

# **Electricity Engineers Association of New Zealand Conference and Trade Exhibition 2011**

**Auckland, New Zealand  
23-24 June 2011**

ISBN: 978-1-61839-307-4

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2011) by the Electricity Engineers Association of NZ (EEA)  
All rights reserved.

Printed by Curran Associates, Inc. (2011)

For permission requests, please contact the Electricity Engineers Association of NZ (EEA)  
at the address below.

Electricity Engineers Association of NZ (EEA)  
PO Box 5324  
Wellington New Zealand

Phone: 64 4 473 6800  
Fax: 64 4 473 8601

admin@eea.co.nz

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2634  
Email: curran@proceedings.com  
Web: www.proceedings.com

# TABLE OF CONTENTS

## ASSET MANAGEMENT

<b>Good Governance and Good Engineering – Do They Really Go Together?</b> .....	1
<i>G. Richard Gibbons</i>	
<b>The Cost of Losses for Future Network Investment in the New Networks Regime</b> .....	11
<i>Harry Colebourn</i>	
<b>Condition Monitoring of Electrical Cables Using Line Resonance Analysis (LIRA)</b> .....	34
<i>Paolo F. Fantoni, Jon Ivar Juvik</i>	

## SMART GRIDS

<b>Future Architecture of Substation Data Networking</b> .....	38
<i>Victor Tan</i>	
<b>Smart Fault Level Management – The Automatic Bus Transfer Scheme</b> .....	52
<i>Dylan Jenkins, Nirmal Nair</i>	
<b>Progress with the Development of a Superconducting Transformer</b> .....	63
<i>Neil Glasson, Mike Staines, Mohinder Pannu, Goran Stojadinovic, Peter Bingley</i>	

## ENERGY STRATEGY

<b>Power Factor, Reactive Power and Voltage Stability in the New Zealand Power System</b> .....	70
<i>David Hume</i>	
<b>Loss Modelling in the New Zealand Electricity Market</b> .....	74
<i>Ramu Naidoo, David Hume</i>	
<b>The Enduring Grid</b> .....	77
<i>Mike Parker, Andrew Smaill</i>	

## SAFETY

<b>Options for Managing Safety with Elderly Switchgear</b> .....	89
<i>Richard Blakeley</i>	
<b>GPG 304 Critical Analysis</b> .....	103
<i>Guy Paine</i>	
<b>Equipotential Zones Designing a Workable Solution</b> .....	115
<i>Graeme Johnson</i>	

## ASSET MANAGEMENT – PROTECTION

<b>Power System Protection and Large Scale Wind Integration</b> .....	125
<i>Waqar A. Qureshi, Nirmal Nair</i>	
<b>Power System Security Automatic Constraints Implemented</b> .....	143
<i>Peter Monney</i>	
<b>PSC New Zealand</b> .....	153
<i>Johan H. L. Hendriks</i>	

## GENERATION

<b>Wye Creek Power Station Refurbishment Project (1.7MW)</b> .....	166
<i>Peter McClean</i>	
<b>Performing Stator Core Ring Flux Tests on a Large Hydro Generator: The Rangipo Experiences</b> .....	178
<i>Wade Enright, Mathew O'Neill</i>	

<b>Use of IG-541 (Inergen) Gaseous Fire Extinguishing Systems in Hydro Generators in New Zealand</b> .....	188
<i>Gilbert Gordon, Malcolm Preston</i>	

## **ASSET MANAGEMENT**

<b>A Comparison of Different Cable Diagnostic Techniques</b> .....	202
<i>Gary Catlin</i>	
<b>Airborne Laser Scanning for Existing Power Line Upgrade or New Route Design</b> .....	209
<i>Jeremy Neilson, Edward Hardie</i>	
<b>EEA Guide for HV SWER Systems - An Introduction</b> .....	219
<i>Peter M. R. Browne</i>	

## **SMART GRID – TRANSMISSION**

<b>Otahuhu 220 kV C Pass Filter Bank Protection</b> .....	231
<i>Steve Read, Stuart Sim, Rebecca Stevens</i>	
<b>The Intelligent Integration of Wide Scale Renewable Resources – A Review of the Issues</b> .....	241
<i>Alister Gardiner</i>	
<b>Seriously - Series Capacitors to Extend Transmission Capacity</b> .....	252
<i>Stuart Macdonald, Alex Joosten, Kent Yu</i>	

## **ASSET MANAGEMENT – SUBSTATIONS**

<b>Trends and Drivers in Benchmarked Performance of Outdoor Buswork</b> .....	263
<i>Rimjhim Saxena</i>	
<b>Tailor-Made Solutions for Transformer Modernization</b> .....	273
<i>Johannes Gebauer, Werner Fleischmann</i>	
<b>The Evolution of VLF Testing Technologies over the Past Two Decades</b> .....	283
<i>H. T. Putter, F. Petzold, Peter Herpertz, Greg Mac Mahon</i>	

## **SMART GRIDS**

<b>Global and Local Trends of Smart Grid Applications in Distribution Networks</b> .....	288
<i>Thahirah Syed Jalal, Numan Rashid, Alan Wood</i>	
<b>Realising the Holy Grail of Electricity Storage</b> .....	296
<i>Chris Winter, Jamie Silk</i>	
<b>An Integrated Approach Is the Intelligent Way Forward</b> .....	305
<i>Stephen Drew, Michael Jefferson, Fiona Stevens McFadden</i>	

## **ASSET MANAGEMENT – SUBSTATIONS**

<b>Robust Methodology for Estimating After Diversity Maximum Demand for Zonal Substations</b> .....	313
<i>Ferdin Antony, Naveen Joseph, John Welch, Nirmal Nair</i>	
<b>New 220 kV GIS Substation at Otahuhu</b> .....	330
<i>Malcolm Stewart, Jitesh Raniga, Graeme Oakden</i>	
<b>In-Situ Repair and Inspections of a 220/16.5kV 300MVA Transformer: An Asset Owner’s Practical Approach</b> .....	344
<i>Ami Singh, Mat O’Neill</i>	

## **SMART GRIDS**

<b>Visualising MV and LV Distribution Networks</b> .....	354
<i>James Northcote-Green, Jesper Klingsten Nielsen, Martin Speiermann, Adrian Clark, Shannon Frohlich-Terpstra</i>	
<b>The Use of IEC61850-9-2 (Sampled Values) and 61850-8-1 (Goose Messaging) In a Small Rural Substation</b> .....	364
<i>Stephen Hirsch</i>	

<b>LV Underground Cable Network Automation System</b> .....	376
<i>Brendan Normoyle</i>	

## **SAFETY**

<b>lineFIT® - Electrix Distribution Wellness Programme</b> .....	385
<i>Graeme Johnson</i>	
<b>US Chemical Safety Board Investigations of Relevance to the ESI</b> .....	393
<i>Harvey O'Sullivan</i>	
<b>The Fallible Component in the System Is the Human</b> .....	403
<i>Philip Carrivick, Kieran Lee</i>	

## **ASSET MANAGEMENT – TRANSMISSION**

<b>NZ Inter Island HVDC Pole 3 Project Update</b> .....	412
<i>Peter Griffiths, Daniel Crawshaw, Ivan Hunt, Matthew Gnad</i>	
<b>DC Currents in the New Zealand AC Power System</b> .....	423
<i>Michael Dalzell</i>	
<b>Electricity Infrastructure and Supply for Rugby World Cup 2011</b> .....	436
<i>Paul Bagg, Paul Blue, Ross Dixon</i>	

## **CONDITION MONITORING**

<b>Properties of Aging Mineral Insulating Oils in Service</b> .....	452
<i>Per Wiklund, Bruce Pahlavanpour, Lauren Rocher</i>	
<b>Optimising Plant Management by Continuous Condition Monitoring</b> .....	475
<i>Bob Verrall</i>	
<b>Arguments for Condition Based Monitoring of Medium and High Voltage Cables Using International Standards as a Basis</b> .....	484
<i>Gary Catlin, Phil Beaumont</i>	

## **ASSET MANAGEMENT**

<b>LV Monitoring and Management Strategy</b> .....	491
<i>Michael Rushmer</i>	
<b>Volcanic Ash Contamination of High Voltage Insulators</b> .....	492
<i>Alan Wightman</i>	
<b>A Methodology to Develop Sustainable Electricity for Small Rural Communities: Supply System Design for Critical Load Matching</b> .....	509
<i>Muaviyath Mohamed, Miraz Mohamed Fulhu, Susan Krundieck</i>	
<b>Remote Rural Electrification of Bhutan – Problems and Solutions</b> .....	519
<i>Murray Hendrickson</i>	

## **SMART GRIDS**

<b>Delivering Transmission Tomorrow</b> .....	520
<i>John Clarke, Garth Dibly</i>	
<b>The Impact of Climate Change on Future Distribution Planning &amp; Infrastructure</b> .....	521
<i>Leith Elder</i>	
<b>The Smart Grid and Smart Metering: Will They Really Benefit The Consumer?</b> .....	548
<i>Bryan Leyland</i>	
<b>Assessment of Demand Billing</b> .....	557
<i>Michael Newton, Brent Norriss</i>	

## **TRANSMISSION**

<b>Lower North Island Transmission Grid Development .....</b>	<b>567</b>
<i>Simon Todd</i>	
<b>Upper North Island Demand Side Initiatives .....</b>	<b>578</b>
<i>Siobhan Procter</i>	
<b>Commissioning and Operational Experience with Recent Facts Projects in the Upper South Island.....</b>	<b>587</b>
<i>Ivan Hunt, Predrag Milosevic, Peter Cahill, Stuart Macdonald</i>	
<b>Towards a National Frequency Keeping Market.....</b>	<b>596</b>
<i>Chris Callaghan, Mike Collis, Neil Walbran</i>	

## **ENVIRONMENT**

<b>Closing the Metal Loop. A Closer Look at Metal Recycling in Relation to the Electrical Industry within New Zealand.....</b>	<b>605</b>
<i>Paul Coyte</i>	
<b>Designing, Consenting and Building New Infrastructure in Environmentally Sensitive Places .....</b>	<b>608</b>
<i>Neville Goodwin, Colin Boggiss</i>	
<b>The Cost of Creating and Maintaining Resilient, Intelligent and Sustainable Electricity Assets: Budgeting for the Property and RMA Elements of an Electricity Project.....</b>	<b>620</b>
<i>Laurence Sherriff</i>	
<b>Consenting the Wairakei to Whakamaru C Line Under the Resource Management Act to Enable the Transmission of Renewable Electricity .....</b>	<b>630</b>
<i>Gavin Murray, Joel De Boer</i>	

## **GENERATION**

<b>Te Uku Wind Farm – Project Experiences and Cutting Edge Ancillary Services .....</b>	<b>631</b>
<i>Ray W. Brown, Hayden Scott-Dye</i>	
<b>Small Hydro New Zealand Made. Lessons .....</b>	<b>643</b>
<i>Paul Currie</i>	

## **SMART GRIDS – TRANSMISSION**

<b>Voltage Optimisation – A Powerful Distribution Tool .....</b>	<b>644</b>
<i>Grahame Foulger</i>	
<b>Christchurch Reactive Power Controller – Factory Testing.....</b>	<b>646</b>
<i>Simon Bell, Ping Wang, Marc Pelletier, Jin Phoon</i>	

## **SAFETY**

<b>Climbing Using Wire Type Fall-Arrest Systems: Why It’s the Method of the Future .....</b>	<b>658</b>
<i>Wal Marshall</i>	
<b>4 September 2010 and 22 February 2011 Christchurch Earthquakes from a Transmission Infrastructure Perspective: Asset Structural Performance and Lessons Learned.....</b>	<b>667</b>
<i>Craig McGhie, Christophe Tудо-Bornarel</i>	

## **GENERATION**

<b>The Impacts of Generation Mix on New Zealand’s Susceptibility to Dry Year Shortages.....</b>	<b>679</b>
<i>Thahirah Syed Jalal, Pat Bodger</i>	
<b>An Assessment of Base Load Concentrating Solar Thermal Power Generation for New Zealand.....</b>	<b>688</b>
<i>Timothy Anderson, Mike Duke, James Carson</i>	

**POWER QUALITY**

**Development of PQ Guidelines for New Zealand** ..... 697  
*Neville Watson, Stewart Hardie, Vic Gosbell, Sean Elphick, Sarath Perera*

**Power Quality Analysis of Small Scale Distributed Generation Cells in Vector Network – Micro Wind  
Turbine and Solar Photovoltaic Cells** ..... 707  
*Lei Jing, Nirmal Nair*

**ADDITIONAL PAPER**

**Electromagnetic Interference and Harmonic Currents in Rural New Zealand** ..... 729  
*David Robinson*

**Author Index**