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Investigation of data reporting techniques and analysis of continuous power quality data in the Vector distribution network

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Investigation of Data Reporting Techniques & Analysis of Continuous Power Quality Data in the Vector Distribution Network

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Certification

I, Glenn C Nicholson, declare that this thesis, submitted in fulfilment of the requirements of Master of Engineering (Research), in the School of Electrical, Computer & Telecommunications Engineering, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Glenn C Nicholson

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List of abbreviations

Abbreviation	
AVD	Absolute Voltage Deviation
CBEMA	Computer and Business Equipment Manufacturers Assoc
CT	Current Transformer
EPRI	Electric Power Research Institute
FFT	Fast Fourier Transform
GXP	Grid Exit Point
HI	Harmonics Index
HoLI	Harmonics outside Limits Index
IEC	International Electrotechnical Commission
IEPQRC	Integral Energy Power Quality & Reliability Centre
ITIC	Information Technology Industry Council
LV	Low voltage (< 1 KV)
MV	Medium voltage (1KV – 35 KV inclusive)
PCC	Point of Common Coupling
PQ	Power quality
PWM	Pulse Width Modulation
rms	Root mean square
THD	Total Harmonic Distortion
UoLI	Unbalance over Limit Index
UoW	University of Wollongong
UPQI	Unified Power Quality Index
VDF	Voltage Distribution Factor
VI	Voltage Index
VoRI	Voltage outside Range Index
VT	Voltage transformer
VUF	Voltage Unbalance Factor
WT	Wavelet Transform

Abstract

Power quality (PQ) has been defined as the study of the sources, effects and control of disturbances that propagate via the electric power supply. The three principal stakeholders in power quality are the electricity user, the electricity supplier and the electrical equipment manufacturer, each of which has a different perspective on power quality.

This thesis looks at power quality primarily from the perspective of the electricity utility. Power quality has traditionally been considered in terms of reliability of supply, and this has been assessed in terms of frequency and duration of interruptions to the supply. However, with the proliferation of electrical equipment that is sensitive to a variety of disturbances in the supply, the reliability of the supply can no longer be defined solely in terms of interruptions. A supply that suffers from disturbance levels that damage or cause misoperation of equipment can be just as expensive and inconvenient to a customer as a supply that suffers from sustained interruptions.

Despite routine power quality monitoring by utilities becoming more common, there is still little standardisation in the methodology for carrying out such surveys. Standard methods for data acquisition, analysing and reporting the data are required. Standardisation is necessary to allow benchmarking of PQ levels between utilities and to allow the determination of typical disturbance levels.

This thesis is an investigation into the practice of routine PQ monitoring by utilities, and in particular the monitoring and reporting of power quality by Vector Ltd (New Zealand). Vector owns and operates the lines network that supplies electricity to most of the Auckland area. Vector has made a significant commitment to PQ monitoring and a large amount of data has been gathered since monitoring began in 1999. The main purpose of this study has been to look at present PQ monitoring and reporting methods at Vector, compare these methods with current industry best practice, and to suggest ways in which these methods could be improved to better meet the needs of Vector.

The focus of this study has been on continuous PQ disturbances (continuous voltage variation, voltage unbalance and harmonic distortion) as opposed to discrete disturbances (voltage sags/swells, transients). Deficiencies in existing analysis techniques have been identified, and an alternative index for voltage variation has been proposed. Methods for deriving seasonal and annual site PQ indices have also been implemented using data from the Vector network covering one full year. Statistical analysis of the data has also been carried out to determine the degree of influence of individual PQ disturbance types on the overall PQ level at a site, and to investigate the influence of each of the known physical characteristics of a site on its power quality performance.

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