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

REPORT ON WIND MONITORING STUDY AT MALAMPUZHA DAM, PALAKKAD DISTRICT, KERALA

Final Report

Prepared for

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

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Prepared for

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

नीवे NIWE
(ISO 9001:2008)

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

July 2017

NATIONAL INSTITUTE OF WIND ENERGY

WIND RESOURCE ASSESSMENT UNIT

EXECUTIVE SUMMARY

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

The location Malampuzha Dam, Palakkad 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 15.05.2013 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 May 2015 and the data recovery rate is 99.90%.

Based on the analysis of two year data collected at Malampuzha Dam, the Mean Annual Wind Power Density (MAWPD) at 80m level for the period from June 2013 to May 2014 is found to be 163.49 W/m² and June 2014 to May 2015 is found to be 154.09 W/m² respectively. The predominant wind direction is found to be West (W) for both years.

Table of Contents

List of Figures

List of Tables & Annexure

REPORT ON WIND MONITORING STUDY AT MALAMPUZHA DAM, PALAKKAD DISTRICT, KERALA

1.0. BACKGROUND

M/s. Agency for Non-Conventional Energy and Rural Technology *(ANERT), Trivandrum* vide their letter no. *4431/WRA/ANERT/2009 dated 22.11.2011* - approached NIWE for a proposal to measure wind characteristics by establishing a Wind Monitoring study at Malampuzha Dam, Palakkad 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 15.05.2013 and data collection was carried out till May 2015. 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 Malampuzha Dam, 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 Malampuzha village, Palakkad District-Kerala and is approximately 6.66kms East from Chadayangulay town. The orography of the site is Plain Terrain and the soil type is known to be Alfisols.

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

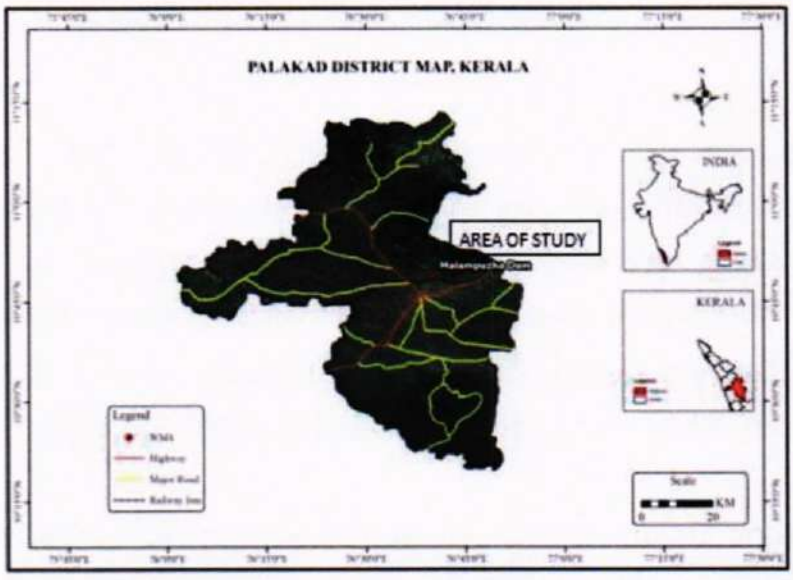

FIGURE 1: DISTRICT MAP OF PALAKKAD

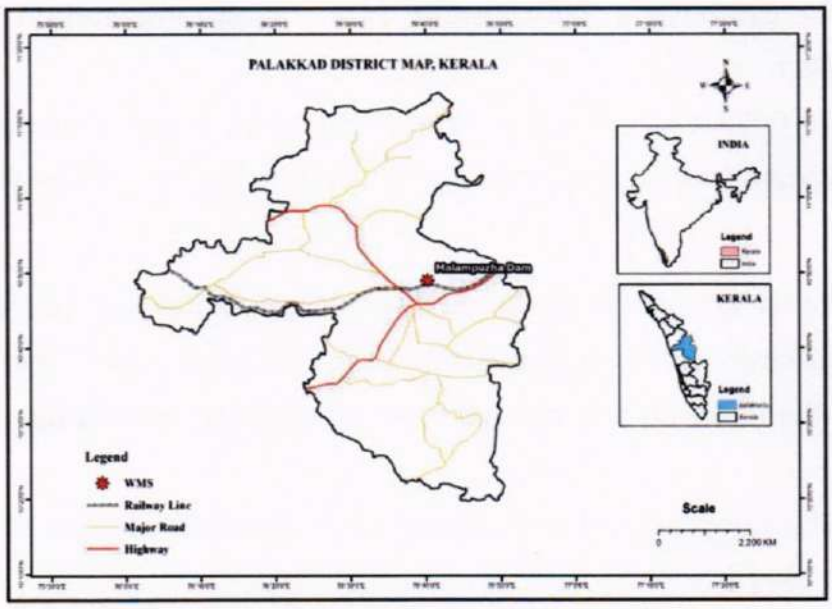

FIGURE.2. MAST LOCATION

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

Latitude	10° 48' 57.7" N
Longitude	076° 40' 10.3" E
Elevation	117 m AMSL SOI Topomap No.58-B9
State	Kerala
District	Palakkad
Taluk	Palakkad
Village	Malampuzha
Nearest town	Palakkad
Nearest Railway station	Olavakodu
Nearest Airport	Coimbatore
Orography	Plain Terrain
Soil	Alfisols
Earthquake	Zone III
Land Use	Vast land
Physiographic Division	Semi Complex Terrain
Nearest NIWE mast location	CHADAYANGULAY -6.66kms aerially towards East Latitude - 10°48'11" Longitude - 76°43'47"
Nearest wind farm in operation	Nil

4.0. DESCRIPTION OF THE MASTS &INSTRUMENTATION

A 80m tall guyed tubular wind mast was commissioned on 15.05.2013. 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, 78msouth, 50m & 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 at 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	179500166150 179500166147 179500166146 179500166143	0.76430 0.76417 0.76440 0.76288	0.32285 0.30537 0.33178 0.31667
Wind Vane	78m 48m	610 609	-	-
Temperature sensor	10m	005	-	-
Pressure Sensor	8m	18178	-	-

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, 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 Malapuzham Dam, Palakkadas per the project terms & conditions and Two-year data collection was completed in the month of May 2015.As the data collection at the location for Two year, the customer had been informed by NIWE in May 2015that the data collection would be completed and terminates in the month of June 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 Malapuzham Dam are given in Table 4 and 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 &80msoutharegiven in Table 6, 6A, 6Band6C 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 99.90%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)
2013-2014	46.23	109.68	166.63	163.49
2014-2015	41.86	98.51	150.40	154.90

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)
2013-2014	3.54	4.85	5.68	5.62
2014-2015	3.32	4.55	5.35	5.40

Year	Mean Annual		
	Temperature ^{0} C	Air density Kg/m^3	Power law
2013-2014	27.41	1.158	0.33
2014-2015	27.13	1.160	0.34

7.1. WIND FREQUENCY DISTRIBUTION

A common method of displaying a year wind data is by wind frequency distribution, which shows the percentage of time that each wind speed occurs. Table 7, 7A, 7B and 7C of Annexure-1 shows 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 shows the joint frequency distribution for 50m, 78msouth and 80msouth 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 shows the monthly wind roses at 80msouth, 78msouth and 50mheights. From the wind roses, it is revealed that the wind is flowing predominantly from West (W) direction.

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 July 2013 to May 2014(at 80m AGL) at15m/s is 0.17 (17%)&July 2014 to May 2015 (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& 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 May 2015at 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: 10° 48' 57.7"
Longitude Range: 076° 40' 10.3"
**AMSL – Above Mean Sea Level*

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
2004	2.9	2.8	2.6	1.9	4.0	5.5	4.8	5.3	3.1	3.0	3.3	3.6	3.6
2005	2.6	2.7	2.2	1.8	2.7	5.1	5.5	4.7	4.4	2.4	2.8	2.8	3.3
2006	3.3	3.4	2.0	2.2	3.7	4.5	5.8	4.8	3.8	2.7	2.5	3.9	3.5
2007	3.7	2.9	2.0	1.8	3.4	4.6	5.0	4.3	4.1	2.7	2.4	3.8	3.4
2008	3.2	2.5	3.0	2.1	3.6	4.8	4.8	4.0	4.0	2.5	2.5	3.4	3.4
2009	3.4	2.8	2.0	2.4	3.3	5.0	5.9	4.2	4.1	2.8	2.8	3.2	3.5
2010	3.0	2.4	2.5	2.0	3.3	4.9	5.1	4.8	3.2	3.1	2.1	2.6	3.3
2011	3.1	2.7	2.4	1.9	3.4	5.2	5.0	4.9	4.2	2.5	3.2	3.4	3.5
2012	3.0	3.3	2.5	2.1	3.5	4.7	4.9	4.5	3.9	2.8	2.4	3.7	3.5
2013	3.2	3.2	2.7	2.3	3.3	5.5	5.7	4.3	4.0	2.9	2.4	3.2	3.5
2014	3.1	2.5	2.6	2.1	2.7	4.8	5.5	4.5	3.6	2.2	2.9	3.1	3.3
2015	2.7	2.8	2.2	1.7	2.6								2.7
						AVG							3.4

TABLE 3: MERRA REANALYSIS DATA FOR, MALAMPUZHA DAM, KERALA (JANUARY 2004 –MAY 2015)

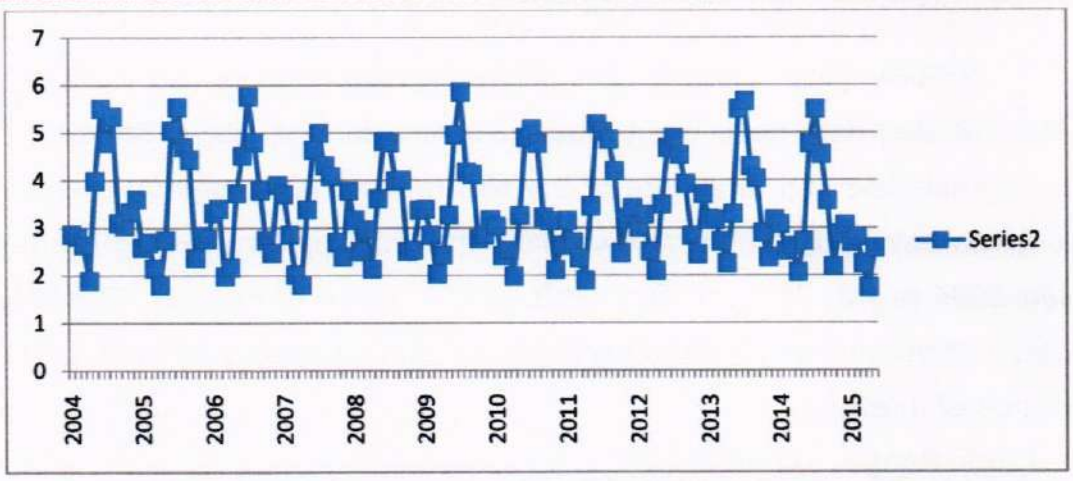

FIGURE.3A. MERRA REANALYSIS DATA FOR MALAMPUZHA DAM, KERALA (JANUARY 2004 – MAY 2015)

8.0. CONCLUSION

Based on the analysis of two year data collected at Malampuzha Dam, the Mean Annual Wind Power Density (MAWPD) at 80m level for the period from June 2013 to May 2014 is found to be 163.49W/$m^2$and June 2014 to May 2015 is found to be 154.09 W/m^2.

The monthly average wind speed at 80m level for the period from June 2013 to May 2014 is found to be 5.62 m/s and June 2014 to May 2015 is found to be 5.40 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 not having promising wind power potential for the development of large-scale wind power projects at the area of interest.

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MALAMPUZHA DAM

2013 - 2015

Annexure-1

Data(Tables & Figures)

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MALAMPUZHA DAM

STATE	:	KERALA
DISTRICT	:	PALAKKAD
TALUK	:	PALAKKAD
VILLAGE	:	MALAMPUZHA
LATITUDE	:	10° 48' 57.7" N
LONGITUDE	:	076° 40' 10.3" E
ELEVATION	:	117M AMSL
INSTRUMENTS USED	:	NOMAD-2
PERIOD OF DATA	:	JUNE 2013 to MAY 2015
COMMISSIONED ON	:	15.05.2013
MAST HEIGHT	:	80m
MEASURED WIND SPEED AT 80m south AGL (JUNE 2013 to MAY 2014)	:	5.62 m/s
MEASURED WIND SPEED AT 78m south AGL (JUNE 2013 to MAY 2014)	:	5.68 m/s
MEASURED WIND SPEED AT 50m AGL (JUNE 2013 to MAY 2014)	:	4.85 m/s
MEASURED WIND POWER DENSITY AT 80m south AGL (JUNE 2013 to MAY 2014)	:	163.49 W/m^2
MEASURED WIND POWER DENSITY AT 78m south AGL (JUNE 2013 to MAY 2014)	:	166.63 W/m^2
MEASURED WIND POWER DENSITY AT 50m AGL (JUNE 2013 to MAY 2014)	:	109.68 W/m^2
MEASURED WIND SPEED AT 80m south AGL (JUNE 2014 to MAY 2015)	:	5.40 m/s

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MEASURED WIND SPEED AT 78m south AGL (JUNE 2014 to MAY 2015)	***:***	***5.35 m/s***
MEASURED WIND SPEED AT 50m AGL (JUNE 2014 to MAY 2015)	***:***	***4.55 m/s***
MEASURED WIND POWER DENSITY AT 80m south AGL (JUNE 2014 to MAY 2015)	***:***	***154.94 W/m^2***
MEASURED WIND POWER DENSITY AT 78m south AGL (JUNE 2014 to MAY 2015)	***:***	***150.40 W/m^2***
MEASURED WIND POWER DENSITY AT 50m AGL (JUNE 2014 to MAY 2015)	***:***	***98.51 W/m^2***
SOI TOPO MAP NUMBER	***:***	***58-B9***

Ist Year

Jun 2013 - May 2014

TABLE 4

MALAMPUZHA DAM

CONSOLIDATED TABLE

	JAN-14	FEB-14	MAR-14	APR-14	MAY-14	JUN-13	JUL-13	AUG-13	SEP-13	OCT-13	NOV-13	DEC-13	ANNUAL
Monthly Mean Wind Speed (m/s)													
20m	5.00	3.34	3.31	2.76	3.38	3.83	3.96	3.80	3.43	2.79	2.89	3.97	3.54
50m	6.84	4.68	4.60	3.71	4.59	5.26	5.44	4.98	4.66	3.85	4.06	5.57	4.85
78 m	7.67	5.27	5.16	4.28	5.37	6.36	6.58	6.05	5.71	4.74	4.69	6.33	5.68
80m	7.66	5.22	5.06	4.07	5.24	6.34	6.56	5.98	5.67	4.69	4.66	6.32	5.62
Monthly Wind Power Density (Watts/Sq.m)													
20m	102.99	45.64	44.49	25.51	38.51	44.90	48.22	46.19	35.18	24.34	32.43	66.33	46.23
50m	243.61	109.58	104.69	54.94	87.05	108.28	117.54	102.48	81.26	57.28	80.30	169.18	109.68
78 m	341.89	154.20	144.18	80.32	131.32	182.80	199.95	169.75	136.47	94.11	119.39	245.20	166.63
80m	342.32	152.56	141.01	73.83	124.40	179.59	196.32	163.58	132.91	90.35	119.03	245.94	163.49
Power Law Index (PLI)													
	0.31	0.32	0.31	0.28	0.32	0.36	0.36	0.33	0.36	0.37	0.34	0.34	0.33
Energy Pattern Factor													
20m	1.42	2.12	2.13	2.12	1.74	1.38	1.34	1.45	1.50	1.93	2.31	1.83	1.77
50m	1.31	1.85	1.88	1.88	1.56	1.29	1.26	1.43	1.38	1.73	2.06	1.68	1.61
78 m	1.31	1.83	1.83	1.79	1.47	1.23	1.21	1.32	1.26	1.52	1.99	1.66	1.54
80m	1.31	1.86	1.89	1.90	1.51	1.22	1.20	1.31	1.25	1.50	2.03	1.68	1.56
Air Density (kg/m^3)													
	1.160	1.156	1.149	1.148	1.151	1.157	1.162	1.163	1.164	1.163	1.159	1.163	1.158
Temperature (^{0} C)													
	27.35	27.97	29.88	29.82	28.55	--	--	25.85	25.40	25.91	27.14	26.27	27.41
Turbulance Intensity (at 80m agl)													
At 15m/s : 0.17													
Data Availability (Based on 10 Minutes Interval)													
	4464	4032	4464	4320	4464	4319	4464	4457	4320	4464	4320	4464	

Based on Data June 2013 to May 2014

TABLE 5

MALAMPUZHA DAM

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)
6.84	7.66	7.67	1.16	1.10	1.08	15.44 1/26/2014 11:30	16.39 1/26/2014 11:30	16.38 1/26/2014 11:30	E	E
4.68	5.22	5.27	0.84	0.81	0.81	11.43 2/1/2014 8:40	12.27 2/1/2014 8:40	12.21 2/1/2014 8:40	E	E
4.60	5.06	5.16	0.90	0.88	0.87	11.23 3/26/2014 11:50	11.94 3/14/2014 9:20	11.90 3/14/2014 9:20	E	E
3.71	4.07	4.28	0.73	0.73	0.72	10.17 4/10/2014 18:40	11.14 4/10/2014 17:20	11.34 4/10/2014 17:20	W	W
4.59	5.24	5.37	0.82	0.79	0.79	11.08 5/28/2014 18:50	12.45 5/28/2014 18:50	12.51 5/28/2014 18:50	W	W
5.26	6.34	6.36	1.00	0.95	0.97	13.13 6/14/2013 13:40	14.95 6/14/2013 13:40	15.06 6/14/2013 13:40	W	W
5.44	6.56	6.58	1.03	0.98	1.01	12.01 7/31/2013 13:00	13.87 7/31/2013 13:00	14.06 7/31/2013 13:00	W	W
4.98	5.98	6.05	0.95	0.89	0.91	12.71 8/1/2013 13:50	14.24 8/1/2013 13:50	14.32 8/1/2013 13:50	W	W
4.66	5.67	5.71	0.85	0.79	0.81	11.96 9/18/2013 15:30	13.07 9/18/2013 15:30	13.22 9/18/2013 15:30	W	W
3.85	4.69	4.74	0.70	0.67	0.67	9.51 10/18/2013 17:50	10.62 10/18/2013 17:50	10.74 10/18/2013 17:50	W	W
4.06	4.66	4.69	0.74	0.72	0.71	11.64 11/18/2013 18:20	13.75 11/18/2013 18:20	13.69 11/18/2013 18:20	SE	SE
5.57	6.32	6.33	0.96	0.92	0.91	13.94 12/13/2013 10:00	15.73 12/13/2013 8:20	15.70 12/13/2013 8:20	E	E
4.85	**5.62**	**5.68**	**0.89**	**0.85**	**0.86**	**15.44 1/26/2014 11:30**	**16.39 1/26/2014 11:30**	**16.38 1/26/2014 11:30**	**W**	**W**

Based on Data June 2013 to May 2014

TABLE 6

MALAMPUZHA DAM

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	7.67	7.78	7.96	8.35	8.76	9.08	9.18	9.10	8.70	8.57	8.49	8.46	8.32	7.95	7.67	7.20	6.75	6.10	6.08	6.25	6.18	6.26	6.36	6.68	7.66
FEB	3.66	4.13	4.50	4.92	5.26	5.52	5.60	5.51	5.97	6.31	6.54	6.37	6.08	5.58	5.08	4.67	4.65	4.72	5.38	6.01	5.27	5.00	4.57	3.94	5.22
MAR	3.69	3.53	3.33	3.70	4.04	4.46	4.65	4.84	4.62	5.36	5.70	5.94	6.40	6.42	6.24	5.85	5.43	5.74	6.09	6.17	5.31	5.18	4.67	4.21	5.06
APR	4.00	3.63	3.42	3.04	2.49	2.20	2.19	2.02	1.90	2.49	3.16	3.63	3.99	4.22	4.51	4.97	5.87	7.05	7.30	6.32	5.57	5.00	4.55	4.22	4.07
MAY	4.35	4.25	4.04	4.16	4.44	4.29	3.98	3.72	3.90	4.55	5.29	5.81	6.00	6.25	6.70	6.65	6.88	6.95	6.46	6.03	5.64	5.24	5.05	5.02	5.24
JUN	5.71	5.73	6.07	6.20	5.90	5.87	6.12	5.86	5.97	6.19	6.39	6.95	7.06	7.61	7.39	7.13	7.09	6.94	6.41	6.24	6.13	5.89	5.97	5.87	6.36
JUL	6.20	6.24	6.14	6.33	6.05	6.05	5.97	6.12	5.87	6.16	6.33	6.48	7.19	7.66	7.62	7.59	7.65	7.04	7.07	6.68	6.58	6.23	6.08	6.20	6.56
AUG	5.52	5.63	5.45	5.16	5.15	5.09	4.99	5.08	5.35	5.74	6.25	6.69	7.29	7.54	7.89	7.73	7.57	7.27	6.75	6.13	5.55	5.68	5.41	5.29	6.09
SEP	5.40	5.54	5.62	5.37	4.75	4.58	4.49	4.30	4.37	5.09	5.52	5.63	6.20	6.66	6.72	6.97	7.06	6.68	6.35	6.00	5.82	5.60	5.64	5.74	5.67
OCT	4.20	4.12	3.91	4.00	3.86	3.84	3.65	3.53	3.61	4.26	4.50	4.77	5.16	5.48	5.73	5.80	5.66	5.89	5.98	5.47	5.18	4.94	4.61	4.48	4.69
NOV	3.77	3.93	4.05	4.62	5.07	5.12	5.16	5.07	4.79	5.23	5.47	5.45	5.34	5.25	4.68	4.38	4.42	4.73	4.92	4.65	4.25	4.21	3.78	3.43	4.66
DEC	6.14	6.30	6.43	6.54	6.76	6.92	7.21	7.34	7.21	7.19	7.07	6.78	6.57	6.03	5.79	5.49	5.14	5.10	5.63	6.02	5.70	5.79	6.18	6.30	6.32
Annual	5.03	5.07	5.08	5.20	5.21	5.25	5.27	5.21	5.19	5.59	5.89	6.08	6.30	6.39	6.34	6.20	6.18	6.18	6.20	6.00	5.60	5.42	5.24	5.11	5.63

SENSOR HEIGHT: 80m

Based on Data June 2013 to May 2014

TABLE 6A

MALAMPUZHA DAM

MEAN HOURLY WIND SPEED

MONTH	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	7.68	7.78	7.96	8.34	8.74	9.06	9.16	9.08	8.68	8.57	8.50	8.47	8.34	7.97	7.68	7.22	6.77	6.13	6.10	6.28	6.22	6.29	6.38	6.69	7.67
FEB	3.74	4.19	4.54	4.97	5.30	5.54	5.61	5.51	5.97	6.33	6.57	6.40	6.12	5.63	5.13	4.72	4.71	4.79	5.46	6.10	5.35	5.07	4.63	4.01	5.27
MAR	3.82	3.67	3.45	3.81	4.11	4.54	4.74	4.92	4.74	5.46	5.79	6.02	6.47	6.49	6.32	5.94	5.52	5.82	6.18	6.27	5.41	5.28	4.78	4.33	5.16
APR	4.22	3.85	3.65	3.30	2.72	2.42	2.44	2.27	2.15	2.70	3.35	3.81	4.16	4.39	4.67	5.12	6.02	7.20	7.46	6.50	5.77	5.21	4.77	4.45	4.28
MAY	4.52	4.42	4.23	4.31	4.57	4.43	4.10	3.85	4.03	4.69	5.42	5.93	6.13	6.37	6.82	6.77	7.01	7.08	6.59	6.16	5.78	5.39	5.19	5.17	5.37
JUN	5.70	5.72	6.08	6.22	5.91	5.88	6.14	5.86	5.99	6.21	6.41	6.99	7.09	7.66	7.43	7.17	7.14	6.98	6.43	6.24	6.13	5.91	5.99	5.87	6.38
JUL	6.20	6.25	6.14	6.33	6.03	6.03	5.96	6.11	5.83	6.14	6.32	6.51	7.26	7.74	7.69	7.65	7.72	7.09	7.11	6.71	6.61	6.24	6.08	6.20	6.58
AUG	5.58	5.69	5.49	5.19	5.17	5.11	5.01	5.10	5.40	5.79	6.33	6.78	7.39	7.65	8.01	7.87	7.68	7.37	6.84	6.20	5.62	5.73	5.46	5.35	6.16
SEP	5.42	5.55	5.63	5.37	4.76	4.59	4.51	4.32	4.36	5.11	5.57	5.69	6.27	6.74	6.81	7.05	7.14	6.74	6.39	6.04	5.86	5.62	5.68	5.76	5.71
OCT	4.24	4.16	3.94	4.04	3.89	3.88	3.66	3.53	3.62	4.29	4.54	4.84	5.23	5.55	5.81	5.87	5.74	5.97	6.06	5.53	5.25	5.00	4.67	4.53	4.74
NOV	3.82	3.96	4.09	4.66	5.10	5.14	5.17	5.08	4.82	5.26	5.50	5.48	5.38	5.29	4.71	4.42	4.45	4.77	4.96	4.70	4.30	4.26	3.84	3.47	4.69
DEC	6.15	6.30	6.44	6.55	6.77	6.92	7.21	7.34	7.22	7.22	7.09	6.80	6.60	6.06	5.82	5.51	5.16	5.12	5.63	6.03	5.71	5.80	6.19	6.31	6.33
Annual	5.09	5.13	5.14	5.26	5.26	5.29	5.31	5.25	5.23	5.65	5.95	6.14	6.37	6.46	6.41	6.28	6.26	6.26	6.27	6.06	5.67	5.48	5.30	5.18	5.70

SENSOR HEIGHT: 78m

Based on Data June 2013 to May 2014

TABLE 6B

MALAMPUZHA DAM **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	6.84	6.91	7.04	7.38	7.67	7.93	8.02	7.90	7.66	7.75	7.82	7.82	7.69	7.36	7.08	6.65	6.18	5.45	5.25	5.46	5.34	5.46	5.61	5.93	6.84
FEB	3.19	3.67	4.10	4.57	4.73	4.75	4.80	4.79	5.21	5.78	6.08	5.95	5.70	5.25	4.78	4.40	4.32	4.29	4.71	5.17	4.51	4.24	3.90	3.41	4.68
MAR	3.22	3.13	2.99	3.27	3.54	3.90	4.04	4.20	4.26	5.05	5.38	5.65	6.07	6.04	5.88	5.55	5.08	5.28	5.44	5.34	4.60	4.57	4.08	3.74	4.60
APR	3.37	3.09	2.91	2.58	2.08	1.84	1.96	1.84	1.97	2.49	3.14	3.62	3.93	4.12	4.40	4.75	5.48	6.43	6.58	5.56	4.92	4.37	3.94	3.62	3.71
MAY	3.58	3.52	3.36	3.47	3.69	3.49	3.18	3.11	3.52	4.26	4.98	5.46	5.64	5.87	6.26	6.13	6.24	6.21	5.66	5.11	4.72	4.39	4.25	4.17	4.59
JUN	4.46	4.51	4.83	5.00	4.67	4.64	4.95	4.73	4.98	5.33	5.55	6.08	6.20	6.65	6.44	6.16	6.11	5.87	5.27	5.01	4.92	4.69	4.79	4.64	5.27
JUL	5.05	5.06	4.95	5.11	4.86	4.81	4.72	4.94	4.80	5.17	5.43	5.62	6.27	6.69	6.58	6.50	6.54	5.95	5.86	5.45	5.33	4.98	4.85	5.01	5.44
AUG	4.32	4.46	4.27	3.97	3.95	3.92	3.91	4.16	4.55	5.03	5.59	5.99	6.59	6.76	7.03	6.83	6.54	6.13	5.56	4.92	4.35	4.48	4.24	4.15	5.07
SEP	4.09	4.26	4.26	4.06	3.59	3.48	3.31	3.14	3.53	4.47	4.98	5.08	5.65	6.04	6.04	6.22	6.18	5.76	5.23	4.84	4.60	4.32	4.34	4.38	4.66
OCT	3.03	2.94	2.86	2.89	2.84	2.77	2.67	2.59	3.02	3.87	4.11	4.38	4.77	5.02	5.26	5.24	4.98	5.04	4.97	4.39	4.05	3.77	3.48	3.34	3.85
NOV	3.18	3.35	3.55	3.95	4.26	4.27	4.32	4.23	4.15	4.75	5.06	5.11	4.98	4.90	4.35	4.06	3.97	4.08	4.19	3.99	3.56	3.52	3.07	2.71	4.06
DEC	5.30	5.53	5.61	5.68	5.85	6.03	6.17	6.33	6.35	6.54	6.55	6.32	6.12	5.63	5.39	5.03	4.66	4.45	4.76	5.02	4.74	4.90	5.26	5.45	5.57
Annual	4.13	4.20	4.23	4.33	4.31	4.32	4.34	4.33	4.50	5.04	5.39	5.59	5.80	5.86	5.79	5.63	5.53	5.41	5.29	5.02	4.64	4.48	4.32	4.21	4.86

SENSOR HEIGHT : 50m

Based on Data June 2013 to May 2014

TABLE 6C

MALAMPUZHA DAM **MEAN HOURLY WIND SPEED**

MONTH	OO	O1	O2	O3	O4	O5	O6	O7	O8	O9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	4.74	4.89	4.97	5.32	5.60	5.80	5.88	5.80	5.86	6.04	6.12	6.17	6.06	5.83	5.57	5.21	4.69	3.84	3.38	3.40	3.19	3.50	3.93	4.12	5.00
FEB	2.06	2.37	2.68	2.97	3.09	3.12	3.20	3.29	3.89	4.56	4.84	4.77	4.56	4.23	3.87	3.47	3.25	3.04	3.16	3.44	2.97	2.72	2.48	2.17	3.34
MAR	2.04	2.00	1.85	2.05	2.35	2.54	2.57	2.73	3.21	4.01	4.29	4.55	4.95	4.85	4.63	4.27	3.80	3.89	3.82	3.54	3.10	3.16	2.72	2.52	3.31
APR	2.24	1.99	1.84	1.58	1.18	1.04	1.10	1.14	1.59	2.09	2.64	3.07	3.34	3.46	3.71	3.87	4.30	4.96	5.01	4.14	3.58	3.13	2.73	2.47	2.76
MAY	2.36	2.33	2.22	2.28	2.41	2.21	2.00	2.09	2.76	3.49	4.09	4.44	4.59	4.75	5.03	4.84	4.85	4.72	4.18	3.57	3.20	2.98	2.87	2.82	3.38
JUN	2.99	3.09	3.36	3.48	3.19	3.18	3.42	3.33	3.73	4.06	4.35	4.72	4.80	5.08	4.95	4.71	4.60	4.36	3.77	3.53	3.41	3.25	3.33	3.18	3.83
JUL	3.61	3.57	3.52	3.59	3.34	3.28	3.20	3.45	3.41	3.82	4.20	4.37	4.86	5.18	5.02	4.91	4.89	4.43	4.26	3.89	3.75	3.52	3.40	3.56	3.96
AUG	3.18	3.33	3.08	2.86	2.89	2.84	2.94	3.37	3.74	4.07	4.52	4.76	5.20	5.28	5.42	5.25	4.92	4.61	4.13	3.66	3.22	3.33	3.16	3.10	3.87
SEP	2.79	2.93	2.91	2.74	2.43	2.41	2.22	2.19	2.80	3.66	4.03	4.12	4.56	4.84	4.74	4.84	4.69	4.29	3.71	3.34	3.18	2.93	2.97	2.98	3.43
OCT	1.95	1.91	1.85	1.91	1.87	1.75	1.68	1.72	2.43	3.22	3.42	3.58	3.91	4.03	4.20	4.04	3.72	3.68	3.47	2.99	2.66	2.48	2.28	2.19	2.79
NOV	1.99	2.24	2.45	2.67	2.87	2.87	2.92	2.90	3.13	3.73	3.97	4.06	3.96	3.92	3.50	3.21	2.95	2.69	2.68	2.57	2.23	2.25	1.94	1.71	2.89
DEC	3.61	3.86	3.89	3.90	4.15	4.27	4.28	4.50	4.76	5.02	5.09	4.97	4.77	4.40	4.13	3.81	3.45	3.03	3.03	3.13	2.97	3.10	3.45	3.68	3.97
Annual	2.80	2.88	2.88	2.94	2.95	2.94	2.95	3.04	3.44	3.98	4.30	4.47	4.63	4.65	4.56	4.37	4.18	3.96	3.72	3.43	3.12	3.03	2.94	2.87	3.54

SENSOR HEIGHT : 20m

Based on Data June 2013 to May 2014

MALAMPUZHA DAM

TABLE 7

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	ANNUAL
0.0-1.0	3.11	11.66	13.44	15.25	10.89	1.50	0.96	4.46	4.26	15.52	22.52	11.42	9.58
1.0-2.0	6.54	19.84	19.96	22.59	12.95	6.11	3.76	6.15	10.21	15.23	16.76	11.78	12.66
2.0-3.0	6.88	16.82	13.89	20.28	16.44	19.22	16.78	18.33	24.54	26.28	13.29	10.75	16.96
3.0-4.0	11.42	14.43	14.11	17.73	19.85	29.80	33.40	25.94	27.25	19.83	12.62	11.27	19.80
4.0-5.0	16.42	14.14	16.02	13.38	22.02	25.38	26.28	23.85	20.39	14.65	18.70	17.94	19.10
5.0-6.0	21.86	11.81	12.12	8.22	12.41	12.16	11.74	14.38	10.02	6.72	12.43	19.44	12.78
6.0-7.0	18.91	7.37	7.06	2.27	4.88	4.28	4.91	5.72	2.71	1.59	3.36	10.89	6.16
7.0-8.0	11.98	3.52	2.91	0.23	0.49	1.25	1.59	1.05	0.58	0.18	0.28	5.15	2.44
8.0-9.0	2.35	0.40	0.47	0.05	0.07	0.21	0.54	0.09	0.02	0.00	0.05	1.28	0.46
9.0-10.0	0.31	0.02	0.02	0.00	0.00	0.07	0.04	0.02	0.02	0.00	0.00	0.07	0.05
10.0-11.0	0.13	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01
11.0-12.0	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
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 June 2013 to May 2014**

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

MALAMPUZHA DAM

TABLE 7A

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	ANNUAL
0.0-1.0	1.14	4.76	6.52	7.92	6.25	0.23	0.11	3.81	2.08	11.51	13.24	6.00	5.30
1.0-2.0	2.13	10.04	10.84	13.66	6.61	1.32	1.03	3.03	3.54	8.15	11.55	7.53	6.62
2.0-3.0	3.74	15.03	14.78	18.31	10.30	5.02	3.16	6.35	9.81	10.82	13.38	7.97	9.89
3.0-4.0	5.00	14.51	10.42	17.48	11.78	14.42	11.20	15.59	17.18	18.75	11.97	8.40	13.06
4.0-5.0	6.23	11.58	11.92	15.60	17.56	23.32	25.00	20.28	26.00	22.69	10.25	8.38	16.57
5.0-6.0	13.64	11.83	13.98	13.75	21.24	26.23	27.44	20.93	21.55	15.77	12.36	10.37	17.43
6.0-7.0	16.58	12.45	13.04	7.57	15.64	16.69	17.74	16.13	13.06	8.00	14.81	17.27	14.08
7.0-8.0	19.80	9.03	9.36	4.28	7.82	7.59	8.24	8.77	4.47	3.27	8.91	16.47	9.00
8.0-9.0	15.57	6.67	5.49	1.11	2.20	3.29	3.67	3.81	1.57	0.90	2.85	8.94	4.67
9.0-10.0	10.37	3.13	2.91	0.25	0.47	1.18	1.48	1.01	0.56	0.13	0.51	5.15	2.26
10.0-11.0	4.57	0.89	0.72	0.07	0.11	0.51	0.74	0.16	0.16	0.00	0.14	2.35	0.87
11.0-12.0	0.76	0.07	0.02	0.00	0.02	0.16	0.16	0.09	0.02	0.00	0.02	0.83	0.18
12.0-13.0	0.27	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.27	0.05
13.0-14.0	0.07	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.07	0.01
14.0-15.0	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
15.0-16.0	0.04	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 June 2013 to May 2014**

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

MALAMPUZHA DAM

TABLE 7B

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	ANNUAL
0.0-1.0	1.28	4.59	6.23	5.44	4.03	0.00	0.00	2.22	0.53	5.91	8.22	5.69	3.68
1.0-2.0	1.79	8.38	8.94	10.83	4.79	0.28	0.09	2.22	1.23	6.09	11.94	5.78	5.20
2.0-3.0	2.51	11.41	11.51	15.02	7.91	1.50	1.21	2.40	4.35	8.45	12.94	7.46	7.22
3.0-4.0	3.88	12.08	9.52	15.56	9.39	5.63	4.14	6.21	9.56	10.82	10.60	6.83	8.68
4.0-5.0	4.32	11.66	9.70	15.81	11.72	13.17	10.15	13.73	15.28	17.14	10.49	6.38	11.63
5.0-6.0	7.80	10.96	12.10	14.00	16.69	22.44	22.18	20.01	24.40	23.86	9.65	7.64	15.98
6.0-7.0	13.37	11.19	14.00	11.85	20.83	24.87	25.90	21.14	24.31	17.07	11.71	10.73	17.25
7.0-8.0	16.62	11.66	11.98	6.92	16.20	16.60	18.32	16.51	13.08	6.92	11.37	15.50	13.47
8.0-9.0	17.97	7.79	8.22	3.01	5.91	8.82	10.01	9.63	4.79	2.89	8.70	15.41	8.60
9.0-10.0	13.06	6.13	4.68	1.30	1.77	3.70	4.48	4.08	1.50	0.63	3.47	9.23	4.50
10.0-11.0	9.81	2.95	2.55	0.21	0.60	1.90	2.08	1.35	0.67	0.22	0.65	5.35	2.36
11.0-12.0	5.40	1.12	0.56	0.05	0.13	0.72	0.85	0.29	0.21	0.00	0.21	2.67	1.02
12.0-13.0	1.68	0.10	0.00	0.00	0.02	0.25	0.43	0.13	0.07	0.00	0.02	0.76	0.29
13.0-14.0	0.29	0.00	0.00	0.00	0.00	0.09	0.13	0.04	0.02	0.00	0.02	0.43	0.09
14.0-15.0	0.07	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.09	0.02
15.0-16.0	0.11	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.04	0.01
16.0-17.0	0.04	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 June 2013 to May 2014**

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

MALAMPUZHA DAM

TABLE 7C

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	ANNUAL
0.0-1.0	1.41	5.18	8.04	8.40	5.26	0.00	0.00	2.00	0.46	5.35	9.07	6.21	4.28
1.0-2.0	1.86	8.61	9.21	11.92	5.20	0.09	0.02	2.51	1.20	6.59	12.25	5.94	5.45
2.0-3.0	2.49	11.38	11.29	14.47	7.55	1.46	0.85	2.56	4.26	8.83	12.43	7.10	7.06
3.0-4.0	4.08	12.15	8.40	15.00	9.34	5.39	3.92	6.15	9.75	11.00	10.56	6.88	8.55
4.0-5.0	4.21	11.53	10.46	15.53	12.30	13.75	10.39	14.29	15.32	17.97	10.35	6.25	11.86
5.0-6.0	7.80	10.64	11.72	13.63	17.41	22.76	22.78	20.69	25.63	24.31	9.51	7.48	16.20
6.0-7.0	13.31	11.28	13.69	11.04	20.95	24.94	26.59	21.20	24.38	16.31	11.37	10.46	17.13
7.0-8.0	16.22	11.28	11.49	6.18	14.74	16.86	18.48	16.69	12.27	6.27	11.25	15.37	13.09
8.0-9.0	18.10	7.69	7.97	2.69	5.13	8.52	9.63	9.09	4.49	2.78	8.68	15.30	8.34
9.0-10.0	12.90	6.18	4.79	0.90	1.48	3.50	4.17	3.41	1.41	0.47	3.63	9.57	4.37
10.0-11.0	10.01	2.80	2.40	0.21	0.49	1.76	1.81	1.01	0.58	0.13	0.63	5.47	2.28
11.0-12.0	5.38	1.17	0.54	0.02	0.13	0.65	0.87	0.20	0.21	0.00	0.23	2.67	1.01
12.0-13.0	1.68	0.10	0.00	0.00	0.02	0.28	0.38	0.16	0.02	0.00	0.02	0.76	0.29
13.0-14.0	0.34	0.00	0.00	0.00	0.00	0.02	0.09	0.02	0.02	0.00	0.02	0.43	0.08
14.0-15.0	0.07	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.09	0.02
15.0-16.0	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01
16.0-17.0	0.04	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 June 2013 to May 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 8

MALAMPUZHA DAM

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	0.32	0.35	0.35	0.32	0.41	0.28	0.25	0.26	0.54	0.84	0.93	0.45	5.30
1.0-2.0	0.14	0.28	0.55	0.57	0.57	0.30	0.27	0.29	0.54	1.47	1.31	0.29	6.58
2.0-3.0	0.04	0.40	0.74	0.73	0.66	0.21	0.10	0.13	0.80	3.42	2.37	0.23	9.83
3.0-4.0	0.01	0.29	0.53	0.92	0.74	0.16	0.02	0.06	1.57	6.34	2.29	0.11	13.02
4.0-5.0	0.00	0.14	0.60	1.41	1.01	0.06	0.00	0.00	2.65	8.85	1.79	0.06	16.58
5.0-6.0	0.00	0.04	0.97	2.45	1.49	0.01	0.00	0.00	2.61	8.75	1.12	0.02	17.46
6.0-7.0	0.00	0.01	1.02	3.08	1.97	0.00	0.00	0.00	1.27	6.09	0.64	0.02	14.11
7.0-8.0	0.00	0.02	0.76	2.77	1.76	0.00	0.00	0.00	0.35	2.96	0.40	0.01	9.03
8.0-9.0	0.00	0.01	0.44	1.78	1.08	0.00	0.00	0.00	0.13	1.08	0.17	0.00	4.68
9.0-10.0	0.00	0.00	0.18	1.06	0.61	0.00	0.00	0.00	0.03	0.31	0.07	0.00	2.27
10.0-11.0	0.00	0.00	0.08	0.43	0.22	0.00	0.00	0.00	0.01	0.09	0.04	0.00	0.88
11.0-12.0	0.00	0.00	0.03	0.09	0.02	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.18
12.0-13.0	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
13.0-14.0	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
14.0-15.0	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	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
Total	0.51	1.53	6.29	15.63	10.56	1.03	0.65	0.75	10.50	40.23	11.14	1.19	100.00

SENSOR HEIGHT: 50m **Based on Data June 2013 to May 2014**

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

TABLE 8A

MALAMPUZHA DAM

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	0.71	0.14	0.17	0.17	0.20	0.18	0.18	0.18	0.33	0.50	0.53	0.37	3.67
1.0-2.0	0.70	0.06	0.23	0.40	0.35	0.26	0.29	0.20	0.30	0.66	1.04	0.67	5.16
2.0-3.0	0.53	0.05	0.36	0.55	0.51	0.34	0.21	0.12	0.18	0.83	2.25	1.24	7.18
3.0-4.0	0.30	0.02	0.22	0.37	0.63	0.54	0.16	0.08	0.09	1.04	3.82	1.38	8.64
4.0-5.0	0.19	0.00	0.16	0.41	0.95	0.64	0.19	0.03	0.07	2.16	5.43	1.38	11.61
5.0-6.0	0.14	0.00	0.14	0.64	1.42	1.03	0.15	0.01	0.08	3.62	7.18	1.59	16.00
6.0-7.0	0.10	0.00	0.08	0.96	2.26	1.48	0.09	0.01	0.06	3.52	7.37	1.36	17.29
7.0-8.0	0.06	0.00	0.04	0.88	2.98	1.52	0.06	0.00	0.03	1.95	4.99	1.00	13.50
8.0-9.0	0.04	0.00	0.02	0.49	2.96	1.32	0.01	0.00	0.01	0.71	2.50	0.56	8.63
9.0-10.0	0.02	0.00	0.00	0.37	1.85	0.83	0.01	0.00	0.00	0.22	0.97	0.23	4.51
10.0-11.0	0.01	0.00	0.00	0.12	1.14	0.53	0.00	0.00	0.00	0.09	0.35	0.14	2.37
11.0-12.0	0.01	0.00	0.00	0.06	0.61	0.17	0.00	0.00	0.00	0.01	0.12	0.05	1.02
12.0-13.0	0.00	0.00	0.00	0.03	0.16	0.03	0.00	0.00	0.00	0.01	0.03	0.03	0.29
13.0-14.0	0.00	0.00	0.00	0.02	0.03	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.09
14.0-15.0	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
15.0-16.0	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
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
Total	2.79	0.27	1.43	5.47	16.07	8.91	1.36	0.63	1.15	15.33	36.59	10.00	100.00

SENSOR HEIGHT: 78m **Based on Data June 2013 to May 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

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TABLE 8B

MALAMPUZHA DAM

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	0.80	0.15	0.21	0.22	0.25	0.20	0.22	0.21	0.37	0.58	0.63	0.43	4.27
1.0-2.0	0.70	0.06	0.27	0.43	0.36	0.28	0.27	0.18	0.26	0.66	1.17	0.76	5.41
2.0-3.0	0.47	0.05	0.33	0.50	0.48	0.33	0.19	0.11	0.18	0.76	2.36	1.24	7.01
3.0-4.0	0.28	0.01	0.21	0.37	0.62	0.53	0.18	0.09	0.08	1.06	3.74	1.34	8.50
4.0-5.0	0.19	0.00	0.15	0.39	0.97	0.67	0.19	0.02	0.07	2.16	5.62	1.41	11.85
5.0-6.0	0.14	0.00	0.13	0.66	1.42	1.03	0.14	0.01	0.08	3.69	7.33	1.59	16.22
6.0-7.0	0.09	0.00	0.08	0.96	2.23	1.47	0.09	0.01	0.06	3.51	7.35	1.32	17.16
7.0-8.0	0.05	0.00	0.03	0.85	2.93	1.49	0.06	0.00	0.03	1.95	4.79	0.94	13.12
8.0-9.0	0.03	0.00	0.02	0.48	2.96	1.33	0.01	0.00	0.01	0.67	2.32	0.54	8.37
9.0-10.0	0.02	0.00	0.00	0.37	1.87	0.84	0.01	0.00	0.00	0.21	0.83	0.22	4.37
10.0-11.0	0.01	0.00	0.00	0.11	1.15	0.53	0.00	0.00	0.00	0.07	0.30	0.11	2.29
11.0-12.0	0.01	0.00	0.00	0.06	0.61	0.17	0.00	0.00	0.00	0.01	0.11	0.05	1.01
12.0-13.0	0.00	0.00	0.00	0.03	0.16	0.03	0.00	0.00	0.00	0.01	0.03	0.03	0.29
13.0-14.0	0.00	0.00	0.00	0.02	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.08
14.0-15.0	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
15.0-16.0	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
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
Total	2.79	0.27	1.43	5.47	16.07	8.91	1.36	0.63	1.15	15.33	36.59	10.00	100.00

SENSOR HEIGHT: 80m **Based on Data June 2013 to May 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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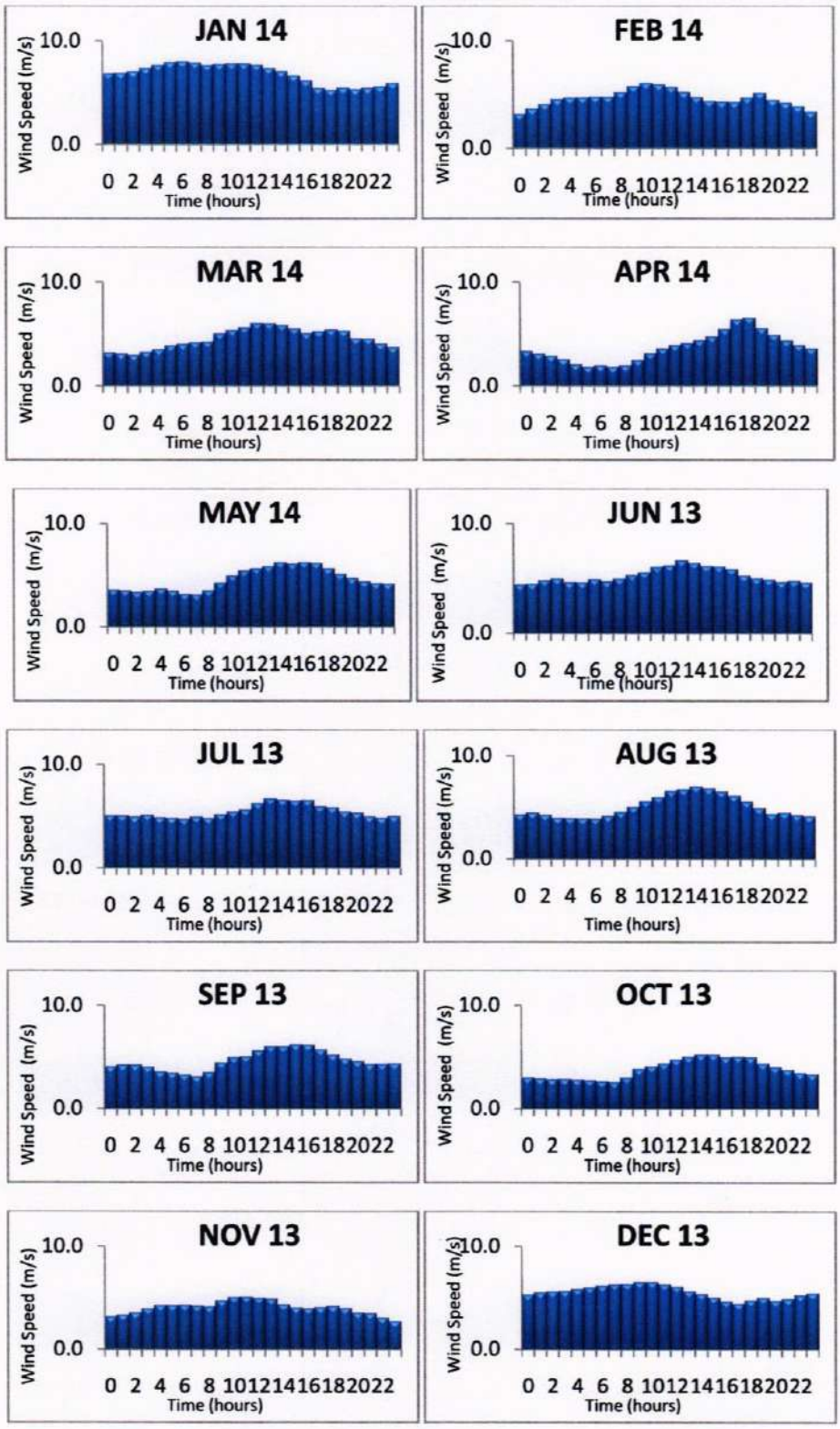

SENSOR HEIGHT: 50m

FIGURE 4: MEAN HOURLY WIND SPEED
(JUNE 2013 TO MAY 2014)

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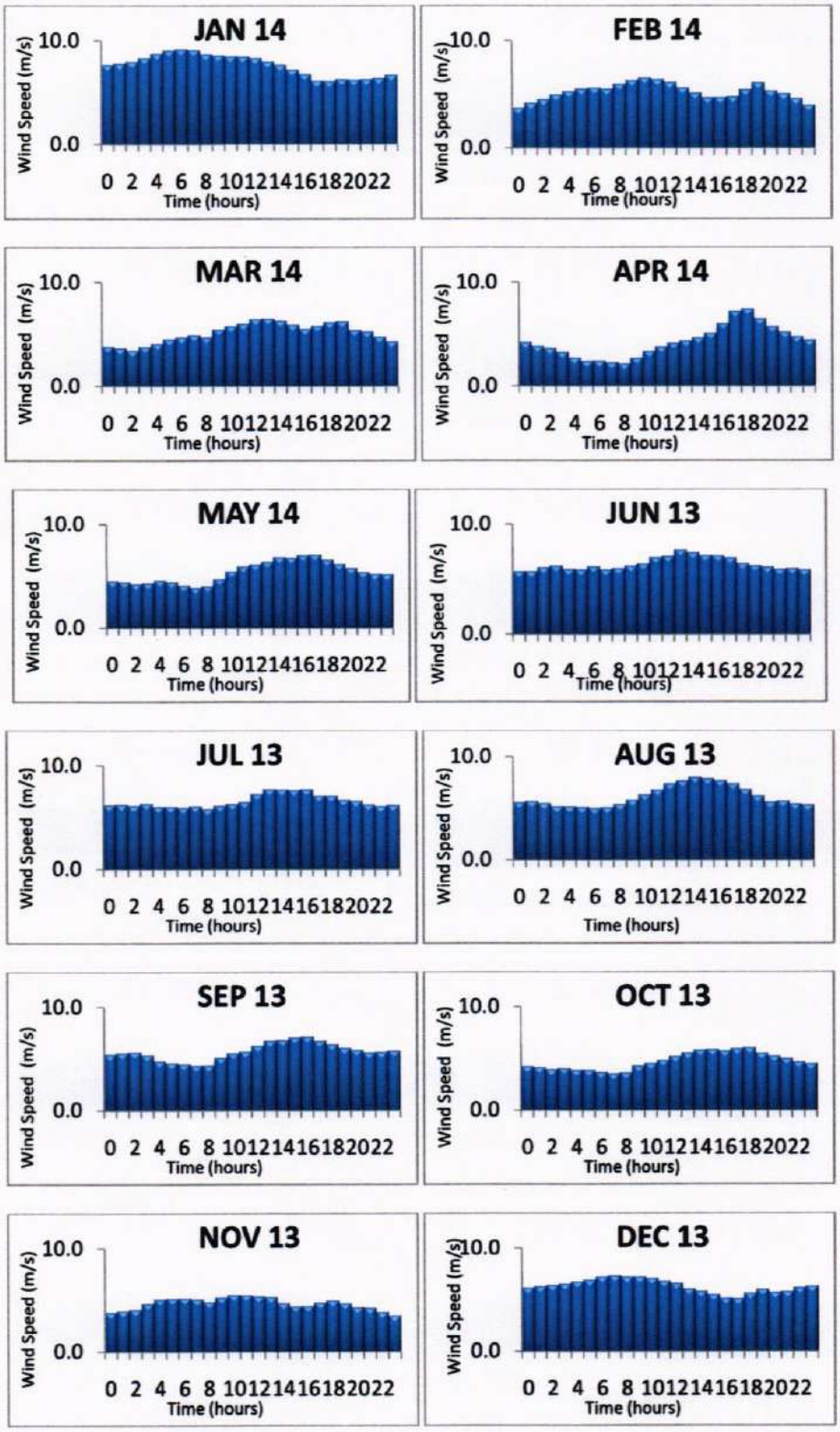

SENSOR HEIGHT: 78m

FIGURE 4A: MEAN HOURLY WIND SPEED
(JUNE 2013 TO MAY 2014)

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(ISO 9001:2008)

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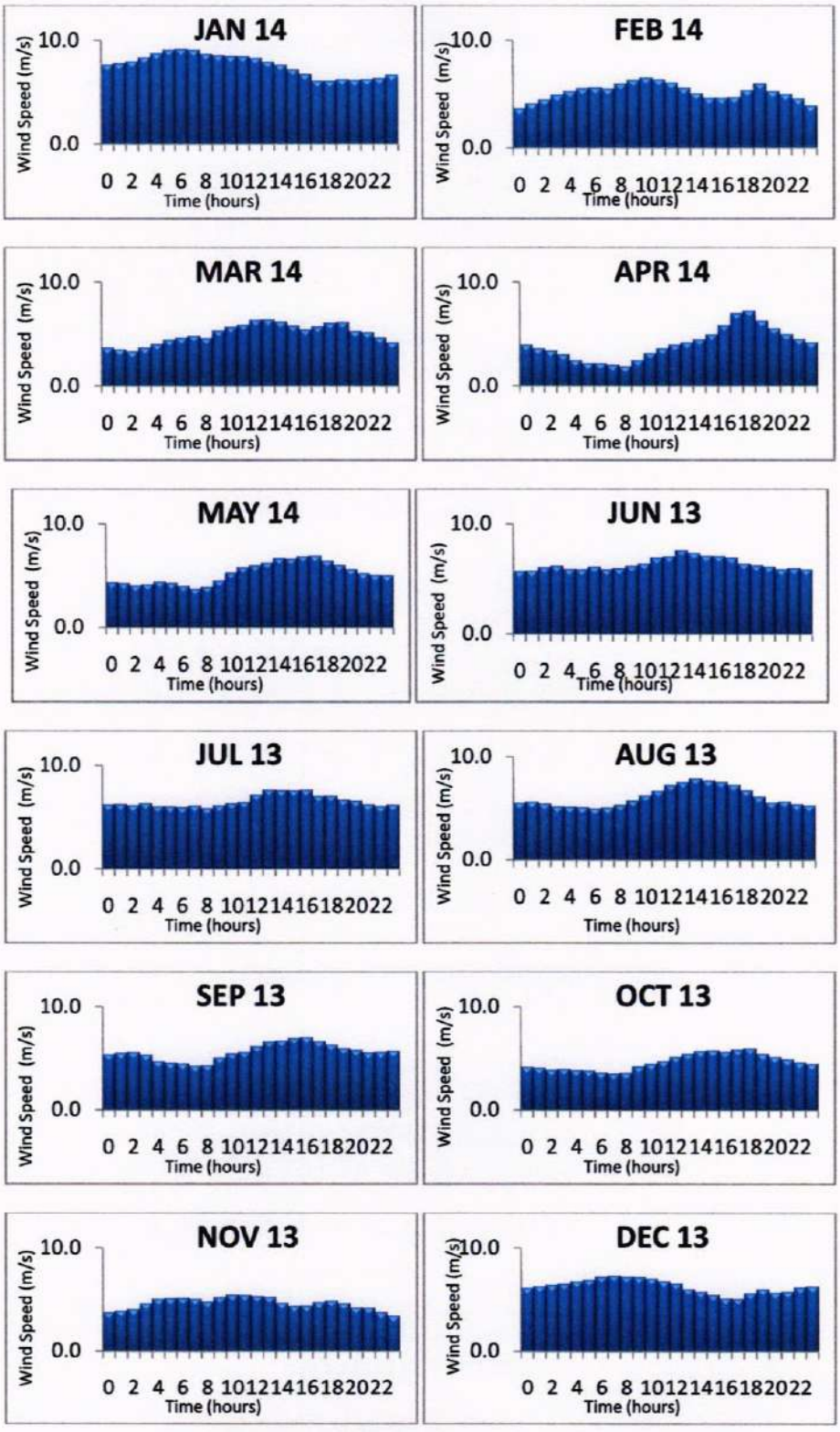
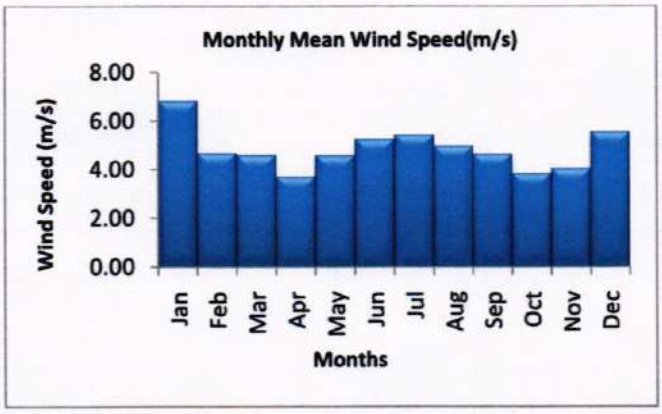
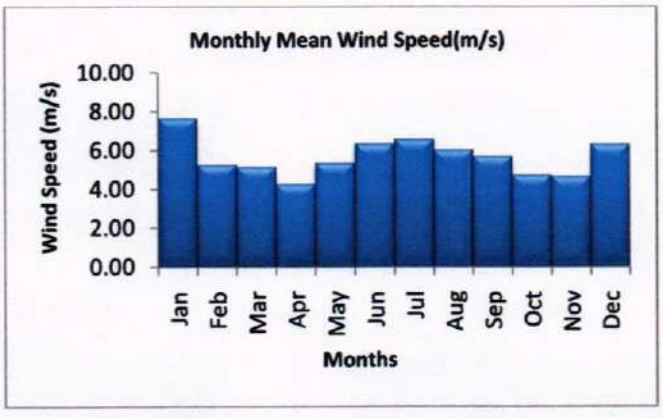


SENSOR HEIGHT: 80m

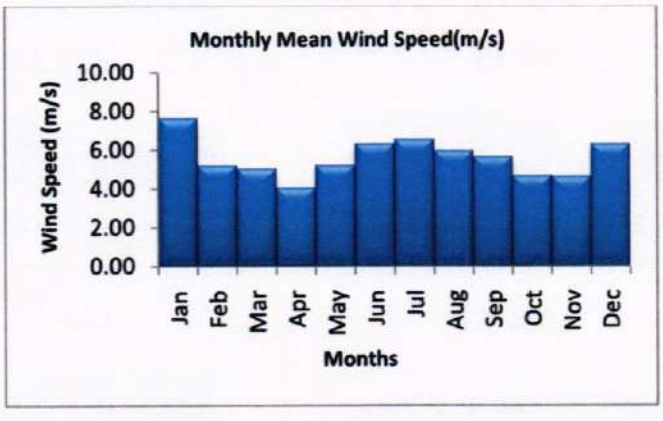
FIGURE 4B: MEAN HOURLY WIND SPEED
(JUNE 2013 TO MAY 2014)



SENSOR HEIGHT: 50m

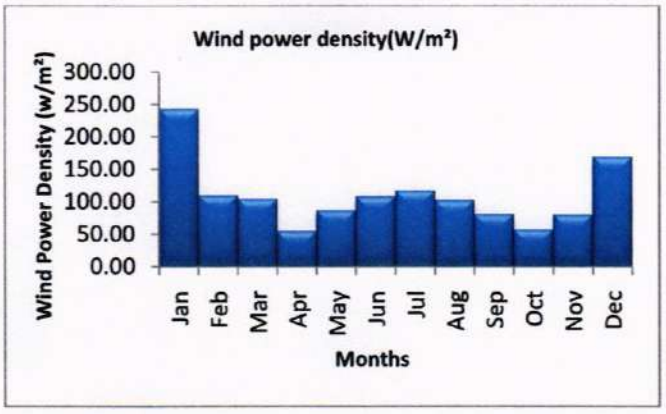


SENSOR HEIGHT: 78 m

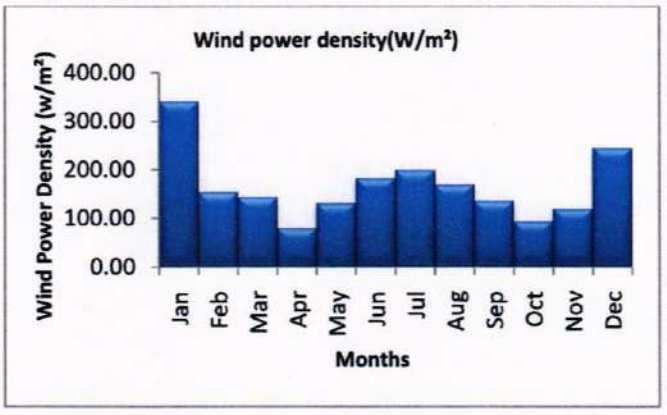


SENSOR HEIGHT: 80m

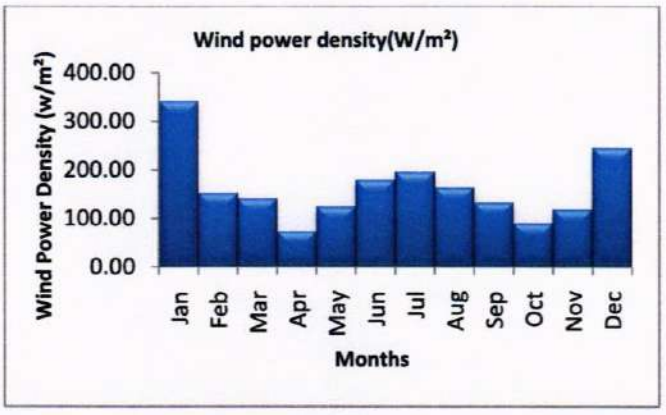
FIGURE 5: MONTHLY MEAN WIND SPEED (JUNE 2013 TO MAY 2014)



SENSOR HEIGHT: 50m



SENSOR HEIGHT: 78m



SENSOR HEIGHT: 80m

FIGURE 6: MONTHLY MEAN WIND POWER DENSITY (JUNE 2013 TO MAY 2014)

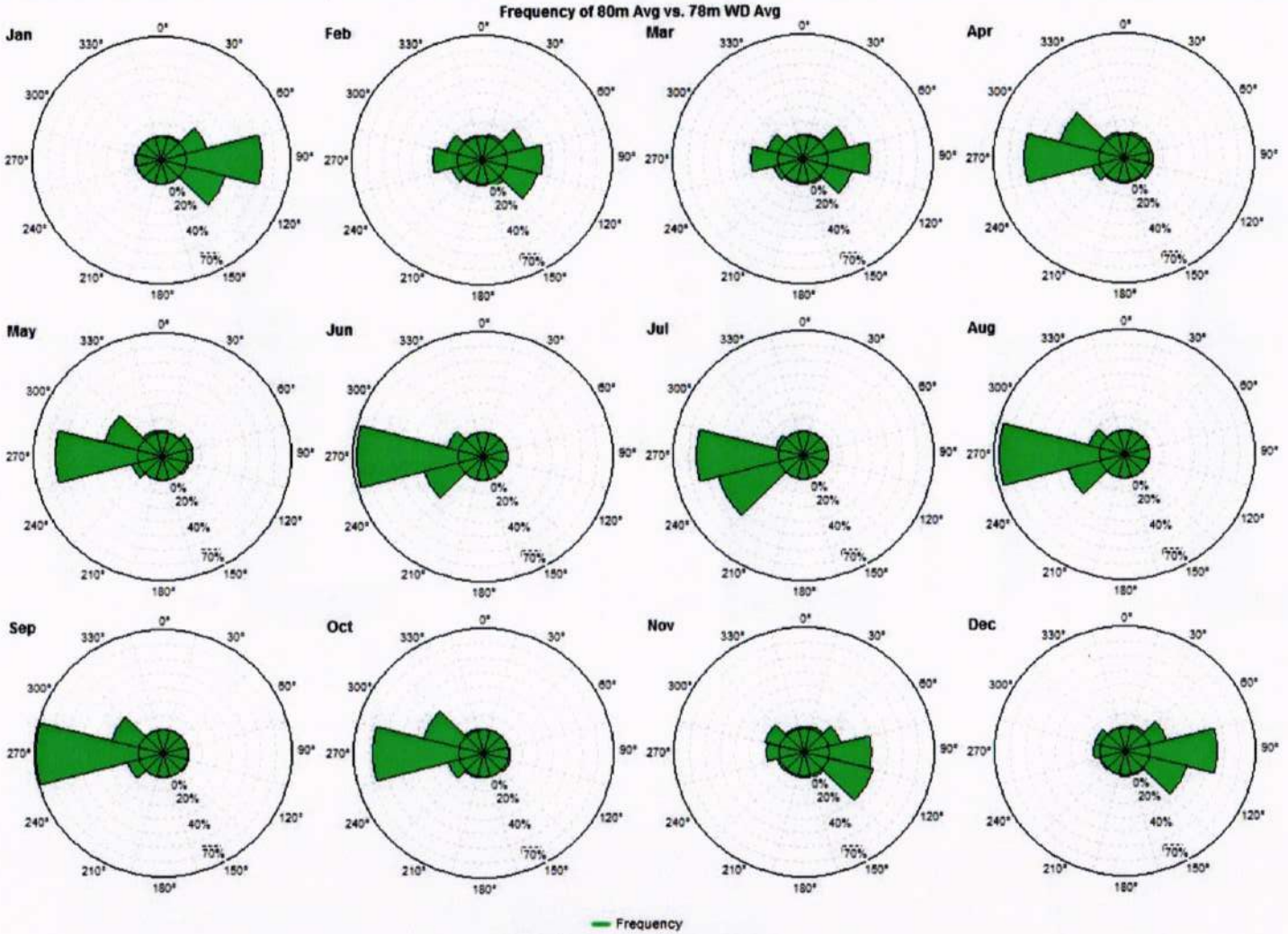


FIGURE 7: WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(June 2013 to May 2014)

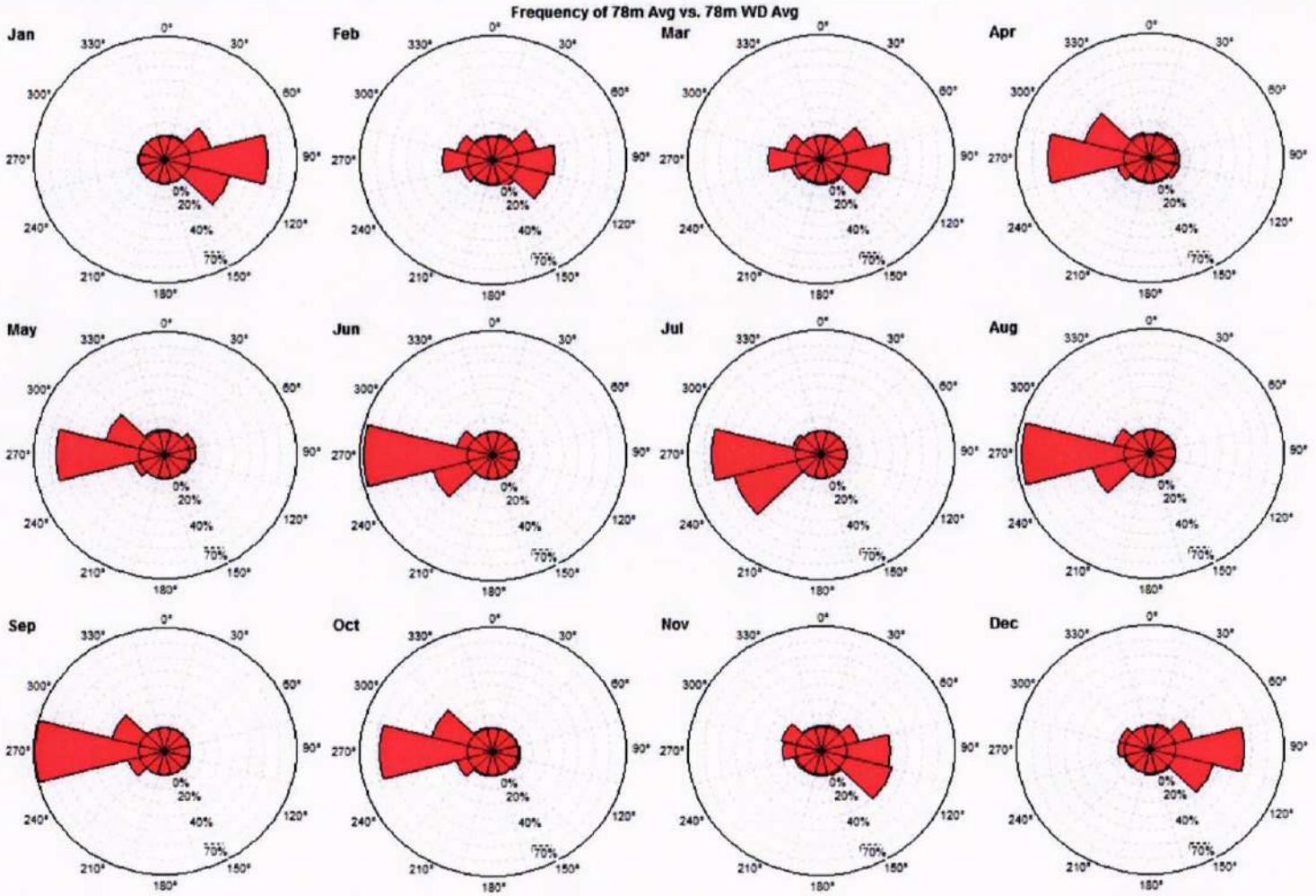


FIGURE 7A: WIND ROSE
SENSOR HEIGHT: (78m Anemometer and 78m Wind vane)
(June 2013 to May 2014)

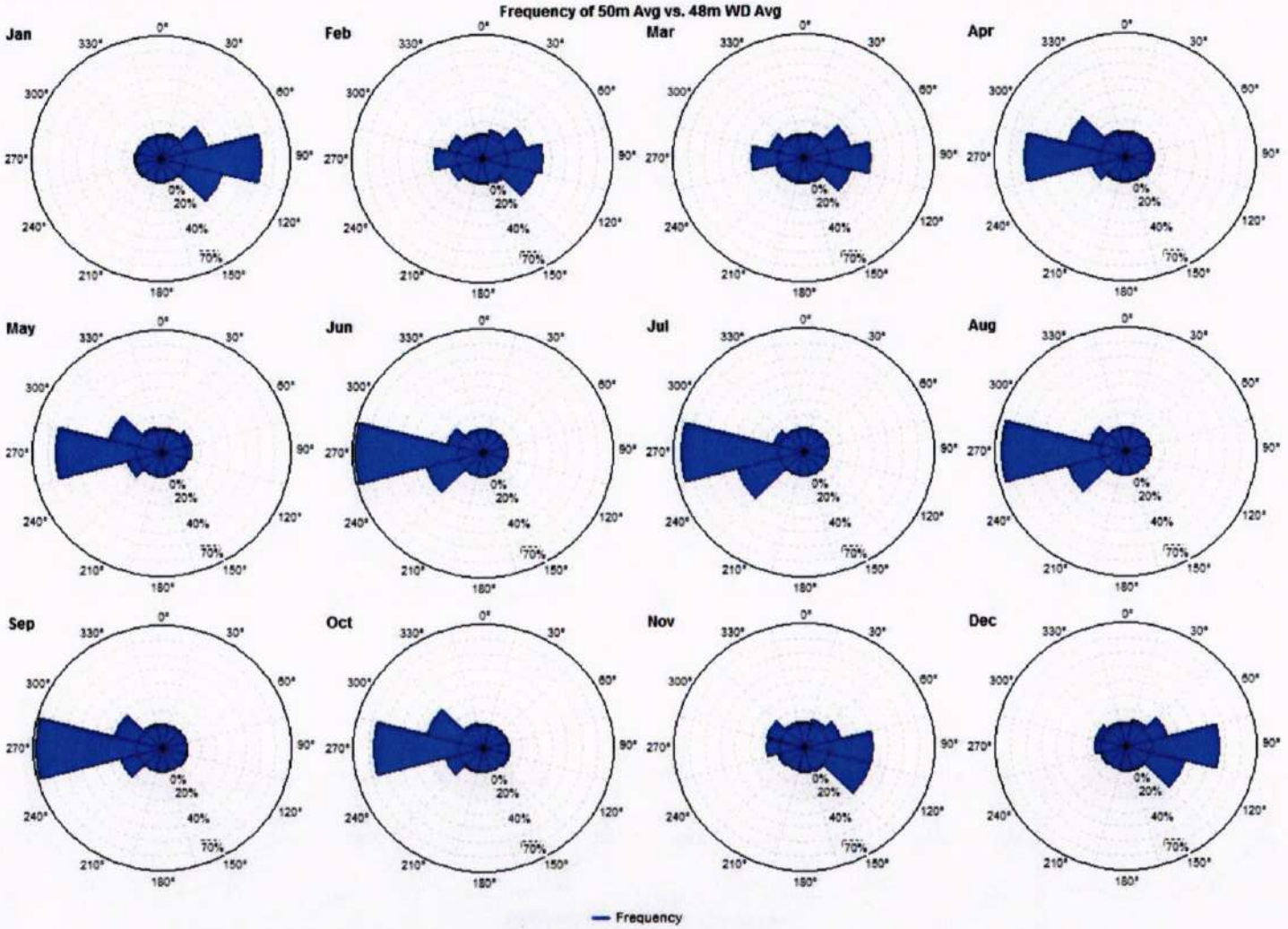


FIGURE 7B: WIND ROSE
SENSOR HEIGHT: (50m Anemometer and 48m Wind vane)
(June 2013 to May 2014)

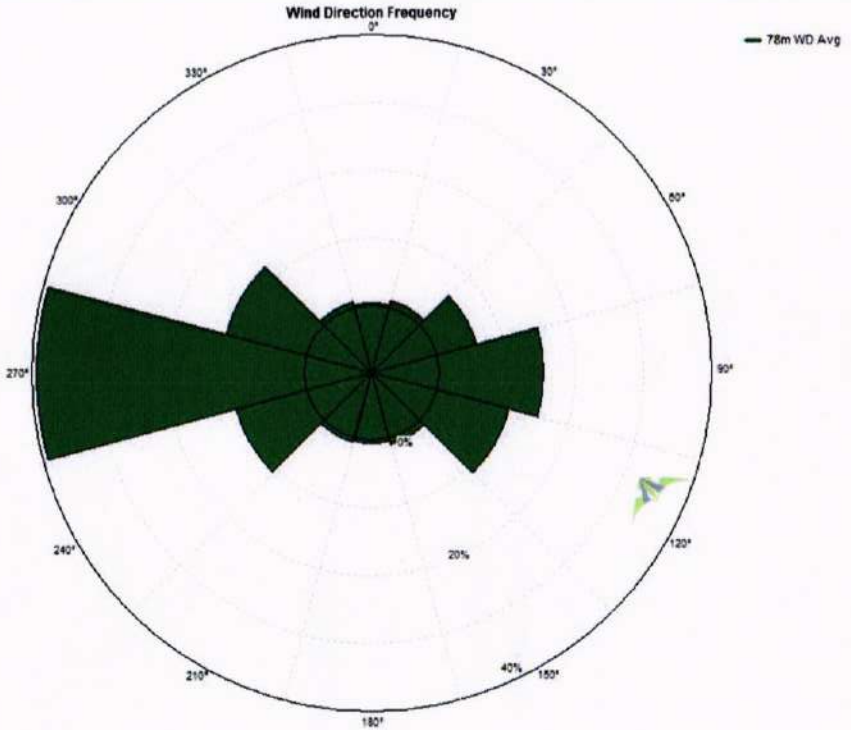
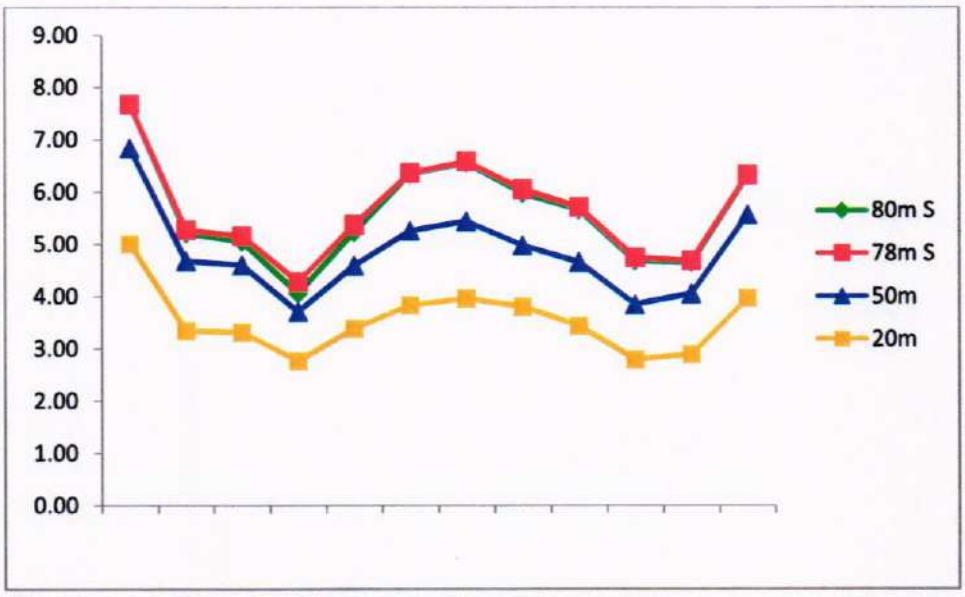
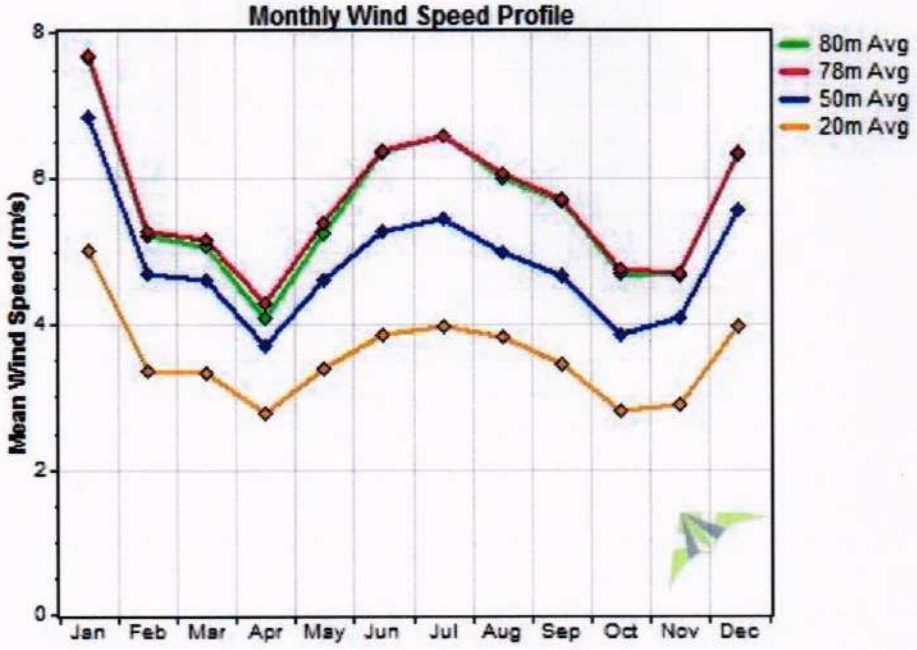


FIGURE 7C: ANNUAL WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(June 2013 to May 2014)



MONTHLY MEAN WIND SPEED
(JUNE2013 TO MAY2014)



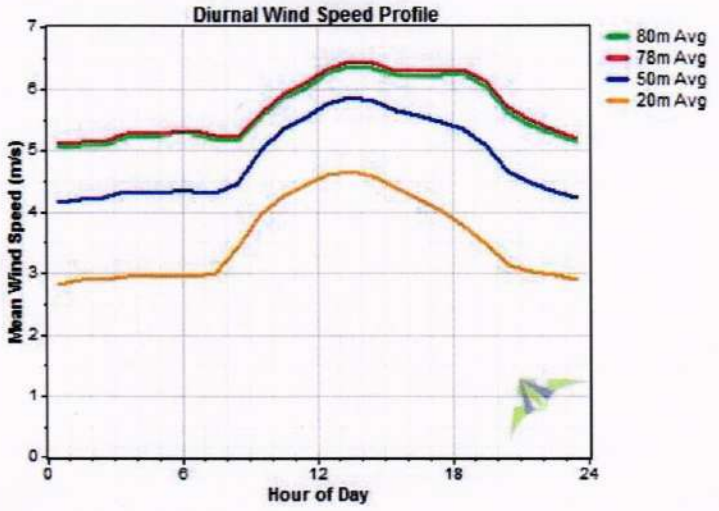


FIGURE 8: MONTHLY WIND SPEED AND DAILY WIND SPEED – MALAMPUZHA DAM (JUNE2013 TO MAY2014)

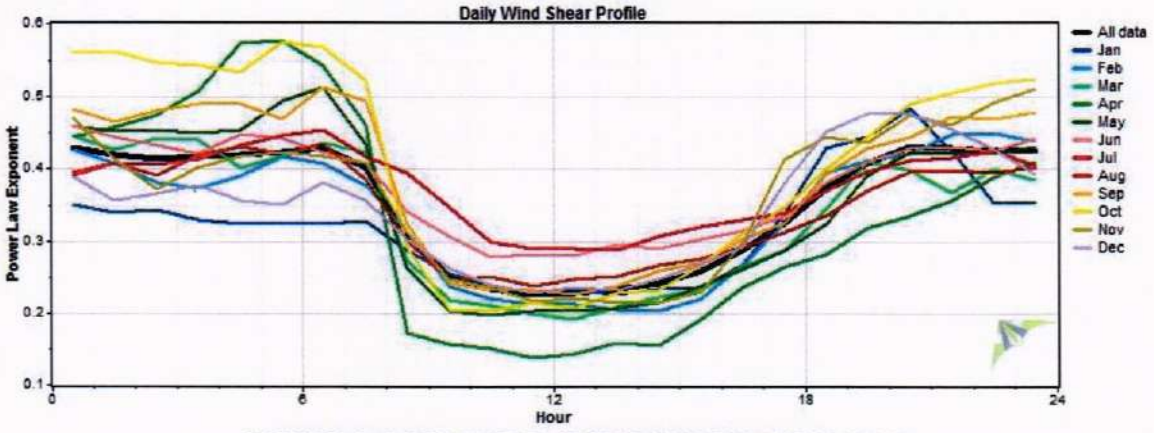


FIGURE 9: DAILY WIND SHEAR-MALAMPUZHA DAM (JUNE2013 TO MAY2014)

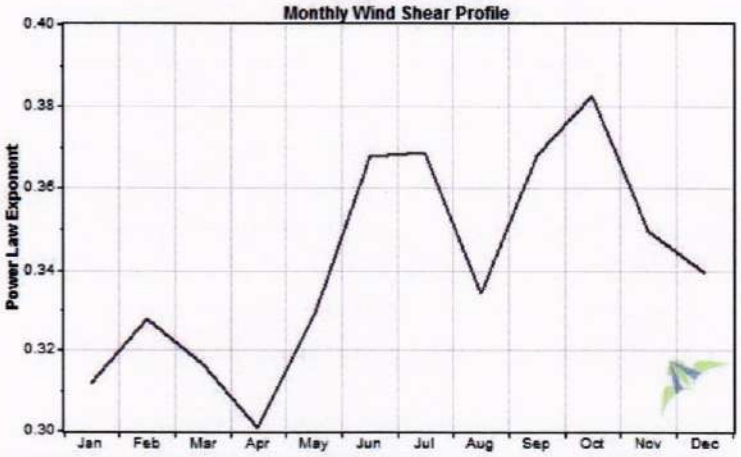


FIGURE 10: MONTHLY WIND SHEAR- MALAMPUZHA DAM (JUNE2013 TO MAY2014)

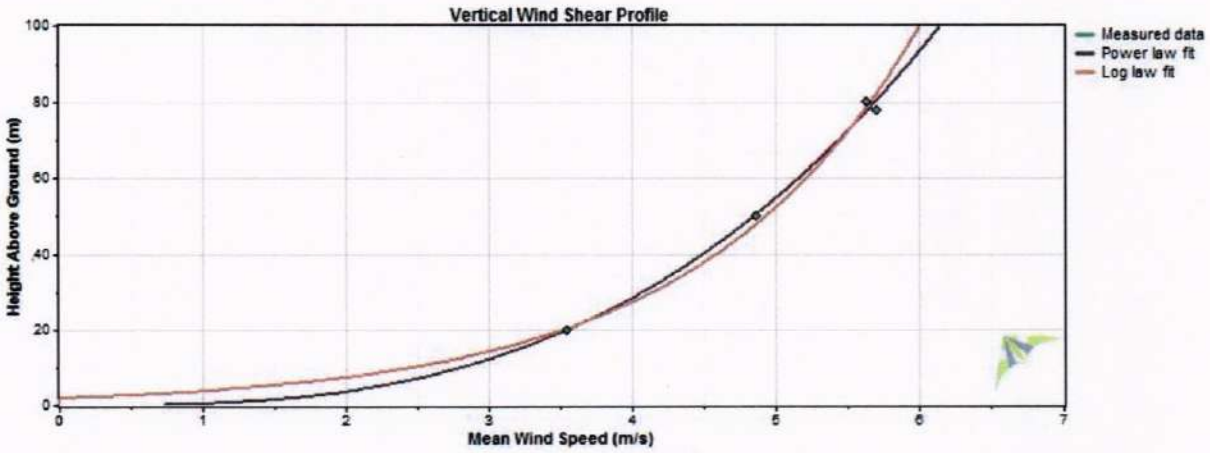
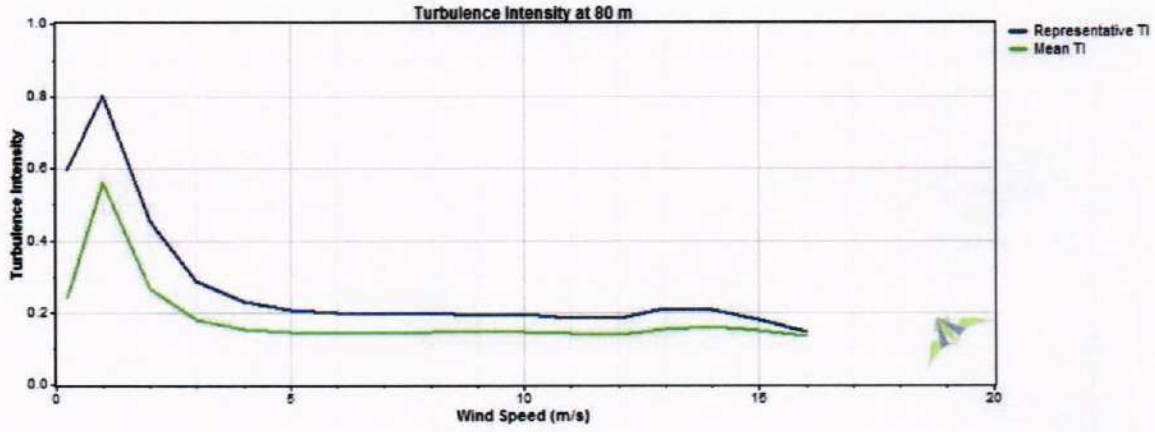
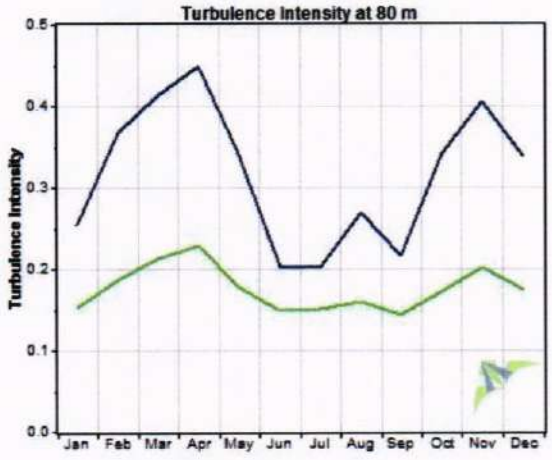
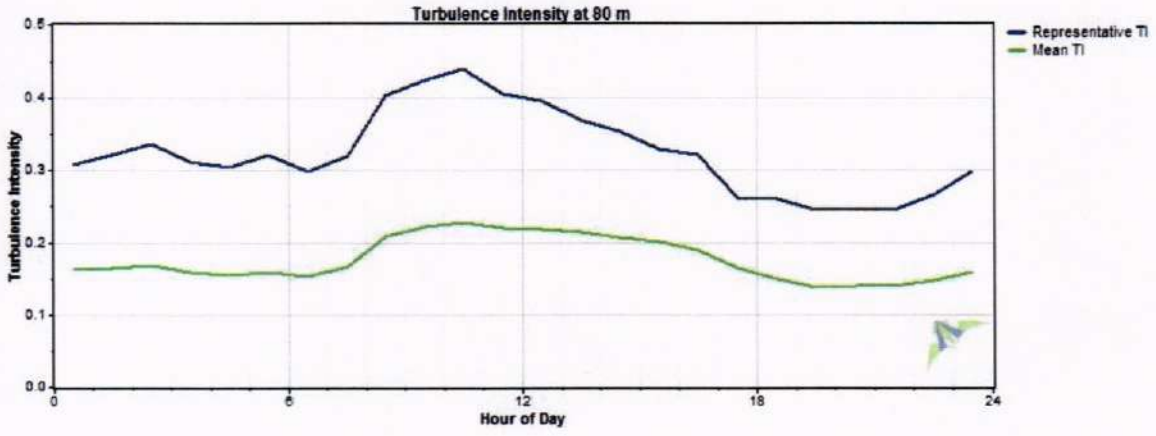


FIGURE 11: VERTICALWIND SHEAR- MALAMPUZHA DAM (JUNE2013 TO MAY2014)







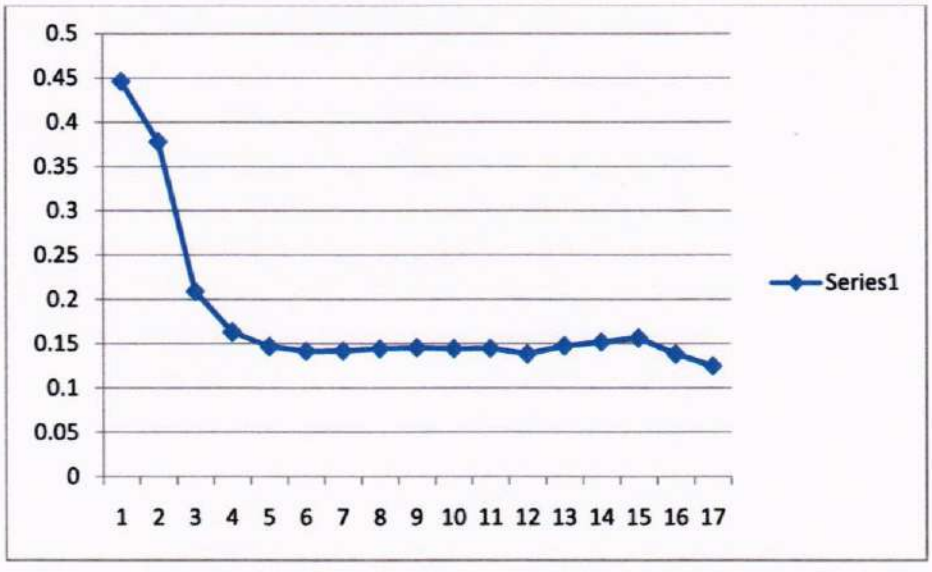


FIGURE 12: TURBULANCE INTENSITY – MALAMPUZHA DAM (JUNE2013 TO MAY2014)

IInd Year

Jun 2014 - May 2015

TABLE 4

MALAMPUZHA DAM

CONSOLIDATED TABLE

	JAN-15	FEB-15	MAR-15	APR-15	MAY-15	JUN-14	JUL-14	AUG-14	SEP-14	OCT-14	NOV-14	DEC-14	ANNUAL
Monthly Mean Wind Speed (m/s)													
20m	3.87	3.91	2.51	2.09	2.84	4.01	4.04	3.44	3.31	2.33	3.34	4.10	3.32
50m	5.34	5.37	3.48	2.88	3.78	5.48	5.52	4.71	4.48	3.36	4.60	5.63	4.55
78 m	6.02	6.03	3.93	3.47	4.52	6.50	6.64	5.80	5.43	4.12	5.30	6.41	5.35
80m	6.03	6.03	3.85	3.39	--	6.43	6.62	5.79	5.39	4.10	5.30	6.45	5.40
Monthly Wind Power Density (Watts/Sq.m)													
20m	62.13	64.46	23.37	15.16	28.95	51.39	51.17	36.59	37.06	20.17	47.85	63.96	41.86
50m	146.65	150.95	52.95	35.15	63.32	119.27	122.36	86.62	83.74	50.35	115.83	154.87	98.51
78 m	207.23	210.65	73.41	54.70	97.92	190.15	205.70	149.52	135.42	82.24	170.21	227.65	150.40
80m	209.46	212.29	71.40	52.24	--	183.63	202.63	147.33	131.96	81.51	171.38	231.14	154.09
Power Law Index (PLI)													
	0.32	0.31	0.31	0.35	--	0.34	0.36	0.38	0.35	0.41	0.33	0.33	0.34
Energy Pattern Factor													
20m	1.85	1.87	2.57	2.85	2.19	1.37	1.33	1.54	1.75	2.74	2.21	1.60	1.99
50m	1.65	1.69	2.18	2.56	1.95	1.25	1.25	1.42	1.60	2.29	2.04	1.49	1.78
78 m	1.63	1.66	2.09	2.26	1.76	1.19	1.21	1.32	1.46	2.03	1.97	1.49	1.67
80m	1.64	1.67	2.16	2.32	--	1.19	1.20	1.30	1.45	2.04	1.98	1.49	1.68
Air Density (kg/m^3)													
	1.164	1.158	1.153	1.156	1.153	1.157	1.162	1.165	1.162	1.162	1.161	1.162	1.160
Temperature (^{0} C)													
	26.71	28.22	29.56	28.30	27.62	26.69	--	25.08	26.02	26.44	26.87	26.93	27.13
Turbulance Intensity (at 80m agl)													
At 15m/s : 0.17													
	4464	4032	4464	4320	4366	4320	4464	4464	4320	4464	4320	4464	

Based on Data June 2014 to May 2015

TABLE 5

MALAMPUZHA DAM

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)
5.34	6.03	6.02	0.91	0.87	0.86	12.51 1/26/2015 2:10	14.06 1/26/2015 2:10	14.03 1/26/2015 2:10	E	E
5.37	6.03	6.03	0.96	0.92	0.91	12.34 2/4/2015 4:50	13.92 2/4/2015 4:50	13.87 2/4/2015 4:50	E	E
3.48	3.85	3.93	0.74	0.72	0.72	10.57 3/12/2015 10:40	11.81 3/12/2015 6:50	11.79 3/12/2015 6:50	W	W
2.88	3.39	3.47	0.66	0.65	0.65	11.41 4/9/2015 11:40	12.48 4/12/2015 18:30	12.32 4/12/2015 18:30	W	W
3.78	--	4.52	0.78	--	0.74	14.96 5/8/2015 17:50	11.28 5/4/2015 16:10	16.32 5/28/2015 1:10	W	--
5.48	6.43	6.50	0.95	0.92	0.93	12.20 6/20/2014 11:40	13.60 6/20/2014 11:40	13.81 6/20/2014 11:40	W	W
5.52	6.62	6.64	1.04	1.00	1.02	13.17 7/23/2014 13:00	15.10 7/23/2014 13:00	15.33 7/23/2014 13:00	--	--
4.71	5.79	5.80	0.91	0.86	0.85	11.87 8/5/2014 18:30	13.62 8/5/2014 18:30	13.77 8/5/2014 18:30	W	W
4.48	5.39	5.43	0.86	0.81	0.82	10.86 9/6/2014 17:20	12.18 9/6/2014 17:20	12.33 9/6/2014 17:20	W	W
3.36	4.10	4.12	0.67	0.65	0.65	10.26 10/25/2014 14:00	12.76 10/25/2014 14:00	12.81 10/25/2014 14:00	W	W/NW
4.60	5.30	5.30	0.82	0.8	0.79	12.72 11/20/2014 00:50	14.08 11/20/2014 00:50	14.06 11/20/2014 00:50	E	E
5.63	6.45	6.41	0.96	0.92	0.9	12.26 12/20/2014 20:00	14.19 12/20/2014 20:30	14.12 12/20/2014 20:30	E	E/SE
4.55	**5.40**	**5.35**	**0.86**	**0.83**	**0.82**	**14.96 5/8/2015 17:50**	**15.10 7/23/2014 13:00**	**16.32 5/28/2015 1:10**	**W**	**W**

Based on Data June 2014 to May 2015

TABLE 6

MALAPUZHA DAM

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	4.72	5.64	5.77	6.27	6.50	6.53	6.88	7.03	6.84	6.98	7.26	7.39	7.13	6.60	6.29	5.93	5.49	5.23	4.97	4.95	5.42	5.28	4.86	4.79	6.03
FEB	5.07	5.42	5.34	5.78	6.11	6.31	6.60	6.96	6.75	6.66	6.66	6.87	6.89	6.47	6.27	5.90	5.37	5.53	5.86	6.52	5.67	5.32	5.38	5.07	6.03
MAR	2.48	2.14	2.15	2.27	2.57	2.79	2.89	3.13	2.96	3.65	4.09	4.42	4.57	4.61	4.65	4.66	4.58	5.14	5.74	5.77	5.47	4.79	3.89	3.11	3.85
APR	3.20	3.29	2.85	2.72	2.47	2.26	2.09	2.21	2.11	2.33	2.63	2.89	3.04	3.08	3.31	3.70	4.49	5.56	6.14	5.14	4.26	4.13	3.86	3.57	3.39
MAY	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN	5.63	5.71	5.69	5.63	5.72	5.88	5.96	5.80	5.79	6.23	6.66	7.24	7.63	7.62	7.74	7.54	7.60	7.19	6.90	6.39	6.29	5.94	5.91	5.67	6.43
JUL	5.85	6.11	6.32	6.41	6.31	6.36	6.11	5.84	5.99	6.16	6.44	6.90	7.47	7.75	8.00	7.79	7.97	7.57	7.30	6.68	6.13	5.83	6.02	6.06	6.64
AUG	5.29	5.27	5.27	5.18	5.18	4.98	5.11	4.96	5.03	5.28	5.56	5.83	6.19	6.56	7.19	6.96	6.68	6.90	6.73	6.24	5.92	5.70	5.48	5.39	5.79
SEP	4.98	4.60	4.99	4.86	4.64	4.49	4.46	4.35	4.48	4.88	5.01	5.64	6.00	6.21	6.43	7.00	7.11	6.67	6.22	5.80	5.51	5.17	4.94	4.88	5.39
OCT	3.34	3.38	3.21	2.93	3.07	3.01	3.32	3.53	3.64	3.95	4.16	4.76	4.74	4.96	5.14	5.02	5.12	5.02	5.01	4.80	4.57	4.21	3.91	3.46	4.09
NOV	5.81	5.41	5.41	5.00	4.80	4.94	4.80	4.46	4.32	4.66	5.27	5.64	5.60	5.79	5.86	5.33	5.02	5.27	5.24	5.54	5.59	5.47	5.96	6.11	5.30
DEC	6.70	6.68	6.71	6.62	6.68	6.52	6.70	6.74	6.72	6.81	6.77	7.09	7.04	6.54	6.37	6.03	5.72	5.56	5.59	6.00	6.13	6.11	6.27	6.59	6.45
Annual	4.82	4.88	4.88	4.88	4.91	4.91	4.99	5.00	4.97	5.24	5.50	5.88	6.03	6.02	6.11	5.99	5.92	5.97	5.97	5.80	5.54	5.27	5.14	4.97	5.40

* Data not recorded properly

SENSOR HEIGHT: 80m

Based on Data June 2014 to May 2015

TABLE 6 A

MALAPUZHA DAM

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	4.72	5.63	5.76	6.25	6.48	6.51	6.85	6.99	6.80	6.97	7.25	7.39	7.12	6.60	6.29	5.92	5.49	5.24	4.96	4.95	5.43	5.28	4.86	4.79	6.02
FEB	5.08	5.42	5.34	5.76	6.09	6.29	6.56	6.93	6.73	6.65	6.65	6.87	6.89	6.46	6.26	5.89	5.37	5.54	5.86	6.51	5.67	5.34	5.39	5.08	6.03
MAR	2.58	2.24	2.26	2.37	2.66	2.86	2.96	3.18	3.02	3.73	4.16	4.48	4.63	4.67	4.71	4.72	4.64	5.20	5.82	5.86	5.57	4.88	3.98	3.21	3.93
APR	3.28	3.37	2.92	2.78	2.56	2.38	2.18	2.31	2.23	2.44	2.72	2.98	3.11	3.15	3.39	3.79	4.57	5.65	6.21	5.23	4.35	4.21	3.93	3.65	3.47
MAY	3.88	3.76	3.96	3.79	3.80	3.93	3.79	3.99	4.07	4.10	3.63	3.60	3.71	3.78	3.82	3.90	4.04	4.15	3.93	3.87	3.80	3.93	3.88	4.08	3.88
JUN	5.68	5.76	5.74	5.65	5.75	5.91	5.98	5.82	5.84	6.31	6.74	7.35	7.74	7.73	7.85	7.64	7.71	7.29	7.01	6.49	6.39	6.02	5.98	5.72	6.50
JUL	5.84	6.12	6.33	6.42	6.31	6.37	6.10	5.82	5.98	6.16	6.47	6.96	7.54	7.83	8.07	7.87	8.04	7.63	7.34	6.70	6.11	5.81	6.01	6.06	6.66
AUG	5.29	5.26	5.26	5.17	5.18	4.98	5.11	4.94	5.02	5.29	5.59	5.86	6.23	6.61	7.25	7.00	6.70	6.93	6.76	6.26	5.93	5.71	5.50	5.40	5.80
SEP	4.99	4.61	5.02	4.88	4.66	4.48	4.45	4.35	4.48	4.91	5.06	5.70	6.06	6.28	6.51	7.09	7.19	6.74	6.28	5.86	5.55	5.19	4.96	4.90	5.43
OCT	3.37	3.40	3.21	2.93	3.10	3.03	3.35	3.55	3.66	3.97	4.17	4.76	4.76	4.98	5.17	5.05	5.14	5.02	5.05	4.84	4.61	4.25	3.95	3.50	4.12
NOV	5.81	5.41	5.40	4.99	4.80	4.94	4.78	4.45	4.31	4.65	5.27	5.64	5.61	5.79	5.86	5.33	5.03	5.26	5.24	5.54	5.59	5.47	5.95	6.11	5.30
DEC	6.66	6.64	6.67	6.57	6.62	6.45	6.65	6.69	6.66	6.77	6.74	7.07	7.02	6.52	6.34	6.00	5.71	5.53	5.56	5.96	6.10	6.08	6.23	6.54	6.41
Annual	4.76	4.80	4.82	4.80	4.83	4.84	4.90	4.92	4.90	5.16	5.37	5.72	5.87	5.87	5.96	5.85	5.80	5.85	5.83	5.67	5.42	5.18	5.05	4.92	5.30

SENSOR HEIGHT: 78m

Based on Data June 2014 to May 2015

TABLE 6 B

MALAPUZHA DAM

MEAN HOURLY WIND SPEED

MONTH	OO	O1	O2	O3	O4	O5	O6	O7	O8	O9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AVE
JAN	4.15	4.92	5.10	5.57	5.70	5.66	5.95	5.96	5.79	6.26	6.66	6.85	6.61	6.15	5.86	5.48	5.05	4.69	4.25	4.22	4.58	4.46	4.11	4.12	5.34
FEB	4.49	4.83	4.64	5.20	5.42	5.56	5.65	5.91	5.82	5.99	6.10	6.37	6.41	6.02	5.84	5.49	4.97	5.05	5.16	5.54	4.81	4.50	4.60	4.42	5.37
MAR	2.04	1.81	1.92	2.09	2.23	2.46	2.60	2.65	2.56	3.42	3.88	4.20	4.33	4.37	4.42	4.40	4.30	4.71	5.13	5.07	4.82	4.17	3.33	2.61	3.48
APR	2.45	2.47	2.21	2.07	1.87	1.74	1.54	1.63	1.70	2.07	2.43	2.74	2.90	2.93	3.12	3.45	4.13	4.99	5.37	4.42	3.52	3.35	3.07	2.85	2.88
MAY	3.82	3.58	3.89	3.62	3.68	3.67	3.90	3.90	4.20	4.04	3.84	3.50	3.67	3.53	3.77	3.80	4.02	3.85	3.84	3.55	3.78	3.65	3.91	3.90	3.79
JUN	4.51	4.64	4.60	4.48	4.52	4.63	4.72	4.69	4.95	5.57	6.07	6.63	6.94	6.90	7.00	6.78	6.77	6.30	5.97	5.31	5.24	4.88	4.81	4.58	5.48
JUL	4.68	4.95	5.14	5.20	5.07	5.16	4.87	4.72	4.99	5.29	5.60	6.03	6.59	6.78	7.01	6.81	6.87	6.41	6.02	5.38	4.85	4.65	4.82	4.86	5.53
AUG	4.04	4.01	4.01	3.99	4.01	3.84	3.93	3.79	4.06	4.44	4.85	5.12	5.44	5.79	6.33	6.07	5.70	5.80	5.55	4.91	4.60	4.43	4.29	4.13	4.71
SEP	3.84	3.59	3.88	3.78	3.63	3.41	3.41	3.37	3.78	4.28	4.47	5.16	5.45	5.63	5.79	6.27	6.30	5.78	5.19	4.62	4.33	4.05	3.80	3.80	4.48
OCT	2.54	2.55	2.36	2.13	2.33	2.27	2.55	2.69	3.02	3.39	3.69	4.32	4.33	4.50	4.62	4.41	4.45	4.14	4.07	3.80	3.56	3.22	2.96	2.61	3.36
NOV	4.90	4.64	4.60	4.26	4.10	4.24	4.08	3.77	3.69	4.17	4.82	5.17	5.15	5.32	5.38	4.84	4.48	4.52	4.40	4.59	4.63	4.57	4.99	5.21	4.60
DEC	5.72	5.78	5.83	5.69	5.66	5.51	5.67	5.68	5.78	6.08	6.14	6.52	6.48	6.03	5.87	5.50	5.19	4.83	4.75	5.16	5.19	5.22	5.31	5.56	5.63
Annual	3.93	3.98	4.01	4.01	4.02	4.01	4.07	4.06	4.19	4.58	4.88	5.22	5.36	5.33	5.42	5.28	5.19	5.09	4.98	4.71	4.49	4.26	4.17	4.05	4.55

SENSOR HEIGHT : 50m

Based on Data June 2014 to May 2015

TABLE 6 C

MALAPUZHA DAM

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	2.79	3.28	3.50	3.81	3.88	3.90	4.15	4.21	4.25	4.96	5.37	5.48	5.34	5.02	4.74	4.37	3.98	3.47	2.75	2.50	2.71	2.85	2.72	2.77	3.87
FEB	3.04	3.24	3.16	3.51	3.77	3.90	3.95	4.09	4.31	4.77	4.92	5.13	5.15	4.87	4.74	4.39	3.90	3.81	3.65	3.66	3.06	2.84	3.00	2.92	3.91
MAR	1.14	1.08	1.17	1.24	1.29	1.52	1.59	1.62	1.87	2.75	3.15	3.37	3.54	3.60	3.57	3.42	3.28	3.49	3.74	3.57	3.49	2.93	2.22	1.59	2.51
APR	1.55	1.47	1.34	1.23	1.11	1.00	0.84	0.92	1.30	1.81	2.05	2.37	2.46	2.52	2.66	2.86	3.25	3.75	3.95	3.12	2.55	2.35	1.99	1.82	2.10
MAY	3.30	3.11	3.34	3.25	3.28	3.28	3.40	3.60	3.89	3.83	3.48	3.26	3.25	3.18	3.31	3.24	3.44	3.39	3.26	3.14	3.29	3.18	3.38	3.45	3.36
JUN	3.02	3.11	3.08	2.98	3.00	3.07	3.13	3.32	3.80	4.43	4.90	5.29	5.45	5.41	5.47	5.32	5.21	4.75	4.37	3.70	3.70	3.35	3.32	3.14	4.01
JUL	3.29	3.47	3.62	3.68	3.58	3.62	3.37	3.31	3.74	4.07	4.38	4.70	5.13	5.24	5.42	5.24	5.19	4.80	4.38	3.81	3.39	3.22	3.33	3.40	4.06
AUG	2.71	2.70	2.70	2.72	2.73	2.58	2.61	2.56	3.04	3.57	3.94	4.12	4.33	4.56	4.96	4.71	4.36	4.34	4.08	3.41	3.16	3.06	2.94	2.79	3.44
SEP	2.65	2.49	2.63	2.60	2.47	2.27	2.29	2.39	3.03	3.50	3.67	4.22	4.41	4.52	4.63	4.94	4.82	4.31	3.69	3.13	2.96	2.72	2.61	2.61	3.32
OCT	1.49	1.49	1.36	1.28	1.40	1.33	1.56	1.70	2.22	2.64	3.02	3.49	3.55	3.65	3.65	3.36	3.34	2.92	2.73	2.35	2.15	1.92	1.79	1.54	2.33
NOV	3.43	3.26	3.19	2.95	2.84	2.90	2.80	2.65	2.78	3.31	3.81	4.12	4.15	4.25	4.20	3.74	3.42	3.23	2.97	3.07	3.07	3.06	3.41	3.61	3.34
DEC	4.00	4.09	4.12	4.03	3.97	3.83	3.95	3.98	4.29	4.71	4.85	5.13	5.12	4.78	4.63	4.33	3.98	3.48	3.14	3.46	3.48	3.55	3.63	3.80	4.10
Annual	2.70	2.73	2.77	2.77	2.78	2.77	2.80	2.86	3.21	3.70	3.96	4.22	4.32	4.30	4.33	4.16	4.01	3.81	3.56	3.24	3.08	2.92	2.86	2.79	3.36

SENSOR HEIGHT : 20m

Based on Data June 2014 to May 2015

MALAMPUZHA DAM

TABLE 7

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	ANNUAL
0.0-1.0	10.98	9.65	21.71	29.40	18.13	1.23	0.61	6.56	11.48	30.00	18.77	7.19	13.81
1.0-2.0	13.40	13.84	25.29	25.74	13.26	5.09	3.79	9.81	10.88	17.70	16.67	9.88	13.78
2.0-3.0	11.58	13.69	17.47	19.28	14.87	16.13	16.57	18.75	18.08	17.65	10.79	10.28	15.43
3.0-4.0	12.70	12.72	13.87	11.97	13.75	31.69	30.46	29.64	24.75	14.31	10.00	16.64	18.54
4.0-5.0	17.11	15.13	11.49	8.38	14.11	21.78	25.81	21.98	19.68	12.84	15.56	20.07	16.99
5.0-6.0	17.27	16.39	7.35	4.26	11.50	15.21	14.89	9.09	9.63	5.82	17.38	20.12	12.41
6.0-7.0	11.78	11.58	2.22	0.86	8.15	6.34	5.85	3.36	4.31	1.50	8.70	11.49	6.35
7.0-8.0	4.32	5.73	0.58	0.07	4.32	2.20	1.53	0.69	1.11	0.18	1.74	3.63	2.17
8.0-9.0	0.74	1.12	0.02	0.02	1.58	0.28	0.38	0.09	0.09	0.00	0.37	0.56	0.44
9.0-10.0	0.11	0.15	0.00	0.02	0.21	0.05	0.09	0.02	0.00	0.00	0.02	0.13	0.07
10.0-11.0	0.00	0.00	0.00	0.00	0.03	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
11.0-12.0	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
12.0-13.0	0.00	0.00	0.00	0.00	0.03	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 June 2014 to May 2015**

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

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

MALAMPUZHA DAM

TABLE 7A

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	ANNUAL
0.0-1.0	5.67	4.19	10.82	19.47	15.91	0.28	0.18	4.03	7.50	19.00	11.71	3.79	8.54
1.0-2.0	7.08	7.74	16.69	18.54	10.95	0.67	0.70	4.64	6.39	12.43	11.71	4.91	8.54
2.0-3.0	9.32	10.76	21.24	19.72	12.53	3.50	3.23	6.77	7.66	14.90	11.88	6.68	10.68
3.0-4.0	8.92	11.33	14.36	16.02	14.84	10.74	11.15	13.40	14.61	13.89	8.63	8.85	12.23
4.0-5.0	10.01	8.83	11.29	10.02	14.51	24.51	22.96	25.38	21.48	14.70	7.18	12.21	15.26
5.0-6.0	14.47	11.71	11.27	8.17	14.05	26.60	26.46	24.10	21.02	12.66	10.00	15.12	16.30
6.0-7.0	15.43	15.10	8.36	5.23	10.40	17.66	19.20	13.35	11.57	7.73	14.72	17.14	12.99
7.0-8.0	13.46	13.59	4.14	2.15	4.68	9.77	9.44	5.35	5.46	3.18	13.61	16.11	8.41
8.0-9.0	9.77	9.38	1.21	0.44	1.55	3.98	4.46	2.08	3.36	1.32	7.59	9.61	4.56
9.0-10.0	4.46	5.01	0.45	0.14	0.46	1.76	1.44	0.69	0.88	0.16	2.29	4.19	1.83
10.0-11.0	1.10	1.96	0.18	0.05	0.03	0.35	0.49	0.13	0.07	0.04	0.49	1.14	0.50
11.0-12.0	0.27	0.32	0.00	0.05	0.00	0.16	0.20	0.07	0.00	0.00	0.16	0.13	0.11
12.0-13.0	0.04	0.07	0.00	0.00	0.03	0.02	0.07	0.00	0.00	0.00	0.02	0.13	0.03
13.0-14.0	0.00	0.00	0.00	0.00	0.03	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	0.03	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 June 2014 to May 2015**

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

MALAMPUZHA DAM

TABLE 7B

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	ANNUAL
0.0-1.0	4.86	3.55	8.83	11.78	12.20	0.19	0.04	2.24	4.10	12.10	8.70	3.76	6.03
1.0-2.0	6.34	6.65	13.66	16.48	11.34	0.25	0.27	3.07	4.54	10.44	10.44	3.47	7.25
2.0-3.0	7.59	8.23	18.03	18.59	13.29	0.83	1.08	3.79	6.34	13.10	11.46	5.40	8.98
3.0-4.0	7.08	10.29	15.34	16.64	14.36	4.33	4.08	6.32	8.24	12.72	8.54	6.63	9.55
4.0-5.0	8.24	8.68	11.54	12.41	13.26	10.35	9.87	11.72	13.75	11.96	6.27	9.12	10.60
5.0-6.0	10.37	8.16	11.09	9.61	15.91	21.53	19.94	23.32	20.44	16.42	6.64	11.56	14.58
6.0-7.0	13.46	11.66	10.46	7.96	11.50	28.50	24.92	24.60	20.07	11.18	10.90	14.07	15.77
7.0-8.0	14.76	15.00	6.54	3.91	5.35	17.59	19.96	15.41	12.80	7.10	13.87	15.66	12.33
8.0-9.0	12.14	13.05	3.18	1.81	2.07	9.79	11.50	5.67	5.67	3.25	12.04	14.25	7.87
9.0-10.0	9.09	7.76	0.74	0.44	0.46	3.84	5.16	2.76	2.82	1.48	7.62	9.07	4.27
10.0-11.0	4.59	4.02	0.43	0.25	0.18	1.83	1.91	0.78	1.13	0.16	2.59	4.66	1.88
11.0-12.0	1.12	2.16	0.16	0.09	0.03	0.69	0.72	0.22	0.07	0.07	0.65	1.86	0.65
12.0-13.0	0.20	0.60	0.00	0.02	0.00	0.19	0.36	0.09	0.02	0.02	0.25	0.34	0.17
13.0-14.0	0.11	0.20	0.00	0.00	0.00	0.09	0.11	0.02	0.00	0.00	0.00	0.09	0.05
14.0-15.0	0.02	0.00	0.00	0.00	0.03	0.00	0.07	0.00	0.00	0.00	0.02	0.07	0.02
15.0-16.0	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
16.0-17.0	0.00	0.00	0.00	0.00	0.03	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 June 2014 to May 2015**

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

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

MALAMPUZHA DAM

TABLE 7C

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND SPEED

CLASS INTERVAL (m/s)	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	ANNUAL
0.0-1.0	5.02	3.75	10.73	13.59	12.59	0.16	0.07	2.13	3.98	12.57	8.50	3.36	6.37
1.0-2.0	6.54	6.82	13.44	16.57	11.34	0.30	0.20	2.69	4.84	10.53	11.11	3.61	7.33
2.0-3.0	7.39	8.18	17.70	18.10	13.26	0.79	1.01	3.99	6.18	12.77	11.34	5.58	8.86
3.0-4.0	6.97	10.02	14.72	16.32	13.78	4.38	3.86	6.25	8.36	12.75	8.40	6.43	9.35
4.0-5.0	8.36	8.48	11.72	12.01	14.23	11.18	9.96	12.07	13.84	12.41	6.20	9.09	10.80
5.0-6.0	10.24	8.28	10.89	9.63	15.60	22.43	20.34	23.68	21.02	16.22	6.74	11.67	14.73
6.0-7.0	13.17	11.51	10.24	7.99	11.28	28.08	25.23	25.20	20.00	10.69	10.60	13.62	15.63
7.0-8.0	14.63	14.73	6.27	3.43	5.11	17.31	20.14	14.85	12.71	6.99	13.31	15.43	12.08
8.0-9.0	11.90	13.07	3.00	1.71	2.10	9.31	11.42	5.53	5.32	3.32	12.48	14.38	7.79
9.0-10.0	9.57	7.96	0.72	0.30	0.46	3.68	4.87	2.62	2.78	1.48	7.66	9.50	4.30
10.0-11.0	4.70	4.19	0.40	0.23	0.15	1.57	1.79	0.69	0.88	0.20	2.69	4.93	1.87
11.0-12.0	1.19	2.16	0.18	0.07	0.03	0.56	0.67	0.18	0.07	0.07	0.69	1.90	0.65
12.0-13.0	0.18	0.64	0.00	0.05	0.03	0.19	0.25	0.09	0.02	0.02	0.25	0.34	0.17
13.0-14.0	0.13	0.20	0.00	0.00	0.00	0.07	0.11	0.02	0.00	0.00	0.00	0.07	0.05
14.0-15.0	0.02	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.02	0.09	0.02
15.0-16.0	0.00	0.00	0.00	0.00	0.03	0.00	0.02	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 June 2014 to May 2015**

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

MALAMPUZHA DAM

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	0.44	0.56	0.74	0.71	0.91	0.58	0.38	0.46	0.75	1.24	1.37	0.72	8.85
1.0-2.0	0.14	0.47	0.84	0.92	1.03	0.51	0.34	0.38	0.67	1.96	1.62	0.37	9.26
2.0-3.0	0.05	0.60	1.00	1.11	1.00	0.41	0.19	0.22	0.89	3.25	2.43	0.23	11.38
3.0-4.0	0.01	0.35	0.74	1.39	1.10	0.25	0.06	0.06	1.18	4.78	2.08	0.09	12.08
4.0-5.0	0.01	0.13	0.75	2.11	1.64	0.10	0.01	0.02	1.89	6.08	1.59	0.05	14.37
5.0-6.0	0.00	0.03	0.99	3.27	2.30	0.04	0.01	0.01	1.74	5.92	0.98	0.03	15.33
6.0-7.0	0.01	0.01	0.87	3.81	2.88	0.01	0.00	0.00	0.77	3.62	0.56	0.02	12.55
7.0-8.0	0.00	0.00	0.58	3.13	2.65	0.00	0.00	0.01	0.28	1.74	0.23	0.01	8.64
8.0-9.0	0.00	0.00	0.32	2.01	1.61	0.00	0.00	0.00	0.08	0.74	0.11	0.00	4.87
9.0-10.0	0.00	0.00	0.11	0.89	0.67	0.00	0.00	0.00	0.02	0.22	0.04	0.00	1.95
10.0-11.0	0.00	0.00	0.02	0.26	0.20	0.00	0.00	0.00	0.00	0.04	0.03	0.00	0.56
11.0-12.0	0.00	0.00	0.00	0.06	0.03	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.12
12.0-13.0	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
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	0.00	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
Total	0.66	2.16	6.94	19.70	16.04	1.89	1.00	1.16	8.27	29.60	11.04	1.53	100.00

SENSOR HEIGHT: 50m **Based on Data June 2014 to May 2015**

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

MALAMPUZHA DAM

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	0.42	0.41	0.44	0.48	0.62	0.40	0.37	0.37	0.54	0.79	0.84	0.51	6.19
1.0-2.0	0.18	0.40	0.73	0.77	0.85	0.51	0.36	0.37	0.74	1.23	1.22	0.31	7.68
2.0-3.0	0.04	0.35	0.93	0.99	1.08	0.46	0.21	0.23	0.65	2.52	1.88	0.18	9.51
3.0-4.0	0.01	0.25	0.72	1.02	1.08	0.27	0.08	0.05	0.61	3.40	2.14	0.07	9.70
4.0-5.0	0.00	0.10	0.63	1.46	1.34	0.16	0.02	0.01	0.76	4.05	1.79	0.05	10.37
5.0-6.0	0.01	0.02	0.77	2.17	1.72	0.06	0.01	0.01	1.31	5.61	1.94	0.05	13.67
6.0-7.0	0.00	0.01	0.90	3.08	2.36	0.02	0.01	0.00	1.17	5.94	1.53	0.02	15.05
7.0-8.0	0.00	0.00	0.73	3.38	2.88	0.00	0.00	0.00	0.56	3.86	0.80	0.03	12.25
8.0-9.0	0.00	0.00	0.48	2.77	2.48	0.01	0.00	0.00	0.22	1.70	0.36	0.01	8.03
9.0-10.0	0.00	0.00	0.26	1.62	1.75	0.00	0.00	0.00	0.07	0.71	0.16	0.01	4.59
10.0-11.0	0.00	0.00	0.09	0.76	0.83	0.00	0.00	0.00	0.00	0.29	0.06	0.00	2.03
11.0-12.0	0.00	0.00	0.01	0.25	0.34	0.00	0.00	0.00	0.00	0.04	0.05	0.00	0.69
12.0-13.0	0.00	0.00	0.00	0.06	0.08	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.18
13.0-14.0	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.06
14.0-15.0	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	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
Total	0.67	1.55	6.68	18.85	17.43	1.90	1.06	1.06	6.63	30.14	12.80	1.22	100.00

SENSOR HEIGHT: 78m **Based on Data June 2014 to May 2015**

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

MALAMPUZHA DAM

TABLE 8B

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED

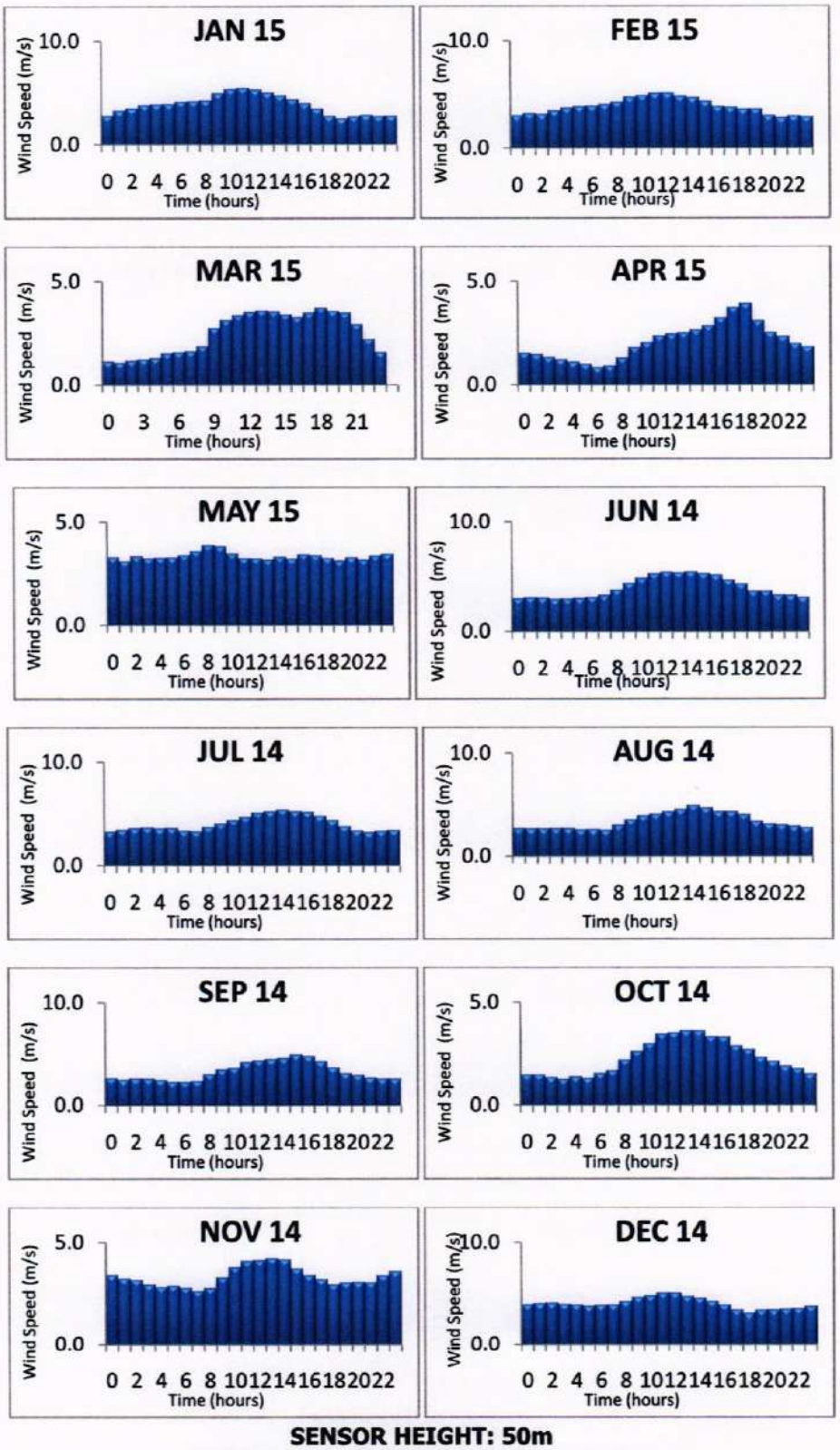
Deg/ (m/s)	345-15	15-45	45-75	75-105	105-135	135-165	165-195	195-225	225-255	255-285	285-315	315-345	ANNUAL
0.0-1.0	0.40	0.45	0.50	0.54	0.62	0.41	0.37	0.39	0.58	0.83	0.90	0.53	6.53
1.0-2.0	0.19	0.41	0.76	0.78	0.88	0.51	0.37	0.36	0.73	1.33	1.20	0.29	7.80
2.0-3.0	0.04	0.33	0.90	0.98	1.04	0.45	0.20	0.23	0.61	2.43	1.98	0.18	9.38
3.0-4.0	0.02	0.23	0.68	0.97	1.06	0.27	0.08	0.04	0.60	3.46	2.07	0.07	9.55
4.0-5.0	0.00	0.08	0.65	1.45	1.35	0.15	0.02	0.01	0.77	4.12	1.82	0.05	10.47
5.0-6.0	0.00	0.03	0.76	2.20	1.71	0.07	0.01	0.01	1.28	5.75	1.94	0.04	13.79
6.0-7.0	0.01	0.01	0.88	2.99	2.31	0.03	0.01	0.00	1.21	5.96	1.50	0.02	14.93
7.0-8.0	0.00	0.00	0.72	3.35	2.79	0.00	0.00	0.00	0.55	3.74	0.75	0.03	11.94
8.0-9.0	0.00	0.00	0.49	2.78	2.52	0.01	0.00	0.00	0.22	1.57	0.35	0.01	7.95
9.0-10.0	0.00	0.00	0.26	1.70	1.80	0.00	0.00	0.00	0.07	0.68	0.15	0.01	4.67
10.0-11.0	0.00	0.00	0.09	0.78	0.88	0.00	0.00	0.00	0.00	0.23	0.05	0.00	2.04
11.0-12.0	0.00	0.00	0.01	0.25	0.35	0.00	0.00	0.00	0.00	0.03	0.05	0.00	0.70
12.0-13.0	0.00	0.00	0.00	0.06	0.08	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.18
13.0-14.0	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.06
14.0-15.0	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	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
Total	0.67	1.55	6.68	18.85	17.43	1.90	1.06	1.06	6.63	30.14	12.80	1.22	100.00

SENSOR HEIGHT: 80m **Based on Data June 2014 to May 2015**

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

NATIONAL INSTITUTE WIND ENERGY
CHENNAI

नीवे NIWE
(ISO 9001:2008)



SENSOR HEIGHT: 50m

FIGURE 4: MEAN HOURLY WIND SPEED

(July 2014toMay 2015)

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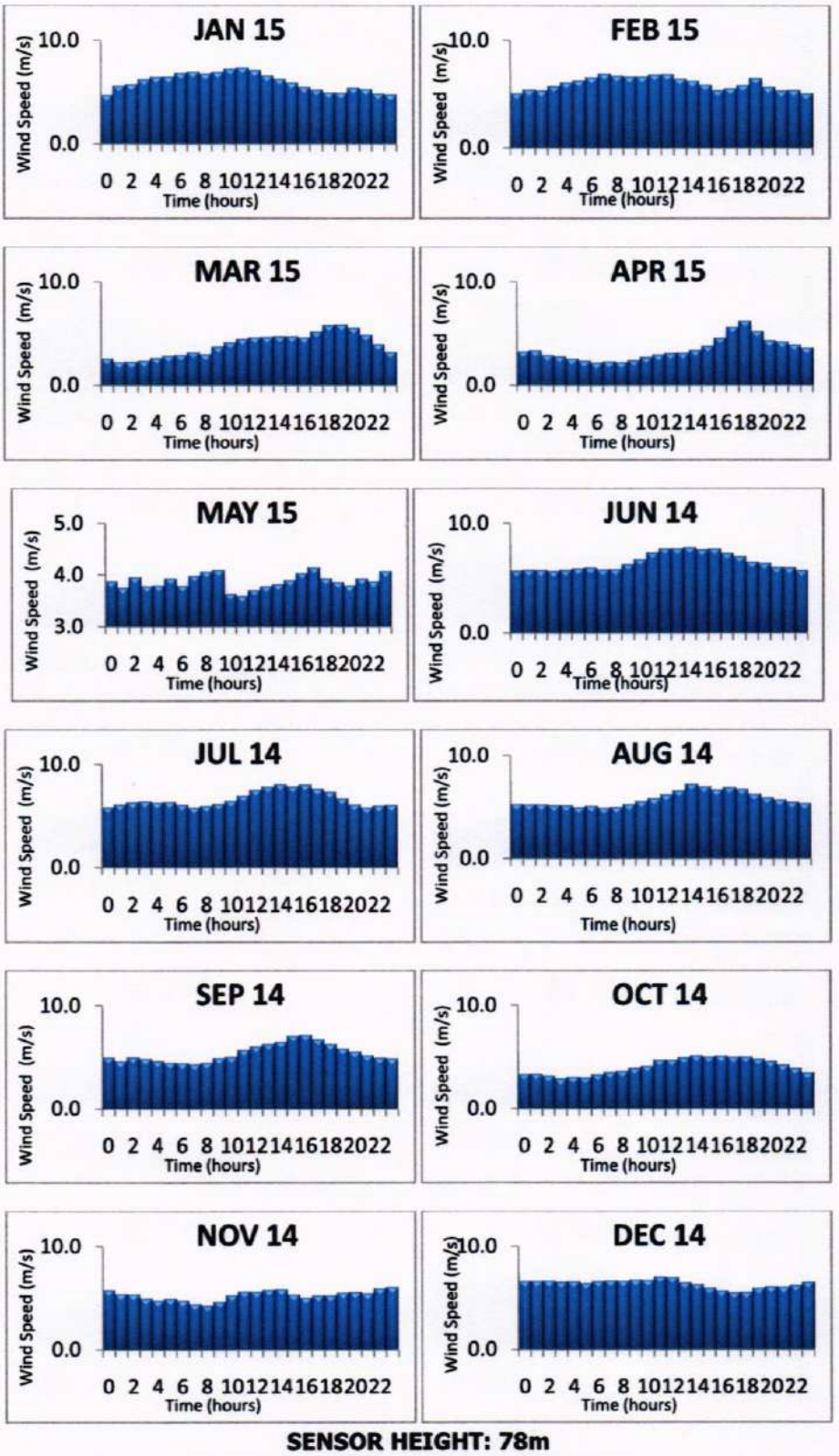
(ISO 9001:2008)



SENSOR HEIGHT: 78m

FIGURE 4A: MEAN HOURLY WIND SPEED

(July 2014 toMay 2015)

NATIONAL INSTITUTE WIND ENERGY
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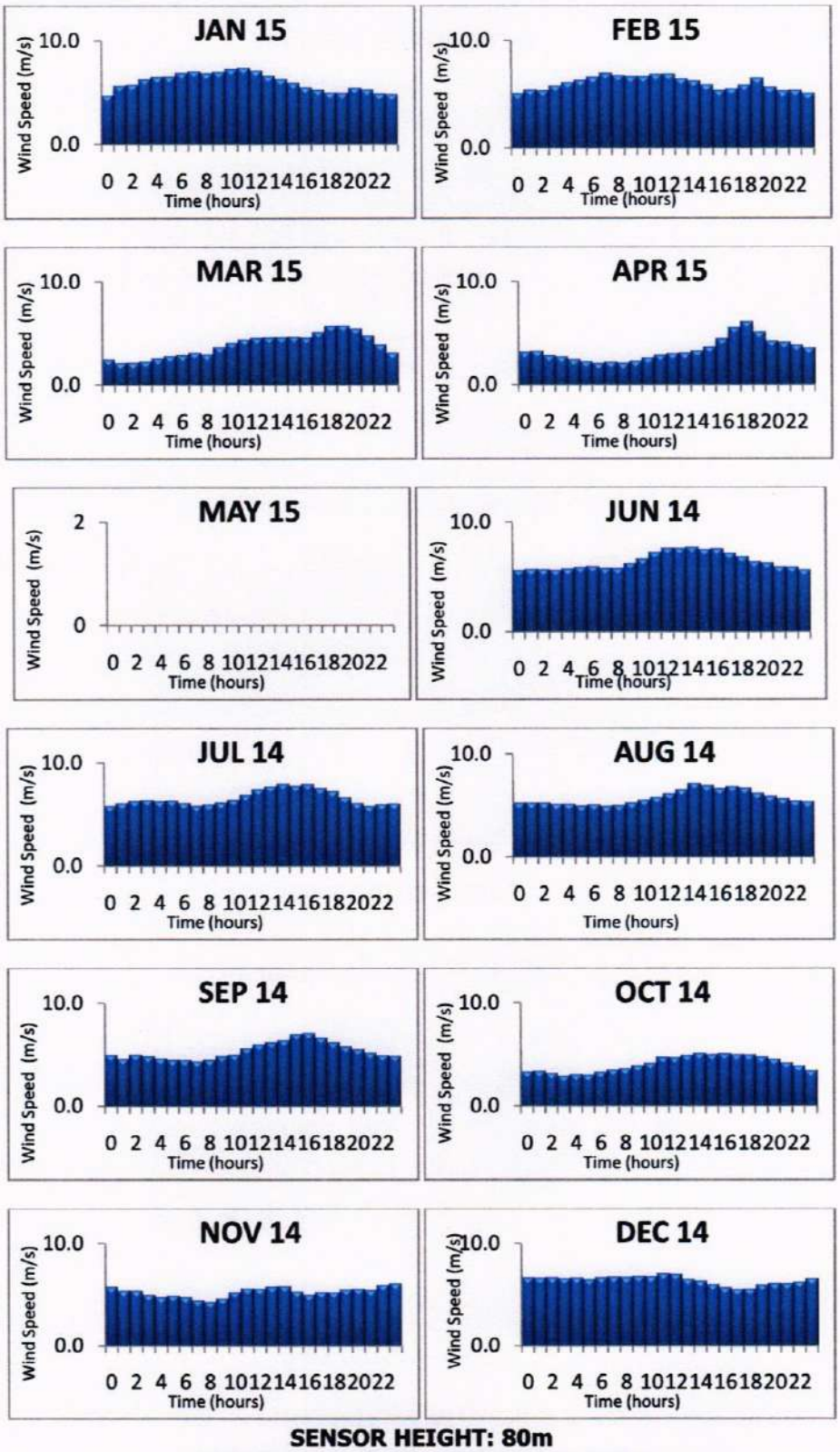
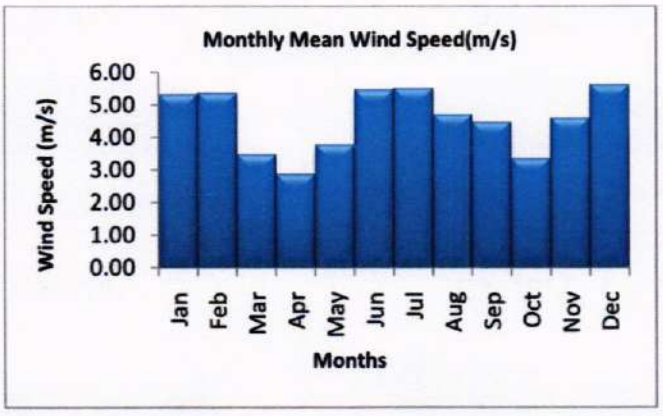
(ISO 9001:2008)



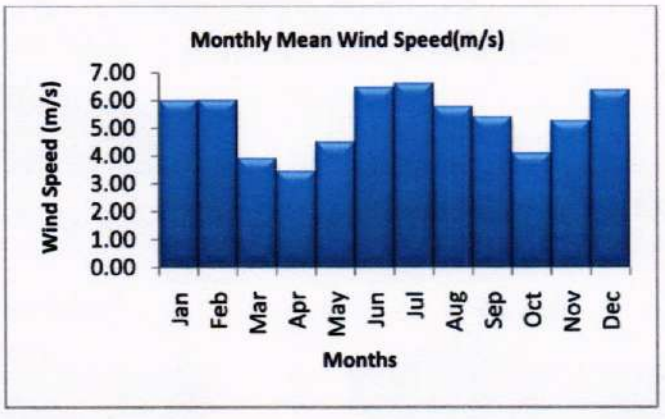
SENSOR HEIGHT: 80m

FIGURE 4B: MEAN HOURLY WIND SPEED

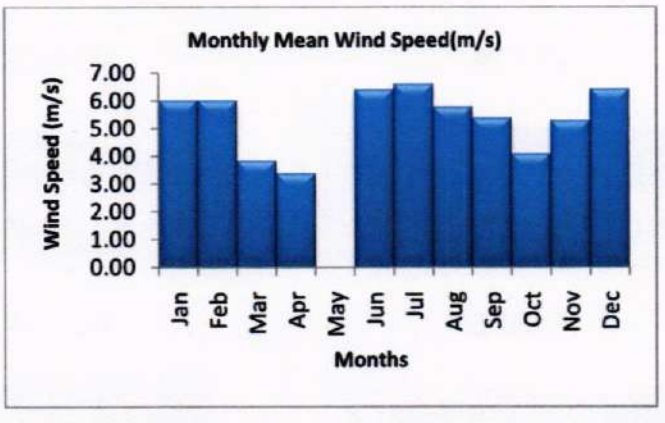
(July 2014 toMay 2015)



SENSOR HEIGHT: 50m

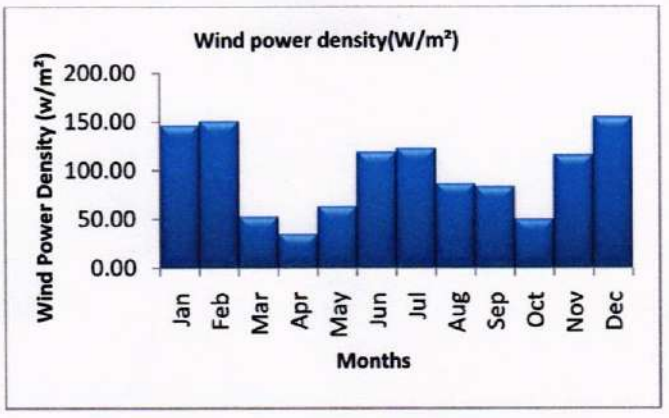


SENSOR HEIGHT: 78 m

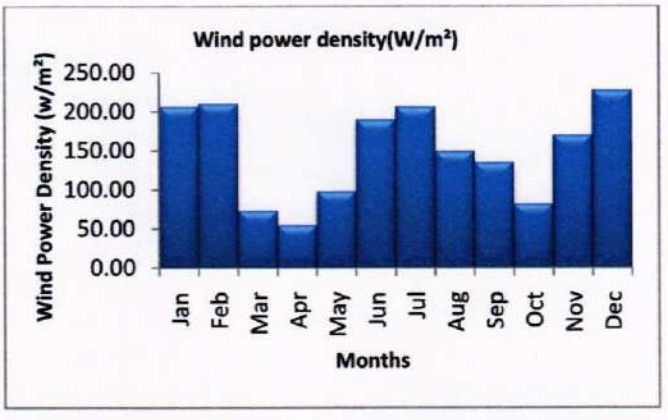


SENSOR HEIGHT: 80m

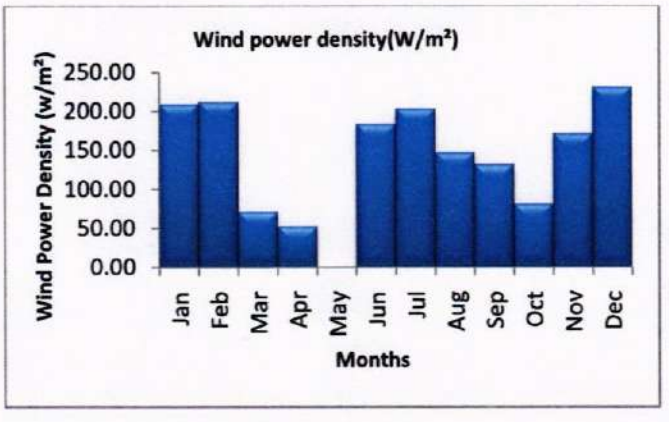
**FIGURE 5: MONTHLY MEAN WIND SPEED
(July 2014 to May 2015)**



SENSOR HEIGHT: 50m



SENSOR HEIGHT: 78m



SENSOR HEIGHT: 80m

FIGURE 6: MONTHLY MEAN WIND POWER DENSITY (July 2014toMay 2015)

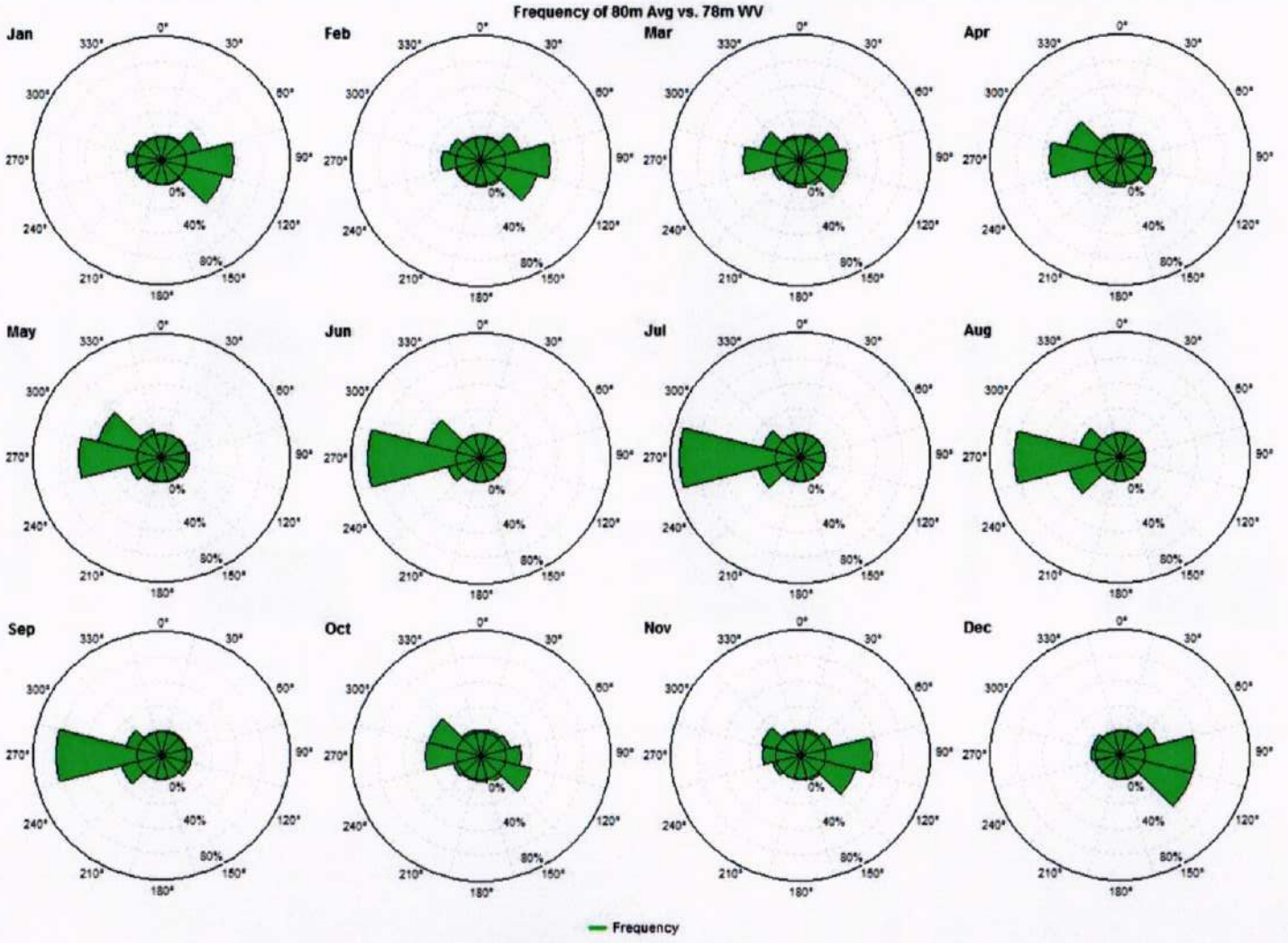


FIGURE 7: WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(June 2014 to May 2015)

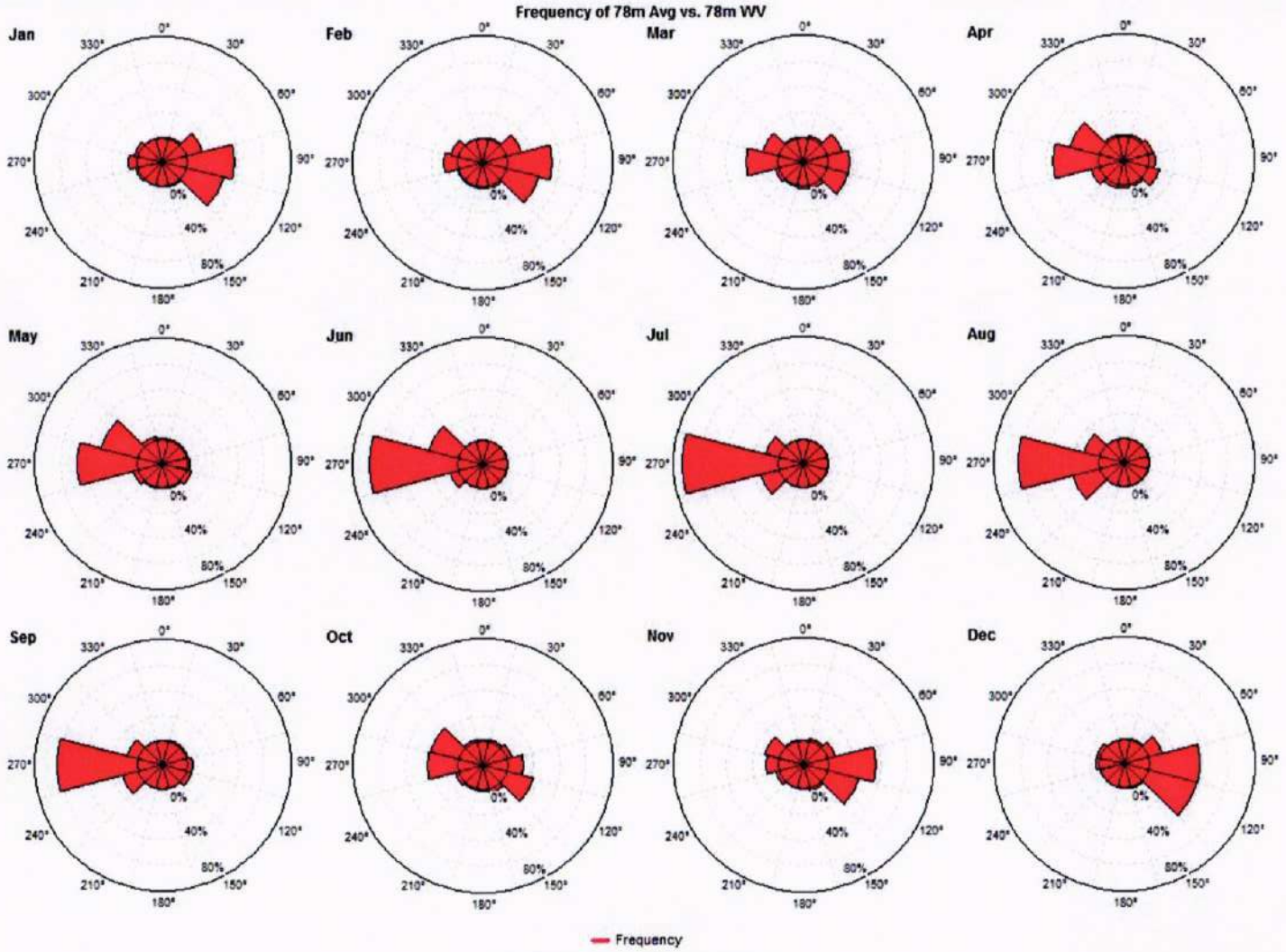


FIGURE 7A: WIND ROSE
SENSOR HEIGHT: (78m Anemometer and 78m Wind vane)
(June 2014 to May 2015)

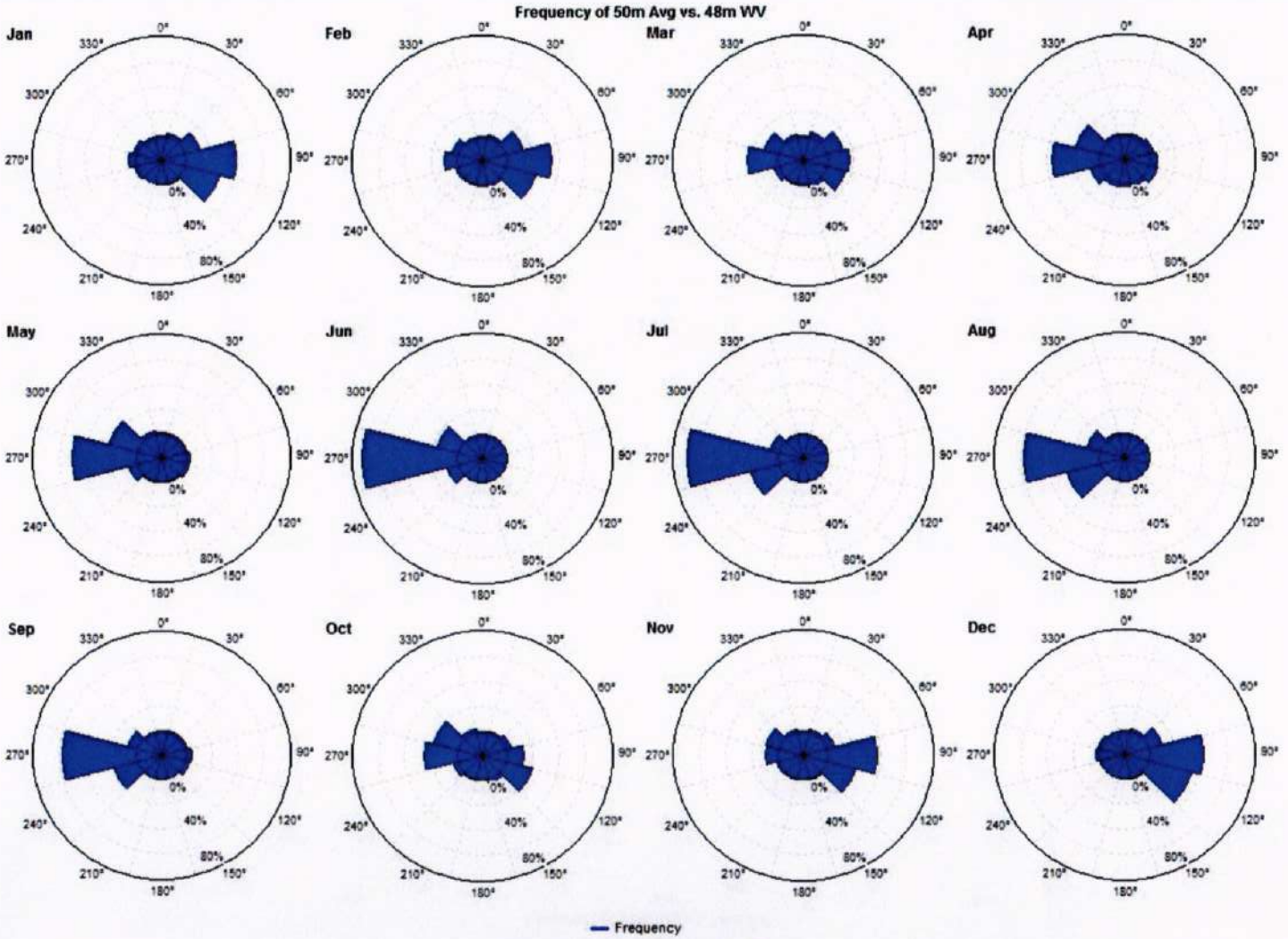


FIGURE 7B: WIND ROSE
SENSOR HEIGHT: (50m Anemometer and 48m Wind vane)
(June 2014 to May 2015)

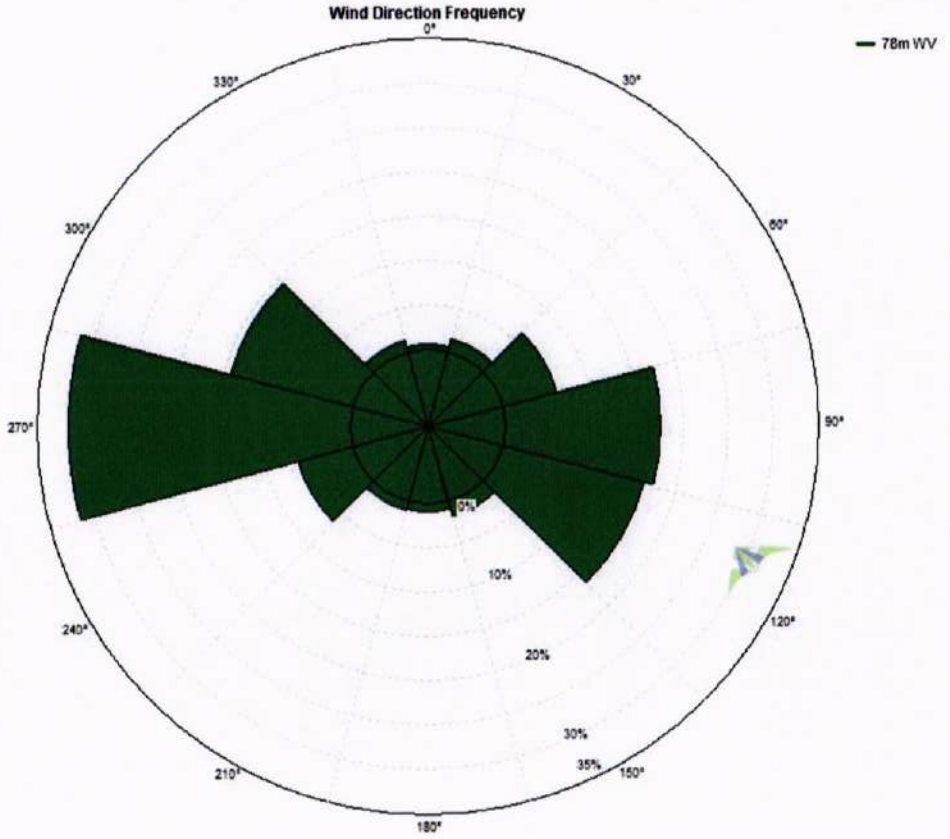


FIGURE 7C: ANNUAL WIND ROSE
SENSOR HEIGHT: (80m Anemometer and 78m Wind vane)
(June 2014 to May 2015)

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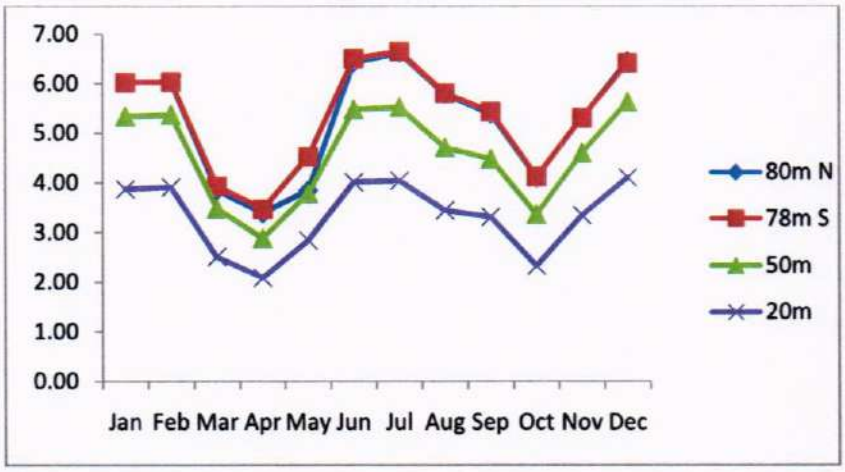
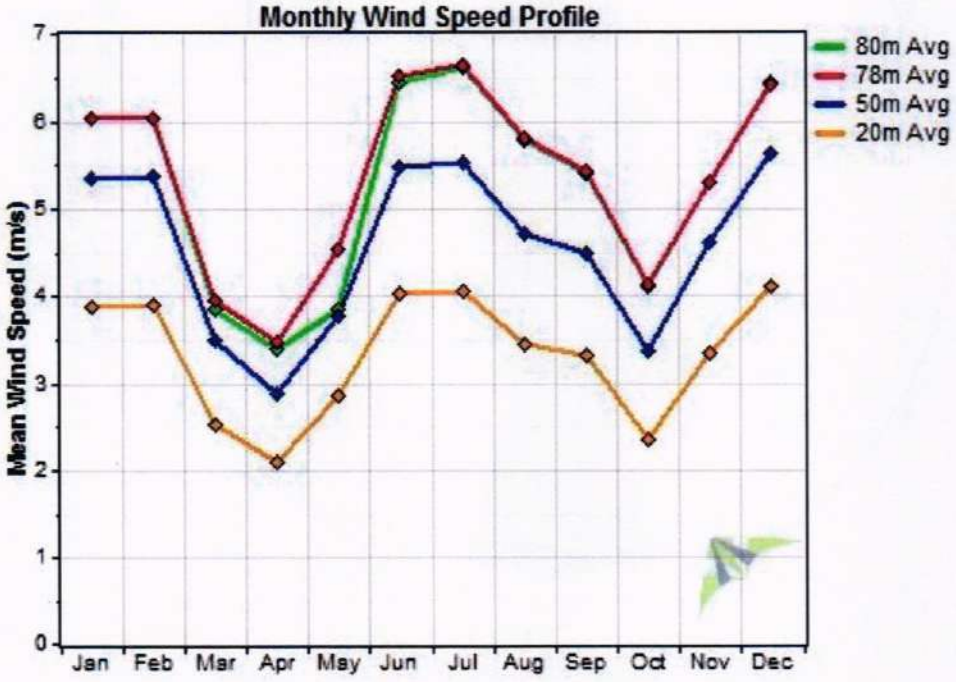


MONTHLY MEAN WIND SPEED
(JUNE2014 TO MAY 2015)



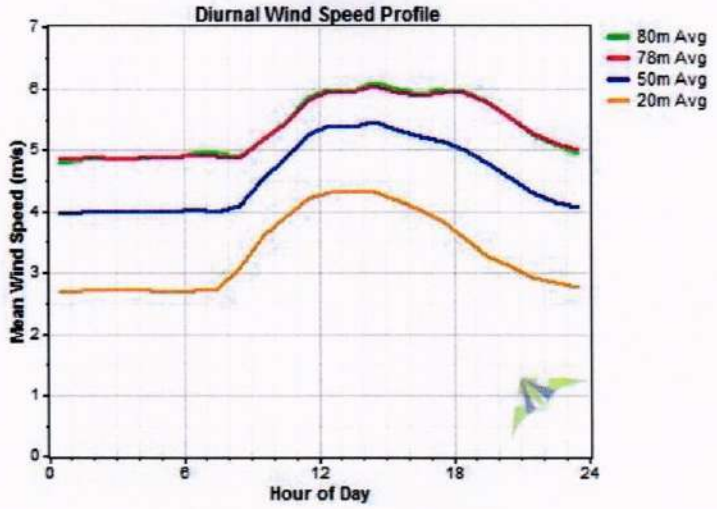


FIGURE 8: MONTHLY WIND SPEED AND DAILY WIND SPEED – MALAPUZHA DAM (JUNE2014 TO MAY 2015)

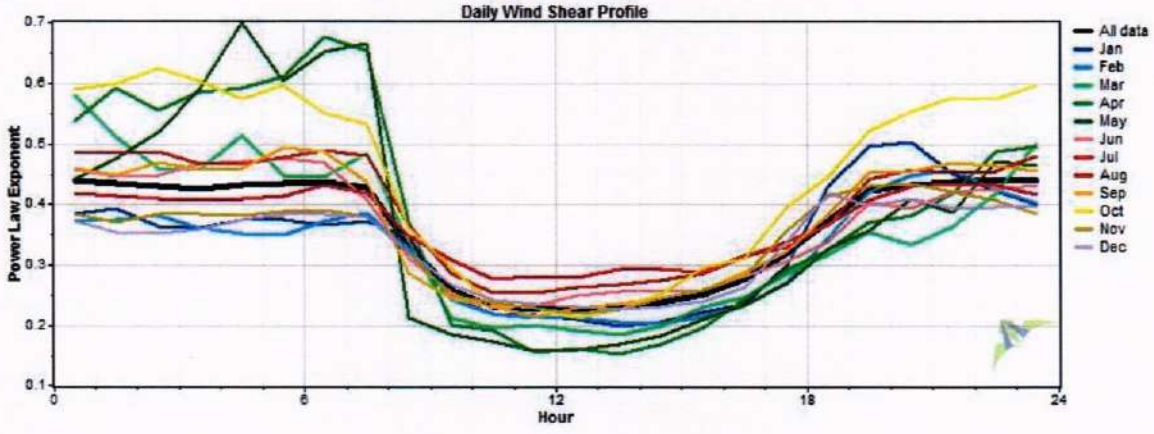


FIGURE 9: DAILY WIND SHEAR-MALAPUZHA DAM (JUNE2014 TO MAY2015)

FIGURE 10: MONTHLY WIND SHEAR- MALAPUZHA DAM (JUNE2014 TO MAY2015)

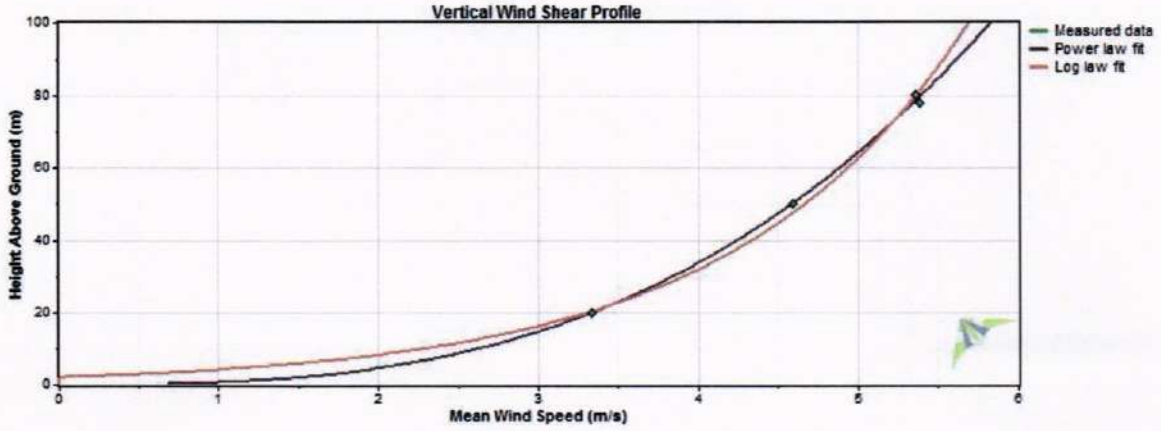
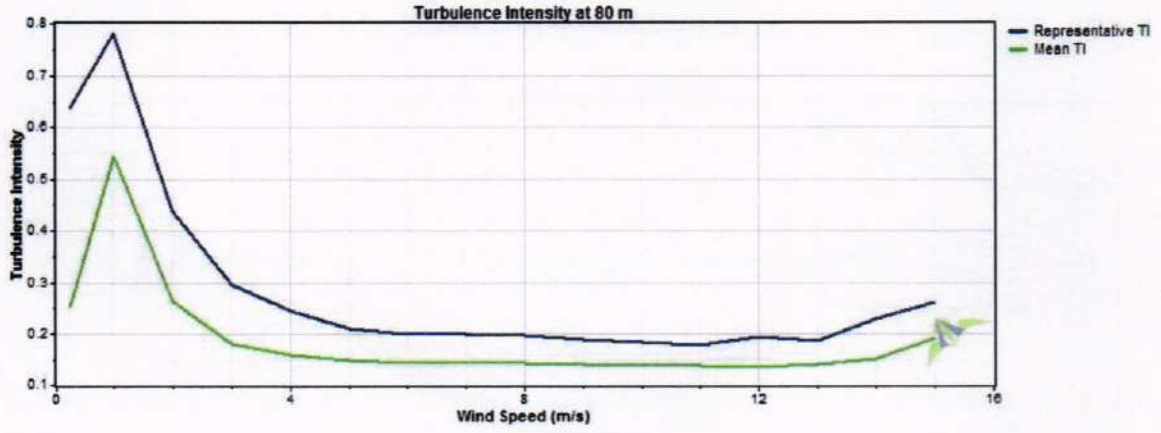
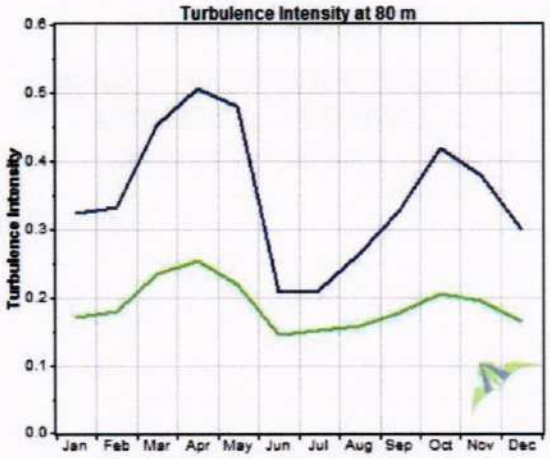
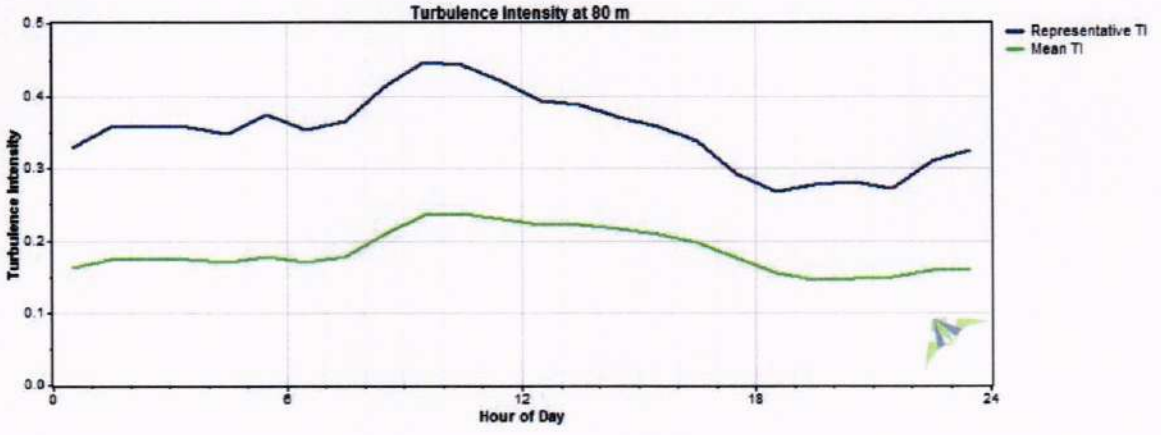


FIGURE 11: VERTICALWIND SHEAR- MALAPUZHA DAM (JUNE2014 TO MAY2015)







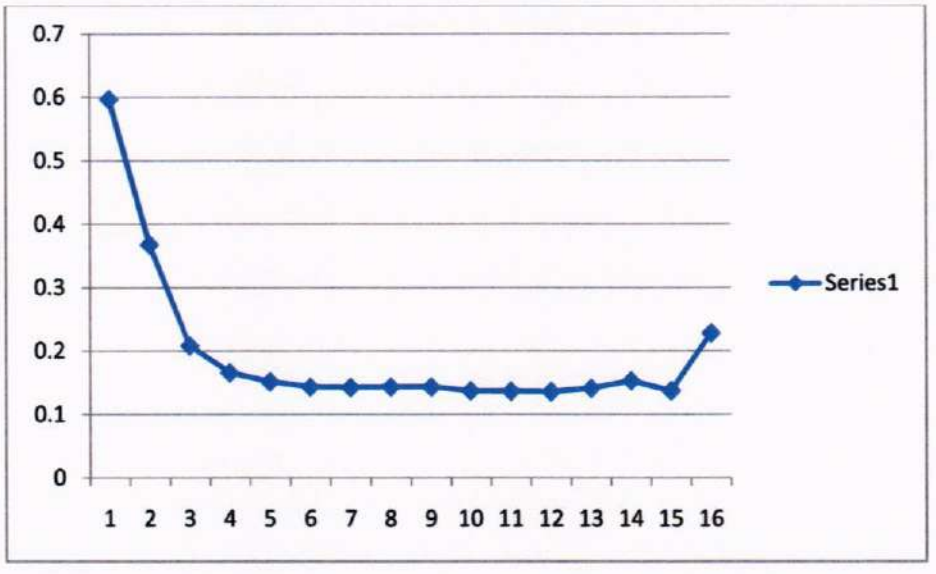
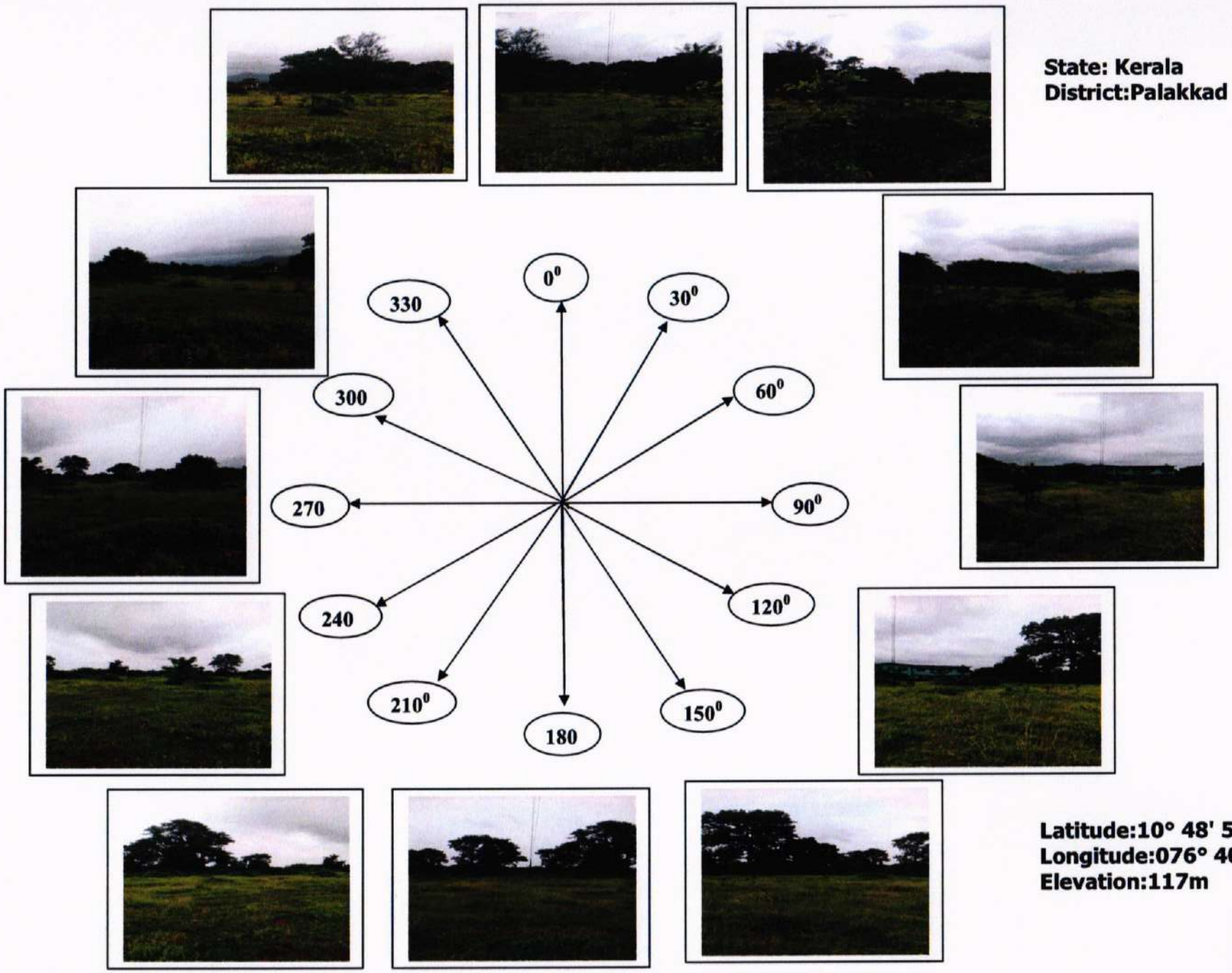


FIGURE 12: TURBULANCE INTENSITY – MALAPUZHA DAM (JUNE2014 TO MAY2015)

Annexure -2

Site Photographs

(a) 12Sector wise photograph of "Malampuzha Dam" site



State: Kerala
District:Palakkad

Latitude:10° 48' 57.7"
Longitude:076° 40' 10.3"
Elevation:117m

नीवे NIWE
(ISO 9001:2008)

Annexure-3

Calibration Reports

Svend Ole Hansen ApS

SCT. JØRGENS ALLÉ 7 · DK-1615 KØBENHAVN V · DENMARK
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WIND ENGINEERING FLUID DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.1059 **Date of issue:** February 14, 2011

Type: NRG #40 **Serial number:** 179500166150

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 13, 2011

Calibrated by: asj **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] = 0.76430 · f [Hz] + 0.32285

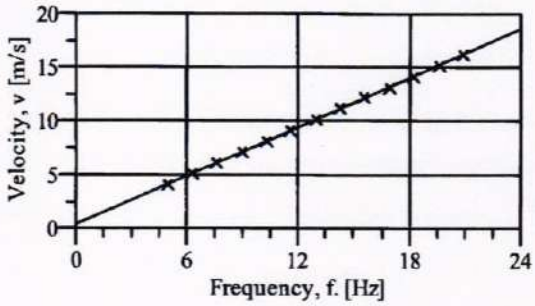
Standard uncertainty, slope: 0.00136 **Standard uncertainty, offset:** 0.04443

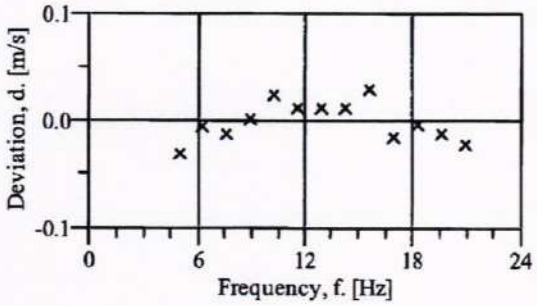
Covariance: -0.0000139 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999990$

Absolute maximum deviation: 0.030 m/s at 12.232 m/s

Barometric pressure: 1018.9 hPa **Relative humidity:** 16.1%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.85	30.1	23.9	4.108	4.9912	-0.029	0.028
4	15.32	30.0	24.0	5.121	6.2828	-0.004	0.033
6	21.98	29.8	24.1	6.134	7.6175	-0.011	0.038
8	29.82	29.7	24.2	7.144	8.9218	0.002	0.043
10	39.07	29.6	24.2	8.175	10.2412	0.025	0.049
12	49.37	29.5	24.2	9.188	11.5818	0.013	0.055
13-last	60.81	29.5	24.2	10.197	12.9023	0.013	0.061
11	73.31	29.6	24.3	11.197	14.2115	0.013	0.067
9	87.45	29.7	24.2	12.232	15.5428	0.030	0.073
7	102.14	29.8	24.2	13.221	16.8963	-0.015	0.079
5	118.81	29.9	24.1	14.262	18.2410	-0.002	0.085
3	136.38	30.0	24.0	15.282	19.5869	-0.011	0.091
1-first	154.83	30.2	23.9	16.289	20.9180	-0.022	0.097





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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.

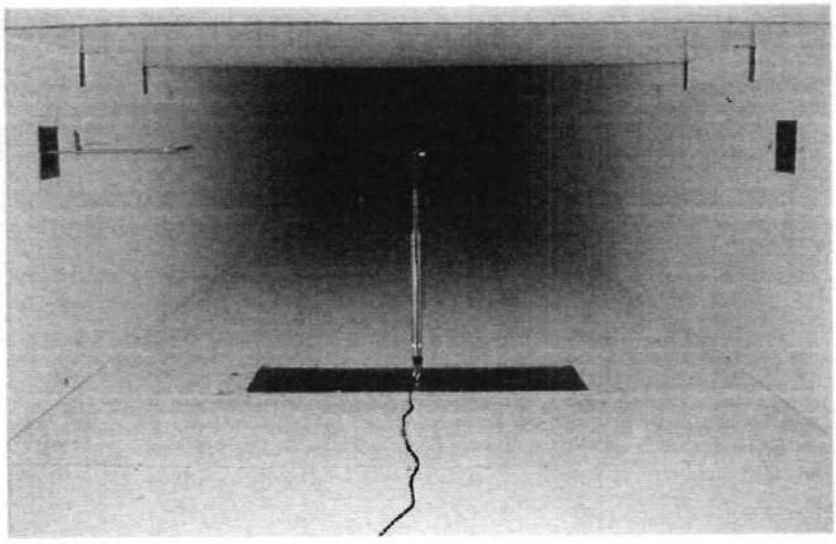

Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

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: 11.02.1059

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WIND ENGINEERING FLUID DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0930 **Date of issue:** February 10, 2011

Type: NRG #40 **Serial number:** 179500166147

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] = 0.76417 · f [Hz] + 0.30537

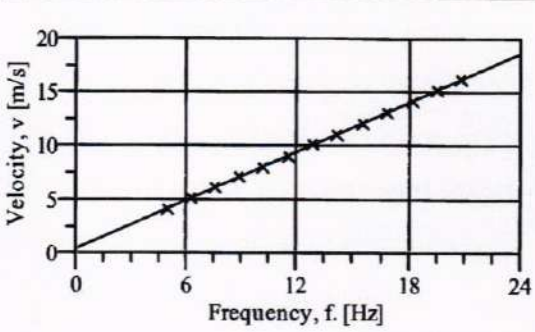
Standard uncertainty, slope: 0.00121 **Standard uncertainty, offset:** 0.04168

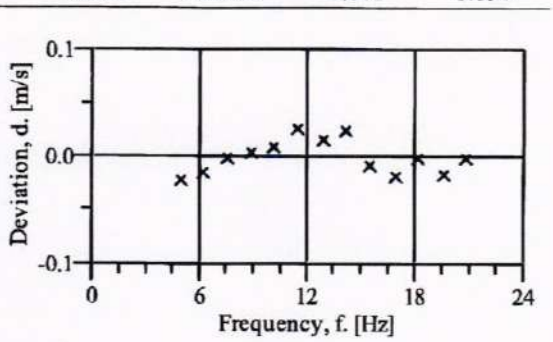
Covariance: -0.0000110 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999992$

Absolute maximum deviation: 0.026 m/s at 9.141 m/s

Barometric pressure: 1021.0 hPa **Relative humidity:** 20.0%

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	30.8	23.8	4.093	4.9829	-0.021	0.028
4	15.14	30.6	23.8	5.094	6.2852	-0.014	0.032
6	21.59	30.5	23.8	6.082	7.5607	-0.001	0.037
8	29.53	30.4	23.9	7.112	8.9018	0.004	0.043
10	38.38	30.3	23.9	8.106	10.1962	0.009	0.048
12	48.83	30.3	23.9	9.141	11.5285	0.026	0.054
13-last	60.53	30.2	23.9	10.177	12.8960	0.017	0.060
11	72.77	30.3	23.9	11.161	14.1733	0.024	0.066
9	86.35	30.4	23.9	12.159	15.5221	-0.007	0.072
7	101.50	30.5	23.8	13.185	16.8789	-0.019	0.078
5	117.78	30.6	23.8	14.206	18.1922	-0.001	0.084
3	135.11	30.7	23.8	15.219	19.5389	-0.017	0.090
1-first	153.78	30.9	23.8	16.242	20.8559	-0.001	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.

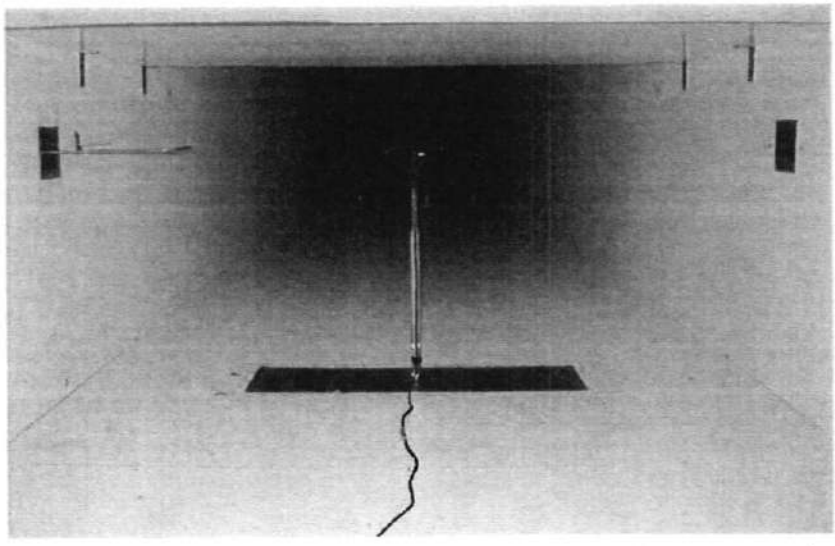

Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

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: 11.02.0930

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WIND ENGINEERING FLUID DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0931 **Date of issue:** February 10, 2011

Type: NRG #40 **Serial number:** 179500166146

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: jj **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] = 0.76440 · f [Hz] + 0.33178

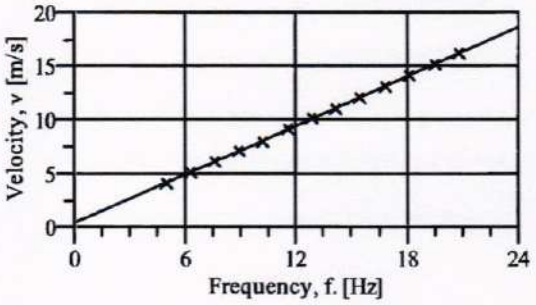
Standard uncertainty, slope: 0.00169 **Standard uncertainty, offset:** 0.05359

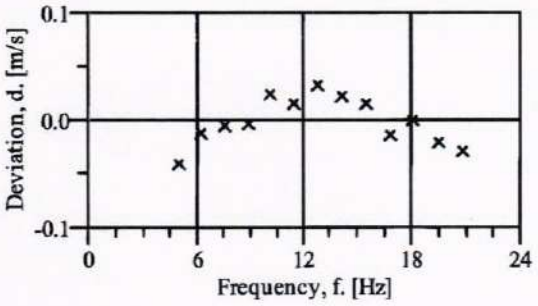
Covariance: -0.0000215 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999984$

Absolute maximum deviation: -0.039 m/s at 4.117 m/s

Barometric pressure: 1021.3 hPa **Relative humidity:** 19.8%

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	9.89	30.8	24.0	4.117	5.0038	-0.039	0.028
4	15.12	30.7	24.0	5.091	6.2399	-0.011	0.032
6	21.73	30.6	24.0	6.100	7.5520	-0.004	0.037
8	29.60	30.5	24.0	7.119	8.8816	-0.002	0.043
10	38.44	30.4	24.0	8.112	10.1451	0.025	0.048
12	48.93	30.3	24.0	9.151	11.5146	0.017	0.054
13-last	60.49	30.3	24.0	10.174	12.8325	0.033	0.060
11	72.65	30.4	24.0	11.151	14.1226	0.024	0.066
9	86.37	30.5	24.0	12.160	15.4529	0.016	0.072
7	101.16	30.5	24.0	13.162	16.8010	-0.012	0.078
5	117.15	30.7	24.0	14.167	18.0972	0.002	0.083
3	134.71	30.8	24.0	15.196	19.4707	-0.020	0.090
1-first	152.80	31.0	24.1	16.190	20.7822	-0.028	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	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.

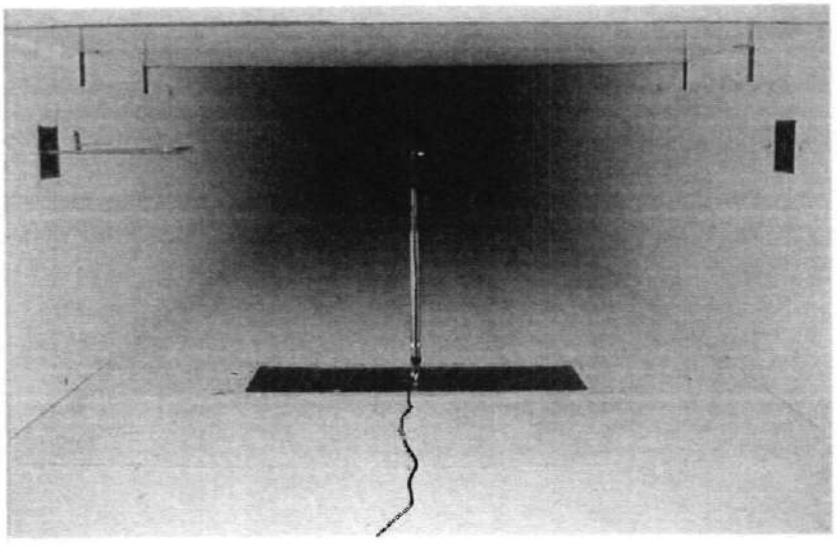

Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

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: 11.02.0931

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WIND
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CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 11.02.0934 **Date of issue:** February 10, 2011

Type: NRG #40 **Serial number:** 179500166143

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

Calibration equation obtained: v [m/s] = 0.76288 · f [Hz] + 0.31667

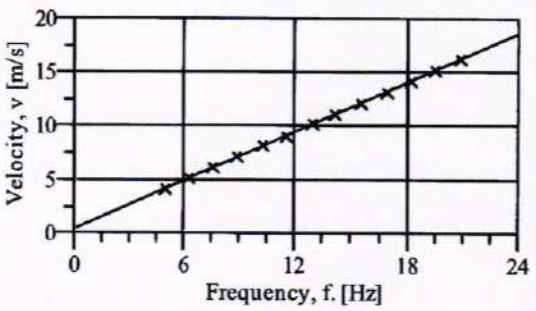
Standard uncertainty, slope: 0.00088 **Standard uncertainty, offset:** 0.02941

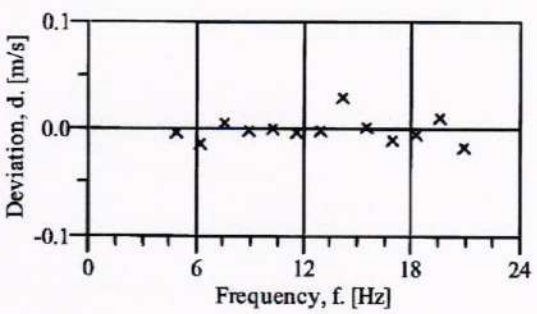
Covariance: -0.0000059 $(m/s)^2/Hz$ **Coefficient of correlation:** $\rho = 0.999996$

Absolute maximum deviation: 0.030 m/s at 11.152 m/s

Barometric pressure: 1021.0 hPa **Relative humidity:** 19.7%

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	9.72	31.1	24.4	4.084	4.9409	-0.002	0.028
4	15.17	30.9	24.4	5.100	6.2878	-0.013	0.032
6	21.76	30.8	24.3	6.107	7.5835	0.005	0.037
8	29.45	30.7	24.3	7.105	8.8989	0.000	0.043
10	38.61	30.6	24.2	8.133	10.2440	0.002	0.048
12	48.77	30.5	24.2	9.140	11.5694	-0.003	0.054
13-last	60.44	30.5	24.2	10.175	12.9224	0.000	0.060
11	72.59	30.5	24.2	11.152	14.1631	0.030	0.066
9	86.38	30.6	24.2	12.167	15.5305	0.002	0.072
7	101.62	30.7	24.3	13.199	16.8994	-0.010	0.078
5	117.60	30.9	24.3	14.201	18.2062	-0.005	0.084
3	135.63	31.0	24.4	15.254	19.5673	0.010	0.090
1-first	153.76	31.2	24.4	16.249	20.9049	-0.016	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	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.

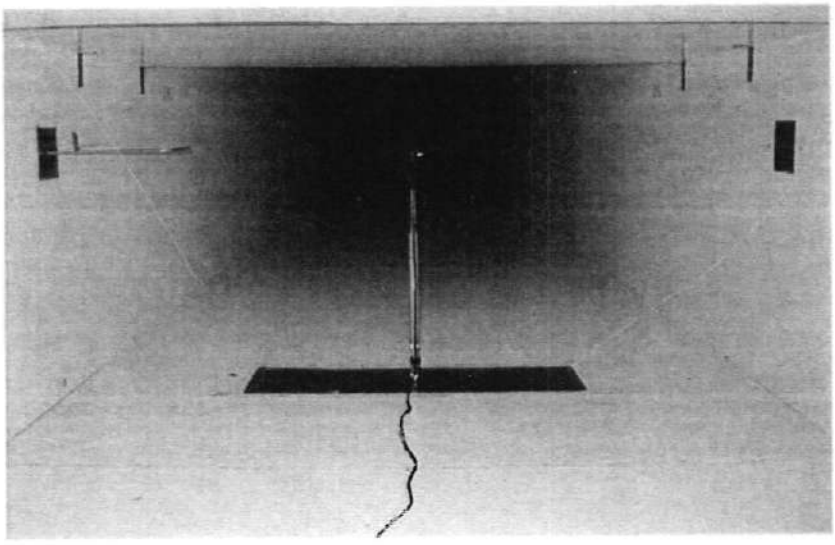

Photo of a cup anemometer in the wind tunnel. The shown anemometer is of the same type as the calibrated one.

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: 11.02.0934