NATIONAL INSTITUTE OF WIND ENERGY
WIND RESOURCE ASSESSMENT UNIT
Chennai-600100

REPORT ON WIND MONITORING STUDY AT CHELAMALA (ALIGARH UNIVERSITY), MALAPURAM DISTRICT, KERALA

Final Report

Prepared for

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

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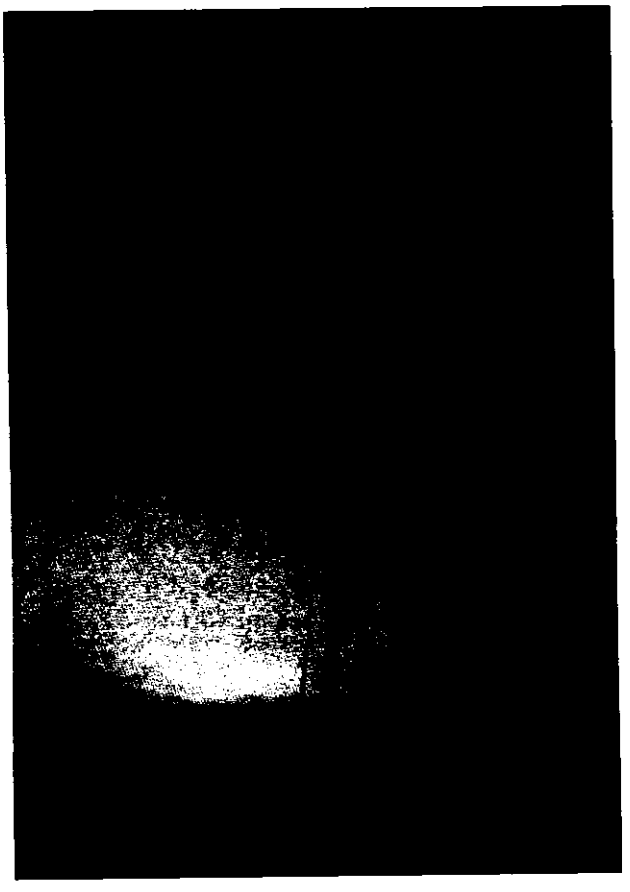
M/s. ANERT.,
THIRUVANNATHAPURAM



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

July 2017

NATIONAL INSTITUTE OF WIND ENERGY

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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 Chelamala (Aligarh University), Malapuram district, Kerala. This report gives the results of the detailed analysis carried out about the wind characteristics at Chelamala (Aligarh University), Malapuram district, Kerala.

The location Chelamala (Aligarh University), Malapuram 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 13.12.2012 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 99.99%.

Based on the analysis of Two year data collected at Chelamala, the Mean Annual Wind Power Density (MAWPD) at 80m level for the period from January 2013 to December 2013 is found to be 94.15 W/m2 and January 2014 to December 2014 is found to be 92.47 W/m2. The predominant wind direction is found to be North West for both 2013 and 2014.

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REPORT ON WIND MONITORING STUDY AT CHELAMALA (ALIGARH UNIVERSITY), MALAPURAM 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 to measure wind characteristics by establishing a Wind Monitoring stations at Chelamala (Aligarh University), Malapuram District, Kerala. Based on their request, NIWE submitted a project proposal on 28.09.2012 for the aforesaid study with 80m tall tubular met mast.

A Wind Monitoring Station was commissioned on 13.12.2012 and data collection was carried out till December 2014. This report gives the results of the wind monitoring study carried out for two year.

2.0. OBJECTIVE

- To establish a 80m height wind monitoring station at Chelamala, 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 inside the campus of Aligarh University, at Chelamala village, Malapuram District-Kerala and is approximately 13km West from Kadampuzha town. The orography of the site is slightly undulated terrain with majority of simple grassland with few shrubs, bushes and scattered trees.

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

The location details of the site and the mast are given in Fig 1 & Fig 2:

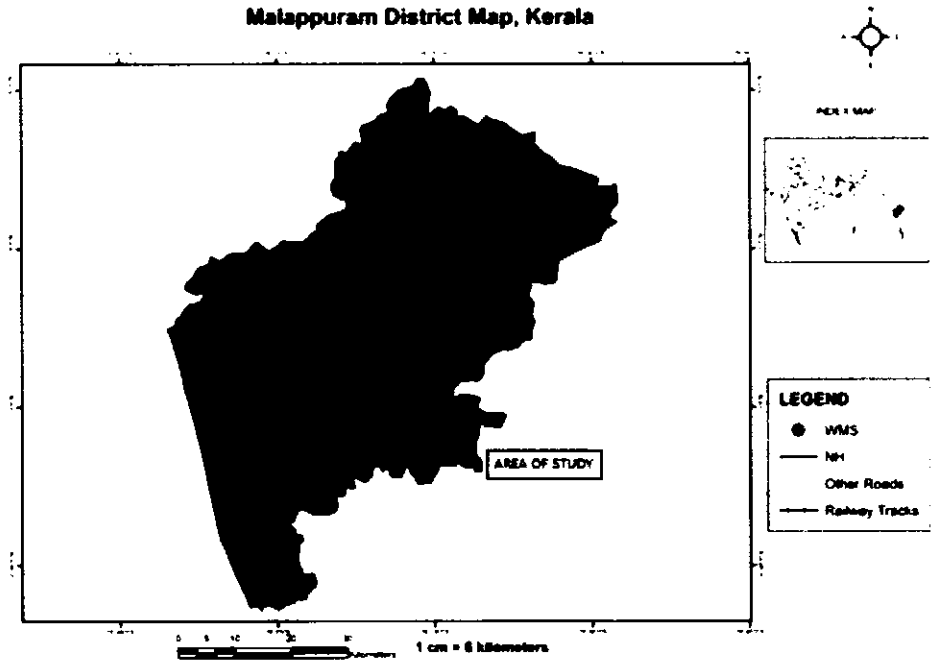

FIGURE 1: DISTRICT MAP OF MALAPURAM

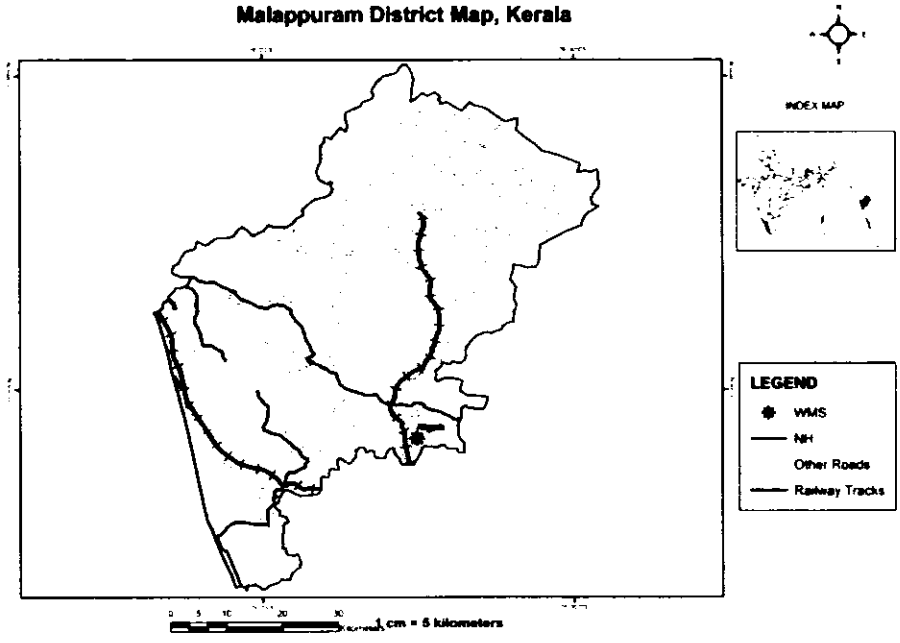

FIGURE.2. MAST LOCATION

TABLE 1: GLOBAL POSITION AND OTHER USEFUL INFORMATION OF CHELAMALA WIND MONITORING STATION

Latitude	10°55'21.48" N
Longitude	76°14' 53.4" E
Elevation	206 m AMSL SOI Topomap No.58-B1
State	Kerala
District	Malapuram
Taluk	Perunthulmanna
Village	Chelamala
Nearest town	Perunthulmanna
Nearest Railway station	Cherukara
Nearest Airport	Kozhikodi
Orography	An isolated NW. so oriented ridge in otherwise, undulated terrain
Soil	Laterite Soil
Earthquake	Zone III
Land Use	Open scrub
Physiographic Division	Semi-complex terrain
Nearest NIWE mast location	KADAMPUZHA–13kms aerially towards West Latitude-10°56'00"Longitude-76°07'00"
Nearest wind farm in operation	Nil

4.0. DESCRIPTION OF THE MASTS &INSTRUMENTATION

A 80m tall guyed tubular wind mast was commissioned on 13.12.2012. A picture of the mast mounting arrangements and a panoramic view taken from the site is presented below (Fig 3).

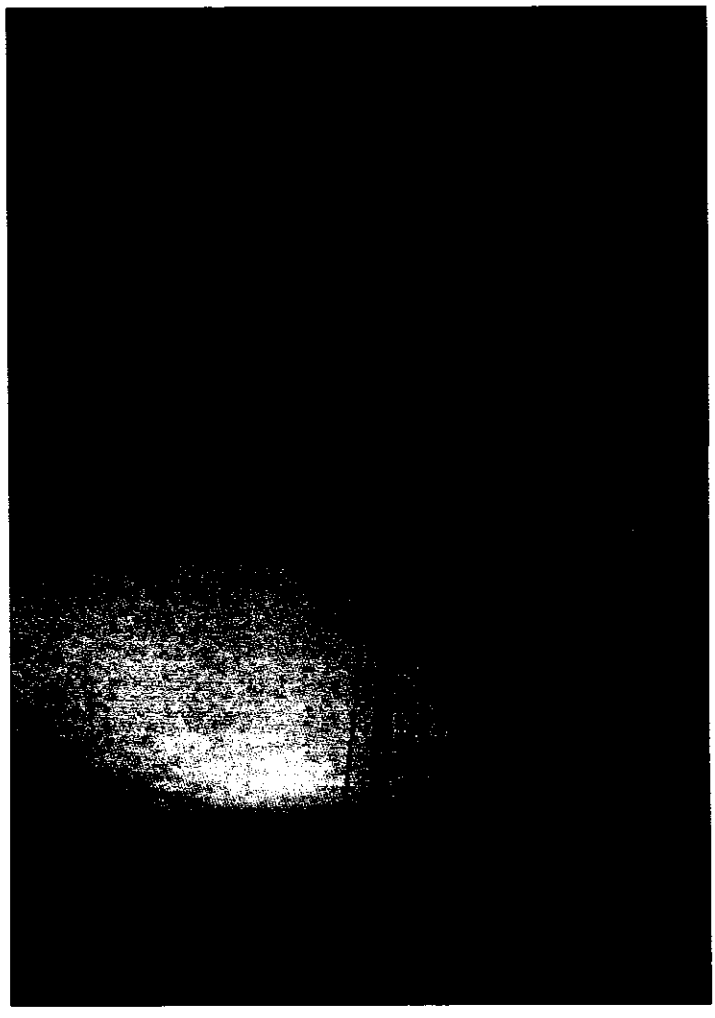

FIG 3. VIEW OF MET MAST

Anemometers (wind speed sensors) were fixed at 80m south, 78m south, 50m and 20m and the Windvane (wind direction sensors) were fixed at 78m and 48m levels. The outputs from the sensors were connected to an automatic sophisticated data logger system that was kept about 1.5m 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 1: DETAILS OF WIND SENSORS USED IN THE SITE

Sensors	Height	Sensor serial Number	Slope	offset
Anemometer	80m south	179500166137	0.76492	0.31972
	78m south	179500166138	0.76251	0.32481
	50m	179500166139	0.76301	0.31949
	20m	179500166140	0.76425	0.31450
Wind Vane	78m	605	-	-
	48m	606	-	-
Temperature sensor	10m	003	-	-
Pressure Sensor	8m	18176	-	-

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, 78mS and 80m S) are shown in Figure 8 of Annexure-1.

6.0. DETAILS OF DATA ANALYSED

The Wind Monitoring Station was commissioned at Chelamala, Malapuram 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 by 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 Mat lab, 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 Chelamala are given in Table 4 & Table 5respectivelyof 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 four heights viz., 20m, 50m, 78msouth and 80msouth are given in Table 6, 6A, 6B & 6C of Annexure-1. The graphical representations for the same are given in Figure 4, 4A and 4B of Annexure-1.

7.0. RESULTS

The data recovery rate is 99.99%for the period of measurement. The comparative details of various parameters are as follows,

Year	Mean Annual Wind Power Density(W/m^2)			
	At height 20m (AGL)	At height 50m (AGL)	At height 78m south (AGL)	At height 80m south (AGL)
2012-2013	23.17	62.11	93.38	94.15
2013-2014	23.39	59.75	90.65	92.47

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	2.72	3.89	4.49	4.49
2013-2014	2.77	3.79	4.40	4.44

Year	Mean Annual		
	Temperature ^{0} C	Air density Kg/m^3	Power law
2012-2013	26.44	1.147	0.36
2013-2014	26.57	1.147	0.34

7.1. WIND FREQUENCY DISTRIBUTION

A common method of displaying a year wind data is a wind frequency distribution, which shows the percentage of time that each wind speed occurs. Table 7, 7A, 7B and 7C of Annexure-1 show the month wise percentage frequency distribution for the four 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, 78m south and 80m 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 North West (NW) 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 0.14 (14%) and January 2014 to December 2014(at 80m AGL) at 15m/s is 0.18 (18%).

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 asTable-4 and Figure-6. 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 Jan 2004 to Dec 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: 09° 45' 30.2"
Longitude Range: 077° 10' 41.3"
**AMSL – Above Mean Sea Level*

TABLE 3: MERRA REANALYSIS DATA FOR CHELAMALA (Aligarh University), KERALA (JANUARY 2004 – DECEMBER 2014)

3.5	**3.2**	**3.1**	**3.4**	**5.3**	**7.0**	**6.6**	**7.0**	**4.3**	**3.8**	**3.4**	**3.9**	**4.5**
3.1	3.3	3.2	2.8	4.4	6.4	7.4	6.2	6.0	3.8	3.1	3.3	4.4
3.3	**3.8**	**3.2**	**3.7**	**5.3**	**5.6**	**7.4**	**6.1**	**5.0**	**3.3**	**2.6**	**4.4**	**4.5**
3.8	3.6	3.5	3.3	4.5	5.8	6.2	5.5	5.0	3.7	2.8	4.1	4.3
3.8	**3.0**	**3.4**	**3.1**	**4.8**	**5.9**	**6.6**	**5.4**	**4.7**	**3.0**	**2.8**	**3.5**	**4.2**
3.7	3.1	2.9	3.8	4.8	5.9	7.1	5.7	5.7	3.8	3.3	3.6	4.4
3.3	**2.9**	**3.8**	**3.2**	**4.6**	**6.4**	**6.5**	**6.5**	**4.2**	**4.3**	**2.9**	**2.8**	**4.3**
3.6	3.3	3.2	3.3	4.7	6.2	5.9	5.9	5.3	3.3	3.9	3.8	4.4
3.3	**3.4**	**3.6**	**3.4**	**5.1**	**5.2**	**6.1**	**5.5**	**4.9**	**3.3**	**2.9**	**3.8**	**4.2**
3.4	3.5	3.5	3.7	4.8	6.8	7.0	5.6	4.6	3.8	2.9	3.7	4.5
3.5	**3.7**	**3.3**	**3.0**	**3.7**	**5.7**	**6.6**	**5.4**	**4.8**	**2.9**	**3.1**	**3.2**	**4.1**

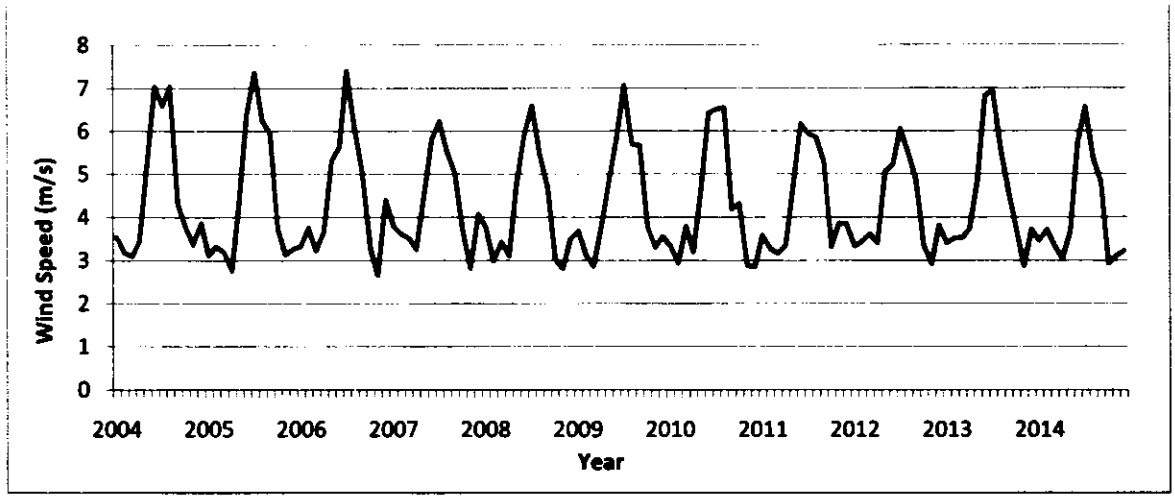

FIGURE.3A. MERRA REANALYSIS DATA FOR CHELAMALA (Aligarh University), KERALA (JANUARY 2004 - DECEMBER 2014)

8.0. CONCLUSION

Based on the analysis of Two year data collected at Chelamala, the Mean Annual Wind Power Density (MAWPD) at 80m level for the period from January 2013 to December 2013 is found to be 94.15 W/m^2 and January 2014 to December 2014 is found to be 92.47 W/m^2.

The mean annual average wind speed at 80m level for the period from January 2013 to December 2013 is found to be 4.49 m/s and January 2014 to December 2014 is found to be 4.40 m/s. The predominant wind direction is North West (NW) for the both years.

It has been observed from the analysis and the computation of WPD at 80m level, that the site is not having promising wind power potential for the development of large-scale wind power projects at the area of interest.

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CHELAMALA

2012 - 2014

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Annexure-1

Data(Tables & Figures)

Wind Resource Assessment Unit
National Institute of Wind Energy, Chennai
July 2017

NATIONAL INSTITUTE OF WIND ENERGY

WIND RESOURCE ASSESSMENT UNIT

CHELAMALA

STATE	:	***KERALA***
DISTRICT	:	***MALAPURAM***
TALUK	:	***PERUNTHULMANNA***
VILLAGE	:	***CHELAMALA***
LATITUDE	:	***10°55'21.48" N***
LONGITUDE	:	***76°14' 53.4" E***
ELEVATION	:	***206M AMSL***
INSTRUMENTS USED	:	***NOMAD-2***
PERIOD OF DATA	:	***JANUARY 2013 to DECEMBER 2014***
COMMISSIONED ON	:	***13/12/2012***
MAST HEIGHT	:	***80m***
MEASURED WIND SPEED AT 80m south AGL (January 2012 to December 2013)	:	***4.49 m/s***
MEASURED WIND SPEED AT 78m south AGL (January 2013 to December 2013)	:	***4.49 m/s***
MEASURED WIND SPEED AT 50m AGL (January 2013 to December 2013)	:	***3.89 m/s***
MEASURED WIND POWER DENSITY AT 80m south AGL (January 2013 to December 2013)	:	***94.15 W/m^2***
MEASURED WIND POWER DENSITY AT 78m south AGL (January 2013 to December 2013)	:	***93.38 W/m^2***
MEASURED WIND POWER DENSITY AT 50m AGL (January 2013 to December 2013)	:	***62.11 W/m^2***
MEASURED WIND SPEED AT 80m south AGL (January 2014 to December 2014)	:	***4.44 m/s***

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MEASURED WIND SPEED AT 78m south AGL (January 2014 to December 2014)	:	***4.40 m/s***
MEASURED WIND SPEED AT 50m AGL (January 2014 to December 2014)	:	***3.79 m/s***
MEASURED WIND POWER DENSITY AT 80m south AGL (January 2014 to December 2014)	:	***92.47 W/m^2***
MEASURED WIND POWER DENSITY AT 78m south AGL (January 2014 to December 2014)	:	***90.65 W/m^2***
MEASURED WIND POWER DENSITY AT 50m AGL (January 2014 to December 2014)	:	***59.75 W/m^2***
SOI TOPO MAP NUMBER	:	***58-B1***

Ist Year

Jan 2013 - Dec 2013

CHELAMALA

TABLE 4

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	2.85	2.71	2.38	2.47	2.94	2.77	3.05	3.36	2.40	2.13	2.33	3.19	2.72
50m	3.93	3.74	3.32	3.54	4.02	4.09	4.69	4.94	3.60	3.13	3.11	4.55	3.89
78m	4.45	4.13	3.61	3.89	4.57	4.97	5.71	5.90	4.33	3.71	3.57	5.01	4.49
80m	4.49	4.16	3.58	3.84	4.56	4.90	5.74	5.92	4.33	3.72	3.53	5.06	4.49
Monthly Wind Power Density (Watts/Sq.m)													
20m	21.62	21.78	18.12	20.22	27.41	24.13	28.20	35.28	18.61	14.35	14.81	33.46	23.17
50m	65.14	59.05	42.71	42.16	57.43	65.33	84.68	97.54	46.80	33.69	41.68	109.14	62.11
78m	92.01	81.64	56.82	54.60	79.77	111.06	146.85	159.37	74.92	51.02	60.65	151.80	93.38
80m	94.95	83.64	56.53	53.11	79.19	107.63	147.92	161.13	74.71	51.48	61.86	157.64	94.15
Power Law Index (PLI)													
	0.33	0.31	0.29	0.32	0.32	0.41	0.46	0.41	0.43	0.40	0.30	0.33	0.36
Energy Pattern Factor													
20m	1.63	1.91	2.35	2.36	1.90	1.98	1.71	1.61	2.32	4.33	2.59	1.80	2.21
50m	1.87	1.97	2.05	1.67	1.56	1.65	1.43	1.41	1.74	2.49	1.91	2.02	1.81
78 m	1.82	2.03	2.11	1.63	1.47	1.57	1.36	1.34	1.60	2.09	1.74	2.10	1.74
80m	1.83	2.03	2.16	1.65	1.47	1.59	1.36	1.35	1.60	2.09	1.74	2.11	1.75
Air Density (kg/m^3)													
	1.144	1.145	1.140	1.138	1.139	1.154	1.155	1.152	1.152	1.151	1.145	1.152	1.147
Temperature (^{0} C)													
	27.90	27.67	28.63	28.88	28.20	24.27	23.91	24.99	24.94	25.58		25.90	26.44
Turbulance Intensity (at 50m agl)													
At 15m/s : 0.14													
Data Availability (Based on 10 Minutes Interval)													
	4464	4032	4464	4320	4464	4320	4464	4464	4320	4463	4316	4462	

Based on Data January 2013 to December 2013

CHELAMALA

TABLE 5
SUMMARY OF WIND DATA

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)	(78m)	(80m)	(50m)	(78m)	(80m)	(50m)	(78m)	(80m)	(50m)	(80m)
3.93	4.45	4.49	0.68	0.64	0.63	11.81 01-23-2013 12:30	13.68 01-15-2013 7:30	13.92 01-15-2013 7:30	SE	SE
3.74	4.13	4.16	0.69	0.65	0.64	12.19 02-12-2013 1:10	13.64 02-12-2013 1:10	13.91 02-12-2013 1:10	SE	SE
3.32	3.61	3.58	0.66	0.64	0.63	11.44 03-06-2013 3:30	12.74 03-06-2013 3:30	12.77 03-06-2013 3:30	W	W
3.54	3.89	3.84	0.64	0.62	0.61	9.69 04-24-2013 3:20	10.32 04-24-2013 3:20	10.36 04-24-2013 3:20	W	W
4.02	4.57	4.56	0.71	0.69	0.67	11.74 05-20-2013 3:10	12.12 05-20-2013 3:10	12.39 05-20-2013 3:10	W	W
4.09	4.97	4.90	0.77	0.73	0.72	14.07 06-14-2013 4:00	16.29 06-14-2013 4:00	16.07 06-14-2013 4:00	W	W
4.69	5.71	5.74	0.86	0.79	0.77	12.35 07-04-2013 3:30	13.35 07-04-2013 3:30	13.36 07-04-2013 3:30	W	NW
4.94	5.90	5.92	0.90	0.84	0.82	10.92 08-01-2013 1:20	12.58 08-01-2013 1:20	12.53 08-01-2013 1:20	NW	NW
3.60	4.33	4.33	0.62	0.57	0.56	12.54 09-01-2013 5:30	12.16 09-01-2013 5:30	11.88 09-01-2013 5:30	W	W
3.14	3.71	3.73	0.78	0.75	0.74	10.30 10-18-2013 5:20	11.58 10-18-2013 5:20	11.56 10-18-2013 5:10	W	W
3.11	3.57	3.53	0.57	0.55	0.55	11.14 11-05-2013 12:30	12.50 11-05-2013 12:30	12.69 11-05-2013 12:30	E	E/SE
4.55	5.01	5.06	0.68	0.63	0.63	14.36 12-13-2013 8:50	15.91 12-13-2013 8:50	16.20 12-13-2013 8:50	SE	SE
3.89	**4.49**	**4.49**	**0.71**	**0.68**	**0.66**	**14.36 12-13-2013 8:50**	**16.29 06-14-2013 4:00**	**16.20 12-13-2013 8:50**	**NW**	**NW**

Based on Data January 2013 to December 2013

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TABLE 6

CHELAMALA

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	3.8	4.1	4.6	5.0	5.5	5.6	5.9	6.2	5.9	4.6	3.9	3.8	3.6	3.3	3.2	3.1	3.8	4.4	5.0	5.2	5.0	4.4	4.2	3.9	4.5
FEB	3.3	3.2	3.2	3.6	4.2	4.5	5.0	5.4	4.8	3.6	3.4	3.4	3.6	3.7	4.0	4.2	4.9	5.5	5.8	5.0	4.4	3.9	3.7	3.6	4.2
MAR	2.7	2.8	2.9	3.2	3.2	2.8	2.8	3.3	3.0	2.6	2.7	2.8	3.1	3.5	3.8	4.7	5.8	5.9	5.7	4.8	4.4	3.6	3.1	2.6	3.6
APR	3.4	3.2	3.2	3.0	3.0	2.9	2.8	2.6	1.9	2.1	2.5	2.9	3.7	4.5	5.5	6.5	6.4	6.1	5.5	4.6	4.3	4.1	3.8	3.5	3.8
MAY	4.2	4.2	4.0	3.8	3.7	3.8	3.6	3.4	2.8	3.3	3.7	4.1	4.6	5.3	6.2	6.9	6.9	6.1	5.8	4.9	4.8	4.5	4.4	4.4	4.6
JUN	5.1	4.9	4.9	4.7	4.8	4.7	4.6	4.1	4.0	3.4	4.0	4.4	5.0	5.6	5.3	5.3	5.7	5.2	5.4	5.5	5.2	5.3	5.3	5.0	4.9
JUL	5.4	5.6	5.9	5.6	5.4	5.4	5.7	5.2	5.4	4.4	4.6	5.5	5.8	6.2	6.6	6.5	6.1	6.2	6.0	6.3	6.3	5.9	5.9	5.7	5.7
AUG	5.8	5.8	6.0	5.6	5.6	5.4	5.4	5.2	4.5	4.8	5.2	5.7	6.0	6.5	6.8	7.2	7.0	6.8	6.3	6.4	6.5	6.2	5.7	5.7	5.9
SEP	4.2	4.3	4.2	3.8	3.8	3.7	3.4	3.3	2.9	2.6	3.4	3.7	4.2	4.8	5.6	6.1	6.0	5.8	5.5	5.1	4.9	4.2	4.1	4.2	4.3
OCT	3.4	3.5	3.3	3.1	3.2	2.8	2.9	2.8	2.4	2.2	2.9	3.2	3.5	4.4	5.0	5.3	5.7	5.3	5.0	4.5	4.0	3.9	3.7	3.5	3.7
NOV	3.1	3.0	3.2	3.4	3.1	3.7	3.9	4.0	3.1	2.8	3.2	3.1	2.9	3.1	3.3	3.3	4.1	4.6	4.9	4.4	4.0	3.7	3.6	3.3	3.5
DEC	5.7	5.7	5.7	5.7	5.8	6.1	6.4	5.6	4.6	4.2	4.1	3.8	3.6	3.7	3.8	4.2	4.3	4.9	5.4	5.1	4.9	5.0	5.4	5.4	5.0
Annual	4.2	4.2	4.2	4.2	4.3	4.3	4.4	4.3	3.8	3.4	3.6	3.9	4.1	4.5	4.9	5.3	5.6	5.6	5.5	5.1	4.9	4.6	4.4	4.2	4.5

SENSOR HEIGHT : 80m

Based on Data January 2013 to December 2013

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 6 A

CHELAMALA

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	3.8	4.1	4.5	4.9	5.4	5.5	5.9	6.2	5.9	4.5	3.9	3.8	3.6	3.3	3.1	3.1	3.7	4.4	5.0	5.2	4.9	4.4	4.2	3.8	4.5
FEB	3.3	3.1	3.1	3.5	4.1	4.4	5.0	5.3	4.8	3.6	3.4	3.4	3.5	3.7	3.9	4.2	4.9	5.5	5.8	5.0	4.5	3.8	3.6	3.6	4.1
MAR	2.7	2.8	2.9	3.2	3.2	2.7	2.8	3.3	3.1	2.8	2.8	2.9	3.2	3.5	3.9	4.7	5.8	5.9	5.8	4.9	4.4	3.7	3.1	2.7	3.6
APR	3.4	3.2	3.2	3.0	3.0	2.9	2.8	2.7	2.0	2.3	2.7	3.0	3.7	4.5	5.6	6.5	6.5	6.1	5.6	4.7	4.4	4.2	3.8	3.5	3.9
MAY	4.2	4.2	3.9	3.8	3.7	3.8	3.6	3.4	2.8	3.3	3.7	4.1	4.6	5.3	6.3	7.0	6.9	6.1	5.8	5.0	4.8	4.5	4.4	4.4	4.6
JUN	5.1	5.0	5.0	4.8	4.9	4.8	4.7	4.2	4.0	3.5	4.1	4.5	5.0	5.7	5.3	5.4	5.7	5.3	5.5	5.6	5.3	5.4	5.4	5.1	5.0
JUL	5.4	5.6	5.9	5.5	5.4	5.4	5.6	5.2	5.3	4.3	4.5	5.5	5.8	6.2	6.6	6.5	6.1	6.2	6.1	6.3	6.4	5.9	5.9	5.6	5.7
AUG	5.9	5.8	6.0	5.6	5.6	5.4	5.3	5.1	4.5	4.8	5.1	5.7	5.9	6.4	6.8	7.1	7.0	6.8	6.3	6.4	6.5	6.2	5.7	5.7	5.9
SEP	4.2	4.3	4.1	3.8	3.8	3.6	3.4	3.3	2.9	2.7	3.5	3.7	4.2	4.8	5.6	6.1	6.1	5.8	5.5	5.1	4.9	4.2	4.0	4.2	4.3
OCT	3.4	3.4	3.3	3.1	3.1	2.7	2.8	2.8	2.3	2.2	2.9	3.1	3.5	4.4	5.0	5.3	5.7	5.3	5.0	4.5	4.1	3.9	3.7	3.5	3.7
NOV	3.1	3.0	3.2	3.5	3.2	3.7	4.0	4.1	3.2	2.9	3.2	3.1	2.9	3.0	3.3	3.3	4.1	4.6	4.9	4.4	4.0	3.7	3.7	3.4	3.6
DEC	5.6	5.7	5.6	5.6	5.7	6.1	6.4	5.5	4.5	4.2	4.1	3.8	3.6	3.7	3.7	4.2	4.2	4.9	5.4	5.0	4.9	4.9	5.3	5.3	4.9
Annual	4.2	4.2	4.2	4.2	4.2	4.3	4.3	4.3	3.8	3.4	3.6	3.9	4.1	4.5	4.9	5.3	5.6	5.6	5.6	5.2	4.9	4.6	4.4	4.2	4.5

SENSOR HEIGHT : 78m

Based on Data January 2013 to December 2013

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 6 B

CHELAMALA

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	3.1	3.6	4.0	4.3	4.8	4.9	5.3	5.7	5.0	4.0	3.5	3.5	3.3	3.0	2.8	2.8	3.4	3.9	4.3	4.5	4.3	3.7	3.4	3.2	3.9
FEB	2.8	2.8	2.9	3.2	3.8	4.0	4.5	4.7	4.0	3.3	3.2	3.2	3.3	3.5	3.8	4.0	4.6	5.0	5.2	4.5	4.0	3.4	3.2	3.0	3.7
MAR	2.4	2.5	2.6	2.9	2.9	2.5	2.7	3.1	2.7	2.5	2.6	2.8	3.1	3.3	3.7	4.5	5.4	5.5	5.3	4.3	3.9	3.3	2.6	2.3	3.3
APR	3.0	2.9	2.8	2.7	2.7	2.6	2.5	2.2	1.8	2.1	2.5	2.9	3.6	4.3	5.3	6.2	6.1	5.7	5.0	4.2	3.8	3.6	3.3	3.1	3.5
MAY	3.6	3.5	3.2	3.2	3.2	3.2	3.0	2.6	2.4	3.0	3.4	3.8	4.3	4.9	5.8	6.5	6.4	5.6	5.2	4.3	4.1	3.8	3.7	3.7	4.0
JUN	4.1	4.0	4.0	3.9	3.9	3.8	3.7	3.2	3.1	2.9	3.5	3.9	4.4	4.9	4.6	4.6	4.9	4.4	4.6	4.6	4.3	4.3	4.4	4.1	4.1
JUL	4.2	4.5	4.7	4.4	4.3	4.3	4.5	4.0	4.1	3.5	3.9	4.8	5.1	5.4	5.7	5.5	5.2	5.2	5.0	5.2	5.1	4.7	4.8	4.5	4.7
AUG	4.7	4.7	4.8	4.5	4.4	4.3	4.2	4.0	3.5	4.1	4.5	5.1	5.3	5.8	6.1	6.3	6.2	5.9	5.4	5.3	5.3	5.0	4.6	4.6	4.9
SEP	3.4	3.5	3.3	2.9	2.9	2.8	2.6	2.4	2.1	2.2	3.0	3.3	3.8	4.4	5.0	5.4	5.4	5.1	4.7	4.2	4.0	3.3	3.2	3.3	3.6
OCT	2.7	2.7	2.6	2.4	2.6	2.1	2.2	2.1	1.8	1.8	2.5	2.8	3.3	4.0	4.6	4.9	5.1	4.6	4.3	3.8	3.3	3.2	2.9	2.8	3.1
NOV	2.6	2.6	2.8	3.0	2.7	3.2	3.5	3.5	2.6	2.6	2.9	2.8	2.7	2.9	3.1	3.1	3.6	4.1	4.3	3.8	3.3	3.0	3.0	2.7	3.1
DEC	5.1	5.1	5.1	5.2	5.2	5.5	5.7	4.8	4.1	3.9	3.8	3.6	3.3	3.4	3.4	3.8	3.8	4.4	4.8	4.5	4.4	4.4	4.7	4.8	4.5
Annual	3.5	3.5	3.6	3.5	3.6	3.6	3.7	3.5	3.1	3.0	3.3	3.5	3.8	4.2	4.5	4.8	5.0	4.9	4.8	4.4	4.2	3.8	3.6	3.5	3.9

SENSOR HEIGHT : 50m

Based on Data January 2013 to December 2013

NATIONAL INSTITUTE OF WIND ENERGY
CHENNAI

TABLE 6 C

CHELAMALA

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	2.1	2.6	2.8	2.9	3.3	3.3	3.6	3.8	3.3	3.1	2.9	3.0	2.8	2.6	2.4	2.3	2.7	2.9	3.2	3.2	3.0	2.6	2.3	2.0	2.8
FEB	1.8	2.0	2.2	2.3	2.6	2.6	3.1	2.9	2.6	2.5	2.6	2.6	2.7	2.7	3.0	3.2	3.6	3.9	3.9	3.3	2.8	2.3	2.0	1.8	2.7
MAR	1.4	1.5	1.6	1.7	1.7	1.6	2.0	2.2	1.8	1.9	2.0	2.3	2.5	2.7	3.0	3.7	4.4	4.4	4.1	3.1	2.6	2.1	1.5	1.3	2.4
APR	1.6	1.5	1.4	1.3	1.4	1.5	1.4	1.1	1.1	1.5	1.8	2.4	2.9	3.6	4.5	5.3	5.1	4.6	3.9	3.0	2.5	2.2	1.9	1.7	2.5
MAY	2.2	2.1	1.9	1.9	2.0	2.0	1.8	1.5	1.8	2.3	2.6	3.1	3.6	4.2	4.9	5.5	5.3	4.5	4.0	3.1	2.9	2.6	2.4	2.4	2.9
JUN	2.5	2.4	2.4	2.4	2.4	2.4	2.1	1.9	2.0	2.1	2.6	3.0	3.4	3.8	3.6	3.5	3.8	3.2	3.1	3.0	2.8	2.8	2.7	2.5	2.8
JUL	2.5	2.6	2.7	2.4	2.3	2.4	2.6	2.2	2.5	2.4	2.8	3.6	3.9	4.1	4.3	4.1	3.7	3.7	3.4	3.3	3.2	2.8	2.8	2.7	3.1
AUG	2.9	2.8	2.9	2.6	2.6	2.5	2.4	2.3	2.3	3.0	3.4	3.9	4.2	4.6	4.8	4.9	4.6	4.3	3.8	3.5	3.4	3.2	2.8	2.8	3.4
SEP	1.9	2.0	1.7	1.5	1.5	1.4	1.3	1.3	1.3	1.6	2.4	2.6	3.1	3.6	4.0	4.4	4.3	3.9	3.3	2.8	2.5	1.8	1.7	1.8	2.4
OCT	1.3	1.4	1.4	1.3	1.4	1.1	1.2	1.0	1.2	1.5	2.1	2.3	2.8	3.4	3.9	4.1	4.2	3.5	3.1	2.5	2.0	1.8	1.5	1.4	2.1
NOV	1.9	1.9	2.1	2.2	2.0	2.3	2.5	2.4	2.1	2.2	2.4	2.3	2.2	2.3	2.4	2.4	2.8	3.0	3.1	2.8	2.4	2.1	2.1	2.0	2.3
DEC	3.3	3.3	3.4	3.5	3.6	3.7	3.8	3.4	3.1	3.1	3.0	2.8	2.7	2.6	2.7	2.9	2.7	3.1	3.2	3.2	2.9	2.9	3.2	3.2	3.1
Annual	2.1	2.2	2.2	2.2	2.3	2.2	2.3	2.2	2.1	2.3	2.6	2.8	3.0	3.4	3.6	3.9	3.9	3.7	3.5	3.1	2.8	2.4	2.2	2.1	2.7

SENSOR HEIGHT : 20m

Based on Data January 2013 to December 2013

TABLE 7

CHELAMALA

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	5.95	9.76	10.81	8.80	3.63	5.03	2.43	3.25	10.22	14.55	14.05	5.15	7.80
1.0-2.0	11.04	12.37	18.12	14.24	8.80	9.38	6.59	5.20	11.89	15.49	18.05	13.36	12.04
2.0-3.0	18.18	18.94	22.73	20.59	17.90	16.04	11.48	9.92	17.06	17.55	21.96	16.55	17.41
3.0-4.0	21.72	18.81	18.23	19.63	21.91	18.63	16.99	13.93	17.16	18.39	17.28	15.58	18.19
4.0-5.0	17.28	16.39	12.65	16.19	19.98	18.84	18.12	15.87	17.33	16.51	11.83	13.93	16.24
5.0-6.0	10.64	10.14	8.29	10.76	13.61	14.68	16.17	18.11	13.91	11.04	7.56	9.98	12.08
6.0-7.0	6.20	5.77	4.96	7.20	8.14	8.36	12.72	15.89	7.57	4.49	3.86	6.83	7.67
7.0-8.0	4.37	3.66	2.08	2.36	3.94	4.45	8.21	9.83	3.45	1.56	2.51	5.99	4.37
8.0-9.0	2.26	2.33	1.13	0.19	1.31	2.27	4.36	5.00	1.13	0.26	1.48	5.20	2.24
9.0-10.0	1.38	1.06	0.55	0.02	0.49	1.13	1.97	2.06	0.20	0.07	0.92	4.11	1.16
10.0-11.0	0.60	0.38	0.27	0.01	0.16	0.64	0.77	0.59	0.06	0.03	0.34	1.99	0.49
11.0-12.0	0.26	0.25	0.13	0.00	0.11	0.38	0.12	0.30	0.01	0.03	0.11	0.76	0.20
12.0-13.0	0.10	0.12	0.03	0.00	0.01	0.14	0.06	0.05	0.01	0.00	0.04	0.39	0.08
13.0-14.0	0.03	0.02	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.12	0.02
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.04	0.00
15.0-16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00
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	0.00
20.0-21.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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 ENERGYCHENNAI

TABLE 7A

CHELAMALA

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	5.49	8.09	8.10	5.81	2.32	3.23	1.02	2.31	7.13	10.48	13.61	4.22	5.98
1.0-2.0	9.12	10.81	15.55	10.73	5.35	6.33	3.14	2.77	9.40	14.06	16.51	11.80	9.63
2.0-3.0	15.58	17.03	22.75	20.01	14.95	12.73	7.46	6.85	14.57	16.82	20.11	15.09	15.33
3.0-4.0	19.79	18.42	20.23	22.71	24.06	19.14	16.06	11.14	18.39	19.70	16.58	14.14	18.36
4.0-5.0	19.03	17.10	13.41	17.65	22.03	22.06	19.86	16.11	20.54	18.62	13.14	13.50	17.75
5.0-6.0	11.90	12.03	8.92	11.44	14.74	16.82	19.31	21.03	15.82	12.79	8.71	9.67	13.60
6.0-7.0	7.99	6.97	5.94	8.72	9.59	9.53	15.50	18.94	8.69	5.25	4.61	8.03	9.15
7.0-8.0	5.50	4.65	2.55	2.73	4.54	4.92	9.50	11.79	3.92	1.80	3.20	7.85	5.25
8.0-9.0	2.81	2.70	1.38	0.17	1.56	2.59	4.95	5.72	1.23	0.29	1.91	6.71	2.67
9.0-10.0	1.60	1.29	0.67	0.02	0.55	1.32	2.16	2.30	0.22	0.09	1.01	4.97	1.35
10.0-11.0	0.74	0.46	0.34	0.01	0.20	0.72	0.83	0.67	0.06	0.03	0.45	2.39	0.57
11.0-12.0	0.34	0.31	0.15	0.00	0.10	0.42	0.13	0.31	0.01	0.03	0.12	0.95	0.24
12.0-13.0	0.09	0.12	0.03	0.00	0.01	0.15	0.07	0.04	0.01	0.00	0.05	0.42	0.08
13.0-14.0	0.03	0.02	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.16	0.02
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.04	0.00
15.0-16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00
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	0.00
20.0-21.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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.

TABLE 7B

CHELAMALA

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	6.07	9.67	10.85	8.91	3.75	4.84	2.34	3.34	10.30	14.43	13.88	5.23	7.80
1.0-2.0	10.99	12.50	18.13	14.27	8.77	9.86	6.77	4.97	11.88	15.64	18.25	13.38	12.12
2.0-3.0	18.08	18.88	22.53	20.54	17.89	15.87	11.24	10.27	16.86	17.41	22.14	16.49	17.35
3.0-4.0	22.01	18.84	18.35	19.34	22.19	18.63	17.17	13.64	17.03	18.62	17.19	15.40	18.20
4.0-5.0	17.12	16.35	12.85	16.32	19.62	18.54	18.01	16.18	17.66	16.50	11.71	13.93	16.23
5.0-6.0	10.55	10.32	8.03	10.89	13.54	14.84	16.50	17.96	13.63	11.12	7.66	10.18	12.10
6.0-7.0	6.18	5.67	5.06	7.19	8.27	8.49	12.25	15.93	7.73	4.39	3.74	6.65	7.63
7.0-8.0	4.39	3.65	2.12	2.34	3.98	4.38	8.38	9.51	3.49	1.46	2.55	6.13	4.36
8.0-9.0	2.20	2.25	1.06	0.17	1.24	2.19	4.57	5.33	1.15	0.29	1.48	5.13	2.25
9.0-10.0	1.34	1.10	0.55	0.02	0.44	1.11	1.90	1.93	0.26	0.08	0.96	4.21	1.16
10.0-11.0	0.72	0.37	0.30	0.02	0.15	0.66	0.69	0.60	0.02	0.02	0.30	1.92	0.48
11.0-12.0	0.22	0.24	0.13	0.00	0.15	0.47	0.13	0.25	0.02	0.03	0.10	0.77	0.21
12.0-13.0	0.10	0.15	0.03	0.00	0.00	0.09	0.03	0.08	0.00	0.00	0.05	0.37	0.08
13.0-14.0	0.03	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.13	0.02
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
15.0-16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00
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	0.00
20.0-21.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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 ENERGYCHENNAI

TABLE 7C

CHELAMALA

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	4.10	7.64	8.09	6.20	1.77	2.34	0.69	1.61	5.28	8.00	12.72	4.26	5.23
1.0-2.0	8.40	9.87	14.96	9.47	4.28	5.49	1.90	2.11	7.13	12.01	14.94	11.20	8.48
2.0-3.0	13.91	15.92	20.90	17.69	11.63	10.00	5.15	5.40	13.68	16.11	19.23	13.78	13.62
3.0-4.0	18.55	16.96	19.60	20.93	21.82	15.79	10.78	8.71	16.09	18.12	16.29	13.60	16.44
4.0-5.0	18.50	17.73	14.22	19.26	23.66	20.35	18.01	11.09	19.03	19.96	13.04	12.32	17.26
5.0-6.0	14.38	12.18	9.52	12.94	17.05	19.88	19.51	19.15	19.33	15.37	9.85	10.39	14.96
6.0-7.0	8.36	7.84	6.52	9.65	10.64	12.20	17.99	22.60	11.34	6.90	5.42	7.52	10.58
7.0-8.0	6.00	4.76	2.73	3.50	5.98	6.53	13.22	15.34	5.76	2.84	3.75	7.23	6.47
8.0-9.0	3.63	3.77	1.72	0.32	1.95	3.63	7.55	8.42	1.90	0.47	2.09	7.09	3.55
9.0-10.0	2.40	2.03	0.90	0.02	0.81	1.76	3.38	3.79	0.35	0.09	1.65	6.53	1.97
10.0-11.0	1.08	0.57	0.49	0.02	0.25	1.02	1.41	1.05	0.09	0.04	0.72	3.48	0.85
11.0-12.0	0.45	0.45	0.27	0.00	0.16	0.65	0.27	0.63	0.02	0.07	0.21	1.50	0.39
12.0-13.0	0.18	0.22	0.07	0.00	0.02	0.30	0.11	0.09	0.00	0.00	0.09	0.74	0.15
13.0-14.0	0.07	0.05	0.00	0.00	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.20	0.03
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01
15.0-16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00
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	0.00
20.0-21.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SENSOR HEIGHT: 20m **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 8

CHELAMALA

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	0.65	0.55	0.41	0.64	0.54	0.27	0.56	0.57	0.69	0.61	0.55	0.66	6.7
1.0-2.0	0.88	0.43	0.60	1.04	0.92	0.44	0.69	0.93	1.08	1.22	1.24	1.29	10.8
2.0-3.0	0.87	0.25	0.58	1.52	1.60	0.54	0.76	1.27	2.27	2.60	2.63	2.13	17.0
3.0-4.0	0.72	0.15	0.47	1.41	1.75	0.49	0.45	0.79	2.71	4.91	4.11	2.34	20.3
4.0-5.0	0.46	0.11	0.32	1.21	1.62	0.31	0.15	0.33	2.60	4.85	4.22	2.06	18.2
5.0-6.0	0.20	0.04	0.17	1.00	1.16	0.15	0.04	0.17	1.99	3.66	2.67	1.00	12.3
6.0-7.0	0.14	0.02	0.13	0.77	1.10	0.05	0.02	0.08	1.11	2.27	1.59	0.48	7.7
7.0-8.0	0.10	0.03	0.08	0.67	0.93	0.01	0.01	0.04	0.43	0.80	0.68	0.27	4.0
8.0-9.0	0.05	0.03	0.09	0.44	0.42	0.01	0.01	0.02	0.06	0.28	0.24	0.17	1.8
9.0-10.0	0.03	0.01	0.07	0.29	0.07	0.01	0.00	0.00	0.01	0.10	0.07	0.08	0.7
10.0-11.0	0.02	0.01	0.01	0.15	0.01	0.00	0.00	0.00	0.00	0.04	0.03	0.03	0.3
11.0-12.0	0.02	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.1
12.0-13.0	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
13.0-14.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14.0-15.0	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
15.0-16.0	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
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	4.2	1.6	2.9	9.2	10.1	2.3	2.7	4.2	12.9	21.3	18.0	10.5	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

CHELAMALA

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	0.48	0.43	0.30	0.48	0.45	0.22	0.31	0.39	0.39	0.56	0.54	0.53	5.1
1.0-2.0	0.69	0.41	0.38	0.85	0.80	0.39	0.45	0.60	0.61	0.91	0.94	1.02	8.0
2.0-3.0	1.01	0.28	0.46	1.23	1.50	0.67	0.59	0.88	1.34	1.97	2.02	1.93	13.9
3.0-4.0	0.82	0.17	0.32	1.12	1.77	0.66	0.48	0.50	1.59	3.03	3.50	2.67	16.6
4.0-5.0	0.59	0.12	0.25	0.90	1.72	0.38	0.22	0.23	1.31	3.88	4.97	2.72	17.3
5.0-6.0	0.33	0.06	0.15	0.86	1.33	0.28	0.08	0.13	1.08	4.20	4.20	2.29	15.0
6.0-7.0	0.15	0.04	0.06	0.68	1.11	0.13	0.03	0.08	0.77	3.38	2.91	1.27	10.6
7.0-8.0	0.12	0.02	0.03	0.58	1.09	0.06	0.01	0.04	0.38	1.69	1.78	0.81	6.6
8.0-9.0	0.11	0.02	0.03	0.44	0.90	0.02	0.01	0.01	0.11	0.72	0.75	0.47	3.6
9.0-10.0	0.07	0.02	0.04	0.42	0.51	0.01	0.00	0.02	0.03	0.28	0.27	0.28	1.9
10.0-11.0	0.04	0.01	0.03	0.26	0.14	0.01	0.00	0.00	0.00	0.12	0.08	0.12	0.8
11.0-12.0	0.02	0.00	0.01	0.12	0.03	0.00	0.00	0.00	0.00	0.04	0.03	0.06	0.3
12.0-13.0	0.01	0.01	0.01	0.07	0.01	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.2
13.0-14.0	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.0
14.0-15.0	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
15.0-16.0	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
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	4.5	1.6	2.1	8.0	11.4	2.8	2.2	2.9	7.6	20.8	22.0	14.2	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.

TABLE 8B

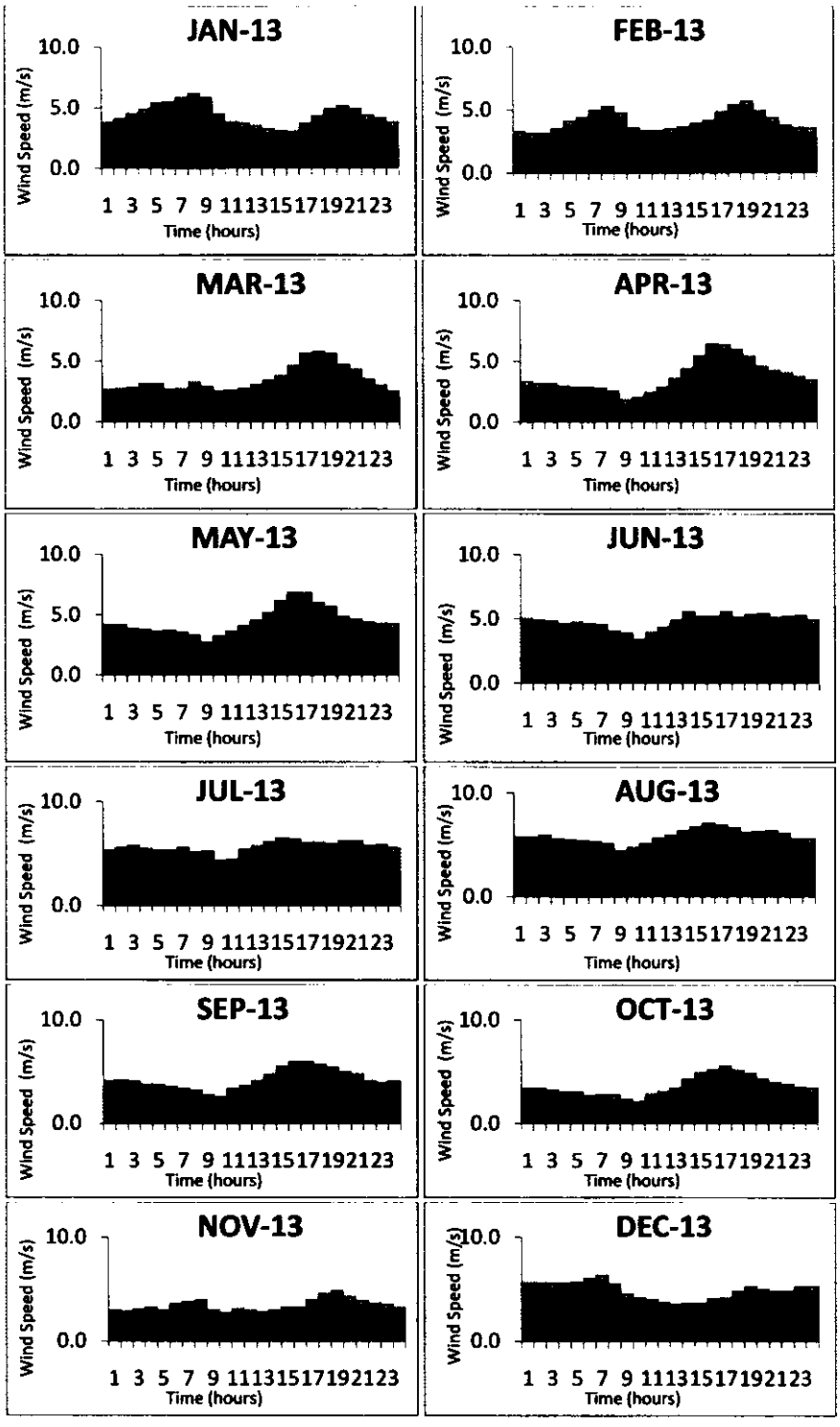
CHELAMALA

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED

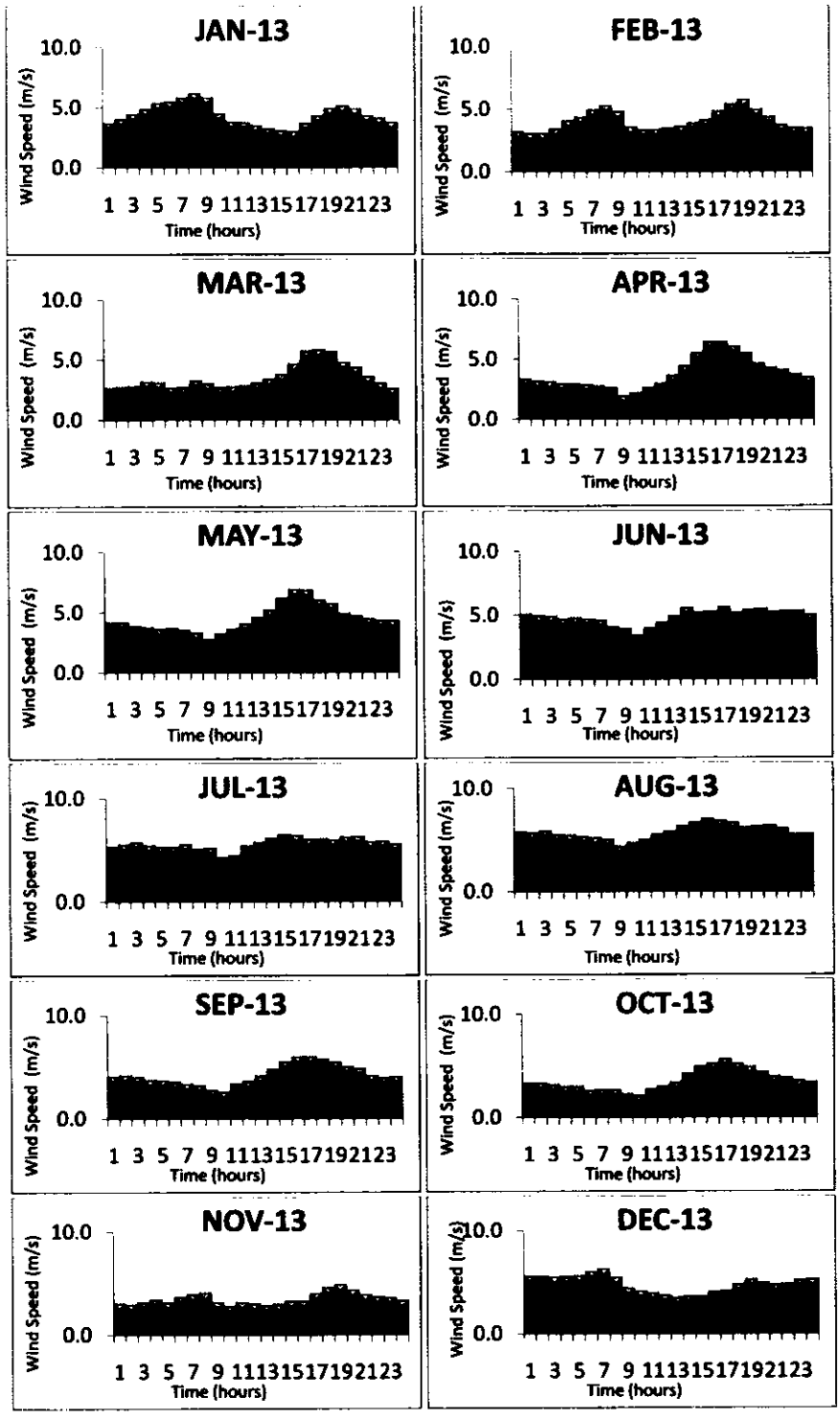
Deg/ (m/s)	345-15	15-45	45-75	75-105	105-135	135-165	165-195	195-225	225-255	255-285	285-315	315-345	ANNUAL
0.0-1.0	0.47	0.40	0.30	0.51	0.51	0.25	0.29	0.38	0.39	0.58	0.54	0.56	5.2
1.0-2.0	0.68	0.43	0.40	0.90	0.86	0.39	0.52	0.65	0.66	0.94	0.98	1.07	8.5
2.0-3.0	1.03	0.29	0.46	1.20	1.43	0.63	0.54	0.85	1.33	2.01	1.99	1.82	13.6
3.0-4.0	0.83	0.15	0.31	1.09	1.70	0.65	0.48	0.49	1.58	3.12	3.43	2.58	16.4
4.0-5.0	0.61	0.14	0.23	0.88	1.69	0.38	0.23	0.23	1.31	3.95	4.97	2.63	17.3
5.0-6.0	0.32	0.06	0.15	0.84	1.31	0.27	0.08	0.13	1.06	4.24	4.19	2.31	15.0
6.0-7.0	0.14	0.04	0.06	0.68	1.12	0.14	0.03	0.08	0.77	3.31	2.92	1.33	10.6
7.0-8.0	0.13	0.02	0.03	0.56	1.04	0.07	0.01	0.04	0.38	1.59	1.78	0.85	6.5
8.0-9.0	0.10	0.02	0.04	0.45	0.89	0.02	0.01	0.02	0.11	0.65	0.77	0.49	3.6
9.0-10.0	0.07	0.02	0.04	0.40	0.58	0.00	0.00	0.01	0.03	0.25	0.28	0.29	2.0
10.0-11.0	0.04	0.01	0.04	0.28	0.16	0.01	0.00	0.00	0.00	0.11	0.08	0.14	0.9
11.0-12.0	0.02	0.00	0.02	0.15	0.04	0.00	0.00	0.00	0.00	0.04	0.03	0.08	0.4
12.0-13.0	0.01	0.01	0.01	0.06	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.2
13.0-14.0	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.0
14.0-15.0	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
15.0-16.0	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
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	4.5	1.6	2.1	8.0	11.4	2.8	2.2	2.9	7.6	20.8	22.0	14.2	100.0

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

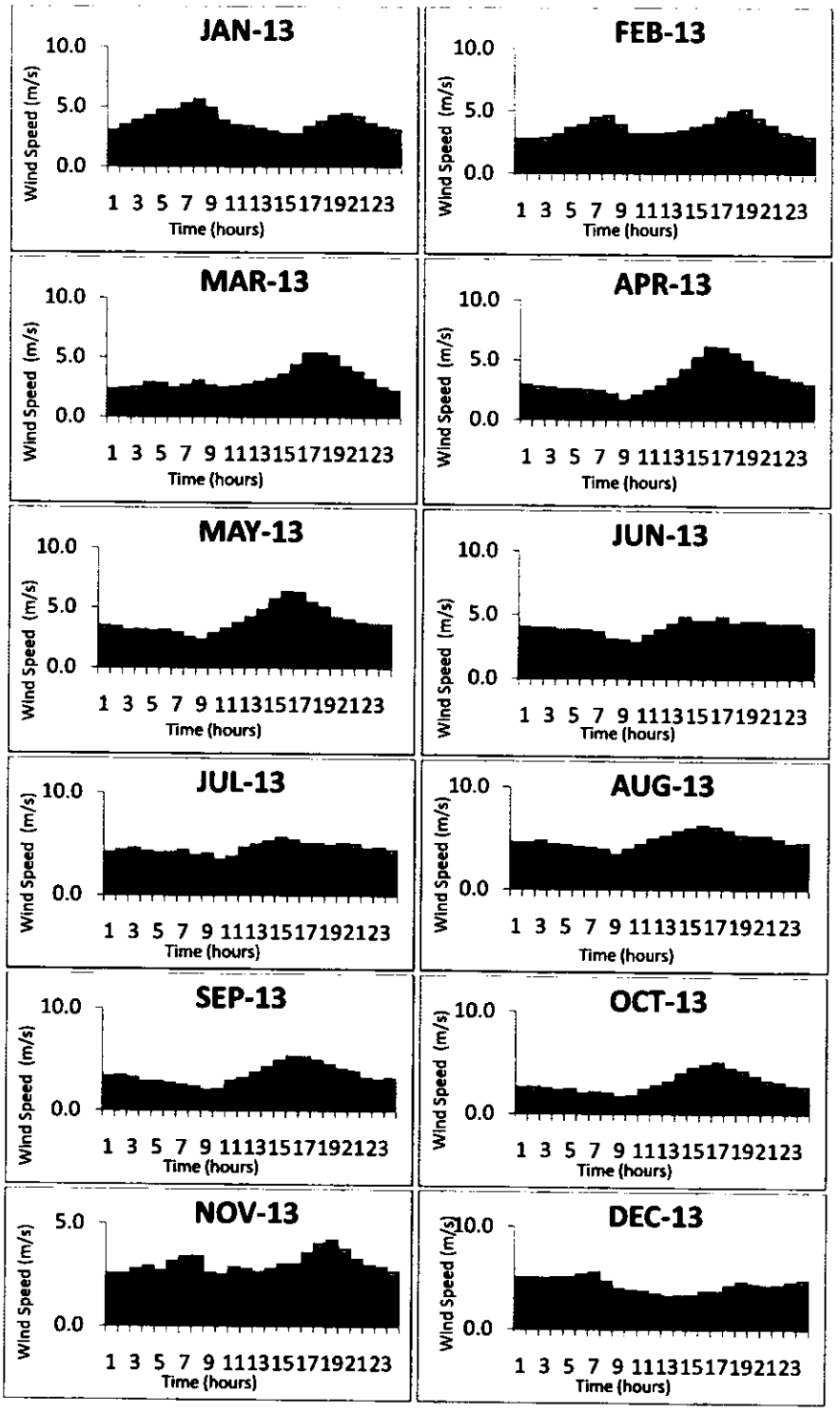
Range 0--1 Extends from 0 to 0.99 m/s &
1-- 2 Extends from 1 to 1.99 m/s etc.



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

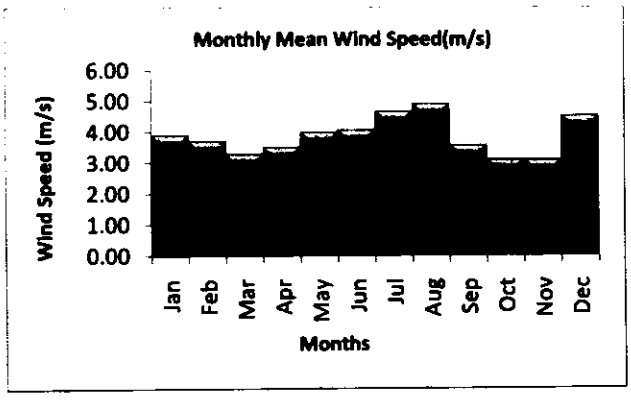


SENSOR HEIGHT: 78m
FIGURE 4A: MEAN HOURLY WIND SPEED
(JANUARY 2013 TO DECEMBER 2013)

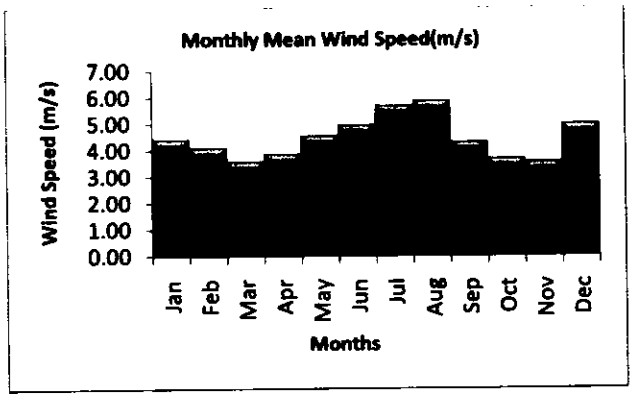


SENSOR HEIGHT: 50m

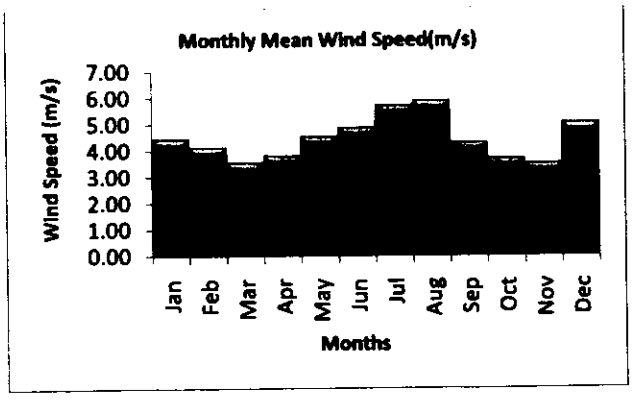
FIGURE 4B: MEAN HOURLY WIND SPEED (JANUARY 2013 TO DECEMBER 2013)



SENSOR HEIGHT: 50m

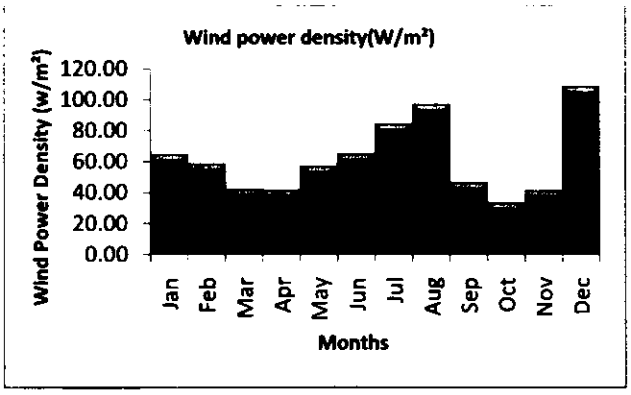


SENSOR HEIGHT: 78 m

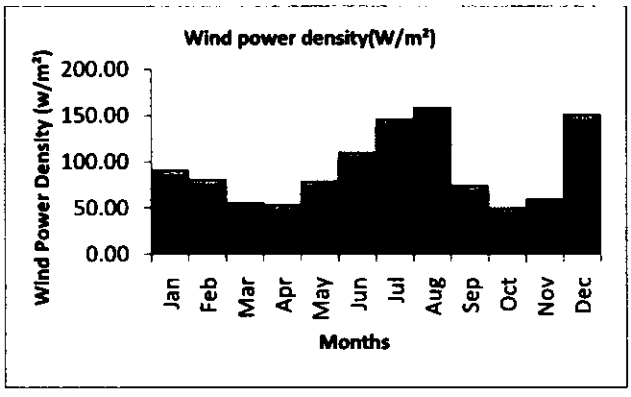


SENSOR HEIGHT: 80m

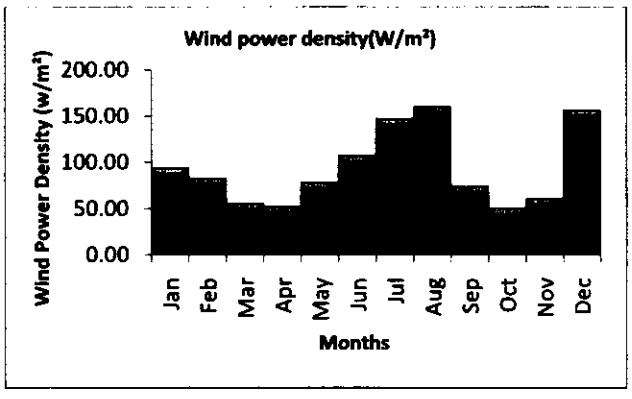
FIGURE 5: MONTHLY MEAN WIND SPEED (JANUARY 2013 TO DECEMBER 2013)



SENSOR HEIGHT: 50m



SENSOR HEIGHT: 78 m



SENSOR HEIGHT: 80m

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

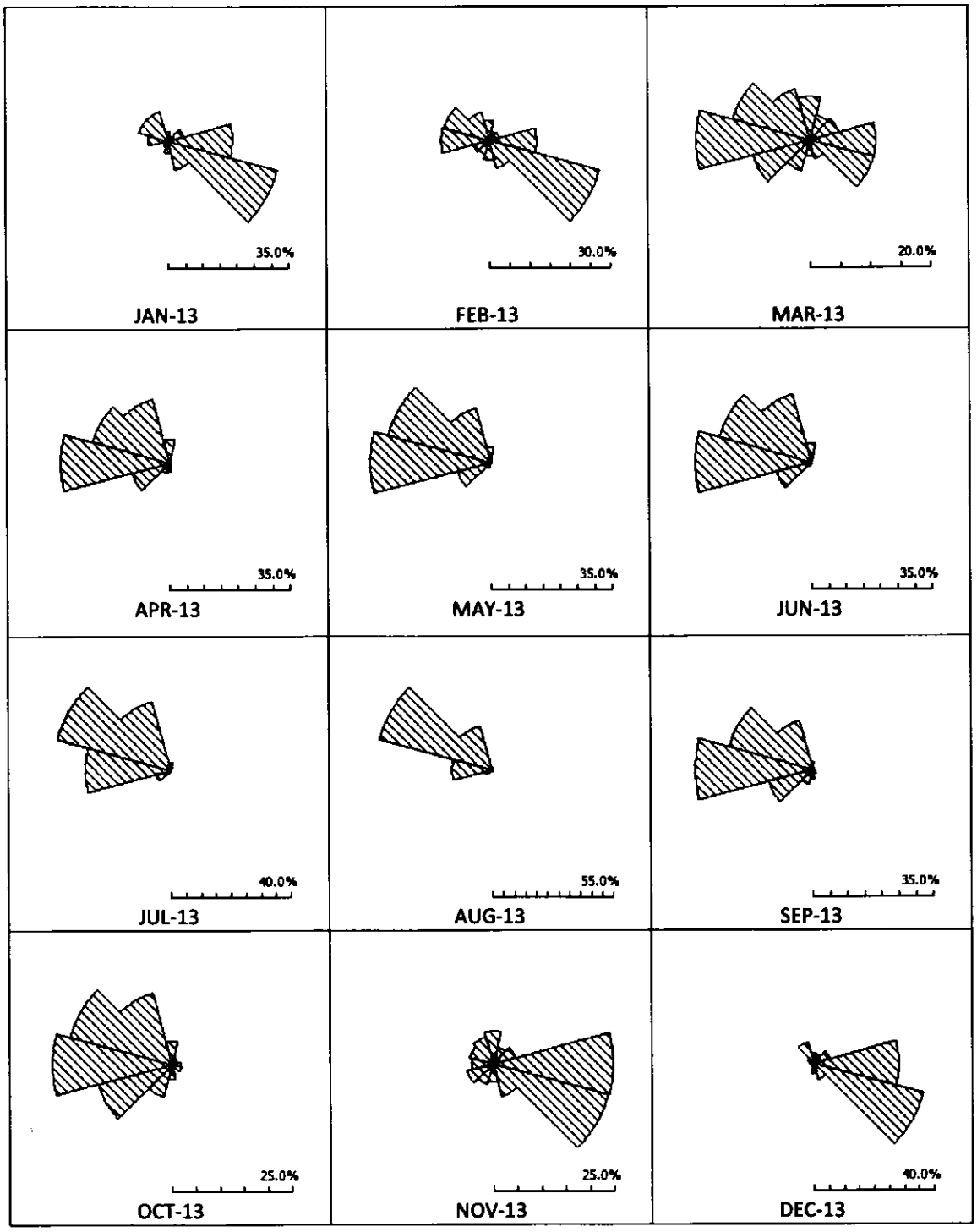


FIGURE 7: WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(January 2013 to December 2013)

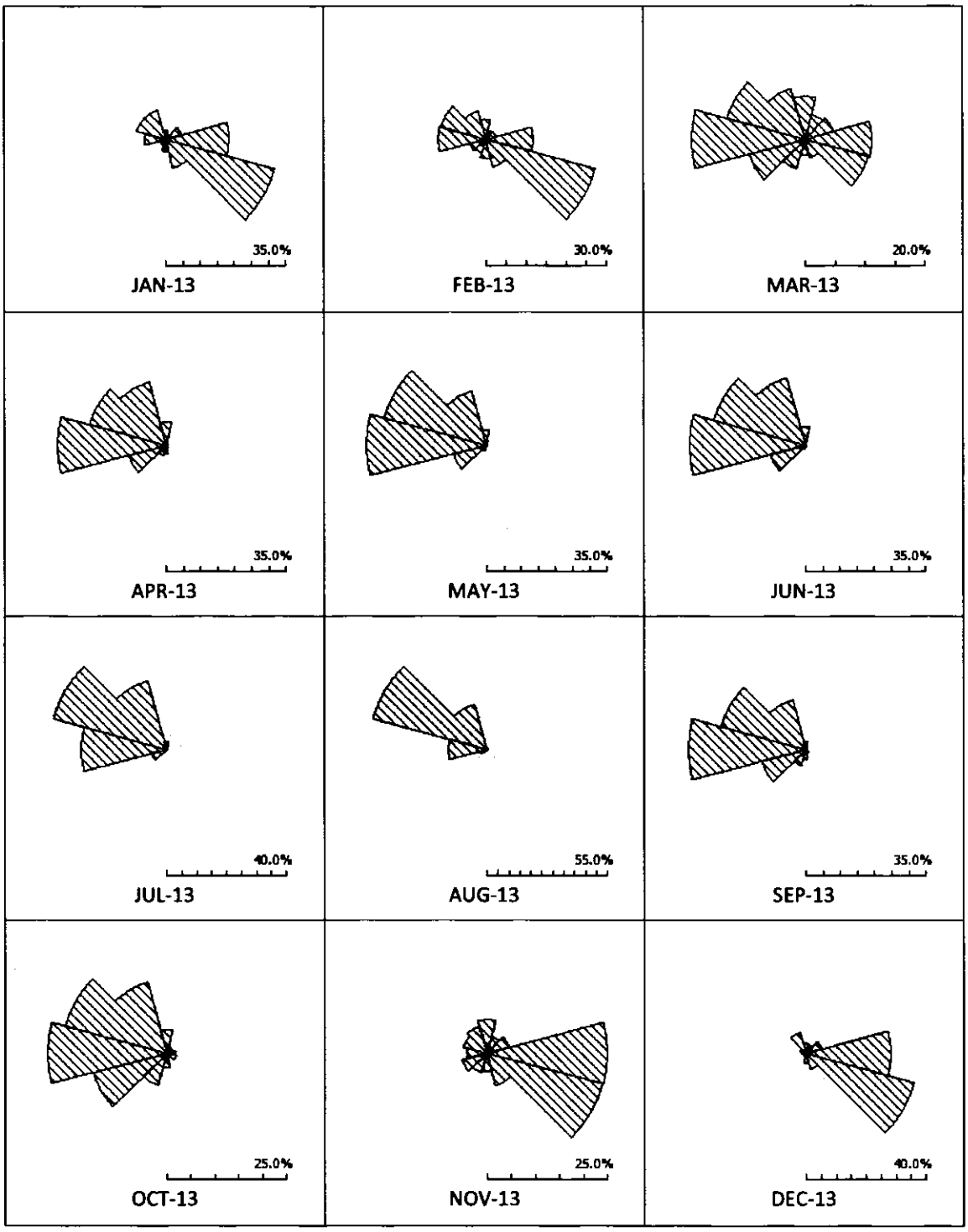


FIGURE 7A: WIND ROSE
SENSOR HEIGHT: (78m Anemometer and 78m Wind vane)
(January 2013 to December 2013)

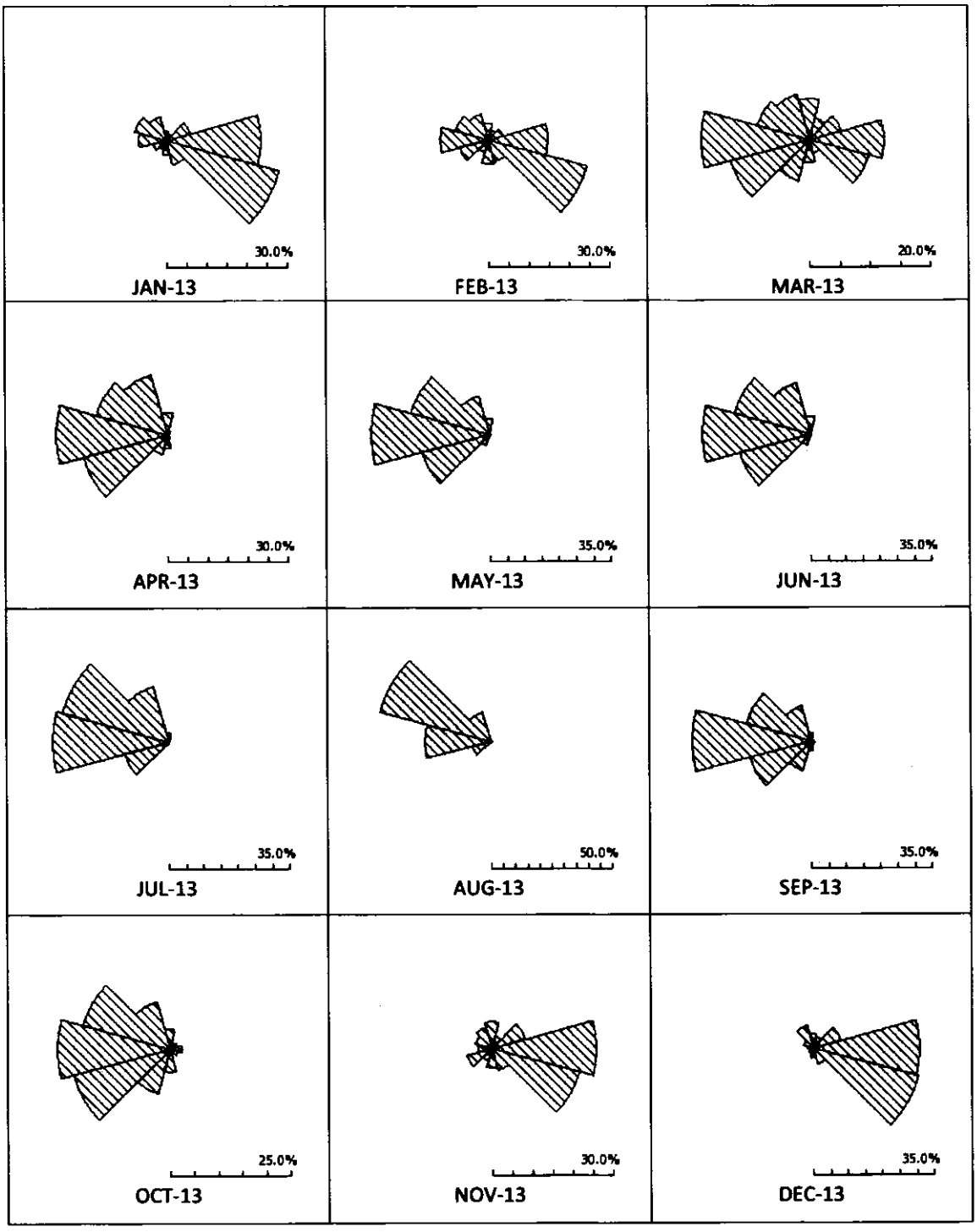


FIGURE 7B: WIND ROSE
SENSOR HEIGHT: (50m Anemometer and 48m Wind vane)
(January 2013 to December 2013)

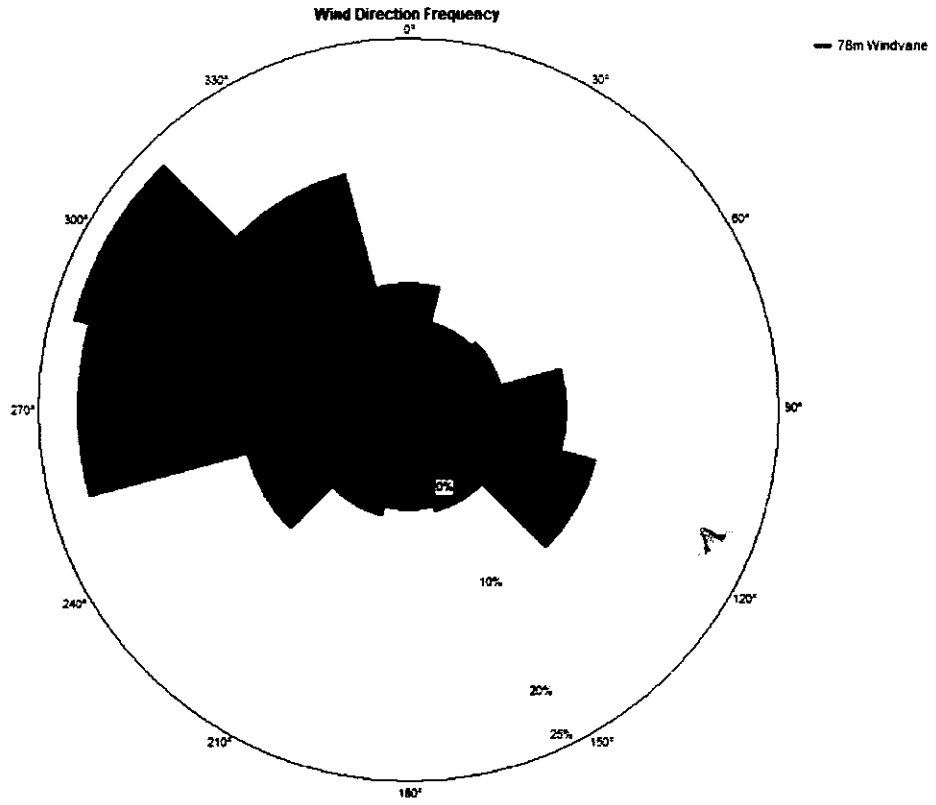
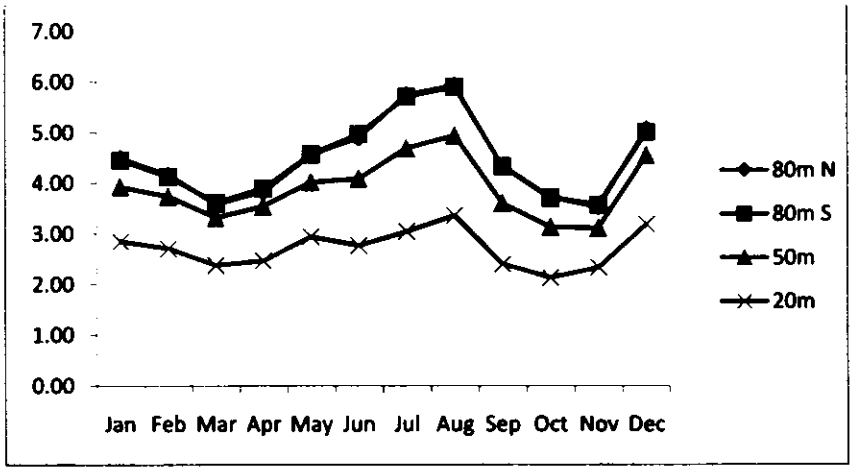
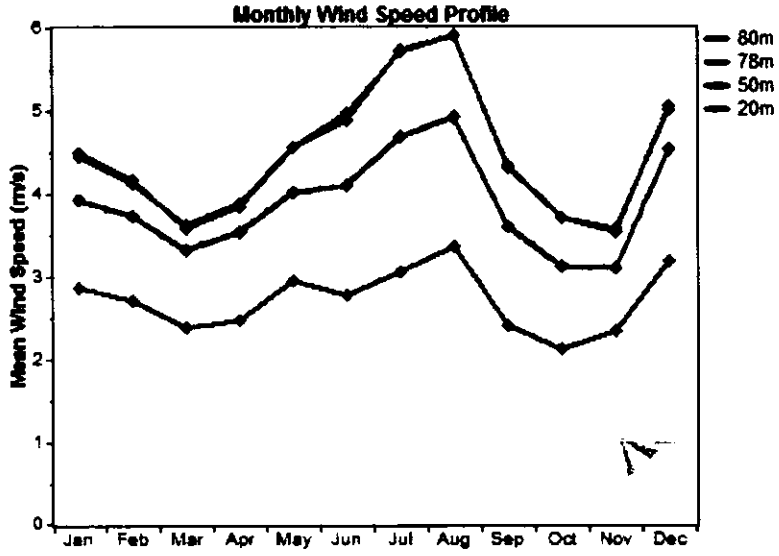


FIGURE 7C: ANNUAL WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(January 2013 to December 2013)



MONTHLY MEAN WIND SPEED
(JANUARY 2013 TO DECEMBER2013)



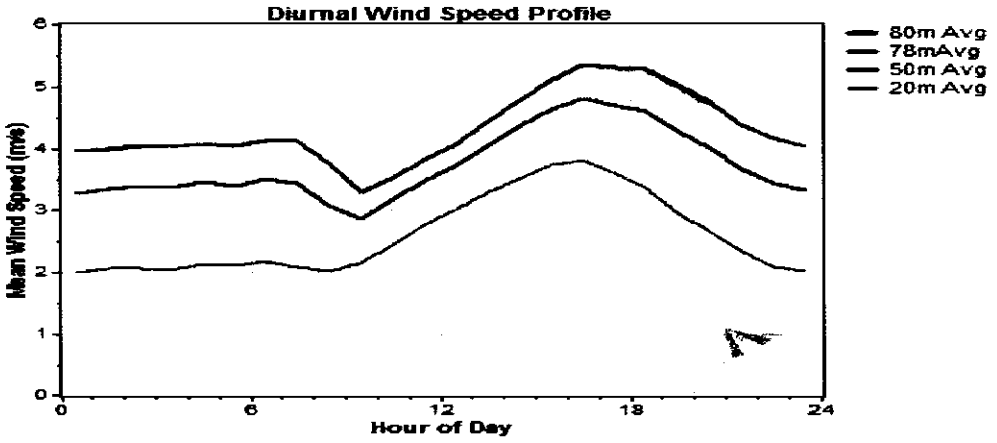


FIGURE 8: MONTHLY WIND SPEED AND DAILY WIND SPEED – CHELAMALA (JANUARY 2013 TO DECEMBER2013)

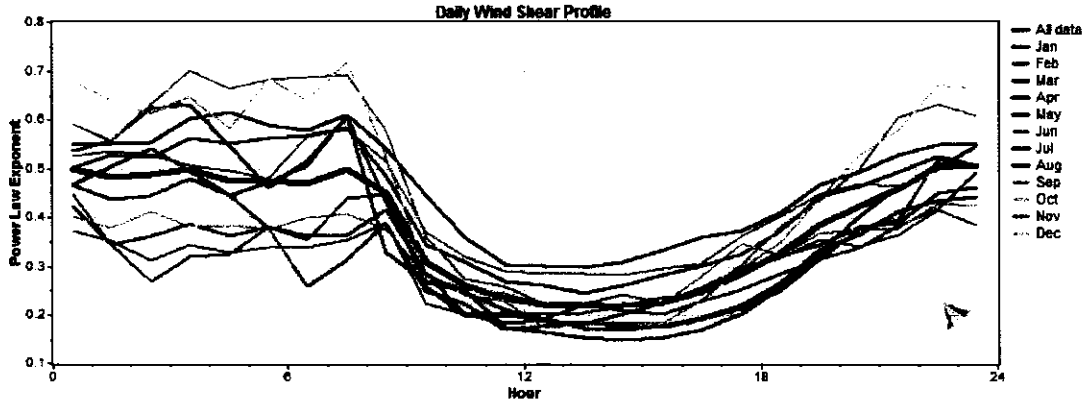


FIGURE 9: DAILY WIND SHEAR-CHELAMALA (JANUARY 2013 TO DECEMBER2013)

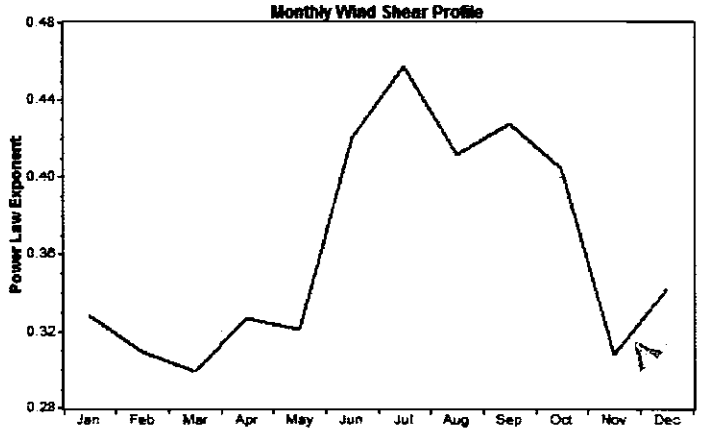


FIGURE 10: MONTHLY WIND SHEAR- CHELAMALA (JANUARY 2013 TO DECEMBER2013)

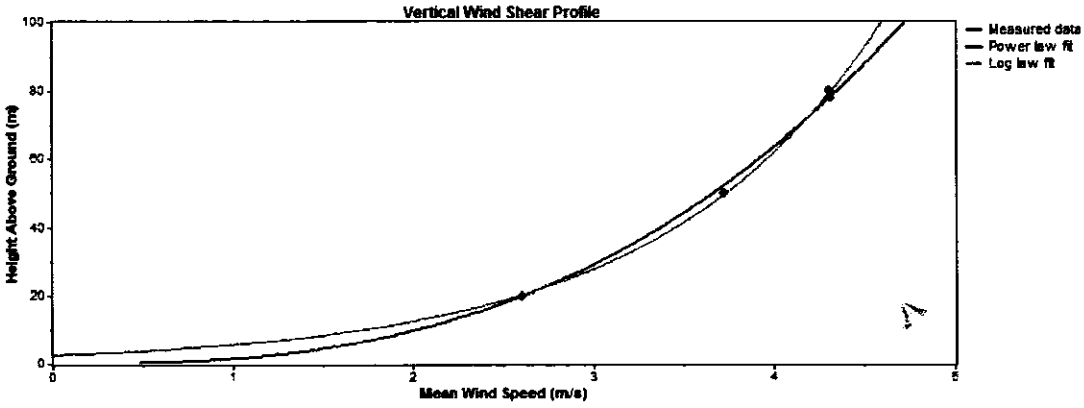
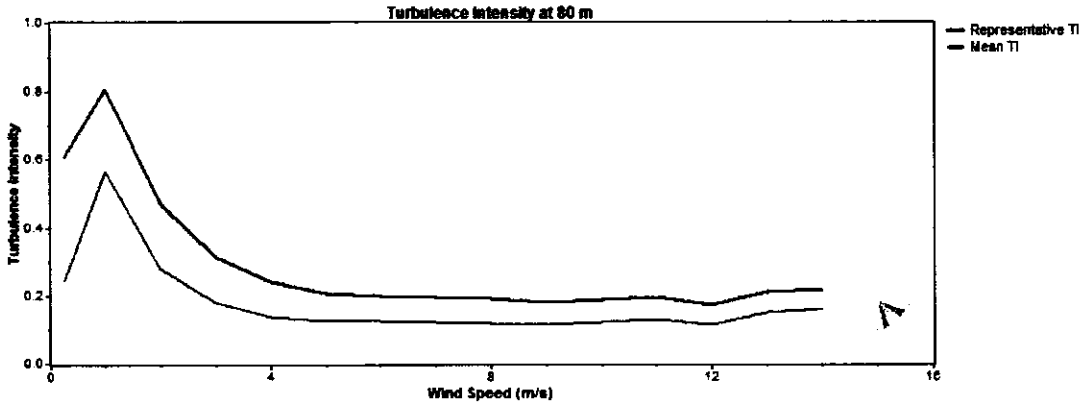
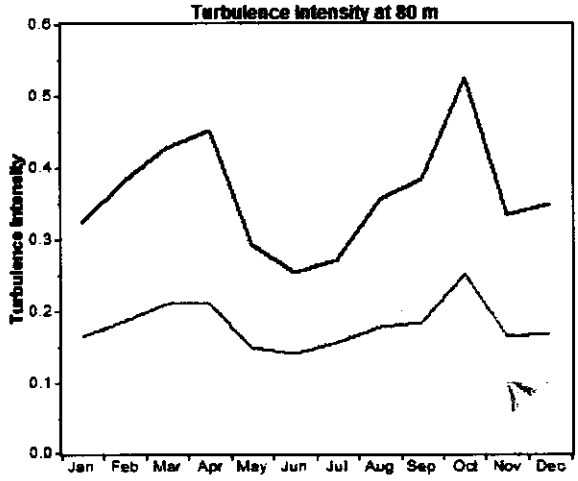
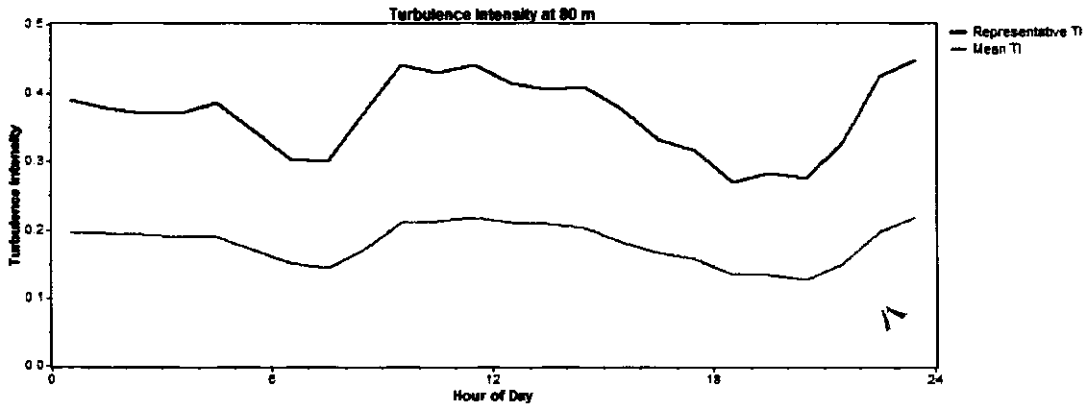


FIGURE 11: VERTICALWIND SHEAR- CHELAMALA (JANUARY 2013 TO DECEMBER2013)







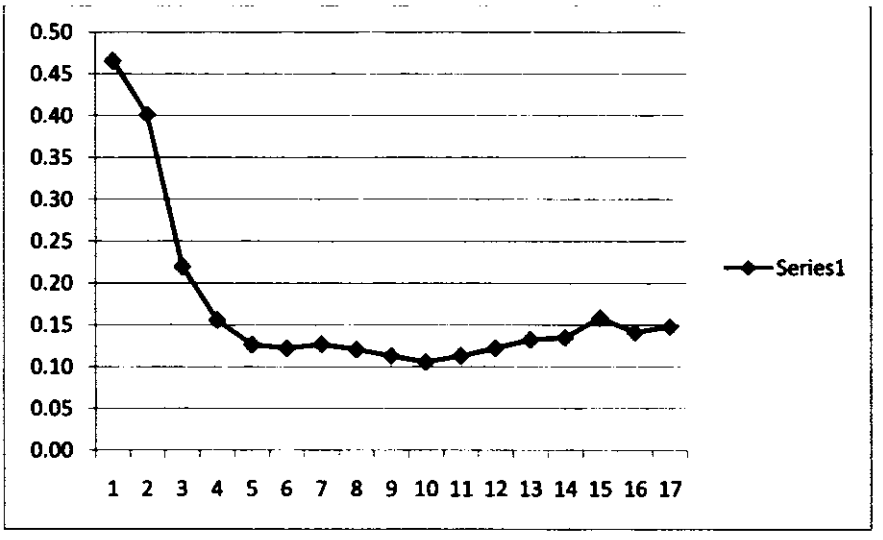


FIGURE 12: TURBULANCE INTENSITY – CHELAMALA (JANUARY 2013 TO DECEMBER2013)

IInd Year

Jan 2014 - Dec 2014

CHELAMALA

TABLE 4A

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	3.53	2.88	2.76	2.39	2.54	2.83	3.28	2.58	2.87	1.98	2.59	3.03	2.77
50m	4.83	3.75	3.50	2.99	3.44	4.12	4.85	3.82	3.97	2.64	3.40	4.15	3.79
78m	5.44	4.23	3.91	3.43	3.95	4.94	5.90	4.65	4.74	3.12	3.86	4.61	4.40
80m	5.52	4.32	4.03	3.46	3.97	4.96	5.92	4.64	4.73	3.10	3.88	4.70	4.44
Monthly Wind Power Density (Watts/Sq.m)													
20m	37.09	22.24	23.75	18.10	17.38	26.51	33.90	20.12	23.68	11.21	18.47	28.21	23.39
50m	107.38	54.17	52.12	33.34	38.42	70.50	92.04	52.44	56.63	26.34	50.15	83.44	59.75
78m	153.32	77.98	72.12	45.87	55.39	120.74	156.37	88.49	92.71	40.32	70.17	114.29	90.65
80m	159.54	81.12	75.30	46.50	55.74	122.13	157.17	88.45	91.74	40.09	72.04	119.78	92.47
Power Law Index (PLI)													
	0.32	0.29	0.27	0.27	0.32	0.40	0.43	0.42	0.36	0.32	0.29	0.32	0.34
Energy Pattern Factor													
20m	1.47	1.62	1.98	2.33	1.85	1.94	1.66	2.03	1.75	2.52	1.86	1.77	1.90
50m	1.66	1.80	2.13	2.18	1.65	1.75	1.40	1.63	1.57	2.49	2.23	2.03	1.88
78 m	1.66	1.79	2.11	2.00	1.57	1.70	1.32	1.53	1.51	2.31	2.13	2.03	1.81
80m	1.65	1.76	2.01	1.97	1.56	1.69	1.31	1.54	1.51	2.34	2.15	2.01	1.79
Air Density (kg/m^3)													
	1.149	1.145	1.140	1.139	1.141	1.146	1.154	1.153	1.151	1.151	1.149	1.150	1.15
Temperature (^{0} C)													
	26.66	27.25	28.78	28.84	27.85	26.25	24.63	24.66	25.54	25.81	26.27	26.25	26.57
Turbulance Intensity (at 50m agl)													
	At 15m/s : 0.18												
Data Availability (Based on 10 Minutes Interval)													
	4464	4032	4464	4320	4464	4319	4464	4464	4320	4464	4320	4464	

Based on Data January 2014 to December 2014

CHELAMALA

TABLE 5A
SUMMARY OF WIND DATA

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)	(78m)	(80m)	(50m)	(78m)	(80m)	(50m)	(78m)	(80m)	(50m)	(80m)
4.83	5.44	5.52	0.80	0.73	0.74	12.47 26-01-2014 12:00	13.26 26-01-2014 12:00	13.50 26-01-2014 12:00	SE	SE
3.75	4.23	4.32	0.68	0.65	0.64	10.39 25-02-2014 07:30	11.83 25-02-2014 07:40	12.04 25-02-2014 07:40	SE	SE
3.50	3.91	4.03	0.70	0.67	0.66	11.61 16-03-2014 12:40	12.51 16-03-2014 12:40	12.73 16-03-2014 12:40	SE	SE
2.99	3.43	3.46	0.61	0.59	0.57	14.16 10-04-2014 7:50	15.60 10-04-2014 7:50	15.74 10-04-2014 07:50	W	W
3.44	3.95	3.97	0.61	0.57	0.56	11.66 07-05-2014 07:10	12.16 07-5-2014 07:10	12.31 07-05-2014 07:10	W	W
4.12	4.94	4.96	0.76	0.70	0.69	11.62 19-06-2014 01:00	13.71 20-06-2014 16:10	13.94 20-06-2014 16:10	NW	NW
4.85	5.90	5.92	0.92	0.87	0.85	12.92 23-07-2014 01:20	14.27 23-07-2014 01:20	14.33 23-07-2014 01:20	NW	NW
3.82	4.65	4.64	0.72	0.68	0.67	10.86 04-08-2014 6:30	12.92 04-08-2014 6:30	12.89 04-08-2014 6:30	W	NW
3.97	4.74	4.73	0.72	0.67	0.65	12.68 28-09-2014 06:20	13.65 28-09-2014 06:20	12.97 26-09-2014 05:50	NW	NW
2.64	3.12	3.10	0.56	0.55	0.54	10.08 16-10-2014 07:30	11.58 21-10-2014 12:10	11.82 21-10-2014 12:10	SE	SE
3.40	3.86	3.88	0.57	0.55	0.55	11.42 24-11-2014 08:40	12.43 10-11-2014 3:20	12.65 10-11-2014 3:20	E	E
4.15	4.61	4.70	0.62	0.59	0.58	12.77 17-12-2014 13:00	13.85 17-12-2014 13:00	14.12 17-12-2014 13:20	SE	SE
3.79	**4.40**	**4.44**	**0.69**	**0.65**	**0.64**	14.16 10-04-2014 07:50	15.60 10-04-2014 07:50	15.74 10-04-2014 07:50	NW	NW

Based on Data January 2014 to December 2014

CHELAMALA

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

TABLE 6

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	4.1	5.0	6.0	6.6	7.2	7.5	7.5	7.5	6.7	5.6	5.2	5.4	5.3	4.7	4.3	4.2	4.7	5.1	5.3	5.6	5.3	5.0	4.5	4.0	5.5
FEB	3.2	3.7	4.1	4.3	4.5	5.1	5.6	6.0	5.5	4.2	3.9	3.8	3.6	3.5	3.2	3.4	4.4	5.1	5.3	5.1	4.7	4.2	4.0	3.4	4.3
MAR	3.3	3.8	3.3	3.1	3.2	3.2	3.7	4.0	3.9	3.4	3.3	3.6	3.8	3.8	4.1	5.2	6.0	6.1	5.9	5.1	4.6	3.9	3.4	3.2	4.0
APR	3.2	2.8	2.9	2.8	2.7	2.5	2.2	1.7	1.4	1.8	2.1	2.4	2.9	3.4	4.3	5.7	6.1	6.1	5.7	5.0	4.6	3.9	3.6	3.4	3.5
MAY	3.8	3.4	3.3	3.4	3.2	3.6	3.4	3.6	2.9	2.6	3.0	3.4	3.9	4.3	4.9	5.6	5.8	5.6	5.0	4.7	4.4	4.0	3.7	3.8	4.0
JUN	4.6	4.6	4.5	4.5	4.9	5.0	4.5	4.6	4.8	4.3	4.9	5.4	5.3	5.4	5.8	5.6	5.6	5.3	5.1	5.6	5.0	4.8	4.5	4.6	5.0
JUL	5.8	6.1	6.7	6.7	6.8	7.0	6.8	6.0	6.1	6.3	6.4	6.1	5.8	5.9	6.0	5.9	5.6	5.9	5.5	5.3	5.4	4.6	4.5	5.1	5.9
AUG	4.5	4.9	5.3	5.6	5.7	5.8	5.7	5.5	5.2	4.8	4.6	4.6	4.7	4.5	4.3	4.2	4.3	3.8	4.3	4.1	4.0	3.6	3.4	4.0	4.6
SEP	4.1	4.4	4.8	5.5	6.1	6.4	6.3	5.6	5.1	5.1	4.7	4.3	4.1	4.2	4.5	4.7	4.8	4.5	4.4	4.5	4.4	3.5	3.3	3.7	4.7
OCT	2.6	3.0	3.3	3.4	3.7	4.1	4.7	4.5	4.1	3.6	3.2	2.8	2.7	2.7	2.6	2.7	2.8	2.9	2.9	2.9	2.7	2.3	2.1	2.3	3.1
NOV	3.0	3.4	3.4	3.5	3.7	4.1	4.7	5.2	5.6	5.1	4.5	4.0	4.0	3.5	3.5	3.6	3.3	3.4	3.8	3.9	4.0	3.8	3.3	2.8	3.9
DEC	3.8	3.8	3.8	3.9	3.8	4.0	4.2	5.1	5.5	5.5	5.4	5.5	5.4	5.4	5.0	5.0	4.9	4.8	5.1	5.0	5.3	4.9	4.1	3.5	4.7
Annual	3.8	4.1	4.3	4.5	4.6	4.8	4.9	4.9	4.7	4.4	4.3	4.3	4.3	4.3	4.4	4.7	4.9	4.9	4.9	4.7	4.5	4.0	3.7	3.6	4.4

SENSOR HEIGHT: 80m N

Based on Data January 2014 to December 2014

CHELAMALA

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

TABLE 6A

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	4.1	5.1	5.9	6.5	7.0	7.3	7.4	7.4	6.6	5.5	5.1	5.4	5.2	4.7	4.3	4.3	4.7	5.2	5.3	5.7	5.4	4.9	4.4	4.0	5.5
FEB	3.0	3.6	4.0	4.2	4.3	5.0	5.5	5.9	5.4	4.1	3.9	3.7	3.5	3.4	3.2	3.3	4.4	5.0	5.3	5.0	4.7	4.2	3.9	3.3	4.2
MAR	3.2	3.6	3.2	2.9	3.0	3.0	3.5	3.8	3.8	3.3	3.2	3.5	3.7	3.7	4.0	5.1	5.9	6.0	5.9	5.1	4.5	3.9	3.3	3.0	3.9
APR	3.2	2.8	2.8	2.7	2.7	2.5	2.2	1.7	1.3	1.7	2.0	2.4	2.8	3.3	4.3	5.7	6.1	6.1	5.7	5.0	4.6	3.9	3.5	3.4	3.4
MAY	3.8	3.4	3.3	3.4	3.2	3.5	3.4	3.6	2.8	2.6	3.0	3.4	3.9	4.2	4.9	5.6	5.8	5.6	5.0	4.8	4.4	3.9	3.7	3.8	4.0
JUN	4.6	4.5	4.4	4.5	4.9	5.0	4.5	4.6	4.8	4.3	4.9	5.3	5.3	5.3	5.8	5.6	5.5	5.3	5.1	5.6	5.0	4.8	4.4	4.6	4.9
JUL	5.8	6.0	6.7	6.7	6.8	7.0	6.8	6.0	6.2	6.3	6.4	6.0	5.7	5.8	6.0	5.8	5.6	5.8	5.4	5.2	5.3	4.5	4.4	5.1	5.9
AUG	4.4	4.8	5.2	5.6	5.7	5.8	5.7	5.6	5.2	4.9	4.6	4.6	4.7	4.5	4.3	4.2	4.4	3.9	4.3	4.1	4.0	3.6	3.3	3.9	4.6
SEP	4.1	4.4	4.8	5.6	6.2	6.5	6.4	5.7	5.2	5.1	4.7	4.3	4.1	4.2	4.5	4.7	4.8	4.5	4.4	4.4	4.4	3.5	3.3	3.8	4.7
OCT	2.6	2.9	3.2	3.4	3.7	4.1	4.7	4.6	4.2	3.6	3.3	2.8	2.7	2.7	2.7	2.7	2.8	2.9	2.9	2.9	2.8	2.3	2.0	2.2	3.1
NOV	3.0	3.4	3.4	3.4	3.6	4.1	4.7	5.2	5.5	5.0	4.5	4.0	4.0	3.5	3.5	3.6	3.3	3.4	3.8	3.9	4.0	3.8	3.3	2.7	3.9
DEC	3.7	3.7	3.7	3.8	3.7	3.9	4.1	5.0	5.4	5.4	5.3	5.5	5.3	5.3	4.9	4.9	4.8	4.7	5.0	4.9	5.2	4.9	4.1	3.5	4.6
Annual	3.8	4.0	4.2	4.4	4.6	4.8	4.9	4.9	4.7	4.3	4.2	4.2	4.2	4.2	4.4	4.6	4.8	4.9	4.8	4.7	4.5	4.0	3.6	3.6	4.4

SENSOR HEIGHT: 78m S

Based on Data January 2014 to December 2014

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TABLE 6B

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	3.6	4.3	5.2	5.8	6.2	6.5	6.6	6.5	5.7	4.9	4.7	4.9	4.8	4.3	4.0	3.8	4.2	4.6	4.7	5.0	4.7	4.3	3.8	3.4	4.9
FEB	2.5	3.0	3.6	3.7	3.8	4.5	4.9	5.2	4.6	3.6	3.5	3.4	3.3	3.2	2.9	3.1	4.0	4.6	4.7	4.4	4.1	3.6	3.3	2.6	3.7
MAR	2.7	3.1	2.7	2.5	2.5	2.7	3.1	3.5	3.3	3.0	2.9	3.2	3.4	3.5	3.7	4.8	5.5	5.5	5.3	4.5	3.9	3.3	2.8	2.6	3.5
APR	2.6	2.2	2.3	2.1	2.1	2.0	1.8	1.3	1.1	1.6	1.9	2.3	2.7	3.1	4.0	5.3	5.6	5.5	5.0	4.3	3.9	3.2	3.0	2.8	3.0
MAY	3.1	2.8	2.8	2.9	2.7	3.0	2.9	2.9	2.3	2.4	2.8	3.2	3.6	3.9	4.5	5.1	5.2	5.0	4.4	4.1	3.7	3.3	3.0	3.1	3.4
JUN	3.7	3.8	3.7	3.8	4.2	4.3	3.7	3.7	3.9	3.5	4.1	4.6	4.5	4.5	5.0	4.8	4.7	4.4	4.2	4.6	4.1	3.9	3.6	3.8	4.1
JUL	5.1	5.3	5.9	5.9	5.9	6.1	5.7	4.9	5.0	5.1	5.1	4.8	4.5	4.6	4.8	4.7	4.4	4.7	4.3	4.2	4.2	3.4	3.6	4.3	4.9
AUG	3.9	4.2	4.6	4.9	5.0	5.0	4.9	4.7	4.2	3.9	3.7	3.7	3.8	3.5	3.4	3.3	3.4	3.0	3.5	3.3	3.1	2.7	2.6	3.4	3.8
SEP	3.7	4.0	4.3	5.0	5.6	5.8	5.5	4.8	4.3	4.2	3.8	3.4	3.3	3.4	3.7	3.8	3.8	3.5	3.5	3.6	3.5	2.7	2.8	3.3	4.0
OCT	2.3	2.7	3.0	3.1	3.3	3.6	4.0	4.0	3.6	3.1	2.7	2.2	2.1	2.2	2.1	2.2	2.2	2.4	2.4	2.3	2.3	1.8	1.7	2.0	2.6
NOV	2.7	3.1	3.1	3.2	3.3	3.6	4.2	4.6	4.9	4.4	4.0	3.5	3.4	3.0	2.9	3.2	2.9	2.9	3.4	3.5	3.5	3.1	2.7	2.4	3.4
DEC	3.5	3.5	3.4	3.5	3.4	3.6	3.7	4.5	4.9	4.9	4.7	4.8	4.7	4.8	4.4	4.5	4.2	4.2	4.4	4.4	4.6	4.3	3.5	3.2	4.2
Annual	3.3	3.5	3.7	3.9	4.0	4.2	4.3	4.2	4.0	3.7	3.7	3.7	3.7	3.7	3.8	4.0	4.2	4.2	4.1	4.0	3.8	3.3	3.0	3.1	3.8

SENSOR HEIGHT : 50m

Based on Data January 2014 to December 2014

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

TABLE 6C

CHELAMALA

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	2.6	2.9	3.5	3.9	4.2	4.4	4.6	4.4	4.1	3.9	3.8	3.9	3.8	3.4	3.2	3.1	3.2	3.4	3.4	3.5	3.4	3.1	2.8	2.4	3.5
FEB	1.8	2.2	2.7	2.7	2.9	3.2	3.4	3.7	3.3	2.9	3.0	2.9	2.8	2.7	2.6	2.6	3.4	3.8	3.6	3.3	3.0	2.6	2.3	1.9	2.9
MAR	2.0	2.2	1.9	1.7	1.9	2.1	2.4	2.6	2.5	2.5	2.5	2.7	3.0	3.0	3.2	4.0	4.5	4.5	4.3	3.6	2.9	2.5	2.1	1.9	2.8
APR	1.9	1.6	1.6	1.5	1.5	1.4	1.3	1.1	1.1	1.5	1.7	2.0	2.4	2.8	3.5	4.6	4.7	4.6	4.1	3.3	2.9	2.3	2.1	1.9	2.4
MAY	2.0	1.8	1.8	1.9	1.9	2.1	2.0	1.7	1.7	2.0	2.3	2.6	3.1	3.3	3.7	4.2	4.2	3.9	3.3	2.9	2.6	2.2	2.0	2.1	2.5
JUN	2.5	2.6	2.6	2.7	2.9	2.9	2.6	2.4	2.6	2.4	2.9	3.3	3.3	3.3	3.6	3.4	3.3	3.0	2.6	3.0	2.6	2.6	2.4	2.5	2.8
JUL	3.9	4.1	4.6	4.6	4.6	4.7	4.2	3.4	3.3	3.2	3.2	2.9	2.7	2.8	2.9	2.8	2.7	2.9	2.5	2.4	2.5	2.2	2.6	3.2	3.3
AUG	3.1	3.4	3.7	4.0	4.0	3.9	3.7	3.4	2.7	2.5	2.3	2.2	2.3	2.0	1.9	1.8	2.0	1.7	2.0	1.9	1.7	1.6	1.8	2.5	2.6
SEP	3.0	3.3	3.6	4.2	4.6	4.8	4.3	3.7	3.1	2.8	2.5	2.2	2.2	2.1	2.3	2.4	2.3	2.2	2.2	2.1	2.1	1.9	2.3	2.8	2.9
OCT	2.0	2.3	2.5	2.7	2.8	3.0	3.1	3.0	2.7	2.3	1.9	1.6	1.4	1.6	1.5	1.5	1.4	1.4	1.5	1.4	1.5	1.2	1.5	1.8	2.0
NOV	2.3	2.5	2.6	2.6	2.7	2.8	3.2	3.3	3.4	3.0	2.8	2.5	2.4	2.2	2.2	2.5	2.4	2.3	2.5	2.6	2.6	2.3	2.2	2.1	2.6
DEC	2.8	2.8	2.8	2.8	2.8	2.8	2.7	3.2	3.5	3.5	3.3	3.3	3.2	3.3	3.2	3.2	3.0	3.0	3.0	3.1	3.2	2.8	2.6	2.6	3.0
Annual	2.5	2.6	2.8	2.9	3.1	3.2	3.1	3.0	2.8	2.7	2.7	2.7	2.7	2.7	2.8	3.0	3.1	3.1	2.9	2.8	2.6	2.3	2.2	2.3	2.8

SENSOR HEIGHT : 20m

Based on Data January 2014 to December 2014

TABLE 7

CHELAMALA

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	1.70	3.52	4.59	9.56	3.27	5.35	0.45	4.44	4.65	16.40	10.05	4.73	5.73
1.0-2.0	5.00	10.14	11.94	15.05	8.83	6.16	1.19	5.76	6.04	15.75	13.06	9.72	9.05
2.0-3.0	10.08	15.53	20.63	19.68	17.72	10.05	3.83	10.13	9.54	19.80	16.34	15.79	14.09
3.0-4.0	14.85	18.55	18.30	19.51	21.62	13.43	9.44	15.01	12.96	17.83	15.65	15.55	16.06
4.0-5.0	15.37	16.91	15.91	13.87	21.66	17.59	16.57	20.16	19.19	12.12	14.81	13.75	16.49
5.0-6.0	12.84	14.73	10.78	11.57	15.82	13.73	21.05	20.05	19.40	9.32	12.96	11.13	14.45
6.0-7.0	10.10	9.87	8.31	6.90	7.26	13.08	20.52	13.82	16.27	5.29	7.66	8.80	10.66
7.0-8.0	9.97	4.94	4.14	3.15	2.69	10.21	13.59	6.88	8.54	2.28	4.10	8.00	6.54
8.0-9.0	9.52	3.15	2.37	0.42	0.74	5.83	8.48	2.51	2.66	0.81	2.87	5.62	3.75
9.0-10.0	6.65	2.11	1.43	0.19	0.18	2.94	3.03	0.83	0.58	0.29	1.74	3.90	1.99
10.0-11.0	2.64	0.45	0.85	0.07	0.09	1.34	1.10	0.34	0.12	0.07	0.42	1.66	0.76
11.0-12.0	1.05	0.07	0.60	0.02	0.11	0.16	0.43	0.04	0.00	0.04	0.25	0.90	0.31
12.0-13.0	0.20	0.02	0.13	0.00	0.02	0.09	0.13	0.04	0.05	0.00	0.09	0.27	0.09
13.0-14.0	0.02	0.00	0.00	0.00	0.00	0.02	0.13	0.00	0.00	0.00	0.00	0.13	0.03
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.04	0.01
15.0-16.0	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00
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	0.00
20.0-21.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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.

NATIONAL INSTITUTE OF WIND ENERGYCHENNAI

TABLE 7A

CHELAMALA

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	2.20	4.89	7.10	9.54	3.92	5.46	0.49	4.32	4.84	16.02	9.86	5.76	6.20
1.0-2.0	5.38	10.14	12.21	15.32	8.36	5.93	1.55	5.80	5.88	16.29	13.36	9.88	9.17
2.0-3.0	10.04	15.72	20.18	20.90	17.54	10.56	3.97	10.44	9.93	19.20	16.00	15.46	14.16
3.0-4.0	14.76	17.91	17.85	18.75	21.95	13.77	9.78	14.65	12.34	17.92	15.88	15.75	15.94
4.0-5.0	15.30	16.64	14.56	13.50	21.21	16.81	16.19	20.09	18.77	12.39	15.39	13.28	16.18
5.0-6.0	13.04	14.76	10.48	11.32	16.15	13.66	20.87	19.71	19.51	9.30	12.92	11.11	14.40
6.0-7.0	9.99	9.62	8.49	6.81	6.97	13.50	20.13	14.61	16.64	5.47	7.57	8.96	10.73
7.0-8.0	10.30	5.01	3.97	3.08	2.76	9.75	13.86	6.72	8.63	2.31	3.87	8.20	6.54
8.0-9.0	9.41	3.13	2.28	0.49	0.81	6.02	8.41	2.42	2.73	0.78	3.08	5.44	3.75
9.0-10.0	6.25	1.74	1.48	0.19	0.11	3.22	2.89	0.74	0.53	0.22	1.37	3.49	1.85
10.0-11.0	2.31	0.35	0.76	0.07	0.13	1.02	1.14	0.40	0.14	0.07	0.44	1.52	0.70
11.0-12.0	0.87	0.10	0.56	0.02	0.07	0.19	0.36	0.04	0.00	0.04	0.19	0.76	0.27
12.0-13.0	0.13	0.00	0.07	0.00	0.02	0.09	0.18	0.04	0.02	0.00	0.09	0.22	0.07
13.0-14.0	0.02	0.00	0.00	0.00	0.00	0.02	0.11	0.00	0.02	0.00	0.00	0.16	0.03
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.01
15.0-16.0	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00
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	0.00
20.0-21.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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.

NATIONAL INSTITUTE OF WIND ENERGYCHENNAI

TABLE 7B

CHELAMALA

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	3.07	6.92	9.01	13.70	5.80	7.80	1.03	7.01	6.11	21.08	9.86	6.79	8.18
1.0-2.0	6.74	11.58	15.28	18.94	13.26	8.40	3.41	8.53	8.77	19.47	13.36	12.54	11.69
2.0-3.0	12.48	18.40	20.83	22.36	20.74	14.63	8.68	15.52	13.03	21.19	16.00	16.49	16.70
3.0-4.0	17.16	20.29	19.69	17.50	24.35	18.08	18.74	21.95	20.42	16.31	15.88	16.71	18.92
4.0-5.0	16.94	17.61	13.55	12.69	19.96	15.88	23.70	22.51	22.59	11.22	15.39	14.02	17.17
5.0-6.0	12.63	13.27	9.43	8.19	10.51	15.69	20.31	14.67	17.59	6.68	12.92	11.47	12.78
6.0-7.0	11.60	6.52	6.50	4.79	3.90	11.20	13.16	6.50	8.10	2.78	7.57	8.83	7.62
7.0-8.0	10.04	3.47	2.98	1.48	1.08	5.42	7.31	2.22	2.66	0.87	3.87	6.83	4.02
8.0-9.0	6.21	1.46	1.48	0.28	0.22	2.41	2.24	0.72	0.58	0.27	3.08	3.43	1.86
9.0-10.0	2.49	0.42	0.81	0.00	0.09	0.28	0.83	0.27	0.09	0.09	1.37	1.75	0.71
10.0-11.0	0.49	0.05	0.40	0.05	0.07	0.16	0.31	0.09	0.00	0.04	0.44	0.78	0.24
11.0-12.0	0.13	0.00	0.04	0.00	0.02	0.05	0.18	0.00	0.02	0.00	0.19	0.25	0.07
12.0-13.0	0.02	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.02	0.00	0.09	0.11	0.03
13.0-14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14.0-15.0	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15.0-16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00
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	0.00
20.0-21.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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 ENERGYCHENNAI

TABLE 7C

CHELAMALA

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	3.38	7.96	10.60	18.17	11.90	14.31	5.49	16.42	10.37	28.36	13.56	8.56	12.42
1.0-2.0	10.93	18.53	23.79	27.15	25.38	18.43	15.13	20.45	18.22	25.99	23.03	17.36	20.37
2.0-3.0	22.07	27.60	26.93	26.13	29.05	23.24	24.35	25.60	25.63	23.66	24.65	25.49	25.37
3.0-4.0	27.02	25.57	18.32	13.33	18.71	19.38	24.66	20.59	25.63	13.64	23.63	24.13	21.22
4.0-5.0	20.90	14.53	10.55	7.96	10.84	15.65	17.26	11.22	12.57	6.38	10.49	15.10	12.79
5.0-6.0	12.01	5.06	6.88	5.46	3.47	6.97	8.77	4.26	6.06	1.61	4.00	6.21	5.90
6.0-7.0	3.16	0.72	2.64	1.55	0.56	1.81	3.16	0.99	1.41	0.29	0.51	2.31	1.59
7.0-8.0	0.49	0.02	0.27	0.19	0.09	0.14	0.83	0.45	0.12	0.04	0.09	0.67	0.28
8.0-9.0	0.04	0.00	0.02	0.02	0.00	0.07	0.27	0.02	0.00	0.02	0.02	0.16	0.05
9.0-10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.02	0.01
10.0-11.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11.0-12.0	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12.0-13.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.0-14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15.0-16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00
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	0.00
20.0-21.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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.

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TABLE 8

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	1.15	0.76	0.69	0.54	0.31	0.38	0.80	0.76	0.76	0.76	0.70	0.84	8.5
1.0-2.0	1.27	0.65	0.85	0.90	0.74	0.47	0.88	1.00	1.18	1.27	1.23	1.38	11.8
2.0-3.0	1.07	0.37	0.73	1.41	1.43	0.76	1.01	1.26	1.96	2.31	2.41	2.00	16.7
3.0-4.0	0.70	0.15	0.54	1.74	1.98	0.71	0.66	0.66	2.12	3.98	3.53	2.28	19.1
4.0-5.0	0.39	0.08	0.31	1.54	2.26	0.38	0.18	0.29	1.86	4.28	3.68	2.02	17.3
5.0-6.0	0.16	0.02	0.22	1.30	1.98	0.18	0.05	0.15	1.38	3.10	2.83	1.14	12.5
6.0-7.0	0.06	0.02	0.24	1.19	1.42	0.08	0.02	0.07	0.84	1.61	1.47	0.44	7.4
7.0-8.0	0.02	0.00	0.15	1.03	1.07	0.02	0.01	0.01	0.30	0.60	0.63	0.16	4.0
8.0-9.0	0.01	0.00	0.08	0.79	0.34	0.00	0.01	0.02	0.06	0.15	0.22	0.08	1.8
9.0-10.0	0.00	0.00	0.06	0.35	0.11	0.00	0.00	0.00	0.03	0.04	0.04	0.01	0.6
10.0-11.0	0.00	0.00	0.02	0.12	0.03	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.2
11.0-12.0	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.1
12.0-13.0	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.0
13.0-14.0	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
14.0-15.0	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
15.0-16.0	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
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	4.8	2.1	3.9	11.0	11.7	3.0	3.6	4.2	10.5	18.1	16.8	10.4	100.0

SENSOR HEIGHT: 50m **Based on Data January2013 to December2013**

Range 0--1 Extends from 0 to 0.99 m/s &

1-- 2 Extends from 1 to 1.99 m/s etc.

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TABLE 8A

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	0.72	0.61	0.56	0.41	0.33	0.25	0.44	0.61	0.56	0.57	0.48	0.63	6.2
1.0-2.0	0.81	0.65	0.61	0.80	0.57	0.41	0.64	0.76	0.77	0.93	1.08	1.09	9.1
2.0-3.0	1.20	0.45	0.58	1.12	1.24	0.68	0.82	0.93	1.25	1.74	2.07	2.05	14.1
3.0-4.0	0.94	0.21	0.42	1.30	1.86	0.80	0.76	0.70	1.17	2.36	2.89	2.52	15.9
4.0-5.0	0.55	0.08	0.26	1.17	2.15	0.64	0.25	0.29	0.89	3.31	4.09	2.52	16.2
5.0-6.0	0.30	0.03	0.13	1.05	2.07	0.29	0.08	0.14	0.78	3.49	3.74	2.32	14.4
6.0-7.0	0.09	0.01	0.10	1.05	1.73	0.17	0.02	0.07	0.53	2.74	2.75	1.47	10.7
7.0-8.0	0.06	0.00	0.06	0.94	1.44	0.10	0.02	0.02	0.28	1.31	1.60	0.72	6.6
8.0-9.0	0.02	0.00	0.03	0.84	1.12	0.03	0.01	0.01	0.09	0.57	0.71	0.34	3.8
9.0-10.0	0.02	0.00	0.01	0.59	0.61	0.00	0.00	0.01	0.03	0.20	0.18	0.20	1.9
10.0-11.0	0.00	0.00	0.01	0.32	0.14	0.00	0.01	0.00	0.02	0.07	0.07	0.07	0.7
11.0-12.0	0.00	0.00	0.00	0.14	0.08	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.3
12.0-13.0	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.1
13.0-14.0	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.0
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.0
15.0-16.0	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
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	4.7	2.0	2.8	9.8	13.4	3.4	3.1	3.5	6.4	17.3	19.7	13.9	100.0

SENSOR HEIGHT: 78m **Based on Data January2014 to December2014**

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

CHELAMALA

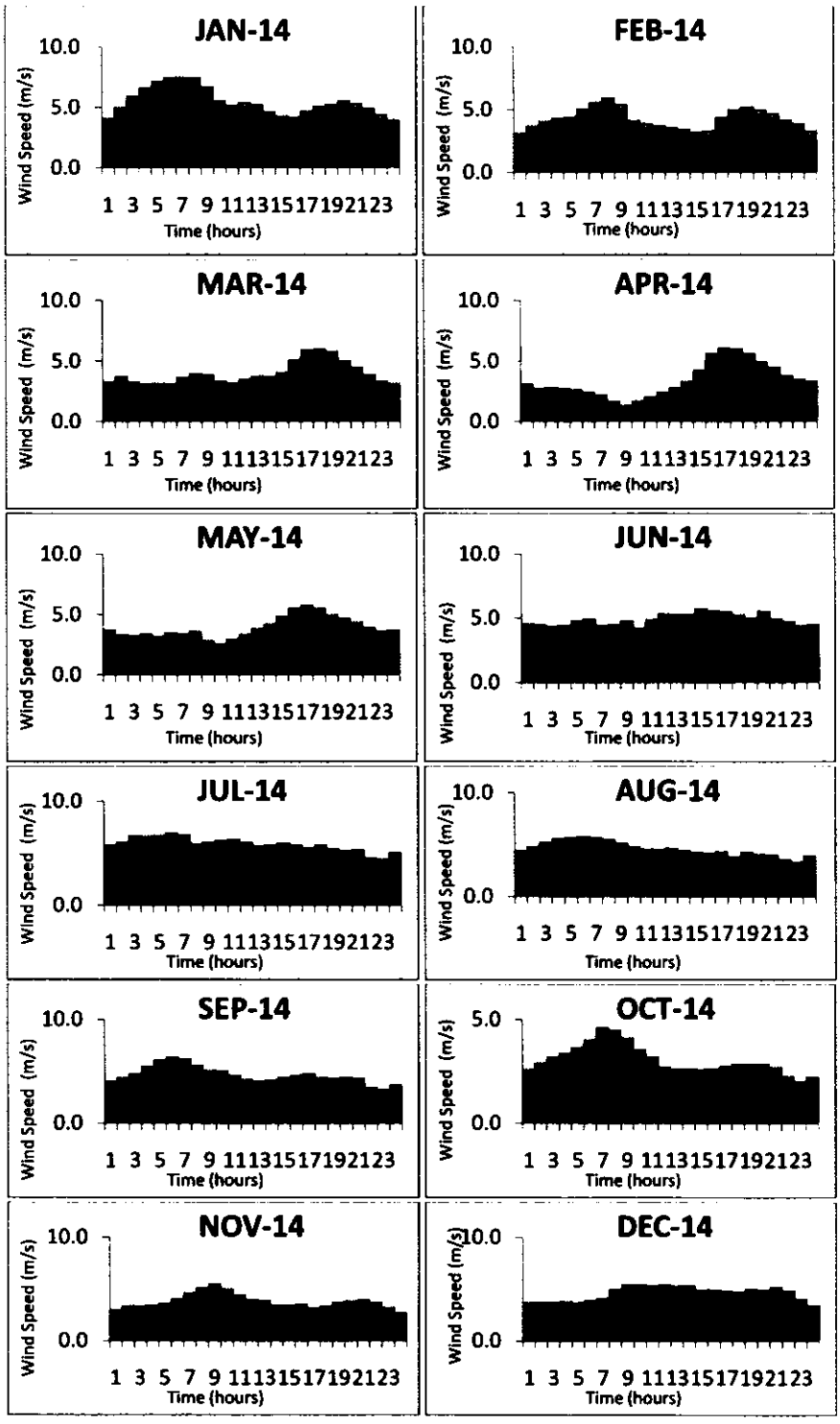
TABLE 8B

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	0.64	0.52	0.51	0.37	0.31	0.25	0.40	0.56	0.51	0.50	0.50	0.65	5.7
1.0-2.0	0.82	0.64	0.64	0.81	0.55	0.37	0.65	0.77	0.75	0.94	0.99	1.05	9.0
2.0-3.0	1.25	0.49	0.60	1.15	1.18	0.67	0.81	0.94	1.28	1.73	2.04	1.94	14.1
3.0-4.0	0.95	0.24	0.42	1.26	1.86	0.81	0.78	0.71	1.21	2.46	2.86	2.46	16.0
4.0-5.0	0.56	0.10	0.26	1.14	2.14	0.65	0.27	0.32	0.89	3.47	4.20	2.48	16.5
5.0-6.0	0.29	0.03	0.13	1.04	2.05	0.30	0.08	0.14	0.78	3.55	3.77	2.33	14.5
6.0-7.0	0.10	0.01	0.10	1.03	1.72	0.18	0.03	0.07	0.52	2.65	2.73	1.52	10.7
7.0-8.0	0.06	0.00	0.07	0.95	1.43	0.11	0.02	0.02	0.28	1.25	1.58	0.80	6.6
8.0-9.0	0.03	0.00	0.03	0.82	1.13	0.03	0.01	0.01	0.10	0.52	0.72	0.37	3.8
9.0-10.0	0.02	0.00	0.01	0.65	0.69	0.00	0.00	0.01	0.03	0.17	0.20	0.22	2.0
10.0-11.0	0.00	0.00	0.01	0.33	0.18	0.00	0.00	0.00	0.02	0.06	0.07	0.10	0.8
11.0-12.0	0.00	0.00	0.00	0.18	0.08	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.3
12.0-13.0	0.00	0.00	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.1
13.0-14.0	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.0
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.0
15.0-16.0	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
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	4.7	2.0	2.8	9.8	13.4	3.4	3.1	3.5	6.4	17.3	19.7	13.9	100.0

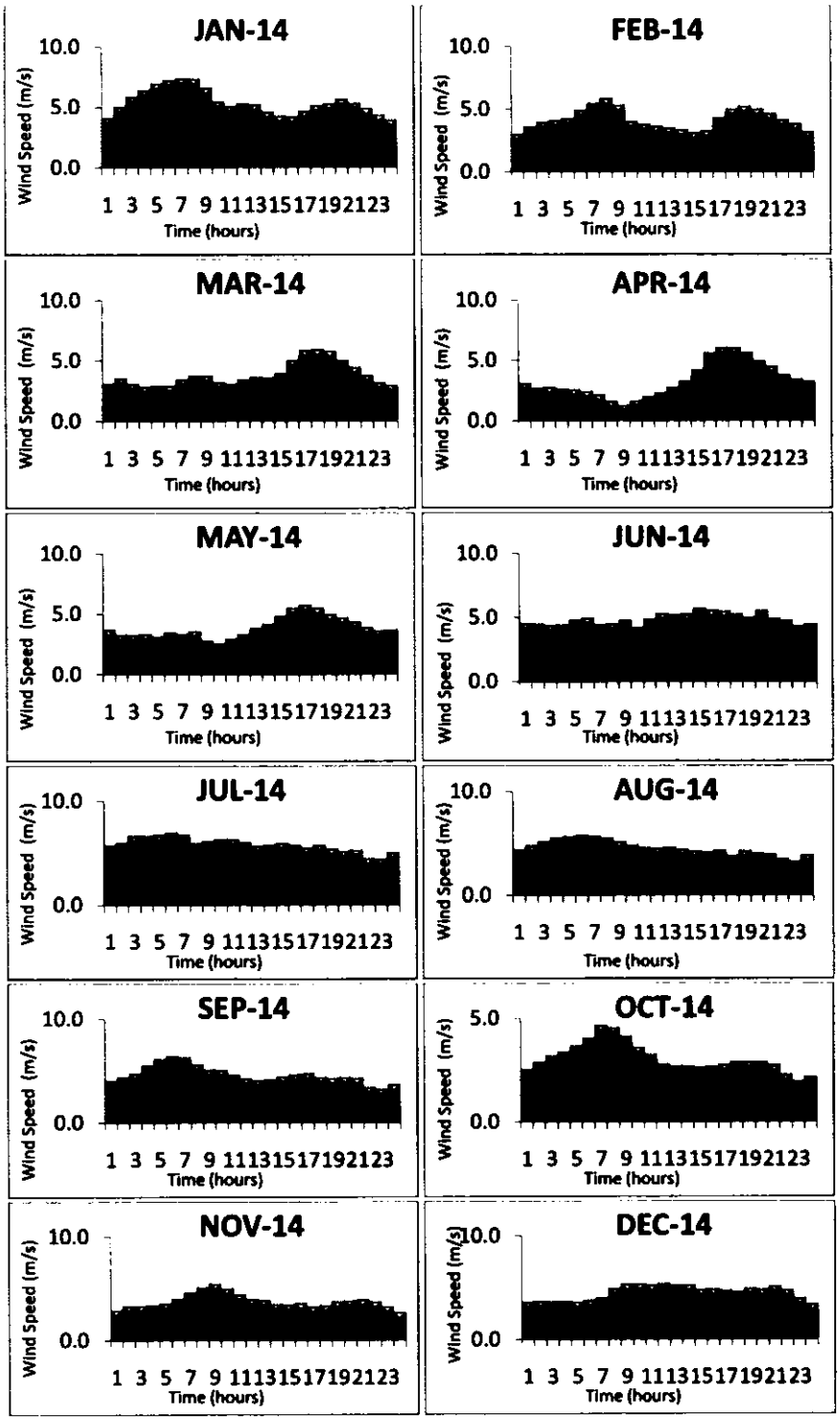
SENSOR HEIGHT: 80m **Based on Data January2013 to December2013**

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



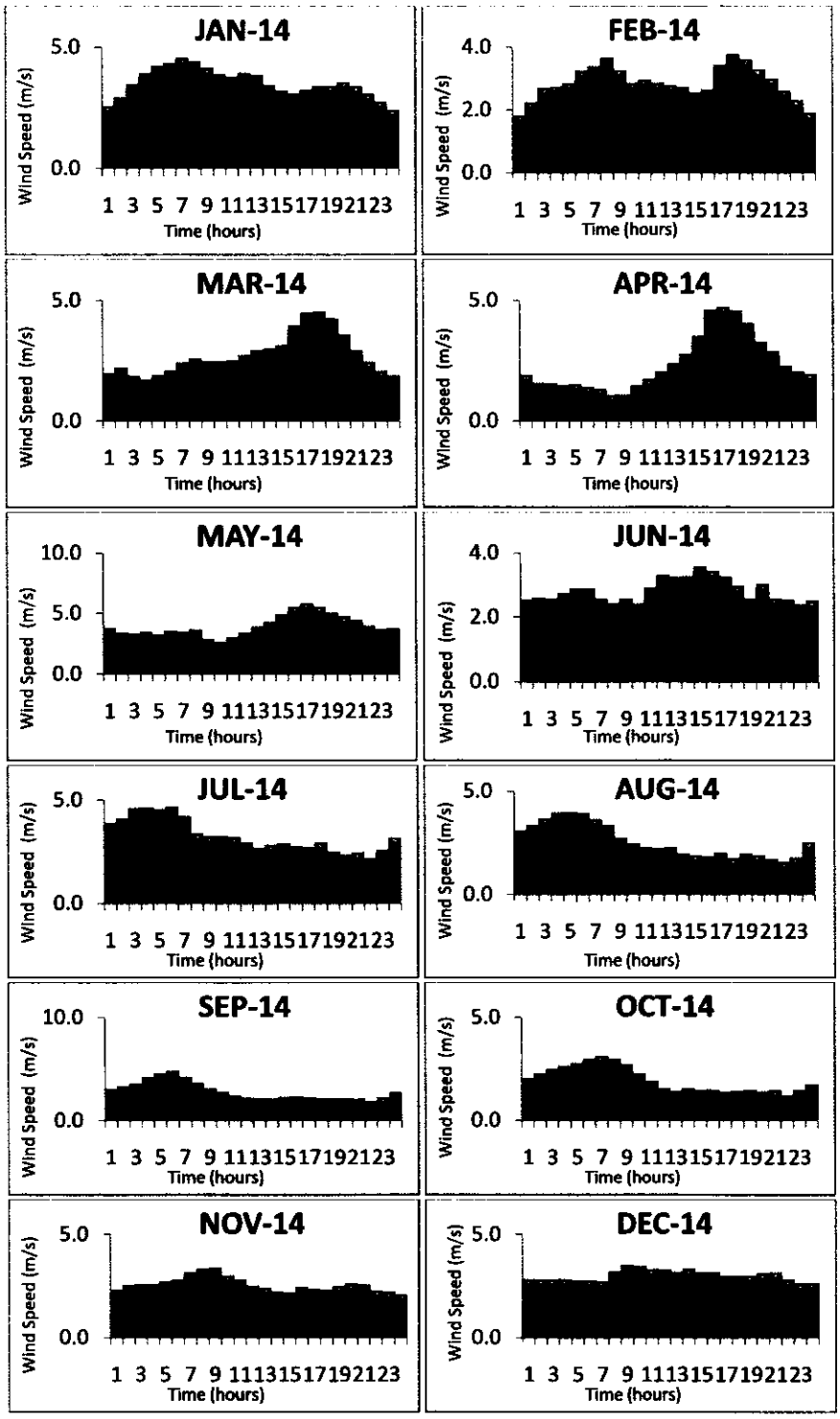
SENSOR HEIGHT: 80m

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



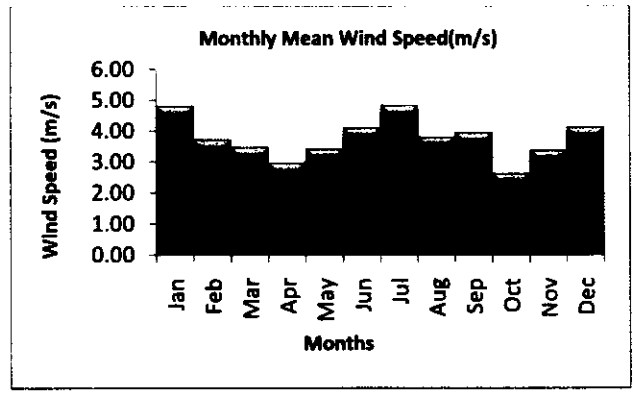
SENSOR HEIGHT: 78m

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

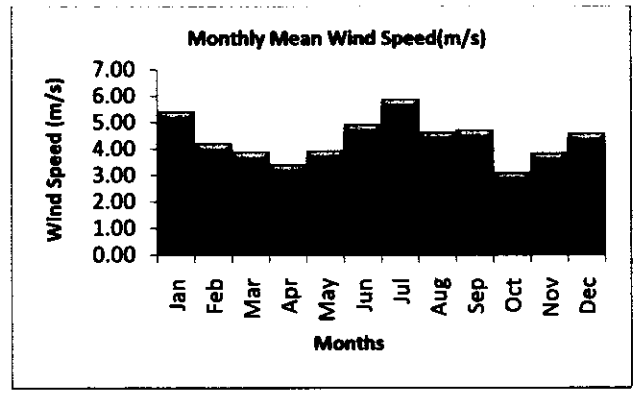


SENSOR HEIGHT: 50m

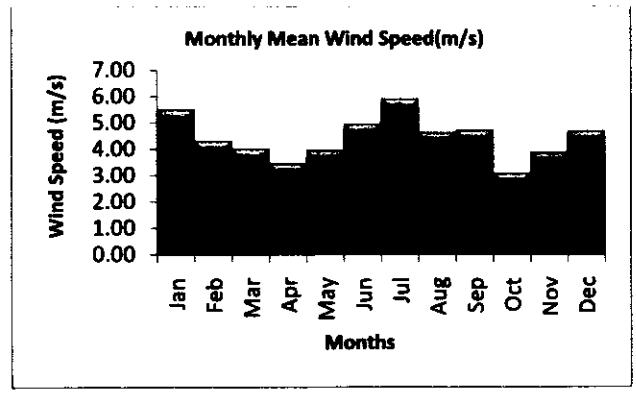
FIGURE 4B: MEAN HOURLY WIND SPEED
(JANUARY 2014 TO DECEMBER 2014)



SENSOR HEIGHT: 50m

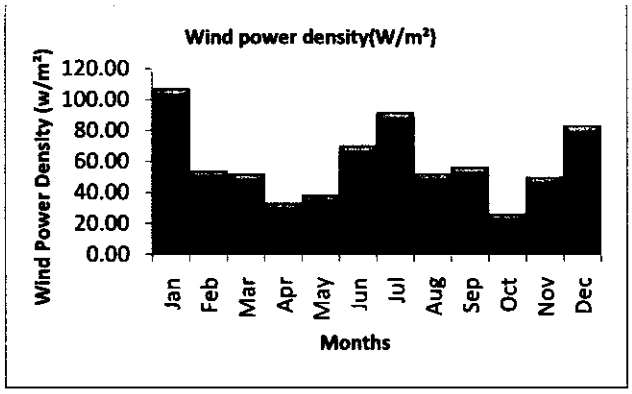


SENSOR HEIGHT: 78 m

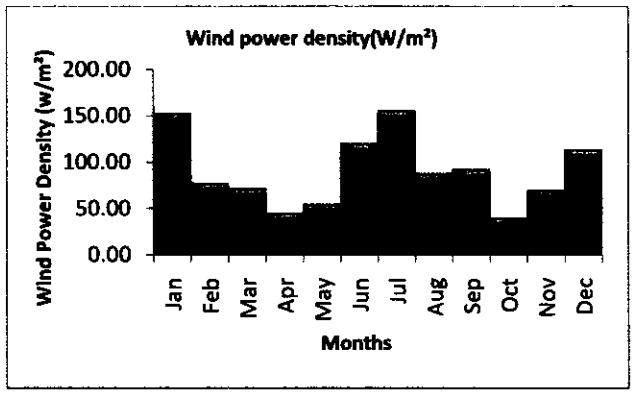


SENSOR HEIGHT: 80m

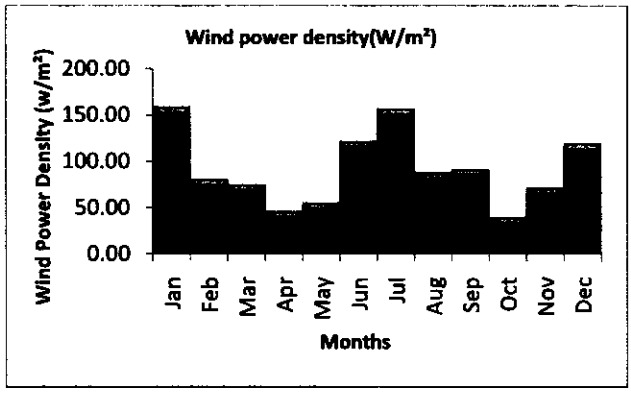
FIGURE 5: MONTHLY MEAN WIND SPEED (JANUARY 2014 TO DECEMBER 2014)



SENSOR HEIGHT: 50m



SENSOR HEIGHT: 78 m



SENSOR HEIGHT: 80m

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

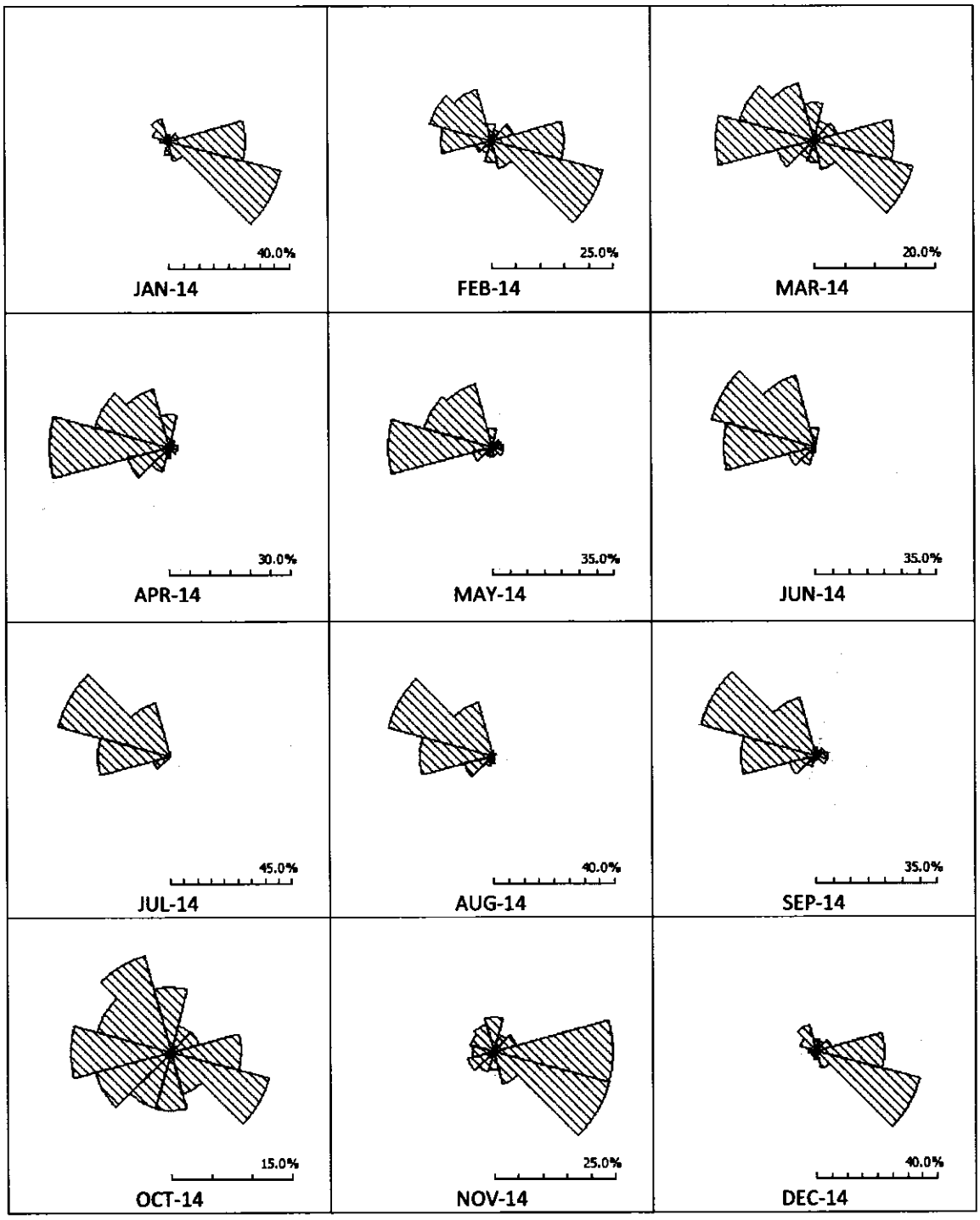


FIGURE 7: WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(January 2014 to December 2014)

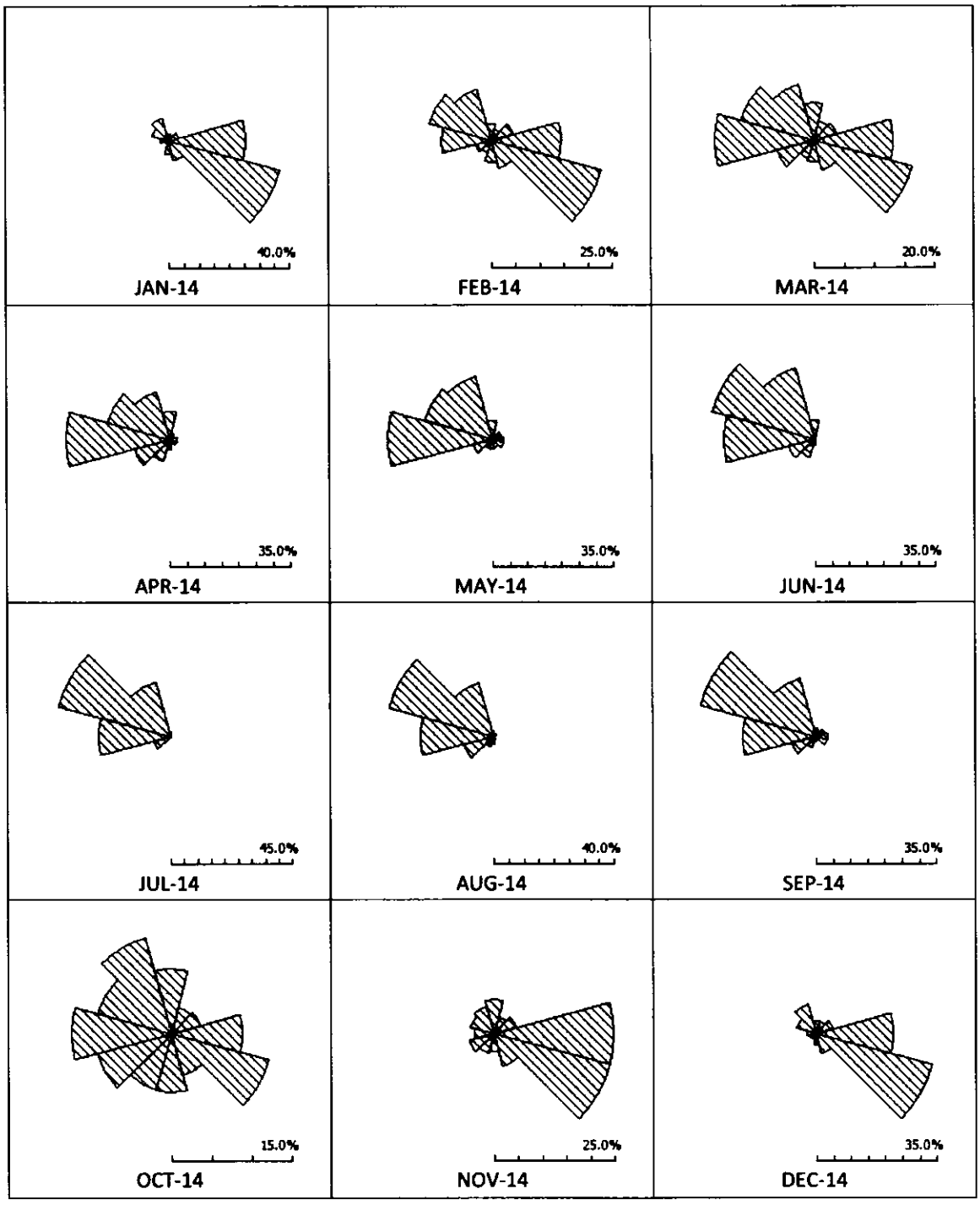


FIGURE 7A: WIND ROSE
SENSOR HEIGHT: (78m Anemometer and 78m Wind vane)
(January 2014 to December 2014)

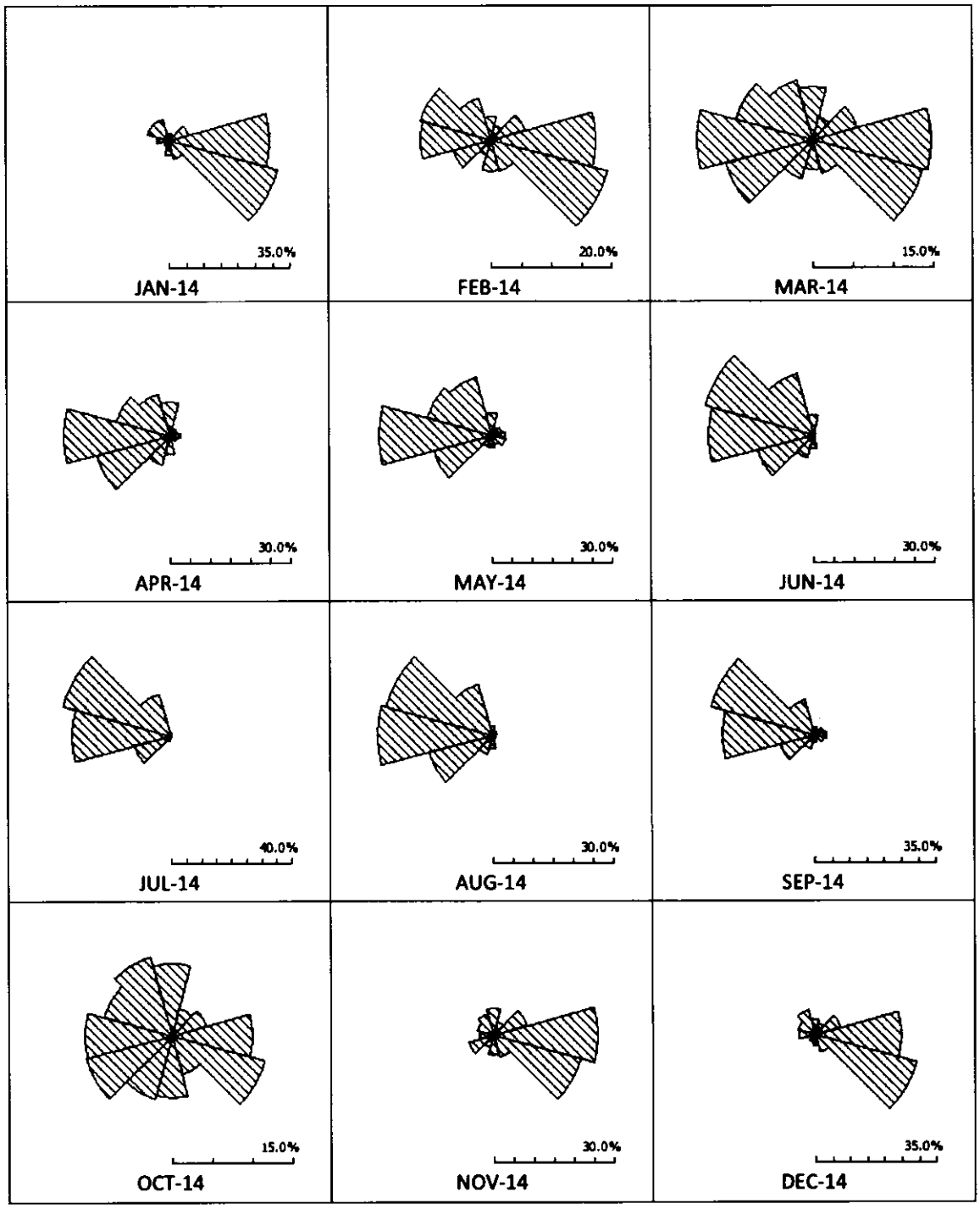


FIGURE 7B: WIND ROSE
SENSOR HEIGHT: (50m Anemometer and 48m Wind vane)
(January 2014 to December 2014)

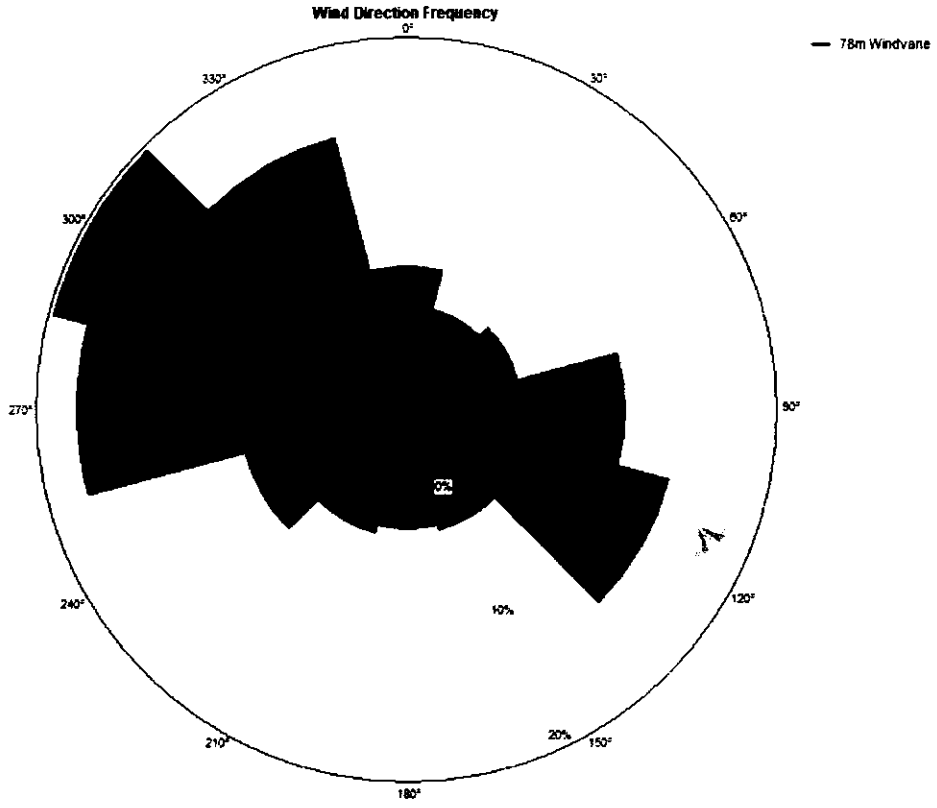
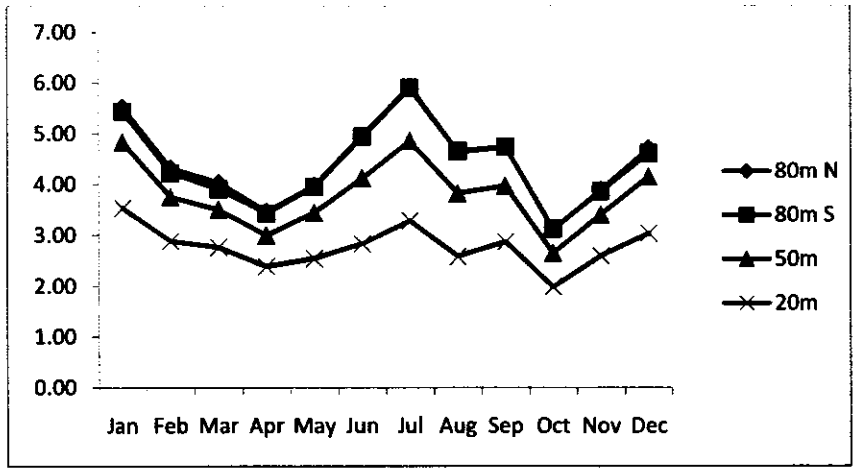
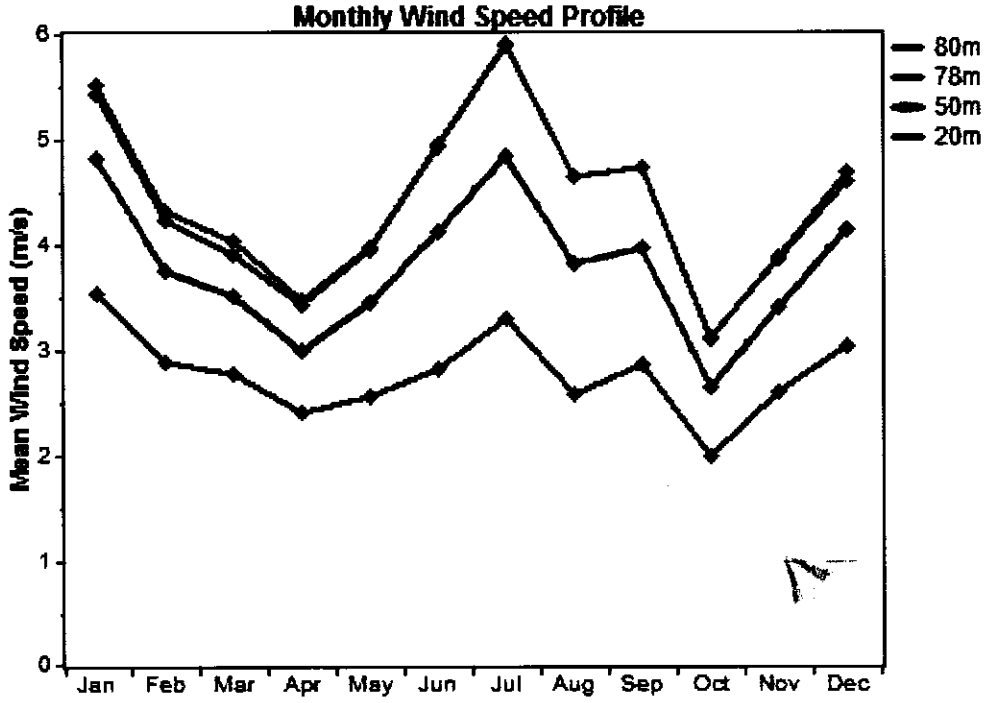


FIGURE 7C: ANNUAL WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(January 2014 to December 2014)



MONTHLY MEAN WIND SPEED
(JANUARY 2014 TO DECEMBER 2014)



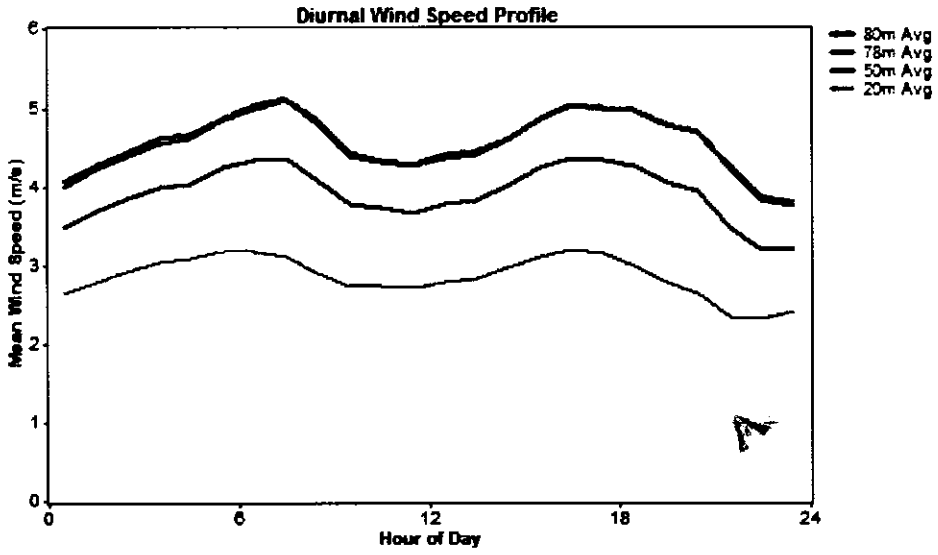


FIGURE 8: MONTHLY WIND SPEED AND DAILY WIND SPEED – CHELAMALA (JANUARY 2014 TO DECEMBER 2014)

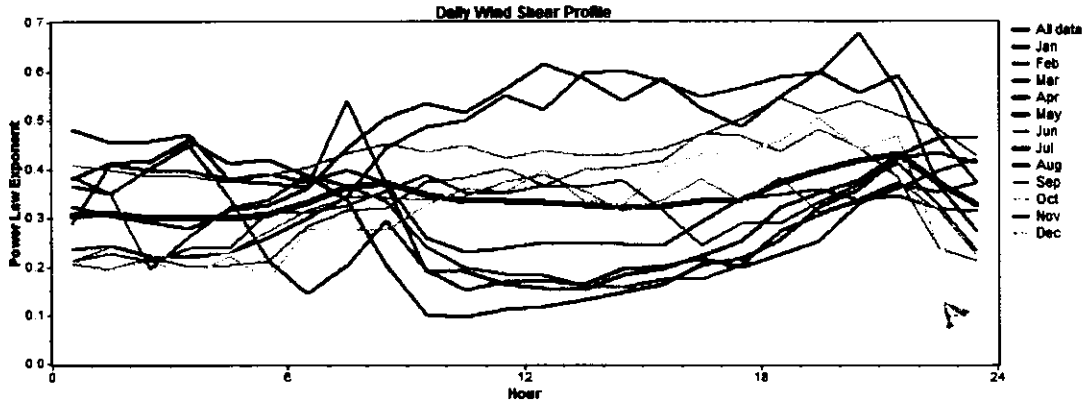


FIGURE 9: DAILY WIND SHEAR-CHELAMALA (JANUARY 2014 TO DECEMBER 2014)

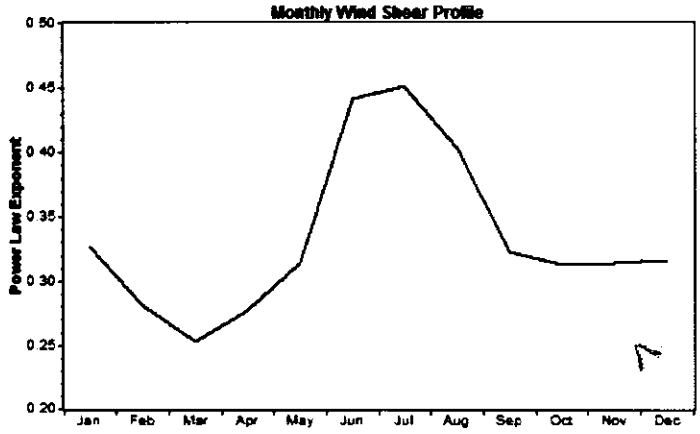


FIGURE 10: MONTHLY WIND SHEAR- CHELAMALA (JANUARY 2014 TO DECEMBER 2014)

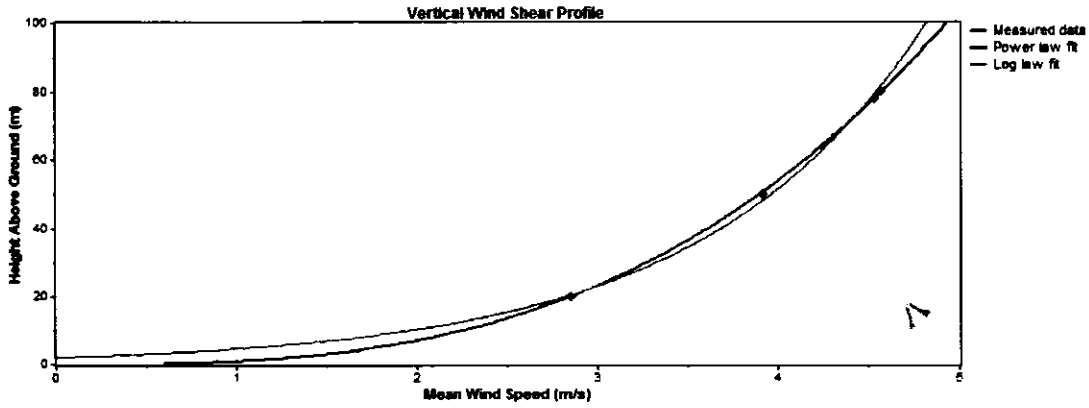
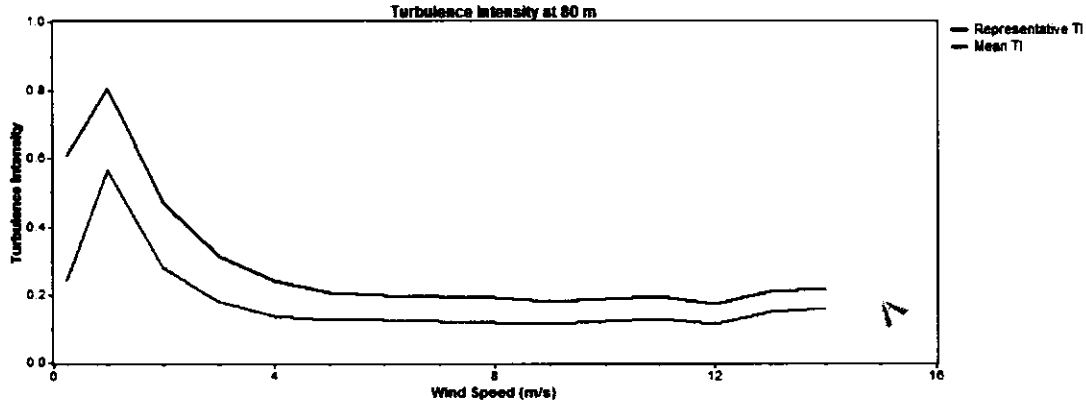
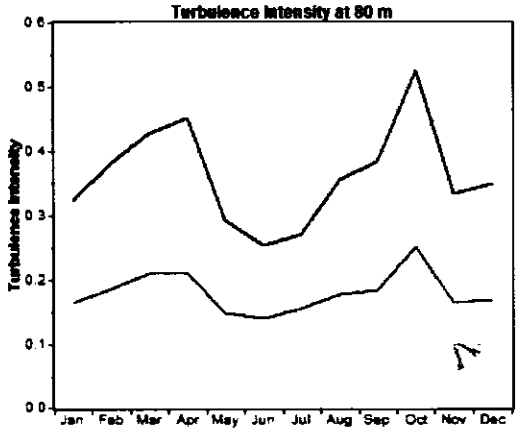
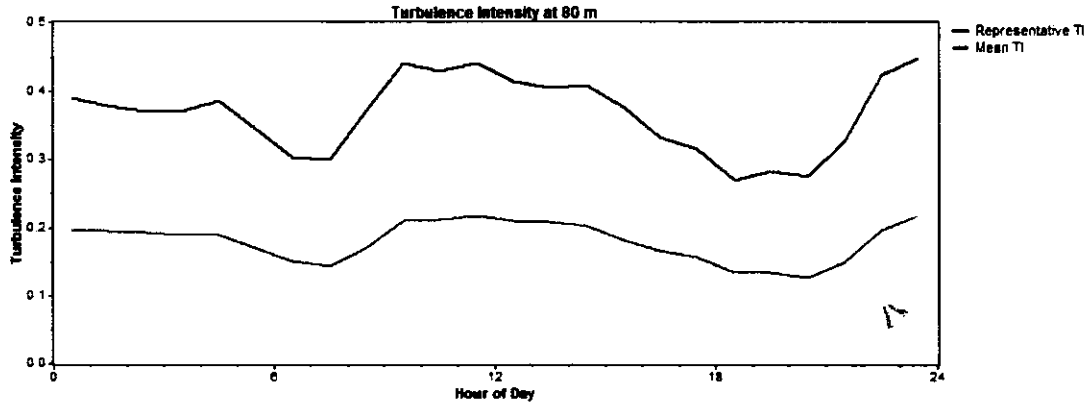


FIGURE 11: VERTICALWIND SHEAR- CHELAMALA (JANUARY 2014 TO DECEMBER 2014)







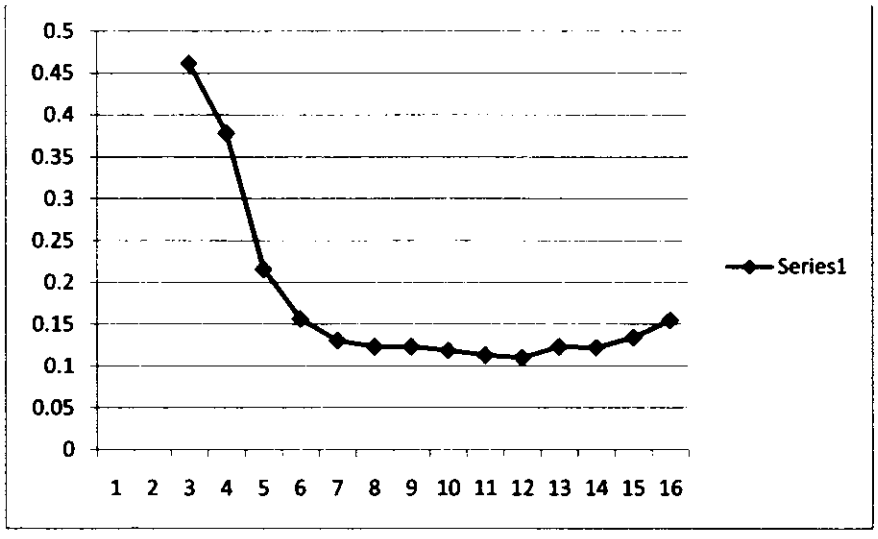


FIGURE 12: TURBULANCE INTENSITY – CHELAMALA (JANUARY 2014 TO DECEMBER 2014)

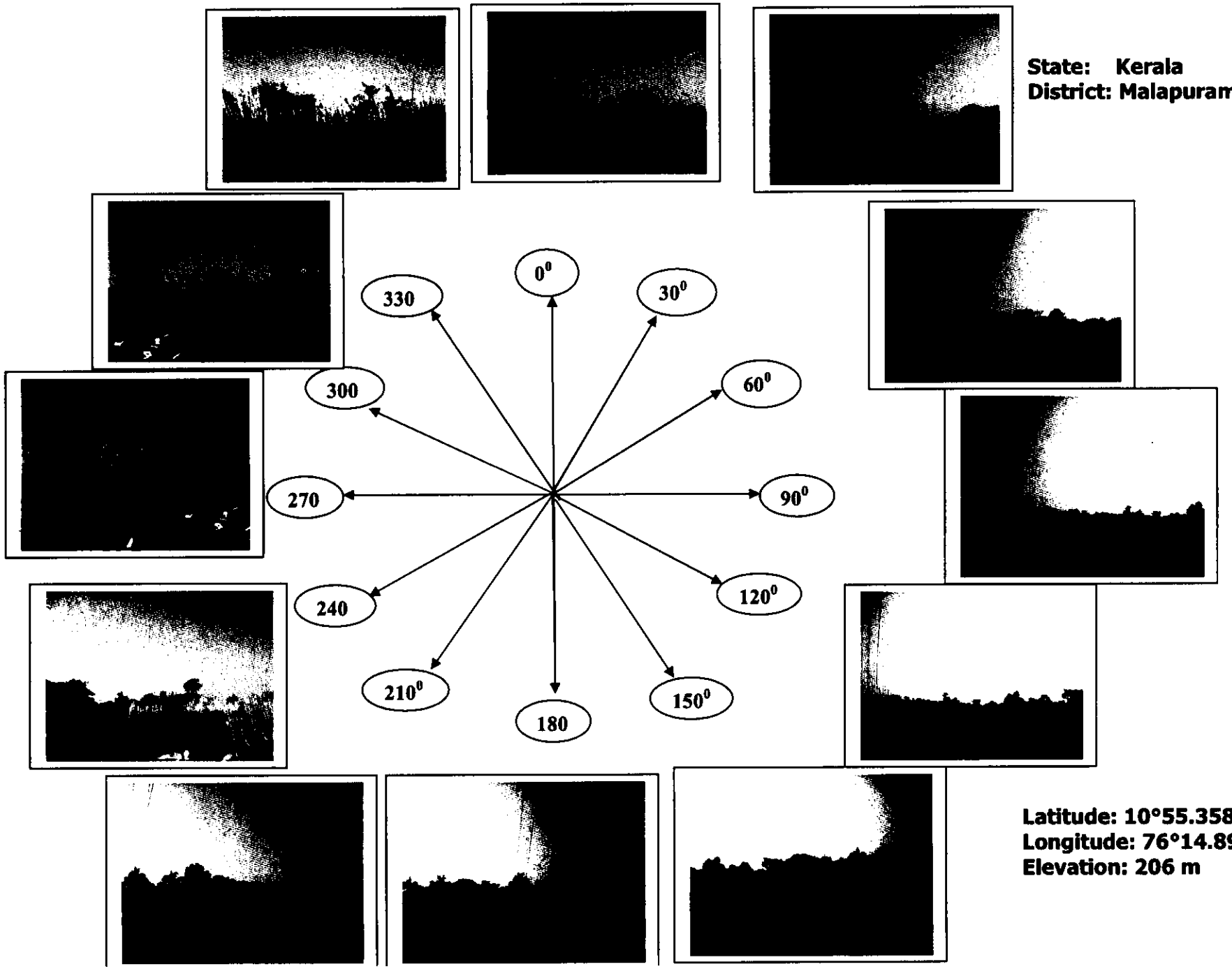
NATIONAL INSTITUTE WIND ENERGY
CHENNAI

Annexure -2

Site Photographs

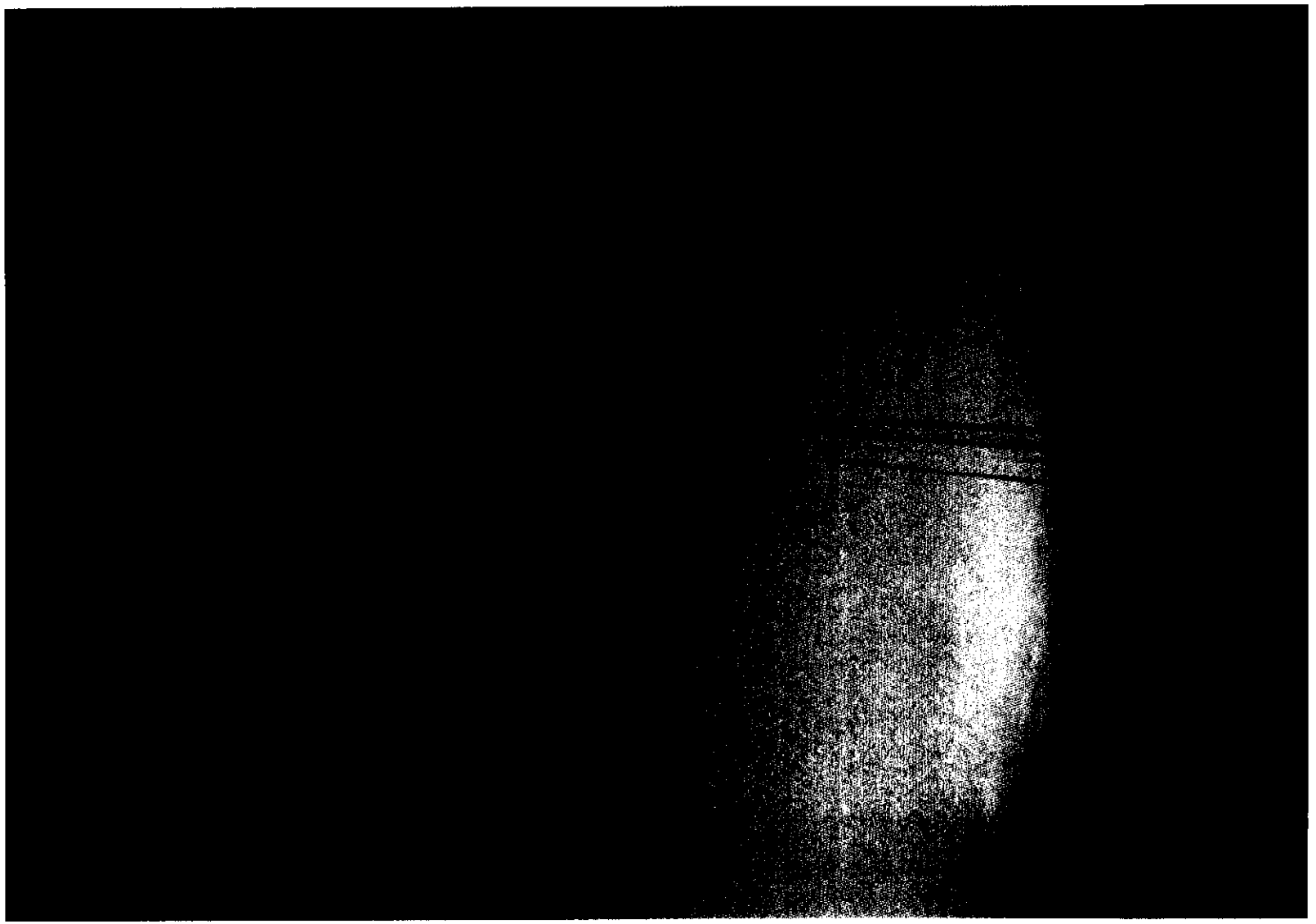
Wind Resource Assessment Unit
National Institute of Wind Energy, Chennai
July 2017

(a) 12 Sector wise photograph of "Chelamala" site



State: Kerala
District: Malapuram

Latitude: 10°55.358′
Longitude: 76°14.89′
Elevation: 206 m



NATIONAL INSTITUTE WIND ENERGY
CHENNAI

Annexure-3

Calibration Reports

Wind Resource Assessment Unit
National Institute of Wind Energy, Chennai
July 2017

Svend Ole Hansen ApS

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WIND
ENGINEERING
FLUID
DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0906 **Date of issue:** February 9, 2011

Type: NRG #40 **Serial number:** 179500166137

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

Calibration equation obtained: v [m/s] = 0.76492 f [Hz] + 0.31972

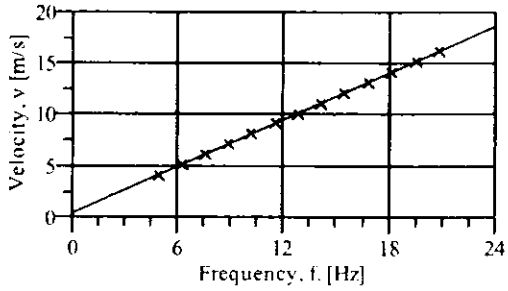
Standard uncertainty, slope: 0.00157 **Standard uncertainty, offset:** 0.05184

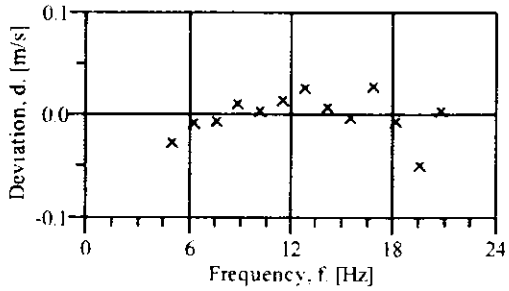
Covariance: -0.0000186 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999986$

Absolute maximum deviation: -0.049 m/s at 15.222 m/s

Barometric pressure: 1014.1 hPa **Relative humidity:** 21.6%

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	9.82	28.4	23.8	4.101	4.9772	-0.026	0.028
4	15.24	28.3	23.8	5.106	6.2684	-0.008	0.032
6	21.83	28.1	23.7	6.111	7.5784	-0.005	0.037
8	29.62	28.0	23.7	7.117	8.8717	0.011	0.042
10	38.63	28.0	23.7	8.127	10.2002	0.005	0.048
12	48.98	27.9	23.7	9.151	11.5269	0.014	0.054
13-last	60.49	27.9	23.7	10.169	12.8418	0.026	0.060
11	72.88	27.9	23.7	11.162	14.1660	0.007	0.065
9	86.48	28.0	23.7	12.162	15.4838	-0.002	0.071
7	101.90	28.1	23.7	13.203	16.8060	0.028	0.077
5	117.86	28.2	23.8	14.202	18.1550	-0.005	0.083
3	135.34	28.3	23.8	15.222	19.5461	-0.049	0.089
1-first	154.23	28.6	23.8	16.256	20.8287	0.004	0.095





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.

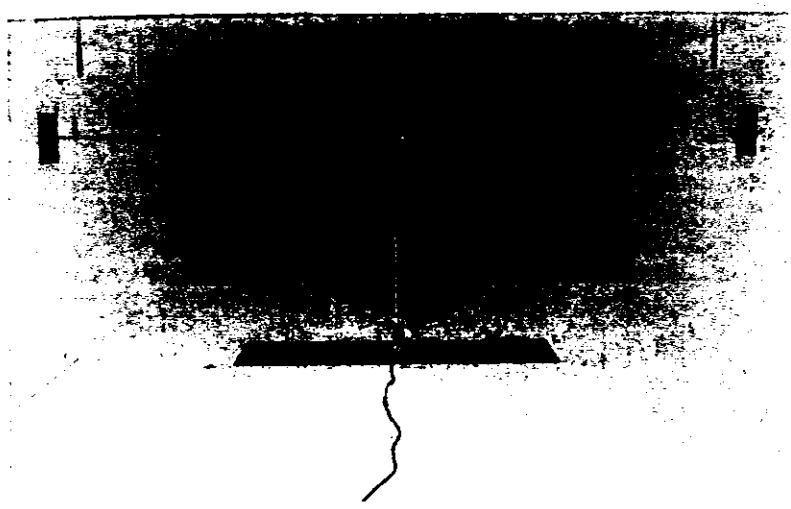


Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

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: 11.02.0906

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WIND
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CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0907 **Date of issue:** February 9, 2011

Type: NRG #40 **Serial number:** 179500166138

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

Calibration equation obtained: v [m/s] = 0.76251 · f [Hz] + 0.32481

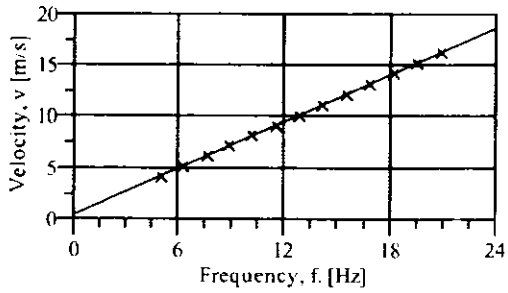
Standard uncertainty, slope: 0.00177 **Standard uncertainty, offset:** 0.05750

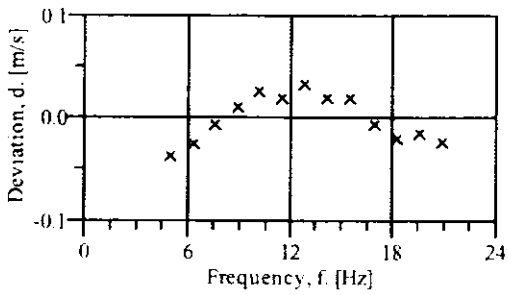
Covariance: -0.0000236 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999983$

Absolute maximum deviation: -0.037 m/s at 4.123 m/s

Barometric pressure: 1014.1 hPa **Relative humidity:** 21.6%

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	9.92	28.5	23.8	4.123	5.0296	-0.037	0.028
4	15.27	28.4	23.8	5.113	6.3125	-0.025	0.032
6	21.96	28.2	23.8	6.130	7.6212	-0.006	0.037
8	29.67	28.2	23.7	7.125	8.9035	0.011	0.042
10	38.65	28.1	23.7	8.130	10.2014	0.027	0.048
12	48.82	28.0	23.6	9.137	11.5320	0.019	0.054
13-last	60.31	28.0	23.5	10.155	12.8479	0.034	0.060
11	72.66	28.0	23.7	11.147	14.1668	0.020	0 065
9	86.65	28.1	23.7	12.175	15.5149	0.020	0.071
7	101.63	28.2	23.8	13.188	16.8770	-0.005	0.077
5	118.14	28.3	23.8	14.221	18.2514	-0.020	0.083
3	135.41	28.5	23.8	15.229	19.5659	-0.015	0.089
1-first	154.03	28.7	23.8	16.249	20.9139	-0.023	0.095





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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	PTB100A Vaisala 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.

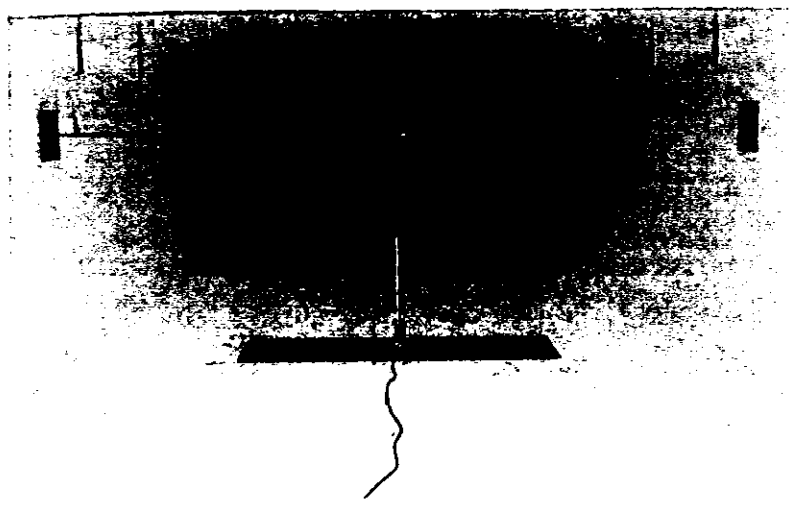

Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one

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: 11.02.0907

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WIND
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CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0927 **Date of issue:** February 10. 2011

Type: NRG #40 **Serial number:** 179500166139

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 9, 2011

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

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

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Calibration equation obtained: v [m/s] = 0.76301 · f [Hz] + 0.31949

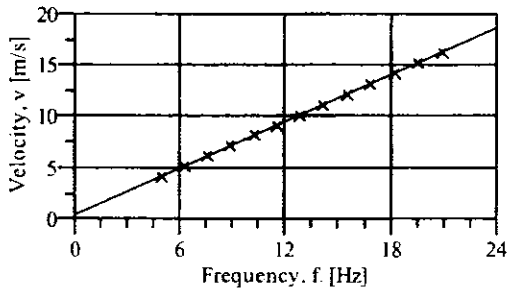
Standard uncertainty, slope: 0.00181 **Standard uncertainty, offset:** 0.05985

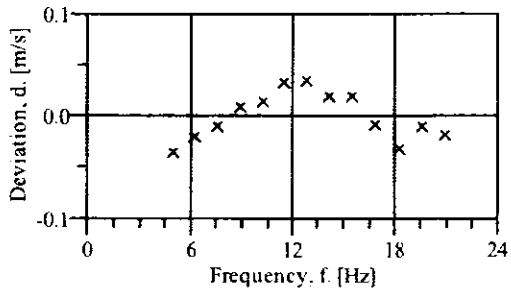
Covariance: -0.0000247 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999982$

Absolute maximum deviation: -0.035 m/s at 4.101 m/s

Barometric pressure: 1021.5 hPa **Relative humidity:** 20.4%

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	9.82	30.4	24.4	4.101	5.0024	-0.035	0.028
4	15.22	30.3	24.3	5.103	6.2938	-0.019	0.032
6	21.73	30.2	24.3	6.097	7.5853	-0.010	0.037
8	29.62	30.1	24.3	7.116	8.8957	0.009	0.043
10	38.79	30.0	24.2	8.143	10.2355	0.014	0.048
12	48.88	30.0	24.2	9.140	11.5169	0.033	0.054
13-last	60.45	29.9	24.2	10.164	12.8554	0.035	0.060
11	72.95	30.0	24.2	11.166	14.1890	0.021	0.066
9	86.60	30.1	24.2	12.168	15.5026	0.020	0.072
7	101.14	30.2	24.3	13.152	16.8295	-0.008	0.077
5	117.67	30.3	24.3	14.189	18.2200	-0.032	0.083
3	135.53	30.4	24.3	15.231	19.5545	-0.009	0.090
1-first	153.92	30.6	24.4	16.237	20.8861	-0.018	0.096





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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.

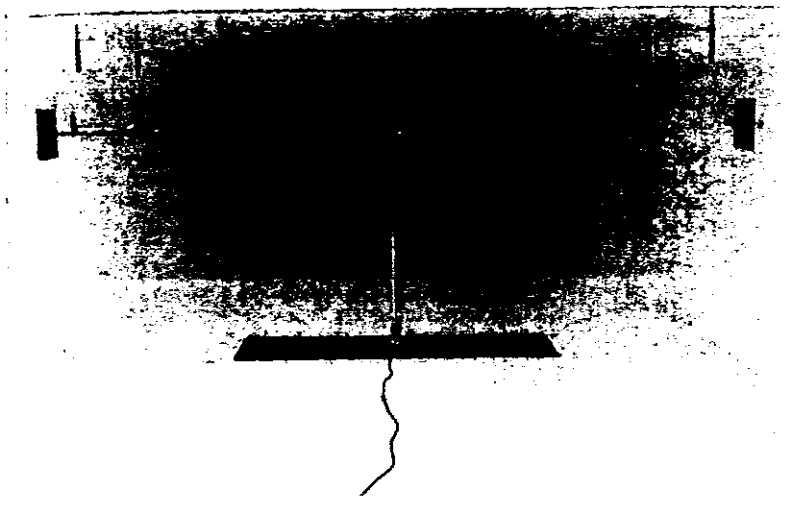

Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

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: 11.02.0927

Svend Ole Hansen ApS

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WIND
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CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0937 **Date of issue:** February 10, 2011

Type: NRG #40 **Serial number:** 179500166140

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 10, 2011

Calibrated by: jj **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] = 0.76425 · f [Hz] + 0.31450

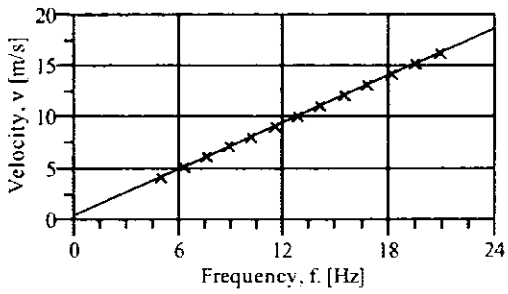
Standard uncertainty, slope: 0.00188 **Standard uncertainty, offset:** 0.06304

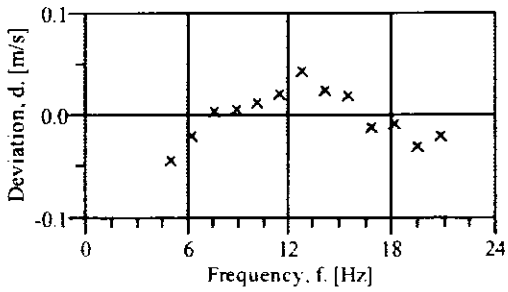
Covariance: -0.0000266 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999981

Absolute maximum deviation: 0.043 m/s at 10.158 m/s

Barometric pressure: 1019.6 hPa **Relative humidity:** 19.5%

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	9.77	31.2	24.0	4.099	5.0084	-0.043	0.028
4	15.17	31.1	24.0	5.106	6.2952	-0.020	0.032
6	21.63	30.9	24.0	6.095	7.5586	0.004	0.037
8	29.45	30.8	23.9	7.111	8.8860	0.005	0.043
10	38.29	30.7	23.9	8.107	10.1794	0.013	0.048
12	48.60	30.7	23.9	9.133	11.5102	0.022	0.054
13-last	60.13	30.6	23.9	10.158	12.8230	0.043	0.060
11	72.56	30.7	23.9	11.159	14.1577	0.025	0.066
9	86.38	30.8	23.9	12.178	15.4978	0.019	0.072
7	100.96	30.9	23.9	13.168	16.8315	-0.010	0.078
5	117.38	31.0	24.0	14.202	18.1814	-0.008	0.084
3	134.61	31.1	24.0	15.211	19.5323	-0.031	0.090
1-first	153.31	31.4	24.0	16.240	20.8631	-0.019	0.096





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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.

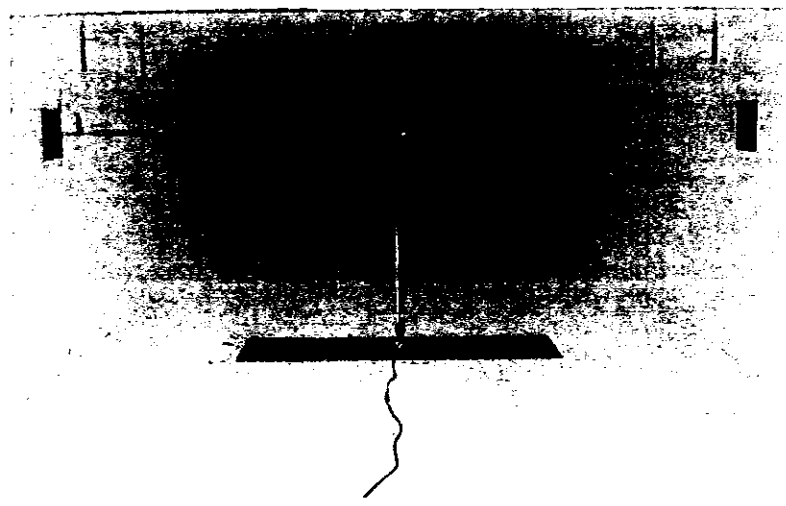

Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

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 02.0937