WETC



Power Quality Assessment Zafarana Wind Farm Transformer No. 1 [75 MVA] Installed capacity [54.2 MW]

Conducted By

Eng. Amagd M. El-Hewehy Eng. El-Sayed M. Mansour

New and Renewable Energy Authority [NREA] Hurghada Wind Farm

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Abstract

The report describes power quality assessment performed on transformer substation at Zafarana wind farm regarding the requirements of the standard specification ISO 9001 / 2000.



Overview for Zafarana wind farm

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1. Preface

Reasons for Power Quality Assessment

Power quality is an issue of increasing importance. The main reason for this is the increasing demands from the customers with respect to security and quality of supply in order for them to rely on the public power supply in such as way that they do not have to take special measures to ensure that they can conduct their business without concern about the availability of computers, machines, appliances etc.

The varying of the power output from wind turbines has an impact on both the operation of the power system and on the power quality of the system. This impact increases as the level of penetration increases.

The influence on power quality is mainly on the level and fluctuations of voltage and frequency, the stability of voltage and frequency should not be degraded significantly, as the controllers of systems are required to be able to prevent instability. Furthermore, the shape of the voltage should not be degraded by the inclusion of wind power in the system. If wind turbines or storage systems applying power electronics are included in the system, it should be ensured that the distortion of the voltage is within required limits.

The voltage level at the point of connection of the wind turbine to the grid will depend on the output from the wind turbines and on the consumer load. Situations where the voltage becomes high due to a high wind power production and a low consumer load will quite often occur. Design should limit maximum voltage to acceptable levels. Normally, nominal voltage \pm 10 % as instantaneous value or \pm 5 % as 10-minute average value.

Another important aspect is the power fluctuations. The power fluctuations create fluctuations in the voltage and they impose fluctuations to the grid. The voltage fluctuations have to be low to avoid disturbances e.g. in the light intensity. The power fluctuations do not only depend on the amount of installed wind power capacity, but also on whether the wind farm consists of a few large wind turbines or correspondingly more, but smaller wind turbines. The relative power fluctuation level basically is decreasing as the number of wind turbines is increasing and as the power output from the wind turbines is increasing.

2. Introduction

This wind farm measurements and studies program deals with Power Quality Assessment, the measurements for the study of power quality were carried out at Zafarana wind farm and have been approximately one month from 16/12/2005 to 15/01/2006.

This study should primarily be seen as an initiation and illustration of possibilities for activities and studies regarding wind farms at Zafarana, the main task of this study is to evaluate the wind farm performance and electrical properties, as well as the wind farm impact on power quality.

The installation of equipments has been accomplished with technical support and assist from protection and resident engineers at Zafarana substation.

- Shaaban Ali Atwa
- Ehab El-Sayed Hassan
- Abdel-Fattah Helmy

The CMS engineers at Zafarana wind farm have been checked the measurement system and data files, as well as they participated in installation of equipments, and the required data concerning wind speed, errors list during the measurement period had been compiled and reported by them.

- Akmal El-Hewehy
- Mohamed Hader

The analysis of measurements and printout were carried out at Hurghada WETC by:

- Amgad El-Hewehy
- Sayed Mansour

3. Objectives

The power quality is most often described in terms of voltage stability, frequency stability and phase balance. The frequency of larger power systems is normally very stable and therefore no problem. At autonomous grids where for example diesel generators are used, wind turbines may cause frequency variations.

Since wind turbine generators represent balanced three-phase sources, they will actually improve the phase balance of the grid when they are connected. Voltage stability can be subdivided into slow voltage variations, voltage dips, flicker, transient and harmonic voltage distortion.

The objective of Power Quality Assessment task is to:

- Illustrate the wind farm impact on power quality in terms of reactive consumption, voltage and frequency deviations.
- Analyze the measurements taken and relate the results obtained to international standards and theoretical calculations.

4. Description of The Site

4.1 Zafarana Wind Farm

Zafarana is situated along the coast of Suez Gulf, 250 km north of Hurghada and 110 km south of Suez, the wind farm (total area approx.156 km², length of 20 km and width of 8 km, annual average wind speed about 9.4 m/s) located 10 km north of Zafarana town towards Suez city. Figure (1) is an overview map of the Suez Gulf.

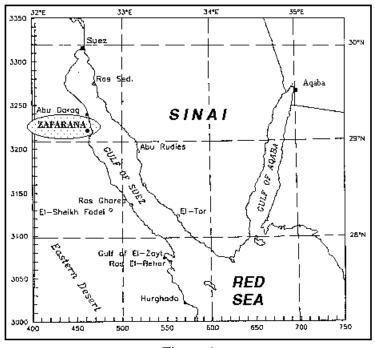


Figure 1

Zafarana wind farm presently consists of:

- Nordex wind turbines [(D1 & KFW1), 63 MW] with total capacity of 105 X 600 kW (N43 600 kW, 3 blades, stall regulation), the wind turbine is connected to a 50 Hz, 22 kV medium voltage system by a separate transformer of (800 kVA, 0.69/22 kV).
- Vestas wind turbines [(D2 & KFW2 & KFW3), 77 MW] with total capacity of 117 X 660 kW (V47 660 kW, 3 blades, pitch control), the wind turbine is connected to a 50 Hz, 22 kV medium voltage system by a separate transformer of (800 kVA, 0.69/22 kV), Figure (2) is an overview for part of zafarana wind farm.

4.2 Zafarana Substation

Zafarana wind farm has been linked to the national grid via a transformer substation located few kilometers north of the site; substation has two stationary transformers and mobile one. The substation has many incoming and outgoing coupling points, as shown in Figure (3).

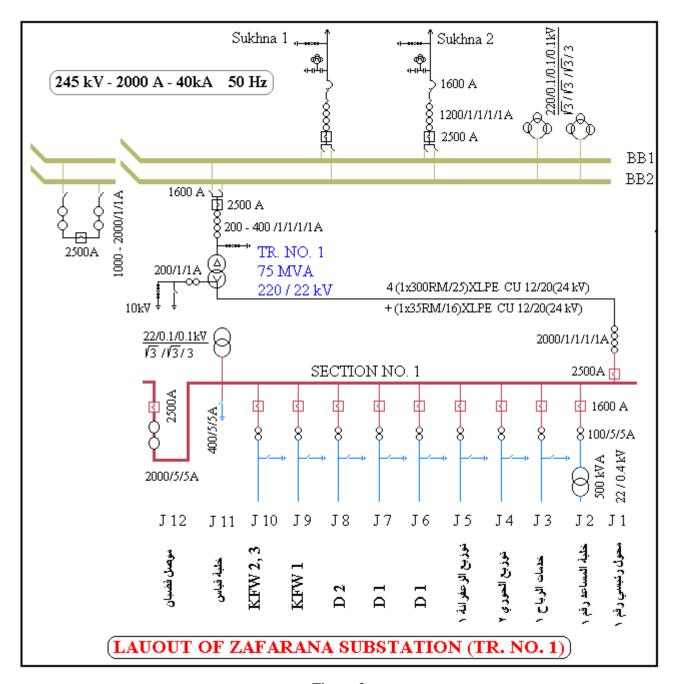


Figure 3

The substation presently consists of two transformers of 75 MVA, 220 kV for each (TR.1 of 54.2 MW and TR. 2 of 64.9 MW installed capacity), and mobile substation (25 KVA - 21.1 MW).

Each wind turbine is connected to a 50 Hz, $22 \, kV$ medium voltage system by a separate transformer of $800 \, kVA$, $0.69/22 \, kV$.

The turbines and its feeders connected to transformer No. 1 are shown in figure (4) (schematic diagram of Zafarana Substation, Transformer No. 1), [Appendix 9, Table (1)].

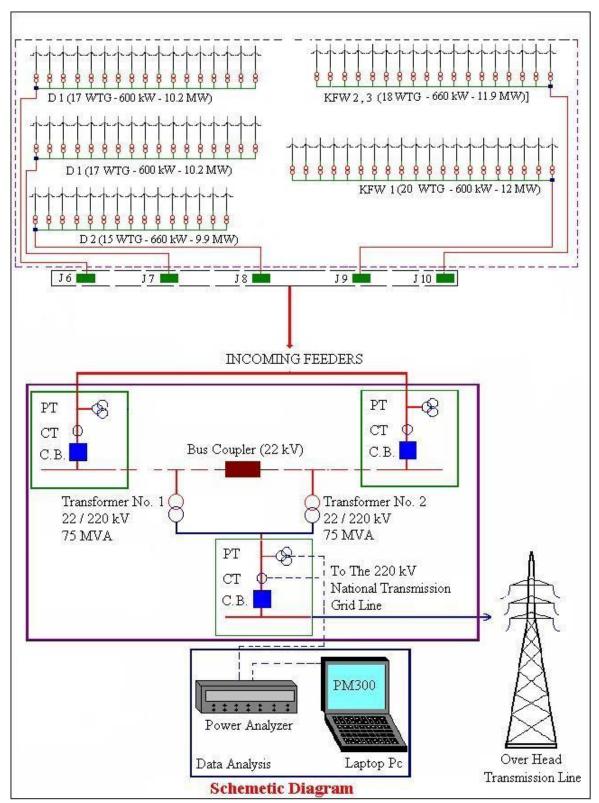


Figure 4

5. Data Acquisition and Analysis

5.1 Measurement System

The power analyzing system consists of a Voltech PM300 power analyzer, an Olivetti ECHOS 120 laptop PC, and a data logging program called PM300.EXE developed in the programming language Quick Basic 4.5 by Risø National Laboratory. The Voltech PM300 power analyzer performs the actual power measurements, whereas the Basic program PM300.EXE running on the Olivetti laptop computer controls the power analyzer and logs data from it.

The laptop PC running the program PM300.EXE was applied to control the power analyzer and to store data in the hard disk of the PC. The power analyzer was set-up to give total and fundamental values of the three phase active and reactive power, voltage and currents as well as the fundamental frequency, the total harmonic voltage distortion, the odd voltage harmonics up to 11th and the total harmonic current distortion, the sampling rate for storing data to the hard disk was set to 10 second, the measurement continued from 16/12/2005 to 15/01/2006.

The logged raw data are stored in ASCII format on files (Time series) named with 8 digits [(00000000.txt), (name)(year)(month)(day).txt], [Appendix 9, Table (2)]

Voltech PM300 Power Analyzer

The main specifications:

Connection : three-phase Voltage Bandwidth : DC to 250 kHz

Current accuracy : 0.2 % Current range (direct) : 20 A rms (200 A peak)

Watt accuracy : 0.4 % Voltage range : 1000 V peak

The power analyzer has a front panel from which it can be controlled manually and a display to show the measured values however, it is not able to store data.

Laptop CPU

The main specifications:

Processor : 120 MHz Pentium Memory : 16 MB RAM

Screen : SVGA Color Screen (600x800) CD-ROM : 6X Speed HD : 1.2 GB

5.2 Description of Data Handling Routines

Basic program PM300.EXE

The Basic software program sets up the power analyzer and logs the measurements, the communication between the laptop computer and the power analyzer is based on RS232. Basic has been chosen as programming language because a simple starter program in Basic is given in the PM300 user manual for RS232 communication (Ref 5).

The first line in the set-up file is the name of the configuration file (Zaf.CFG), the configuration file is an ASCII file, which enables configuration of the PM300 before the data logging starts, the parameters that can be controlled are wiring, current and voltage scaling, range selection etc.

The second line in the input file is the name of the selection file (Zaf.SEL), this file is also an ASCII file. It determines which channels are logged (channel 1, 2, 3, sum, and possibly neutral) and which parameters are logged (power, reactive power, voltage, frequency, current, etc).

The third line in the set-up file is the name of an ASCII output file. As example, Zb060110.txt has been selected. The head of the output file contains copies of the set-up file, the configuration file, and the selection file. Moreover, after setting the specified configuration, the PM300.EXE program gets all configuration codes from the power analyzer and copies them to the output files. This information is useful if the communication between the laptop PC and the power analyzer has failed. The remainder (and main part) of the output file is the logged data in columns with the time as the first column.

The sixth parameter in the set-up file is the sampling time. The PM300 does not specify how fast the sampling time can be, but our experience showed that it should be more than 3 seconds. The minimum sampling time depend on the specified set-up, for instance if specific time consuming calculations such as harmonics have been selected.

The last parameter is the number of measurement channels. This parameter can-in simple cases-be calculated according to the specifications in the selection file using the table (Page 64) in the RS232 manual. If this number is too small, the Basic program will make confusion in the output data file, and if it is too large, it will stop, waiting for data from the PM300.

The set-up file

The Basic program PM300.EXE runs from DOS with a single parameter: the set-up file name. The set-up file is an ASCII file. For the power quality measurements described in this report, the set-up file Zaf.sup has been used.

The fourth parameter in the set-up file is the baud rate, this parameter must be the same in the input file as set manually on the PM300, because no communication is possible when the baud rate is conflicting.

The fifth parameter in the set-up file is the measurement time. In the example, it is 360000 second corresponding to 100 hours. This high value has been selected to ensure that the data logging is not interrupted by the program. When the user of the program wants to stop the data logging, the Break key can always be used, which will not be sent. An easy way to determine the number of measurement channels is to specify a very high value, and then run PM300.EXE. Then the program will stop after the first sample of data is send from the power analyzer. The program writes data both to the output file and to the screen. Therefore, the number of channels can be counted either from the screen or from the output file after the program has been interrupted.

Note that parameter 4 to 7 in the set-up file consists of data followed by a comment. The three first parameters, however, have only file names and no comments. Because of the simple reading procedure of the Basic program, this syntax must be followed.

Configuration file

The configuration file specifies the configuration such as wiring, scaling etc. A complete list of the available parameters is given in the RS232 manual for the PM300 (Pages 58-63). The first two columns are data used by the PM300.EXE Basic program to configure the power analyzer. The following text is only for comments to the user. Note that the user must specify a comment, because PM300.EXE reads it from the file.

The frequency source (configuration parameter 14 and 15) can cause problems with keeping a fixed sampling time if the frequency of the current shall be calculated but the current is approximately zero. Therefore, the frequency source has been selected to voltage.

Selection file

The original purpose of the selection file was only to enable the specification of selection commands such as: SEL: SUM and: SEL: WAT as described in the RS232 manual for the PM300 (Pages 64-66). However, the PM300.EXE Basic program has implemented this task simply by sending the contents of the selection file to the Power Analyzer. Consequently, the selection file can also be used to specify other commands than selection commands to the power analyzer. As an example of that, the command: HMX: ODD 11 is added to the configuration file below, specifying odd harmonic orders up to 11 the harmonic [RS232 manual (Page 40)].

Data Analysis files

A software program called PM300sta.EXE developed by Risø were used to generate statistical file (STA, 10-minute Average) [Appendix 9, Table (3)]. from time series file (TXT, 10-sec)

As well as another software program (Consolstanal.EXE, input, listfile) developed by Risø were used for generate two output files, the first is statistical file (the mean value for continuously 10 minute, daily "measurement period") and the second is diurnal file (the mean value as 10-minute over 24 hour throughout measurement period from midnight to midnight), [Appendix 9, Table (4)].

The data analysis were performed using Microsoft Excel.

5.3 The Measurements

The measurements were carried out at Zafarana substation on 22 kV Bus Bar, the substation has no single feeder with the total output power of the wind farm, thereby a direct measurements of the total output power is not possible. At substation there are two permanent transformer and mobile one, in order to measure the total power, the currents of the three transformers (TR. 1, TR. 2 and mobile one) must be summed simultaneously using summation transformer where it was not available during the measurements period.

According to the situation at zafarana substation, it is decided to achieve the measurements individually on transformer No. 2 and transformer No. 1, thereby the measurement equipments had been connected to the secondary side of the potential transformer (22000/100 V) to measure the voltage, as well as the current measured using current clamps (1 mV: 1 mA) on the secondary side of the existing current transformer (2000:1 A) of transformer No. 1.

6. Measurements Analysis and Results

Key data for Zafarana wind farm measurements

ITEM	DESCRIPTION
Start Date	16/12/2005
Stop Date	15/01/2006
Nominal power	54.2 MW
Max. output power (10-minute average)	46.14 MW
Min. output power (10-minute average)	0.12 MW
Mean. output power (10-minute average)	12.44 MW
Mean PF (10-minute average)	76.1
Mean CF (10-minute average)	22.95
Mean Bus-Bar Voltage (10-minute average)	22.87 kV

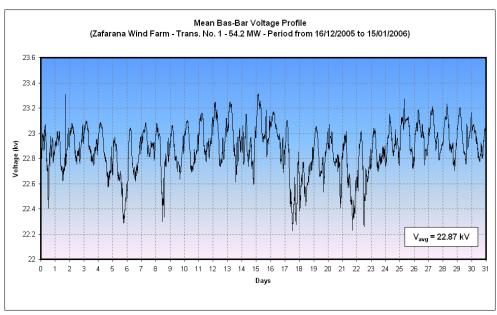
6.1 Bus-Bar Voltage

The valid measurement with the power analyzer on 22 kV Bus-Bar give basis for assessing the voltage quality and to analyze the impact of the wind farm on the voltage quality.

Plot (1) is the statistical data of the mean value of the Bus-Bar voltage, the voltage level during the measurement period between 22.25 kV and 23.31 kV, or in other words 22 kV + 5.97 % and -1.03 %.

International standard (IEC - Ref 3) specifies that the voltage level should be within \pm 5 % of its nominal value measured as 10-minute average data or \pm 10 % of its measured instantaneous values.

From the results obtained, it could be stated that the voltage level when reaches to its minimum value still within the required limit, meanwhile it is out of range when reaches to its maximum value.

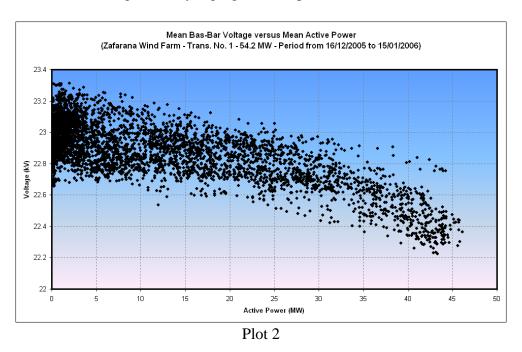


Plot 1

Plot (2) is the statistical data as 10-minute average values of the Bus-Bar voltage plotted versus the 10-minute average values of the output active power from the wind turbines.

In this plot, the voltage level decreases for increasing the active power from the wind turbines, as well as the voltage level seems to be extremely high at low power generated from the wind turbines (cloudy points seen in the plot).

The situation is predicted, since the nominal power of the wind turbine connected to transformer no.1 is 54.2 MW, which is significantly high-generated power.



Plot (3) is the statistical data of the three phase voltages as 10-minute average during the measurement period, the limits of the three phase voltages are shown below:

```
Phase No. 1 varies from 12.62 \text{ kV} to 13.26 \text{ kV}, or 12.7 \text{ kV} + 4.39\% and -0.6 \%.
```

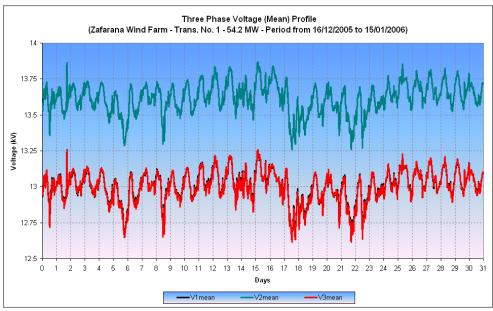
Phase No. 2 varies from 13.26 kV to 13.87 kV, or 12.7 kV + 9.21 % and -4.38 %.

Phase No. 3 varies from 12.62 kV to 13.26 kV, or 12.7 kV + 4.39% and -0.6 %.

The international standard specifies that the voltage level should be within \pm 5 % of its nominal value measured as 10-minute average data.

From the results obtained, it could be stated that the maximum and minimum values of phase No. 2 and phase No. 3 respectively, are critically out of range.

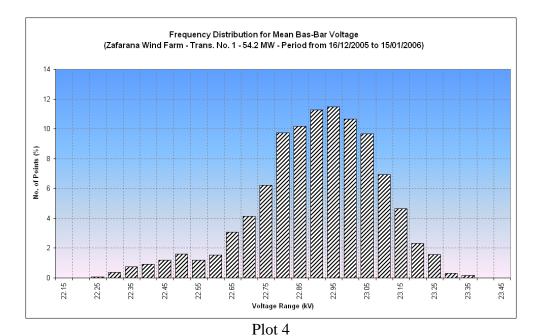
note: The amplitude of the resulting voltage, drop or rise will depend on the impedance of the feeder between the wind turbine and the substation. The stability of the grid will be sensitive to the ratio of X/R where (X) is the source impedance's reactance and (R) is the source impedance's resistance.



Plot 3

Plot (4) is the absolute value of the frequency distribution as 10-minute average value of the Bus-Bar voltage, there are two different situations are clearly observable in the plot, the first is the distribution is not symmetrical around the nominal value (22 kV) (\mathbb{Z}_0).

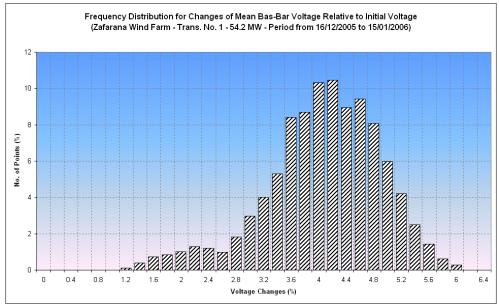
The second is that two peaks are noticed at 22.1 kV and 22.2 kV, as well as the voltage range is quite narrow due to the wind farm connected to a large network. The voltage varies almost from 21.3 kV (Z_1) to 22.7 kV (Z_2) during the measurement period.



Hint: for a given set of values and a given set of bins (intervals), a frequency distribution counts how many of the values occur in each interval.

Plot (5) is the voltage change relative to the initial (nominal) value "22 kV" from one 10-minute value to the next, the majority of the relative voltage changes are between +2.2 % and -2.6 % as magnitude (bin).

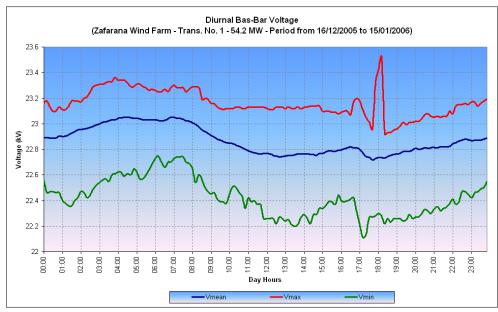
The plot shows that voltage varies in a small range and very few values above +3 % occur. No significant peaks are noticed in the plot, as well as the distribution is not symmetrical around Z_O (when $V_{mean} = V_{initial}$).



Plot 5

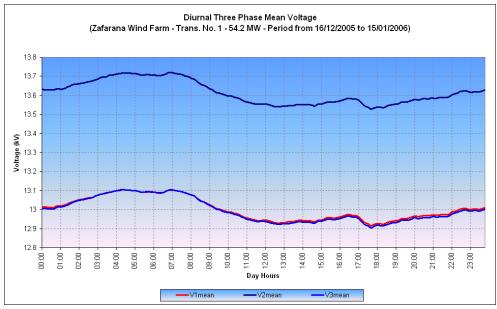
$$V_{relative} = \left[\frac{V_{mean} - V_{initial}}{V_{initial}}\right] * 100$$

Plot (6) is the diurnal pattern for the mean, maximum and minimum value of the Bus-Bar voltage, the plot is the typical value of the Bus-Bar voltage profile, since the plot is the average value throughout the measurement period.



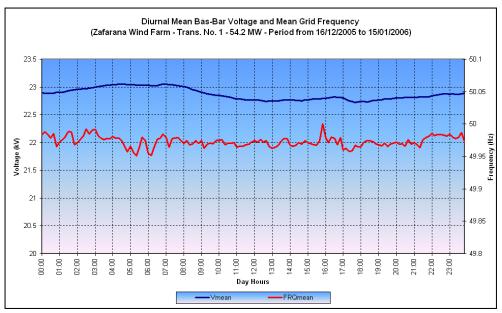
Plot 6

Plot (7) is the diurnal pattern of the three phase voltages as 10-minute average, it is clearly seen in the plot that phase No. 1 and phase No. 3 are slightly lower than phase No. 2.



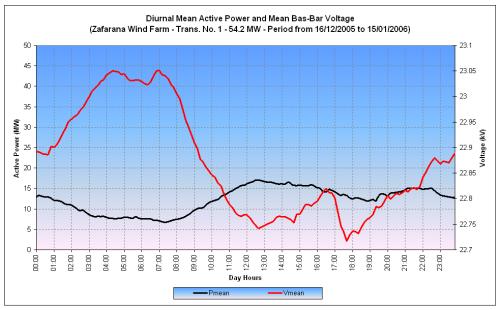
Plot 7

Plot (8) is the diurnal pattern of the grid voltage and grid frequency, the plot shows that the grid frequency is almost constant independent of the Bus-Bar voltage level.



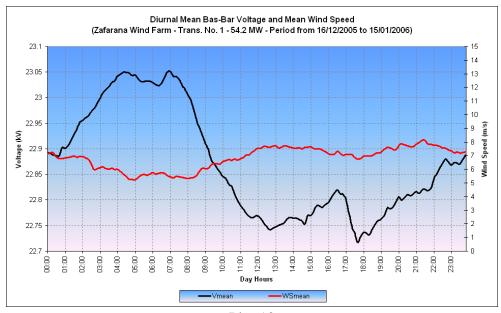
Plot 8

Plot (9) illustrates the diurnal pattern of the Bus-Bar voltage and active power, the plot shows that the voltage varies reversely to the active power. Assuming a fairly relation between the voltage and the output power, it is obviously seen in the plot that the maximum value of active power (50.9 MW) corresponds to minimum value of voltage (21.5 kV) as 10-minute average value.



Plot 9

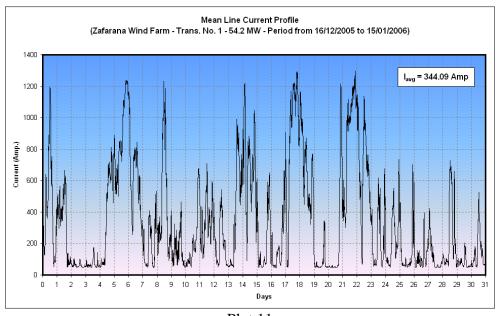
Plot (10) is the diurnal pattern of the Bus-Bar voltage and mean wind speed, the plot indicates that the voltage values seem to vary reversely to the wind speed values. The plot corresponds with voltage-power correlation as shown in Plot (9).



Plot 10

6.2 Line Current

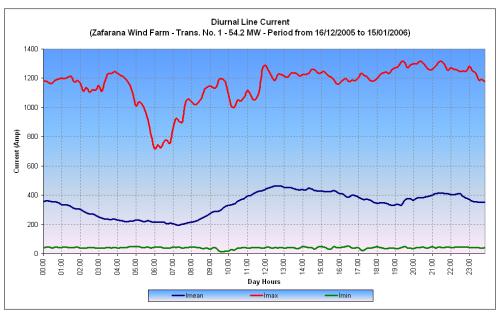
Plot (11) is the statistical data of the line current as 10-minute average during the measurement period.



Plot 11

Plot (12) is the diurnal pattern of mean, maximum and minimum values of line current. The plot is the typical value of the line current profile as the plot is the average of the measurement period.

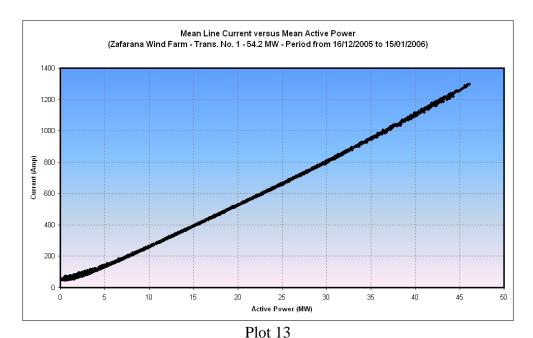
The maximum value looks constant; meanwhile, the mean and minimum values look fluctuated very much.



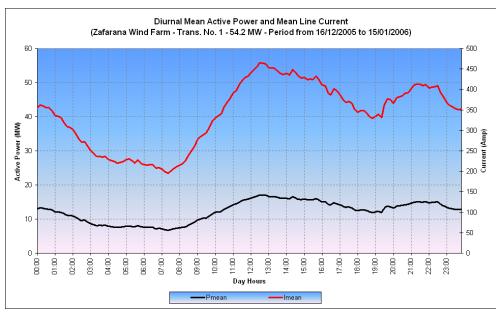
Plot 12

Plot (13) is the statistical data of a correlation between the output active power and line current as 10-minute average value, the plot shows that the power varies proportionally to the line current; however, there is a situation where, a small deviation has been occurred.

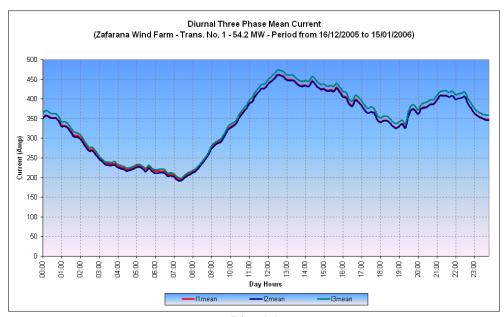
The raw data (Time series as 10-sec.) has been investigated carefully, and it is concluded that the current reading of phase No.1 was not match (lower than) with the other two phases, only on day 7/9/2005. The reason for this still unknown.



Plot (14) illustrates the diurnal pattern of active power and line current as 10-minute average, the plot shows that the output power varies proportionally to the line current.

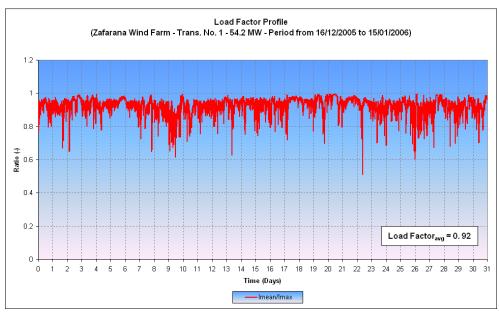


Plot (15) is the diurnal pattern of three phase line currents as mean value. The plot is the typical values of the three-phase currents profile as the plot is the average throughout the measurement period



Plot 15

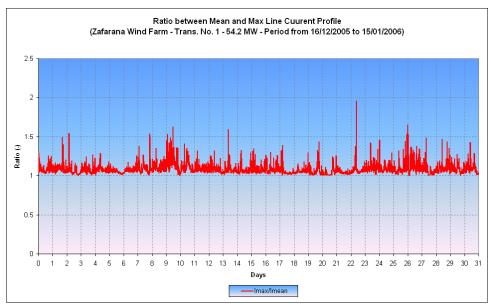
Plot (16) is the statistical data of the load factor as 10-minute average value; the load factor is 0.96 as an average value as shown in the plot.



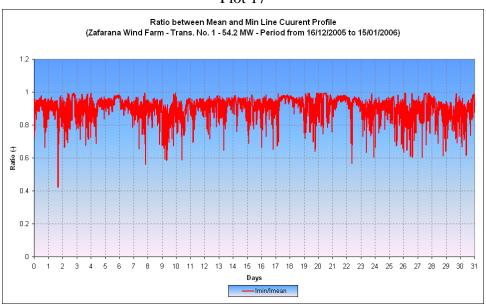
Plot 16

Plot (17), (18) and (19) illustrate the ratio between max, min and mean values of the statistical data as 10-minute average value respectively.

The ratio looks constant even though the two peaks and drops seen in the plots. The interpretation for the two peaks and drops are related to low power production at low wind speed.



Plot 17



Plot 18

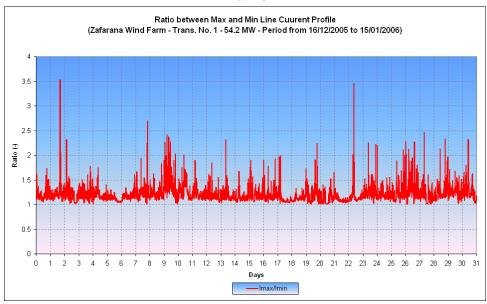
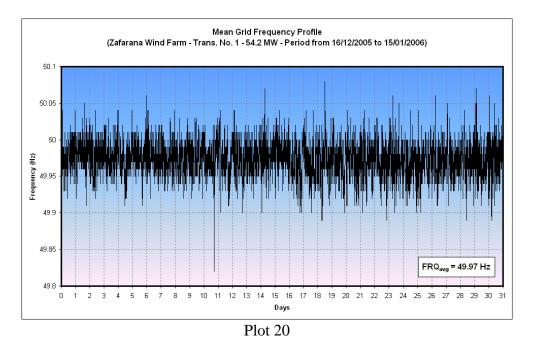


Fig 19

6.3 Grid Frequency

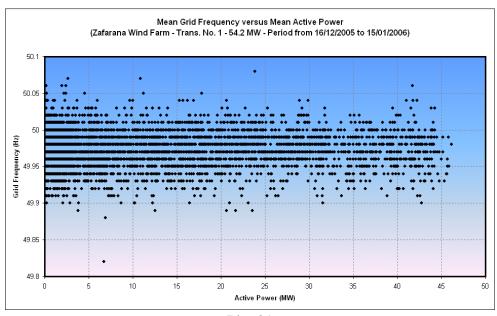
Plot (20) is the statistical data of the grid frequency profile as 10-minute average values. It is seen from the plot that the grid frequency is very stable independent of other grid parameters; the average value is 49.96 Hz during the measurement period.

The plot shows that the frequency lays within a narrow band between 49.86 Hz and 50.13 Hz that comply with the international standards (50 Hz \pm 1 %).



Plot (21) is the statistical data of a correlation between the grid frequency and active power, the grid frequency remains constant independent of the produced power from the wind turbines.

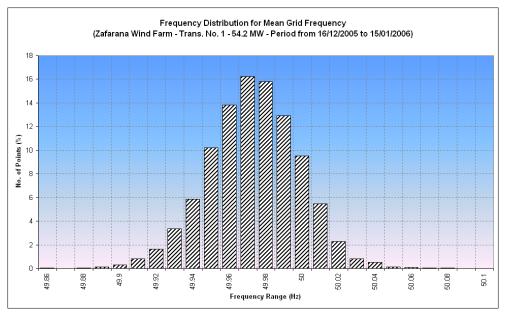
It is noticed also that the cloudy points in the plot is quit wide at high output power from the farm, however, the changes in the frequency still in a very small range.



Plot 21

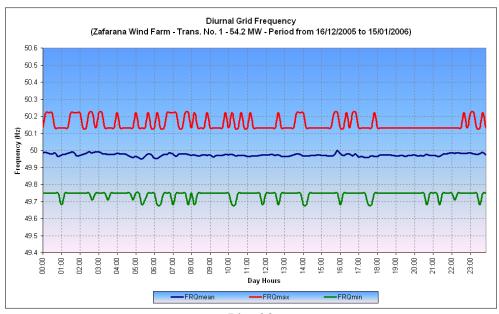
Plot (22) is the absolute change of the frequency distribution as 10–minute average values of the grid frequency, it is obviously seen in the plot that, the frequency is well controlled with only small deviations from the 50 Hz nominal setting, these small deviations are slightly above 50 Hz.

The grid frequency is quite symmetrical and triangular around 49.98 Hz, varying from 49.92 Hz to 50.03 Hz.



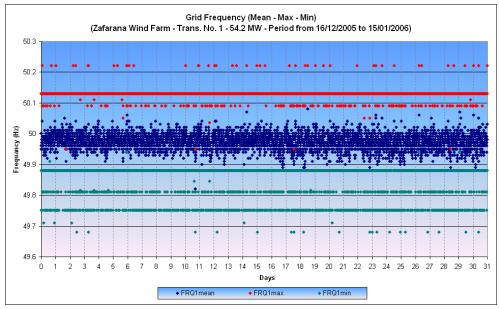
Plot 22

Plot (23) is the diurnal pattern of the mean, maximum and minimum values of the grid frequency, the plot emphasis the result obtained in Plot (22).



Plot 23

Plot (24) is the statistical data of mean, maximum and minimum values of grid frequency as 10-minute average value.

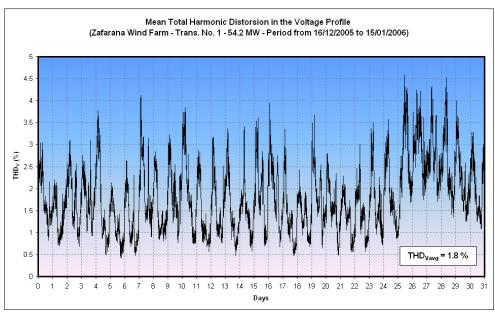


Plot 24

6.4 Voltage Harmonics

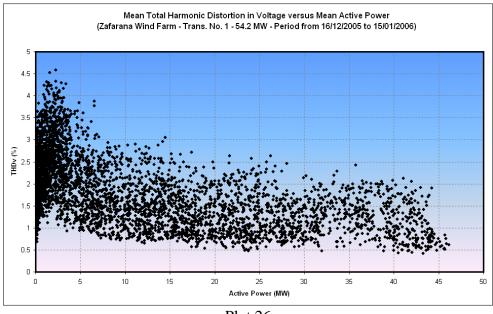
Plot (25) is the statistical data as 10-minutes average value of the Total Harmonic Distortion (THD) of the Bus-Bar voltage.

It can be seen from the plot that the measured THD within the measurement period are between 0.3 % and 3.11 %, which comply with the international standards (Voltage THD should less than 5% measured as 10-minute average) for supply voltage characteristics.



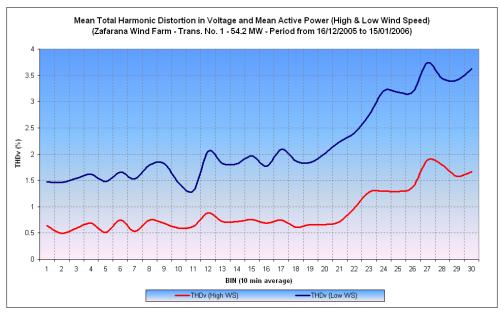
Plot 25

Plot (26) is the statistical data of a correlation between voltage THD and active power as 10-minute average value, the maximum value (3.11%) of THD occurred at 0.5 MW, indicating no particular relation between the output active power and the voltage THD, but the voltage THD follows the daily load pattern.

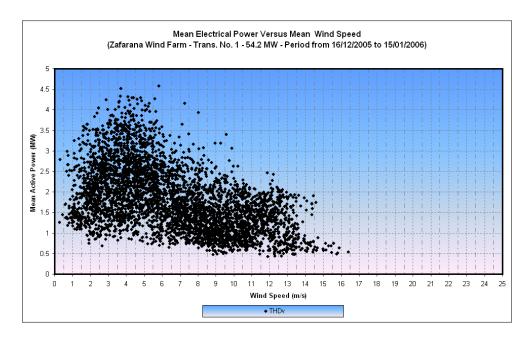


Plot 26

Plot (27) is the voltage THD in case of high and low wind speed, the plot emphasizes the fact that the wind turbines are not responsible for causing any significant harmonic distortion, in particular, the wind turbines at the site are fixed-speed with induction generator (without a power electronic converter).

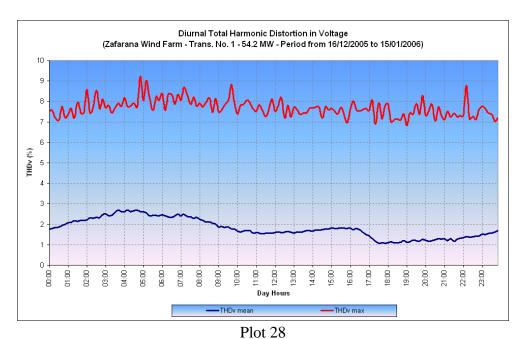


Plot 27

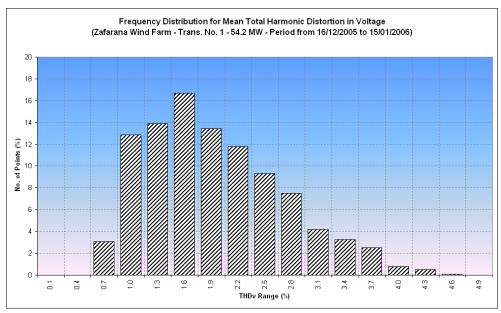


Plot (28) is the diurnal pattern of the mean and maximum values of the total harmonic distortion of the Bus-Bar voltage.

The plot is the typical voltage THD profile since the plot is the average value throughout the measurement period.



Plot (29) illustrate the absolute value of the frequency distribution of the voltage THD, the plot does not show any particular features except for a low mean value of THD.

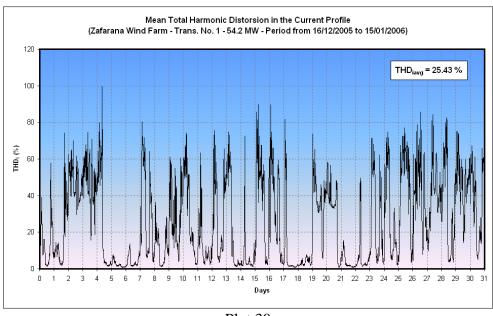


Plot 29

6.5 Current Harmonics

Plot (30) is the statistical data as 10-minute average value of the line current THD, it is clearly seen from the plot that there is a peak of 70 % of THD, and it is clarified that the peak corresponds with low wind speed during the measurement period.

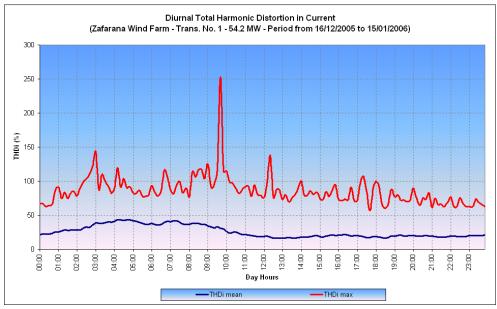
However, the other situations in the plot show very low line THD which comply with the IEC.



Plot 30

Plot (31) is the diurnal pattern of the mean and maximum values of the line current THD, the plot shows that the line current THD follows load pattern except for the situation of low wind speed.

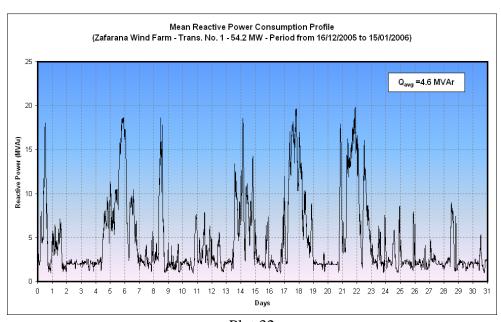
The plot corresponds with the diurnal line current plot (Plot 12), i.e. maximum current THD occurred at minimum line current.



Plot 31

6.6 Consumed Reactive Power

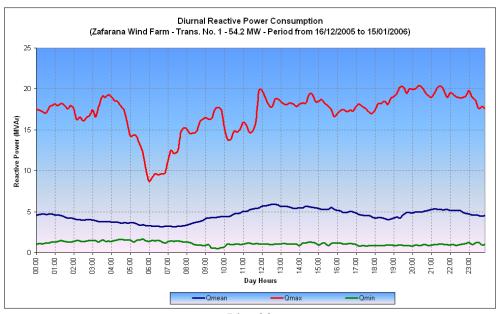
Plot (32) is the statistical data as 10-minute average values of the consumed reactive power by the wind turbines. The mean value of the consumed reactive power is 17.22 kVAr during the measurement period.



Plot 32

Plot (33) is the diurnal pattern of the mean, maximum and minimum values of the consumed reactive power.

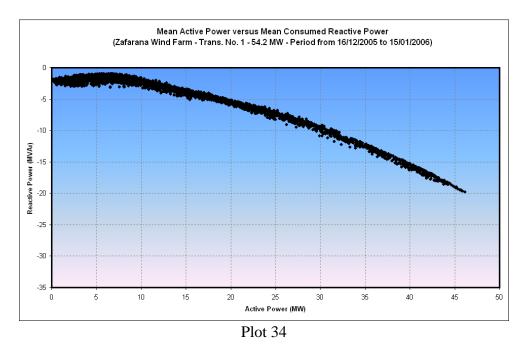
The plot is the typical consumed reactive power profile since the graph is the average values of the measurements period.



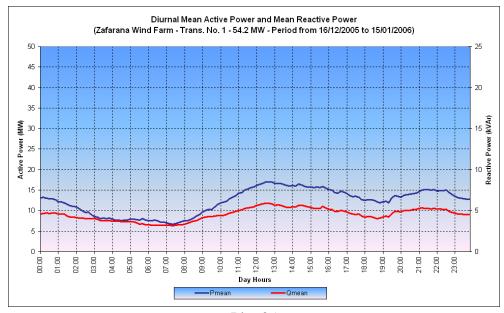
Plot 33

Plot (34) is the statistical data of the reactive power consumption as a function of active power production, the plot shows that the reactive power varies proportionally to the active power, even though the values are scattered when the active power is high.

The vague correlation between active and reactive power on one day still needs for an interpretation, the consumed reactive power on that day looks higher than the active power.



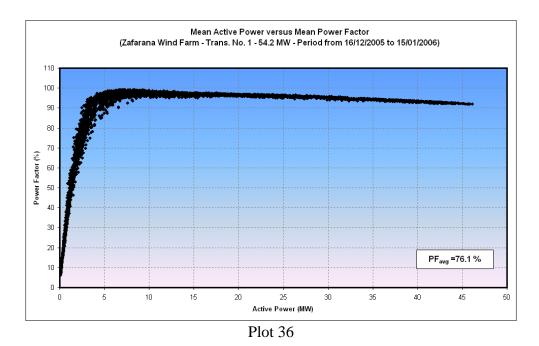
Plot (35) is the diurnal pattern of the consumed reactive power and the active power as mean value, the plot shows that the reactive power varies proportionally to the active power.



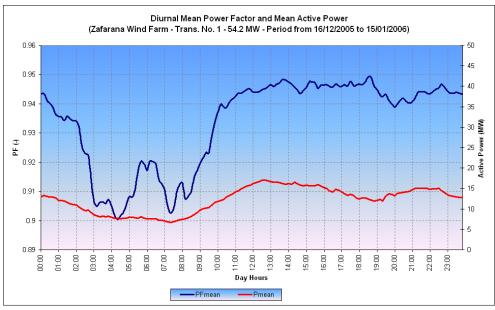
Plot 35

Plot (36) is the statistical data of a correlation between power factor and output power, the power factor looks reasonable at a value above 0.90 due to the two types of the wind turbines (Nordex – Vestas) are regulated by 200 kVAr and 250 kVAr of capacitor banks respectively.

The power factor " $\cos (\phi)$ " has its maximum value of about 0.99 around 4.41 MW output power from the wind turbines.



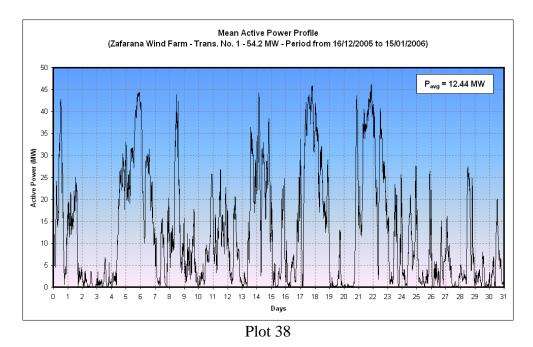
Plot (37) is the diurnal pattern of the power factor and active power as mean value, the plot shows that the power factor decreases for increasing the active power.



Plot 37

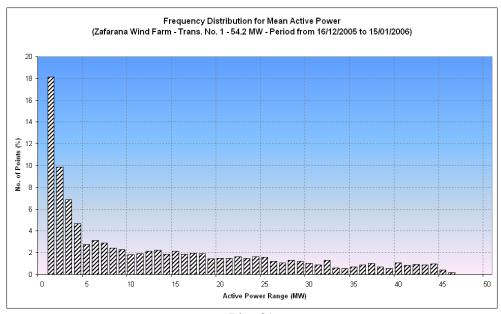
6.7 Produced Active Power

Plot (38) is the statistical data as 10-minute average of the output active power from the wind turbines, from the plot it is seen that the average value of the output active power is 42.12 MW during the measurement period, the plot corresponds with the line current plot (Plot 11).



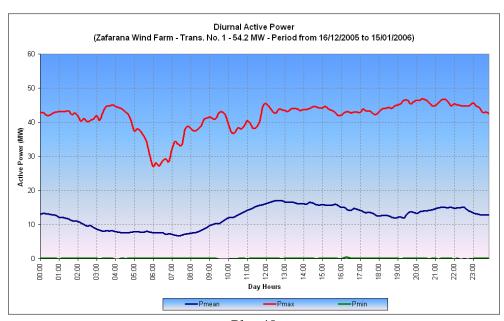
Plot (39) is the absolute value of the frequency distribution of statistical data as 10–minute average of the output active power from the wind turbines.

The distribution has a tail towards low production as well as the output active power varies from Zero MW to 55.06 MW as mean value and the majority of high active power data represent more than 60 % of the full data.



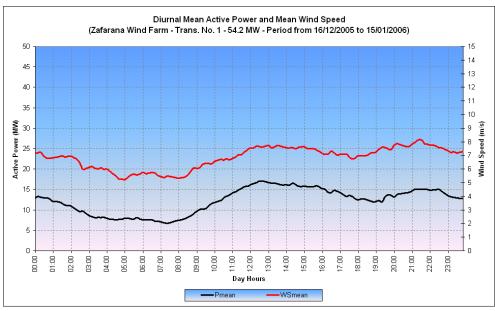
Plot 39

Plot (40) is the diurnal pattern of the mean, maximum and minimum of the active power value. The maximum value looks constant meanwhile the minimum value is somewhat does not show any particular features. The plot corresponds with the diurnal line current profile plot (Plot 12).



Plot 40

Plot (41) is the diurnal pattern of the active power and wind speed as mean value, it is observed that the wind speed is rather high during the measurement period, [Appendix 9, Table (5)].



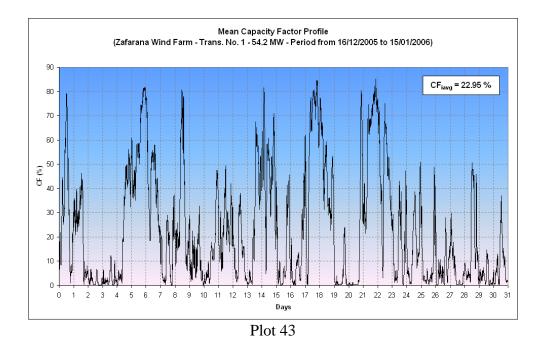
Plot 41

6.8 Capacity Factor

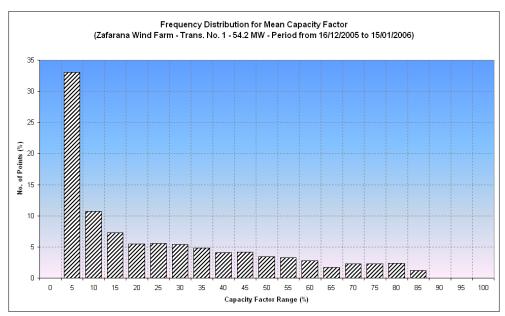
Plot (43) is the statistical data of the capacity factor (CF) as 10-minute average values, the average capacity factor during the measurement period is 64.94 %, which is quite high.

The capacity factor is determined according to the following equation:-

$$CF = [\frac{Power_{act}}{Power_{theo}}]*100$$



Plot (44) is the absolute value of the frequency distribution of statistical data as 10–minute average of the capacity factor, the capacity factor varies from zero to 85 % as mean value, and the majority of high values of CF represent more than 60 % of the full data.



Plot 44

7. Conclusion and Recommendations

◆ During the measurement period the voltage level at Zafarana substation was between 21.06 kV and 22.73 kV, or in other words 22 kV +3.3 % and −4.27 %, International standard IEC (Ref 3) specifies that the voltage level should be within ± 5 % of its nominal value measured as 10-minute average data or ± 10 % of its measured instantaneous values. From the results obtained it could be stated that the voltage level when reaches to its maximum value still within the required limit, meanwhile it is critical when reaches to its minimum value.

- ♦ The voltage level at substation (point of connection of the wind turbines to the grid) depends on the output power from the wind turbines.
- ♦ The absolute value of the voltage changes lays in a narrow range and non-symmetrical around the nominal value, considering the wind farm connected to the 220 kV national grid.
- ♦ The maximum value of phase No.2 is 13.40 kV (12.7 kV + 5.50 %) and minimum value of phase No.3 is 11.98 kV (12.7 kV -5.70 %), the two voltage limits are out of range.
- ♦ In case of adding more wind turbines, a through analysis must be executed, in particular voltage level.
- During the measurement period, the grid frequency was between 49.86 Hz and 50.13 Hz being within the required limits to comply with international standards on supply voltage characteristics.
- The load factor (mean / max) is 96 % which is quite reasonable.
- ♦ During the measurement period, the measured total harmonic distortion THD of the voltage on day 7/9/2005 reached to 3.11% being within the required limit to comply with international standards on supply voltage characteristics.
- ♦ The total harmonic distortion in voltage is not due to the output power from the wind turbines, but follows the daily load pattern.
- No correspondence between harmonic amplitude and overall power output level.
- Fixed-speed wind turbines do not produce any harmonics; meanwhile variable-speed wind turbines may be produce different amounts and orders of harmonics depending on the type of inverter used.
- ♦ The maximum current THD occurred at minimum line current.
- The reactive power consumption of the wind farm increases for increasing output power.
- ♦ The maximum value of the power factor is 0.99 at output power 4.41 MW.
- The average capacity factor of the wind farm is 64.9 % during the measurement period.
- The majority of high active power data represent more than 60 % of the full data.
- ♦ The average wind speed throughout the measurement period is 12.69 m/s.
- ♦ No measurements were performed regarding power fluctuations, flicker, and transient since this kind of measurements requires specific instruments that were not available.

8. References

1. Isolated System with Wind Power, Results of Measurements in Egypt.

Henrik Bindner, Risø National Laboratory, Laila Saleh, Salah Abdel-Hafiez and El-Sayed Mansour, New and Renewable Energy Authority.

2. Hurghada Wind Energy Center (WETC), Demonstration Wind Farm Studies, Power Quality Assessment.

Jhon Tande, Poul Sorensen, Risø National Laboratory, Denmark, Mohamed Galal, Usama Naoman, El-Sayed Mansour, Amgad El-Hewehy, Ahmed El-Maghawry and Ibrahim Darweesh, New and Renewable Energy Authority.

3. Grid Interaction and power Quality of Wind Turbine Generator Systems.

Ake Larsson, Chalmers University of Technology.

- 4. The International Energy Community standard (IEC).
- 5. The PM300 User Manual of RS232

9. Appendix

Table (1) Wind Turbines and its Feeders connected to TR 1

Project		D 1 F 1			D 1 F 2		I	D 2 OT		K	FW F3	1		FW 2 LOT	′
Feeders		J 6			J 7			J 8			J 9			J 10	
Number of WTGs		17			17			15			20			18	
WTG capacity (kW)		600			600			660			600			660	
Total capacity (MW)		10.2			10.2			9.9			12.0			11.9	
	1	2	3	11	12	13	1	2	3	24	25	26	22	23	24
	4	5	6	14	15	16	4	5	6	27	28	29	25	26	27
	7	8	9	17	18	33	7	8	24	30	31	32	28	29	30
WTG no.	10	26	27	34	35	36	25	26	27	33	34	35	31	32	33
	28	29	30	37	38	39	28	29	30	36	37	38	34	35	36
	31	32		40	41					39	40	41	37	38	39
										42	43				

Table 1

Table (2) The Output Text File (Time series) from PM300.EXE program

```
SETUP FILE ZAF.SUP:
 ZAF.CFG
 ZAF.SEL
ZA050817.txt
        BAUD RATE
1000000 MEASUREMENT TIME (SEC)
        SAMPLE TIME (SEC)
10
        NUMBER OF MEASUREMENTS (CHANNELS) CORRESP TO SPECIF IN SELECTION FILE
25
CONFIGURATION FILE ZAF.CFG:
14
       FAST OPERATING
20
       3 PHASE 4 WIRE
4 1
       FIXED AVERAGING
       AVERAGING DEPTH
6 1
        EXTERINAL CURRENT SHUNT
       FIXED VOLTAGE RANGING
10 0
11 0
        FIXED CURRENT RANGING
        MANUAL FREQ SOURCE
14 1
15 1
        FREQ SOURCE IS VOLTAGE
19 1
        VOLTAGE HARM ENAB
23 11
        HARMONIC ORDER
        ODD HARMONICS
38 220 VOLTAGE SCALING
        CURRENT SCALING
39 25
 SELECTION FILE ZAF.SEL:
 :SEL:CLR
 :SEL:CH1;:SEL:CH2;:SEL:CH3;:SEL:SUM;
 :SEL:WAT;:SEL:VAR;:SEL:VLT;:SEL:AMP;:SEL:VDF;:SEL:ADF
 :SEL:FRQ
  14:17:39
            14181000 15964000 15417000 45560000 7039000
                                                              6505000 20020000 12342 12757 12276 21580 1282.8 1348.4 1363 1331.4 49.94 49.94 49.94 0.72 0.69 0.74 1.25 1.31 1.26
                                                      6407000
  14:17:49
           14449000 16247000 15659000 46360000 7210000
                                                      6605000
                                                              6682000 20560000 12312 12740 12253 21540 1311.5 1376.6 1389.4 1359.2 49.88 49.88 49.88 0.51 0.86 1.08 0 1.15 0.98
  14:17:59
           14391000 16020000 15457000 45870000 6907000
                                                      6332000
                                                              6418000
                                                                      19714000 12388 12774 12290 21620 12886 1348.5 1361.8 1333 49.94 49.94 0.48 0.72 0.98 1.28 1.04 0.85
  14:18:09
            14287000 15846000 15343000 45480000 6915000
                                                      6365000
                                                              6452000
                                                                       19783000 12427 12747 12273 21620 1277.2 1339.7 1356.2 1324.4 50.05 50.05 50.05 0.64 0.55 0.62 1.03 0.98 0.99
  14:18:19
            14267000 15967000 15404000 45640000 6988000
                                                      6413000
                                                              6498000
                                                                       19959000 12398 12762 12276 21610 1281.4 1348.4 1361.9 1330.5 49.94 49.94 49.94 0.63 0.58 0.61 1.09 1.02 0.95
            14459000 16130000 15557000 46150000 7055000
                                                                      20150000 12390 12750 12267 21600 1298.5 1363.3 1376.3 1346 49.95 49.95 49.95 0 0.49 0.69 0 0
```

Table 2

Table (3) The Output Statistical File (10-minute average) generated by using PM300STA.EXE program

150000 19753200 60 49.98 0.09 50.13 49.88 49.98 0.09 50.13 49.88 0.61 1.13 6.5 0 141000 19750200 15 0.66 0.32 1.51 0 0.72 0.14 1.08 0.57 0.68 0.58 1.28 0 1.06 0.48 1.86 0	DATE: 08	-17-2005																	1
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SELCUR SELCURS-SELVAN-SELVEN-SELVAN-SELVOF-SELAMP SELVOF-SELAMP SELVOF-S																			
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143000 19754400 61 1482484 183489 183480 183280 18																			
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145000 19752600 60 49.96 0.08 50.13 49.75 49.96 0.08 50.13 49.75 49.96 0.08 50.13 49.75 0.68 1.29 6.33 0 150000 19753200 60 49.98 0.09 50.13 49.88 49.98 0.09 50.13 49.88 49.98 0.09 50.13 49.88 0.61 1.13 6.5 0 141000 19750200 15 0.66 0.32 1.51 0 0.72 0.14 1.08 0.57 0.68 0.58 1.28 0 1.06 0.48 1.86 0 14200 19750800 60 1.09 1.51 7.13 0 0.74 0.25 1.62 0 0.76 0.57 1.59 0 1.45 1.83 7.34 0 143000 19751400 60 0.71 0.76 6.09 0.44 0.61 0.13 1.12 0.45 0.87 0.39 1.25 0 1.12 1.04 6.5 0 144000 19750200 60 0.66 0.77 6.17 0 0.64 0.28 1.54 0 0.77 0.48 1.41 0 1.07 1.29 6.72 0 145000 19752600 60 0.84 1.38 7.14 0 0.57 0.21 1.34 0 0.63 0.49 1.32 0 1.18 1.65 6.55 0 15000 19753200 60 0.84 1.38 7.14 0 0.66 0.26 1.64 0 0.69 0.5 1.58 0 1.16 1.6 7.34 0 144000 19750800 60 1.21 0.98 6.4 0 144000 1975080 60 0.28 1.21 0.98 6.4 0 144000 1975080 60 0.086 0.28 1.27 0 145000 1975400 60 0.99 0.16 1.33 0.59 144000 19752600 60 0.86 0.28 1.27 0 145000 19752600 60 0.86 0.28 1.27 0 145000 19752600 60 0.86 0.28 1.27 0 145000 19752600 60 0.86 0.28 1.27 0 145000 19752600 60 0.86 0.28 1.27 0 145000 19752600 60 0.86 0.28 1.27 0																			0
150000 19753200 60																			0
141000 19750200 15 0.66 0.32 1.51 0 0.72 0.14 1.08 0.57 0.68 0.58 1.28 0 1.06 0.48 1.86 0 142000 19750800 60 1.09 1.51 7.13 0 0.74 0.25 1.62 0 0.76 0.57 1.59 0 1.45 1.83 7.34 0 143000 19751400 60 0.71 0.76 6.09 0.44 0.61 0.13 1.12 0.45 0.87 0.39 1.25 0 1.12 1.04 6.5 0 144000 19752000 60 0.66 0.77 6.17 0 0.64 0.28 1.54 0 0.77 0.48 1.41 0 1.07 1.29 6.72 0 145000 19752000 60 0.84 1.38 7.14 0 0.65 0.26 1.64 0 0.69 0.5 1.58																			0
142000 19750800 60 1.09 1.51 7.13 0 0.74 0.25 1.62 0 0.76 0.57 1.59 0 1.45 1.83 7.34 0 143000 19751400 60 0.71 0.76 6.09 0.44 0.61 0.13 1.12 0.45 0.87 0.39 1.25 0 1.12 1.04 6.5 0 144000 1975200 60 0.66 0.77 6.17 0 0.64 0.28 1.54 0 0.77 0.48 1.41 0 1.07 1.29 6.72 0 145000 1975200 60 0.84 1.38 7.14 0 0.57 0.21 1.34 0 0.63 0.49 1.32 0 1.18 1.65 6.55 0 145000 1975200 60 0.84 1.38 7.14 0 0.6 0.26 1.64 0 0.69 0.5 1.58 0 1.16 1.6 7.34 0 142000 1975200 60 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>																			
144000 1975200 60 0.66 0.77 6.17 0 0.64 0.28 1.54 0 0.77 0.48 1.41 0 1.07 1.29 6.72 0 145000 1975260 60 0.71 1.05 6.17 0 0.57 0.21 1.34 0 0.63 0.49 1.32 0 1.18 1.65 6.55 0 15000 1975200 60 0.84 1.38 7.14 0 0.6 0.26 1.64 0 0.69 0.5 1.58 0 1.16 1.6 7.34 0 141000 19750200 15 0.98 0.3 1.3 0 14200 1975080 60 1.21 0.98 6.4 0 14300 1975400 60 0.99 0.16 1.33 0.59 144000 1975200 60 0.86 0.28 1.27 0 145000 1975200 60 0.86 0.28 1.27 0 145000 1975260 60 0.79 0.34 1.24 0													0.57						0
145000 19752600 60 0.71 1.05 6.17 0 0.57 0.21 1.34 0 0.63 0.49 1.32 0 1.18 1.65 6.55 0 15000 19753200 60 0.84 1.38 7.14 0 0.6 0.26 1.64 0 0.69 0.5 1.58 0 1.16 1.6 7.34 0 141000 19750200 15 0.98 0.3 1.3 0 142000 19751400 60 0.99 0.16 1.33 0.59 144000 19751400 60 0.99 0.16 1.33 0.59 144000 1975200 60 0.86 0.28 1.27 0 145000 19752600 60 0.79 0.34 1.24 0																			
150000 19753200 60 0.84 1.38 7.14 0 0.6 0.26 1.64 0 0.69 0.5 1.58 0 1.16 1.6 7.34 0 141000 19750200 15 0.98 0.3 1.3 0 142000 19751400 60 0.99 0.16 1.33 0.59 144000 19752000 60 0.86 0.28 1.27 0 145000 19752600 60 0.79 0.34 1.24 0																			0
141000 19750200 15 0.98 0.3 1.3 0 142000 19750800 60 1.21 0.98 6.4 0 143000 19751400 60 0.99 0.16 1.33 0.59 144000 19752000 60 0.86 0.28 1.27 0 145000 19752600 60 0.79 0.34 1.24 0																			0
143000 19751400 60 0.99 0.16 1.33 0.59 144000 19752000 60 0.86 0.28 1.27 0 145000 19752600 60 0.79 0.34 1.24 0	141000	19750200	15	0.98	0.3	1.3													
144000 19752000 60 0.86 0.28 1.27 0 145000 19752600 60 0.79 0.34 1.24 0																			
145000 19752600 60 0.79 0.34 1.24 0																			
150000 19753200 60 1.05 1.01 6.29 0																			
	150000	19753200	60	1.05	1.01	6.29	0												
	<u> </u>																		

Table 3

Table (4) The Diurnal file (10-minute average) generated by PM300STA.EXE program

	4.40	4000000	440.00	40000	40000	40000.0	445.004	40000	40000	10.0.7	444.000	400000	40440	04005 0 054 40	1 00,70	04070
0	1413	12590.9		12899	12250 12284	12988.8		10288 10258	12607 12643		144.235	12775		21965.0 251.18 21949.1 250.02		21370
10 20	1389	12584.4 12587.6		12976 12965	12297	12957.5 12960.9		13253	12670		140,090 106,114	12761 12746	12183	21955.1 237.31		21430
30	1440	12591.3		12996	12214	12960.9	127,597	13250	12591		126,258	12760	12118	21980.0 220.02		21330
40	1440	12394.4		12994	12227	12967	122,541	13254	12395	12485.8		12761	12127	21986.8 212.69		21340
30	1424	12611.8		12879	12236	12981.A		13250	12813		127,488	12760	12153	21995.1 221.74		21370
100	1394	12399.2		12807	12217	12967.A		10209	12617		126,199	12729	12147	21974.2 219.42		21360
110	1441	12596		12858	12216	12954.1		13227	12619		128.778	12738	12147	21951.8 223.45		21370
120	1500	12801.5		12922	12209		138,748	10288	12615		136,934	12904	12140	21976.5 207.75		21350
130	1500	12813.3		12924	12234	12980.1		10297	12990		105.270	12900	12188	21998.1 234.85		21420
140	1500	12819.7		12942	12229	12996.7		10298	12638		107,108	12819	12178	22009.0 238.29		21400
130	1500	12625.0		12921	12251	12990.3		10282	12861		134,894	12906	12197	22018 233.57		21440
200	1500	12807.6	143,058	12990	12261	12970.9	138,447	10250	12863	12505	140.147	12774	12189	21987.4 242.98	1 22480	21440
210	1580	12598.1	143,574	12843	12239	12962	138,457	10195	12889	12498.5	140.115	12727	12188	21971.8 242.98	22390	21420
220	1580	12800.7	139,305	12841	12273	12983.3	138,194	10209	12871	12499.2	136,632	12735	12209	21975.8 237.22	5 22390	21430
230	1580	12611.6	139,867	12995	12239	12974.8	136,278	10208	12801	12509.6	107,001	12739	12156	21994.6 237.82	22400	21370
240	1580		144,906	12907	12259		141,432	13280	12614		141,628	12778	12170	22009 248.50		21400
230	1536	12831.2		12901	12012	12990.2		10205	12863		135,995	12775	12218	22027.6 236.03		21490
300	1500		137,057	12909	12324	13009.5		10276	12898		135.248	12787	12241	220552 234,42		21520
310	1500	12852.7		12905	12333	13014.9		13241	12898		138.025	12772	12248	22065 239.55		21540
320	1500	12656.0		12917	12319	10019.6		10270	12897	12554.9		12780	12233	22072.5 241.98		21510
330	1500	12656.5		12908	12015	10019.6		10270	12891		138,087	12796	12225	22072.A 239.79		21500
340	1900	12854.5		12928	12319	10018.8		13309	12713		135,095	12921	12232	22089.9 234.28		21510
330 400	1500 1500	12857.1 12855.6		12941 12951	12324		105,678	13319	12898		138,319 138,642	12827 12835	12243 12254	22073 236.6 22071.4 240.07	22560 3 22570	21530 21540
410	1500	12655.6 12664.8		12967	12332	13019.4 13028.9		13334	12706 12707		145,491	12846	12234	22087.0 251.82		
420	1500	12872		12991	12371	13028.9		13348	12707	12570.2		12870	12285	22099.7 257.89		21530 21600
430	1500	12673.2		12980	12379	10007.8		13347	12741		149,755	12969	12286	22102.3 259.86		21800
440	1440	12672.2		13004	12373	13037.A		13365	12745	12570.5		12876	12280	22100.9 257.77		21600
430	1441	12874.6		13021	12376	10009.8		13375	12741		152.275	12995	12284	22104.6 264.00		21610
500	1440	12875.3		13045	12407		147,638	13408	12751	12573.1		12936	12316	22106.4 256.87		21650
510	1440	12875.5		13044	12409	13041.1		13405	12777		145,800	12925	12317	22106.7 252.49		21660
520	1440	12681.6	148,481	13067	12438	13047	144,485	13414	12900		145,401	12958	12329	22117 252,49		21700
530	1440	12687	144,307	10009	12441	13053	109,884	13397	12815	12585.6	141,432	12919	12344	22127.2 245.34	5 22720	21720
540	1441	12898.9	147,749	13033	12399	10064,4	143,847	13398	12792	12596.7	145.00	12917	12323	22147.1 251.67	1 22710	21670
530	1500	12890.8	153,898	13049	12421	10058.6	148,576	13406	12788	12592	150,671	12926	12326	22138.1 261.02	9 22730	21690
800	1500	12898.2	145.917	13035	12445	13062.1	141.169	10074	12908	12596.0	140,095	12910	12349	22145 248,09	22890	21720
610	1500	12898.9	148.101	13011	12402	13080.2	144,002	13359	12754	12594.8	148,354	12990	12303	22142.0 252.56	2 22650	21640
620	1500	12700.6		13030	12380	13065.1		13368	12745		130,488	12900	12287	22149.5 280.00		21610
630	1500	12710.8		13032	12379	10075.8		13380	12753		152,506	12908	12297	22167.4 264.44		21620
640	1500	12716.7		13043	12417	13081.2		13410	12779	12615	157.47	12900	12329	22177.7 272.86		21690
630	1500	12717.5		13045	12409	13082.6		10097	12779	12616.0		12926	12012	22179.6 282.88		21670
700	1500	12705.6		10084	12366	13070	169,156	13433	12717		170,016	12957 12951	12287 12257	22158.8 294.99		21570
710 720	1500 1500	12891.9 12879.2		10076	12356 12352	13057.2	172,978 174,434	13430 13422	12725 12719	12591.4 12577.0	174.79 176.578	12953	12236	22135.8 300.47 22112.8 306.35		21580 21550
730	1440	12674.7		13064	12328	10009.8		13421	12702		178.028	12943	12232	22105.5 309.16		21520
740	1440	12859.8		13058	12287		178,465	13407	12863	12558.6		12940	12202	22079.7 011.74		21450
750	1440	12645.9		13055	12280	13009.8		13403	12670		178,071	12941	12181	22054.2 309.27		21440
800	1440	12616.9		13027	12248	12980.6		13354	12652	12514.6		12893	12171	22004 314,71		21410
810	1381	12585.9		12995	12256	12949.9	180.82	13347	12830		180,684	12975	12156	21950.5 019.05		21400
820	1380	12554.9		12982	12209	12919,4	184,82	13310	12800	12453.6		12844	12139	21897.7 321.80		21350
830	1390	12532	188,891	12912	12229	12896.5	187,983	10266	12589	12430.1	186,892	12798	12135	21857.6 025.05		21350
840	1320	12517.5	189,933	12991	12189	12992.7		10260	12567	12415.7	188,307	12781	12092	21802.9 027.65	22470	21270
830	1320	12504	186,498	12878	12218	12969.6	184.95	13229	12570	12400.1	180,565	12756	12121	21808.2 319.99	1 22420	21320
900	1286	12500.7		12850	12187	12870.3		10207		12099.5		12735		21808.6 319.02		
910	1320	12511.4		12857	12162		190,577	13218	12536		190,015	12738		21819.7 338.17		
920	1280	12523.5		12820	12147	12889.9		10191	12520		182,406	12725		21841.6 317.2		21200
900	1280	12521.2		12778	12154		175,040	10149	12535	12415.6		12864	12009	21807.0 004.82		21200
940	1280	12524.6		12900	12139	12890.5		10169	12539	12419.2		12696		21843.5 305.07		21220
930	1280	12530.8		12983	12145	12899.8		10208	12512	12428.3		12761	12001	21859.6 310.07		21190
1000	1280	12538		12995	12143		182,137	13240	12529		181,199	12762		21965.7 315.64		21210
1010	1280	12531.6		12879	12148			10229	12534		180,202	12757		21854.4 018.85		
1020	1223	12529.7 12534.6		12996	12122	12990.7 12999.4		10227	12489	12423.1		12751	12010	21859.9 309.88		21150
1030	1200	12534.6 12535.2		12840 12835	12133 12091			10189 10194	12505 12482	12429.7 12429.5		12710 12714		21859.9 309.89		21110
1040	1140		1917199		12108			10191	12477	12442.5		12711		21884.4 320.35		21130
1040	1140		187 344	12920		123124			12488		179.512	12716				
1050	1080	12550.1		12800		12918.8	179 715									
1050 1100	1090 1090	12550.1 12553.6	181,555	12825	12110	12916.6 12907.6		10194 10175						21891.1 011.44 21875.9 295.09		
1050 1100 1110	1090 1090 1090	12550.1 12553.6 12544.8	181.555 172.424	12825 12817	12110 12147	12907.6	169,601	10175	12518	12407.8	170,088	12696	12004	21875.9 295.09	7 22320	21190
1050 1100 1110 1120	1090 1090 1090 1090	12550.1 12553.6 12544.8 12539.9	181.555 172,424 171,801	12825 12817 12811	12110 12147 12148	12907.6 12900.8	169,601 169,54	10175 10170	12518 12520	12407.8 12401.8	170,066 169,392	12696 12679	12034 12038	21875.9 295.09 21865.7 290.84	7 22320 22310	21190 21200
1050 1100 1110 1120 1130	1090 1090 1090 1090 1090	12550.1 12553.6 12544.8 12539.9 12539.7	181.555 172.424 171.801 173.058	12825 12817 12811 12815	12110 12147 12148 12125	12907.6 12900.8 12901.9	169,801 169,54 170,504	10175 10170 10170	12518 12523 12498	12407.8 12401.8 12402.7	170,088 169,392 171,139	12696 12679 12680	12034 12038 12013	21875.9 295.09 21865.7 290.84 21886.7 296.77	7 22020 22010 2 22020	21190 21200 21150
1050 1100 1110 1120	1090 1090 1090 1090	12550.1 12553.6 12544.8 12539.9	181.555 172.424 171.801 173.056 167.164	12825 12817 12811	12110 12147 12148	12907.6 12900.8 12901.9 12896.9	169,601 169,54 170,504 164,362	10175 10170	12518 12520	12407.8 12401.8 12402.7 12427.2	170,066 169,392	12696 12679	12034 12038	21875.9 295.09 21865.7 290.84 21866.7 296.77 21868 296.77	7 22320 22310 2 22320 1 22290	21190 21200

Table (4)

Table (5) The Average Wind Speed (Daily – Hourly) during measurement period from 16/12/2005 to 15/01/2006

00:00 7.7 11.3 11.8 7.4 1.7 10.4 12.4 8.6 6.0 9.3 8.3 5.3 6.5 2.1 5.4 7.0 01:00 9.9 10.9 13.0 4.8 3.0 10.9 11.9 8.3 5.8 8.9 5.2 4.7 6.8 2.9 3.7 6.7 02:00 4.7 6.9 12.9 2.6 1.9 12.6 12.0 6.0 5.5 8.5 1.5 5.7 6.4 2.7 2.4 6.3 03:00 4.7 4.2 12.0 4.2 1.2 11.2 11.8 3.0 5.9 7.0 2.6 5.7 6.1 1.8 3.5 6.0 04:00 5.2 2.5 12.7 4.4 2.1 10.6 10.7 2.6 5.5 4.5 3.1 5.2 5.0 05:00 3.3 11.9 11.2 2.2 10.1 11.0 7.7 7.5 </th <th>Day</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>Days</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>	Day									Days							
01:00	Hours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
02:00 3.6 7.1 2.3 4.3 2.7 0.4 11.2 7.6 7.3 4.6 4.5 6.5 7.4 4.6 1.13 8.6	00:00	4.0	4.8	3.5	1.8	3.9	10.9	12.4	7.5	4.2	5.2	4.3	8.3	8.4	2.2	11.1	9.0
03:00 4.5 8.2 7.7 2.7 3.8 0.0 10.0 4.7 6.0 6.0 4.3 8.5 8.5 3.0 14.3 4.5 04:00 5.0 7.0 7.9 2.1 2.3 3.5 9.8 8.7 2.7 4.7 3.5 3.7 7.1 3.4 1.2 12.6 6.3 06:00 8.0 8.8 2.4 1.9 3.7 9.8 8.0 3.5 5.2 5.6 2.9 7.7 3.4 1.8 9.0 4.5 07:00 6.1 6.9 2.3 2.4 1.9 3.9 8.0 3.3 6.1 4.8 3.2 8.0 3.1 2.0 7.7 3.3 06:00 6.0 7.1 1.9 2.2 3.0 10.4 9.9 4.8 6.8 3.8 3.5 7.7 5.7 4.4 9.8 1.7 09:00 5.5 6.1 1.6 1.7 7.9 10.7 10.5 7.1 7.8 4.3 4.6 7.9 5.5 8.4 11.1 3.3 10:00 6.2 5.6 2.3 3.5 8.1 10.6 10.5 8.0 9.9 4.1 5.1 8.9 9.2 7.0 10.8 3.1 11:00 7.8 6.0 1.3 3.5 8.1 10.6 10.5 8.0 3.8 6.8 3.8 8.7 2.7 7.9 10.3 3.3 11:00 7.8 6.0 1.3 3.5 8.1 10.7 10.5 10.5 8.4 9.2 5.0 7.0 9.2 9.0 8.0 10.3 5.7 12:00 9.4 6.4 3.3 5.0 9.0 10.5 10.5 8.4 9.2 5.0 7.0 9.2 9.0 8.0 10.3 5.7 13:00 8.4 5.8 4.2 2.9 4.1 6.9 8.0 7.4 6.5 7.7 7.9 11.2 9.1 5.4 15:00 6.6 5.2 4.7 4.5 10.2 12.4 9.5 9.5 5.8 7.7 7.7 9.0 11.1 7.4 15:00 6.6 5.3 3.3 4.1 4.9 12.5 9.0 5.1 6.8 8.7 7.7 7.7 9.1 1.2 9.1 5.4 15:00 3.8 1.6 3.4 2.5 9.2 12.0 8.9 3.4 5.8 5.8 7.2 7.8 9.8 9.5 5.9 16:00 4.5 3.3 4.1 3.1 10.9 13.0 8.2 3.7 3.7 4.6 9.7 9.7 9.1 9.1 5.4 15:00 3.7 2.8 2.1 2.5 10.9 12.5 9.0 5.1 4.8 6.5 8.4 7.2 9.0 11.1 11.1 9.3 18:00 3.7 1.1 3.8 1.5 10.9 13.0 8.2 3.7 3.7 4.6 9.7 9.5 9.8 8.0 9.2 11.7 10.0 20:00 3.7 4.7 4.7 4.8 4.5 4.5 9.5 3.3 4.1 4.5 9.5 3.3 4.1 4.5 9.5 3.3 4.1 4.5 9.5 3.3 4.3 4.5 9.5 3.3 4.3 4.5 9.5 3.3 4.3 4.5 9.5 3.3 4.3 4.5 9.5 3.3	01:00	3.9	6.0	2.4	3.1	2.9	10.7	12.3	7.5	5.1	3.0	4.6	6.5	7.5	2.6	11.7	10.0
04:00 5.0 7.1 7.4 3.0 3.6 9.1 9.9 4.0 5.0 3.0 4.4 8.5 4.9 2.4 13.9 4.8 05:00 7.0 7.9 2.1 2.3 3.5 9.8 8.7 2.7 4.7 3.5 3.7 7.1 3.4 1.2 12.6 6.3 06:00 8.0 8.8 2.4 1.9 9.9 8.0 3.3 5.2 5.6 2.9 7.7 3.4 1.2 12.6 6.3 06:00 8.0 8.8 2.4 1.9 9.9 8.0 3.3 5.1 4.8 3.2 8.0 3.1 2.0 7.7 06:00 8.0 7.1 1.9 2.2 3.0 10.4 9.9 4.8 6.8 3.8 3.5 7.7 5.7 4.4 9.9 1.7 06:00 6.0 7.1 1.9 2.2 3.0 10.4 9.9 4.8 6.8 3.8 3.5 7.7 5.7 4.4 9.1 3.3 10:00 6.2 5.6 2.3 3.5 8.1 10.6 10.5 8.0 7.9 4.1 5.1 8.9 9.2 7.0 10.8 3.1 11:00 7.8 6.0 1.9 3.4 8.8 10.7 10.6 8.4 8.8 3.8 6.8 8.9 8.8 7.2 10.9 4.8 12:00 9.4 6.4 3.3 5.0 9.0 10.5 10.5 8.4 9.2 5.0 7.0 9.2 9.0 8.0 10.3 5.7 13:00 8.4 5.8 4.2 6.2 9.4 10.6 10.1 7.3 9.4 7.4 6.9 7.7 8.4 9.9 9.6 5.4 14:00 6.1 5.7 5.7 5.7 10.2 11.4 10.1 6.9 8.0 7.4 6.9 7.7 8.4 9.9 9.6 5.4 14:00 6.6 5.2 4.7 4.5 10.2 12.4 9.7 5.8 5.8 7.8 7.2 8.8 7.6 11.5 9.9 5.9 16:00 4.5 3.3 4.1 3.4 9.9 12.5 9.0 5.1 5.4 8.8 6.5 8.7 7.1 10.9 11.1 7.4 17:00 3.8 1.6 3.4 2.5 9.2 9.0 5.1 5.4 8.8 6.5 8.7 7.1 10.9 11.1 7.4 17:00 3.7 2.8 2.1 2.5 10.9 12.5 9.2 2.1 4.1 5.8 7.9 8.8 8.0 9.2 11.1 11.1 9.3 18:00 3.7 2.8 2.1 2.5 10.9 12.5 9.2 2.1 4.1 5.8 7.9 5.7 8.0 10.1 10.7 9.7 19:00 3.7 2.8 2.1 2.5 10.9 12.5 9.2 2.1 4.1 5.8 7.9 5.7	02:00	3.6	7.1	2.3	4.3	2.7	10.4	11.2	7.6	7.3	4.6	4.5	6.9	7.4	4.6	11.3	8.6
05:00	03:00	4.5	8.2	1.7	2.7	3.8	10.0	10.0	4.7	6.0	6.0	4.3	8.5	8.5	3.0	14.3	4.5
06:00 8.0 8.8 2.4 9.3 3.7 9.6 8.0 3.5 5.2 5.6 2.9 7.7 3.4 1.8 9.0 4.5 07:00 6.1 6.0 7.1 1.9 2.2 3.0 10.4 9.9 4.8 8.8 3.8 3.5 7.7 5.7 4.4 9.8 1.7 09:00 5.5 6.1 1.6 1.7 7.9 10.7 10.5 7.1 7.8 4.3 4.8 7.9 8.5 8.4 11.1 3.3 10:00 6.2 5.6 2.3 3.5 8.1 10.6 10.5 7.1 7.8 4.3 4.8 7.9 8.5 8.4 11.1 3.3 11:00 7.8 6.0 1.9 3.4 8.8 10.7 10.6 8.4 8.6 8.8 8.8 6.6 8.9 8.7 7.0 10.8 3.1 11:00 7.8 6.0 1.9 3.4 8.8 10.7 10.6 8.4 8.6 3.8 6.6 8.9 8.8 7.2 10.9 4.8 12:00 9.4 6.4 3.3 5.0 9.0 10.5 10.5 8.4 9.2 5.0 7.0 9.2 9.0 8.0 10.3 5.7 13:00 8.4 5.8 4.2 6.2 9.4 10.6 10.5 8.4 9.2 5.0 7.0 9.2 9.0 8.0 10.3 5.7 13:00 6.6 5.7 5.7 5.7 10.2 11.4 10.1 6.9 8.0 7.4 6.5 7.7 7.9 11.2 9.1 5.4 15:00 6.6 5.2 4.7 4.5 10.2 12.4 9.7 5.8 5.8 7.8 7.2 8.8 7.6 11.5 9.9 5.9 16:00 4.5 3.3 4.1 3.4 9.9 12.5 9.0 5.1 5.4 8.8 6.5 8.4 7.2 10.9 11.1 7.4 17:00 3.8 1.6 3.4 2.5 9.2 12.0 8.9 3.4 5.8 6.3 7.1 8.2 8.0 11.1 11.7 7.4 17:00 3.7 2.8 2.1 2.5 10.9 12.5 9.2 2.1 4.1 5.8 7.9 8.8 8.0 9.2 11.7 10.0 18:00 3.9 4.3 2.1 3.1 10.9 12.5 9.2 2.1 4.1 5.8 7.9 8.8 8.0 9.2 11.7 10.0 22:00 4.0 3.2 1.3 5.4 9.5 13.1 8.5 8.3 4.3 3.8 5.1 10.3 8.9 5.7 9.8 12.8 10.6 22:00 4.0 3.2 1.3 5.4 9.5 13.1 8.5 8.8 8.9 5.2 4.7 8.0 9.1 11.7 10.0 22:00 4.0 3.2 1.3 5.4 9.5 13.1 8.5 8.8 8.8 5.5 8.8 5.8 7.8 7.8 11.1 9.2 8.3 23:00 6.2 3.4 1.5 5.1 10.8 12.8 8.4 4.5 4.2 8.9 8.0 1.9 9.8 3.7 9.9 5.9 06:00 7.7 11.3 11.8 7.4 1.7 10.4 12.4 8.6 6.0 9	04:00	5.0	7.1	1.4	3.0	3.6	9.1	9.9	4.0	5.0	3.0	4.4	8.5	4.9	2.4	13.9	4.8
07:00	05:00	7.0	7.9	2.1	2.3	3.5	9.8	8.7	2.7	4.7	3.5	3.7	7.1	3.4	1.2	12.6	6.3
08:00 6.0 7.1 1.9 2.2 3.0 10.4 9.9 4.8 6.8 3.8 3.5 7.7 5.7 4.4 9.8 1.7	06:00	8.0	8.8	2.4	1.9	3.7	9.6	8.0	3.5	5.2	5.6	2.9	7.7	3.4	1.8	9.0	4.5
19:00 5.5 6.1 1.6 1.7 7.9 10.7 10.5 7.1 7.8 4.3 4.6 7.9 8.5 8.4 11.1 3.3 19:00 6.2 5.6 2.3 3.5 8.1 10.6 10.5 8.0 7.9 4.1 5.1 6.9 9.2 7.0 10.8 3.1 11:00 7.8 6.0 1.9 3.4 8.8 10.7 10.6 8.4 8.6 3.8 6.6 8.9 8.8 7.2 10.9 4.8 12:00 9.4 6.4 3.3 5.0 9.0 10.5 10.5 8.4 9.2 5.0 7.0 9.2 9.0 8.0 10.3 5.7 13:00 8.4 5.8 4.2 6.2 9.4 10.6 10.1 7.3 9.4 7.4 6.9 7.7 8.4 9.9 9.6 5.4 14:00 6.6 5.7 5.7 5.7 10.2 11.4 10.1 6.9 8.0 7.4 6.5 7.7 9.1 12.9 1.5 15:00 6.6 5.2 4.7 4.5 10.2 12.4 9.7 5.8 5.8 7.8 7.2 8.8 7.6 11.5 9.9 5.9 15:00 4.5 3.3 4.1 3.4 9.9 12.5 9.0 5.1 5.4 8.8 6.5 8.4 7.2 10.9 11.1 7.4 17:00 3.9 1.1 2.3 2.1 10.2 12.4 9.6 2.0 4.5 5.9 7.4 7.7 8.0 10.1 10.7 9.7 19:00 3.9 4.3 2.1 3.1 10.9 13.0 8.2 3.7 3.7 4.8 9.7 9.9 5.9 11.7 10.0 20:00 3.9 4.3 2.1 3.1 10.9 13.0 8.2 3.7 3.7 4.8 9.7 9.9 5.7 9.8 12.8 10.6 21:00 4.9 4.7 1.1 3.8 10.5 13.0 8.3 4.3 3.9 5.1 10.3 8.9 5.2 10.5 12.0 10.0 22:00 4.9 4.7 1.1 3.8 10.5 13.0 8.3 4.3 3.9 5.1 10.3 8.9 5.2 10.5 12.0 10.0 22:00 4.9 4.7 1.1 3.8 10.5 13.8 4.5 5.8 3.8 3.4 10.6 9.1 3.8 11.1 9.2 8.3 23:00 6.2 3.4 1.5 5.1 10.8 12.8 8.4 4.5 4.5 4.2 8.9 5.9 5.9 4.3 1.1 9.2 8.3 23:00 6.2 3.4 1.5 5.1 10.8 12.8 8.4 4.5 4.5 4.2 8.9 5.9 5.7 6.4 2.7 2.4 6.3 03:00 7.7 11.3 11.8 7.4 1.7 10.4 12.4 8.6 6.0 9.3 8.3 3.3 5.5 5.7 6.4 2.7 2.4 6.3 03:00 7.7 11.3 11.8 7.4 1.7 10.4 12.4 8.6 6.0 9.3 8.9 5.2 4.5 5.7 6.1 8.3 5.6 03:00 7.7 11.3 11.8 7.4 1.7 10.4 12.4	07:00	6.1	6.9	2.3	2.4	1.9	9.9	8.0	3.3	6.1	4.8	3.2	8.0	3.1	2.0	7.7	3.3
10:00	08:00	6.0	7.1	1.9	2.2	3.0	10.4	9.9	4.8	6.8	3.8	3.5	7.7	5.7	4.4	9.8	1.7
11:00	09:00	5.5	6.1	1.6	1.7	7.9	10.7	10.5	7.1	7.8	4.3	4.6	7.9	8.5	8.4	11.1	3.3
12:00	10:00	6.2	5.6	2.3	3.5	8.1	10.6	10.5	8.0	7.9	4.1	5.1	8.9	9.2	7.0	10.8	3.1
13:00	11:00	7.8	6.0	1.9	3.4	8.8	10.7	10.6	8.4	8.6	3.8	6.6	8.9	8.8	7.2	10.9	4.8
14:00	12:00	9.4	6.4	3.3	5.0	9.0	10.5	10.5	8.4	9.2	5.0	7.0	9.2	9.0	8.0	10.3	5.7
15:00	13:00	8.4	5.8	4.2	6.2	9.4	10.6	10.1	7.3	9.4	7.4	6.9	7.7	8.4	9.9	9.6	5.4
16:00	14:00	6.1	5.7	5.7	5.7	10.2	11.4	10.1	6.9	8.0	7.4	6.5	7.7	7.9	11.2	9.1	5.4
16:00	15:00	6.6	5.2	4.7	4.5	10.2	12.4	9.7	5.8	5.8	7.8	7.2	8.8	7.6	11.5	9.9	5.9
17:00 3.8 1.6 3.4 2.5 9.2 12.0 8.9 3.4 5.9 6.3 7.1 8.2 8.0 11.1 11.1 9.3 18:00 3.9 1.1 2.3 2.1 10.2 12.4 9.6 20 4.5 5.9 7.4 7.7 8.0 10.1 10.7 9.7 19:00 3.7 2.8 2.1 2.5 10.9 12.5 9.2 2.1 4.1 5.8 7.9 8.8 8.0 9.2 11.7 10.0 20:00 3.9 4.3 2.1 3.1 10.9 13.0 8.2 3.7 3.7 4.6 9.7 9.9 5.7 9.8 12.8 10.6 21:00 4.9 4.7 1.1 3.8 10.5 13.0 8.3 4.3 3.9 5.1 10.3 8.9 5.2 10.5 12.0 10.0 22:00 4.0 3.2 1.3 5.4 9.5 13.1 8.5 5.8 3.8 3.4 10.6 9.1 3.8 11.1 9.2 8.3 23:00 6.2 3.4 1.5 5.1 10.8 12.8 8.4 4.5 4.4 2.8 9.6 8.0 1.9 9.8 8.3 7.9 AVG _{day} 5.5 5.4 2.6 3.4 7.3 11.2 9.7 5.3 6.0 5.1 6.2 8.2 6.6 7.1 10.8 6.6 Day Hours 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 AVG _{hou} 00:00 7.7 11.3 11.8 7.4 1.7 10.4 12.4 8.6 6.0 9.3 8.3 5.3 6.5 2.1 5.4 7.0 01:00 9.9 10.9 13.0 4.8 3.0 10.9 11.9 8.3 5.8 8.9 5.2 4.7 6.8 2.9 3.7 6.7 02:00 4.7 6.9 12.9 2.6 1.9 12.6 12.0 6.0 5.5 8.5 1.5 5.7 6.4 2.7 2.4 6.3 03:00 4.7 6.9 12.9 2.6 1.9 12.6 12.0 6.0 5.5 8.5 1.5 5.7 6.4 2.7 2.4 6.3 03:00 4.7 6.9 12.9 2.1 2.1 2.1 2.1 3.0 5.9 7.0 2.6 5.5 4.5 3.4 5.2 5.1 3.4 3.1 5.4 04:00 5.2 2.5 12.7 4.4 2.1 10.6 10.7 2.6 5.5 4.5 3.4 5.2 5.1 3.9 3.1 3.1 5.4 06:00 5.3 11.9 11.2 2.2 1.9 10.4 10.7 3.8 5.2 5.0 4.3 5.0 3.5 3.9 2.5 5.6 07:00 3.8 13.1 11.1 3.4 11.1 12.4 3.2 3.2 4.8 4.2 5.5 4.8 4.1 4.3 2.3 5.6 09:00 7.1 11.8 11.4 1.2 1.4 12.2 7.6 5.1 6.3 5.4 3.0 3.3 3.1 3.1 5.4 10:00 6.8 11.7 11.1 3.2 1.9 11.9 10.2 7.7 7.0 5.		4.5	3.3	4.1	3.4	_	_	9.0			8.8	6.5	8.4		_	11.1	
19:00 3.7 2.8 2.1 2.5 10.9 12.5 9.2 2.1 4.1 5.8 7.9 8.8 8.0 9.2 11.7 10.0	17:00	3.8	1.6	3.4	2.5	9.2	12.0	8.9	3.4	5.9	6.3	7.1	8.2	8.0	11.1	11.1	9.3
19:00 3.7 2.8 2.1 2.5 10.9 12.5 9.2 2.1 4.1 5.8 7.9 8.8 8.0 9.2 11.7 10.0	18:00	3.9	1.1	2.3	2.1	10.2	_	9.6	2.0	4.5	5.9	-	7.7		10.1	10.7	9.7
21:00	19:00	3.7	2.8	2.1	2.5	10.9	12.5	9.2	2.1	4.1	5.8	7.9	8.8	8.0	9.2	11.7	10.0
22:00	20:00	3.9	4.3	2.1	3.1	10.9	13.0	8.2	3.7	3.7	4.6	9.7	9.9	5.7	9.8	12.8	10.6
Color	21:00	4.9	4.7	1.1	3.8	10.5	13.0	8.3	4.3	3.9	5.1	10.3	8.9	5.2	10.5	12.0	10.0
AVG _{day} 5.5 5.4 2.6 3.4 7.3 11.2 9.7 5.3 6.0 5.1 6.2 8.2 6.6 7.1 10.8 6.6 Day Days 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 AVG _{hou} 00:00 7.7 11.3 11.8 7.4 1.7 10.4 12.4 8.6 6.0 9.3 8.3 5.3 6.5 2.1 5.4 7.0 02:00 4.7 6.9 12.9 2.6 1.9 12.6 12.0 6.0 5.5 8.5 1.5 5.7 6.4 2.7 2.4 6.3 03:00 4.7 4.2 12.0 4.2 12.0 6.5 4.5 1.5 5.7 6.4 2.7 2.4 6.3 04:00 5.2 2.5 12.7 4.4 2.1 11.8	22:00	4.0	3.2	1.3	5.4	9.5	13.1	8.5	5.8	3.8	3.4	10.6	9.1	3.8	11.1	9.2	8.3
Hours	23:00	6.2	3.4	1.5	5.1	10.8	12.8	8.4	4.5	4.4	2.8	9.6	8.0	1.9	9.8	8.3	7.9
Hours 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 AVGhou 00:00 7.7 11.3 11.8 7.4 1.7 10.4 12.4 8.6 6.0 9.3 8.3 5.3 6.5 2.1 5.4 7.0 01:00 9.9 10.9 13.0 4.8 3.0 10.9 11.9 8.3 5.8 8.9 5.2 4.7 6.8 2.9 3.7 6.7 02:00 4.7 4.2 12.0 4.2 11.2 11.2 11.8 3.0 5.9 7.0 2.6 5.7 6.1 1.8 3.5 6.0 04:00 5.2 2.5 12.7 4.4 2.1 10.6 10.7 2.6 5.5 4.5 3.4 5.2 5.1 2.8 4.1 5.6 05:00 3.7 9.0 12.0 2.3 2.4 1	AVG	EE	E A	26	3.4	73	11 2	9.7	5.3	6.0	5.4	6.2	8 2	6.6	7.1	10.8	6.6
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22:00 10.1 13.0 10.6 1.4 11.6 13.6 8.9 9.5 10.1 7.8 5.1 6.6 6.1 4 4.6 7.5 23:00 11.3 11.9 10.7 1.2 10.5 13.1 9.0 8.9 8.6 7.3 3.6 6.2 4.3 5.7 4.1 7.1	Day Hours 00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 10:00 11:00 12:00 14:00 15:00 15:00 16:00 17:00	7.7 9.9 4.7 5.2 3.7 5.3 3.8 5.8 7.1 6.8 6.9 7.0 6.7 5.7 6.1 7.1 8.6 9.3	18 11.3 10.9 6.9 4.2 2.5 9.0 11.8 12.9 11.8 12.6 13.0 13.2 13.4 13.1 13.2 13.4 14.7 15.6	19 11.8 13.0 12.9 12.0 12.7 12.0 11.2 11.1 11.6 11.4 11.0 9.9 9.1 9.1 9.2 9.5 8.9 9.2	20 7.4 4.8 2.6 4.2 4.4 2.3 2.2 3.4 2.9 1.2 2.8 2.8 3.7 3.3 4.7 6.7 6.4	21 1.7 3.0 1.9 1.2 2.1 2.4 1.9 1.1 1.0 1.4 1.9 2.2 2.3 2.9 2.7 4.3 5.2 7.3 8.6 10.5	22 10.4 10.9 12.6 10.6 10.6 10.4 12.1 11.8 12.2 11.9 12.0 12.1 12.4 12.9 12.6 13.0 12.9 13.6	23 12.4 11.9 12.0 11.8 10.7 10.4 10.7 9.0 3.7 7.6 10.2 11.4 11.8 11.7 12.0 11.2 10.6 10.5 10.0 9.9	24 8.6 8.3 6.0 2.6 2.9 3.8 3.2 4.7 5.1 7.0 8.2 9.5 8.8 8.5 7.4 5.3 3.4 2.7	5.5 5.5 5.5 5.2 4.2 5.6 6.3 7.0 8.2 8.3 9.0 6.5 8.0 7.1 6.0 7.2 7.4	26 9.3 8.9 8.5 7.0 4.5 4.5 5.0 4.2 4.6 5.3 3.9 3.9 4.6 5.0 5.0 5.5 5.6 5.8 6.6	27 8.3 5.2 1.5 2.6 3.4 4.1 4.3 5.6 4.4 3.0 1.6 3.2 4.7 2.3 2.9 4.2 4.4 4.6 4.0	28 5.3 4.7 5.7 5.2 5.2 5.0 4.8 3.7 2.3 1.8 2.6 2.3 3.5 3.7 2.6 2.2 1.9	29 6.5 6.8 6.4 6.1 5.1 3.9 3.5 4.1 3.4 3.1 6.8 8.7 9.7 9.6 8.9 7.8 6.8 7.0	30 2.1 2.9 2.7 1.8 2.8 3.1 3.9 4.3 3.1 2.4 2.2 2.7 5.8 5.1 1.7 1.5 4.2	31 5.4 3.7 2.4 3.5 4.1 3.1 2.5 2.3 2.1 3 7.8 6.7 7.4 6.8 6.4 4.6	AVGhour 7.0 6.7 6.3 6.0 5.6 5.4 5.6 6.3 6.8 7.2 7.7 7.8 7.6 7.5 7.1 6.9 6.9
23:00 11.3 11.9 10.7 1.2 10.5 13.1 9.0 8.9 8.6 7.3 3.6 6.2 4.3 5.7 4.1 7.1	Day Hours 00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 10:00 11:00 12:00 14:00 15:00 16:00 17:00 18:00 19:00	7.7 9.9 4.7 5.2 3.7 5.3 3.8 5.8 7.1 6.8 6.9 7.0 6.7 5.7 6.1 7.1 8.6 9.3	18 11.3 10.9 6.9 4.2 2.5 9.0 11.8 12.9 11.8 12.6 13.0 13.2 13.4 13.1 13.2 13.4 14.7 15.6	19 11.8 13.0 12.9 12.0 12.7 12.0 11.2 11.1 11.6 11.4 11.0 9.9 9.1 9.1 9.2 9.5 8.9 9.2 8.5	20 7.4 4.8 2.6 4.2 2.3 2.2 3.4 2.9 1.2 2.8 2.8 3.7 3.3 4.7 6.7 6.4 4.4	21 1.7 3.0 1.9 1.2 2.1 2.4 1.9 1.1 1.0 1.4 1.9 2.2 2.3 2.9 2.7 4.3 5.2 7.3 8.6 10.5	22 10.4 10.9 12.6 10.6 10.6 10.4 12.1 11.8 12.2 11.9 12.0 12.1 12.4 12.9 12.6 13.0 12.9 13.6	23 12.4 11.9 12.0 11.8 10.7 10.4 10.7 9.0 3.7 7.6 10.2 11.4 11.8 11.7 12.0 11.2 10.6 10.5 10.0 9.9	24 8.6 8.3 6.0 2.6 2.9 3.8 3.2 4.7 5.1 7.0 8.2 9.5 8.8 8.5 7.4 5.3 3.4 2.7 5.7	5.5 5.5 5.5 5.2 4.2 5.6 6.3 7.0 8.2 8.3 9.0 6.5 8.0 7.1 6.0 7.2 7.4	26 9.3 8.9 8.5 7.0 4.5 4.5 5.0 4.2 4.6 5.3 3.9 3.9 4.6 5.0 5.0 5.5 5.6 5.8 6.6	27 8.3 5.2 1.5 2.6 3.4 4.1 4.3 5.6 4.4 3.0 1.6 3.2 4.7 2.3 2.9 4.2 4.4 4.6 4.0	28 5.3 4.7 5.7 5.2 5.2 5.0 4.8 3.7 3.3 2.3 2.3 3.5 2.3 3.7 2.6 2.2 1.9 2.7	29 6.5 6.8 6.4 6.1 5.1 3.9 3.5 4.1 3.4 3.1 6.8 8.7 9.7 9.6 8.9 7.8 6.8 7.0 9.6	30 2.1 2.9 2.7 1.8 2.8 3.1 3.9 4.3 3.1 2.4 2.2 2.7 5.8 5.1 1.7 1.5 4.2 4.8	31 5.4 3.7 2.4 3.5 4.1 3.1 2.5 2.3 2.1 3 5.9 7.8 6.7 7.4 6.8 6.4 4.6 4.6 4.5	AVGhour 7.0 6.7 6.3 6.0 5.6 5.4 5.6 6.3 6.8 7.2 7.7 7.8 7.6 7.5 7.1 6.9 6.9 7.3 7.5
	Day Hours 00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 10:00 11:00 12:00 14:00 15:00 16:00 17:00 18:00 17:00 18:00 19:00 19:00	7.7 9.9 4.7 5.2 3.7 5.3 3.8 5.8 7.1 6.8 6.9 7.0 6.7 5.9 5.7 6.1 7.1 8.6 9.3 9.4	18 11.3 10.9 6.9 4.2 2.5 9.0 11.9 11.8 12.9 11.8 13.2 13.4 13.1 13.2 13.4 14.7 15.6 15.1	19 11.8 13.0 12.9 12.0 12.7 12.0 11.2 11.1 11.6 11.4 11.0 9.9 9.1 9.1 9.2 9.5 8.9 9.2 8.5 9.7	20 7.4 4.8 2.6 4.2 2.3 2.2 3.4 2.9 1.2 2.8 2.8 3.7 3.3 4.7 6.7 6.4 4.4 2.4	21 1.7 3.0 1.9 1.2 2.1 1.9 1.1 1.0 1.4 1.9 2.2 2.3 2.9 2.7 4.3 5.2 7.3 8.6 10.5 12.8	22 10.4 10.9 12.6 10.6 10.6 10.4 12.1 11.8 12.2 11.9 12.0 12.1 12.4 12.9 12.6 13.0 12.9 13.6 13.5	23 12.4 11.9 12.0 11.8 10.7 10.4 10.7 9.0 3.7 7.6 10.2 11.4 11.7 12.0 11.2 10.6 10.5 10.0 9.9 10.0	24 8.6 8.3 6.0 2.6 2.9 3.8 3.2 4.7 5.1 7.0 8.2 9.5 8.8 8.5 7.4 5.3 3.4 2.7 5.7 8.2	Days 25 6.0 5.8 5.5 5.9 5.5 4.2 5.6 6.3 7.0 8.2 8.3 9.0 7.1 6.0 7.2 7.4 7.3	26 9.3 8.9 8.5 7.0 4.5 4.5 5.0 4.2 4.6 5.4 5.3 3.9 4.6 5.0 5.6 5.6 5.6 5.8 6.6 7.3 9.5	27 8.3 5.2 1.5 2.6 3.4 4.1 4.3 5.6 4.4 3.0 1.6 3.2 5.4 4.7 2.3 2.9 4.2 4.4 4.6 4.0 5.1 6.3	28 5.3 4.7 5.7 5.2 5.2 5.0 4.8 3.7 3.3 2.3 3.5 2.3 3.5 2.6 2.2 1.9 2.7 3.8	29 6.5 6.8 6.4 6.1 5.1 3.9 3.5 4.1 3.4 3.1 6.8 8.7 9.7 9.6 8.9 7.8 6.8 7.0 9.6 7.6	30 2.1 2.9 2.7 1.8 2.8 3.1 3.9 4.3 3.1 2.4 2.2 2.7 5.8 5.1 1.7 1.5 4.2 4.8 4.3	31 5.4 3.7 2.4 3.5 4.1 3.1 2.5 2.3 2.1 3 5.9 7.8 6.7 7.4 6.8 6.4 4.6 4.5 4.5	AVGhour 7.0 6.7 6.3 6.0 5.6 5.4 5.6 6.3 6.8 7.2 7.7 7.8 7.6 7.5 7.1 6.9 6.9 7.3 7.5 7.8
	Day Hours 00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 10:00 11:00 12:00 14:00 15:00 16:00 17:00 18:00 17:00 18:00 19:00 20:00 21:00 22:00	7.7 9.9 4.7 5.2 3.7 5.3 3.8 5.8 7.1 6.8 6.9 7.0 6.7 5.9 5.7 6.1 7.1 8.6 9.3 9.4 9.7 10.1	18 11.3 10.9 6.9 4.2 2.5 9.0 11.9 11.8 12.9 11.8 13.0 13.2 13.4 13.1 13.2 13.4 14.7 15.6 15.1 14.1 13.0	19 11.8 13.0 12.9 12.0 12.7 12.0 11.2 11.1 11.6 11.4 11.0 9.9 9.1 9.1 9.2 9.5 8.9 9.2 8.5 9.7 11.2 10.6	20 7.4 4.8 2.6 4.2 2.3 2.2 3.4 2.9 1.2 2.8 3.7 3.3 4.7 6.7 6.4 4.4 2.4 2.1 1.4	21 1.7 3.0 1.9 1.2 2.1 1.0 1.4 1.9 2.2 2.3 2.9 2.7 4.3 5.2 7.3 8.6 10.5 12.8 13.4 11.6	22 10.4 10.9 12.6 10.6 10.6 10.4 12.1 11.8 12.2 11.9 11.7 12.0 12.1 12.4 12.9 12.6 13.0 12.9 13.6 13.5 14.1 13.6	23 12.4 11.9 12.0 11.8 10.7 10.4 10.7 9.0 3.7 7.6 10.2 11.4 11.8 11.7 12.0 11.2 10.6 10.5 10.0 9.9 10.0 8.3	24 8.6 8.3 6.0 2.6 2.9 3.8 3.2 4.7 5.1 7.0 8.2 9.5 8.8 5.3 3.4 2.7 5.7 8.2 2.7 5.7	Days 25 6.0 5.8 5.5 4.2 5.6 6.3 7.0 8.2 8.3 9.0 7.1 6.0 7.2 7.4 7.3 8.6	26 9.3 8.9 8.5 7.0 4.5 4.5 5.0 4.2 4.6 5.3 3.9 4.6 5.0 5.6 5.6 5.6 5.8 6.6 7.3 9.5 7.8	27 8.3 5.2 1.5 2.6 3.4 4.1 4.3 5.6 4.4 3.0 1.6 3.2 5.4 4.7 2.3 2.9 4.2 4.4 4.6 4.0 5.1 6.3 5.1	28 5.3 4.7 5.7 5.2 5.2 5.0 4.8 3.7 3.3 2.3 3.5 2.3 3.5 2.6 2.2 1.9 2.7 3.8 5.7 6.6	29 6.5 6.8 6.4 6.1 5.1 3.9 3.5 4.1 3.4 3.1 6.8 8.7 9.7 9.6 7.8 6.8 7.0 9.6 7.6 7.0	30 2.1 2.9 2.7 1.8 2.8 3.1 3.9 4.3 3.1 2.4 2.2 2.7 5.8 5 1.7 1.5 4.2 4.8 4.3 4.9	31 5.4 3.7 2.4 3.5 4.1 3.1 2.5 2.3 2.1 3 5.9 7.6 6.7 7.4 6.8 4.6 4.5 4.5 4.5	AVGhour 7.0 6.7 6.3 6.0 5.6 5.4 5.6 6.3 6.8 7.2 7.7 7.8 7.6 7.5 7.1 6.9 6.9 7.3 7.5 7.8
AVG _{day} 7.0 11.7 10.7 3.4 4.7 12.2 10.2 6.2 6.9 5.9 4.2 4.0 6.6 3.7 4.9 6.8	Day Hours 00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 10:00 11:00 12:00 14:00 15:00 16:00 17:00 18:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00	7.7 9.9 4.7 5.2 3.7 5.3 3.8 5.8 7.1 6.8 6.9 7.0 6.7 5.9 5.7 6.1 7.1 8.6 9.3 9.4 9.7 10.1	18 11.3 10.9 6.9 4.2 2.5 9.0 11.9 11.8 12.9 11.8 13.0 13.2 13.4 13.1 13.2 13.4 14.7 15.6 15.1 14.1 13.0	19 11.8 13.0 12.9 12.0 12.7 12.0 11.2 11.1 11.6 11.4 11.0 9.9 9.1 9.1 9.2 9.5 8.9 9.2 8.5 9.7 11.2 10.6	20 7.4 4.8 2.6 4.2 2.3 2.2 3.4 2.9 1.2 2.8 3.7 3.3 4.7 6.7 6.4 4.4 2.4 2.1 1.4	21 1.7 3.0 1.9 1.2 2.1 1.0 1.4 1.9 2.2 2.3 2.9 2.7 4.3 5.2 7.3 8.6 10.5 12.8 13.4 11.6	22 10.4 10.9 12.6 10.6 10.6 10.4 12.1 11.8 12.2 11.7 12.0 12.1 12.4 12.9 12.6 13.0 12.9 13.6 13.5 14.1 13.6 13.6	23 12.4 11.9 12.0 11.8 10.7 10.4 10.7 9.0 3.7 7.6 10.2 11.4 11.8 11.7 12.0 11.2 10.6 10.5 10.0 9.9 10.0 8.3 8.9 9.0	24 8.6 8.3 6.0 2.6 2.9 3.8 3.2 4.7 5.1 7.0 8.2 9.5 8.8 5.3 3.4 2.7 5.7 8.2 2.7 5.7 8.2 2.7 5.7	Days 25 6.0 5.8 5.5 4.2 5.6 6.3 7.0 8.2 8.3 9.0 7.1 6.0 7.2 7.4 7.3 8.6 10.1	26 9.3 8.9 8.5 7.0 4.5 4.5 5.0 4.2 4.6 5.3 3.9 4.6 5.0 5.6 5.6 5.6 5.8 6.6 7.3 9.5 7.8	27 8.3 5.2 1.5 2.6 3.4 4.1 4.3 5.6 4.4 3.0 1.6 3.2 5.4 4.7 2.3 2.9 4.2 4.4 4.6 4.0 5.1 6.3 5.1	28 5.3 4.7 5.7 5.2 5.2 5.0 4.8 3.7 3.3 2.3 3.5 2.3 3.5 2.6 2.2 1.9 2.7 3.8 5.7 6.6	29 6.5 6.8 6.4 6.1 5.1 3.9 3.5 4.1 3.4 3.1 6.8 8.7 9.7 9.6 7.8 6.8 7.0 9.6 7.0 6.1	30 2.1 2.9 2.7 1.8 2.8 3.1 3.9 4.3 3.1 2.4 2.2 2.7 5.8 5 1.7 1.5 4.2 4.8 4.3 4.9	31 5.4 3.7 2.4 3.5 4.1 3.1 2.5 2.3 2.1 3 5.9 7.6 6.7 7.4 6.8 6.7 4.6 4.5 4.5 4.5 4.1	AVGhour 7.0 6.7 6.3 6.0 5.6 5.4 5.6 6.3 6.8 7.2 7.7 7.8 7.6 7.5 7.1 6.9 6.9 7.3 7.5 7.8

Hourly Average Daily Average Period Average

Table (5)