Mr. Jayalakshmi

30/11

NATIONAL INSTITUTE OF WIND ENERGY

WIND RESOURCE ASSESSMENT UNIT

Chennai-600100

REPORT ON WIND MONITORING STUDY AT KULATHUMEDU, IDUKKI DISTRICT, KERALA

Final Report

Prepared for

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

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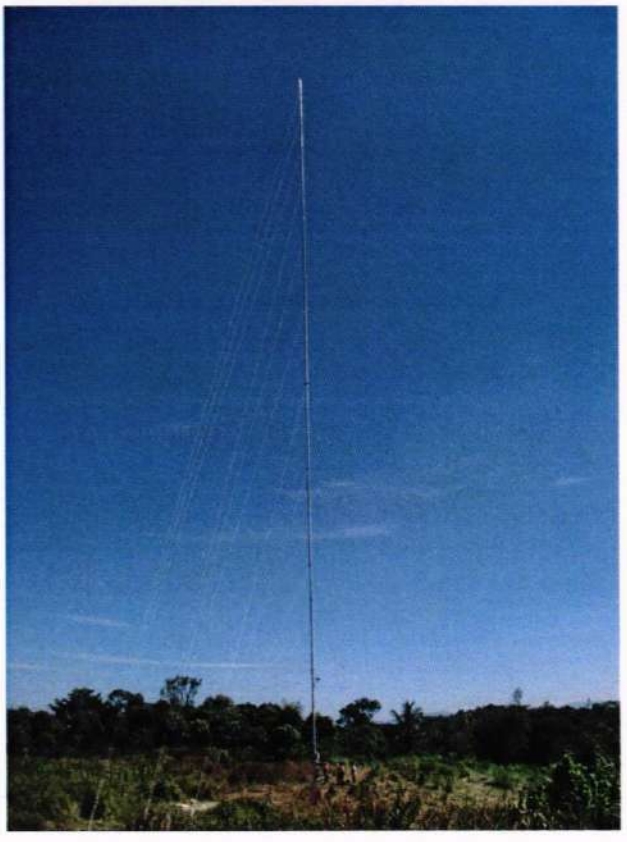
M/s. ANERT.,
THIRUVANANTHAPURAM



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

July 2017

NATIONAL INSTITUTE OF WIND ENERGY

WIND RESOURCE ASSESSMENT UNIT

EXECUTIVE SUMMARY

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

The location Kulathumedu, Idukki 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 10.12.2012 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 98.38%

Based on the analysis of two year data collected at Kulathumedu, the Mean Annual Wind Power Density (MAWPD) at 80m level for the period from January 2013 to December 2013 is found to be 244.22 W/m2 and January 2014 to December 2014 is found to be 212.59 W/m2. The predominant wind direction is found to be West (W) for both 2013 and 2014.

Table of Contents

List of Figures

List of Tables & Annexure

NATIONAL INSTITUTE OF WIND ENERGY

WIND RESOURCE ASSESSMENT UNIT

REPORT ON WIND MONITORING STUDY AT KULATHUMEDU, IDUKKI 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 Kulathumedu, Idukki 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 10.12.2012 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 Kulathumedu, 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 Karunapuram village, Idukki District-Kerala and is approximately 1.48km Southwest from kulathumedu town. The orography of the site is Complex terrain with slightly moderate undulation and the soil type is known to be Laterite.

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

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

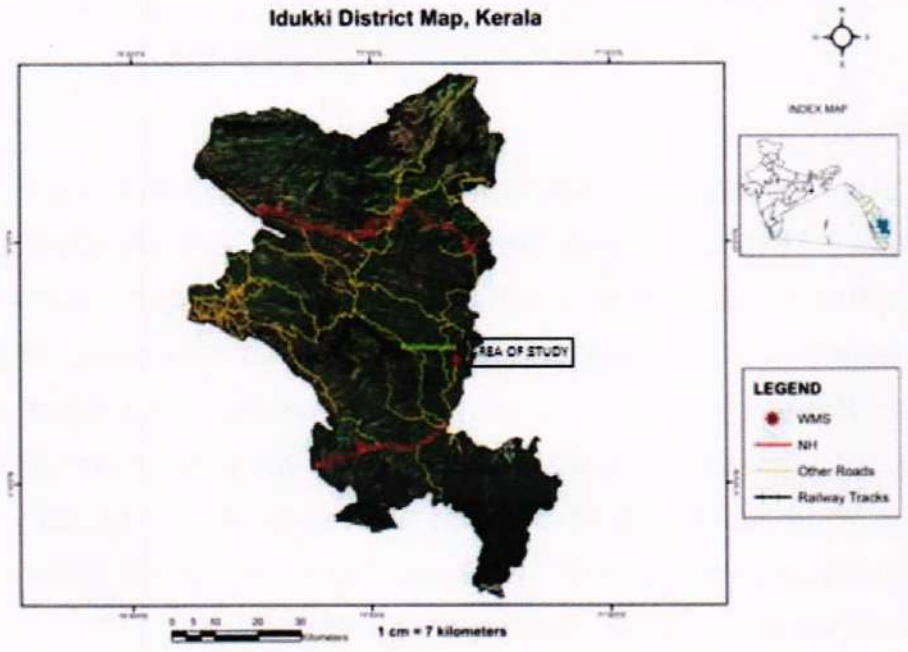

FIGURE 1: DISTRICT MAP OF IDUKKI

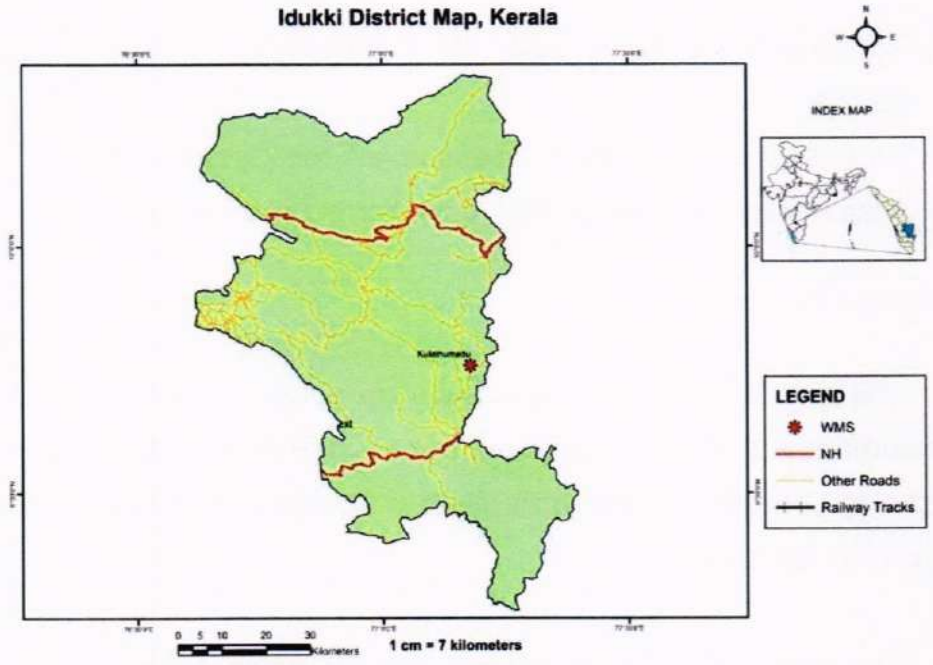

FIGURE.2. MAST LOCATION

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

Latitude	09° 45' 30.2" N
Longitude	077° 10' 41.3" E
Elevation	1095 m AMSL SOI Topomap No.58-G1
State	Kerala
District	Idukki
Taluk	Udumbanchola
Village	Karunapuram
Nearest town	kattapana
Nearest Railway station	Ethumgur
Nearest Airport	Ethumgur
Orography	Complex terrain with moderate undulation.
Soil	Laterite soil
Earthquake	Zone III
Land Use	Vast land
Physiographic Division	Semi Complex Terrain
Nearest NIWE mast location	KULATHUMEDU-1.48 kms aerially towards Southwest Latitude-09°44'42.18" Longitude-77°10'16.4"
Nearest wind farm in operation	Nil

4.0. DESCRIPTION OF THE MASTS &INSTRUMENTATION

A 80m tall guyed tubular wind mast was commissioned on 10.12.2012 A picture of the mast mounting arrangements and a panoramic view taken from the site is presented below (Fig 3).

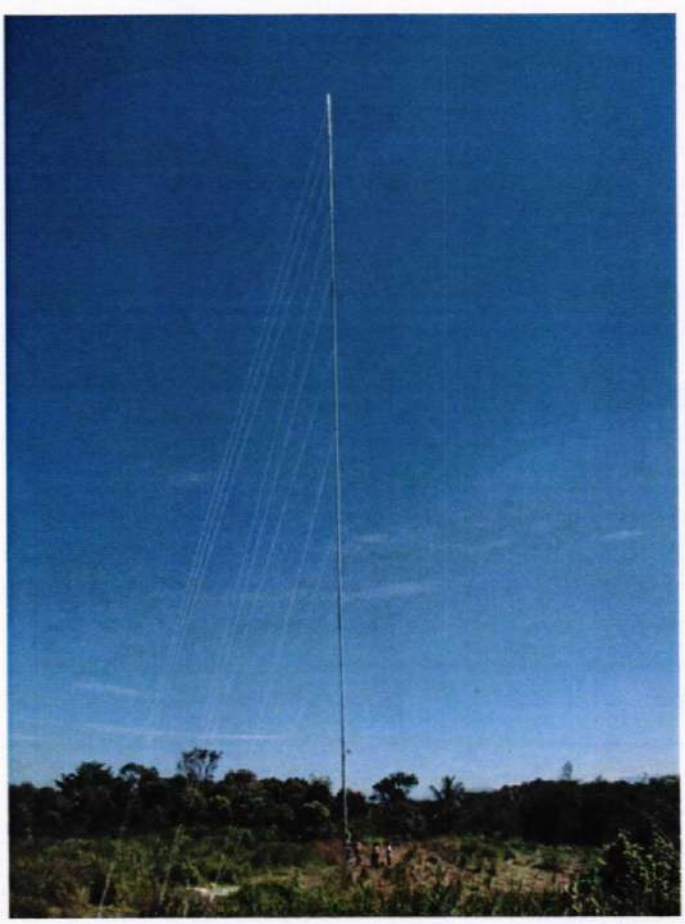

FIG 3. VIEW OF MET MAST

Anemometer (Wind speed sensors) were fixed at 80msouth, 78m south, 50m and 20m and the Wind vane(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 1.5 m above ground level in locked weatherproof housing. The data logger used was imported from M/s. Second Wind Inc, USA. The sensors used were

imported from M/s. NRG systems Inc, USA and the anemometers used were calibrated at M/s. SOHANSEN.DK. Denmark.

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

TABLE 2: DETAILS OF WIND SENSORS USED IN THE SITE

Sensors	Height	Sensor serial Number	Slope	offset
Anemometer	80m south 78m south 50m 20m	179500166133 179500166134 179500166135 179500166136	0.76544 0.76541 0.76166 0.76446	0.32715 0.28802 0.33942 0.31602
Wind Vane	78m 48m	603 604	1.000 1.000	0 0
Temperature sensor	10m	002	-	-
Pressure Sensor	8m	18175	-	-

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. Thecollected 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, 78msouth and 80m south) are shown in Figure 8 of Annexure-1.

6.0. DETAILS OF DATA ANALYSED

The Wind Monitoring Station was commissioned at Kalathumedu, Idukki 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 2014that the data collection would be completed and terminates in the month of January 2015.

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

Mean Hourly Wind Speed, Monthly Mean Wind Speed and Monthly Wind Power Density values are shown graphically in Figure 4 to 6respectively of Annexure-1. The Mean Hourly Wind Speed tables for the four heights viz., 20m, 50m, 78m south and 80m south are given in Table6, 6A, 6B & 6C of Annexure-1. The graphical representations for the same are given in Figure 4, 4A and 4Bof Annexure-1.

7.0. RESULTS

The data recovery rate is 98.38%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	69.36	175.64	235.22	244.22
2013-2014	58.52	154.15	203.71	212.59

Year	Mean Annual Wind Speed (m/s)			
	At height 20m (AGL)	At height 50m (AGL)	At height 78m south (AGL)	At height 80m south (AGL)
2012-2013	4.14	5.78	6.42	6.49
2013-2014	3.89	5.60	6.14	6.21

Year	Mean Annual		
	Temperature ^{0} C	Air density Kg/m^3	Power law
2012-2013	20.53	1.052	0.33
2013-2014	20.31	1.051	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 and7Cof Annexure-1show the month wise percentage frequency distribution for the four measurement heights viz., 20m, 50m, 78m south and 80msouth.

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-1show the monthly wind roses at 80m south, 78m south and 50mheights. From the wind roses, it is revealed that the wind is flowing predominantly from West (W) directions.

7.3. WIND SHEAR PROFILE

The wind shear profile at the site is useful to understand the wind speed variation with height. Figure 9 & 10 of Annexure-1 shows 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) at15m/s is 0.17 (17%)& January 2014 to December 2014 (at 80m AGL) at 15m/s is 0.17 (17%).

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 2014at 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*

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
2004	3.0	2.8	2.5	1.7	4.3	5.7	5.3	5.6	3.4	3.0	3.3	3.6	3.7
2005	2.7	2.8	2.1	1.7	3.0	5.4	5.7	5.0	4.8	2.6	2.4	2.6	3.4
2006	3.5	2.9	1.9	1.8	3.7	4.9	5.6	4.8	4.2	2.8	2.2	3.7	3.5
2007	3.7	2.8	2.2	1.6	3.7	5.0	5.3	4.6	4.5	2.8	2.2	3.6	3.5
2008	3.0	2.5	2.6	1.9	3.9	5.1	5.2	4.2	4.3	2.5	2.2	3.2	3.4
2009	3.2	2.8	2.0	2.6	3.7	5.4	5.9	4.5	4.5	2.7	2.6	3.0	3.6
2010	3.0	2.6	2.5	1.8	3.6	5.3	5.4	5.3	3.4	3.4	2.1	2.7	3.4
2011	3.1	2.4	2.2	1.9	3.6	5.3	5.3	5.1	4.4	2.4	2.7	3.0	3.5
2012	3.0	3.2	2.3	2.1	3.7	5.1	5.2	4.8	4.2	2.7	2.4	3.6	3.5
2013	3.2	3.0	2.5	2.0	3.6	5.8	5.9	4.6	4.5	3.0	2.2	3.0	3.6
2014	3.0	2.4	2.6	1.8	2.8	5.4	5.9	4.8	3.8	2.1	2.8	3.1	3.4
						AVG							3.5

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

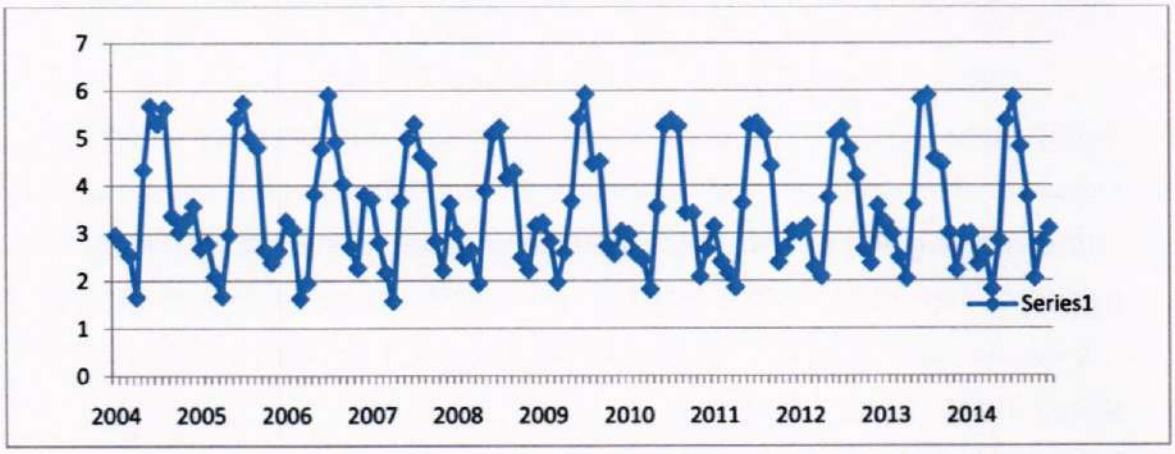

FIGURE.3A. MERRA REANALYSIS DATA FOR KULATHUMEDU, KERALA (JANUARY 2004 – DECEMBER 2014)

8.0. CONCLUSION

Based on the analysis of two year data collected at Kulathumedu, the Mean Annual Wind Power Density (MAWPD) at 80m level for the period from January 2013 to December 2013 is found to be 244.22W/$m^2$and January 2014 to December 2014 is found to be 212.59 W/m^2.

The monthly average wind speed at 80m level for the period from January 2013 to December 2013 is found to be6.49 m/s and January 2014 to December 2014 is found to be 6.21 m/s. The predominant wind direction is found to be West for both years.

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

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KULATHUMEDU

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 WIND ENERGY
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KULATHUMEDU

STATE	:	KERALA
DISTRICT	:	IDUKKI
TALUK	:	UDUMBANCHOLA
VILLAGE	:	KARUNAPURAM
LATITUDE	:	09° 45' 30.2" N
LONGITUDE	:	077° 10' 41.3" E
ELEVATION	:	1095M AMSL
INSTRUMENTS USED	:	NOMAD-2
PERIOD OF DATA	:	JANUARY 2013 to DECEMBER 2014
COMMISSIONED ON	:	10.12.2012
MAST HEIGHT	:	80m
MEASURED WIND SPEED AT 80m south AGL (January 2013 to December 2013)	:	6.49 m/s
MEASURED WIND SPEED AT 78m south AGL (January 2013 to December 2013)	:	6.42 m/s
MEASURED WIND SPEED AT 50m AGL (January 2013 to December 2013)	:	5.78 m/s
MEASURED WIND POWER DENSITY AT 80m south AGL (January 2013 to December 2013)	:	244.22 W/m^2
MEASURED WIND POWER DENSITY AT 78m south AGL (January 2013 to December 2013)	:	235.23 W/m^2
MEASURED WIND POWER DENSITY AT 50m AGL (January 2013 to December 2013)	:	175.64 W/m^2
MEASURED WIND SPEED AT 80m south AGL (January 2014 to December 2014)	:	6.21 m/s

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MEASURED WIND SPEED AT 78m south AGL (January 2014 to December 2014)	***:***	***6.14 m/s***
MEASURED WIND SPEED AT 50m AGL (January 2014 to December 2014)	***:***	***5.60 m/s***
MEASURED WIND POWER DENSITY AT 80m south AGL (January 2014 to December 2014)	***:***	***212.59 W/m^2***
MEASURED WIND POWER DENSITY AT 78m south AGL (January 2014 to December 2014)	***:***	***203.71 W/m^2***
MEASURED WIND POWER DENSITY AT 50m AGL (January 2014 to December 2014)	***:***	***154.15 W/m^2***
SOI TOPO MAP NUMBER	***:***	***58-G1***

Ist Year

Jan 2013 - Dec 2013

KULATHUMEDU

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	3.54	3.26	2.88	2.43	3.85	6.64	7.03	5.42	4.85	3.71	2.82	3.25	4.14
50m	5.19	4.67	4.01	3.33	5.36	9.03	9.49	7.49	6.67	5.21	4.12	4.76	5.78
78 m	5.92	5.33	4.74	3.82	5.93	9.91	10.40	8.18	7.23	5.63	4.62	5.35	6.42
80m	6.01	5.40	4.75	3.86	6.02	10.04	10.54	8.32	7.31	5.71	4.60	5.36	6.49
Monthly Wind Power Density (Watts/Sq.m)													
20m	33.54	29.59	22.94	13.18	39.59	184.24	210.98	125.19	79.25	36.95	23.83	33.00	69.36
50m	99.58	80.49	61.06	31.18	101.51	454.21	510.43	314.27	198.29	95.92	66.83	93.46	175.60
78 m	144.26	114.69	92.91	44.16	135.41	600.33	672.86	413.92	254.66	120.75	94.81	133.34	235.18
80m	150.55	119.63	95.73	45.66	142.11	620.83	698.67	433.21	263.78	125.91	97.74	136.79	244.22
Power Law Index (PLI)													
	0.38	0.36	0.36	0.33	0.32	0.30	0.29	0.31	0.30	0.31	0.35	0.36	0.33
Energy Pattern Factor													
20m	1.46	1.62	1.83	1.76	1.32	1.23	1.15	1.49	1.32	1.38	2.03	1.82	1.53
50m	1.38	1.50	1.81	1.62	1.26	1.21	1.14	1.42	1.27	1.29	1.81	1.63	1.45
78 m	1.34	1.44	1.67	1.51	1.24	1.21	1.13	1.44	1.28	1.28	1.83	1.64	1.42
80m	1.34	1.44	1.70	1.52	1.24	1.20	1.13	1.43	1.28	1.29	1.90	1.67	1.43
Air Density (kg/m^3)													
	1.035	1.050	1.048	1.044	1.045	1.053	1.054	1.052	1.053	1.053	1.054	1.059	1.050
Temperature (^{0} C)													
	--	20.72	22.15	23.04	22.12	19.26	19.13	20.00	19.76	20.27	20.29	19.04	20.53
Turbulance Intensity (at 80m agl)													
At 15m/s : 0.17													
Data Availability (Based on 10 Minutes Interval)													
	4464	4032	4464	4320	4344	4320	4464	2883	4320	4464	4320	4464	

Based on Data January 2013 to December 2013

TABLE 5

KULATHUMEDU

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)	(80m)	(78m)	(50m)	(80m)	(78m)	(50m)	(80m)	(78m)	(50m)	(80m)
5.19	6.01	5.92	0.88	0.82	0.81	13.40 16-01-2013 03:30	15.70 16-01-2013 03:40	15.44 16-01-2013 03:40	E	NE
4.67	5.4	5.33	0.85	0.81	0.8	11.70 11-02-2013 10:20	12.60 11-02-2013 10:20	12.45 11-02-2013 10:20	E	NE
4.01	4.75	4.74	0.82	0.77	0.75	11.42 05-03-2013 21:20	13.63 05-03-2013 21:20	13.40 05-03-2013 21:20	E	NE
3.33	3.86	3.82	0.69	0.64	0.64	11.51 29-04-2013 17:20	12.37 29-04-2013 17:20	12.60 29-04-2013 17:20	NW	W
5.36	6.02	5.93	0.96	0.96	0.95	10.42 25-05-2013 13:30	11.44 29-05-2013 13:40	11.27 25-05-2013 5:10	W	W
9.03	10.04	9.91	1.75	1.76	1.68	15.45 11-06-2013 10:50	17.29 11-06-2013 10:50	17.11 11-06-2013 10:50	W	W
9.49	10.54	10.4	1.84	1.93	1.92	15.40 30-07-2013 11:30	17.04 16-07-2013 12:30	16.87 16-07-2013 12:30	W	W
7.49	8.32	8.18	1.29	1.35	1.36	18.54 02-08-2013 06:30	20.51 02-08-2013 06:30	20.12 02-08-2013 06:30	W	W
6.67	7.31	7.23	1.20	1.24	1.24	13.78 19-09-2013 13:30	15.10 17-09-2013 19:50	14.93 17-09-2013 19:50	W	W
5.21	5.71	5.63	0.90	0.92	0.92	10.18 12-10-2013 03:30	11.44 12-10-2013 03:30	11.29 12-10-2013 03:30	W	W
4.12	4.6	4.62	0.78	0.77	0.74	11.70 04-11-2013 21:30	13.37 04-11-2013 21:30	13.19 04-11-2013 21:30	NE/E	NE
4.76	5.36	5.35	0.84	0.83	0.80	12.90 24-12-2013 08:10	14.83 24-12-2013 08:10	14.68 24-12-2013 08:10	E	NE
5.78	**6.49**	**6.42**	**1.07**	**1.07**	**1.05**	**18.54 02-08-2013 06:30**	**20.51 02-08-2013 06:30**	**20.12 02-08-2013 06:30**	**W**	**W**

Based on Data January 2013 to December 2013

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TABLE 6

KULATHUMEDU

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	6.1	5.9	5.9	6.1	6.1	6.1	6.0	6.4	5.9	6.0	6.4	6.6	6.3	6.0	5.7	5.6	5.4	5.5	5.6	5.8	6.2	6.4	6.3	6.1	6.0
FEB	5.1	4.9	4.6	4.7	4.9	5.1	5.0	5.1	4.9	5.5	6.1	6.4	6.4	6.2	5.9	5.9	5.7	5.5	5.2	5.4	5.4	5.4	5.3	5.2	5.4
MAR	4.6	4.6	4.6	4.5	4.7	4.6	4.4	4.3	4.0	4.3	4.7	5.0	5.2	5.2	5.1	5.2	5.0	4.9	5.1	5.0	4.7	5.0	4.8	4.5	4.8
APR	3.3	3.2	3.5	3.4	3.5	3.5	3.3	2.9	2.7	3.1	3.4	3.6	3.9	4.3	4.7	5.1	5.1	5.2	4.7	4.6	4.4	4.1	3.8	3.6	3.9
MAY	5.9	5.7	6.0	5.9	5.9	6.0	6.1	6.0	5.9	5.8	5.9	5.5	5.5	5.8	6.1	6.1	6.2	6.3	6.4	6.6	6.6	6.1	5.9	5.9	6.0
JUN	9.6	9.6	9.6	9.5	9.7	9.6	9.6	9.4	9.7	10.0	10.3	10.5	10.6	10.1	10.1	10.3	10.3	10.2	10.2	9.7	9.5	9.8	10.0	9.5	9.9
JUL	10.7	10.6	10.5	10.8	11.0	10.7	10.6	10.4	10.4	10.7	10.5	10.4	10.4	10.6	10.2	10.3	10.2	10.6	10.7	10.4	10.7	10.7	10.3	10.7	10.5
AUG	8.2	8.1	8.2	8.5	8.3	8.5	8.5	8.6	8.6	8.7	8.7	8.4	8.6	8.8	8.6	8.6	8.5	8.9	9.0	8.6	8.3	8.3	8.2	7.8	8.5
SEP	7.2	7.1	7.2	7.1	7.3	7.1	7.0	6.9	6.7	6.4	7.0	7.0	7.4	7.6	7.9	7.9	7.7	7.8	7.8	7.6	7.6	7.5	7.4	7.4	7.3
OCT	5.4	5.2	5.3	5.5	5.5	5.8	5.6	5.4	5.1	5.5	5.6	5.8	5.8	6.0	6.3	6.5	6.1	6.0	5.9	6.0	5.9	5.5	5.6	5.5	5.7
NOV	4.4	4.9	5.1	5.0	4.6	4.6	4.6	4.7	4.6	4.6	4.9	5.0	4.6	4.5	4.5	4.3	4.2	4.1	4.4	4.4	4.6	4.6	4.6	4.6	4.6
DEC	5.2	5.0	4.8	5.2	5.3	5.4	5.5	5.7	5.5	5.4	5.4	5.5	5.6	5.5	5.3	5.2	5.2	5.0	5.3	5.5	5.4	5.6	5.7	5.5	5.4
Annual	6.3	6.2	6.3	6.3	6.4	6.4	6.4	6.3	6.2	6.3	6.6	6.6	6.7	6.7	6.7	6.8	6.6	6.7	6.7	6.6	6.6	6.6	6.5	6.4	6.5

SENSOR HEIGHT: 80m

Based on Data January 2013 to December 2013

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

TABLE 6A

KULATHUMEDU

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	6.0	5.8	5.8	6.0	6.0	6.0	5.9	6.3	5.8	5.9	6.3	6.5	6.2	6.0	5.7	5.6	5.3	5.4	5.5	5.7	6.0	6.3	6.2	5.9	5.9
FEB	5.0	4.9	4.6	4.6	4.9	5.0	5.0	5.0	4.8	5.4	6.1	6.4	6.3	6.1	5.8	5.8	5.6	5.4	5.1	5.3	5.3	5.3	5.2	5.2	5.3
MAR	4.6	4.6	4.6	4.6	4.7	4.5	4.4	4.4	4.0	4.3	4.7	5.0	5.2	5.2	5.1	5.2	5.0	4.9	5.1	4.9	4.7	4.9	4.8	4.5	4.7
APR	3.2	3.1	3.5	3.3	3.4	3.4	3.2	2.8	2.6	3.1	3.4	3.6	3.8	4.2	4.7	5.1	5.0	5.1	4.6	4.5	4.4	4.1	3.8	3.5	3.8
MAY	5.8	5.6	5.9	5.8	5.8	5.9	6.0	5.9	5.8	5.8	5.8	5.4	5.4	5.7	6.0	6.1	6.2	6.2	6.4	6.5	6.5	6.0	5.8	5.8	5.9
JUN	9.5	9.5	9.5	9.4	9.5	9.5	9.5	9.2	9.6	9.9	10.1	10.4	10.4	10.0	10.0	10.1	10.2	10.1	10.1	9.6	9.3	9.7	9.9	9.4	9.8
JUL	10.5	10.5	10.4	10.6	10.8	10.6	10.4	10.2	10.2	10.5	10.4	10.2	10.3	10.5	10.1	10.2	10.1	10.5	10.6	10.3	10.5	10.5	10.1	10.6	10.4
AUG	8.1	7.9	8.1	8.4	8.2	8.3	8.4	8.4	8.5	8.6	8.5	8.3	8.4	8.7	8.5	8.4	8.4	8.7	8.9	8.5	8.2	8.2	8.0	7.7	8.3
SEP	7.1	7.0	7.1	7.0	7.2	7.0	7.0	6.8	6.6	6.3	7.0	7.0	7.4	7.5	7.8	7.8	7.6	7.7	7.7	7.5	7.5	7.4	7.3	7.3	7.2
OCT	5.4	5.1	5.2	5.4	5.4	5.7	5.5	5.3	5.0	5.5	5.5	5.7	5.8	5.9	6.2	6.4	6.1	6.0	5.9	5.9	5.8	5.5	5.6	5.4	5.6
NOV	4.5	4.9	5.0	5.0	4.7	4.7	4.6	4.8	4.6	4.7	4.9	5.0	4.6	4.5	4.6	4.3	4.2	4.1	4.4	4.4	4.6	4.7	4.6	4.6	4.6
DEC	5.2	5.0	4.8	5.2	5.3	5.5	5.6	5.7	5.5	5.5	5.4	5.5	5.5	5.5	5.3	5.1	5.2	5.0	5.3	5.4	5.4	5.6	5.6	5.4	5.4
Annual	6.2	6.2	6.2	6.3	6.3	6.3	6.3	6.2	6.1	6.3	6.5	6.6	6.6	6.7	6.6	6.7	6.6	6.6	6.6	6.6	6.5	6.5	6.4	6.3	6.4

SENSOR HEIGHT: 78m

Based on Data January 2013 to December 2013

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

TABLE 6B

KULATHUMEDU

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	5.1	5.0	4.9	5.2	5.2	5.1	5.0	5.4	5.1	5.4	5.8	6.0	5.7	5.5	5.2	5.1	4.8	4.8	4.7	4.8	5.1	5.3	5.2	5.0	5.2
FEB	4.2	4.1	3.8	3.9	4.1	4.3	4.3	4.3	4.2	4.9	5.6	5.9	5.9	5.6	5.3	5.3	5.1	4.8	4.4	4.5	4.5	4.4	4.4	4.3	4.7
MAR	3.8	3.8	3.8	3.7	3.8	3.8	3.6	3.5	3.3	3.7	4.1	4.4	4.6	4.6	4.5	4.6	4.4	4.2	4.3	4.1	3.8	4.1	3.9	3.7	4.0
APR	2.8	2.6	3.0	2.8	2.9	2.9	2.7	2.5	2.3	2.8	3.1	3.2	3.5	3.8	4.3	4.6	4.6	4.6	3.9	3.8	3.7	3.4	3.1	2.9	3.3
MAY	5.1	5.0	5.2	5.1	5.1	5.1	5.2	5.2	5.2	5.2	5.2	4.9	5.1	5.5	5.7	5.7	5.8	5.8	5.8	5.9	5.9	5.4	5.2	5.2	5.3
JUN	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.4	8.8	9.1	9.3	9.5	9.6	9.2	9.2	9.3	9.3	9.2	9.1	8.7	8.4	8.8	8.9	8.5	8.9
JUL	9.6	9.5	9.4	9.6	9.8	9.6	9.5	9.3	9.3	9.6	9.5	9.4	9.5	9.6	9.3	9.4	9.3	9.6	9.6	9.3	9.6	9.6	9.2	9.6	9.5
AUG	7.3	7.2	7.5	7.8	7.6	7.8	7.8	7.9	7.9	8.0	7.8	7.6	7.7	7.9	7.7	7.6	7.6	7.9	8.0	7.6	7.4	7.4	7.3	6.9	7.6
SEP	6.5	6.4	6.5	6.4	6.5	6.4	6.3	6.2	6.2	6.0	6.6	6.6	7.0	7.1	7.4	7.3	7.0	7.1	7.0	6.8	6.8	6.7	6.6	6.6	6.7
OCT	4.9	4.7	4.8	4.8	4.9	5.1	5.0	4.8	4.7	5.3	5.3	5.5	5.6	5.7	6.0	6.1	5.7	5.5	5.3	5.3	5.3	5.0	5.0	4.9	5.2
NOV	3.9	4.3	4.4	4.3	4.1	4.1	4.1	4.2	4.2	4.4	4.6	4.7	4.3	4.3	4.3	4.0	3.9	3.6	3.7	3.8	4.0	4.0	3.9	3.9	4.1
DEC	4.5	4.3	4.1	4.5	4.6	4.8	4.9	5.0	4.9	5.0	5.0	5.1	5.2	5.1	4.9	4.8	4.8	4.5	4.6	4.7	4.6	4.8	4.9	4.6	4.8
Annual	5.5	5.4	5.5	5.6	5.6	5.6	5.6	5.6	5.5	5.8	6.0	6.1	6.1	6.2	6.1	6.1	6.0	6.0	5.9	5.8	5.8	5.7	5.6	5.5	5.8

SENSOR HEIGHT : 50m

Based on Data January 2013 to December 2013

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

TABLE 6C

KULATHUMEDU

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	3.3	3.2	3.1	3.3	3.3	3.3	3.2	3.5	3.5	3.9	4.3	4.5	4.3	4.1	3.9	3.8	3.5	3.3	3.0	3.1	3.3	3.5	3.4	3.3	3.5
FEB	2.8	2.7	2.5	2.5	2.6	2.9	2.9	2.8	3.0	3.7	4.2	4.4	4.4	4.3	4.0	3.9	3.7	3.4	2.9	2.9	3.0	2.9	2.9	2.8	3.3
MAR	2.6	2.6	2.7	2.7	2.7	2.6	2.4	2.4	2.4	2.9	3.2	3.4	3.5	3.5	3.5	3.5	3.3	3.0	2.9	2.7	2.6	2.8	2.7	2.5	2.9
APR	2.0	1.9	2.2	2.0	1.9	1.8	1.8	1.7	1.8	2.2	2.4	2.5	2.7	3.0	3.3	3.6	3.5	3.3	2.8	2.6	2.5	2.4	2.2	2.1	2.4
MAY	3.6	3.4	3.6	3.6	3.6	3.5	3.6	3.7	3.7	3.7	3.7	3.6	3.8	4.1	4.2	4.3	4.4	4.3	4.3	4.3	4.3	3.9	3.6	3.6	3.8
JUN	6.3	6.3	6.3	6.2	6.3	6.3	6.3	6.1	6.5	6.7	6.9	7.1	7.2	6.8	6.8	6.8	6.8	6.8	6.6	6.3	6.2	6.5	6.5	6.3	6.5
JUL	7.2	7.0	7.0	7.1	7.2	7.0	7.0	6.8	6.9	7.1	7.0	7.0	7.1	7.2	6.9	7.0	6.9	7.1	7.1	6.9	7.1	7.1	6.8	7.1	7.0
AUG	5.3	5.3	5.6	5.7	5.6	5.8	5.8	5.9	5.9	5.9	5.6	5.5	5.5	5.6	5.4	5.5	5.4	5.6	5.7	5.4	5.3	5.3	5.2	4.9	5.5
SEP	4.6	4.6	4.7	4.5	4.7	4.6	4.5	4.4	4.5	4.5	4.9	4.9	5.2	5.3	5.5	5.4	5.2	5.2	5.1	4.9	4.8	4.8	4.7	4.7	4.8
OCT	3.4	3.2	3.3	3.4	3.3	3.6	3.5	3.3	3.3	3.9	3.9	4.1	4.2	4.3	4.4	4.5	4.1	4.0	3.7	3.7	3.7	3.5	3.5	3.4	3.7
NOV	2.5	2.7	2.9	2.8	2.7	2.7	2.7	2.9	2.9	3.1	3.4	3.5	3.2	3.2	3.2	2.9	2.8	2.5	2.4	2.4	2.6	2.7	2.5	2.5	2.8
DEC	2.9	2.8	2.8	3.0	3.1	3.2	3.2	3.3	3.3	3.6	3.6	3.8	3.8	3.8	3.6	3.5	3.4	3.1	3.0	3.0	2.9	3.1	3.2	3.0	3.2
Annual	3.9	3.8	3.9	3.9	3.9	3.9	3.9	3.9	4.0	4.3	4.4	4.5	4.6	4.6	4.6	4.6	4.4	4.3	4.1	4.0	4.0	4.0	3.9	3.8	4.1

SENSOR HEIGHT : 20m

Based on Data January 2013 to December 2013

KULATHUMEDU

TABLE 7

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	3.43	7.54	12.25	14.12	2.92	1.50	0.00	1.74	0.72	4.53	14.05	9.12	5.99
1.0-2.0	7.15	9.80	15.79	20.46	5.87	0.05	0.00	3.78	1.41	6.05	17.25	12.99	8.38
2.0-3.0	24.10	26.02	26.32	33.45	12.73	0.44	0.25	6.20	7.92	14.87	27.20	25.31	17.07
3.0-4.0	31.50	28.60	23.16	22.52	30.32	4.86	2.13	9.72	19.98	31.97	20.44	22.58	20.65
4.0-5.0	20.05	15.80	14.40	7.75	32.04	12.85	7.39	20.26	26.67	27.08	10.09	14.25	17.39
5.0-6.0	8.38	8.66	5.62	1.41	11.51	17.92	17.47	25.31	22.41	12.05	7.57	9.74	12.34
6.0-7.0	4.12	2.63	1.86	0.21	3.94	20.95	23.59	14.36	10.88	3.11	2.66	4.32	7.72
7.0-8.0	1.16	0.79	0.54	0.00	0.67	19.93	22.40	7.20	6.27	0.34	0.65	1.19	5.09
8.0-9.0	0.11	0.17	0.04	0.07	0.00	13.31	14.96	4.90	3.06	0.00	0.09	0.45	3.10
9.0-10.0	0.00	0.00	0.00	0.00	0.00	5.69	8.31	3.04	0.58	0.00	0.00	0.04	1.47
10.0-11.0	0.00	0.00	0.00	0.00	0.00	2.22	2.87	2.30	0.12	0.00	0.00	0.00	0.63
11.0-12.0	0.00	0.00	0.00	0.00	0.00	0.21	0.58	0.89	0.00	0.00	0.00	0.00	0.14
12.0-13.0	0.00	0.00	0.00	0.00	0.00	0.07	0.04	0.19	0.00	0.00	0.00	0.00	0.02
13.0-14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.01
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	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 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.

KULATHUMEDU

TABLE 7A

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	1.14	3.47	8.15	7.18	0.90	1.50	0.00	0.74	0.49	1.86	5.39	3.23	2.84
1.0-2.0	1.95	4.22	8.89	12.29	2.74	0.00	0.00	0.93	0.39	2.89	9.75	6.21	4.19
2.0-3.0	6.29	8.33	14.92	22.06	5.11	0.00	0.00	3.15	1.04	4.93	15.67	10.46	7.66
3.0-4.0	15.26	19.62	18.50	24.88	8.77	0.14	0.13	4.90	4.56	9.25	20.90	17.97	12.07
4.0-5.0	24.04	23.83	19.11	19.65	18.42	2.22	0.67	6.27	11.78	21.82	18.36	19.83	15.50
5.0-6.0	20.97	17.88	13.64	10.19	29.83	5.69	2.62	9.76	20.56	27.73	11.71	15.50	15.51
6.0-7.0	14.76	11.43	9.23	3.10	21.29	11.09	7.62	17.29	22.06	19.13	7.34	10.91	12.94
7.0-8.0	8.45	6.80	4.30	0.51	8.49	13.59	13.15	20.45	17.13	8.87	6.39	8.51	9.72
8.0-9.0	4.10	2.75	2.02	0.07	3.57	15.23	17.27	13.40	9.00	2.91	3.10	4.35	6.48
9.0-10.0	2.46	1.07	1.03	0.02	0.74	16.16	18.26	7.20	6.30	0.58	0.95	1.81	4.71
10.0-11.0	0.45	0.50	0.18	0.02	0.14	15.39	16.47	4.75	4.21	0.02	0.35	0.74	3.60
11.0-12.0	0.07	0.10	0.02	0.02	0.00	10.67	12.30	3.93	1.90	0.00	0.09	0.38	2.46
12.0-13.0	0.04	0.00	0.00	0.00	0.00	5.30	7.48	2.60	0.46	0.00	0.00	0.11	1.33
13.0-14.0	0.02	0.00	0.00	0.00	0.00	2.38	2.80	2.63	0.12	0.00	0.00	0.00	0.66
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.51	1.12	1.15	0.00	0.00	0.00	0.00	0.23
15.0-16.0	0.00	0.00	0.00	0.00	0.00	0.12	0.11	0.56	0.00	0.00	0.00	0.00	0.07
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.02
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.01
18.0-19.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	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.

KULATHUMEDU

TABLE 7B

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	0.72	2.36	2.82	3.82	0.53	1.48	0.00	0.71	0.51	1.48	4.28	2.91	1.80
1.0-2.0	1.37	3.13	7.84	9.42	1.89	0.00	0.00	0.85	0.28	2.76	8.50	5.44	3.46
2.0-3.0	3.90	5.78	12.10	17.50	3.61	0.00	0.00	2.15	0.93	4.30	13.43	8.49	6.02
3.0-4.0	8.33	11.76	15.79	23.43	7.30	0.05	0.00	4.64	2.34	6.74	17.20	12.70	9.19
4.0-5.0	18.23	20.44	18.01	21.32	11.35	0.81	0.29	5.94	8.89	15.82	16.60	17.18	12.91
5.0-6.0	21.82	21.43	16.51	15.83	22.88	3.89	1.30	5.86	15.63	25.16	14.21	15.57	15.01
6.0-7.0	18.57	15.38	11.42	7.25	27.14	7.18	4.23	11.65	21.18	23.19	9.81	12.79	14.15
7.0-8.0	12.23	10.44	7.80	1.23	15.98	10.95	8.51	18.33	19.00	12.75	6.06	10.13	11.12
8.0-9.0	7.80	5.36	4.32	0.12	6.56	12.85	13.19	17.85	12.20	5.65	5.30	7.35	8.21
9.0-10.0	4.08	2.38	1.90	0.05	2.05	14.03	15.75	10.28	7.34	1.88	2.96	4.05	5.56
10.0-11.0	2.20	0.99	1.05	0.02	0.60	14.75	17.43	5.79	5.60	0.27	1.06	2.08	4.32
11.0-12.0	0.58	0.47	0.34	0.00	0.12	14.54	14.74	4.23	3.24	0.02	0.37	0.74	3.28
12.0-13.0	0.07	0.10	0.07	0.02	0.00	9.56	11.81	3.78	2.18	0.00	0.19	0.20	2.33
13.0-14.0	0.04	0.00	0.02	0.00	0.00	6.06	7.33	2.78	0.44	0.00	0.02	0.31	1.42
14.0-15.0	0.02	0.00	0.00	0.00	0.00	2.66	3.49	2.34	0.25	0.00	0.00	0.04	0.73
15.0-16.0	0.04	0.00	0.00	0.00	0.00	1.00	1.52	1.60	0.00	0.00	0.00	0.00	0.35
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.19	0.40	0.82	0.00	0.00	0.00	0.00	0.12
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.22	0.00	0.00	0.00	0.00	0.02
18.0-19.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.01
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	0.04	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.

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

KULATHUMEDU

TABLE 7C

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	0.74	2.46	3.79	4.38	0.76	1.48	0.00	0.67	0.49	1.61	6.20	3.56	2.18
1.0-2.0	1.25	3.08	7.55	8.68	2.05	0.00	0.00	0.89	0.32	2.80	8.08	5.60	3.36
2.0-3.0	3.85	5.51	11.60	16.85	3.22	0.00	0.00	2.00	0.86	3.94	13.13	8.49	5.79
3.0-4.0	8.04	11.46	15.82	23.06	6.72	0.05	0.00	4.38	2.31	6.32	16.30	12.10	8.88
4.0-5.0	17.18	19.49	17.34	21.67	10.77	0.56	0.18	5.97	8.19	14.78	15.74	16.44	12.36
5.0-6.0	21.64	21.23	16.33	15.90	21.36	3.80	1.05	5.38	15.12	24.42	13.80	15.50	14.63
6.0-7.0	18.44	15.53	11.47	7.85	26.75	6.62	4.01	10.61	20.86	23.72	10.21	12.72	14.07
7.0-8.0	12.63	11.31	7.86	1.39	17.63	10.07	7.53	18.00	19.00	13.55	6.06	10.35	11.28
8.0-9.0	8.56	5.63	4.59	0.14	7.34	13.01	12.46	17.77	12.78	6.23	5.16	7.37	8.42
9.0-10.0	4.44	2.53	1.90	0.05	2.51	13.89	15.95	10.83	7.62	2.20	3.45	4.21	5.80
10.0-11.0	2.26	1.14	1.28	0.02	0.71	14.49	17.14	6.64	5.72	0.36	1.16	2.17	4.42
11.0-12.0	0.67	0.50	0.36	0.00	0.16	14.93	15.05	4.53	3.54	0.07	0.49	0.90	3.43
12.0-13.0	0.18	0.15	0.09	0.02	0.00	10.12	12.41	3.97	2.34	0.00	0.16	0.20	2.47
13.0-14.0	0.04	0.00	0.02	0.00	0.00	6.39	8.04	2.86	0.58	0.00	0.07	0.34	1.53
14.0-15.0	0.02	0.00	0.00	0.00	0.00	3.24	3.99	2.30	0.25	0.00	0.00	0.04	0.82
15.0-16.0	0.04	0.00	0.00	0.00	0.00	1.11	1.64	1.78	0.02	0.00	0.00	0.00	0.38
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.23	0.54	0.82	0.00	0.00	0.00	0.00	0.13
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.37	0.00	0.00	0.00	0.00	0.03
18.0-19.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.02
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	0.04	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.

TABLE 8

KULATHUMEDU

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	0.37	0.27	0.36	0.22	0.18	0.12	0.11	0.07	0.12	0.34	0.39	0.33	2.9
1.0-2.0	0.31	0.47	0.66	0.44	0.23	0.11	0.14	0.06	0.19	0.52	0.81	0.35	4.3
2.0-3.0	0.12	0.46	1.65	1.38	0.29	0.09	0.08	0.07	0.15	1.42	1.82	0.26	7.8
3.0-4.0	0.04	0.28	3.47	3.17	0.22	0.03	0.02	0.05	0.22	2.38	2.26	0.13	12.3
4.0-5.0	0.01	0.11	4.44	4.40	0.08	0.00	0.02	0.02	0.19	3.72	2.75	0.04	15.8
5.0-6.0	0.00	0.05	2.90	4.06	0.03	0.00	0.00	0.02	0.12	5.58	2.91	0.02	15.7
6.0-7.0	0.01	0.01	1.66	2.99	0.01	0.00	0.00	0.01	0.07	5.36	2.69	0.00	12.8
7.0-8.0	0.00	0.00	1.08	1.88	0.00	0.00	0.00	0.00	0.01	4.31	2.08	0.00	9.4
8.0-9.0	0.00	0.00	0.57	0.83	0.00	0.00	0.00	0.00	0.01	3.31	1.55	0.00	6.3
9.0-10.0	0.00	0.00	0.26	0.37	0.00	0.00	0.00	0.00	0.00	2.90	1.12	0.00	4.7
10.0-11.0	0.00	0.00	0.08	0.11	0.00	0.00	0.00	0.00	0.00	2.50	0.88	0.00	3.6
11.0-12.0	0.00	0.00	0.02	0.04	0.00	0.00	0.00	0.00	0.00	1.75	0.62	0.00	2.4
12.0-13.0	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	1.03	0.26	0.00	1.3
13.0-14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.11	0.00	0.6
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.02	0.00	0.2
15.0-16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01	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	0.01	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	0.9	1.6	17.1	19.9	1.0	0.4	0.4	0.3	1.1	35.8	20.3	1.1	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.

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

TABLE 8A

KULATHUMEDU

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	0.29	0.29	0.15	0.12	0.07	0.06	0.11	0.05	0.10	0.19	0.20	0.20	1.83
1.0-2.0	0.33	0.43	0.55	0.38	0.16	0.10	0.08	0.08	0.17	0.42	0.54	0.31	3.54
2.0-3.0	0.23	0.63	1.34	0.77	0.15	0.06	0.07	0.04	0.23	1.24	1.10	0.27	6.14
3.0-4.0	0.06	0.67	2.92	1.42	0.06	0.01	0.02	0.06	0.27	2.24	1.49	0.09	9.31
4.0-5.0	0.02	0.45	5.19	1.87	0.01	0.00	0.01	0.04	0.33	3.67	1.48	0.04	13.10
5.0-6.0	0.00	0.22	5.79	1.76	0.01	0.01	0.01	0.03	0.38	5.81	1.25	0.01	15.28
6.0-7.0	0.00	0.07	4.48	1.43	0.00	0.01	0.00	0.02	0.28	6.94	0.99	0.01	14.23
7.0-8.0	0.01	0.01	3.00	0.99	0.00	0.00	0.00	0.00	0.14	5.89	0.84	0.00	10.88
8.0-9.0	0.00	0.00	1.97	0.62	0.00	0.00	0.00	0.00	0.06	4.68	0.57	0.00	7.91
9.0-10.0	0.00	0.00	1.01	0.31	0.00	0.00	0.00	0.00	0.04	3.67	0.38	0.00	5.43
10.0-11.0	0.00	0.00	0.55	0.08	0.00	0.00	0.00	0.00	0.02	3.35	0.28	0.00	4.29
11.0-12.0	0.00	0.00	0.18	0.04	0.00	0.00	0.00	0.00	0.01	2.89	0.16	0.00	3.27
12.0-13.0	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.01	2.08	0.16	0.00	2.30
13.0-14.0	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.01	1.26	0.08	0.00	1.38
14.0-15.0	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.66	0.03	0.00	0.69
15.0-16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.01	0.00	0.31
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.09
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
18.0-19.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
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
Total	0.95	2.78	27.23	9.80	0.45	0.24	0.30	0.34	2.03	45.40	9.54	0.92	100.00

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.

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

TABLE 8B

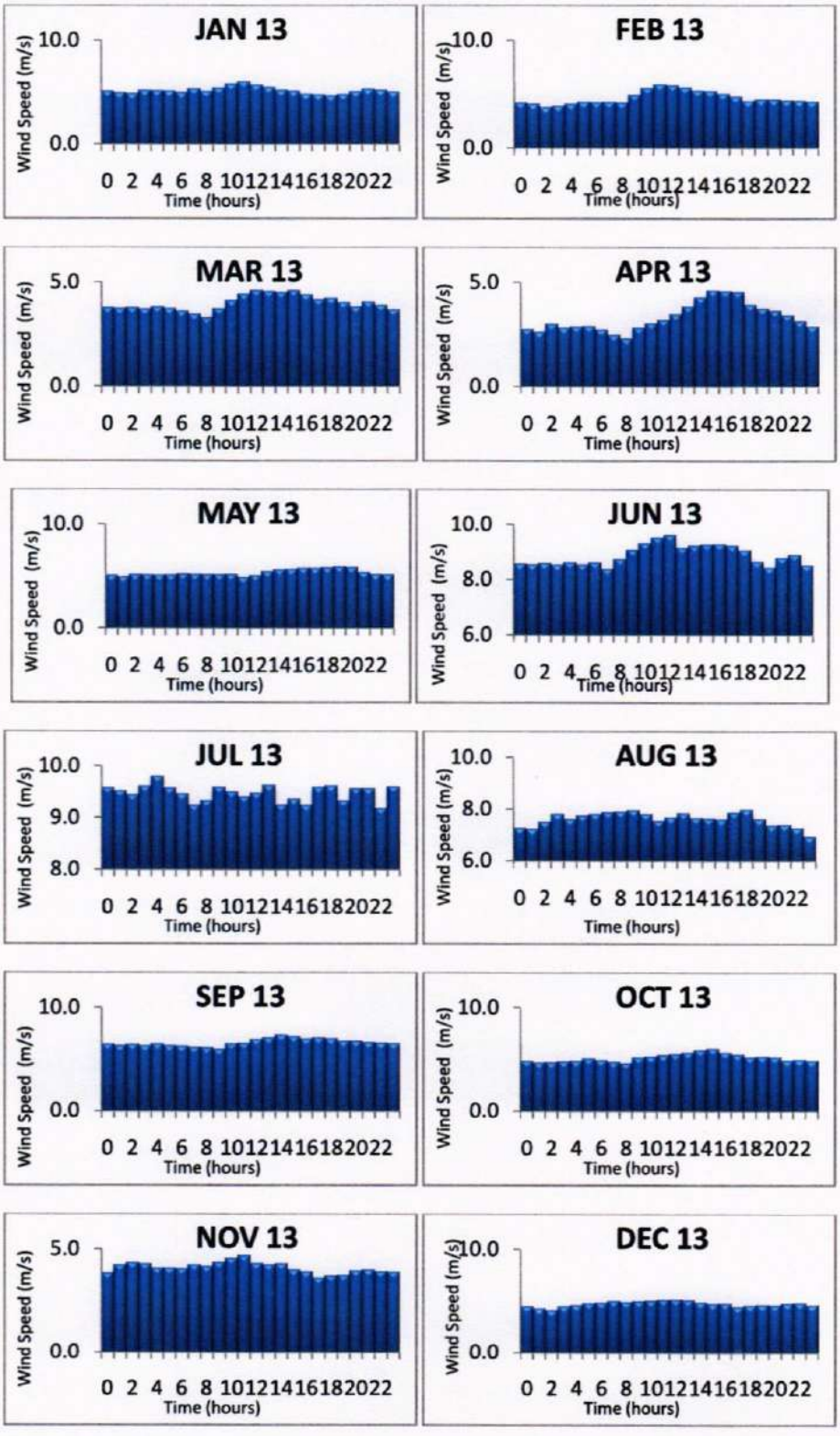
KULATHUMEDU

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	0.31	0.35	0.19	0.16	0.09	0.07	0.11	0.06	0.13	0.25	0.28	0.22	2.2
1.0-2.0	0.31	0.47	0.56	0.35	0.15	0.09	0.08	0.07	0.15	0.41	0.48	0.30	3.4
2.0-3.0	0.22	0.60	1.32	0.77	0.15	0.06	0.06	0.05	0.21	1.11	1.10	0.27	5.9
3.0-4.0	0.07	0.65	2.84	1.42	0.06	0.01	0.02	0.06	0.25	2.16	1.41	0.08	9.0
4.0-5.0	0.03	0.43	4.91	1.82	0.01	0.00	0.01	0.04	0.31	3.45	1.49	0.04	12.5
5.0-6.0	0.00	0.22	5.69	1.75	0.01	0.01	0.01	0.03	0.38	5.59	1.20	0.01	14.9
6.0-7.0	0.00	0.06	4.56	1.41	0.00	0.01	0.00	0.02	0.28	6.85	0.99	0.00	14.2
7.0-8.0	0.01	0.01	3.10	1.03	0.00	0.00	0.00	0.00	0.14	5.95	0.82	0.00	11.1
8.0-9.0	0.00	0.00	2.07	0.62	0.00	0.00	0.00	0.00	0.07	4.73	0.63	0.00	8.1
9.0-10.0	0.00	0.00	1.08	0.35	0.00	0.00	0.00	0.00	0.04	3.79	0.39	0.00	5.7
10.0-11.0	0.00	0.00	0.60	0.09	0.00	0.00	0.00	0.00	0.03	3.36	0.30	0.00	4.4
11.0-12.0	0.00	0.00	0.22	0.04	0.00	0.00	0.00	0.00	0.01	2.98	0.17	0.00	3.4
12.0-13.0	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.01	2.20	0.16	0.00	2.4
13.0-14.0	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.01	1.36	0.09	0.00	1.5
14.0-15.0	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.04	0.00	0.8
15.0-16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.01	0.00	0.3
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.1
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	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	0.01	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	0.9	2.8	27.2	9.8	0.5	0.2	0.3	0.3	2.0	45.4	9.5	0.9	100.0

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

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



SENSOR HEIGHT: 50m

FIGURE 4: MEAN HOURLY WIND SPEED
(January 2013 TO December 2014)

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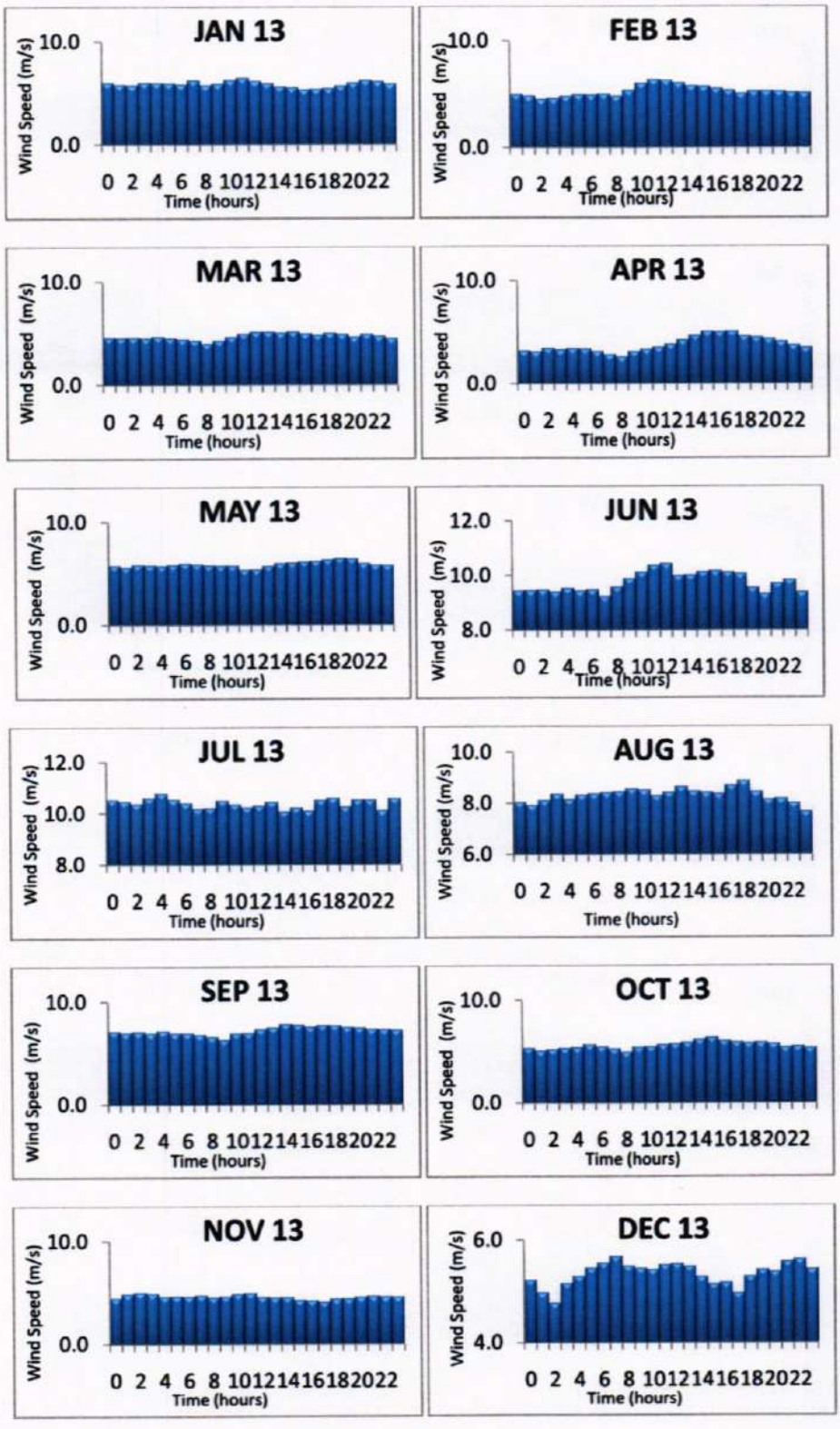
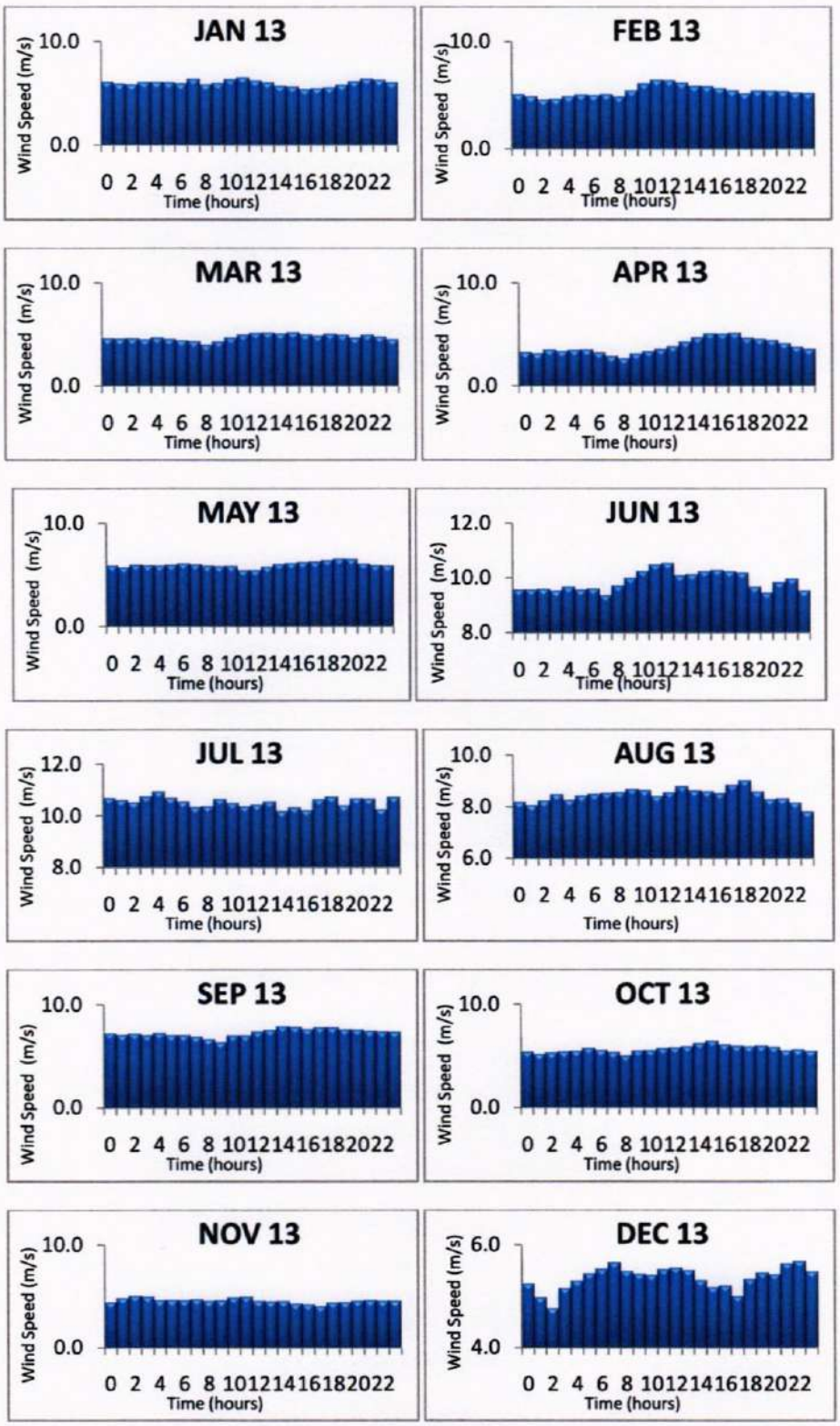


SENSOR HEIGHT: 78m

FIGURE 4A: MEAN HOURLY WIND SPEED

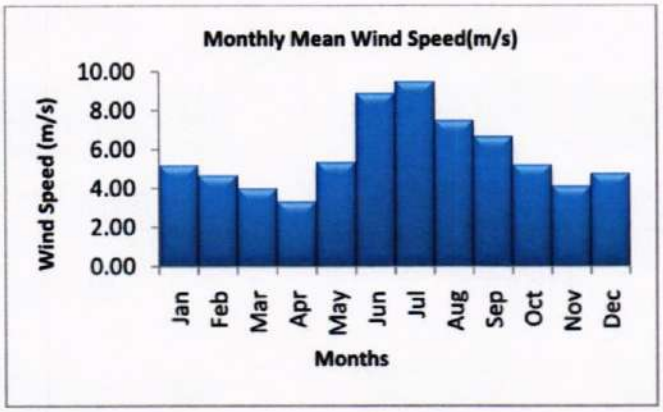
(January 2013 TO December 2014)



SENSOR HEIGHT: 80m

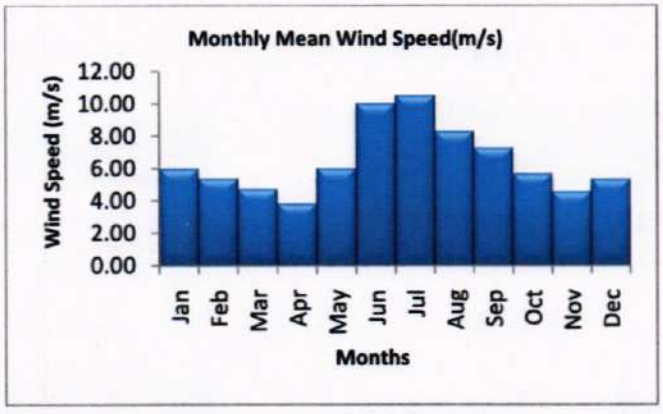
FIGURE 4B: MEAN HOURLY WIND SPEED

(January 2013 TO December 2014)



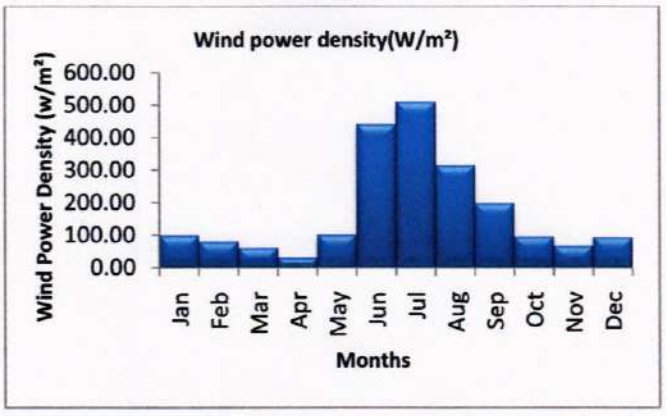
SENSOR HEIGHT: 50m

SENSOR HEIGHT: 78 m

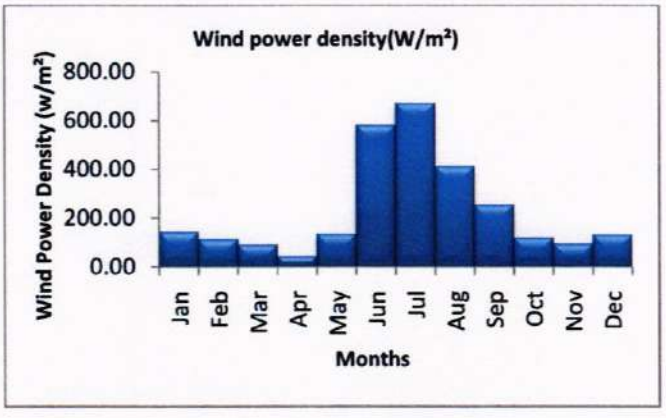


SENSOR HEIGHT: 80m

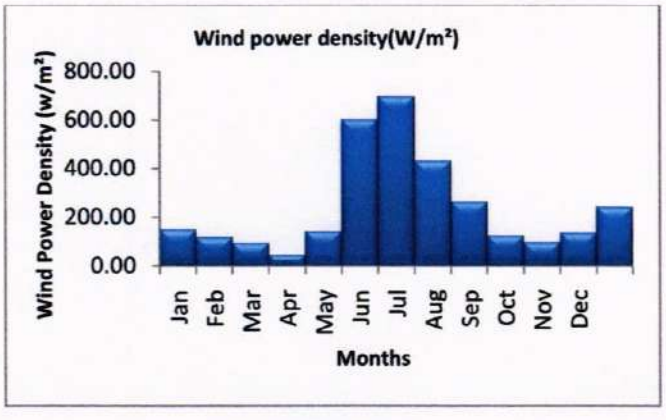
**FIGURE 5: MONTHLY MEAN WIND SPEED
(January 2013 TO December 2014)**



SENSOR HEIGHT: 50m



SENSOR HEIGHT: 78m



SENSOR HEIGHT: 80m

FIGURE 6: MONTHLY MEAN WIND POWER DENSITY (January 2013 TO December 2014)

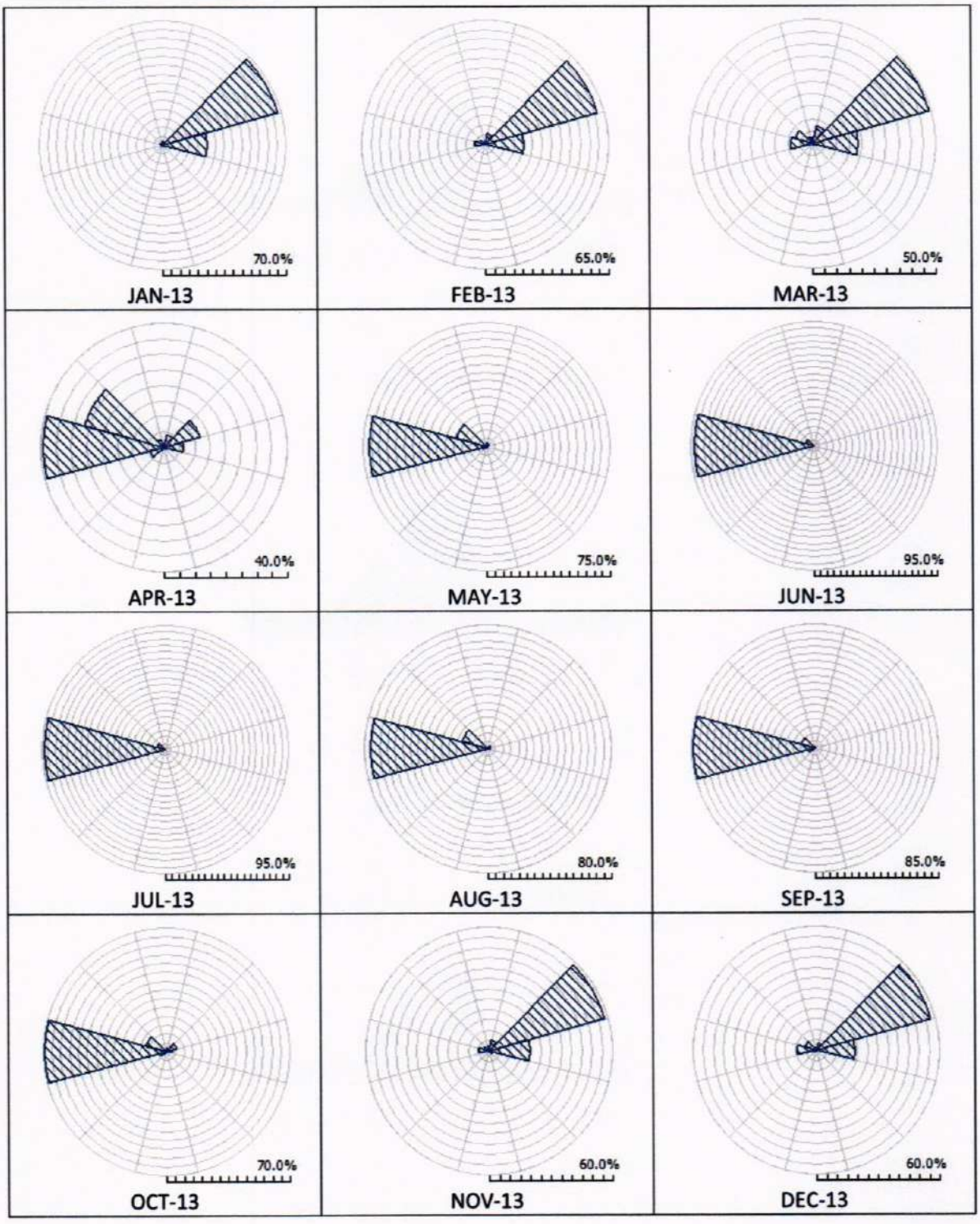


FIGURE 7: WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(January 2013 to December 2013)

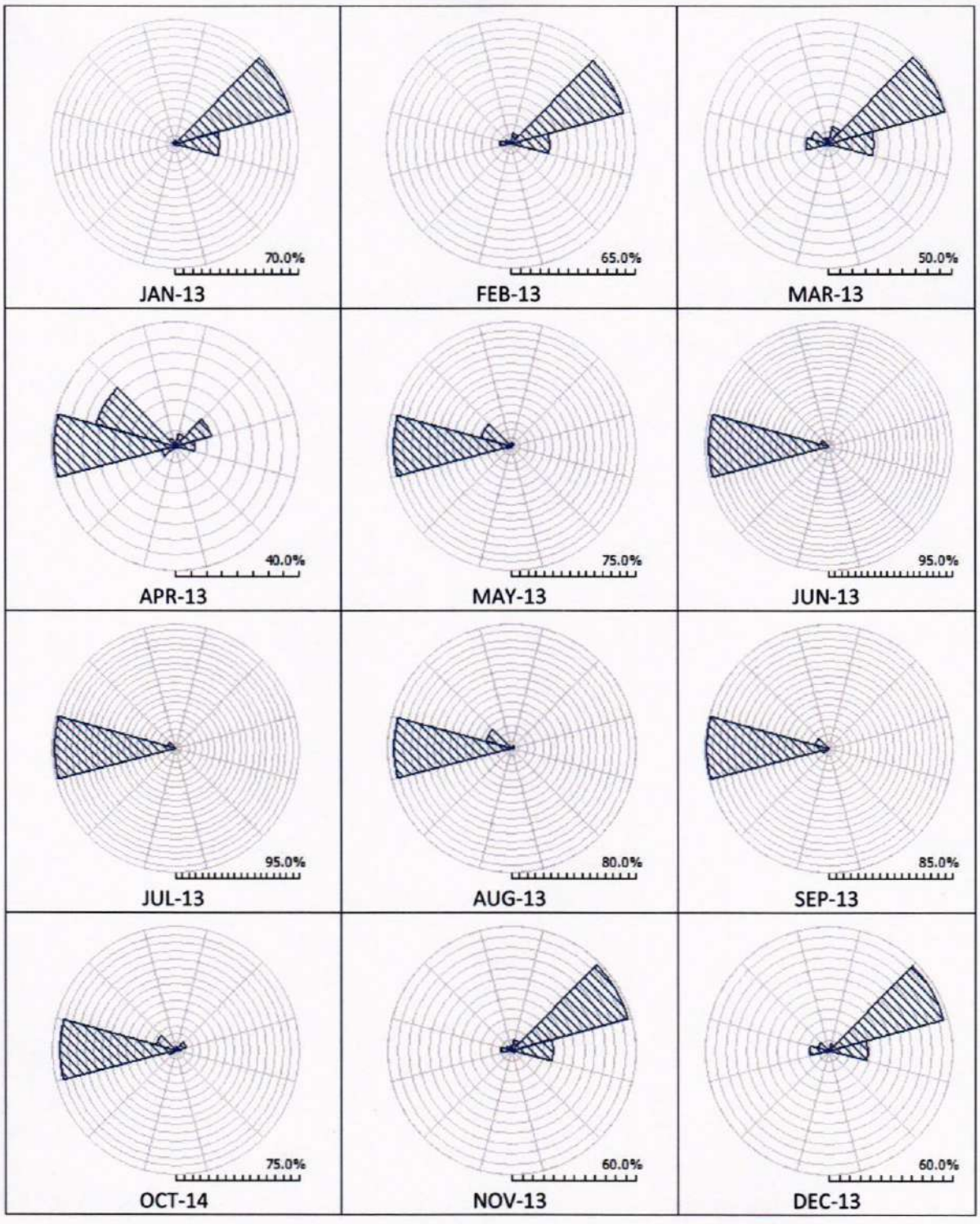


FIGURE 7A: WIND ROSE
SENSOR HEIGHT: (78m Anemometer and 78m Wind vane)
(January 2013 to December 2013)

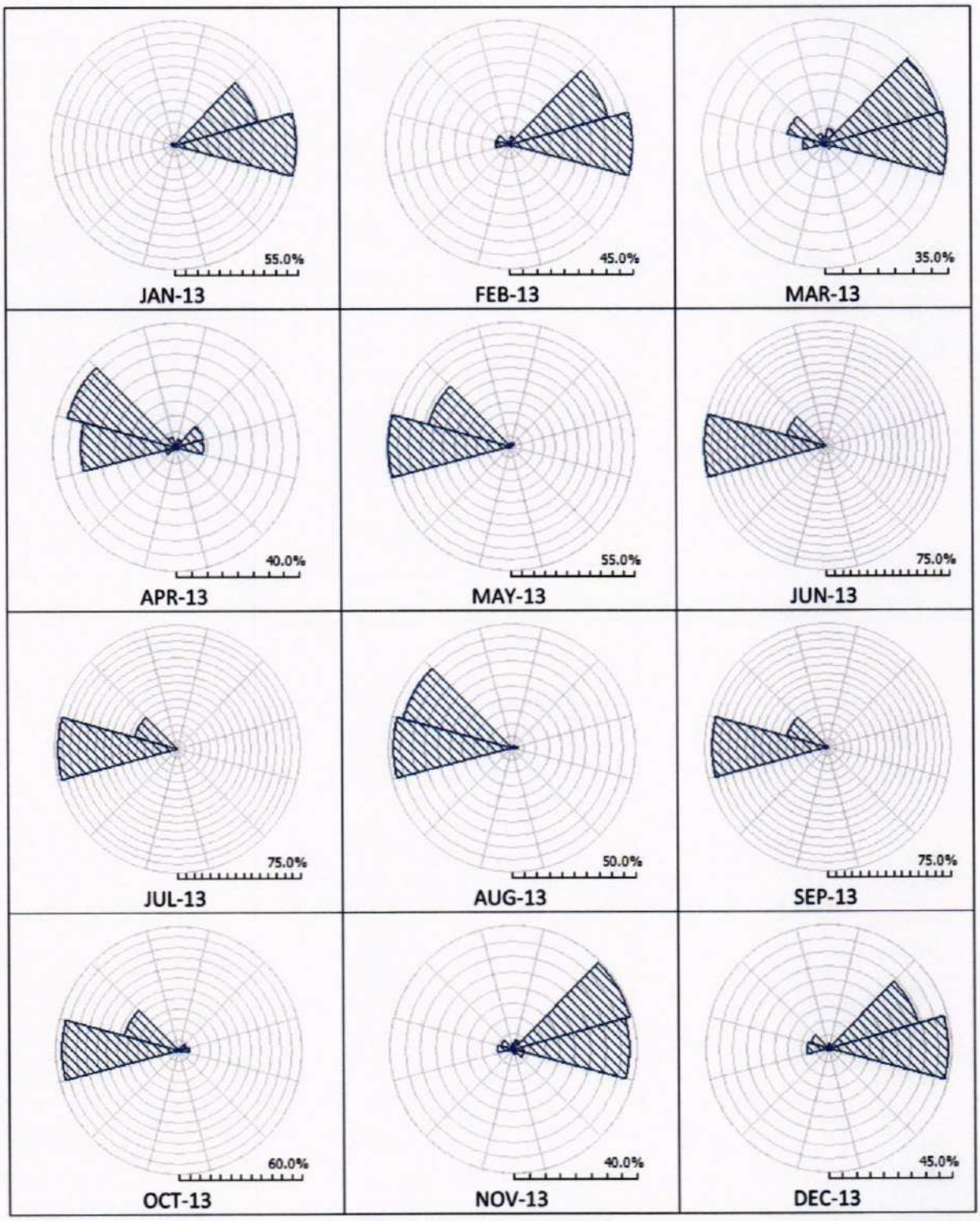


FIGURE 7B: WIND ROSE
SENSOR HEIGHT: (50m Anemometer and 48m Wind vane)
(January 2013 to December 2013)

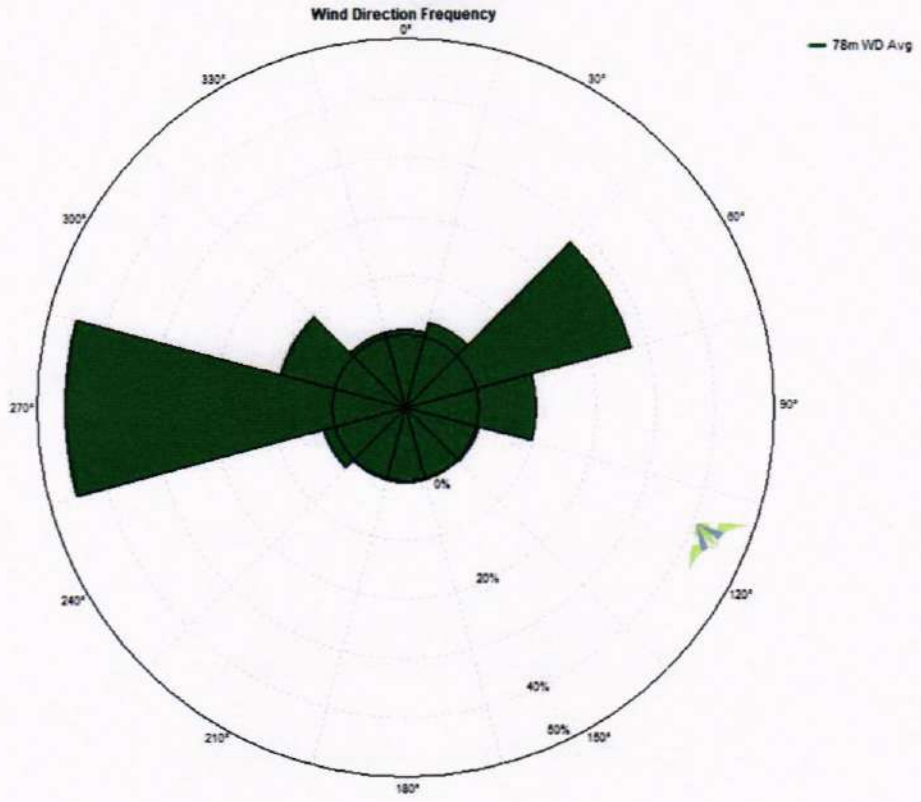
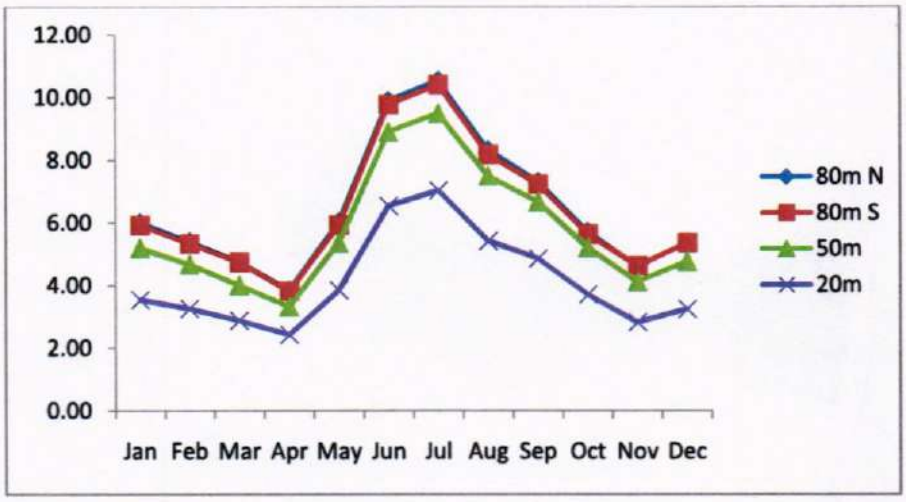
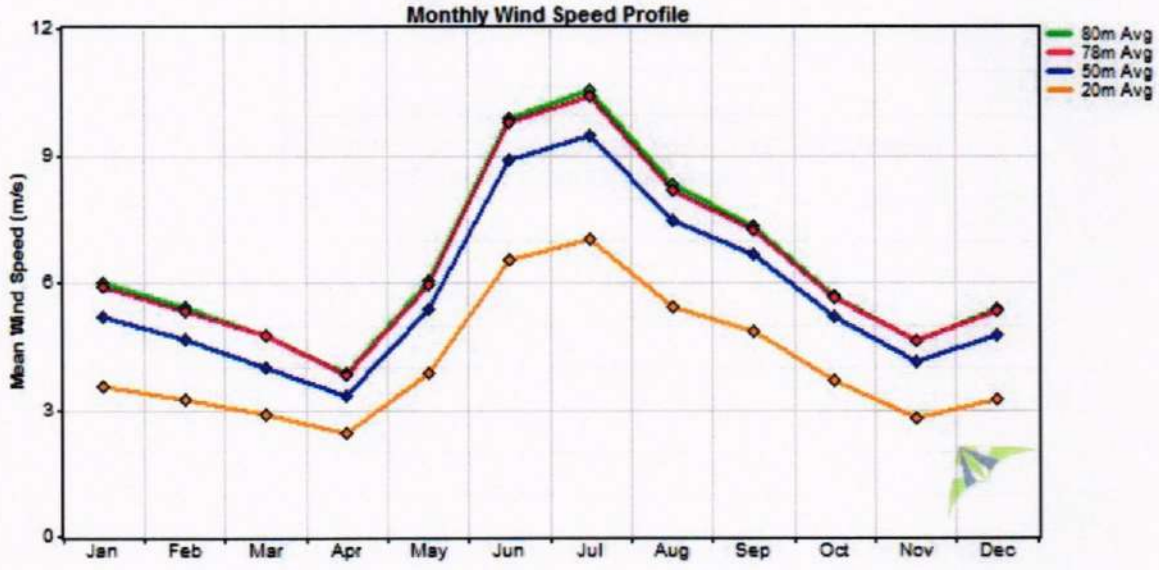


FIGURE 7C: ANNUAL WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(January 2013 to December 2013)



MONTHLY MEAN WIND SPEED
(JANUARY 2013 TO DECEMBER2013)



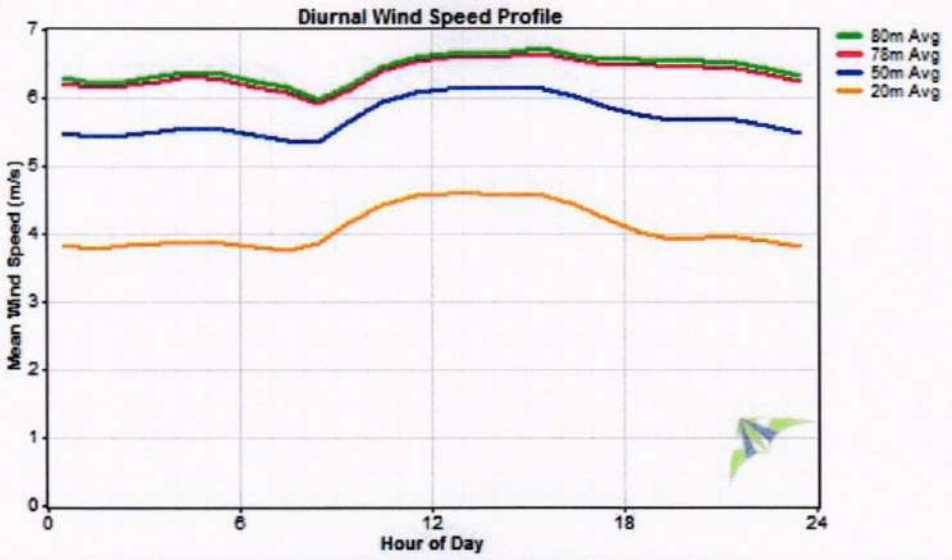


FIGURE 5: MONTHLY WIND SPEED AND DAILY WIND SPEED – KULATHUMEDU (JANUARY 2013 TO DECEMBER2013)

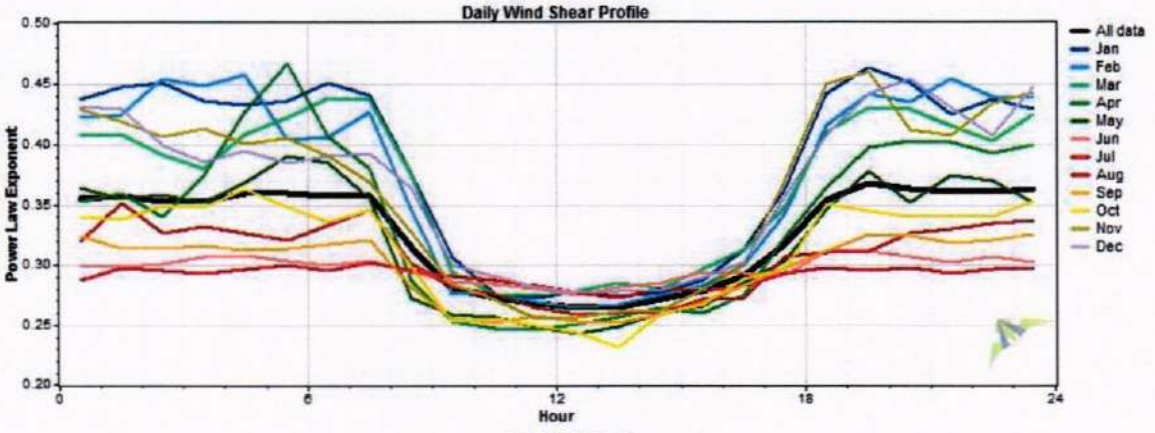


FIGURE 6
DAILY WIND SHEAR-KULATHUMEDU (JANUARY 2013 TO DECEMBER2013)

FIGURE 7
MONTHLY WIND SHEAR- KULATHUMEDU (JANUARY 2013 TO DECEMBER2013)

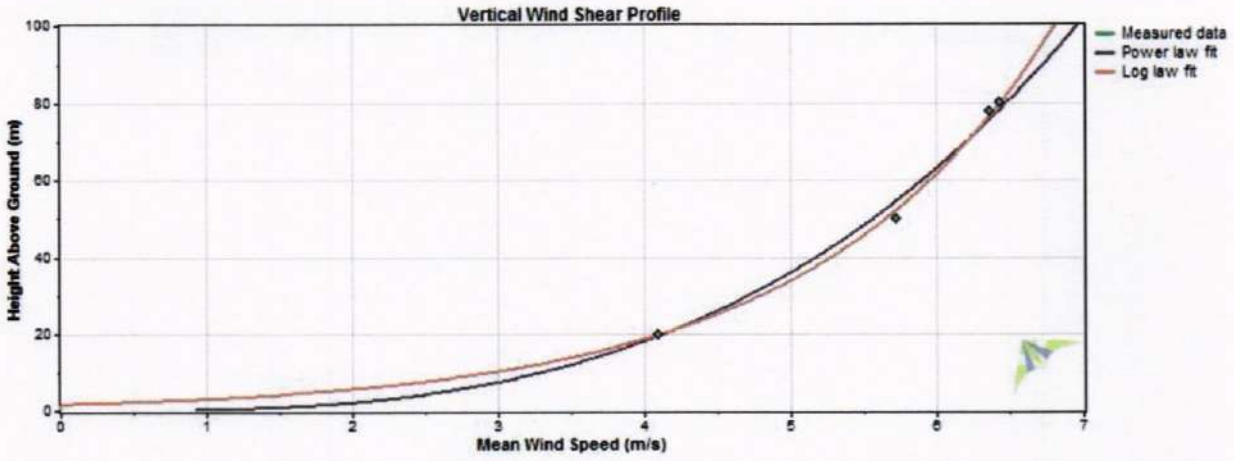
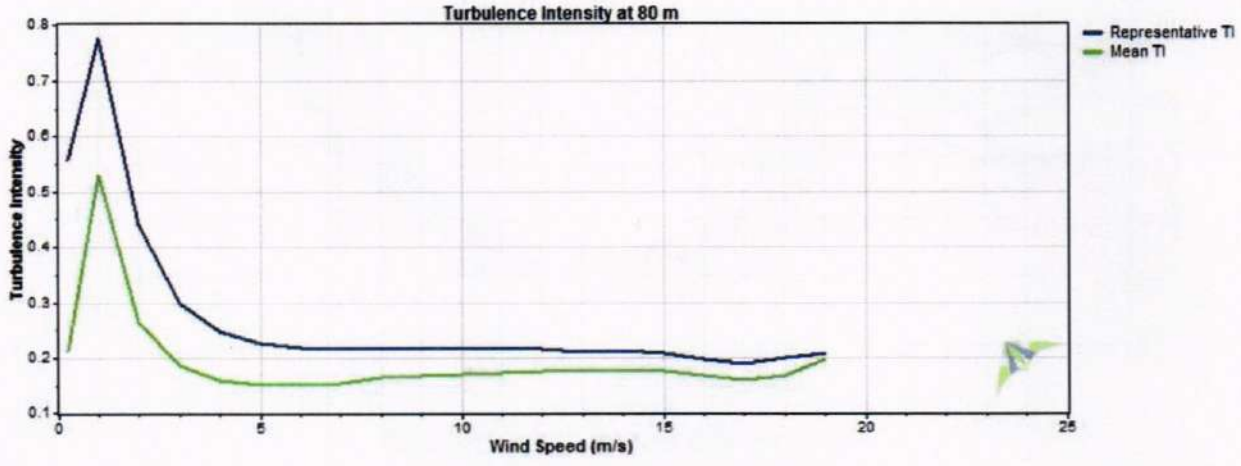
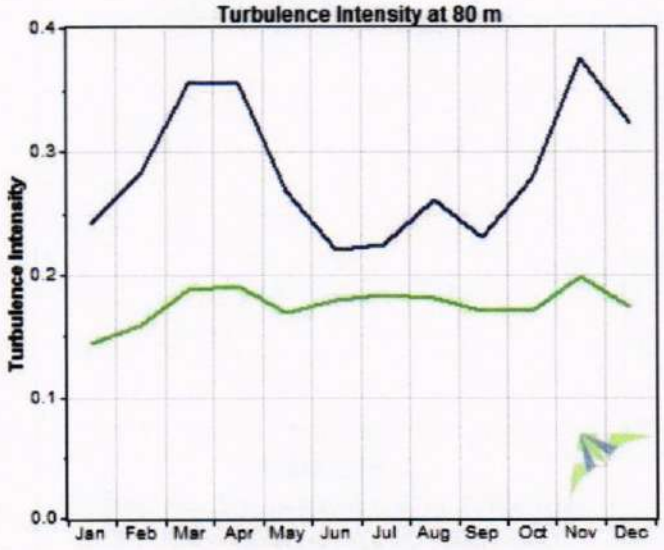
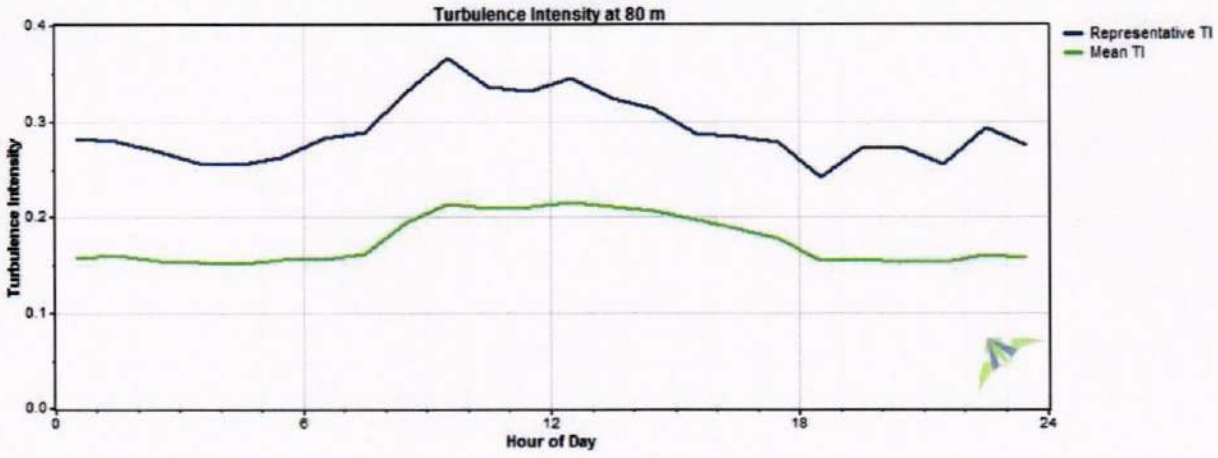


FIGURE 8
VERTICALWIND SHEAR- KULATHUMEDU
(JANUARY 2013 TO DECEMBER2013)







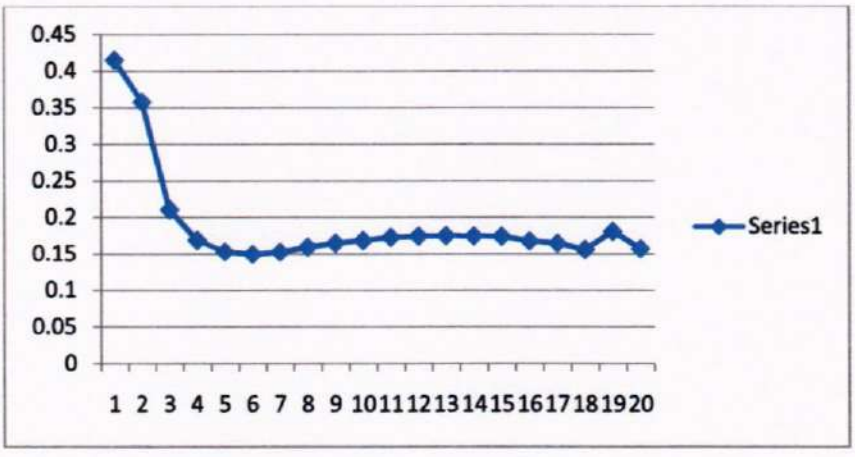


FIGURE 9: TURBULANCE INTENSITY – KULATHUMEDU (JANUARY 2013 TO DECEMBER2013)

IInd Year

Jan 2014 - Dec 2014

KULATHUMEDU

TABLE 4

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	3.93	2.94	3.58	2.39	3.44	5.60	6.75	4.98	4.43	2.68	2.71	3.26	3.89
50m	5.70	4.33	5.23	3.57	4.92	7.82	9.27	6.85	6.26	3.90	4.54	4.76	5.60
78 m	6.42	4.89	5.92	3.95	5.36	8.53	10.14	7.46	6.72	4.10	4.97	5.25	6.14
80m	6.46	4.89	5.93	3.94	5.42	8.66	10.28	7.56	6.87	4.16	4.97	5.38	6.21
Monthly Wind Power Density (Watts/Sq.m)													
20m	45.92	23.73	36.79	12.48	31.58	114.68	202.67	91.30	65.97	19.21	25.84	32.06	58.52
50m	128.62	67.85	105.33	35.21	82.87	304.94	494.23	230.71	175.41	51.83	83.67	89.07	154.15
78 m	180.80	95.82	150.45	47.68	108.30	396.71	644.15	298.17	221.14	63.38	115.74	122.15	203.71
80m	185.17	97.74	153.55	48.29	112.86	413.90	668.80	311.09	235.34	67.33	119.13	137.89	212.59
Power Law Index (PLI)													
	0.36	0.37	0.36	0.36	0.33	0.31	0.30	0.30	0.32	0.32	0.44	0.36	0.34
Energy Pattern Factor													
20m	1.42	1.77	1.52	1.74	1.48	1.24	1.25	1.41	1.45	1.89	2.49	1.75	1.62
50m	1.31	1.58	1.40	1.48	1.33	1.21	1.18	1.37	1.37	1.65	1.71	1.56	1.43
78 m	1.29	1.55	1.38	1.48	1.34	1.22	1.17	1.37	1.39	1.75	1.80	1.59	1.44
80m	1.29	1.59	1.41	1.51	1.35	1.22	1.17	1.38	1.39	1.77	1.85	1.68	1.47
Air Density (kg/m^3)													
	1.060	1.054	1.049	1.045	1.047	1.050	1.055	1.046	1.044	1.054	1.045	1.058	1.051
Temperature (^{0} C)													
	19.17	20.64	22.12	23.27	21.99	20.79	19.52	18.20	19.98	20.50	18.22	19.37	20.31
Turbulance Intensity (at 80m agl)													
At 15m/s : 0.17													
Data Availability (Based on 10 Minutes Interval)													
	4464	4032	4464	4320	4464	4320	4464	4464	4320	4464	4320	4464	

Based on Data January 2013 to December 2014

TABLE 5

KULATHUMEDU

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)	(80m)	(78m)	(50m)	(80m)	(78m)	(50m)	(80m)	(78m)	(50m)	(80m)
5.70	6.46	6.42	0.97	0.93	0.91	12.71 27-01-2014 12:40	14.31 27-01-2014 12:40	14.08 27-01-2014 12:40	E	NE
4.33	4.88	4.88	0.75	0.72	0.71	10.62 25-02-2014 07:20	11.50 25-02-2014 07:20	11.43 25-02-2014 07:20	NE	NE
5.23	5.93	5.92	0.91	0.87	0.85	13.12 16-03-2014 07:10	15.93 16-03-2014 07:10	15.74 16-03-2014 07:20	E	NE
3.57	3.94	3.95	0.67	0.66	0.65	7.88 6-4-2014 13:20	8.70 30-04-2014 16:00	8.71 30-04-2014 16:00	NNW	W
4.92	5.42	5.36	0.86	0.86	0.86	11.59 6-5-2014 23:50	13.58 6-5-2014 23:50	13.46 6-5-2014 23:50	W	W
7.82	8.66	8.53	1.46	1.51	1.52	15.63 19-06-2014 02:50	16.95 19-06-2014 02:50	16.63 19-06-2014 02:50	W	W
9.27	10.28	10.14	2.01	2.10	2.10	17.22 12-07-2014 06:30	18.83 12-07-2014 06:30	18.73 12-07-2014 06:30	W	W
6.85	7.56	7.46	1.29	1.35	1.34	14.64 2-8-2014 5:10	16.29 2-8-2014 5:10	15.97 2-8-2014 5:10	W	W
6.26	6.87	6.73	1.15	1.19	1.17	12.18 18-09-2014 03:50	13.35 18-09-2014 20:00	13.13 18-09-2014 20:00	W	W
3.90	4.16	4.10	0.73	0.74	0.73	10.08 12-10-2014 1:50	10.94 12-10-2014 1:40	10.67 12-10-2014 1:40	E	NE
4.54	4.97	4.97	0.84	0.83	0.81	11.11 24-11-2014 02:20	12.24 24-11-2014 02:20	12.34 24-11-2014 02:20	E	NE
4.76	5.38	5.25	0.84	0.89	0.79	14.75 18-12-2014 01:00	17.27 18-12-2014 01:00	16.44 18-12-2014 01:00	E	NE
5.60	**6.21**	**6.14**	**1.04**	**1.05**	**1.04**	**17.22 12-07-2014 06:30**	**18.83 12-07-2014 06:30**	**18.73 12-07-2014 06:30**	**W**	**W**

Based on Data January 2014 to December 2014

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

TABLE 6

KULATHUMEDU

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	6.6	6.2	6.2	6.3	6.5	6.3	6.3	6.9	7.0	7.1	7.4	7.4	7.2	6.9	6.5	6.1	5.8	5.8	5.6	5.9	5.8	6.0	6.6	6.8	**6.5**
FEB	4.9	4.9	5.0	5.1	5.0	5.1	5.2	5.0	4.7	4.8	5.1	5.2	5.0	5.0	4.8	4.7	4.6	4.5	4.7	4.9	5.0	4.8	4.7	4.7	**4.9**
MAR	5.3	5.5	5.6	5.8	5.7	6.1	6.0	6.0	5.7	5.9	6.2	6.5	6.8	6.8	6.8	6.7	6.3	6.0	5.8	5.7	5.6	5.2	5.0	5.2	**5.9**
APR	3.6	3.5	3.4	3.6	3.5	3.4	3.6	3.4	2.8	3.2	3.4	3.8	4.2	4.5	4.9	5.3	5.0	5.2	4.6	4.5	4.3	3.9	3.6	3.6	**3.9**
MAY	5.3	5.2	5.1	5.2	5.2	5.2	5.3	5.3	4.9	5.1	5.3	5.6	5.9	5.9	6.0	6.2	6.1	5.7	5.5	5.5	5.0	5.2	5.2	5.3	**5.4**
JUN	8.4	8.4	8.6	8.5	8.4	8.5	8.3	8.5	8.5	8.6	8.5	8.9	9.0	9.2	9.2	9.3	9.0	9.0	9.1	8.7	8.6	8.2	8.1	8.4	**8.7**
JUL	10.3	10.2	10.2	10.7	10.5	10.2	10.2	9.9	10.3	10.3	10.2	10.3	10.1	10.5	10.5	10.3	10.4	10.1	10.0	9.9	10.4	10.7	10.2	10.3	**10.3**
AUG	7.1	7.2	7.5	7.3	7.5	7.7	7.5	7.5	7.4	7.4	7.4	7.5	7.5	7.7	8.1	8.0	7.9	7.9	7.6	8.2	7.7	7.4	7.3	7.3	**7.6**
SEP	6.7	6.9	7.0	6.8	6.5	6.4	6.6	6.9	6.5	7.0	6.9	7.2	7.2	7.2	7.4	7.5	7.4	7.1	6.9	6.9	6.5	6.5	6.4	6.4	**6.9**
OCT	4.0	3.8	3.6	3.6	3.7	3.7	4.0	4.0	4.2	4.3	4.5	4.6	4.8	4.9	4.9	4.8	4.4	4.1	4.4	4.3	3.9	3.9	3.8	3.7	**4.2**
NOV	5.1	5.1	4.9	5.1	5.1	5.0	5.1	4.8	4.9	4.6	4.6	4.8	5.0	4.9	4.8	4.6	4.8	4.9	5.2	5.3	4.9	5.2	5.4	5.4	**5.0**
DEC	6.1	5.9	5.6	5.6	5.1	5.4	5.3	5.3	5.4	5.4	5.6	5.6	5.3	5.1	4.8	4.7	4.8	5.0	5.2	5.4	5.5	5.6	5.7	5.9	**5.4**
Annual	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.0**	**6.1**	**6.3**	**6.4**	**6.5**	**6.5**	**6.5**	**6.5**	**6.4**	**6.3**	**6.2**	**6.3**	**6.1**	**6.0**	**6.0**	**6.1**	**6.2**

SENSOR HEIGHT: 80m

Based on Data January 2014 to December 2014

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

TABLE 6A

KULATHUMEDU

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	6.5	6.1	6.1	6.3	6.4	6.3	6.3	6.8	7.0	7.0	7.4	7.4	7.2	6.9	6.4	6.0	5.8	5.8	5.6	5.9	5.8	5.9	6.5	6.7	**6.4**
FEB	4.9	4.9	5.0	5.0	5.0	5.1	5.2	5.0	4.8	4.9	5.1	5.2	5.0	5.0	4.8	4.7	4.6	4.5	4.6	4.9	4.9	4.8	4.7	4.7	**4.9**
MAR	5.3	5.5	5.6	5.8	5.7	6.0	6.0	6.0	5.7	5.9	6.2	6.5	6.8	6.8	6.8	6.7	6.3	5.9	5.8	5.7	5.6	5.2	5.0	5.2	**5.9**
APR	3.6	3.4	3.4	3.6	3.5	3.4	3.6	3.4	3.0	3.3	3.5	3.8	4.2	4.5	4.9	5.3	5.0	5.2	4.6	4.5	4.3	3.9	3.6	3.5	**4.0**
MAY	5.2	5.1	5.0	5.1	5.1	5.1	5.2	5.2	4.9	5.1	5.3	5.5	5.9	5.9	6.0	6.2	6.1	5.7	5.4	5.5	5.0	5.1	5.1	5.2	**5.4**
JUN	8.2	8.2	8.5	8.3	8.3	8.4	8.1	8.3	8.4	8.5	8.4	8.8	8.9	9.1	9.1	9.2	8.9	8.9	8.9	8.6	8.5	8.0	8.0	8.3	**8.5**
JUL	10.2	10.1	10.1	10.5	10.3	10.1	10.1	9.8	10.1	10.2	10.0	10.2	10.0	10.4	10.3	10.2	10.3	10.0	9.9	9.7	10.3	10.5	10.0	10.2	**10.1**
AUG	7.0	7.1	7.4	7.2	7.4	7.6	7.4	7.4	7.3	7.3	7.3	7.4	7.4	7.5	8.0	7.8	7.8	7.8	7.5	8.1	7.5	7.3	7.2	7.2	**7.5**
SEP	6.6	6.7	6.8	6.7	6.3	6.2	6.4	6.7	6.3	6.9	6.8	7.1	7.1	7.1	7.4	7.4	7.3	7.0	6.8	6.7	6.4	6.4	6.3	6.3	**6.7**
OCT	3.9	3.8	3.5	3.6	3.6	3.6	3.9	3.9	4.1	4.3	4.5	4.5	4.7	4.8	4.8	4.8	4.4	4.0	4.3	4.2	3.9	3.8	3.7	3.7	**4.1**
NOV	5.0	5.0	4.9	5.1	5.0	5.0	5.1	4.8	4.9	4.6	4.7	4.8	5.0	4.9	4.8	4.6	4.8	4.9	5.2	5.3	5.0	5.2	5.4	5.4	**5.0**
DEC	5.9	5.7	5.4	5.4	5.0	5.2	5.2	5.1	5.2	5.2	5.4	5.5	5.2	5.1	4.8	4.7	4.8	4.9	5.1	5.3	5.4	5.5	5.5	5.7	**5.3**
Annual	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.1**	**6.2**	**6.4**	**6.4**	**6.5**	**6.5**	**6.5**	**6.3**	**6.2**	**6.1**	**6.2**	**6.0**	**6.0**	**5.9**	**6.0**	**6.1**

SENSOR HEIGHT: 78m

Based on Data January 2014 to December 2014

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

TABLE 6B

KULATHUMEDU

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	5.6	5.3	5.4	5.5	5.5	5.4	5.4	5.9	6.2	6.4	6.8	6.8	6.7	6.4	6.0	5.6	5.3	5.2	4.8	5.0	4.9	5.1	5.6	5.8	**5.7**
FEB	4.1	4.2	4.3	4.3	4.4	4.4	4.5	4.5	4.2	4.5	4.8	4.9	4.6	4.6	4.5	4.4	4.3	4.0	4.0	4.2	4.2	4.1	4.0	3.9	**4.3**
MAR	4.4	4.7	4.8	4.9	4.8	5.3	5.2	5.1	5.1	5.5	5.8	6.0	6.3	6.3	6.2	6.1	5.7	5.3	5.1	4.9	4.8	4.4	4.2	4.3	**5.2**
APR	3.1	3.1	3.0	3.2	3.0	3.0	3.1	3.1	2.7	3.1	3.3	3.6	4.0	4.2	4.6	4.9	4.6	4.8	4.2	4.0	3.8	3.4	3.0	3.1	**3.6**
MAY	4.7	4.5	4.5	4.6	4.6	4.5	4.7	4.7	4.6	4.8	5.0	5.3	5.6	5.6	5.7	5.9	5.7	5.2	4.9	4.8	4.4	4.6	4.5	4.6	**4.9**
JUN	7.5	7.4	7.7	7.6	7.5	7.6	7.4	7.6	7.7	7.9	7.8	8.2	8.3	8.5	8.5	8.5	8.3	8.1	8.1	7.7	7.7	7.3	7.2	7.5	**7.8**
JUL	9.3	9.3	9.2	9.6	9.4	9.2	9.1	9.0	9.3	9.3	9.2	9.4	9.2	9.5	9.5	9.4	9.4	9.1	9.0	8.9	9.4	9.6	9.2	9.3	**9.3**
AUG	6.4	6.4	6.8	6.6	6.7	6.9	6.7	6.8	6.7	6.8	6.9	6.9	7.0	7.1	7.4	7.3	7.2	7.1	6.9	7.4	6.8	6.7	6.6	6.5	**6.9**
SEP	6.0	6.3	6.3	6.1	5.8	5.7	5.9	6.1	6.0	6.5	6.5	6.7	6.7	6.8	7.0	6.9	6.8	6.5	6.2	6.1	5.8	5.9	5.8	5.8	**6.3**
OCT	3.7	3.6	3.4	3.4	3.5	3.6	3.8	3.7	3.9	4.1	4.4	4.4	4.5	4.6	4.6	4.5	4.2	3.8	3.9	3.9	3.7	3.5	3.5	3.5	**3.9**
NOV	4.5	4.6	4.5	4.7	4.6	4.5	4.6	4.3	4.4	4.4	4.4	4.5	4.7	4.6	4.5	4.3	4.5	4.4	4.6	4.7	4.4	4.6	4.9	4.8	**4.5**
DEC	5.2	5.0	4.9	4.8	4.5	4.7	4.6	4.6	4.7	4.9	5.2	5.2	5.0	4.8	4.5	4.4	4.4	4.4	4.5	4.7	4.7	4.8	4.8	5.0	**4.8**
Annual	**5.4**	**5.4**	**5.4**	**5.4**	**5.4**	**5.4**	**5.4**	**5.4**	**5.5**	**5.7**	**5.8**	**6.0**	**6.0**	**6.1**	**6.1**	**6.0**	**5.9**	**5.7**	**5.5**	**5.5**	**5.4**	**5.3**	**5.3**	**5.3**	**5.6**

SENSOR HEIGHT : 50m

Based on Data January 2014 to December 2014

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

TABLE 6C

KULATHUMEDU

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	3.6	3.6	3.6	3.7	3.6	3.6	4.0	4.3	4.6	5.0	5.1	5.0	4.8	4.4	4.1	3.9	3.6	3.2	3.2	3.1	3.3	3.7	3.9	**3.9**
FEB	2.6	2.8	2.8	2.7	2.8	2.8	2.8	2.9	2.9	3.3	3.6	3.6	3.4	3.5	3.3	3.3	3.1	2.8	2.6	2.7	2.6	2.6	2.6	2.5	**2.9**
MAR	2.9	3.1	3.1	3.1	3.1	3.4	3.3	3.3	3.6	4.1	4.3	4.5	4.7	4.7	4.7	4.5	4.2	3.7	3.3	3.1	3.0	2.8	2.7	2.8	**3.6**
APR	1.9	1.9	1.9	2.1	1.9	1.9	1.9	1.8	1.9	2.2	2.4	2.7	3.0	3.1	3.3	3.5	3.2	3.3	2.9	2.6	2.4	2.0	1.8	1.8	**2.4**
MAY	3.1	3.0	2.9	3.1	3.0	3.0	3.1	3.2	3.4	3.6	3.7	4.0	4.3	4.2	4.2	4.3	4.0	3.7	3.3	3.2	2.9	3.1	3.0	3.1	**3.4**
JUN	5.3	5.2	5.5	5.4	5.4	5.4	5.3	5.4	5.5	5.7	5.7	6.0	6.1	6.2	6.2	6.2	6.0	5.8	5.8	5.5	5.5	5.2	5.1	5.3	**5.6**
JUL	6.8	6.8	6.7	7.0	6.9	6.7	6.7	6.5	6.8	6.8	6.7	6.9	6.7	7.0	6.9	6.8	6.8	6.7	6.5	6.4	6.8	7.0	6.7	6.7	**6.8**
AUG	4.6	4.6	4.9	4.7	4.8	5.0	4.8	4.9	4.9	5.0	5.0	5.1	5.2	5.3	5.5	5.4	5.3	5.2	5.0	5.3	4.9	4.8	4.6	4.6	**5.0**
SEP	4.2	4.3	4.4	4.3	4.1	3.9	4.0	4.2	4.2	4.6	4.8	5.0	5.0	5.0	5.2	5.1	5.0	4.6	4.4	4.3	4.0	4.0	4.0	4.0	**4.4**
OCT	2.4	2.4	2.2	2.2	2.3	2.3	2.6	2.5	2.7	3.0	3.2	3.2	3.4	3.4	3.4	3.3	2.9	2.5	2.6	2.5	2.4	2.3	2.3	2.3	**2.7**
NOV	2.6	2.8	2.7	2.8	2.8	2.7	2.7	2.5	2.6	2.7	2.7	2.7	2.8	2.7	2.7	2.7	2.8	2.7	2.6	2.6	2.6	2.7	2.9	2.8	**2.7**
DEC	3.4	3.3	3.2	3.2	2.9	3.0	3.1	3.0	3.2	3.5	3.8	3.9	3.7	3.5	3.3	3.2	3.2	3.1	3.0	3.0	3.0	3.1	3.2	3.4	**3.3**
Annual	**3.6**	**3.6**	**3.7**	**3.7**	**3.6**	**3.6**	**3.7**	**3.7**	**3.8**	**4.1**	**4.2**	**4.4**	**4.4**	**4.5**	**4.4**	**4.4**	**4.2**	**4.0**	**3.8**	**3.7**	**3.6**	**3.6**	**3.5**	**3.6**	**3.9**

SENSOR HEIGHT : 20m

Based on Data January 2014 to December 2014

KULATHUMEDU

TABLE 7

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	1.79	10.32	4.68	15.02	5.11	0.02	0.00	1.46	5.30	17.11	25.16	8.36	7.86
1.0-2.0	4.61	15.97	8.67	21.97	8.98	0.53	0.00	4.82	5.76	15.84	14.51	11.04	9.39
2.0-3.0	20.97	26.81	21.68	31.13	21.12	3.87	0.09	9.05	9.19	23.63	17.25	24.48	17.44
3.0-4.0	27.44	24.63	27.33	23.13	32.17	13.06	2.01	14.85	15.74	23.41	15.42	28.56	20.64
4.0-5.0	23.57	12.38	21.46	7.78	20.56	18.52	10.39	19.40	22.25	14.85	14.44	14.78	16.70
5.0-6.0	13.33	7.47	10.73	0.90	8.51	23.38	21.10	19.85	23.06	4.41	9.24	7.39	12.45
6.0-7.0	5.53	2.06	4.01	0.07	2.76	21.20	26.80	16.15	13.54	0.56	3.52	3.16	8.28
7.0-8.0	1.84	0.35	1.01	0.00	0.69	12.38	19.44	9.57	4.47	0.18	0.42	1.81	4.35
8.0-9.0	0.78	0.02	0.38	0.00	0.09	5.37	11.42	3.74	0.65	0.00	0.05	0.27	1.90
9.0-10.0	0.13	0.00	0.04	0.00	0.00	1.57	5.58	1.03	0.05	0.00	0.00	0.09	0.71
10.0-11.0	0.00	0.00	0.00	0.00	0.00	0.07	2.26	0.07	0.00	0.00	0.00	0.04	0.20
11.0-12.0	0.00	0.00	0.00	0.00	0.00	0.02	0.75	0.02	0.00	0.00	0.00	0.00	0.07
12.0-13.0	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.01
13.0-14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.02	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.

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

KULATHUMEDU

TABLE 7A

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	0.43	3.45	1.34	5.86	1.64	0.00	0.00	0.69	2.25	7.84	6.41	2.78	2.72
1.0-2.0	1.28	7.22	2.44	9.03	2.69	0.00	0.00	1.84	2.20	9.43	7.34	4.53	4.00
2.0-3.0	3.16	13.79	6.90	18.59	6.52	0.35	0.00	3.47	5.53	14.09	11.71	9.27	7.78
3.0-4.0	10.46	20.66	15.61	25.12	16.08	1.60	0.00	6.83	7.59	17.90	17.20	17.76	13.07
4.0-5.0	22.20	19.62	18.15	24.88	24.15	7.75	0.39	9.39	9.26	21.33	14.54	24.44	16.34
5.0-6.0	22.54	15.55	22.69	12.82	26.55	11.76	2.71	13.60	13.22	16.62	15.51	18.44	16.00
6.0-7.0	17.61	10.39	16.62	3.36	13.62	14.05	8.75	15.46	18.26	9.30	12.89	10.46	12.56
7.0-8.0	11.67	6.35	9.95	0.35	5.58	16.88	15.52	15.41	19.12	2.76	8.19	6.00	9.81
8.0-9.0	6.52	2.21	3.58	0.00	1.81	17.75	20.74	14.02	12.99	0.60	4.44	2.89	7.30
9.0-10.0	2.37	0.64	1.39	0.00	1.03	14.42	19.30	9.41	6.48	0.11	1.53	2.08	4.90
10.0-11.0	1.12	0.12	0.60	0.00	0.27	8.98	14.06	5.76	2.59	0.02	0.21	0.99	2.89
11.0-12.0	0.52	0.00	0.43	0.00	0.07	4.35	8.82	3.05	0.49	0.00	0.02	0.22	1.50
12.0-13.0	0.13	0.00	0.25	0.00	0.00	1.60	5.06	0.87	0.02	0.00	0.00	0.04	0.66
13.0-14.0	0.00	0.00	0.04	0.00	0.00	0.44	2.87	0.18	0.00	0.00	0.00	0.04	0.30
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.05	1.32	0.02	0.00	0.00	0.00	0.04	0.12
15.0-16.0	0.00	0.00	0.00	0.00	0.00	0.02	0.36	0.00	0.00	0.00	0.00	0.00	0.03
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.05	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	0.02	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 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.

KULATHUMEDU

TABLE 7B

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	0.40	2.26	0.69	4.54	1.59	0.00	0.00	0.43	2.38	9.36	8.01	2.55	2.68
1.0-2.0	0.94	6.20	2.22	8.47	2.24	0.00	0.00	1.64	2.27	8.60	6.37	4.55	3.62
2.0-3.0	2.06	10.47	4.41	14.72	5.17	0.23	0.00	3.32	4.58	12.25	9.14	7.68	6.17
3.0-4.0	6.21	16.77	10.30	19.88	11.49	0.90	0.00	5.20	6.57	15.61	13.43	12.34	9.89
4.0-5.0	12.68	17.86	14.31	23.89	18.15	4.70	0.18	7.24	7.66	18.86	14.19	19.06	13.23
5.0-6.0	20.99	16.00	18.55	19.07	25.38	9.93	1.00	11.07	10.88	16.69	12.27	21.66	15.29
6.0-7.0	20.79	12.95	20.36	8.06	21.71	11.53	4.92	13.93	14.21	10.98	12.78	13.19	13.78
7.0-8.0	15.57	9.87	15.21	1.23	8.80	13.94	9.89	13.96	18.03	5.42	10.60	8.78	10.94
8.0-9.0	10.46	5.23	8.53	0.14	2.69	15.81	15.47	14.38	15.72	1.81	7.55	4.03	8.49
9.0-10.0	5.96	1.81	2.78	0.00	1.23	15.76	19.76	11.63	10.00	0.34	3.98	2.46	6.31
10.0-11.0	2.17	0.55	1.10	0.00	0.94	12.31	17.11	8.13	5.14	0.07	1.27	2.02	4.23
11.0-12.0	1.03	0.05	0.56	0.00	0.45	8.10	12.78	4.95	1.97	0.00	0.39	1.01	2.61
12.0-13.0	0.63	0.00	0.40	0.00	0.13	4.14	8.30	2.89	0.51	0.00	0.02	0.52	1.46
13.0-14.0	0.09	0.00	0.31	0.00	0.02	1.94	5.10	1.03	0.07	0.00	0.00	0.02	0.72
14.0-15.0	0.02	0.00	0.13	0.00	0.00	0.58	2.99	0.20	0.00	0.00	0.00	0.04	0.33
15.0-16.0	0.00	0.00	0.11	0.00	0.00	0.09	1.69	0.02	0.00	0.00	0.00	0.04	0.16
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.02	0.50	0.00	0.00	0.00	0.00	0.02	0.05
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.02
18.0-19.0	0.00	0.00	0.00	0.00	0.00	0.00	0.02	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.

KULATHUMEDU

TABLE 7C

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	0.47	3.25	1.52	5.81	1.97	0.00	0.00	0.43	2.64	10.24	9.26	3.83	3.28
1.0-2.0	0.94	6.05	2.06	7.99	2.49	0.00	0.00	1.86	2.04	8.22	6.11	4.30	3.50
2.0-3.0	2.08	10.22	4.64	14.49	4.77	0.19	0.00	3.05	4.17	11.54	8.56	6.97	5.89
3.0-4.0	6.00	16.37	9.88	19.40	10.44	0.79	0.00	4.95	6.04	13.78	13.06	12.41	9.43
4.0-5.0	12.34	17.44	13.66	23.19	17.23	4.00	0.16	6.94	7.08	18.82	14.07	17.16	12.68
5.0-6.0	20.27	15.53	17.99	19.14	24.26	9.81	0.93	10.86	10.23	16.76	11.76	19.74	14.77
6.0-7.0	21.15	12.90	20.07	8.45	23.10	11.41	4.47	13.37	13.98	12.10	12.18	13.60	13.90
7.0-8.0	15.77	10.09	15.57	1.39	9.83	13.40	9.00	14.16	18.01	5.85	10.95	9.59	11.13
8.0-9.0	10.39	5.56	8.67	0.14	2.98	15.12	14.65	13.96	15.90	2.15	7.45	4.95	8.49
9.0-10.0	6.41	1.93	3.27	0.00	1.34	15.83	19.19	11.67	10.60	0.47	4.35	2.62	6.47
10.0-11.0	2.31	0.60	1.05	0.00	0.85	13.10	17.48	8.38	6.04	0.09	1.60	1.95	4.45
11.0-12.0	1.03	0.07	0.58	0.00	0.56	8.54	13.72	5.35	2.52	0.00	0.58	1.61	2.88
12.0-13.0	0.65	0.00	0.45	0.00	0.13	4.79	8.75	3.18	0.56	0.00	0.07	0.87	1.62
13.0-14.0	0.16	0.00	0.31	0.00	0.04	2.04	5.42	1.48	0.19	0.00	0.00	0.27	0.83
14.0-15.0	0.02	0.00	0.11	0.00	0.00	0.81	3.37	0.31	0.00	0.00	0.00	0.02	0.39
15.0-16.0	0.00	0.00	0.16	0.00	0.00	0.14	1.85	0.02	0.00	0.00	0.00	0.07	0.19
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.02	0.68	0.02	0.00	0.00	0.00	0.02	0.06
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.02	0.02
18.0-19.0	0.00	0.00	0.00	0.00	0.00	0.00	0.05	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.

TABLE 8

KULATHUMEDU

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	0.18	0.19	0.18	0.23	0.14	0.21	0.23	0.15	0.18	0.35	0.43	0.26	2.7
1.0-2.0	0.26	0.31	0.42	0.46	0.29	0.22	0.12	0.10	0.16	0.58	0.70	0.35	4.0
2.0-3.0	0.14	0.45	1.17	1.27	0.76	0.22	0.12	0.06	0.17	1.51	1.59	0.28	7.8
3.0-4.0	0.03	0.36	2.39	3.18	1.23	0.12	0.05	0.05	0.13	2.73	2.64	0.14	13.1
4.0-5.0	0.01	0.12	3.20	4.88	1.55	0.04	0.04	0.04	0.14	4.04	2.31	0.03	16.4
5.0-6.0	0.01	0.03	2.58	5.18	1.52	0.01	0.00	0.05	0.08	4.50	2.06	0.02	16.0
6.0-7.0	0.00	0.01	1.57	3.74	0.98	0.00	0.00	0.01	0.04	4.26	1.93	0.01	12.6
7.0-8.0	0.00	0.00	0.83	2.37	0.53	0.00	0.00	0.00	0.01	4.20	1.88	0.00	9.8
8.0-9.0	0.00	0.00	0.40	1.11	0.23	0.00	0.00	0.00	0.00	3.71	1.83	0.00	7.3
9.0-10.0	0.00	0.00	0.17	0.50	0.08	0.00	0.00	0.00	0.00	2.99	1.15	0.00	4.9
10.0-11.0	0.00	0.00	0.06	0.19	0.03	0.00	0.00	0.00	0.00	1.99	0.62	0.00	2.9
11.0-12.0	0.00	0.00	0.03	0.07	0.00	0.00	0.00	0.00	0.00	1.10	0.29	0.00	1.5
12.0-13.0	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.49	0.14	0.00	0.7
13.0-14.0	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.24	0.05	0.00	0.3
14.0-15.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.02	0.00	0.1
15.0-16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	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	0.6	1.5	13.0	23.2	7.3	0.8	0.6	0.5	0.9	32.8	17.6	1.1	100.0

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

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

NATIONAL INSTITUTE OF WIND ENERGY CHENNAI

TABLE 8A

KULATHUMEDU

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	0.27	0.30	0.27	0.22	0.15	0.12	0.12	0.14	0.14	0.34	0.36	0.28	2.7
1.0-2.0	0.32	0.40	0.57	0.40	0.14	0.09	0.09	0.07	0.14	0.50	0.58	0.32	3.6
2.0-3.0	0.18	0.62	1.27	0.78	0.16	0.08	0.05	0.07	0.20	1.30	1.15	0.27	6.1
3.0-4.0	0.07	0.70	2.99	1.44	0.08	0.03	0.04	0.04	0.23	2.56	1.59	0.08	9.9
4.0-5.0	0.02	0.60	5.08	1.99	0.02	0.02	0.04	0.03	0.23	3.76	1.44	0.02	13.3
5.0-6.0	0.01	0.29	6.55	2.13	0.00	0.00	0.02	0.05	0.25	5.08	0.94	0.00	15.3
6.0-7.0	0.00	0.09	5.76	1.79	0.00	0.00	0.00	0.04	0.16	5.31	0.63	0.00	13.8
7.0-8.0	0.00	0.02	4.04	1.28	0.01	0.00	0.00	0.01	0.09	4.93	0.56	0.00	11.0
8.0-9.0	0.00	0.01	2.41	0.73	0.00	0.00	0.00	0.00	0.07	4.64	0.62	0.00	8.5
9.0-10.0	0.00	0.00	1.25	0.24	0.00	0.00	0.00	0.00	0.04	4.21	0.55	0.00	6.3
10.0-11.0	0.00	0.00	0.60	0.06	0.00	0.00	0.00	0.00	0.03	3.20	0.34	0.00	4.2
11.0-12.0	0.00	0.00	0.25	0.04	0.00	0.00	0.00	0.00	0.01	2.14	0.17	0.00	2.6
12.0-13.0	0.00	0.00	0.12	0.02	0.00	0.00	0.00	0.00	0.00	1.22	0.09	0.00	1.5
13.0-14.0	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.63	0.04	0.00	0.7
14.0-15.0	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.28	0.03	0.00	0.3
15.0-16.0	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.01	0.00	0.2
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01	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	0.02	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	0.9	3.0	31.2	11.2	0.6	0.3	0.4	0.5	1.6	40.3	9.1	1.0	100.0

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 ENERGY CHENNAI

TABLE 8B

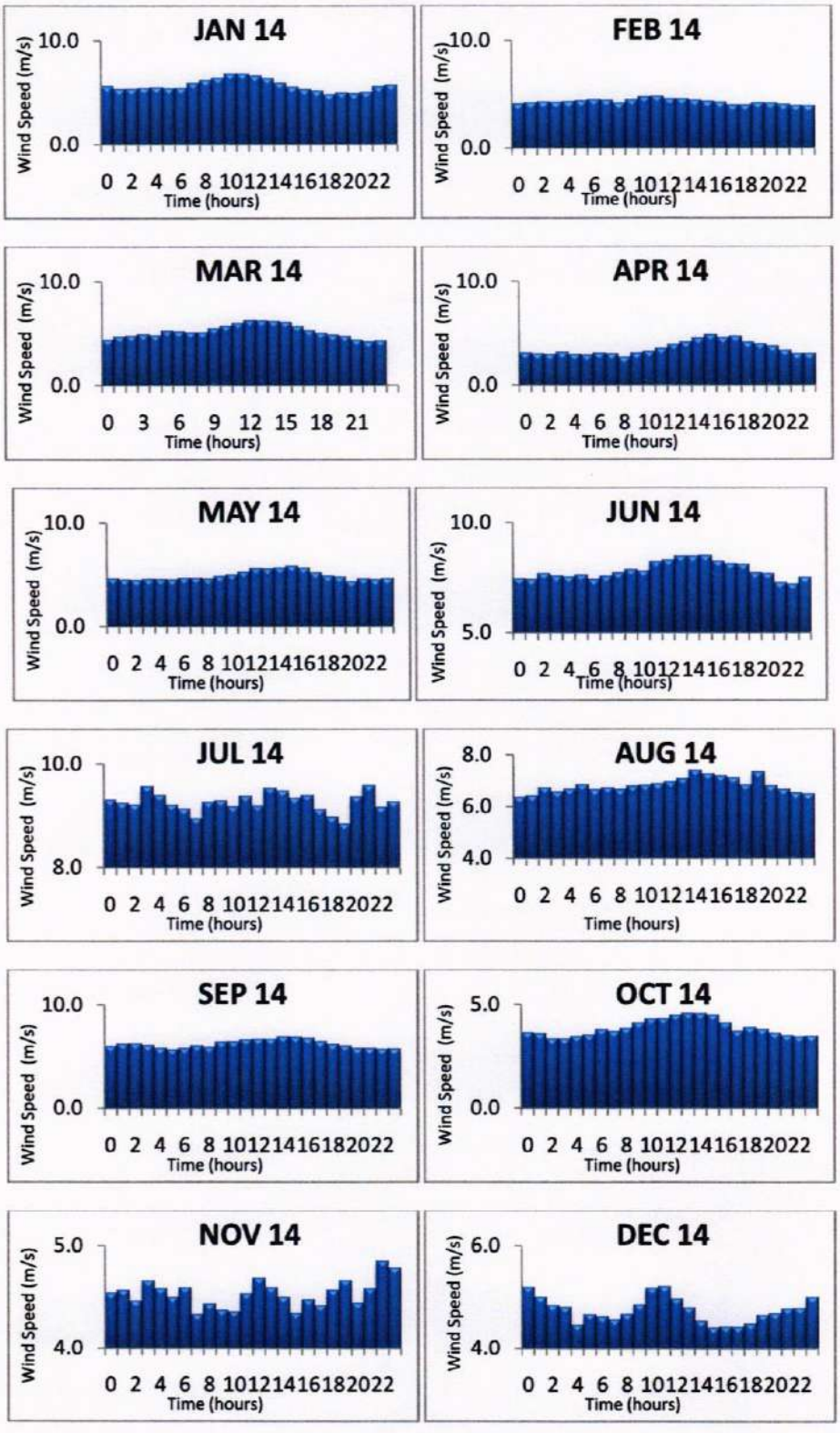
KULATHUMEDU

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	0.30	0.39	0.34	0.25	0.18	0.15	0.14	0.15	0.15	0.42	0.47	0.35	3.3
1.0-2.0	0.30	0.41	0.59	0.42	0.14	0.07	0.07	0.07	0.14	0.49	0.54	0.27	3.5
2.0-3.0	0.17	0.62	1.26	0.75	0.14	0.07	0.05	0.06	0.17	1.24	1.08	0.25	5.9
3.0-4.0	0.07	0.68	2.93	1.43	0.08	0.02	0.04	0.04	0.22	2.29	1.54	0.07	9.4
4.0-5.0	0.02	0.54	4.79	1.97	0.02	0.02	0.04	0.03	0.23	3.57	1.41	0.02	12.7
5.0-6.0	0.01	0.26	6.24	2.12	0.00	0.00	0.02	0.06	0.25	4.92	0.92	0.00	14.8
6.0-7.0	0.00	0.09	5.79	1.77	0.01	0.00	0.01	0.04	0.16	5.40	0.66	0.00	13.9
7.0-8.0	0.00	0.02	4.22	1.30	0.01	0.00	0.00	0.01	0.10	4.94	0.55	0.00	11.1
8.0-9.0	0.00	0.01	2.50	0.74	0.00	0.00	0.00	0.00	0.08	4.55	0.60	0.00	8.5
9.0-10.0	0.00	0.00	1.37	0.28	0.00	0.00	0.00	0.00	0.04	4.22	0.56	0.00	6.5
10.0-11.0	0.00	0.00	0.62	0.07	0.00	0.00	0.00	0.00	0.03	3.39	0.35	0.00	4.5
11.0-12.0	0.00	0.00	0.34	0.04	0.00	0.00	0.00	0.00	0.01	2.28	0.22	0.00	2.9
12.0-13.0	0.00	0.00	0.16	0.03	0.00	0.00	0.00	0.00	0.00	1.32	0.10	0.00	1.6
13.0-14.0	0.00	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.71	0.04	0.00	0.8
14.0-15.0	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.33	0.04	0.00	0.4
15.0-16.0	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.01	0.00	0.2
16.0-17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.00	0.1
17.0-18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	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	0.9	3.0	31.2	11.2	0.6	0.3	0.4	0.5	1.6	40.3	9.1	1.0	100.0

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.



SENSOR HEIGHT: 50m

FIGURE 4: MEAN HOURLY WIND SPEED
(January 2013 TO December 2014)

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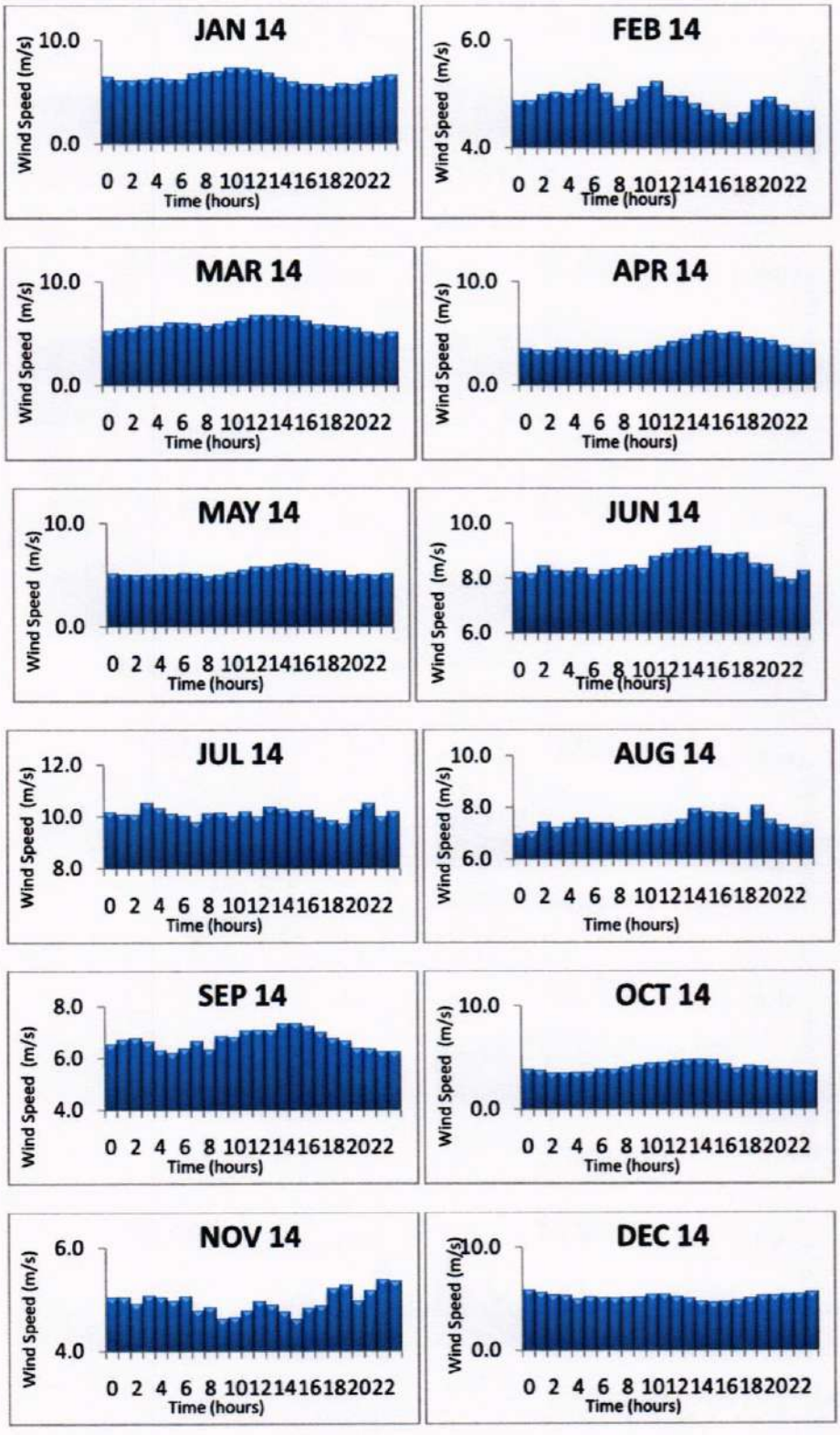
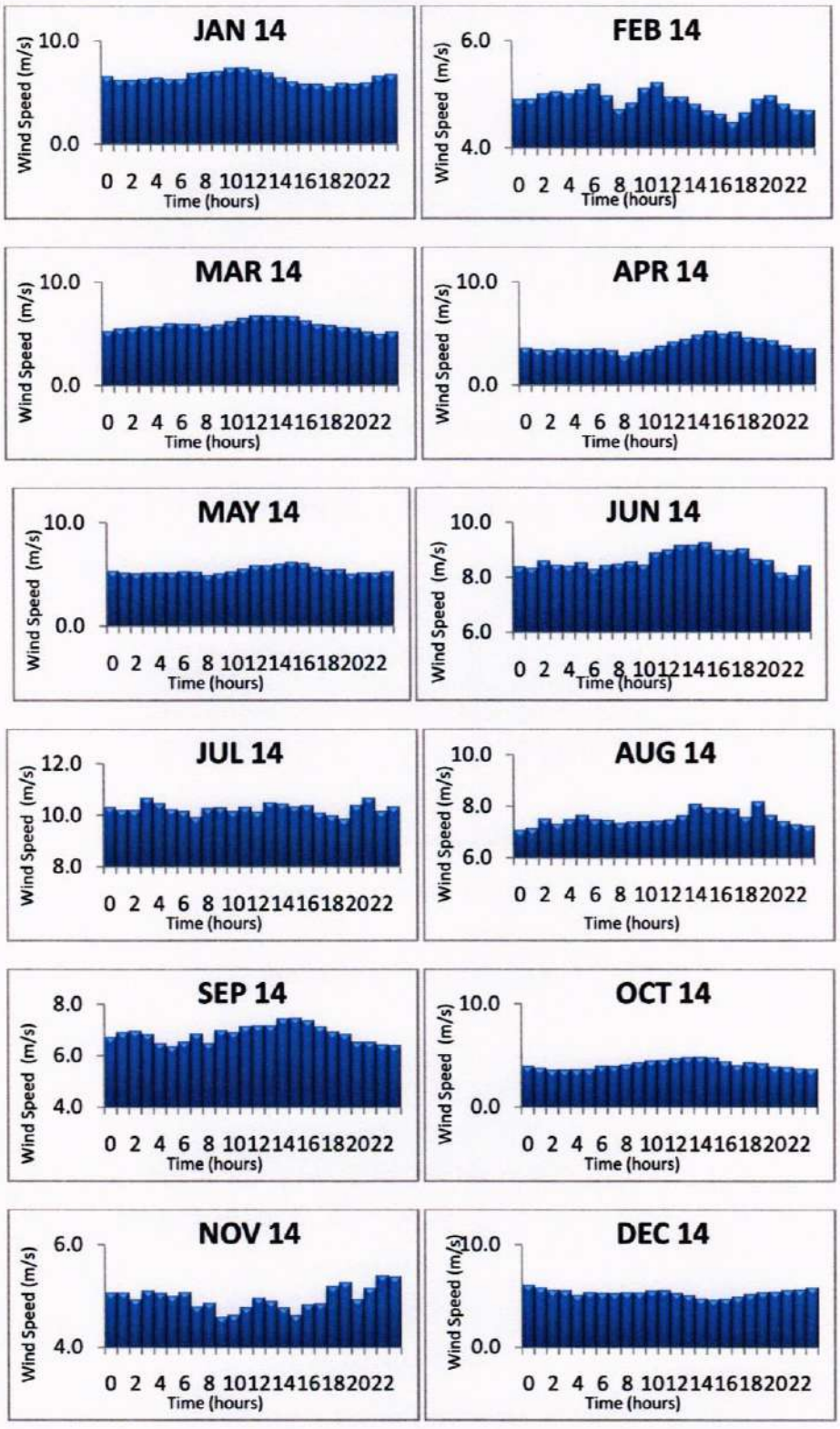
CHENNAI



SENSOR HEIGHT: 78m

FIGURE 4A: MEAN HOURLY WIND SPEED

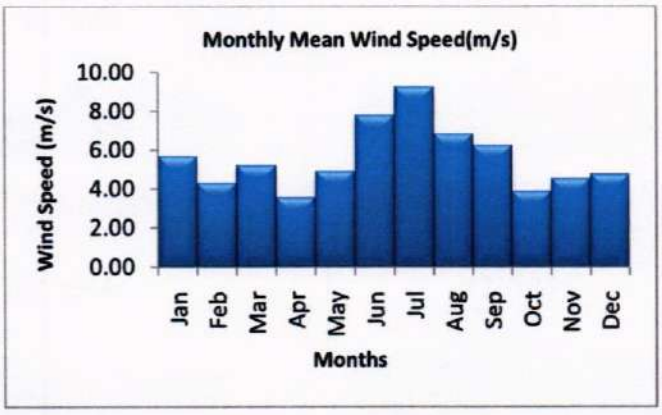
(January 2013 TO December 2014)



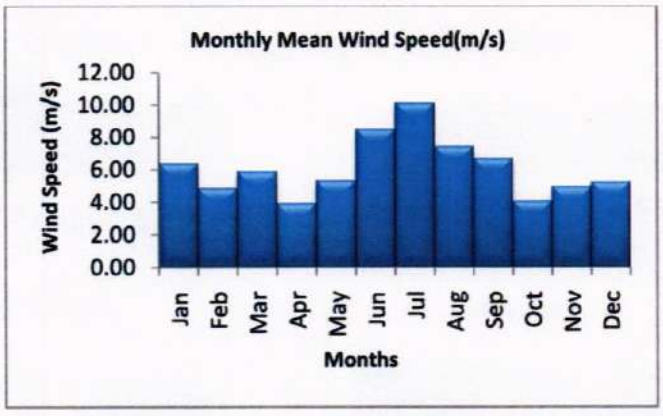
SENSOR HEIGHT: 80m

FIGURE 4B: MEAN HOURLY WIND SPEED

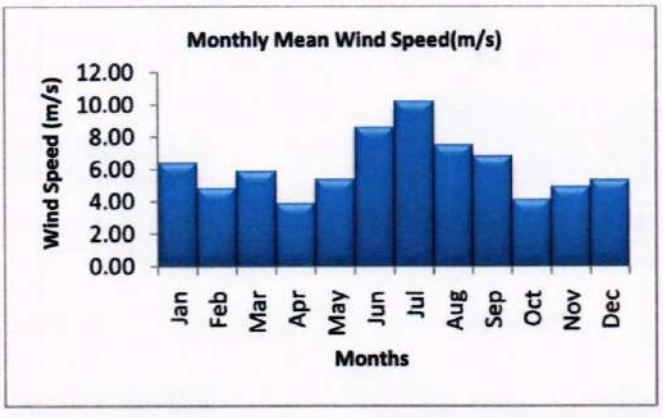
(January 2013 TO December 2014)



SENSOR HEIGHT: 50m

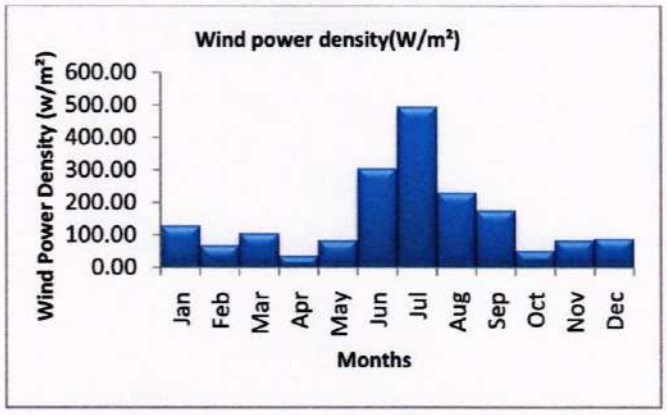


SENSOR HEIGHT: 78 m

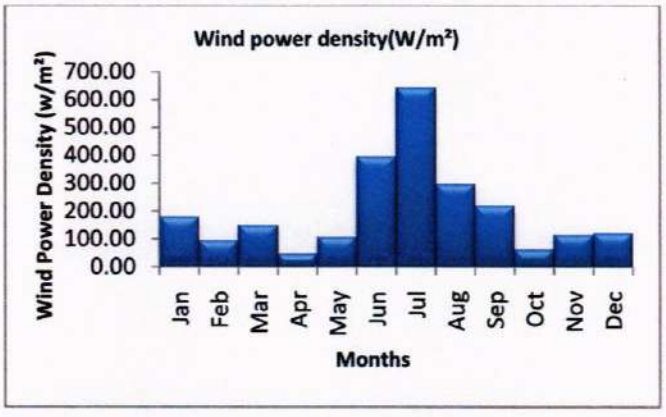


SENSOR HEIGHT: 80m

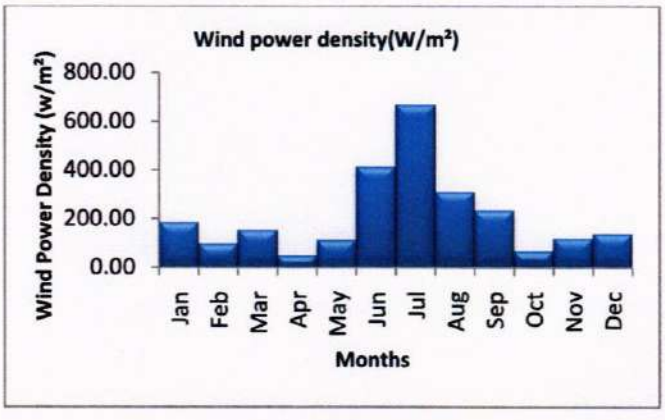
**FIGURE 5: MONTHLY MEAN WIND SPEED
(January 2013 TO December 2014)**



SENSOR HEIGHT: 50m



SENSOR HEIGHT: 78m



SENSOR HEIGHT: 80m

FIGURE 6: MONTHLY MEAN WIND POWER DENSITY (January 2013 TO December 2014)

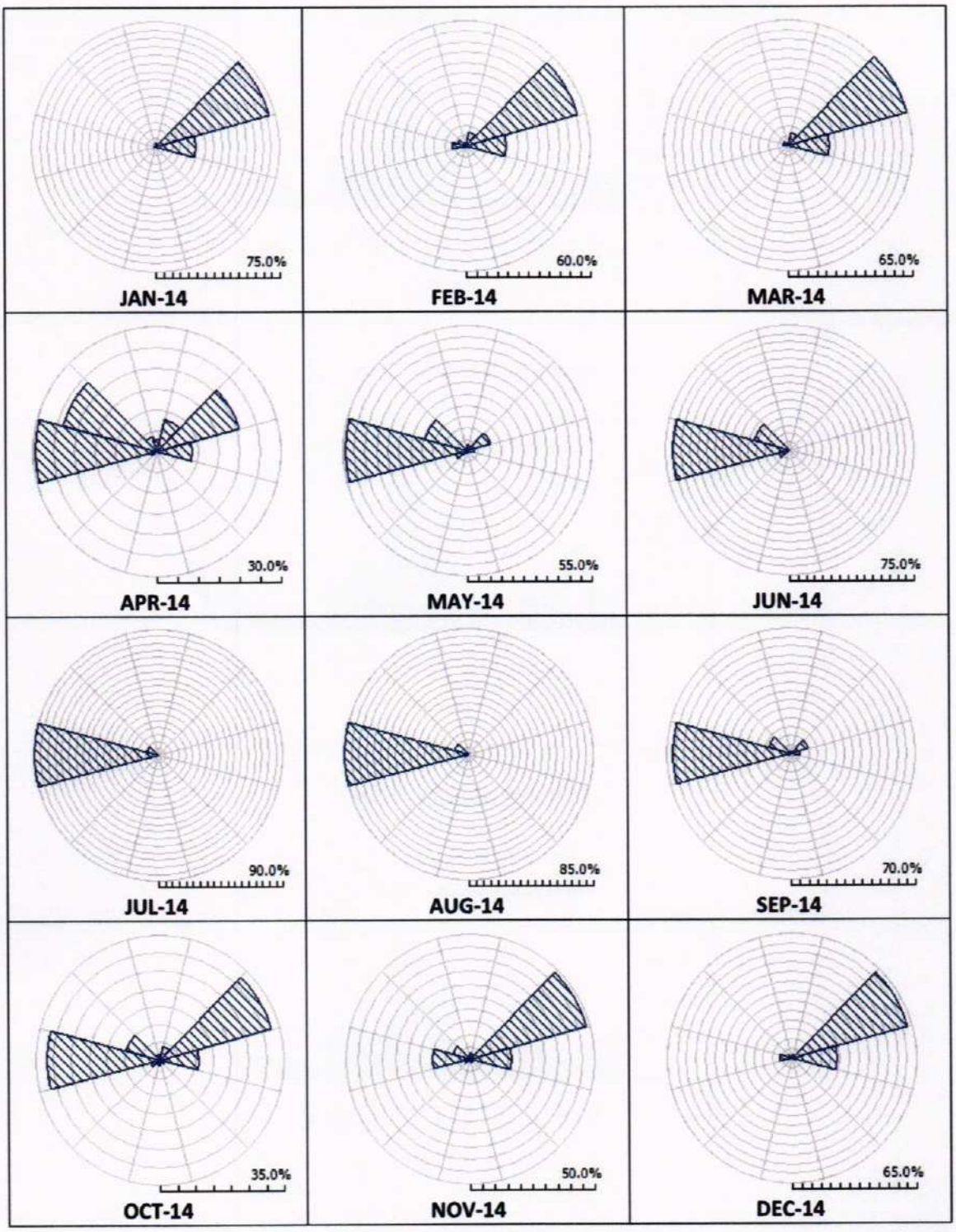


FIGURE 7: WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(January 2014 to December 2014)

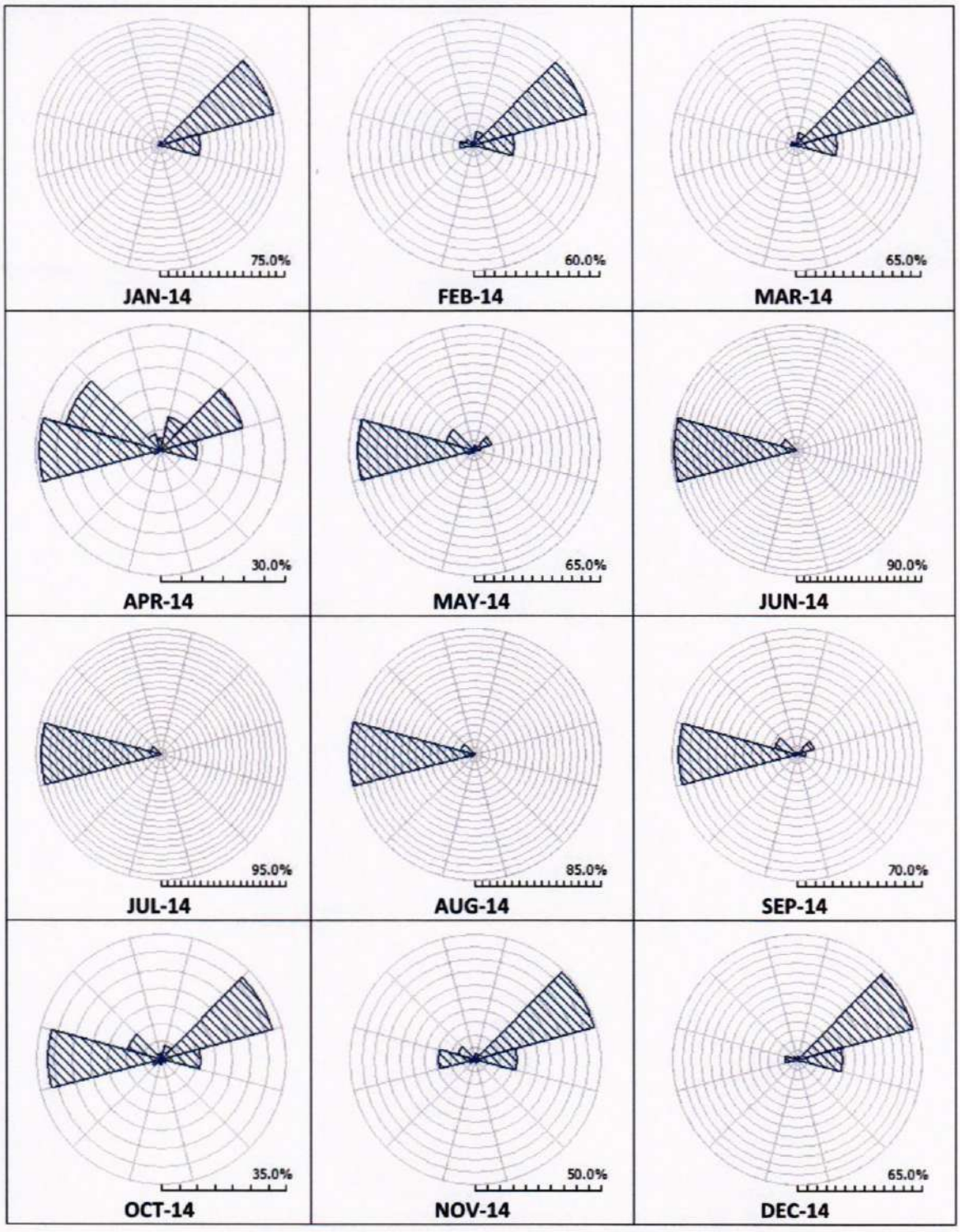


FIGURE 7A: WIND ROSE
SENSOR HEIGHT: (78m Anemometer and 78m Wind vane)
(January 2014 to December 2014)

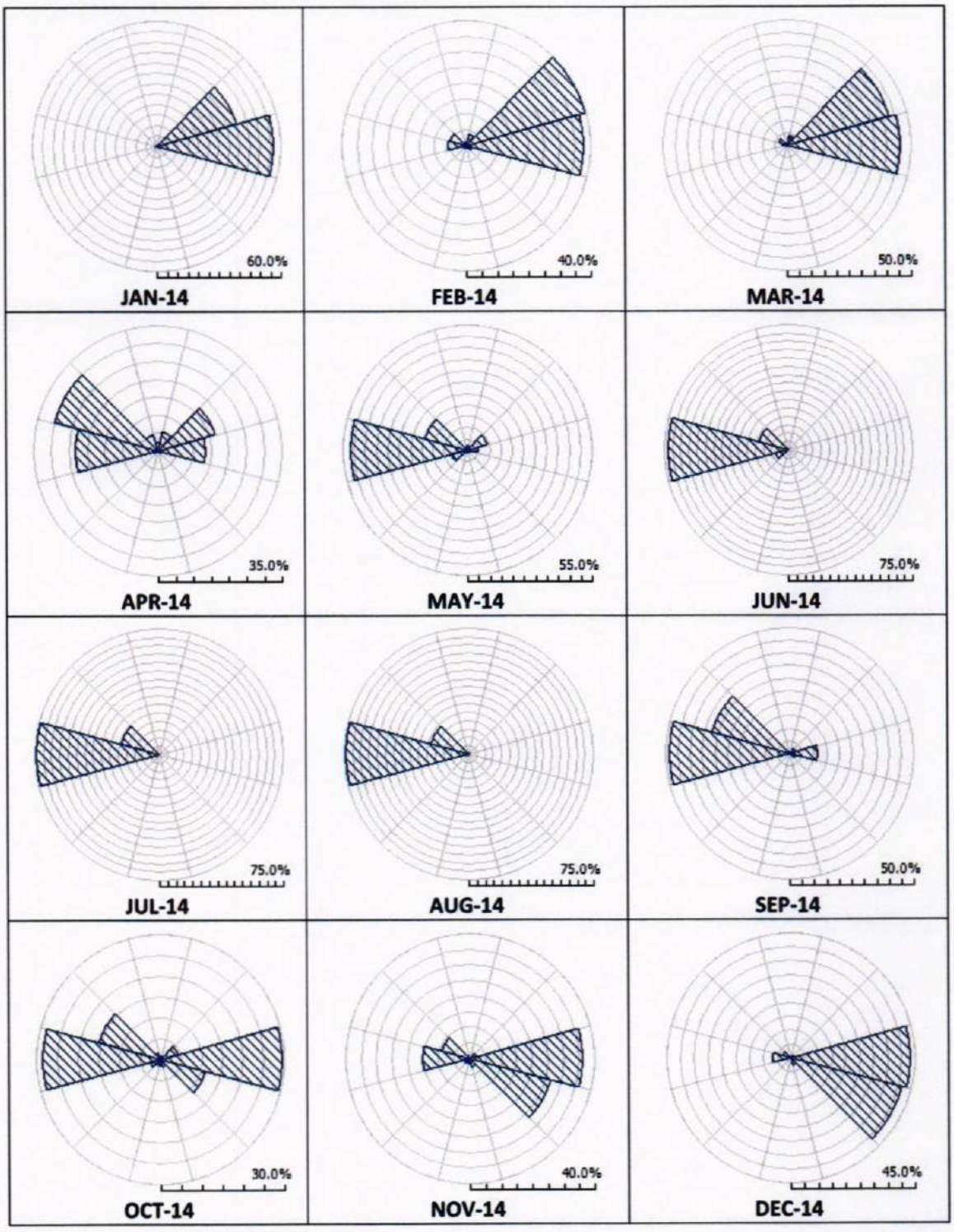


FIGURE 7B: WIND ROSE
SENSOR HEIGHT: (50m Anemometer and 48m Wind vane)
(January 2014 to December 2014)

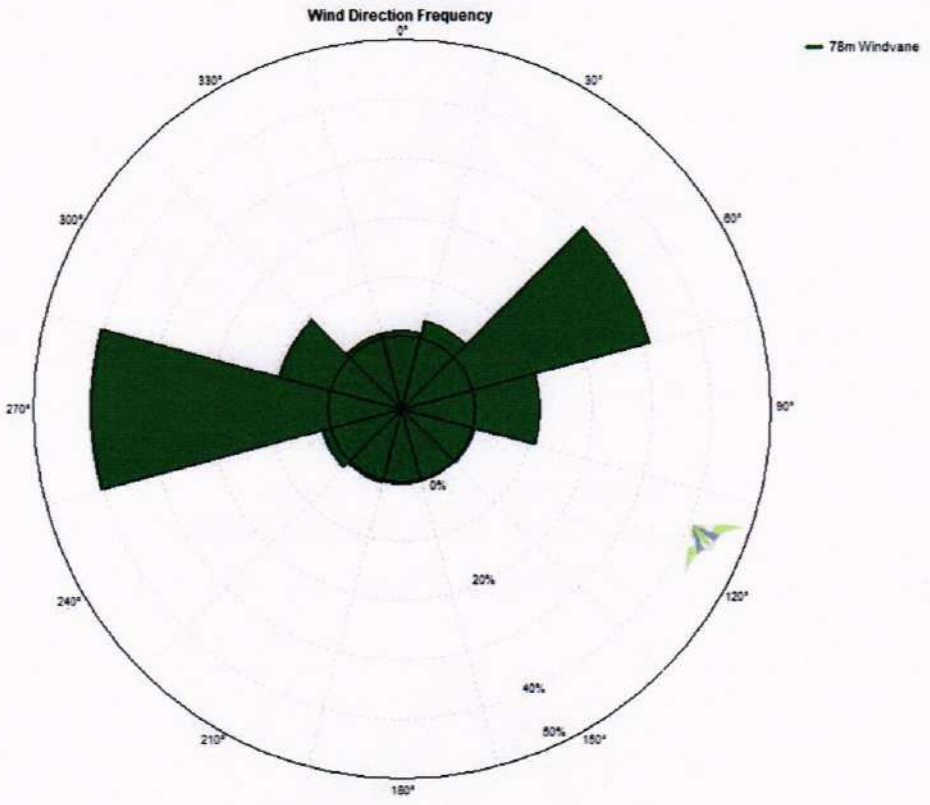
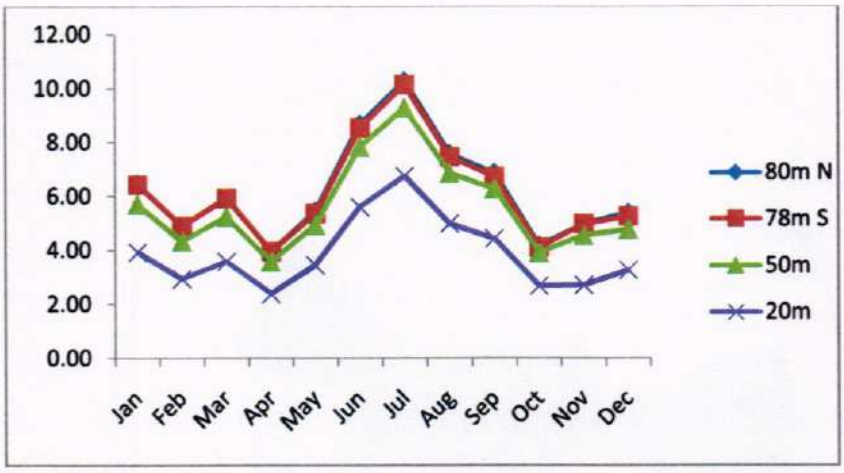


FIGURE 7C: ANNUAL WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(January 2014 to December 2014)



MONTHLY MEAN WIND SPEED
(JANUARY 2014 TO DECEMBER2014)height

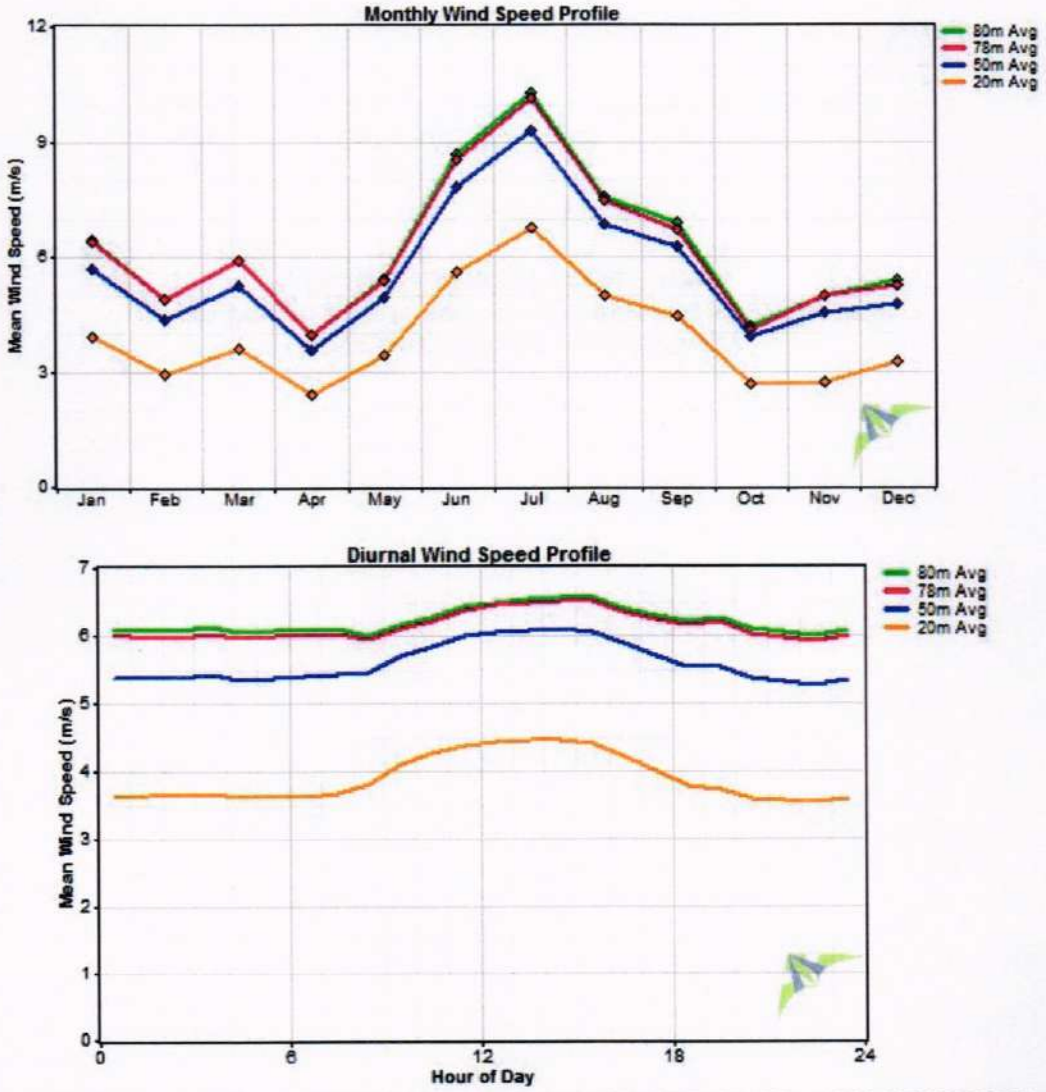


FIGURE 8: MONTHLY WIND SPEED AND DAILY WIND SPEED – KULATHUMEDU (JANUARY 2014 TO DECEMBER2014)

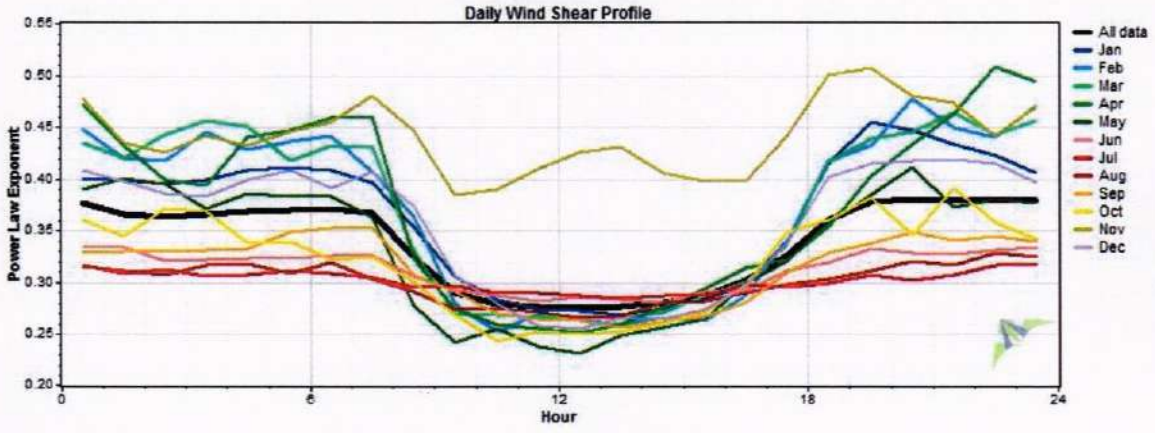


FIGURE 9: DAILY WIND SHEAR-KULATHUMEDU (JANUARY 2014 TO DECEMBER2014)

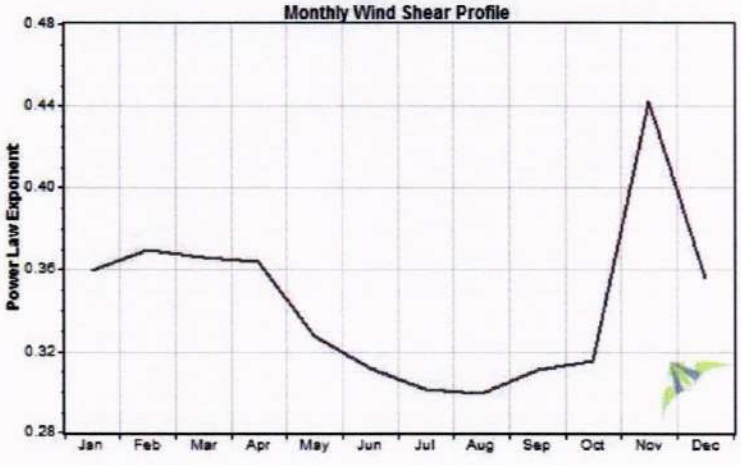


FIGURE 10: MONTHLY WIND SHEAR- KULATHUMEDU (JANUARY 2014 TO DECEMBER2014)

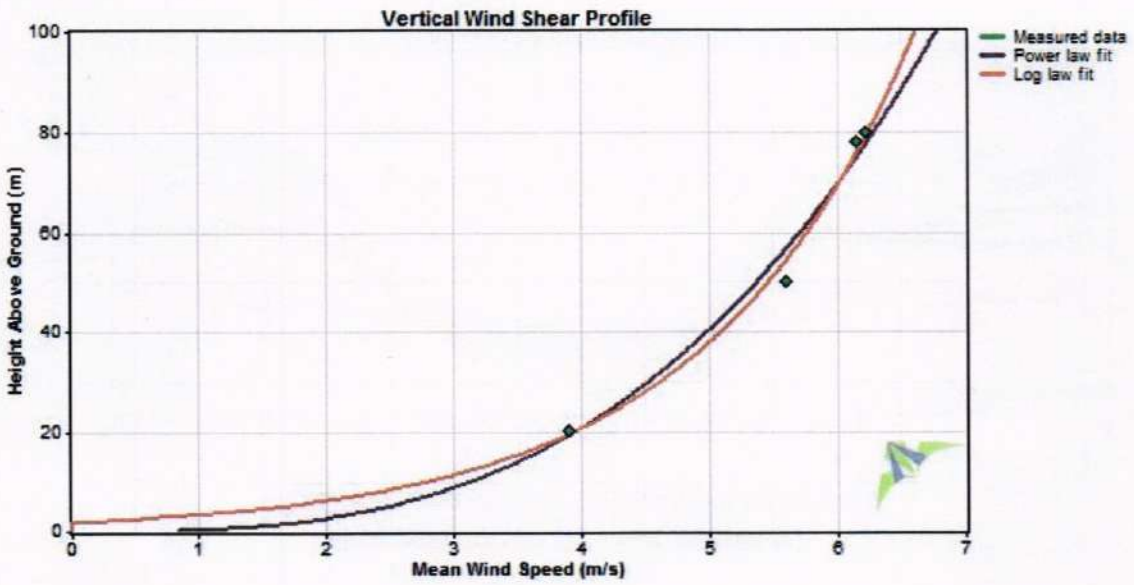
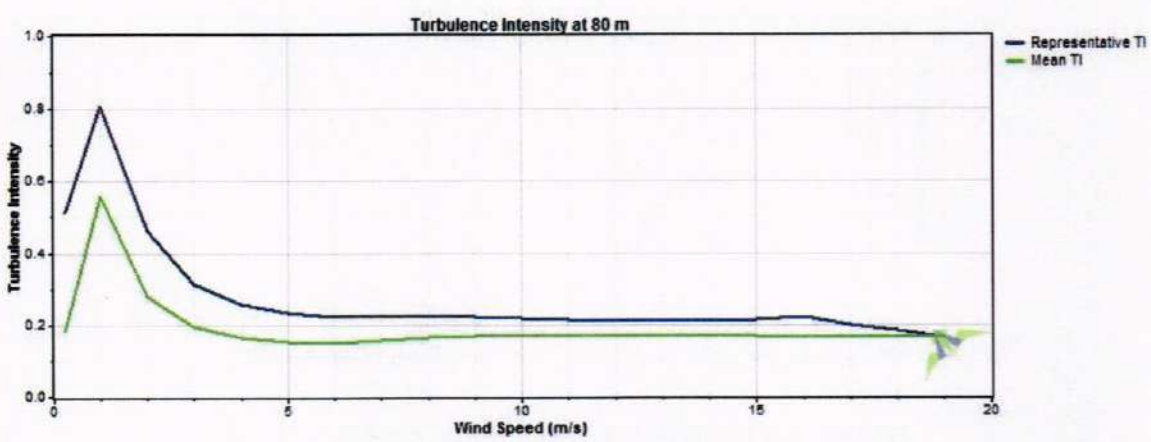
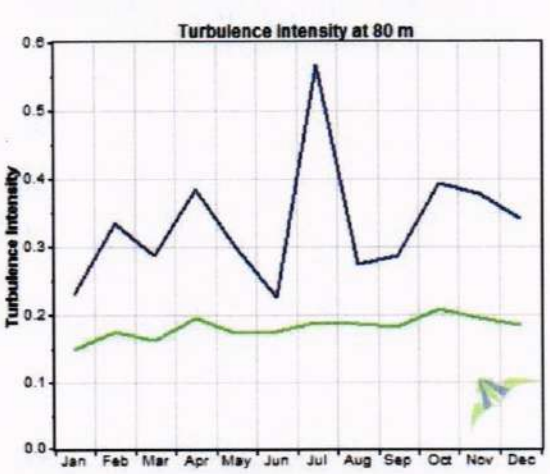
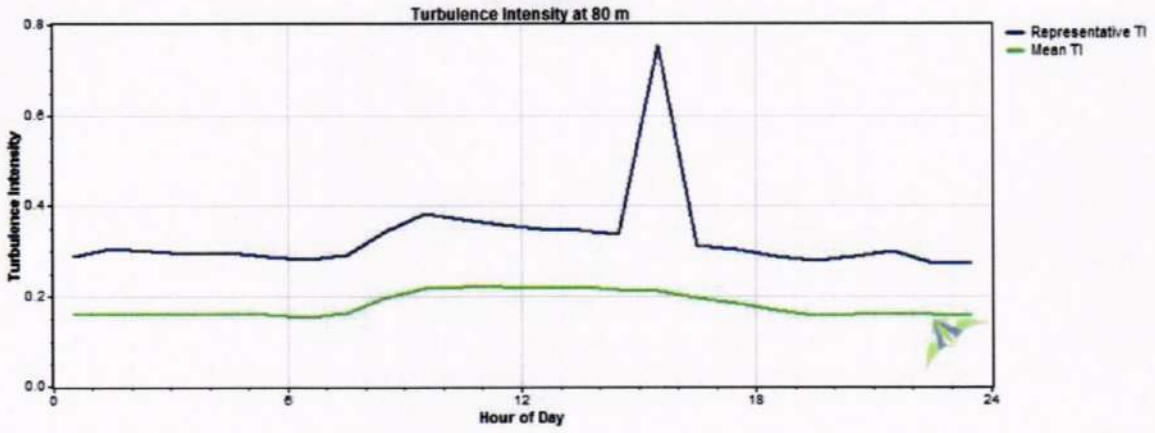


FIGURE 11: VERTICALWIND SHEAR- KULATHUMEDU (JANUARY 2014 TO DECEMBER2014)







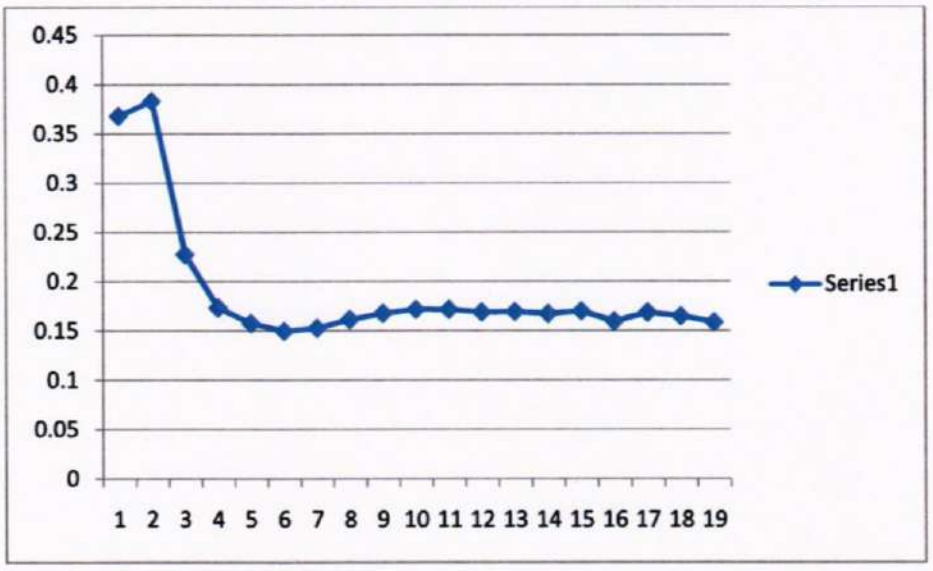
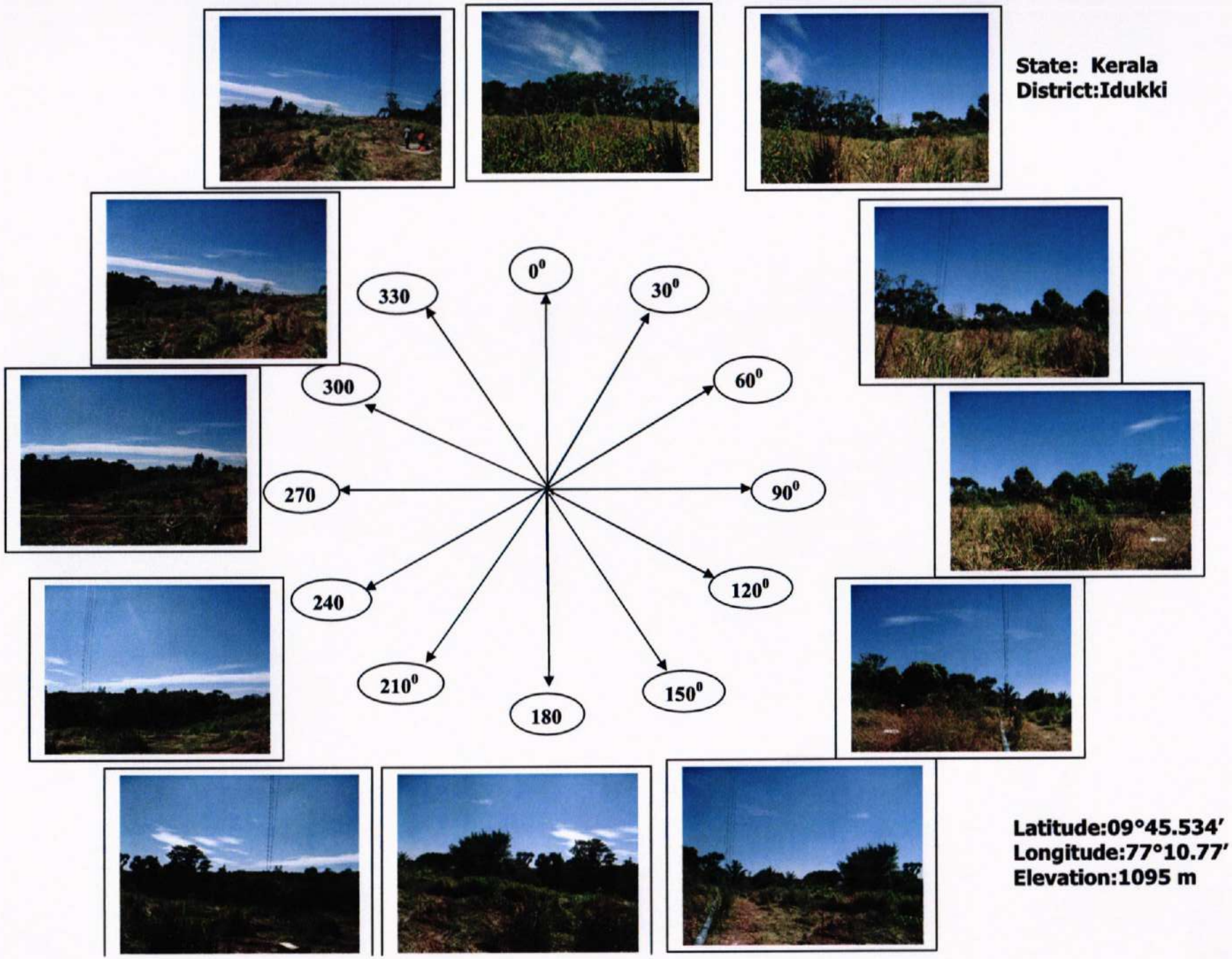


FIGURE 12: TURBULANCE INTENSITY – KULATHUMEDU (JANUARY 2014 TO DECEMBER2014)

Annexure -2

Site Photographs

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



State: Kerala
District:Idukki

Latitude:09°45.534'
Longitude:77°10.77'
Elevation:1095 m

NATIONAL INSTITUTE WIND ENERGY
CHENNAI

नीवे NIWE
(ISO 9001:2008)

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
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CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0902 **Date of issue:** February 9, 2011

Type: NRG #40 **Serial number:** 179500166133

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

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

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

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

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

Svend Ole Hansen

Calibration equation obtained: v [m/s] = 0.76544 · f [Hz] + 0.32715

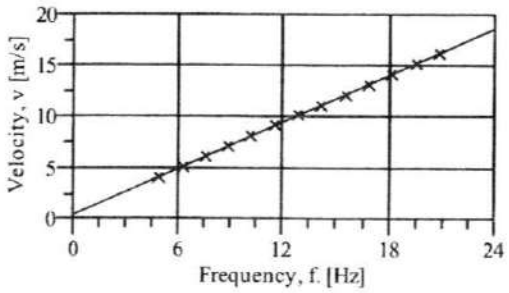
Standard uncertainty, slope: 0.00087 **Standard uncertainty, offset:** 0.02792

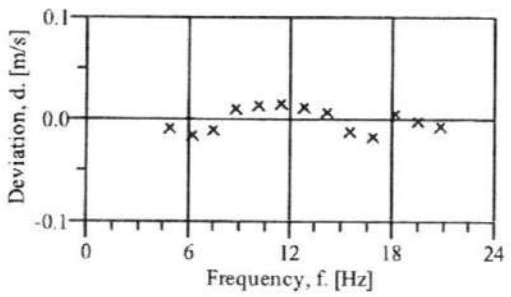
Covariance: -0.0000057 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999996$

Absolute maximum deviation: -0.016 m/s at 13.181 m/s

Barometric pressure: 1013.2 hPa **Relative humidity:** 22.2%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.80	27.2	23.8	4.089	4.9247	-0.008	0.028
4	15.17	27.1	23.8	5.088	6.2385	-0.014	0.032
6	21.69	27.0	23.8	6.082	7.5309	-0.010	0.037
8	29.76	26.9	23.8	7.124	8.8648	0.011	0.042
10	38.85	26.9	23.7	8.138	10.1864	0.014	0.048
12	49.19	26.8	23.7	9.157	11.5158	0.015	0.054
13-last	60.77	26.8	23.7	10.177	12.8518	0.012	0.060
11	73.22	26.8	23.7	11.172	14.1593	0.007	0.065
9	87.07	26.9	23.7	12.184	15.5053	-0.011	0.071
7	101.87	27.0	23.8	13.181	16.8137	-0.016	0.077
5	118.36	27.1	23.8	14.211	18.1312	0.005	0.083
3	136.12	27.1	23.8	15.242	19.4861	-0.001	0.089
1-first	154.33	27.4	23.8	16.236	20.7913	-0.005	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.

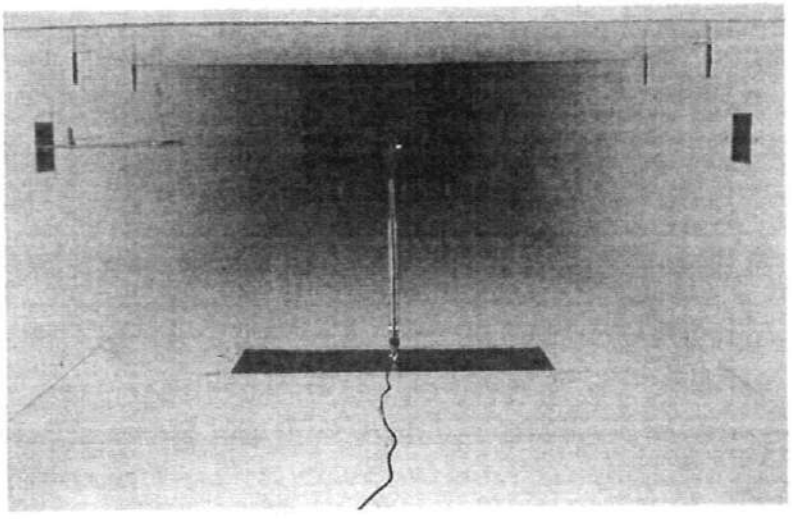

Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

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: 11.02.0902

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WIND
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DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0903 **Date of issue:** February 9, 2011

Type: NRG #40 **Serial number:** 179500166134

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

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

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

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

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

Svend Ole Hansen

Calibration equation obtained: v [m/s] = 0.76541 · f [Hz] + 0.28802

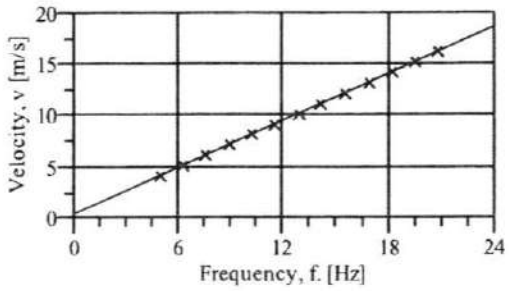
Standard uncertainty, slope: 0.00098 **Standard uncertainty, offset:** 0.03614

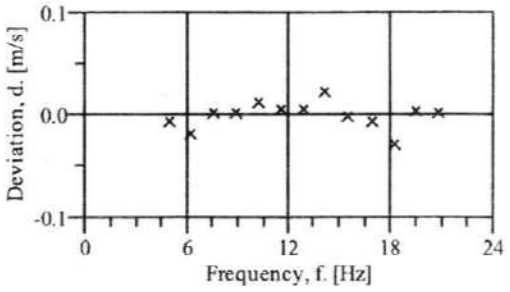
Covariance: -0.0000073 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999995

Absolute maximum deviation: -0.027 m/s at 14.204 m/s

Barometric pressure: 1013.5 hPa **Relative humidity:** 21.9%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.84	27.6	23.7	4.100	4.9884	-0.006	0.028
4	15.16	27.5	23.7	5.088	6.2956	-0.019	0.032
6	21.73	27.4	23.7	6.091	7.5780	0.003	0.037
8	29.66	27.3	23.7	7.116	8.9174	0.002	0.042
10	38.77	27.3	23.7	8.135	10.2350	0.013	0.048
12	49.00	27.2	23.7	9.145	11.5636	0.006	0.054
13-last	60.61	27.2	23.7	10.170	12.9029	0.006	0.060
11	72.87	27.3	23.7	11.153	14.1647	0.023	0.065
9	86.74	27.3	23.7	12.169	15.5236	-0.001	0.071
7	102.11	27.4	23.7	13.205	16.8844	-0.007	0.077
5	118.11	27.5	23.7	14.204	18.2167	-0.027	0.083
3	135.80	27.6	23.7	15.233	19.5211	0.004	0.089
1-first	154.43	27.8	23.8	16.251	20.8512	0.003	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.

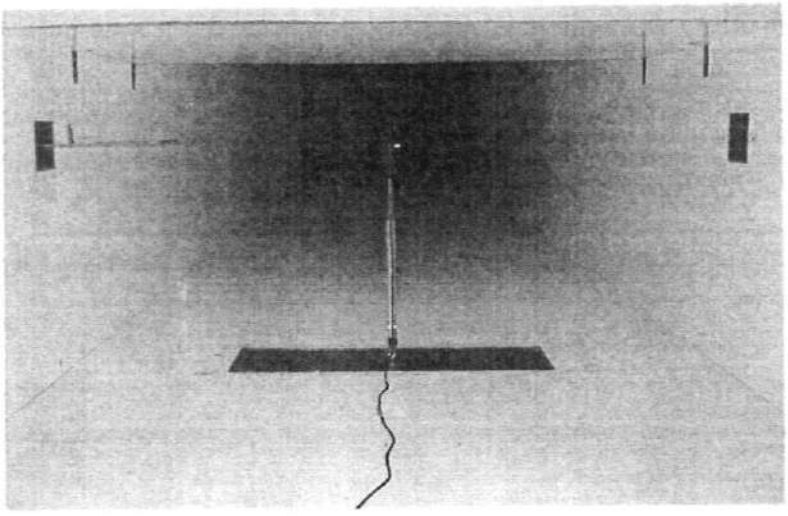

Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

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: 11.02.0903

Svend Ole Hansen ApS

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CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0904 **Date of issue:** February 9, 2011

Type: NRG #40 **Serial number:** 179500166135

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

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

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

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

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

Svend Ole Hansen

Calibration equation obtained: v [m/s] = 0.76166 · f [Hz] + 0.33942

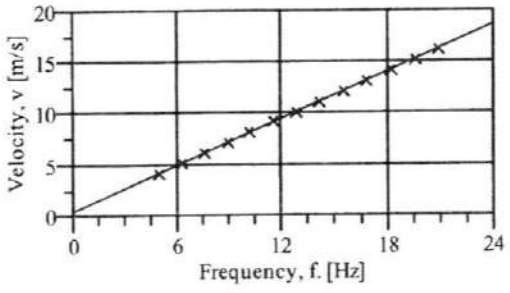
Standard uncertainty, slope: 0.00165 **Standard uncertainty, offset:** 0.05117

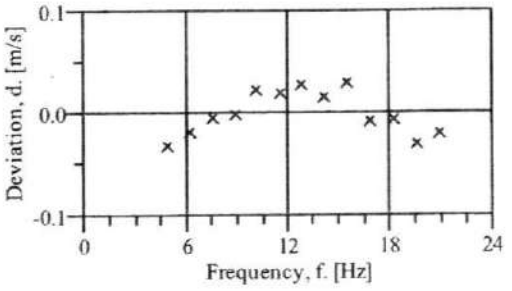
Covariance: -0.0000204 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999985$

Absolute maximum deviation: -0.032 m/s at 4.093 m/s

Barometric pressure: 1013.6 hPa **Relative humidity:** 21.8%

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	9.79	28.0	23.8	4.093	4.9710	-0.032	0.028
4	15.08	27.8	23.8	5.078	6.2455	-0.018	0.032
6	21.84	27.8	23.8	6.110	7.5831	-0.005	0.037
8	29.79	27.7	23.8	7.134	8.9225	-0.001	0.042
10	38.62	27.6	23.7	8.122	10.1874	0.024	0.048
12	49.09	27.5	23.7	9.157	11.5506	0.020	0.054
13-last	60.31	27.5	23.7	10.148	12.8415	0.028	0.059
11	72.97	27.5	23.7	11.164	14.1903	0.017	0.065
9	87.04	27.6	23.8	12.195	15.5268	0.029	0.071
7	101.28	27.7	23.8	13.157	16.8374	-0.007	0.077
5	118.17	27.8	23.8	14.214	18.2242	-0.006	0.083
3	135.88	27.9	23.8	15.245	19.6092	-0.030	0.089
1-first	154.54	28.2	23.8	16.265	20.9345	-0.019	0.095





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MEASNET

EQUIPMENT USED

Serial number	Description
-	Boundary layer wind tunnel.
1256	Control cup anemometer.
-	Mounting tube, D = 25 mm
t1	PT100 temperature sensor, wind tunnel.
t2	PT100 temperature sensor, control room.
9904031	PPC500 Furness pressure manometer
X4650038	HMW71U Humidity transmitter
X4350042	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.

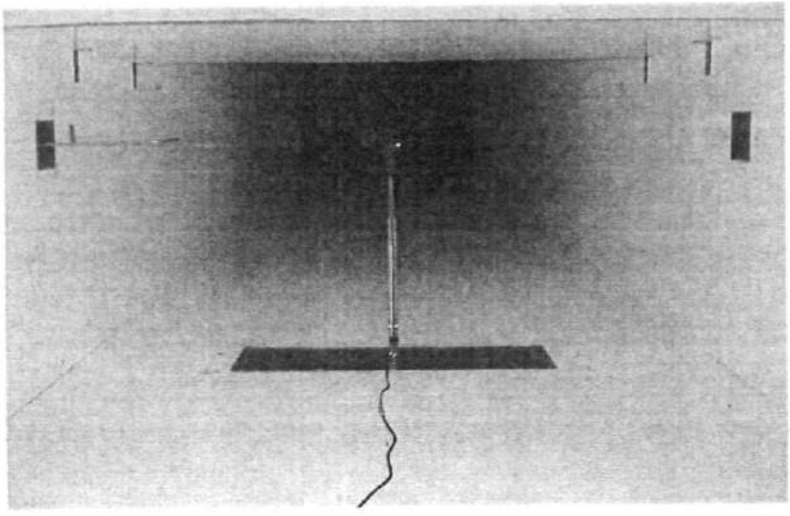

Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

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: 11.02.0904

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CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0905 **Date of issue:** February 9, 2011

Type: NRG #40 **Serial number:** 179500166136

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

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

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

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

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

Svend Ole Hansen

Calibration equation obtained: v [m/s] = 0.76446 · f [Hz] + 0.31602

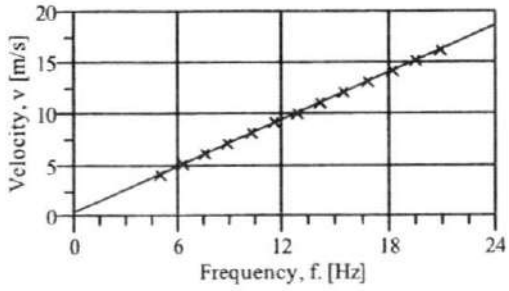
Standard uncertainty, slope: 0.00157 **Standard uncertainty, offset:** 0.05233

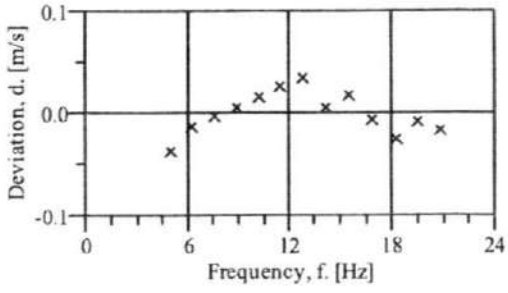
Covariance: -0.0000185 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999986$

Absolute maximum deviation: -0.037 m/s at 4.097 m/s

Barometric pressure: 1013.9 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	9.81	28.3	23.8	4.097	4.9948	-0.037	0.028
4	15.12	28.1	23.8	5.086	6.2570	-0.013	0.032
6	21.66	28.0	23.7	6.087	7.5509	-0.002	0.037
8	29.76	27.9	23.7	7.134	8.9103	0.006	0.042
10	38.73	27.8	23.7	8.136	10.2095	0.015	0.048
12	48.98	27.8	23.7	9.150	11.5200	0.027	0.054
13-last	60.15	27.7	23.7	10.138	12.8030	0.034	0.059
11	72.95	27.8	23.7	11.166	14.1844	0.006	0.065
9	86.51	27.9	23.7	12.161	15.4717	0.018	0.071
7	101.64	28.0	23.7	13.184	16.8418	-0.006	0.077
5	118.34	28.1	23.7	14.229	18.2325	-0.025	0.083
3	135.50	28.2	23.8	15.229	19.5172	-0.008	0.089
1-first	154.24	28.4	23.8	16.255	20.8704	-0.016	0.095





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measnet

EQUIPMENT USED

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

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

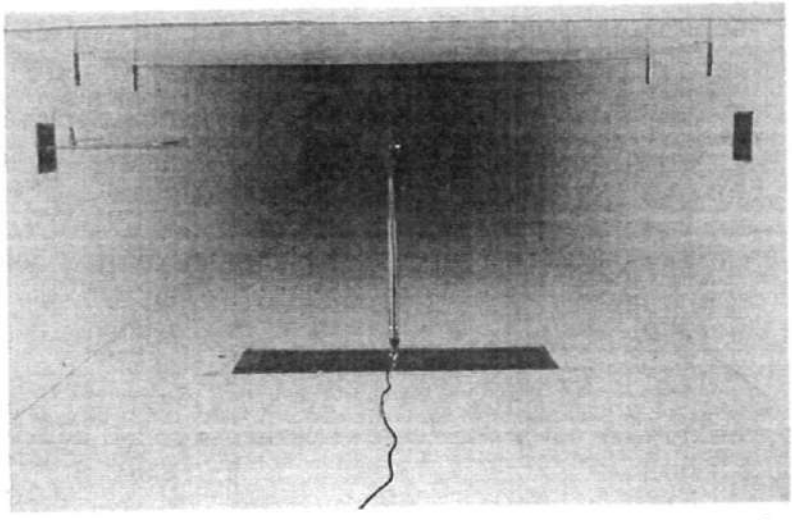

Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

UNCERTAINTIES

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

Certificate number: 11.02.0905