

**ANALYSIS OF POWER QUALITY AND IMPROVEMENT
TECHNIQUES OF GRID CONNECTED WIND POWER
PLANT**

**(CASE STUDY: 3MW PILOT WIND POWER PLANT-
HAMBANTOTA)**

W.N.Jayalath



University of Moratuwa, Sri Lanka.
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Degree of Master of Science

Department of Electrical Engineering

University of Moratuwa

Sri Lanka

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**Dissertation submitted in partial fulfillment of the requirements for the degree
Master of Science**

Department of Electrical Engineering

**University of Moratuwa
Sri Lanka**

March 2013

Declaration of the Candidate & Supervisor

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The above candidate has carried out research for the Masters thesis under my supervision.

Signature of the supervisor:

Date:

Prof: J.P.Karunadasa

Signature of the supervisor:

Date:

Mr. A.M.A.Alwis

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Abstract

Analysis of Power Quality and Improvement Techniques of Grid Connected Wind Power Plant (Case Study: 3MW Pilot Wind Power Plant-Hambantota)

Wind Electricity Generation has come to the foremost form of renewable energy conversion method in the modern world. At the same time critics raise their concerns over the intermittency associated with wind power and its implications on national grids all over the world. There are various methods of grid integration of wind energy which has its own draw backs and advantages. One of the major concerns is the effect on national grid due to power quality issues associated with wind power generation.

Ceylon Electricity Board (CEB) commissioned the country's first ever grid connected wind power plant in 1999 in Hambantota. Since then number of wind farms have been commissioned and grid connected. These wind farms employs different power conversion technologies. Accordingly the power quality issues presented at the point of grid interconnection also assume different forms. The main objectives of this research is to identify and assess the power quality issues pose by Hambantota wind farm and compare with latest developed wind power conversion technologies.

The problems found with the Hambantota wind plant were power factor, reactive power consumption, harmonics, flicker and the voltage distortions level at the existing distribution feeder.

To investigate the above problems, it has been carried out data collection on Power production, Power Factor, Reactive Power absorption, Voltage variations, Harmonics and Flicker at the point of common coupling of Hambantota Plant. With the collected 10 minutes average data, graphically presented the performance of the wind plant and compared the same with newly commissioned Vidathamuni/Seguwanthiu Plants at Puttalam.

With the above study, it can be concluded that the Power Factor and the Reactive Power Consumption of the Hambantota Wind Plant has to be improved. Present days, Flexible AC Transmission (FACT) devices are developed and widely coming to the power system improvements. It is capable of correcting Power Factor and Reactive Power Requirement in Real Time Basis and virtually acts as a Synchronous Condenser (STATCOM-Static Synchronous Var Compensator). Therefore, a FACT device named PQC-STATCOM available in the market has been introduced to be installed at the point of common coupling of the Hambantota Wind Plant.

Table of Contents

Declaration of the candidate & Supervisor	i
Acknowledgements	ii
Abstract	iii
Table of content	iv
List of Figures	vi
List of Tables	ix
List of abbreviations	x
Chapter 1 : Introduction	1
1.1 Wind Power Generation.....	1
1.2 Sri Lankan Perspective	1
1.3 The Study	2
Chapter 2 : Wind Turbine Design.....	8
2.1 Wind Turbine Design.....	8
2.2 Fixed Speed Wind Turbines.....	9
2.3 Variable - Speed Wind Turbines.....	10
2.4 Electrical System in Wind Generators & Systemations.....	11
Chapter 3 : Power Quality.....	15
3.1 Concept of Power Quality.....	15
3.2 Power Quality Measures	15
3.3 Reactive Power Consumption and Power Factor.....	17
3.4 Voltage Variations	18
3.5 Flicker	20
3.6 Harmonics	21
3.7 Transient Effects	21
Chapter 4 : Power Factor and Reactive Power	23
4.1 Measurement of the Pf & Reactive Power at Hambantota Plant.....	23
4.2 Measurement of the Pf & Reactive Power at Puttalam Vidathamunai Plant..	26
4.3 Comments on Power Factor and Reactive Power Requirement	27
Chapter 5 : Power Variations.....	32
5.1 Power Variations.....	32
5.2 Results of Measurements	33
5.3 Comments on the Power Variations	33
Chapter 6 : Switching and Transient Events.....	37
6.1 Switching and Transient Events.....	37

Chapter 7 : Harmonics	40
7.1 Voltage Harmonics	40
7.1.1 Results on Voltage THD Measurement	40
7.1.2 Voltage Harmonic Components.....	43
7.1.3 Comment on Voltage Harmonics at both Plants.....	46
7.2 Current Harmonics.....	47
7.3 Current Inter Harmonics.....	48
Chapter 8 : Flicker	50
8.1 Definition of Flicker	50
8.2 Effects of Voltage Fluctuations	52
Chapter 9 : Power Quality Improvement Techniques.....	53
9.1 Requirement of Improvement	53
9.2 Low power factor and high reactive power consumption.....	53
9.3 Advantages and Disadvantages of PF Correction Methods.....	55
9.4 Mitigation of Voltage Fluctuations in Power Systems	57
9.5 Voltage and Current Harmonic Limits	59
9.6 Filtering of Harmonics by Harmonic Filters.....	60
Chapter 10: Cost of Power Quality Improvement Techniques	
10.1 Interconnection to the Grid 33k V Busbar	65
10.2 Real Time Power Factor Correction System.....	65
10.3 Sizing of Real Time Power Factor Correction System.....	65
Chapter 11: Conclusion	
References	
Appendices	
Appendix A : Circuit Diagram of Soft Starter of the NEG MICON Model NM600/43 Wind Machine.....	71

List of Figures

Figure 1.1 - Grid connection schematics of fixed speed wind turbines at Hambantota	5
Figure 1.2 - Diurnal Wind Pattern at Hambantota Site.....	5
Figure 1.3 - Typical Arrangement of a variable speed converter type wind machine (Vidathamunai Plant Model).....	6
Figure 2.1 - Wind speed-Power curve for 600kW, stall regulated wind Turbine.....	9
Figure 2.2 - Schematic Diagram of a Typical Fixed Speed Wind Turbine.....	10
Figure 2.3 - Schematic Diagram of a Typical Variable Speed Wind Turbine.....	10
Figure 2.4 - Schematic Diagram of a Typical Electrical System of a Fixed Speed Wind Turbine	12
Figure 2.5 - Schematic Diagram of a Typical Electrical System of a Variable Speed Wind Turbine with an Inverter.....	13
Figure 3.1 - Reactive Power Consumption of a Fixed Speed Induction Type Wind Plant...	17
Figure 3.2 - Long Duration Voltage Variation.....	18
Figure 3.3 - Short Duration Voltage Variation	19
Figure 3.4 - Voltage Sags B Phase Oscilloscope and RMS Diagram.....	19
Figure 3.5 - Flicker Curve According to IEC 60868va, Sri Lanka.....	20
Figure 3.6 - Harmonics in the Voltage and Current Waveforms.....	21
Figure 3.7 - Transient at Grid Voltage Drops.....	21
Figure 3.8 - Transient Events at Capacitor Switching.	22
Figure 4.1 - Data Logger Installed at 33 kV Grid Interconnection Control Panel.....	23
Figure 4.2 - Variation of Power Factor Against the Farm Normalized Active Power.....	24
Figure 4.3- Frequency of occurrence of Power Factor at 33 kV grid interconnection point at Hambantota Plan.	24
Figure 4.4 - Variation of Normalised Reactive Power against the Normalized Active Power. Measured at 33 kV grid Interconnection Point.	24
Figure 4.5 - Variation of Power Factor of the Puttalama plant against its Normalized Active Power Measured at 33 kV Interconnection Point.....	26
Figure 4.6 - Variation of Normalised Reactive Power of the Puttalama Plant Against its Normalized Active Power Measured at 33 kV Interconnection Point	27
Figure 4.7 - Reactive Power Consumption and average Wind Speed at Hambantota Plant.....	29
Figure 4.8 - Reactive Power Consumption and average Wind Speed at Hambantota Plant.	29
Figure 4.9 - Reactive Power Consumption and average Wind Speed at Hambantota Plant.	29
Figure 4.10 - Frequency of Occurrence of Power Factor, Measured at the Grid Interconnection Point. Bin Center is Mentioned on the X-axis of the Graph ...	30
Figure 5.11 - Standard Deviation of Power, Against its Mean for Averaging 10 minutes Period South-West Wind Regime.	33

Figure 5.2 - Co-efficient of Variability of Power, Against Mean Wind Speed for Averaging 10 minutes Period. South-west Wind Regime.....	34
Figure 5.3 - Co-efficient of Variability of Power, Against Mean Wind Speed for Various Turbulence Intensities (T %). South-west Wind Regime.....	34
Figure 5.4 - Standard Deviation of Power, Against its Mean for Averaging 10 minutes period North-east Wind Regime.....	35
Figure 5.5 - Co-efficient of Variability of Power, against Mean Wind Speed for Averaging 10 minutes Period. North-east Wind Regime.....	35
Figure 5.6 - Co-efficient of Variability of Power, Against Mean Wind Speed for Various Turbulence Intensities (T %). North-east Wind Regime.....	35
Figure 6.1 - Starting of a Typical Fixed Speed Wind Machine	37
Figure 6.2 - Soft Starter Operation at the Cut in of Generator at Hambantota	37
Figure 6.3 - RMS Voltage and current variation at Cut in Generator at Habmantota	38
Figure 6.4 - Switching of Capacitors	39
Figure 7.1 - Typical Day Variation of THD% Wind Plant Shut Down & Measured at 33kV Interconnection Point at Hambantota	40
Figure 7.2 - Voltage THD% with Power Output at Hambantota Plant at 33 kV Level.....	41
Figure 7.3 - Current THD% with Power Output at Hambantota i Plant at 33kV Level	42
Figure 7.4 - Voltage THD% with Power Output at Vidathamuni Plant at 33 kV Level	42
Figure 7.5 - Current THD% with Power Output at Vidathamuni Plant at 33 kV Level.....	44
Figure 7.6 - Voltage Harmonic Components Comparison.....	43
Figure 7.7 - Current Harmonics of Hambantota Plant at 33 kV Level	49
Figure 7.8 - Voltage Harmonics components at Vidathamuni Plant at 33 kV Level.....	45
Figure 7.9 - Current Harmonic Components of Vidathamuni Plant at 33 kV Level	45
Figure 7.10 - Voltage Harmonics components Comparison at 33 kV Level	46
Figure 7.11 - Current Harmonics components Comparison at 33 kV Level	48
Figure 7.12 - Total Current Interharmonics Distortion with Power Output Hambantota Plant at 33 kV Level	49
Figure 7.13 - Total Current Interharmonics Distortion with Power Output Puttalama Plant at 33 kV Level	49
Figure 8.1 - Flicker Curve according to IEC 60868.....	50
Figure 8.2 - Short Term Flicker at Hambantota Wind Plant at 33 kV PCC	51
Figure 8.3 - Long Term Flicker at Hambantota Wind Plant at 33 kV PCC.....	51
Figure 8.4 - Short Term Flicker at Vidathamunai Wind Plant at 33 kV PCC	52
Figure 8.5 - Long Term Flicker at Vidathamunai Wind Plant at 33kV PCC.....	52
Figure 9.1 - Static VAR Compensator	53
Figure 9.2 - Parallel Operation of Soft Starter and SVC Reactor Controller.....	56

Figure 9.3 - Classification of Dynamic Voltage Stabilizers	59
Figure 9.4 - Voltage Stabilization Control System Using a Synchronous Compensator.....	59
Figure 10.1- Typical Connection Diagram of a Thyristor Switched RTPFC	66
Figure 10.2 Typical Connection Diagram of PQC-STATCON	67

List of Tables

Table 1.1 - Wind Turbine at Hambantota: Technical specifications	5
Table 1.2 - Wind Turbine at Puttalama: Technical specifications.....	7
Table 3.1 - Power Quality effects and Reasons	16
Table 4.1 -Reactive Power Consumption as a Percentage to the Active Power Production at Hambantota Plant.....	29
Table 7.1 - Results of the Voltage THD % Measurement at 33kV	43
Table 7.2 - Summary of Voltage Harmonic Components at Hambantota Wind Plant.....	44
Table 7.3 - Summary of Voltage Harmonic Components at Vidathamunai Wind Plant.....	46
Table 7.4 - Other Voltage Harmonic Components at Vidathamunai Wind Plant	46
Table 9.1 - IEEE Harmonic Voltage Limits	60
Table 9.2 - IEEE Harmonic Current Limits.....	60



List of Abbreviations

A	Ampere
AC	Alternative current
AC-DC-AC	Conversion of power from AC to DC and AC
CIRCUTOR AR	Power Quality Analyzer
COV	Co-efficient of Variability of Power
C _p	Power conversion efficiency
CT	Current Transformer
GS	Grid Substation
Hz	Hertz
IEC	International Electro-Technical Commission
IEEE	International Electrical and Electronic Engineer
IGBT	Integrated Bipolar Transistor
kA	Kilo Amperes
kHz	Kilo Hertz
Km	Kilo meter
kVA	Kilo Volt Amperes
kW	Kilo Watts
M	Meter
m/s	Meters per second
m ²	Square meter
mm ²	Square millimeter
N-E	North-East
P	Power
PCC	Point of common coupling
Pf	Power factor
POC	Point of connection
PT	Potential transformer
PWM	Pulse Width Modulation
Rms	Root mean square value
Rpm	Revolution per minute
RTRPC	Real Time Reactive Power Correction Systems
SCADA	Supervisory Control and Data Acquisition
SVC	Static Var Compensator
S-W	South-West
T	Torque
T%	Turbulence Intensity
THD	Third Harmonics Distortion
V	wind speed
Var	Reactive power
XLPE	Cross link polyurethane
ρ	air density
ω	Rotational speed which is fixed
FACT	Flexible AC Transmission
STATCOM	Static Synchronous Var Compensator



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