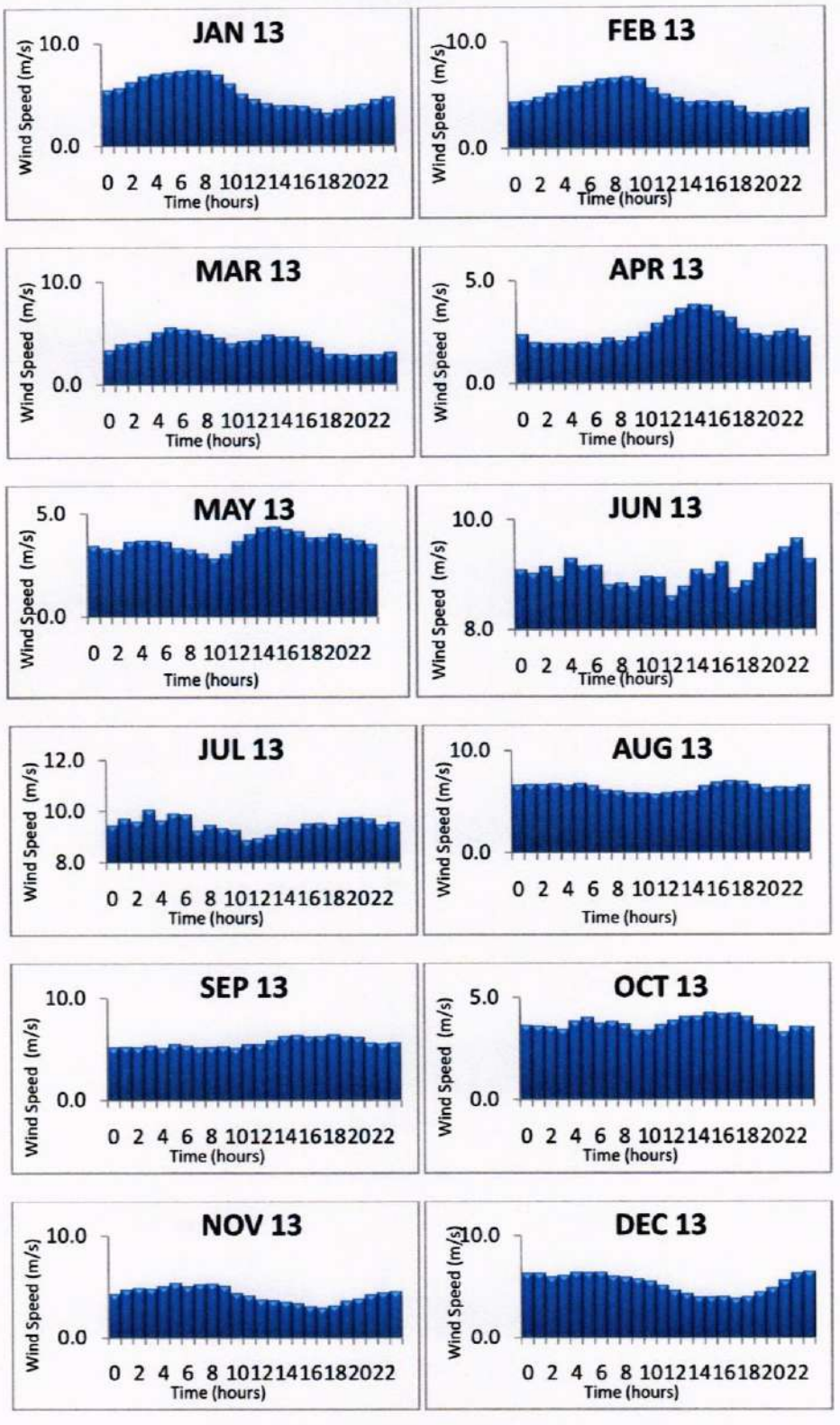
JOINT FREQUENCY DISTRIBUTION OF WIND SPEED

Deg/ (m/s)	345-15	15-45	45-75	75-105	105-135	135-165	165-195	195-225	225-255	255-285	285-315	315-345	ANNUAL
0.0-1.0	0.55	0.42	0.46	0.34	0.26	0.37	0.51	0.59	0.91	0.86	0.76	0.60	6.6
1.0-2.0	0.58	0.52	0.53	0.38	0.18	0.17	0.42	0.63	1.20	1.28	0.93	0.62	7.4
2.0-3.0	0.78	0.73	1.24	0.62	0.16	0.14	0.31	0.88	2.18	2.40	1.20	0.73	11.4
3.0-4.0	0.68	0.70	1.97	0.82	0.07	0.04	0.15	0.64	2.66	2.75	1.10	0.70	12.3
4.0-5.0	0.55	0.39	2.80	0.89	0.03	0.01	0.08	0.29	1.72	2.18	1.06	0.86	10.9
5.0-6.0	0.25	0.21	3.36	0.93	0.01	0.02	0.04	0.17	0.69	2.10	2.09	0.99	10.9
6.0-7.0	0.05	0.14	3.91	0.58	0.00	0.02	0.03	0.15	0.79	3.29	2.09	0.49	11.5
7.0-8.0	0.01	0.07	3.85	0.38	0.00	0.01	0.03	0.07	0.69	2.24	1.42	0.13	8.9
8.0-9.0	0.00	0.07	3.24	0.22	0.00	0.00	0.04	0.03	0.44	1.31	0.66	0.02	6.0
9.0-10.0	0.00	0.04	2.57	0.08	0.00	0.00	0.03	0.02	0.42	1.08	0.45	0.00	4.7
10.0-11.0	0.00	0.02	1.74	0.03	0.00	0.00	0.03	0.02	0.38	0.93	0.26	0.00	3.4
11.0-12.0	0.00	0.02	1.07	0.02	0.00	0.00	0.02	0.00	0.29	0.76	0.15	0.00	2.3
12.0-13.0	0.00	0.01	0.68	0.01	0.00	0.00	0.00	0.00	0.25	0.52	0.07	0.00	1.5
13.0-14.0	0.00	0.01	0.50	0.00	0.00	0.00	0.00	0.00	0.20	0.27	0.05	0.00	1.0
14.0-15.0	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.15	0.13	0.01	0.00	0.6
15.0-16.0	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.08	0.06	0.00	0.00	0.3
16.0-17.0	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.05	0.04	0.00	0.00	0.2
17.0-18.0	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.1
18.0-19.0	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
19.0-20.0	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Total	3.5	3.4	28.5	5.3	0.7	0.8	1.7	3.5	13.1	22.2	12.3	5.1	100.0

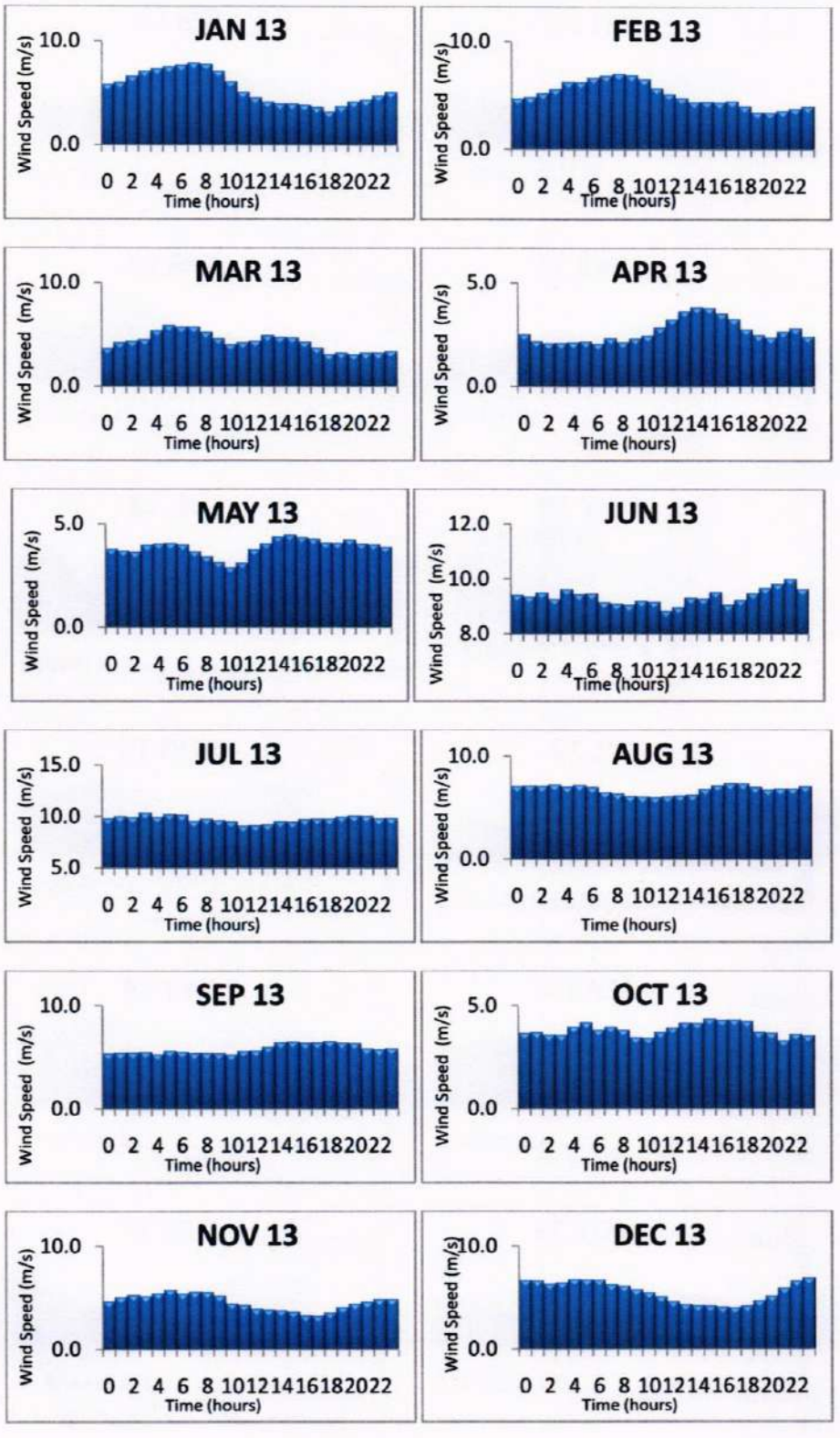
SENSOR HEIGHT: 80m

Based on Data January 2013 to December 2013

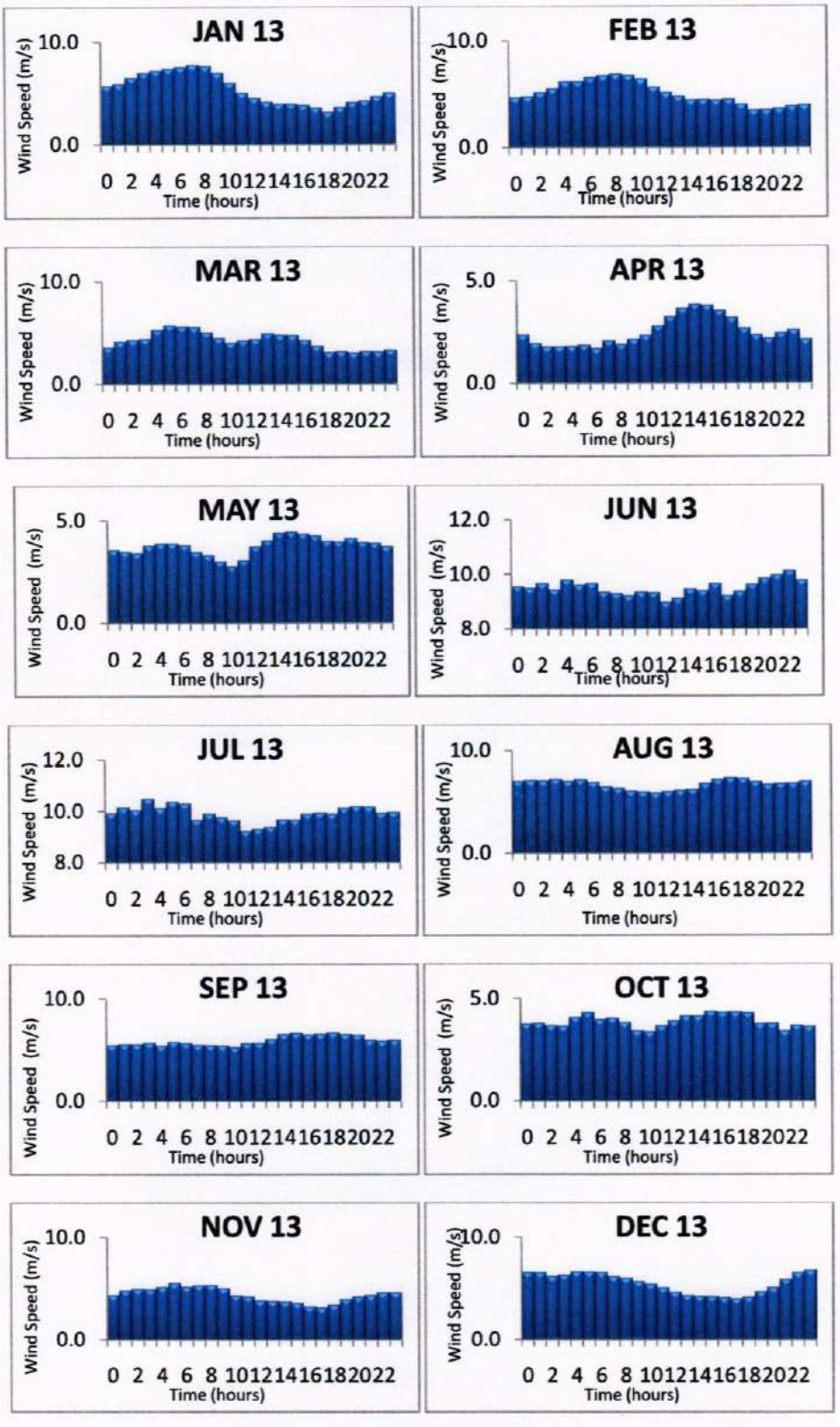
Range 0--1 Extends from 0 to 0.99 m/s &
1-- 2 Extends from 1 to 1.99 m/s etc.



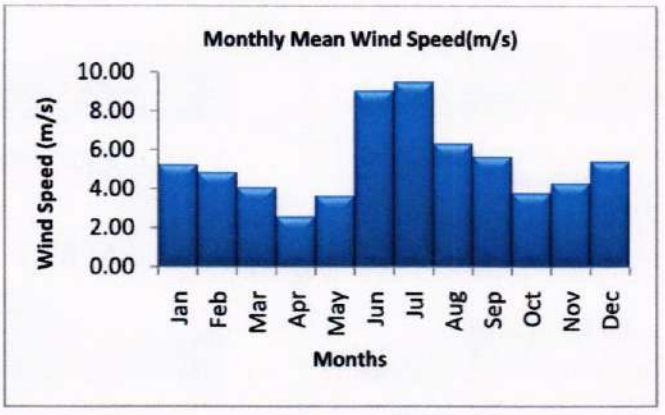
SENSOR HEIGHT: 50m
FIGURE 4: MEAN HOURLY WIND SPEED
(JANUARY 2013 TO DECEMBER 2013)



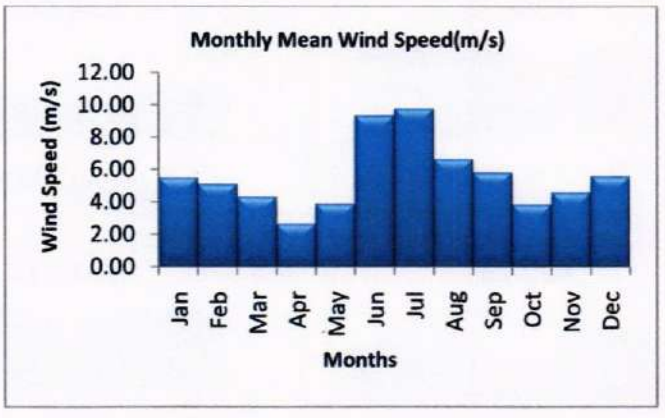
SENSOR HEIGHT: 78m
FIGURE 4A: MEAN HOURLY WIND SPEED
(JANUARY 2013 TO DECEMBER 2013)



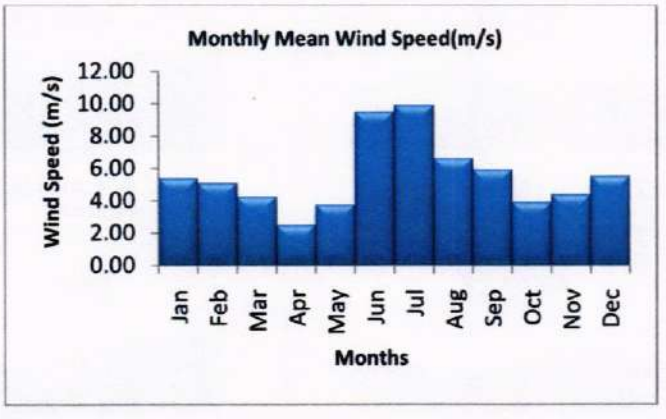
SENSOR HEIGHT: 80m NORTH
FIGURE 4B: MEAN HOURLY WIND SPEED
(JANUARY 2013 TO DECEMBER 2013)



SENSOR HEIGHT: 50m

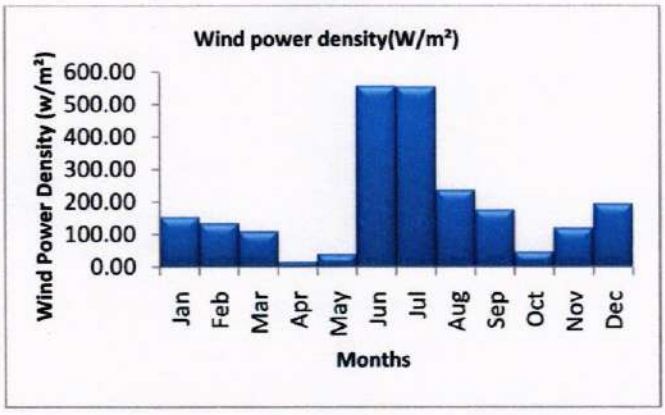


SENSOR HEIGHT: 78m

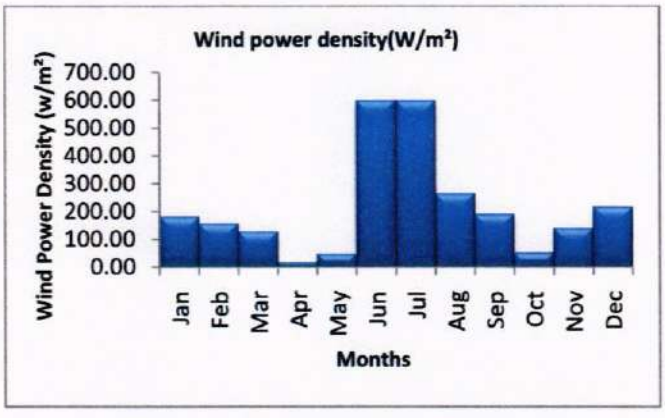


SENSOR HEIGHT: 80m

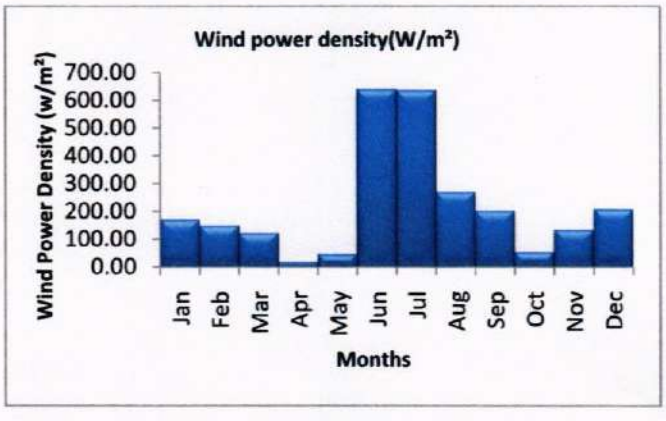
FIGURE 5: MONTHLY MEAN WIND SPEED (JANUARY 2013 TO DECEMBER 2013)



SENSOR HEIGHT: 50m



SENSOR HEIGHT: 78m



SENSOR HEIGHT: 80m

FIGURE 6: MONTHLY MEAN WIND POWER DENSITY (JANUARY 2013 TO DECEMBER 2013)

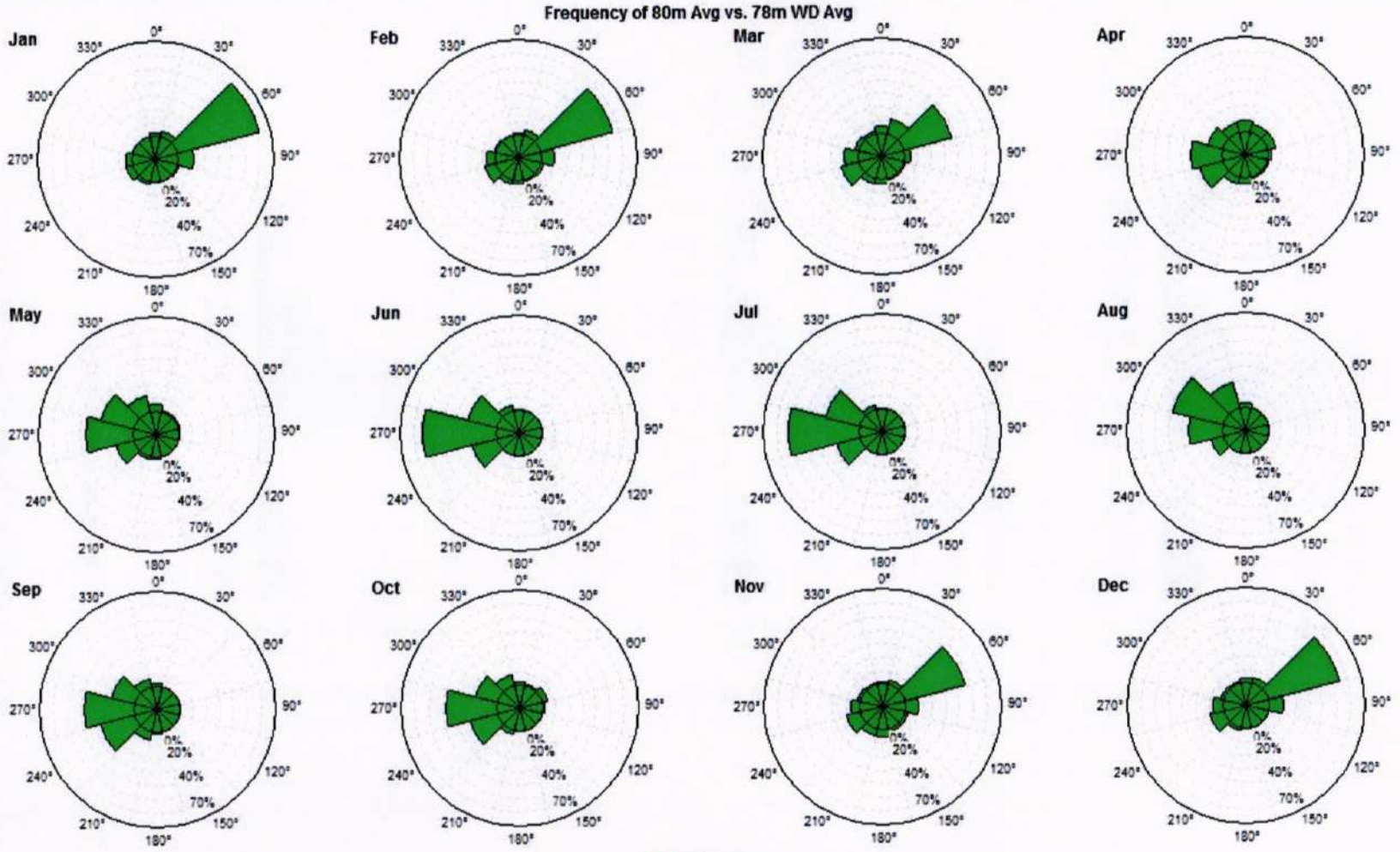


FIGURE 7: WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(January 2013 to December 2013)

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

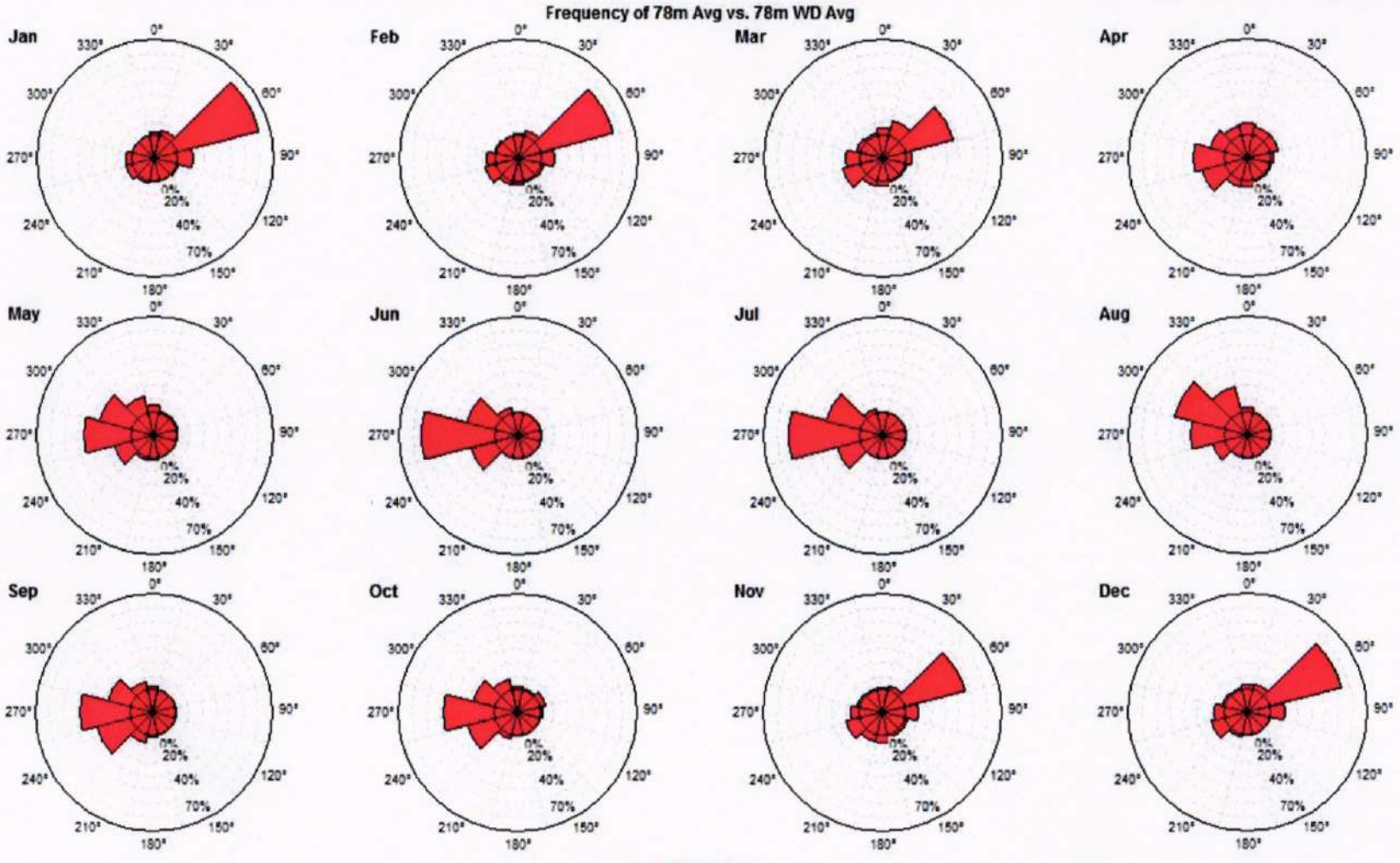


FIGURE 7A: WIND ROSE
SENSOR HEIGHT: (78m Anemometer and 78m Wind vane)
(January 2013 to December 2013)

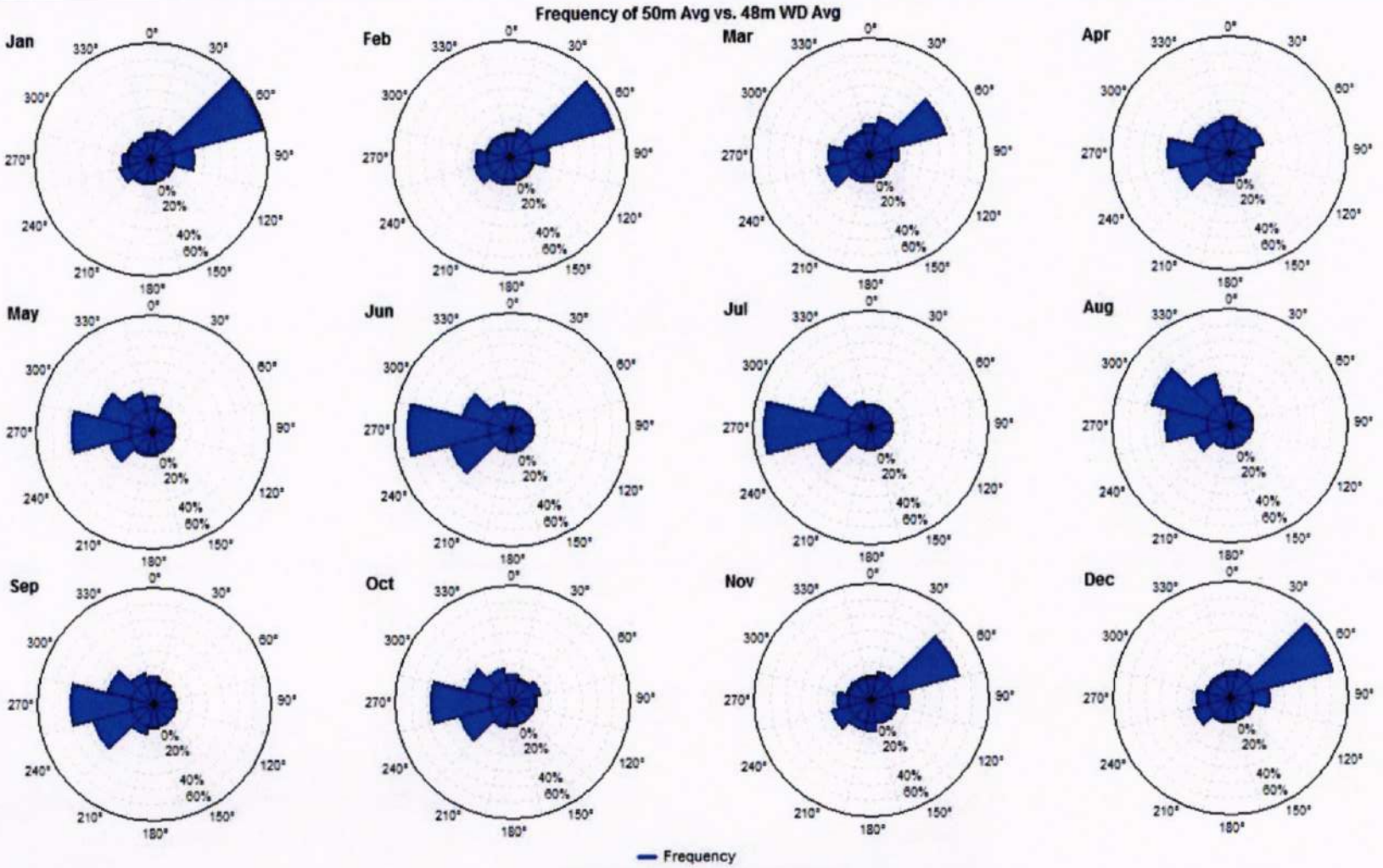


FIGURE 7B: WIND ROSE
SENSOR HEIGHT: (50m Anemometer and 48m Wind vane)
(January 2013 to December 2013)

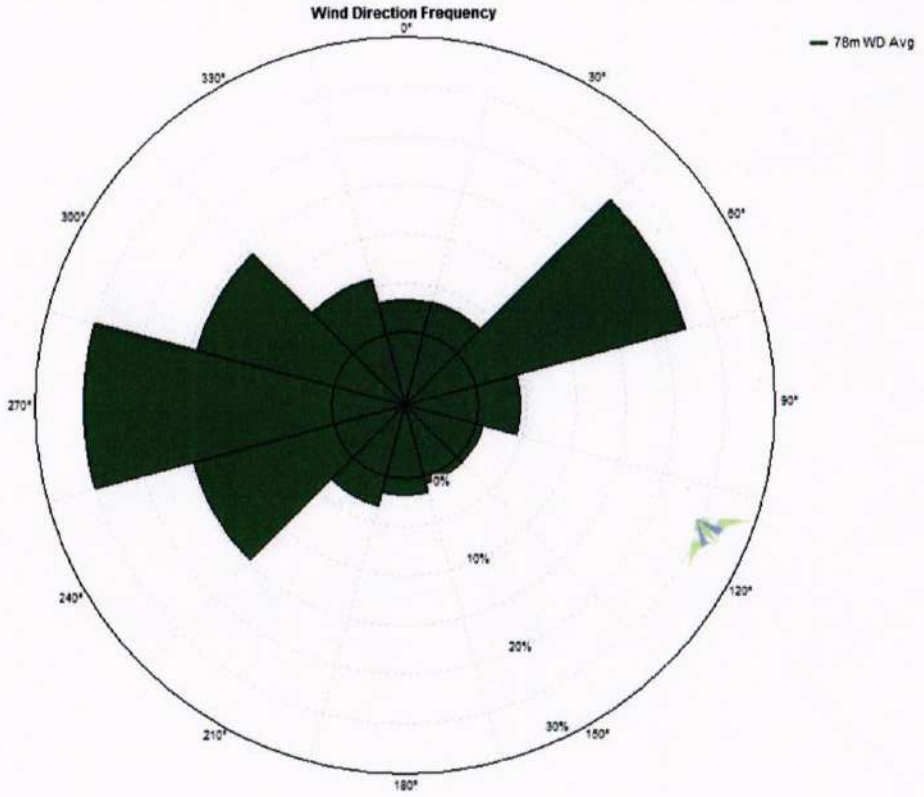
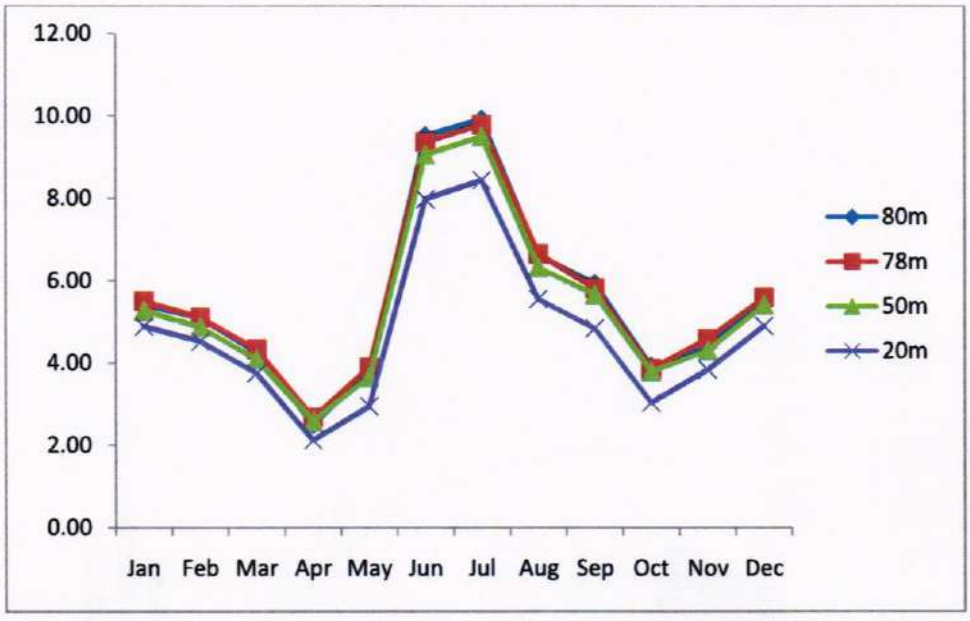
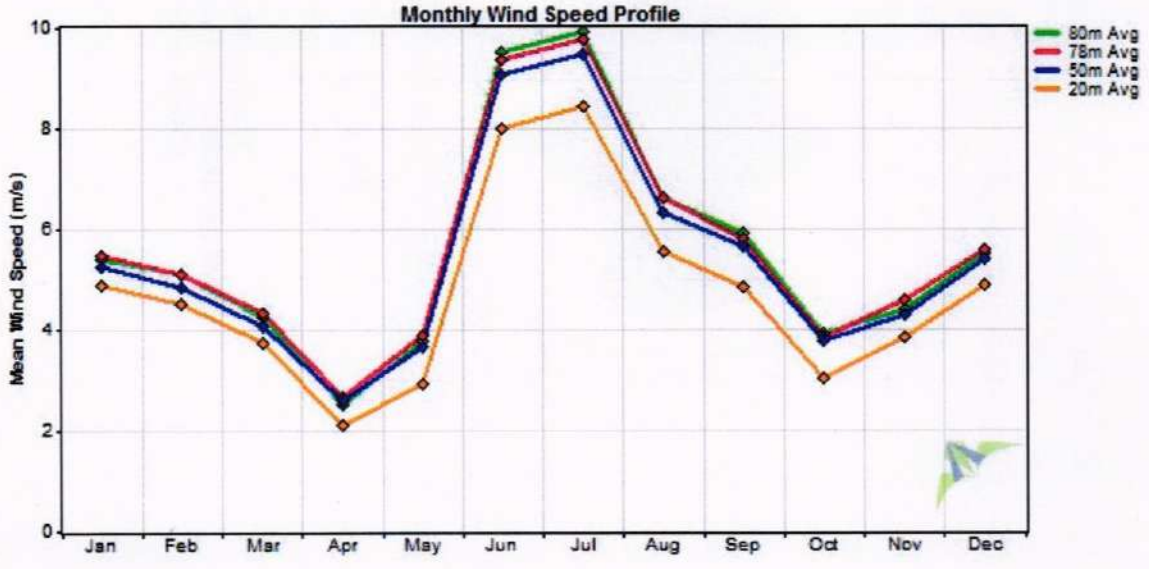


FIGURE 7C: ANNUAL WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(January 2013 to December 2013)



MONTHLY MEAN WIND SPEED
(January 2013 to December 2013)



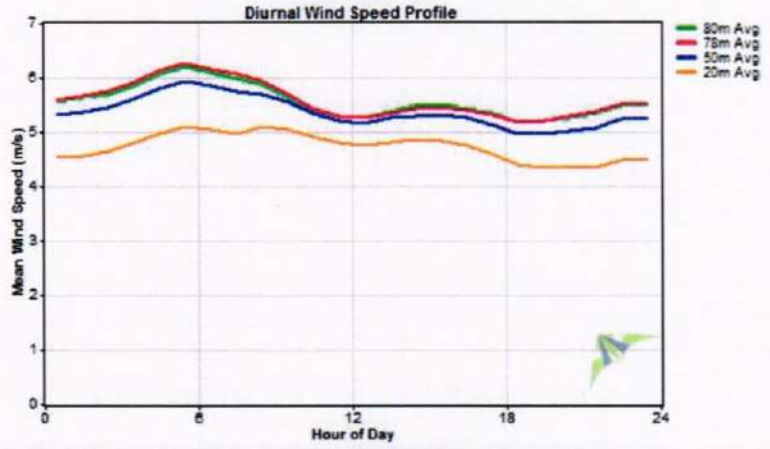


FIGURE 8: MONTHLY WIND SPEED AND DAILY WIND SPEED – PULIKKANAM (January 2013 to December 2013)

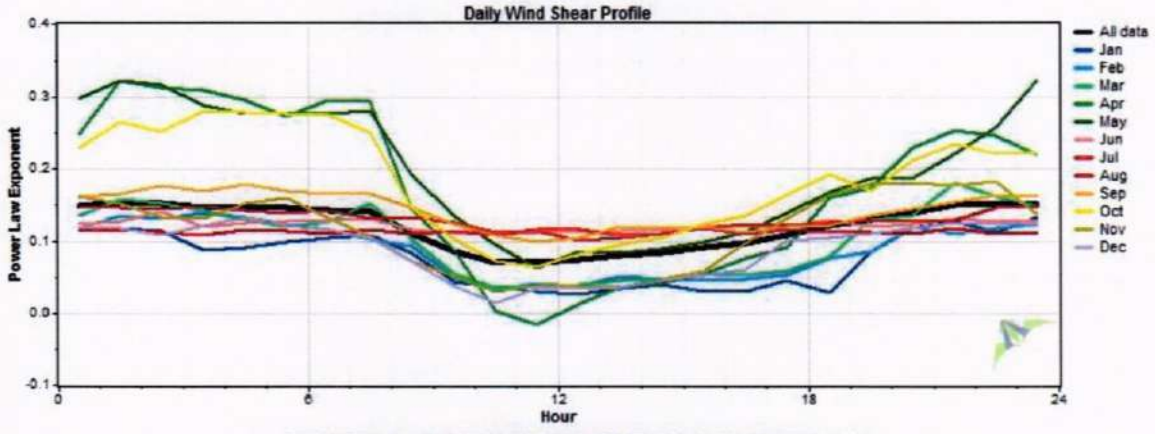


FIGURE 9: DAILY WIND SHEAR-PULIKKANAM (January 2013 to December 2013)

FIGURE 10: MONTHLY WIND SHEAR- PULIKKANAM (January 2013 to December 2013)

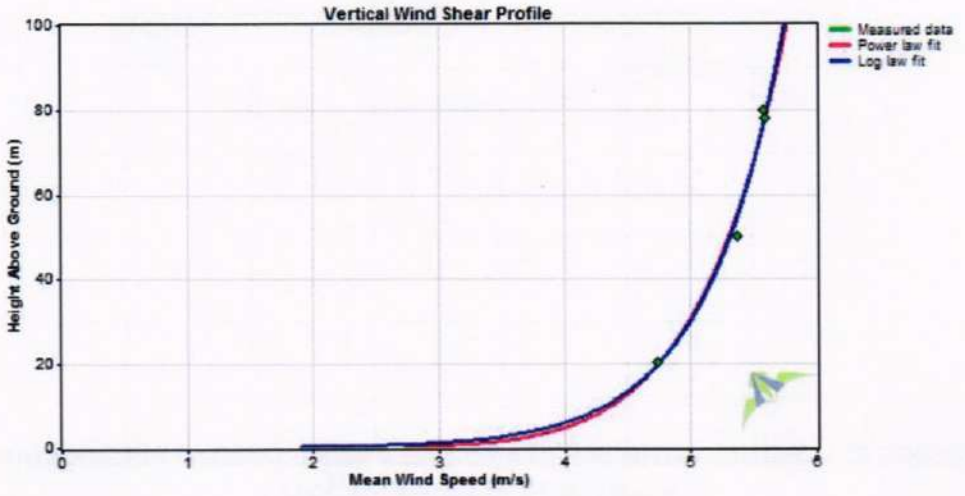
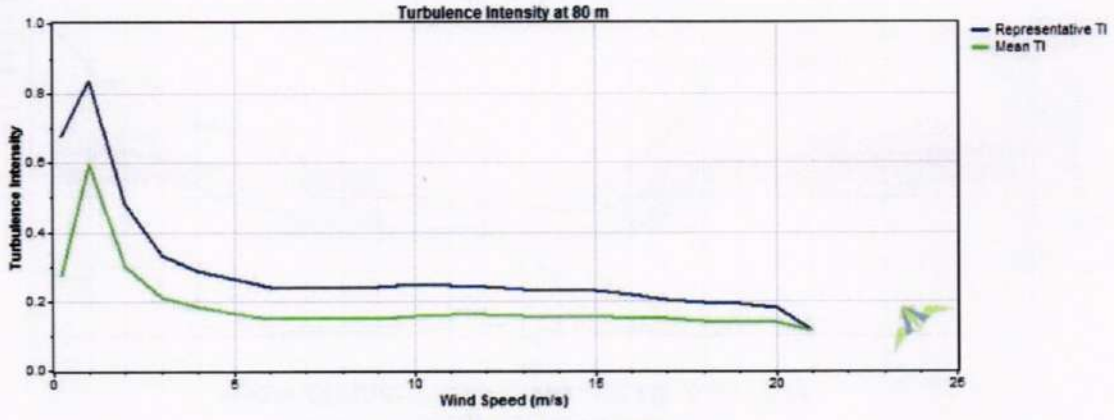
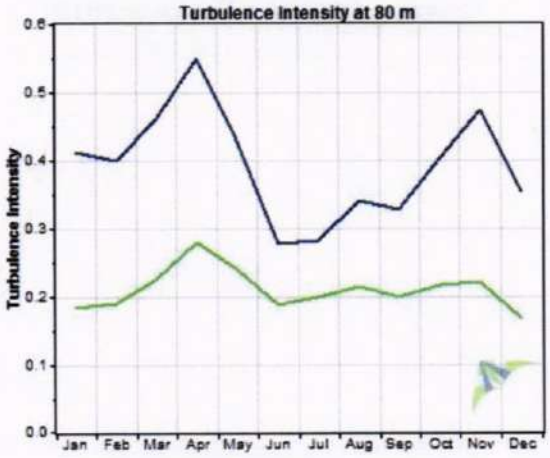
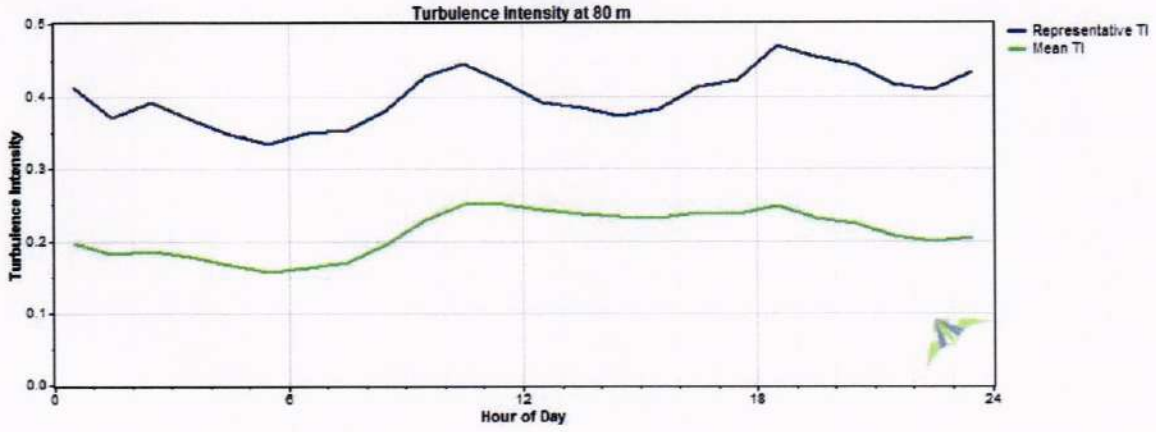


FIGURE 11: VERTICALWIND SHEAR- PULIKKANAM (January 2013 to December 2013)







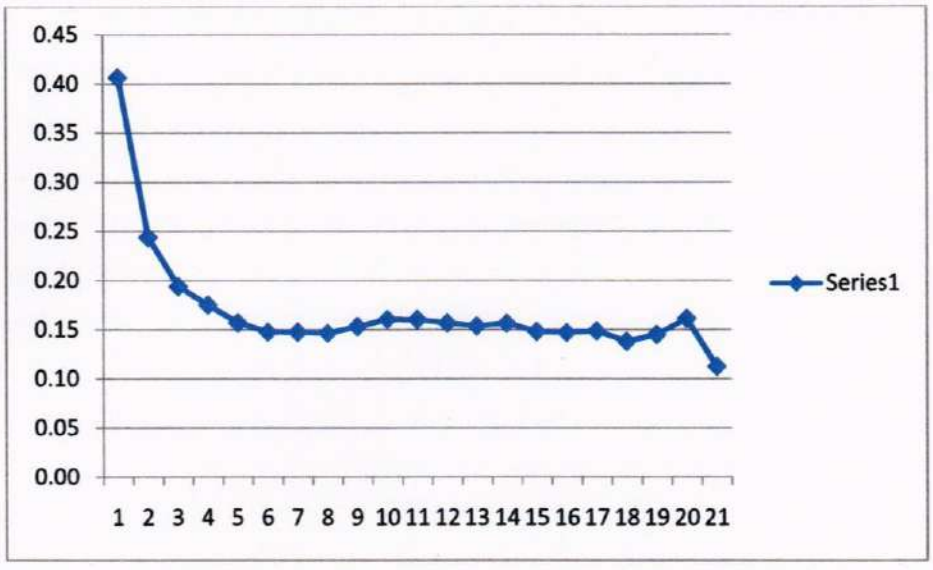


FIGURE 12: TURBULANCE INTENSITY – PULIKKANAM
(January 2013 to December 2013)

IInd Year

Jan 2014 - Dec 2014

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

PULIKKANAM

TABLE 1
CONSOLIDATED TABLE

	JAN-14	FEB-14	MAR-14	APR-14	MAY-14	JUN-14	JUL-14*	AUG-14	SEP-14	OCT-14	NOV-14	DEC-14	ANNUAL
Monthly Mean Wind Speed (m/s)													
20m	6.04	4.32	4.82	2.50	2.94	6.51	--	5.54	4.58	2.86	4.60	5.13	4.53
50m	6.66	4.77	5.42	2.92	3.56	7.53	--	6.44	5.35	3.44	5.23	5.49	5.16
78m S	6.81	4.89	5.63	2.93	3.58	7.79	--	6.62	5.58	3.56	5.35	5.82	5.32
80m S	6.72	4.84	5.56	2.86	3.67	7.94	--	6.82	5.52	3.34	5.29	5.74	5.30
Monthly Wind Power Density (Watts/Sq.m)													
20m	201.27	100.16	116.31	16.32	29.65	224.15	--	177.87	85.54	31.78	141.72	157.64	116.58
50m	271.67	134.81	164.46	23.69	46.62	344.08	--	274.94	133.95	47.37	194.88	193.96	166.40
78m S	294.81	149.92	186.85	25.95	53.43	374.99	--	278.03	145.91	53.52	202.97	223.43	180.89
80m S	279.48	142.71	178.82	25.43	55.29	401.79	--	308.81	149.88	50.28	208.35	223.85	184.06
Power Law Index (PLI)													
	0.08	0.08	0.10	0.10	0.16	0.14	--	0.15	0.13	0.11	0.10	0.08	0.11
Energy Pattern Factor													
20m	1.73	2.36	1.98	1.99	2.23	1.55	--	1.98	1.69	2.58	2.75	2.22	2.10
50m	1.74	2.35	1.97	1.82	1.97	1.53	--	1.95	1.66	2.20	2.58	2.22	2.00
78m S	1.76	2.43	2.00	1.96	2.21	1.15	--	1.81	1.59	2.25	2.51	2.15	1.98
80m S	1.74	2.39	1.98	2.07	2.13	1.53	--	1.84	1.69	2.57	2.67	2.25	2.08
Air Density (kg/m^3)													
	1.058	1.054	1.050	1.047	1.048	1.050	--	1.057	1.056	1.055	1.055	1.056	1.053
Temperature (^{0} C)													
	19.75	20.70	22.04	21.93	21.32	20.28	--	19.10	19.54	20.10	19.87	19.81	20.40
Turbulance Intensity (at 80m agl)													
						At 15m/s : 0.20							
Data Availability (Based on 10 Minutes Interval)													
	4464	4032	4464	4320	4464	3424	1045	4464	4320	4463	4320	4464	
Based on Data January 2014 to December 2014													

* Inadequate data

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

PULIKKANAM

TABLE 2
SUMMARY OF WIND DATA

Month	Monthly Mean wind speed (m/s)			Monthly standard Deviation (m/s)			Peak wind speed(m/s) (date/year/Time of occurance)			Prevailing wind Direction	
	(50m)	(80m south)	(78m south)	(50m)	(80m south)	(78m south)	(50m)	(80m south)	(78m south)	(48m)	(78m)
Jan-14	6.66	6.81	6.72	0.77	0.74	0.73	17.02 27-01-2014 3:20	17.28 27-01-2014 3:20	17.12 27-01-2014 3:20	NE	NE
Feb-14	4.77	4.89	4.84	0.66	0.65	0.65	15.68 03-02-2014 8:00	16.16 03-02-2014 8:00	16.09 03-02-2014 8:00	NE	NE
Mar-14	5.42	5.63	5.56	0.77	0.76	0.75	14.96 12-03-2014 9:40	16.56 14-03-2014 7:30	15.99 14-03-2014 7:30	NE	NE
Apr-14	2.92	2.93	2.86	0.57	0.56	0.56	10.66 30-04-2014 19:50	11.33 4-30-2014 8:10	11.13 4-30-2014 8:10	W	W
May-14	3.56	3.58	3.67	0.70	0.72	0.71	11.78 05-07-2014 12:20	12.49 05-08-2014 12:30	12.59 05-08-2014 12:30	W	W
Jun-14	7.53	7.79	7.94	1.43	1.39	1.42	16.59 06-20-2014 1:40	17.65 06-20-2014 1:40	17.71 06-20-2014 1:40	W	W
Jul-14*	-	-	-	-	-	-	-	-	-	-	-
Aug-14	6.44	6.62	6.82	1.30	1.21	1.25	17.83 08-30-2014 12:50	17.08 08-30-2014 12:50	18.00 08-30-2014 12:50	W	W
Sep-14	5.35	5.58	5.52	1.00	0.96	0.98	16.06 09-01-2014 12:40	15.54 09-01-2014 5:20	16.53 09-01-2014 5:20	W	W
Oct-14	3.44	3.56	3.34	0.60	0.59	0.60	10.43 10-17-2014 7:00	10.80 10-17-2014 7:00	10.91 10-17-2014 7:00	NE	NE
Nov-14	5.23	5.35	5.29	0.72	0.71	0.72	16.97 11-21-2014 1:00	16.92 11-21-2014 1:00	17.11 11-18-2014 4:50	NE	NE
Dec-14	5.49	5.82	5.74	0.70	0.68	0.68	18.94 12-17-2014 23:40	19.25 12-17-2014 23:40	19.79 12-17-2014 23:40	NE	NE
ANNUAL	**5.16**	**5.32**	**5.30**	**0.84**	**0.82**	**0.82**	**18.94 12-17-2014 23:40**	**19.25 12-17-2014 23:40**	**19.79 12-17-2014 23:40**	**NE**	**NE**

Based on Data January 2014 to December 2014

* Inadequate data

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 6

PULIKKANAM

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	7.68	8.14	8.16	8.14	8.51	8.53	8.62	8.84	8.73	8.33	7.57	6.73	5.70	4.92	4.75	4.46	4.38	4.70	4.64	4.47	5.31	6.40	6.58	6.99	6.72
FEB	4.05	4.88	5.59	5.98	6.17	6.28	6.76	6.85	6.45	5.52	5.23	4.64	4.66	4.53	4.53	4.34	4.32	4.43	3.59	3.11	3.22	3.65	3.66	3.64	4.84
MAR	5.45	5.77	6.07	6.37	6.89	6.82	7.02	7.15	6.81	6.42	6.45	6.17	5.91	5.52	5.33	5.15	4.92	4.67	4.64	4.10	3.66	3.52	3.95	4.76	5.56
APR	1.82	1.80	1.91	2.15	2.43	2.67	3.26	3.39	3.20	3.03	2.66	2.99	3.37	3.82	3.99	3.83	3.70	3.35	3.03	3.09	2.65	2.50	2.13	1.99	2.86
MAY	3.76	3.42	3.58	3.43	3.44	3.53	3.69	3.56	3.36	3.23	3.07	3.25	3.52	3.82	4.09	3.99	4.07	4.29	4.22	3.98	3.85	3.58	3.75	3.60	3.67
JUN	7.47	7.82	7.61	7.95	8.14	8.23	8.31	8.42	8.43	8.29	7.76	7.58	7.84	7.80	7.83	7.73	8.07	8.11	8.20	8.31	7.77	7.92	7.56	7.74	7.95
JUL*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG	6.65	6.77	6.75	7.08	7.54	7.05	6.89	6.84	6.32	6.43	6.24	6.16	6.25	6.52	7.11	6.93	6.93	7.15	7.33	7.25	7.11	6.90	6.91	6.68	6.82
SEP	5.31	5.62	5.83	5.71	6.22	6.33	6.38	6.46	5.90	5.38	5.08	4.78	4.70	5.12	5.67	5.55	5.97	5.66	5.42	5.22	5.02	5.06	5.04	5.04	5.52
OCT	3.04	3.03	3.16	3.31	3.70	3.92	3.89	3.84	3.78	3.97	3.41	3.39	3.41	3.38	3.31	3.45	3.37	3.20	3.41	3.15	2.68	2.64	2.74	2.93	3.34
NOV	5.68	5.15	5.18	5.40	5.72	5.79	5.82	5.84	5.64	5.24	5.29	5.29	5.06	4.94	5.11	4.76	4.76	4.85	4.95	4.97	4.99	5.29	5.56	5.69	5.29
DEC	6.91	6.92	6.39	6.32	6.77	6.83	6.72	6.77	6.19	5.89	5.67	4.95	4.37	4.37	4.48	4.11	4.06	4.17	4.55	5.35	5.93	6.48	6.67	6.77	5.74
Annual	5.26	5.39	5.48	5.62	5.96	6.00	6.12	6.18	5.89	5.61	5.31	5.08	4.98	4.98	5.11	4.94	4.96	4.96	4.91	4.82	4.74	4.90	4.96	5.07	5.30

SENSOR HEIGHT: 80m

Based on Data January 2014 to December 2014

* Inadequate data

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 6A

PULIKKANAM

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	7.80	8.27	8.29	8.29	8.69	8.73	8.81	9.03	8.90	8.47	7.68	6.80	5.73	4.92	4.74	4.44	4.38	4.72	4.67	4.51	5.38	6.50	6.69	7.10	6.81
FEB	4.13	4.99	5.73	6.13	6.34	6.47	6.98	7.05	6.58	5.59	5.28	4.65	4.66	4.50	4.48	4.28	4.28	4.40	3.57	3.10	3.14	3.66	3.70	3.70	4.89
MAR	5.56	5.91	6.19	6.51	7.03	6.97	7.15	7.29	6.92	6.48	6.49	6.18	5.91	5.52	5.32	5.14	4.91	4.68	4.67	4.14	3.69	3.55	3.98	4.86	5.63
APR	2.01	1.97	2.08	2.32	2.60	2.81	3.36	3.54	3.20	3.00	2.66	2.96	3.32	3.76	3.92	3.78	3.68	3.39	3.11	3.16	2.75	2.59	2.31	2.14	2.93
MAY	3.60	3.21	3.36	3.27	3.23	3.38	3.55	3.46	3.36	3.28	3.22	3.30	3.54	3.81	4.07	3.97	4.03	4.24	4.15	3.85	3.70	3.41	3.60	3.41	3.58
JUN	7.29	7.64	7.45	7.78	7.95	8.06	8.13	8.27	8.26	8.14	7.62	7.45	7.71	7.66	7.68	7.59	7.95	7.93	8.02	8.13	7.61	7.73	7.39	7.55	7.79
JUL*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG	6.36	6.49	6.47	6.76	7.23	6.83	6.60	6.57	6.14	6.32	6.15	6.09	6.14	6.41	6.97	6.77	6.79	6.99	7.12	7.03	6.89	6.68	6.69	6.44	6.62
SEP	5.43	5.72	5.93	5.79	6.25	6.32	6.42	6.52	5.96	5.44	5.14	4.81	4.72	5.12	5.61	5.51	5.93	5.67	5.51	5.33	5.20	5.23	5.21	5.20	5.58
OCT	3.36	3.31	3.43	3.57	3.95	4.18	4.15	4.09	4.01	4.16	3.59	3.51	3.53	3.48	3.41	3.56	3.50	3.41	3.60	3.38	3.00	2.92	3.04	3.24	3.56
NOV	5.75	5.19	5.25	5.48	5.82	5.88	5.91	5.92	5.71	5.27	5.33	5.36	5.11	4.97	5.11	4.76	4.75	4.90	5.03	5.10	5.09	5.40	5.66	5.75	5.35
DEC	7.02	7.03	6.48	6.42	6.85	6.92	6.84	6.89	6.29	6.00	5.73	5.01	4.42	4.41	4.51	4.15	4.11	4.22	4.62	5.40	6.00	6.59	6.79	6.88	5.82
Annual	5.30	5.43	5.51	5.66	5.99	6.05	6.17	6.24	5.94	5.65	5.35	5.10	4.98	4.96	5.07	4.91	4.94	4.96	4.92	4.83	4.77	4.93	5.01	5.12	5.32

SENSOR HEIGHT:78m

Based on Data January 2014 to December 2014

* Inadequate data

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 6B

PULIKKANAM

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	7.50	8.00	8.06	8.02	8.34	8.41	8.46	8.68	8.70	8.48	7.76	6.81	5.76	4.93	4.76	4.44	4.39	4.70	4.61	4.36	5.17	6.24	6.39	6.77	6.66
FEB	3.96	4.74	5.44	5.88	6.06	6.12	6.65	6.70	6.34	5.66	5.42	4.73	4.72	4.49	4.49	4.28	4.30	4.43	3.57	3.06	3.00	3.53	3.50	3.50	4.77
MAR	5.13	5.51	5.81	6.13	6.66	6.56	6.74	6.89	6.69	6.52	6.53	6.19	5.85	5.49	5.28	5.10	4.86	4.62	4.55	3.96	3.45	3.33	3.69	4.46	5.42
APR	1.97	1.94	2.12	2.22	2.60	2.82	3.28	3.36	3.17	3.07	2.76	3.05	3.41	3.80	3.97	3.80	3.68	3.36	3.04	3.01	2.71	2.55	2.22	2.11	2.92
MAY	3.52	3.21	3.39	3.29	3.26	3.35	3.47	3.38	3.36	3.30	3.22	3.32	3.56	3.80	4.07	3.92	3.94	4.09	4.03	3.78	3.70	3.44	3.61	3.38	3.56
JUN	7.09	7.42	7.22	7.57	7.69	7.78	7.88	7.99	7.99	7.91	7.39	7.27	7.51	7.43	7.45	7.34	7.62	7.64	7.71	7.85	7.37	7.49	7.16	7.29	7.54
JUL*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG	6.15	6.23	6.23	6.58	7.02	6.50	6.37	6.34	5.96	6.22	6.09	6.03	6.09	6.34	6.88	6.65	6.60	6.78	6.94	6.81	6.66	6.44	6.46	6.23	6.44
SEP	5.13	5.42	5.62	5.44	5.92	6.01	5.98	6.08	5.68	5.38	5.05	4.77	4.68	5.07	5.55	5.40	5.81	5.53	5.32	5.09	4.90	4.86	4.84	4.85	5.35
OCT	3.17	3.16	3.29	3.42	3.77	4.00	3.98	3.85	3.90	4.14	3.58	3.54	3.53	3.43	3.33	3.48	3.40	3.26	3.40	3.20	2.88	2.85	2.95	3.09	3.44
NOV	5.57	5.00	5.07	5.37	5.63	5.61	5.67	5.72	5.62	5.30	5.44	5.42	5.13	4.95	5.11	4.78	4.78	4.78	4.86	4.87	4.81	5.12	5.45	5.54	5.23
DEC	6.51	6.57	6.00	5.99	6.47	6.58	6.50	6.44	5.91	5.77	5.57	4.86	4.24	4.27	4.29	3.96	3.88	4.00	4.35	5.02	5.60	6.17	6.37	6.45	5.49
Annual	5.06	5.20	5.30	5.45	5.76	5.79	5.91	5.95	5.76	5.61	5.34	5.09	4.95	4.91	5.02	4.83	4.84	4.83	4.76	4.64	4.57	4.73	4.78	4.88	5.17

SENSOR HEIGHT : 50m

Based on Data January 2014 to December 2014

* Inadequate data

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 6C

PULIKKANAM

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	6.66	7.14	7.16	7.18	7.48	7.49	7.62	7.86	8.03	7.95	7.26	6.36	5.38	4.58	4.39	4.07	4.06	4.29	4.20	3.93	4.56	5.59	5.66	5.98	6.04
FEB	3.42	4.11	4.72	5.06	5.28	5.38	5.82	5.92	5.81	5.35	5.13	4.46	4.52	4.26	4.20	3.99	4.00	4.07	3.34	2.82	2.72	3.07	3.06	3.08	4.32
MAR	4.37	4.66	5.00	5.33	5.85	5.68	5.91	6.02	6.09	6.02	5.98	5.61	5.30	5.04	4.86	4.72	4.52	4.33	4.17	3.52	3.00	2.86	3.08	3.74	4.82
APR	1.44	1.46	1.60	1.61	1.97	2.16	2.47	2.53	2.70	2.86	2.73	3.01	3.34	3.66	3.79	3.57	3.41	3.07	2.66	2.44	2.24	2.07	1.65	1.58	2.50
MAY	2.65	2.39	2.63	2.46	2.44	2.56	2.64	2.48	2.80	2.90	2.95	3.09	3.30	3.52	3.71	3.45	3.45	3.49	3.38	3.03	2.93	2.79	2.85	2.57	2.94
JUN	5.98	6.21	6.15	6.36	6.50	6.56	6.57	6.87	6.93	6.83	6.55	6.33	6.62	6.58	6.54	6.45	6.56	6.65	6.66	6.92	6.47	6.43	6.16	6.21	6.50
JUL*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG	5.26	5.27	5.29	5.51	5.94	5.51	5.37	5.34	5.06	5.38	5.34	5.26	5.32	5.58	5.99	5.77	5.78	5.90	6.03	5.89	5.72	5.54	5.63	5.35	5.54
SEP	4.39	4.53	4.62	4.50	4.89	4.96	4.97	5.10	4.96	4.79	4.48	4.29	4.24	4.57	4.94	4.77	5.07	4.79	4.54	4.35	4.18	4.10	3.98	3.99	4.58
OCT	2.45	2.45	2.58	2.60	2.86	3.09	3.01	2.95	3.27	3.70	3.29	3.35	3.28	3.21	3.09	3.16	3.01	2.78	2.76	2.57	2.29	2.24	2.22	2.34	2.86
NOV	4.75	4.23	4.29	4.55	4.74	4.77	4.87	4.95	5.01	4.81	5.02	5.03	4.75	4.57	4.65	4.37	4.30	4.25	4.28	4.27	4.12	4.43	4.68	4.80	4.60
DEC	5.96	6.00	5.40	5.38	5.86	5.94	5.93	5.91	5.58	5.55	5.35	4.69	4.16	4.23	4.17	3.83	3.76	3.82	4.05	4.65	5.17	5.76	5.92	5.97	5.13
Annual	4.30	4.40	4.49	4.60	4.89	4.92	5.02	5.08	5.11	5.10	4.92	4.68	4.56	4.53	4.58	4.38	4.36	4.31	4.19	4.04	3.95	4.08	4.08	4.15	4.53

SENSOR HEIGHT : 20m

Based on Data January 2014 to December 2014

* Inadequate data

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 7

PULIKKANAM

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14*	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	ANNUAL
0.0-1.0	2.78	9.10	5.60	16.44	11.81	1.37	--	4.53	5.44	19.56	11.88	6.00	8.59
1.0-2.0	6.03	11.36	8.87	21.00	16.87	3.30	--	7.01	4.93	18.73	13.43	9.52	11.00
2.0-3.0	8.11	15.03	12.88	26.46	29.21	6.28	--	11.85	12.73	20.47	13.80	14.52	15.58
3.0-4.0	10.17	18.65	15.21	22.78	22.42	7.54	--	13.66	19.10	16.60	11.18	12.88	15.47
4.0-5.0	11.25	12.72	12.52	9.72	9.14	9.87	--	12.70	17.06	9.41	8.96	9.01	11.12
5.0-6.0	11.98	7.47	12.46	2.55	3.97	13.87	--	10.24	15.67	7.08	9.81	10.51	9.60
6.0-7.0	11.69	7.24	11.94	0.56	2.82	17.35	--	7.80	12.06	4.82	8.31	10.78	8.67
7.0-8.0	11.83	7.09	9.52	0.25	2.08	14.16	--	6.99	6.34	2.31	6.50	8.94	6.91
8.0-9.0	8.98	4.46	5.22	0.23	1.30	8.44	--	8.18	4.12	0.90	5.16	7.03	4.91
9.0-10.0	8.04	2.98	1.90	0.02	0.36	6.07	--	7.35	1.67	0.13	3.94	4.12	3.33
10.0-11.0	4.41	2.36	1.46	0.00	0.02	4.56	--	5.33	0.46	0.00	2.52	2.62	2.16
11.0-12.0	2.31	0.87	1.12	0.00	0.00	3.91	--	2.87	0.37	0.00	1.69	1.79	1.36
12.0-13.0	1.46	0.55	0.92	0.00	0.00	2.13	--	1.14	0.02	0.00	1.44	0.78	0.77
13.0-14.0	0.63	0.12	0.34	0.00	0.00	0.85	--	0.29	0.00	0.00	0.69	0.60	0.32
14.0-15.0	0.31	0.00	0.04	0.00	0.00	0.29	--	0.04	0.02	0.00	0.53	0.47	0.16
15.0-16.0	0.02	0.00	0.00	0.00	0.00	0.00	--	0.02	0.00	0.00	0.16	0.22	0.04
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	--	0.00	0.00	0.00	0.00	0.13	0.01
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	--	0.00	0.00	0.00	0.00	0.07	0.01
18.0-19.0	2.62	1.24	0.81	0.00	0.02	2.54	--	2.91	0.21	0.00	1.41	1.50	1.21
19.0-20.0	1.79	1.12	0.65	0.00	0.00	2.02	--	2.42	0.25	0.00	1.11	1.12	0.95
20.0-21.0	1.10	0.45	0.67	0.00	0.00	2.25	--	1.72	0.23	0.00	0.81	1.19	0.77

SENSOR HEIGHT: 20m **Based on Data January 2014 to December 2014**

Range 0--1 Extends from 0 to 0.99 m/s &
1-- 2 Extends from 1 to 1.99 m/s etc.

* Inadequate data

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 7A

PULIKKANAM

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14*	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	ANNUAL
0.0-1.0	2.17	6.82	3.94	9.28	5.65	0.73	--	4.01	2.78	9.66	6.90	5.38	5.21
1.0-2.0	5.65	10.74	8.18	16.69	10.26	1.14	--	4.19	4.28	15.46	11.99	9.45	8.91
2.0-3.0	6.81	14.34	11.69	28.22	25.20	5.23	--	7.73	8.45	23.10	15.51	13.44	14.52
3.0-4.0	8.69	15.60	12.30	24.65	27.82	5.90	--	11.20	14.24	19.11	10.81	11.85	14.74
4.0-5.0	9.57	14.81	11.96	14.19	15.10	7.30	--	13.35	18.13	11.60	8.66	8.24	12.08
5.0-6.0	10.55	6.80	11.00	4.56	6.65	9.90	--	12.16	16.04	7.73	8.43	9.05	9.35
6.0-7.0	11.54	7.47	11.76	1.50	3.14	14.89	--	8.06	13.15	6.43	9.12	10.26	8.85
7.0-8.0	11.02	6.35	9.83	0.37	2.17	14.84	--	6.79	9.47	4.12	6.92	9.30	7.38
8.0-9.0	10.22	6.67	8.18	0.16	2.11	12.65	--	6.41	5.74	1.81	5.72	7.75	6.13
9.0-10.0	7.19	4.09	4.39	0.21	1.28	7.62	--	6.63	3.87	0.81	5.23	5.82	4.29
10.0-11.0	7.33	2.85	2.73	0.16	0.54	6.25	--	6.68	2.08	0.18	3.22	3.70	3.25
11.0-12.0	3.61	1.93	1.19	0.00	0.09	4.26	--	5.42	0.76	0.00	2.50	2.17	1.99
12.0-13.0	2.53	0.57	1.05	0.00	0.00	3.36	--	4.01	0.56	0.00	1.78	1.50	1.40
13.0-14.0	1.75	0.57	1.16	0.00	0.00	2.37	--	1.61	0.35	0.00	1.39	0.74	0.90
14.0-15.0	0.81	0.32	0.63	0.00	0.00	1.90	--	1.12	0.07	0.00	0.97	0.54	0.58
15.0-16.0	0.38	0.07	0.00	0.00	0.00	1.14	--	0.43	0.02	0.00	0.67	0.47	0.29
16.0-17.0	0.18	0.00	0.00	0.00	0.00	0.53	--	0.18	0.02	0.00	0.19	0.13	0.11
17.0-18.0	0.02	0.00	0.00	0.00	0.00	0.00	--	0.02	0.00	0.00	0.00	0.16	0.02
18.0-19.0	4.03	1.69	1.75	0.07	0.36	3.65	--	3.58	1.25	0.18	1.44	1.84	1.80
19.0-20.0	3.29	1.17	0.99	0.09	0.18	2.60	--	3.09	0.83	0.00	1.78	1.90	1.45
20.0-21.0	1.81	1.07	0.65	0.00	0.07	2.48	--	2.93	0.46	0.00	1.57	1.01	1.10

SENSOR HEIGHT: 50m **Based on Data January 2014 to December 2014**

Range 0--1 Extends from 0 to 0.99 m/s &
1-- 2 Extends from 1 to 1.99 m/s etc.

* Inadequate data

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 7B

PULIKKANAM

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14*	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	ANNUAL
0.0-1.0	2.87	7.69	4.17	12.69	9.18	0.93	--	3.56	2.45	10.75	6.67	4.12	5.92
1.0-2.0	5.13	10.47	7.71	14.05	10.84	1.17	--	3.65	3.89	13.71	11.50	7.95	8.19
2.0-3.0	6.50	14.04	10.95	26.30	21.30	4.41	--	6.70	7.78	20.34	14.98	13.60	13.35
3.0-4.0	8.33	15.58	11.76	24.33	24.26	6.05	--	9.52	12.25	19.87	11.34	12.14	14.13
4.0-5.0	8.67	13.12	10.75	14.17	16.13	6.31	--	12.43	15.39	12.79	8.63	8.20	11.51
5.0-6.0	10.33	7.14	10.93	5.56	7.35	8.47	--	12.75	16.76	7.86	7.29	8.02	9.31
6.0-7.0	11.31	6.05	11.07	1.60	3.65	12.47	--	10.01	13.94	6.07	8.84	9.68	8.61
7.0-8.0	10.86	6.23	10.42	0.60	2.58	15.54	--	7.33	11.74	4.55	7.48	9.52	7.89
8.0-9.0	9.83	6.77	8.51	0.30	1.86	12.88	--	7.19	7.43	2.55	5.90	8.00	6.48
9.0-10.0	7.35	5.58	5.94	0.23	1.48	9.73	--	7.26	4.54	1.08	5.81	6.77	5.07
10.0-11.0	7.37	3.22	2.67	0.07	1.05	6.60	--	7.41	1.99	0.43	3.52	4.70	3.55
11.0-12.0	4.53	1.91	1.72	0.12	0.25	5.23	--	5.62	1.04	0.00	2.92	2.82	2.38
12.0-13.0	3.09	0.99	1.08	0.00	0.07	3.74	--	3.70	0.44	0.00	1.69	1.93	1.52
13.0-14.0	1.93	0.57	1.01	0.00	0.00	2.48	--	1.64	0.28	0.00	1.92	0.90	0.97
14.0-15.0	1.03	0.50	0.96	0.00	0.00	1.93	--	0.83	0.05	0.00	0.86	0.63	0.62
15.0-16.0	0.52	0.12	0.29	0.00	0.00	1.46	--	0.31	0.05	0.00	0.49	0.52	0.34
16.0-17.0	0.27	0.02	0.07	0.00	0.00	0.53	--	0.07	0.00	0.00	0.16	0.22	0.12
17.0-18.0	0.09	0.00	0.00	0.00	0.00	0.09	--	0.02	0.00	0.00	0.00	0.13	0.03
18.0-19.0	3.36	1.79	1.43	0.05	0.67	3.07	--	3.58	1.00	0.31	1.83	2.82	1.81
19.0-20.0	4.01	1.44	1.23	0.02	0.38	3.53	--	3.83	1.00	0.11	1.69	2.04	1.75
20.0-21.0	2.78	1.04	1.14	0.12	0.18	2.83	--	2.91	0.53	0.00	1.55	1.41	1.32

SENSOR HEIGHT: 78m **Based on Data January 2014 to December 2014**

Range 0--1 Extends from 0 to 0.99 m/s &
1-- 2 Extends from 1 to 1.99 m/s etc.

* Inadequate data

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 7C

PULIKKANAM

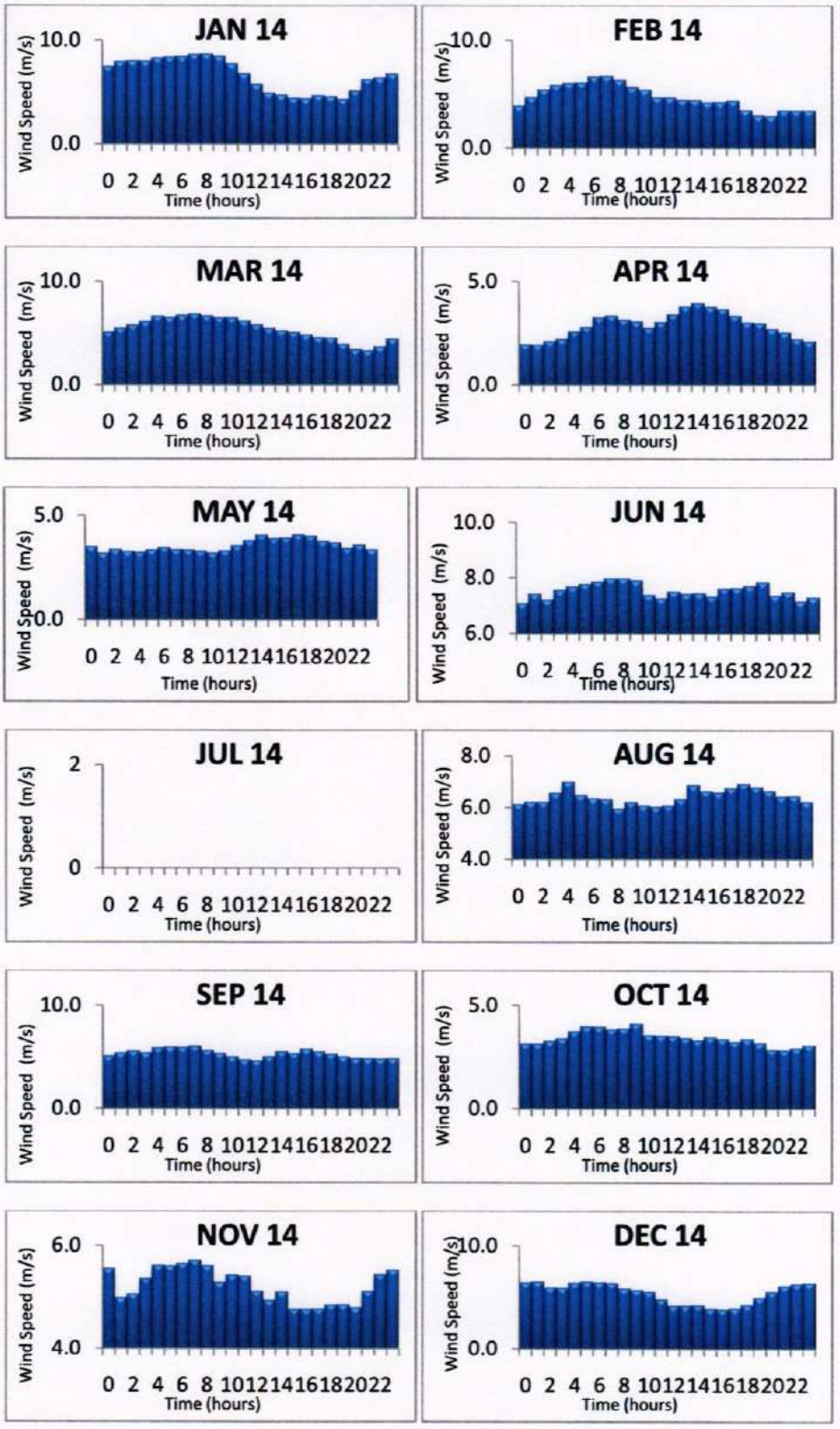
PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14*	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	ANNUAL
0.0-1.0	2.31	8.68	5.31	15.49	7.62	0.85	--	2.67	4.70	17.20	9.65	5.51	7.27
1.0-2.0	5.29	9.47	6.92	14.35	11.29	1.11	--	3.97	3.63	14.00	11.88	7.75	8.15
2.0-3.0	6.50	13.29	10.46	24.44	20.65	4.32	--	6.38	7.59	17.90	12.59	13.49	12.51
3.0-4.0	8.47	15.72	11.83	22.85	24.53	5.72	--	9.48	11.18	17.18	10.39	11.60	13.54
4.0-5.0	9.34	13.72	11.16	14.35	16.55	6.19	--	12.52	15.58	12.12	9.14	8.22	11.72
5.0-6.0	10.84	7.76	11.09	5.72	8.06	8.27	--	12.79	16.92	7.75	7.20	8.58	9.54
6.0-7.0	11.90	5.98	11.25	1.50	3.79	11.74	--	9.81	13.87	5.82	8.80	9.79	8.57
7.0-8.0	10.84	6.47	10.89	0.58	2.71	15.45	--	7.21	11.20	4.37	7.36	9.27	7.85
8.0-9.0	9.77	7.09	8.33	0.32	1.86	13.05	--	6.61	6.16	2.13	5.51	7.77	6.24
9.0-10.0	7.26	5.18	5.31	0.23	1.64	10.05	--	6.21	4.19	1.12	5.67	6.47	4.85
10.0-11.0	7.35	3.00	2.76	0.09	0.92	6.31	--	7.12	2.43	0.40	3.40	4.08	3.44
11.0-12.0	3.97	1.86	1.57	0.07	0.31	5.26	--	6.05	1.25	0.00	2.94	2.71	2.36
12.0-13.0	2.91	0.67	1.14	0.00	0.07	3.77	--	4.57	0.72	0.00	1.64	1.93	1.58
13.0-14.0	1.70	0.69	1.25	0.00	0.00	3.10	--	2.44	0.32	0.00	1.64	0.87	1.09
14.0-15.0	0.96	0.32	0.52	0.00	0.00	2.10	--	1.23	0.21	0.00	1.30	0.65	0.66
15.0-16.0	0.36	0.05	0.22	0.00	0.00	1.49	--	0.56	0.00	0.00	0.69	0.52	0.35
16.0-17.0	0.22	0.02	0.00	0.00	0.00	0.88	--	0.31	0.05	0.00	0.16	0.34	0.18
17.0-18.0	0.02	0.00	0.00	0.00	0.00	0.35	--	0.04	0.00	0.00	0.02	0.25	0.06
18.0-19.0	3.79	1.93	1.39	0.02	0.58	3.15	--	3.92	1.57	0.25	1.81	2.53	1.90
19.0-20.0	3.56	1.07	1.37	0.07	0.34	3.15	--	3.23	0.86	0.16	1.60	1.75	1.56
20.0-21.0	2.46	0.87	0.92	0.07	0.25	2.69	--	3.29	0.88	0.00	1.39	1.43	1.30

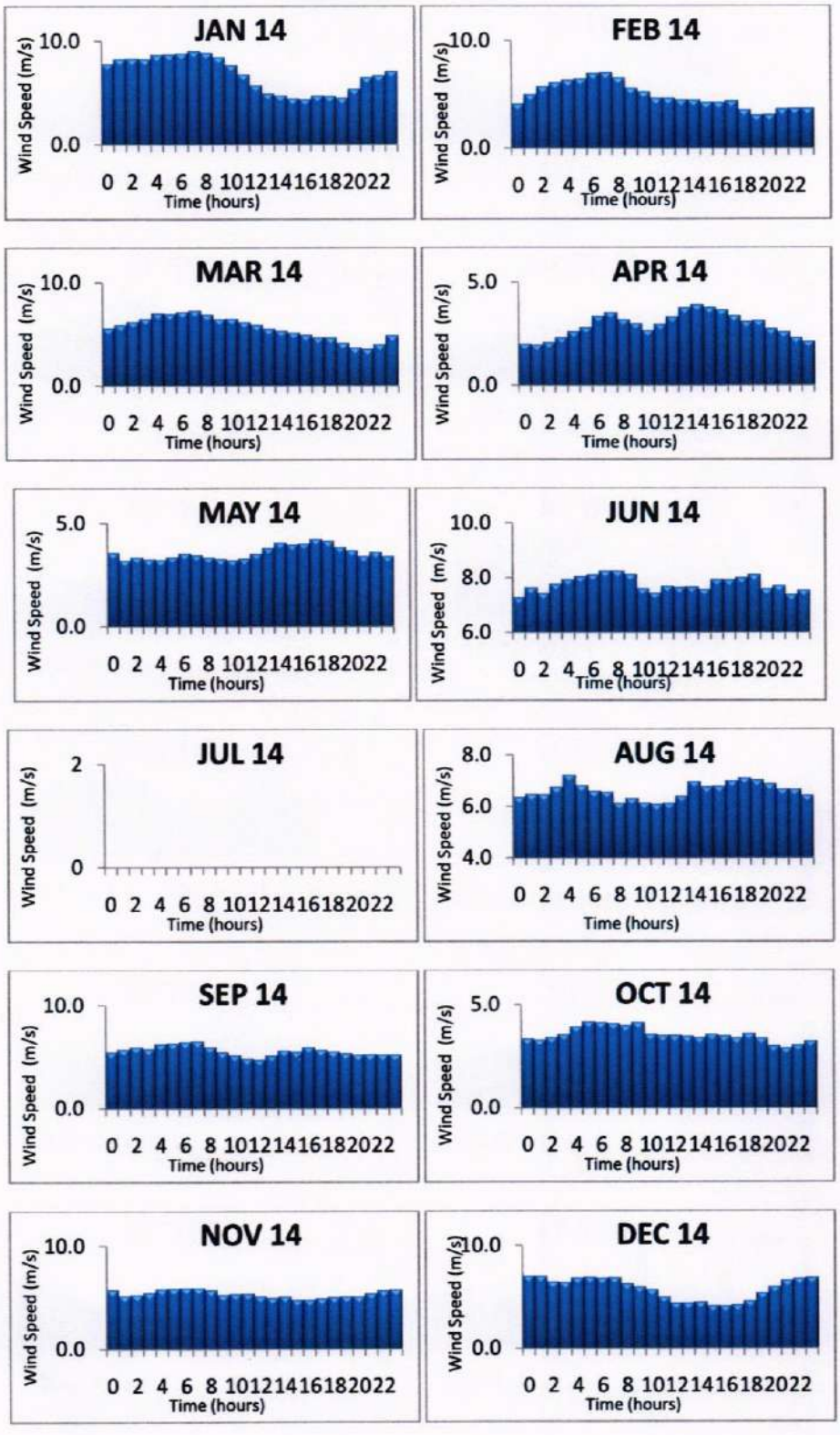
SENSOR HEIGHT: 80m **Based on Data January 2014 to December 2014**

Range 0--1 Extends from 0 to 0.99 m/s &
1-- 2 Extends from 1 to 1.99 m/s etc.

* Inadequate data

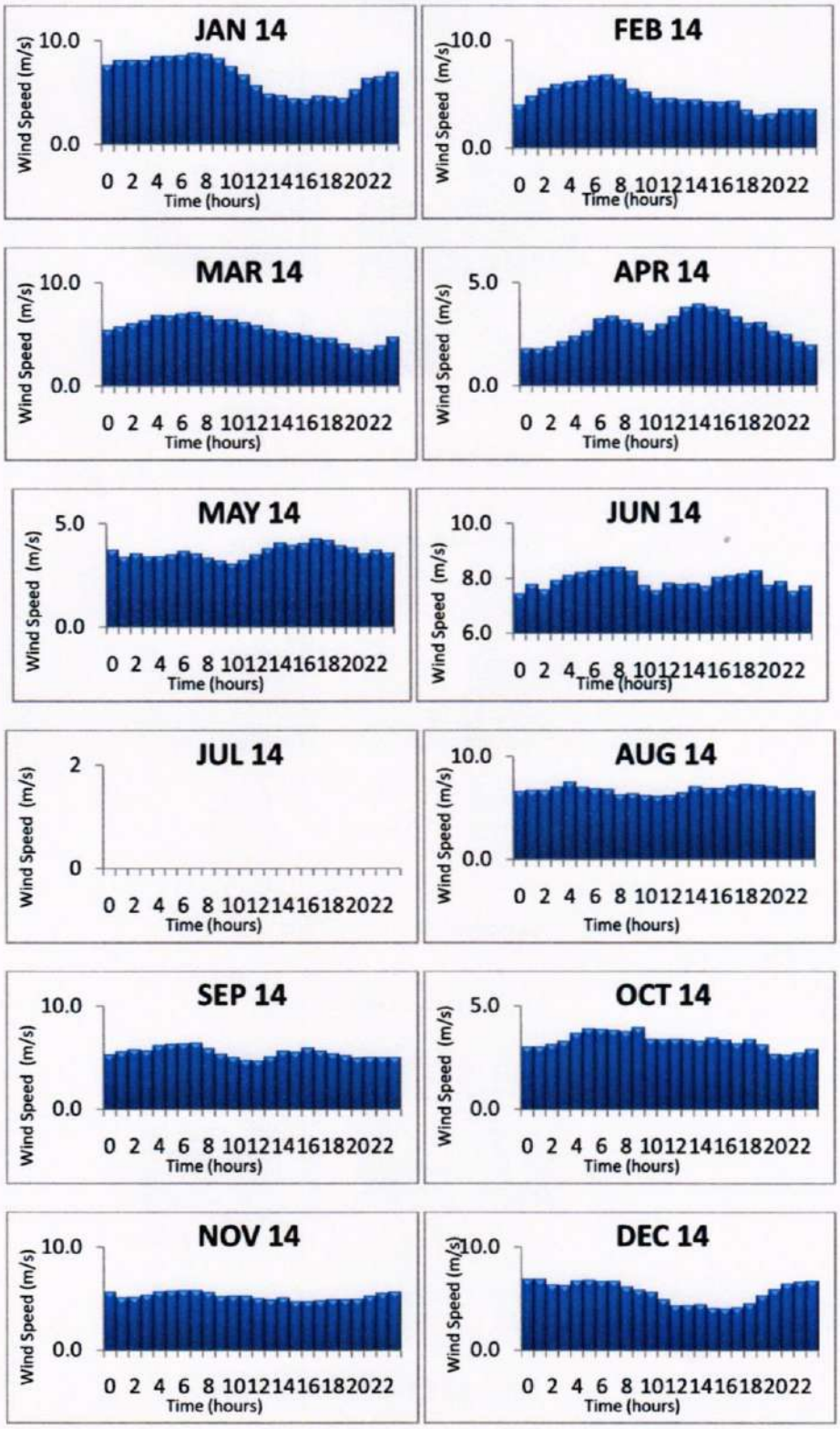


SENSOR HEIGHT: 50m
FIGURE 4: MEAN HOURLY WIND SPEED
(JANUARY 2014 TO DECEMBER 2014)

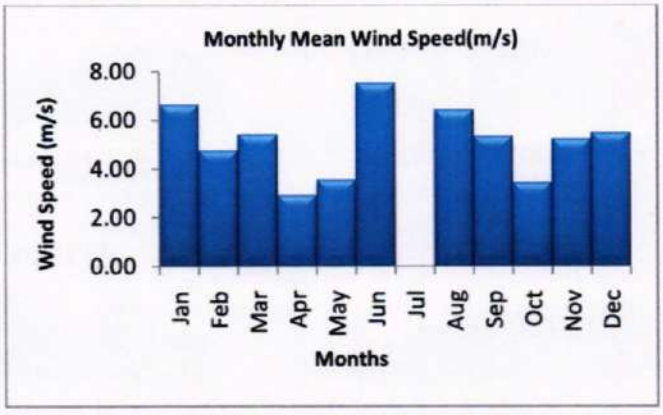


SENSOR HEIGHT: 78m

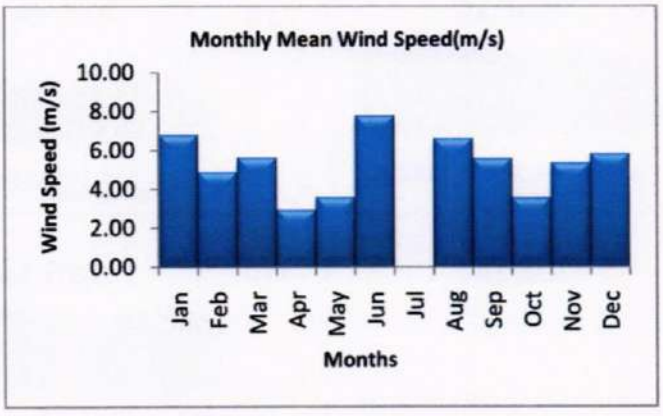
FIGURE 4A: MEAN HOURLY WIND SPEED (JANUARY 2014 TO DECEMBER 2014)



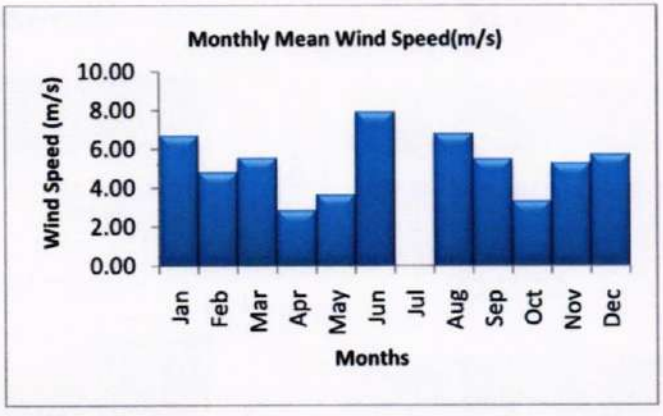
SENSOR HEIGHT: 80m NORTH
FIGURE 4B: MEAN HOURLY WIND SPEED
(JANUARY 2014 TO DECEMBER 2014)



SENSOR HEIGHT: 50m

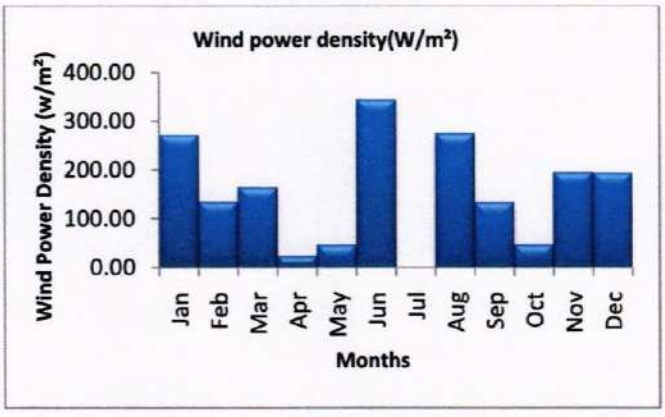


SENSOR HEIGHT: 78m

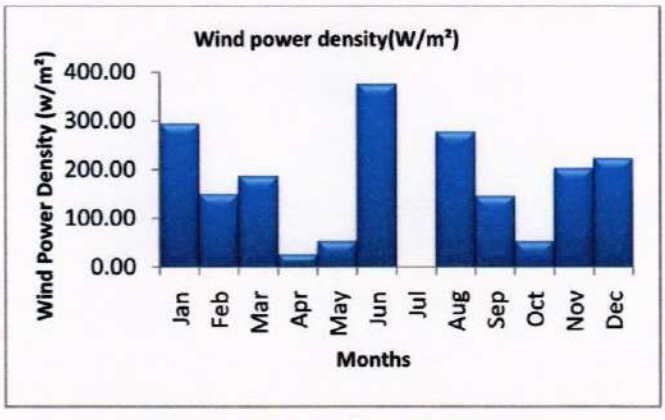


SENSOR HEIGHT: 80m

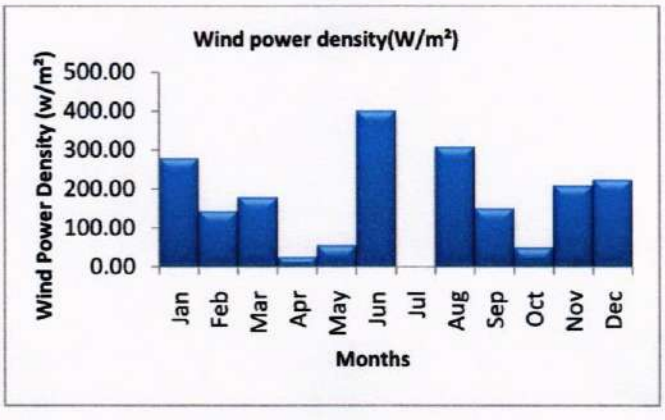
FIGURE 5: MONTHLY MEAN WIND SPEED (JANUARY 2014 TO DECEMBER 2014)



SENSOR HEIGHT: 50m



SENSOR HEIGHT: 78m



SENSOR HEIGHT: 80m

FIGURE 6: MONTHLY MEAN WIND POWER DENSITY (JANUARY 2014 TO DECEMBER 2014)

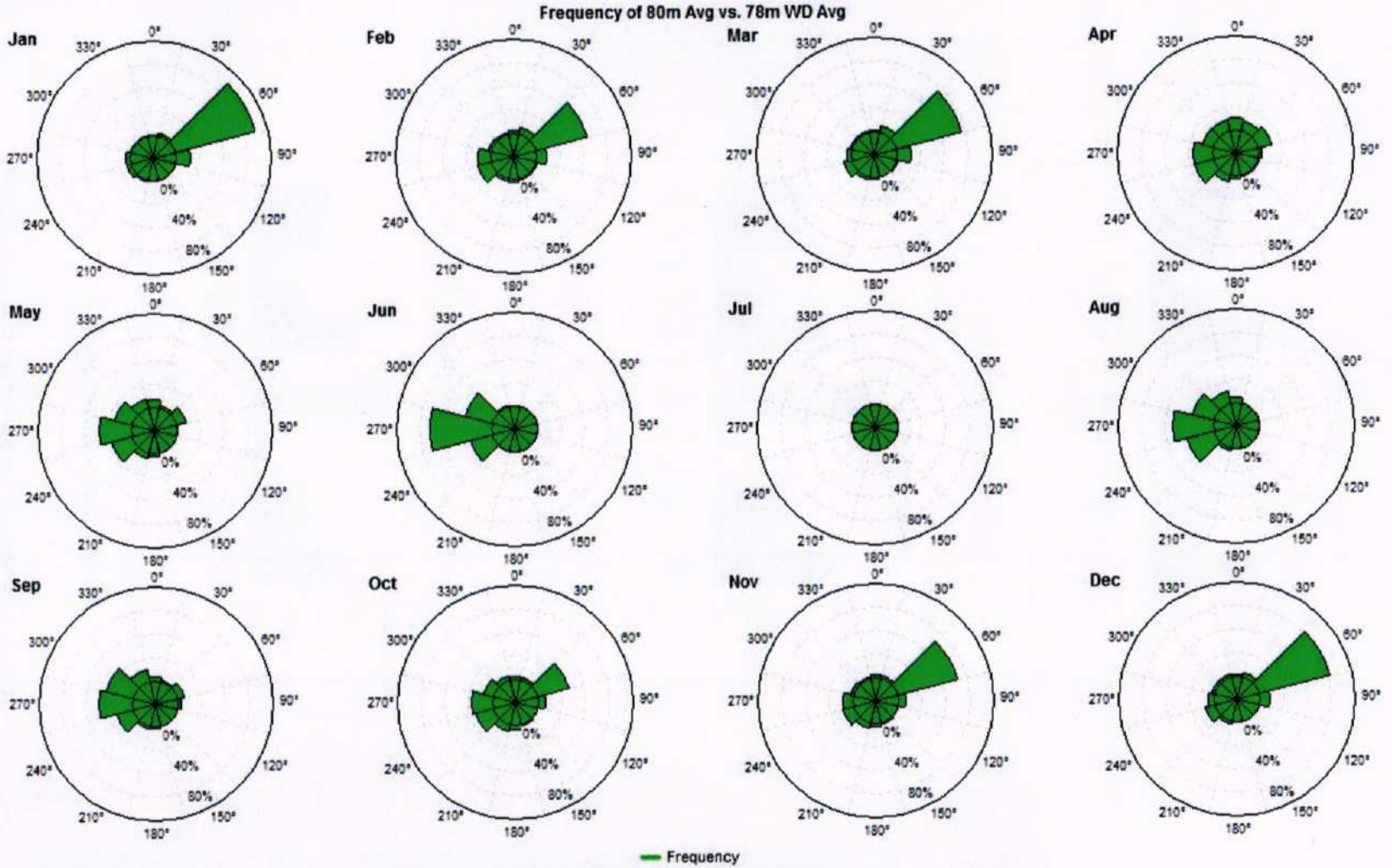


FIGURE 7: WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(January 2014 to December 2014)

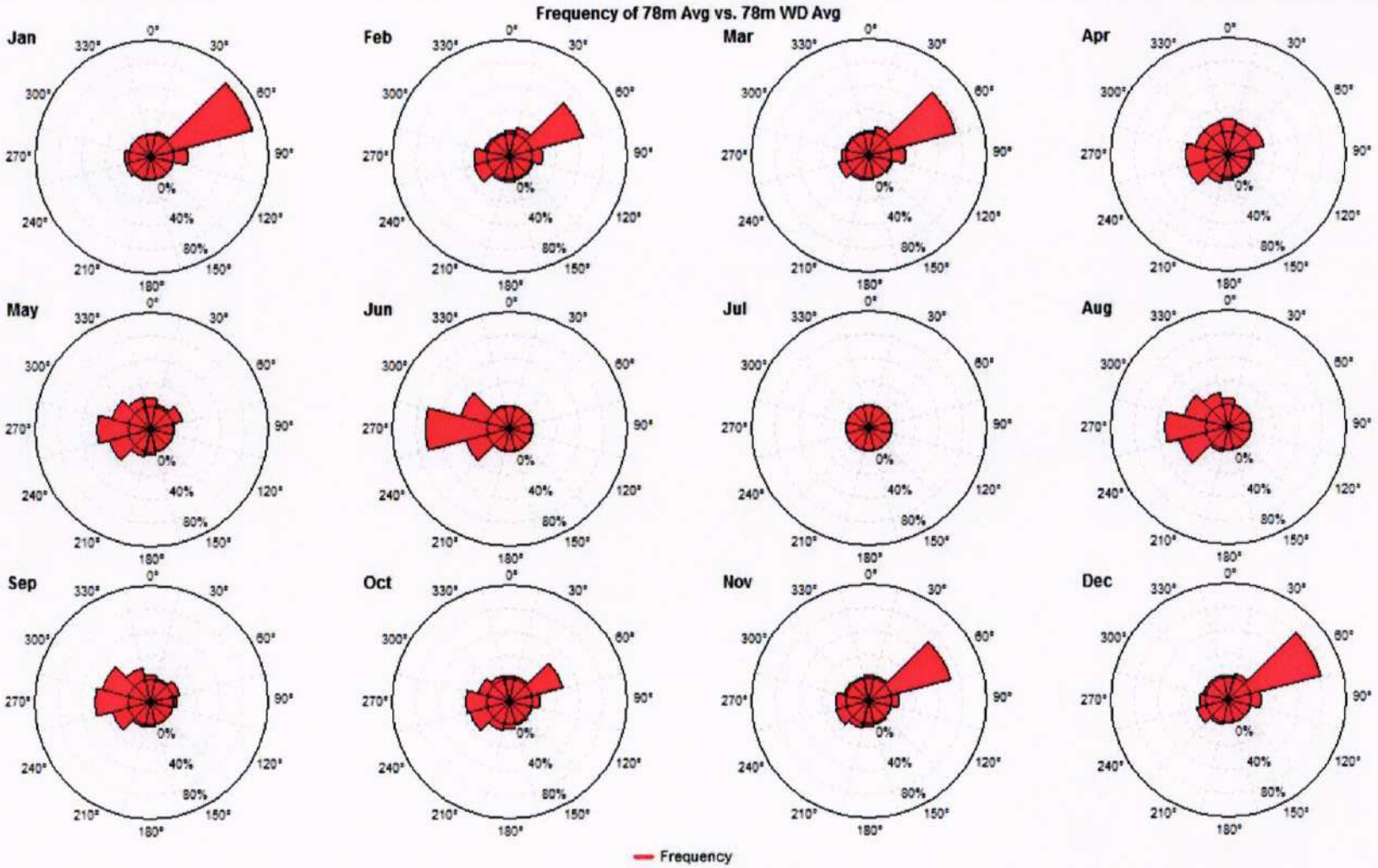


FIGURE 7A: WIND ROSE
SENSOR HEIGHT: (78m Anemometer and 78m Wind vane)
(January 2014 to December 2014)

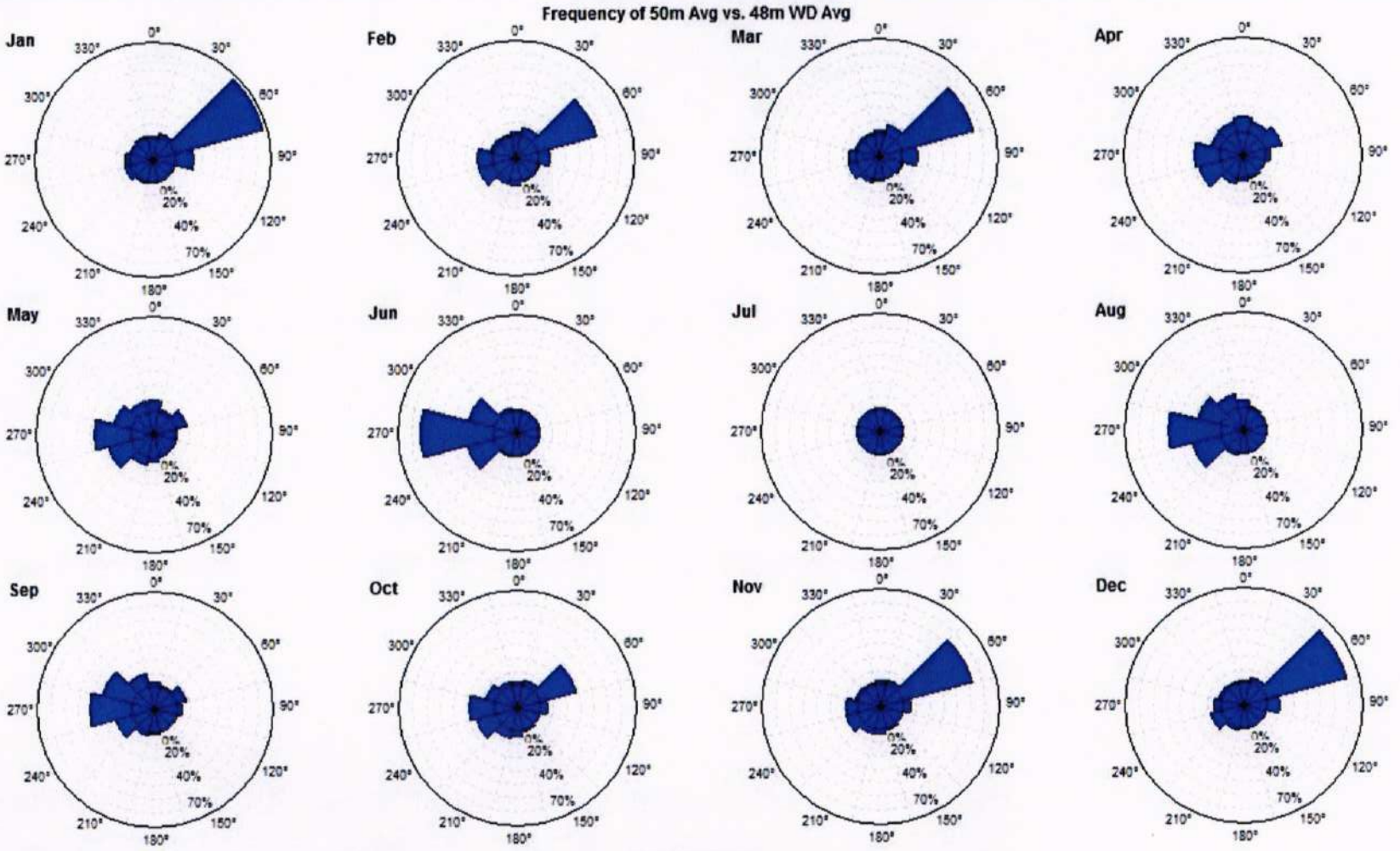
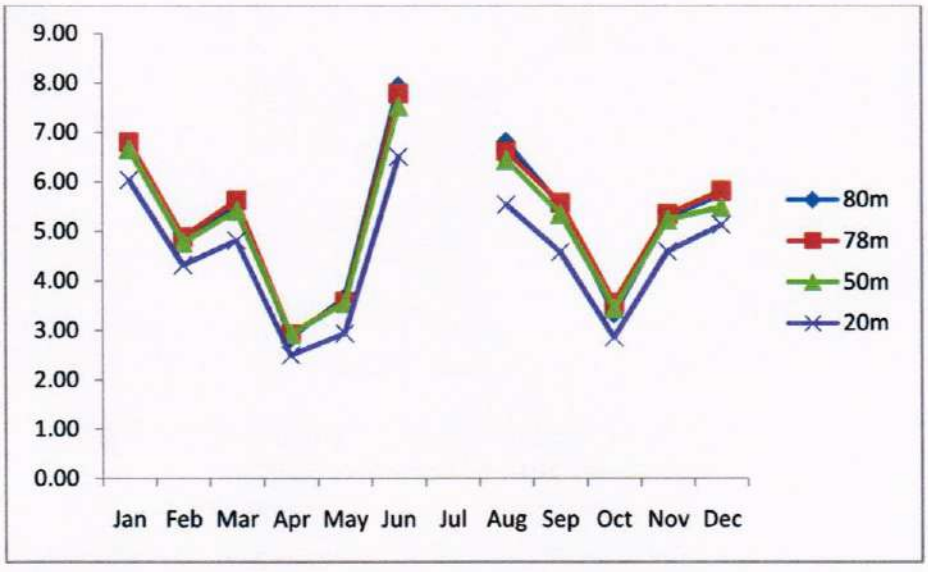
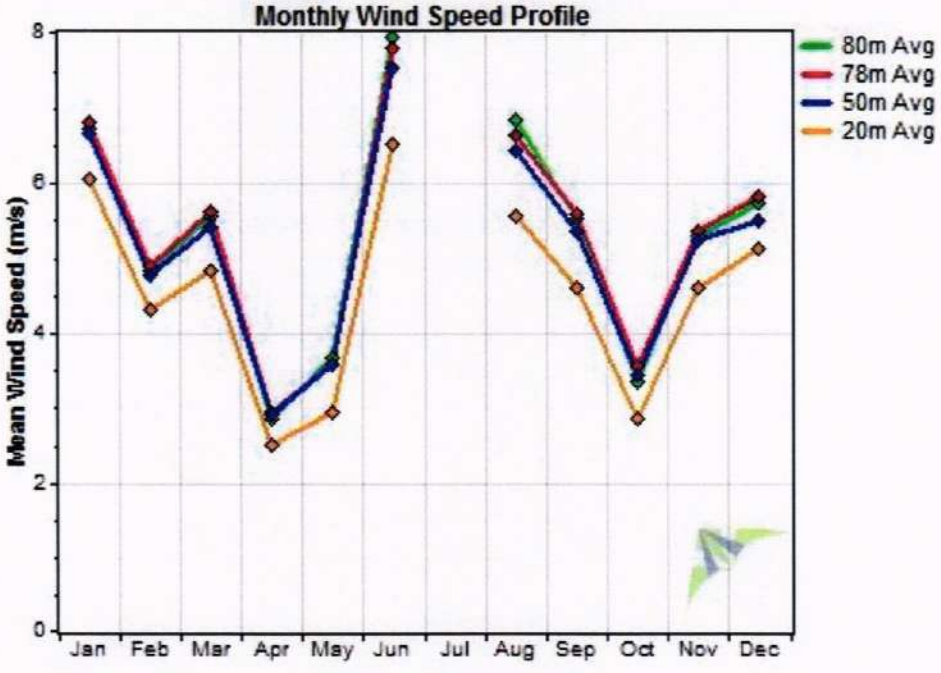


FIGURE 7B: WIND ROSE
SENSOR HEIGHT: (50m Anemometer and 48m Wind vane)
(January 2014 to December 2014)



MONTHLY MEAN WIND SPEED
(January 2014 to December 2014)



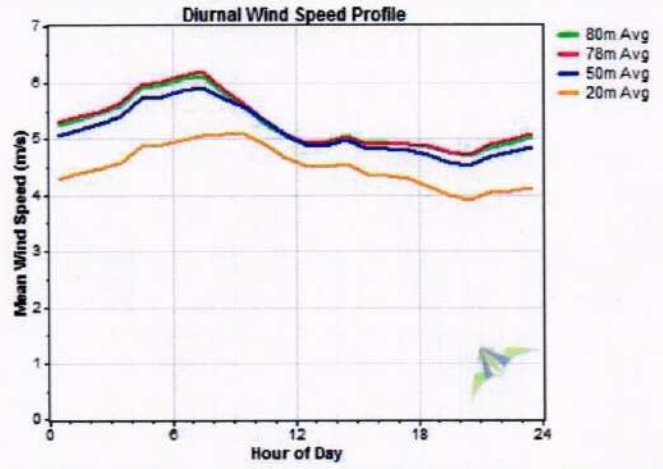


FIGURE 8: MONTHLY WIND SPEED AND DAILY WIND SPEED – PULIKKANAM (January 2014 to December 2014)

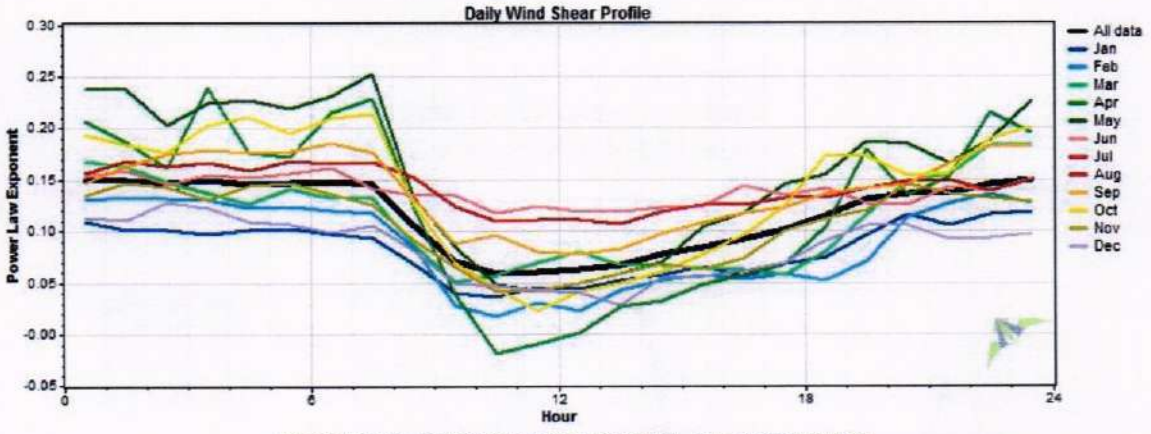


FIGURE 9: DAILY WIND SHEAR-PULIKKANAM (January 2014 to December 2014)

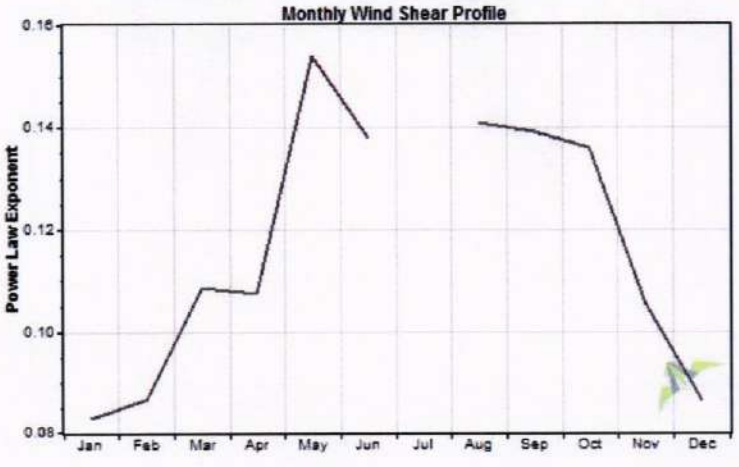


FIGURE 10: MONTHLY WIND SHEAR- PULIKKANAM (January 2014 to December 2014)

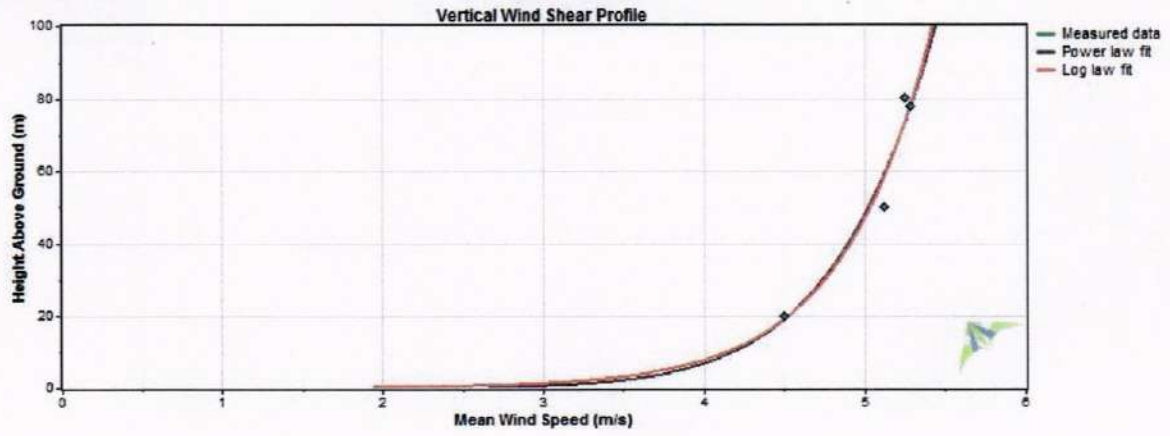
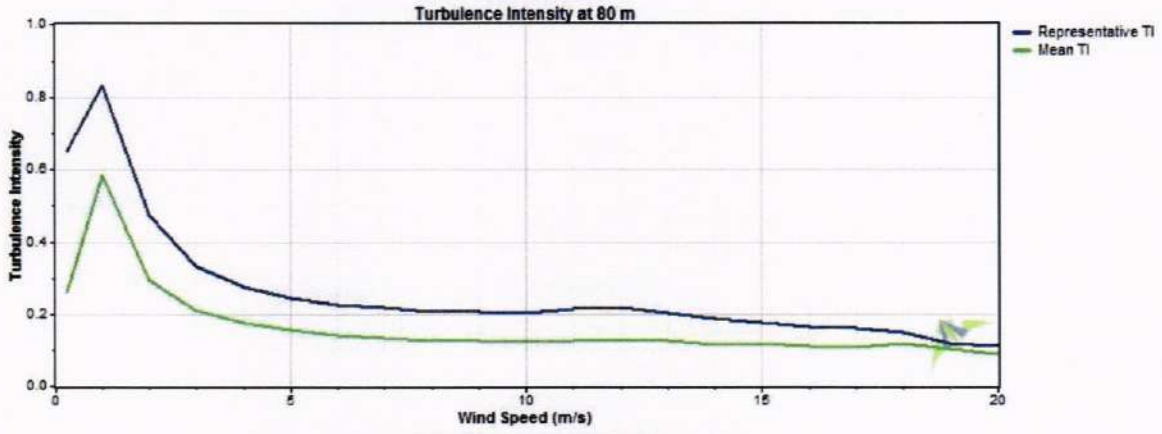
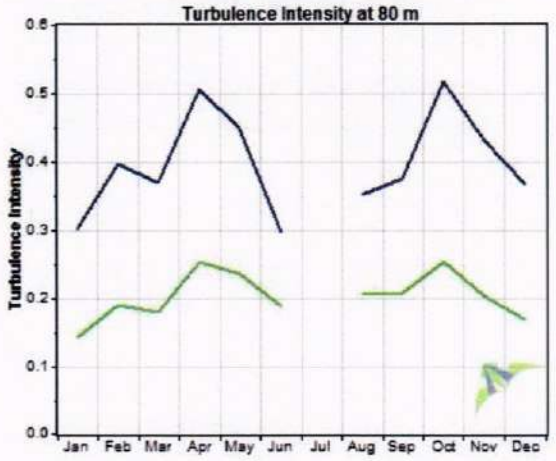
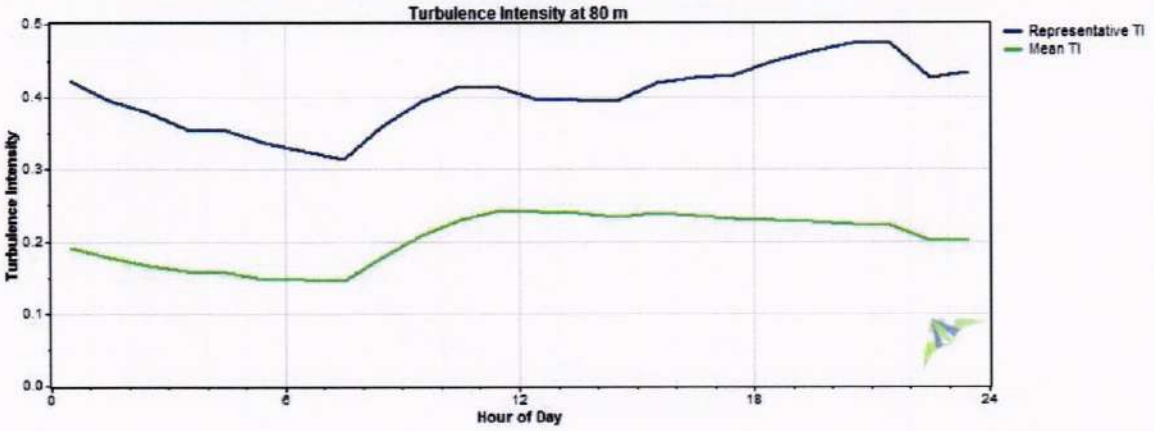


FIGURE 11: VERTICALWIND SHEAR- PULIKKANAM (January 2014 to December 2014)







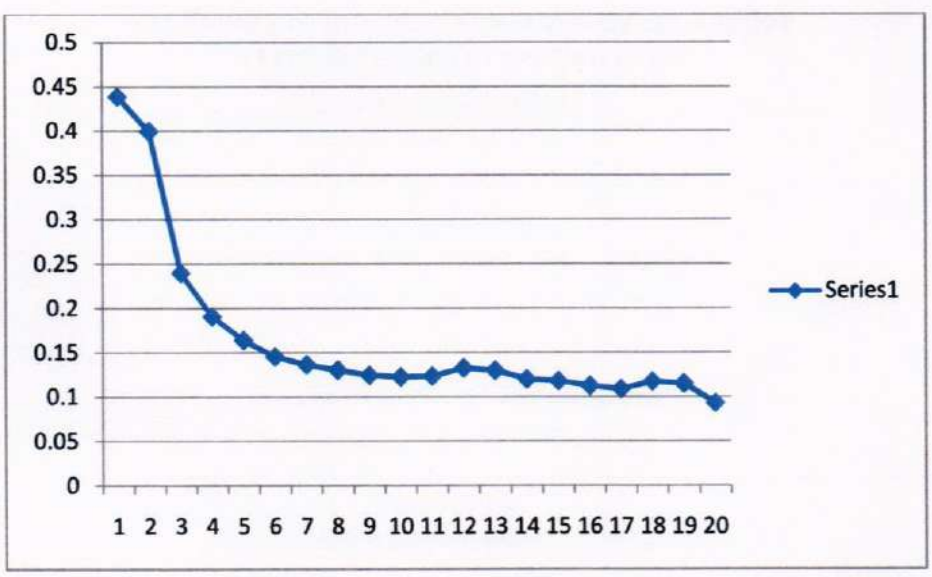
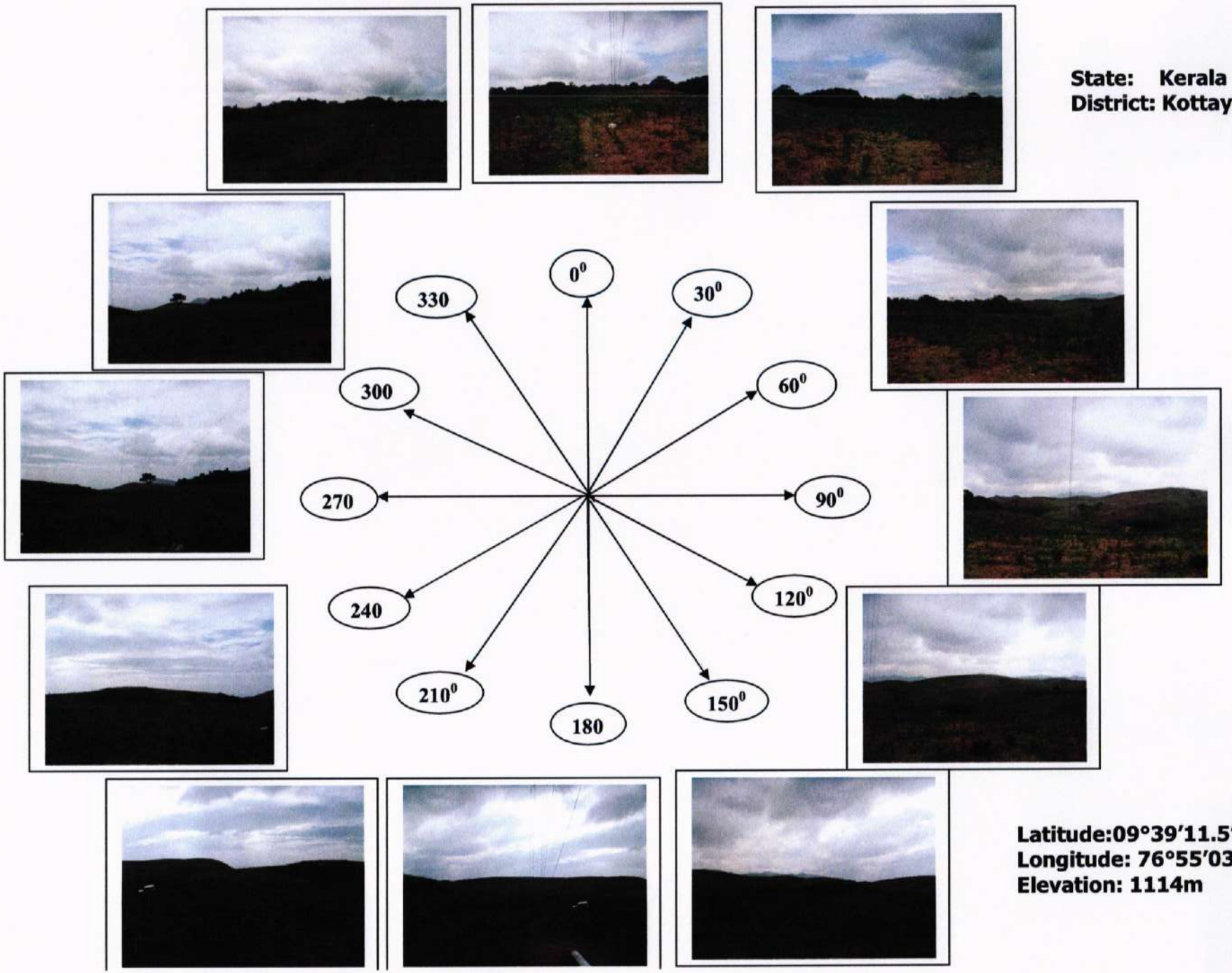


FIGURE 12: TURBULANCE INTENSITY – PULIKKANAM
(January 2014 to December 2014)

Annexure -2

Site Photographs

(a) 12 Sector wise photograph of "Pullikanam Tea Estate" site



State: Kerala
District: Kottayam

Latitude:09°39'11.5"
Longitude: 76°55'03.0"
Elevation: 1114m

Annexure-3

Calibration Reports

Svend Ole Hansen ApS

SCT. JØRGENS ALLÉ 7 · DK-1615 KØBENHAVN V · DENMARK
TEL: (+45) 33 25 38 38 · FAX: (+45) 33 25 38 39 · WWW.SOHANSEN.DK

WIND ENGINEERING FLUID DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0879 **Date of issue:** February 7, 2011

Type: NRG #40 **Serial number:** 179500166128

Manufacturer: NRG Systems, 110 Commerce Street, Hinesburg, Vermont 05461, USA

Client: NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: December 16, 2010 **Anemometer calibrated:** February 7, 2011

Calibrated by: mr **Calibration procedure:** IEC 61400-12-1, MEASNET

Certificate prepared by: jsa **Approved by:** Calibration engineer, soh

Svend Ole Hansen

Calibration equation obtained: v [m/s] = 0.75947 · f [Hz] + 0.29658

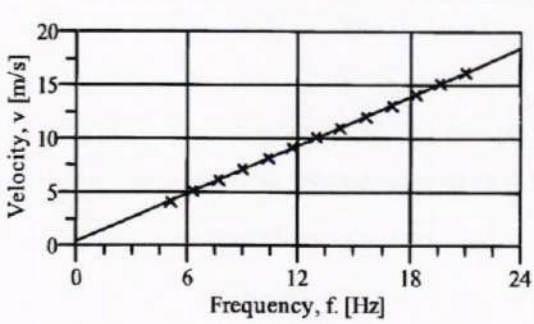
Standard uncertainty, slope: 0.00109 **Standard uncertainty, offset:** 0.03878

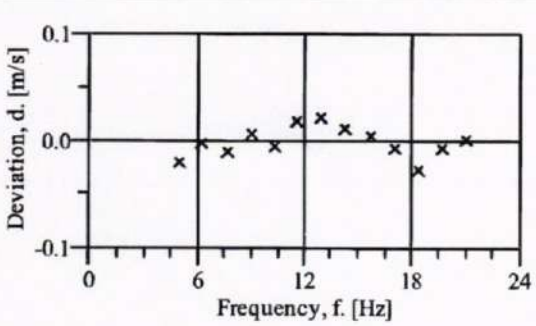
Covariance: -0.0000089 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999993$

Absolute maximum deviation: -0.026 m/s at 14.207 m/s

Barometric pressure: 1008.4 hPa **Relative humidity:** 20.3%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.70	31.3	23.2	4.109	5.0461	-0.020	0.028
4	14.83	31.1	23.2	5.078	6.2965	0.000	0.032
6	21.47	31.0	23.2	6.108	7.6639	-0.009	0.037
8	29.20	30.9	23.2	7.122	8.9771	0.008	0.043
10	38.22	30.8	23.1	8.147	10.3416	-0.004	0.049
12	48.21	30.7	23.1	9.149	11.6293	0.020	0.054
13-last	59.61	30.7	23.1	10.172	12.9735	0.023	0.060
11	71.66	30.8	23.1	11.154	14.2785	0.014	0.066
9	85.59	30.9	23.2	12.192	15.6558	0.005	0.072
7	100.30	31.0	23.2	13.201	17.0003	-0.007	0.078
5	116.11	31.1	23.2	14.207	18.3506	-0.026	0.084
3	133.24	31.2	23.2	15.223	19.6613	-0.006	0.090
1-first	152.25	31.5	23.3	16.279	21.0424	0.002	0.096





DANAK
CAL Reg.nr. 452
Accreditation to ISO 17025

EQUIPMENT USED

Serial number	Description
-	Boundary layer wind tunnel.
1256	Control cup anemometer.
-	Mounting tube, D = 25 mm
t1	PT100 temperature sensor, wind tunnel.
t2	PT100 temperature sensor, control room.
9904031	PPC500 Furness pressure manometer
X4650038	HMW71U Humidity transmitter
X4350042	PTB100AVaisala analogue barometer.
P11	Pitot tube
001551	Computer Board. 16 bit A/D data acquisition board.
-	PC dedicated to data acquisition.

Traceable calibrations of the equipment are carried out by external accredited institutions: Furness (PPC500) and Saab Metech. A real-time analysis module within the data acquisition software detects pulse frequency.

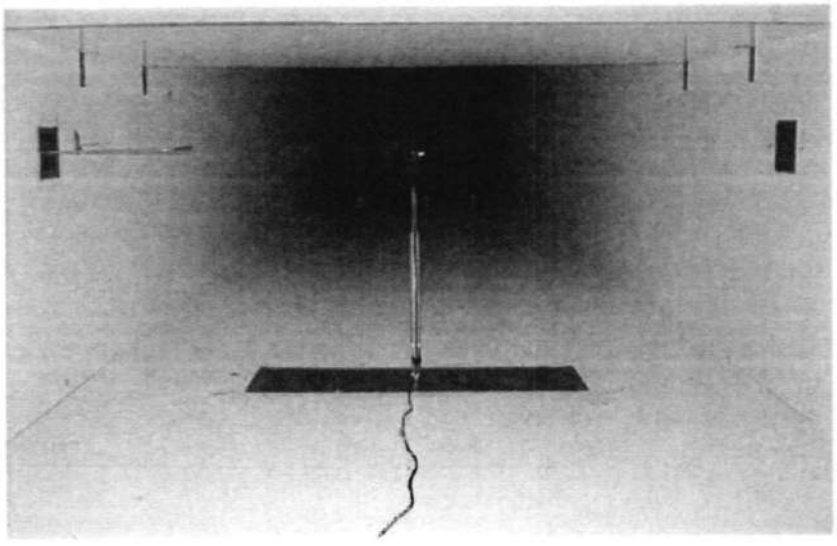


Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the MEASNET procedure that prescribes an absolute uncertainty less than 0.1 m/s at a mean wind velocity of 10 m/s, that is 1%. See Document 97.00.004 "MEASNET - Test report on the calibration campaign" for further details.

Certificate number: 11.02.0879

Svend Ole Hansen ApS

SCT. JØRGENS ALLÉ 7 · DK-1615 KØBENHAVN V · DENMARK
TEL: (+45) 33 25 38 38 · FAX: (+45) 33 25 38 39 · WWW.SOHANSEN.DK

WIND
ENGINEERING
FLUID
DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0881 **Date of issue:** February 7, 2011

Type: NRG #40 **Serial number:** 179500166130

Manufacturer: NRG Systems, 110 Commerce Street, Hinesburg, Vermont 05461, USA

Client: NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: December 16, 2010 **Anemometer calibrated:** February 7, 2011

Calibrated by: mr **Calibration procedure:** IEC 61400-12-1, MEASNET

Certificate prepared by: jsa **Approved by:** Calibration engineer, soh

Svend Ole Hansen

Calibration equation obtained: v [m/s] = 0.76078 · f [Hz] + 0.27547

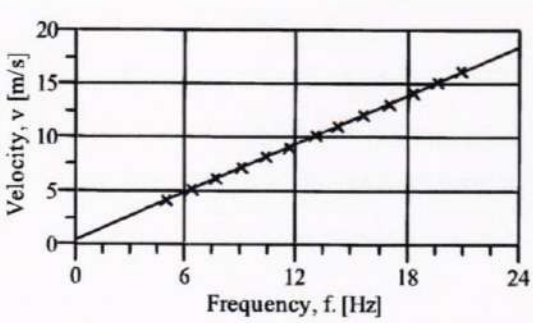
Standard uncertainty, slope: 0.00113 **Standard uncertainty, offset:** 0.04347

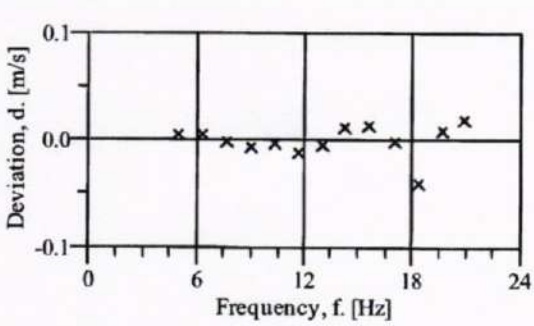
Covariance: -0.0000096 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999993$

Absolute maximum deviation: -0.039 m/s at 14.204 m/s

Barometric pressure: 1009.0 hPa **Relative humidity:** 20.2%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.63	31.3	23.2	4.092	5.0077	0.007	0.028
4	14.95	31.2	23.2	5.097	6.3298	0.006	0.032
6	21.54	31.1	23.2	6.118	7.6793	0.000	0.037
8	29.31	31.0	23.2	7.134	9.0227	-0.006	0.043
10	38.30	30.9	23.2	8.153	10.3590	-0.003	0.049
12	48.17	30.8	23.1	9.143	11.6717	-0.012	0.054
13-last	60.09	30.8	23.1	10.211	13.0660	-0.005	0.060
11	71.76	30.9	23.2	11.160	14.2903	0.013	0.066
9	85.56	30.9	23.2	12.188	15.6398	0.014	0.072
7	100.33	31.0	23.2	13.201	16.9920	-0.001	0.078
5	116.11	31.2	23.2	14.204	18.3599	-0.039	0.084
3	133.63	31.3	23.2	15.241	19.6591	0.009	0.090
1-first	151.45	31.5	23.3	16.232	20.9492	0.019	0.096





ilac-MRA

DANAK
CAL Reg.nr. 452
Accreditation to ISO 17025

measnet

EQUIPMENT USED

Serial number	Description
-	Boundary layer wind tunnel.
1256	Control cup anemometer.
-	Mounting tube, D = 25 mm
t1	PT100 temperature sensor, wind tunnel.
t2	PT100 temperature sensor, control room.
9904031	PPC500 Furness pressure manometer
X4650038	HMW71U Humidity transmitter
X4350042	PTB100AVaisala analogue barometer.
P11	Pitot tube
001551	Computer Board. 16 bit A/D data acquisition board.
-	PC dedicated to data acquisition.

Traceable calibrations of the equipment are carried out by external accredited institutions: Furness (PPC500) and Saab Metech. A real-time analysis module within the data acquisition software detects pulse frequency.

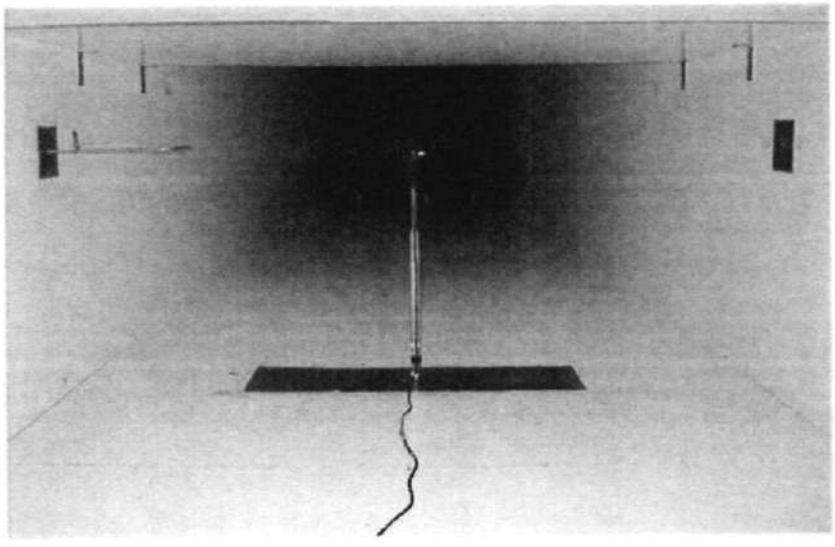


Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the MEASNET procedure that prescribes an absolute uncertainty less than 0.1 m/s at a mean wind velocity of 10 m/s, that is 1%. See Document 97.00.004 "MEASNET - Test report on the calibration campaign" for further details.

Certificate number: 11.02.0881

Svend Ole Hansen ApS

SCT. JØRGENS ALLÉ 7 · DK-1615 KØBENHAVN V · DENMARK
TEL: (+45) 33 25 38 38 · FAX: (+45) 33 25 38 39 · WWW.SOHANSEN.DK

WIND ENGINEERING FLUID DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0882 **Date of issue:** February 7, 2011

Type: NRG #40 **Serial number:** 179500166131

Manufacturer: NRG Systems, 110 Commerce Street, Hinesburg, Vermont 05461, USA

Client: NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: December 16, 2010 **Anemometer calibrated:** February 7, 2011

Calibrated by: mr **Calibration procedure:** IEC 61400-12-1, MEASNET

Certificate prepared by: jsa **Approved by:** Calibration engineer, soh

Svend Ole Hansen

Calibration equation obtained: v [m/s] = 0.76073 · f [Hz] + 0.27465

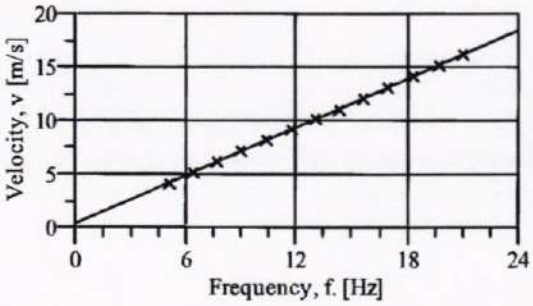
Standard uncertainty, slope: 0.00078 **Standard uncertainty, offset:** 0.02996

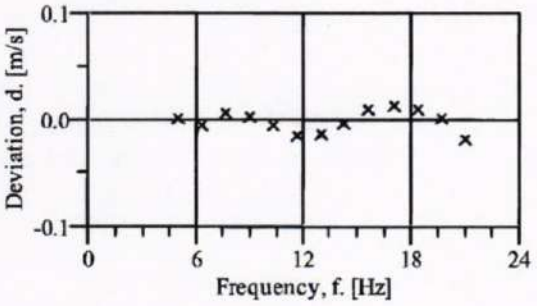
Covariance: -0.0000045 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999997$

Absolute maximum deviation: -0.017 m/s at 16.248 m/s

Barometric pressure: 1009.6 hPa **Relative humidity:** 20.1%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.73	31.4	23.2	4.112	5.0404	0.003	0.028
4	15.12	31.3	23.3	5.125	6.3809	-0.004	0.032
6	21.64	31.1	23.4	6.130	7.6865	0.008	0.037
8	29.11	31.0	23.5	7.108	8.9760	0.005	0.043
10	38.14	30.9	23.5	8.134	10.3369	-0.004	0.048
12	48.45	30.9	23.6	9.167	11.7077	-0.014	0.054
13-last	59.73	30.8	23.6	10.178	13.0342	-0.013	0.060
11	71.73	30.9	23.6	11.154	14.3037	-0.002	0.066
9	85.42	31.0	23.5	12.175	15.6292	0.010	0.072
7	100.44	31.1	23.4	13.204	16.9782	0.014	0.078
5	116.67	31.2	23.3	14.235	18.3359	0.012	0.084
3	133.85	31.3	23.2	15.252	19.6839	0.003	0.090
1-first	151.78	31.6	23.3	16.248	21.0200	-0.017	0.096





DANAK
CAL Reg.nr. 452
Accreditation to ISO 17025

EQUIPMENT USED

Serial number	Description
-	Boundary layer wind tunnel.
1256	Control cup anemometer.
-	Mounting tube, D = 25 mm
t1	PT100 temperature sensor, wind tunnel.
t2	PT100 temperature sensor, control room.
9904031	PPC500 Furness pressure manometer
X4650038	HMW71U Humidity transmitter
X4350042	PTB100AVaisala analogue barometer.
P11	Pitot tube
001551	Computer Board. 16 bit A/D data acquisition board.
-	PC dedicated to data acquisition.

Traceable calibrations of the equipment are carried out by external accredited institutions: Furness (PPC500) and Saab Metech. A real-time analysis module within the data acquisition software detects pulse frequency.

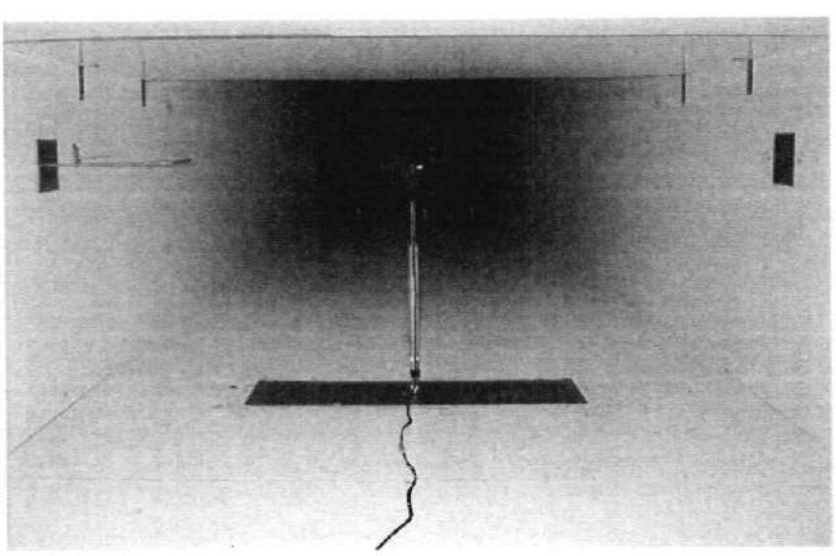


Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the MEASNET procedure that prescribes an absolute uncertainty less than 0.1 m/s at a mean wind velocity of 10 m/s, that is 1%. See Document 97.00.004 "MEASNET - Test report on the calibration campaign" for further details.

Certificate number: 11.02.0882

Svend Ole Hansen ApS

SCT. JØRGENS ALLÉ 7 · DK-1615 KØBENHAVN V · DENMARK
TEL: (+45) 33 25 38 38 · FAX: (+45) 33 25 38 39 · WWW.SOHANSEN.DK

WIND ENGINEERING FLUID DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0901 **Date of issue:** February 9, 2011

Type: NRG #40 **Serial number:** 179500166132

Manufacturer: NRG Systems, 110 Commerce Street, Hinesburg, Vermont 05461, USA

Client: NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: December 16, 2010 **Anemometer calibrated:** February 8, 2011

Calibrated by: bja **Calibration procedure:** IEC 61400-12-1, MEASNET

Certificate prepared by: jsa **Approved by:** Calibration engineer, soh

Svend Ole Hansen

Calibration equation obtained: v [m/s] = 0.75987 · f [Hz] + 0.37450

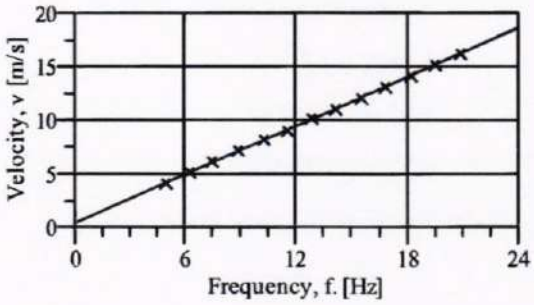
Standard uncertainty, slope: 0.00094 **Standard uncertainty, offset:** 0.02621

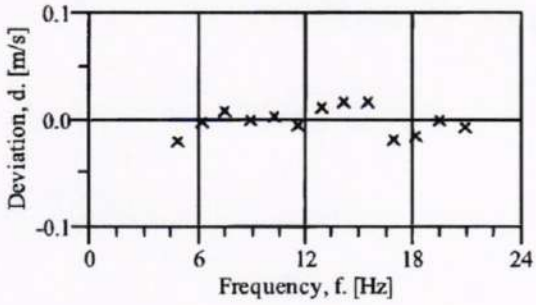
Covariance: -0.0000065 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999995$

Absolute maximum deviation: -0.020 m/s at 4.106 m/s

Barometric pressure: 1012.9 hPa **Relative humidity:** 22.5%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.89	26.7	23.9	4.106	4.9359	-0.020	0.028
4	15.31	26.6	23.9	5.108	6.2309	-0.001	0.032
6	21.82	26.5	23.9	6.096	7.5186	0.009	0.037
8	29.77	26.5	23.8	7.120	8.8776	0.000	0.042
10	38.90	26.4	23.8	8.139	10.2122	0.004	0.048
12	49.05	26.4	23.7	9.139	11.5392	-0.004	0.054
13-last	60.80	26.4	23.7	10.175	12.8819	0.012	0.059
11	73.02	26.4	23.8	11.151	14.1584	0.018	0.065
9	87.06	26.5	23.8	12.176	15.5087	0.017	0.071
7	101.98	26.5	23.8	13.180	16.8757	-0.017	0.077
5	117.90	26.6	23.9	14.174	18.1789	-0.014	0.083
3	135.91	26.7	23.9	15.219	19.5340	0.001	0.089
1-first	154.79	26.9	23.9	16.248	20.8967	-0.005	0.095





ilac-MRA

DANAK
CAL Reg.nr. 452
Accreditation to ISO 17025

measnet

EQUIPMENT USED

Serial number	Description
-	Boundary layer wind tunnel.
1256	Control cup anemometer.
-	Mounting tube, D = 25 mm
t1	PT100 temperature sensor, wind tunnel.
t2	PT100 temperature sensor, control room.
9904031	PPC500 Furness pressure manometer
X4650038	HMW71U Humidity transmitter
X4350042	PTB100AVaisala analogue barometer.
P11	Pitot tube
001551	Computer Board. 16 bit A/D data acquisition board.
-	PC dedicated to data acquisition.

Traceable calibrations of the equipment are carried out by external accredited institutions: Furness (PPC500) and Saab Metech. A real-time analysis module within the data acquisition software detects pulse frequency.

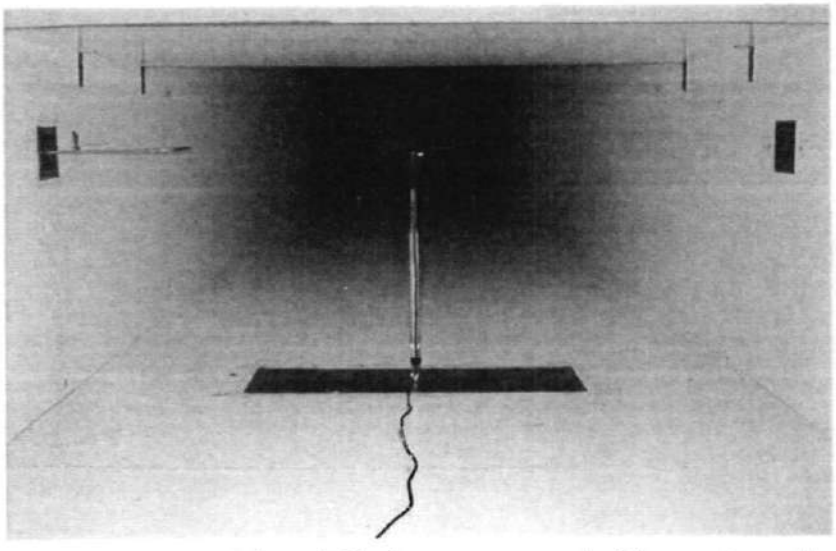


Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the MEASNET procedure that prescribes an absolute uncertainty less than 0.1 m/s at a mean wind velocity of 10 m/s, that is 1%. See Document 97.00.004 "MEASNET - Test report on the calibration campaign" for further details.

Certificate number: 11.02.0901