Electricity Engineers' Association

Professional Development Programme

Annual Power Engineering Exchange

APEX | 2018

SMARTER SOLUTIONS

AUCKLAND — 17TH AUGUST

AUT - WZ BUILDING, 6 ST PAUL STREET, AUCKLAND

8.30am	**Registration — Arrival Tea & Coffee**
8.55am	**Welcome — Peter McClean, APEX Chair**
9.00am	**Akshay Dogra, *Beca*** — An introduction to Rapid Earth Fault Current Limiters (REFCL) & Ground Fault Neutralisers (GFN)
9.25am	**Bishoy Mikhail, *Alpine Energy*** — Disruptive or non-disruptive
9.50am	**Vineeth Isidore, *Delta*** — Lighter, Faster, Stronger - Steel, the future
10.15am	**Henna Chua, *Meridian Energy*** — Aviemore Local Service Upgrade
10.40am	**Morning Tea**
11.00am	**Tiantian Xiao, *Beca*** — Smart control and protection scheme solutions to improve security of supply in Hawke's Bay
11.25am	**Luke Reisima, *Meridian Energy*** — Don't be reluctant, build redundant
11.50am	**Maria Fernando, *Mitton ElectroNet*** — Keep the Lights on - the Argument for Mobile Substations
12.15pm	**Harriet Miller-Brown, *Meridian Energy*** — A paradoxically dry chat on water pumping systems
12.40pm	**Lunch**
1.15pm	**Joshua Rich, *Mitton ElectroNet*** — CDEGS Model Matching
1.40pm	**Jesse Stuart, *Transpower*** — Smart tool development for power system operations
2.05pm	**Patrick Coombe, *Mitton ElectroNet*** — Smart tools for efficient earthing studies
2.30pm	**Robert Sawrey, *Beca*** — Smarter Ways of Designing High Voltage Substations
2.55pm	**Afternoon Tea**
3.20pm	**Panel Discussion** Session facilitator: **Terrence Ibasco, *Beca*** ***'Is there an app for that?'*** Panellists: **Cameron Chapman, *WEL Networks*** **Rebecca Marx, *Mitton ElectroNet*** **Moonis Vegdani, *Vector***
4.20pm	**Presentations — Joint EEA/CIGRE Best APEX Presentation Award and People's Choice Award** **Closing Comments — Peter McClean, APEX Chair**
4.40pm	**Social Function**
6.00pm	**Close of APEX 2018 Summit**

Engineering Excellence—Electricity Engineers' Association | EEA

AUT UNIVERSITY

cigré

HAMER POWER ENGINEERING

Mitton ElectroNet

meridian

ABOUT THE PRESENTERS

8.30am **Registration, Arrival Tea & Coffee**

8.55am **Welcome from Peter McClean, APEX Chair**

9.00am **Akshay Dogra, *Beca***

Akshay Dogra completed his Bachelors degree in Electrical and Electronic Engineering at Auckland University of Technology in 2016. He has been working as a Power Systems Engineer at Beca undertaking a range of projects in Distribution & Transmission sectors and has gained experience in Primary, Secondary, Protection and Earthing design for clients such as Watercare, Vector, First Gas, Auckland Airport & AusNet Services.

An introduction to Rapid Earth Fault Current Limiters (REFCL) & Ground Fault Neutralisers (GFN)

Following the February 2009 Black Saturday bushfires in Victoria, it was evident that implementation of improved earth fault protection systems would reduce the risk of such events. This incident became a catalyst for the installation of REFCL units across distribution substations in Victoria. A REFCL is a type of electrical protection system that responds to earth faults. A well-designed system should significantly reduce the probability of bush fire occurrence.

A GFN is one type of REFCL suitable for such an application. In such a scenario, the GFN detects and neutralizes the earth fault current on the phase within milliseconds, thus reducing the possibility of a fire starting. During a fault the GFN control system maintains low-energy at the fault site by displacing the neutral voltage. As a consequence, phase to ground voltages on the healthy phases are elevated.

Awareness of constant power flow is the first step in ensuring the reliability of the Power System. This can be achieved by implementation of REFCL thus improving the reliability from the operation of the devices and the presence of a stronger network leading to a safer environment.

9.25am **Bishoy Mikhail, *Alpine Energy***

Bishoy Mikhail graduated from the University of Canterbury in 2013 with a Bachelor of Electrical Engineering (Hons). He then worked as a Project Engineer at Infratec specialising in network and power quality analysis, and assisting with renewable energy projects. During that time he project managed and delivered the first Battery Energy Storage System (BESS) installation in the South Island for Alpine Energy.

In his current role as a Planning Engineer at Alpine, he is responsible for four regions' strategic network planning, demand forecasting and providing strategies for new connections. He developed the planning team's network development plan framework with tools for forecasting, feeder loading and multiple interlinked databases for data management.

Disruptive or non-disruptive

What if every house in New Zealand installed PV, EV and replaced all their lighting with LED lights? What would our network look like? How would our load profiles behave? How would our business operate?

All these questions, and more, are facing the electricity industry from generation up to retailing; all are wondering when we will feel the full effects of these emerging technologies. Will the New Zealand electricity industry have the same fate as the American communication industry were in 2003, 95% of households had a landline telephone; today, less than half do, and that number is expected to approach zero by 2025. These uncertainties are causing all these new technologies and innovations to be branded as "Disruptive" technologies… but are they?

Based on early studies worldwide it is starting to be evident that "Disruptive" technologies are actually less disruptive through smart solutions. It shows that meeting innovative technologies with innovative solutions can help the energy industry cope with the ever-changing technological trends. In this presentation we will explore some of these solutions; from grid sized BESS and voltage regulating distribution transformers to smart cost benefit incentives and understanding consumers' behaviours and motivations.

9.50am **Vineeth Isidore, *Delta***

Vineeth Isidore (Age 27) completed his Bachelor of Engineering majoring in Electrical and Electronics at MG University, Kerala, India in 2013 and holds a Post Graduate Diploma in Electrical Engineering from the Auckland University of Technology, Auckland. He has been living in New Zealand for the last two years. He currently works as a Distribution Designer for Delta Utility Services Ltd. in Central Otago. He specialises in design and estimation of both overhead and underground distribution networks.

Lighter, Faster, Stronger - Steel, the future

Electricity transmission providers across New Zealand are undergoing dramatic changes in many aspects of their business, one of them being the use of different types of poles. Utility companies in New Zealand have been relying on wooden and concrete poles since distribution began. Even though steel poles are readily available in the market, there is an inclination in the distribution industry to use wooden and concrete poles.

Apart from being strong and reliable, steel poles offer certain environmental advantages over the wood and concrete poles. Steel is non-combustible, non-toxic and 100 percent recyclable. Steel poles have a high strength rating and are easy to install which makes it suitable for installation in difficult locations. Their lightweight enables transportation of the pole to any location using a helicopter. When utility poles need to be replaced or a new distribution line set up, along with cost and reliability, we should also consider the impact of the material on the environment.

In this presentation, I would like to talk about steel poles; its advantages, disadvantages, environmental impact, how steel poles have a comparative cost advantage in construction where the cost reduction be able to be passed down to end consumer through lower operational fees.

10.15am **Henna Chua, *Meridian Energy***

Henna Chua graduated in April 2017 from University of Canterbury with BE(Hons) in Electrical and Electronics Engineering and started working in Meridian Energy in February 2017. She was based in Twizel for a year in the Tactical Engineering team and is now based in Christchurch, working in the Engineering Strategy Team. She is involved in several projects at Manapouri, Benmore Power Station and Aviemore Power Station. She has a passion towards renewable energies and has written a paper which was presented at EEA Conference 2017 in Wellington, titled “Transitioning New Zealand to Renewable Energy”.

Aviemore Local Service Upgrade

It is time to upgrade and replace the extensive 400V local service system in Aviemore, the equipment are all original and installed when the power station was built in 1968. The 400V local service system includes the switchboards, distribution boards, cables, protection system, etc. The objective of this project is upgrading the Aviemore local service supply system to the latest standards to provide a safe, reliable, efficient and compliant local service network. It is crucial to address safety risks associated with arc flash by providing new switchboards with enclosed bus work, arc flash protection relays and remote operation for all main circuit breakers. Besides, operational costs can be reduced by more efficient use of local service supplies and we would also like to reinforce the station’s black-start capability. Two key innovative ideas incorporated are arc flash protection on the 400V switchboard and Hot Parallel Transfer system. The arc flash protection design involves installing the circuit breaker at the unit auxiliary transformers rather than the main switchboard. The ‘Hot Parallel Transfer’ is a technique we use to allow switching between two systems. The presentation is going to cover the new designs and techniques involved and challenges to overcome in the project.

10.40am **Morning Tea**

11.00am **Tiantian Xiao, *Beca***

Tiantian Xiao has had two years' experience in electrical engineering in the New Zealand power industry prior to completing her engineering degree. She has completed a major research project on thermal issues of underground distribution pillar with Hamer Limited, which was presented at the EEA APEX Conference in 2016. As the Meridian student intern during 2015-2016, Tiantian worked on a wide range of generation asset management projects. Tiantian is now a Power System Engineer at Beca. Recent work includes Redclyffe SMS upgrade, Redclyffe Transformer Overload Protection Scheme design and Kinleith redevelopment. Tiantian is also a 2016 EEA scholar.

Smart control and protection scheme solutions to improve security of supply in Hawke's Bay

Following a number of black-out events relating to 220 kV supply to the Hawke's Bay and the constraints of existing Redclyffe interconnector transformers reticulating power around the Hawke's Bay region, Beca was engaged by Transpower to design a number of control and protection schemes to improve the security of supply to this region.

The smart solutions include upgrading of Single Pole Auto-Reclose on 220 kV Redclyffe-Wairakei (RDF-WRK) and Whirinaki-Wairakei (WHI-WRK) circuits, and implementing Transformer Overload Protection Scheme (TOPS) on Redclyffe 220/110 kV interconnector transformers T3 and T4.

220 kV circuit Single Pole Auto-Reclose was initially implemented in previous upgrades. However due to the limits of technology of the time, reliability during extreme weather events remained a problem. To improve reliability of supply to the Hawke's Bay, line protection was upgraded with improved Auto-Reclosing functionality with the aim of improving the situation.

Redclyffe T3 and T4 interconnector transformers, interconnect the grid to the 110 kV Hawke's Bay regional network. These transformers suffer from a risk of overloading should an unplanned outage occur on the other transformer. To mitigate this risk an overload protection scheme, TOPS has been designed to facilitate automatic load management of the transformers during contingency transformer events.

This paper outlines the smart solutions designed by Beca to remedy these power supply issues.

11.25am **Luke Reisima, *Meridian Energy***

Luke Reisima graduated from the University of Canterbury in 2018 after studying electrical engineering. He is now part of the graduate programme with Meridian Energy working out of Twizel with their tactical engineering team. Interesting projects he's working on include project management for earth grid inspections of all Meridian generation sites, 3D scanning of 220kV switchyards and station transformer platforms and the installation of enough battery banks to prop up South Australia.

Don't be reluctant, build redundant

Smarter solutions are ubiquitous, every man and his dog will attempt to sell you the new smarter way to solve your life's problems. However, for lifeline infrastructure, smarter solutions often mean risking the unknown. For a generator such as Meridian, paying the early adopter tax doesn't mean dealing with a phone that powers off randomly, it means powering off the South Island, and putting the North into load shedding. For us, that means smart solutions are given time to mature by a relentless drive towards redundancy. If our systems can be backed up it means investors have more certainty, traders have less to hedge; more to contract, and most importantly engineers aren't perpetually on call for failures. For that reason, I would propose a smarter solution isn't the 21st century concept of digitising anything and everything, it's building a system that may afford you the luxury of time. While a single smart solution may cost less than a full back up, a single point of failure is necessarily a single point of fear. A well-designed redundant system should give both time to act, and reduce expose to a common failure point; a true smart solution.

11.50am **Maria Fernando, *Mitton ElectroNet***

Maria Fernando is an Assistant Engineer within the Distribution Team at Mitton ElectroNet. Maria has three years' experience in the power industry and has been involved in a diverse range of projects. After completion of her engineering degree at the University of Canterbury in 2014, she initially worked for EA Networks managing technical projects, developing SCADA systems, protection relays and managing assets. She also has a valuable field work experience from working with technicians in the field and supporting control staff after-hours. Maria is currently gaining experience managing small to medium sized substation design projects and assisting senior members of the distribution team with primary and secondary substation design. Most recently, Maria has been working on several distribution projects on substation expansions, GFN installations and safe work processes.

Keep the Lights on - the Argument for Mobile Substations

The mobile substation has recently come to the forefront of modern asset management. Its primary use is to prevent long power outages when activities such as maintenance and protection upgrades take place. It can also act as a spare transformer when power outages occur due to faults or damage in substations. The mobile substation is suitable for smaller substations in rural areas as it handles up to 20 MW of load; equivalent to about 5,000 households. The use of the Mobile Substation can prevent undesirable SAIDI minutes and act as a viable alternative to localized diesel generation or limited backfeeding. This presentation will discuss the technical and operational considerations and weight the Mobile Substation against other options.

12.15pm **Harriet Miller-Brown, *Meridian Energy***

Harriet Miller-Brown completed her BE (Hons) in Mechanical Engineering at the University of Canterbury in 2017. This year she started her graduate programme at Meridian Energy based in Twizel as a member of the Tactical Engineering Team. Harriet is involved in projects across all of Meridian's hydro assets in the Mid Waitaki, Upper Waitaki and Manapouri sites.

A paradoxically dry chat on water pumping systems

Within our hydro power stations we have many systems in place for the protection of the stations. Most systems involve redundancy, testing and maintenance.

For some systems, such as the drainage pumps, testing cannot be carried out in its current state. For a system that is infrequently used, this means the condition of the components becomes unknown. By adding testing facilities to existing pumps, system functionality can be guaranteed when called upon. It also allows appropriate maintenance to be carried out as required.

Meridians drainage pumps were installed during the construction of the stations, and act as a back up to the oil interceptor system. The interceptors separate the oil and water for disposal. The drainage pumps take the water from the sump and discharge it into the tailrace. The use of the drainage pumps is an emergency response as water is untreated.

The installation of recirculation pipework around the drainage pumps allows the pumps to be tested and run at a load comparable to the operating conditions, which ensures their operations in the event we need them. Meridian currently has 6 drainage pumps with unknown condition which puts stations at risk. There are ongoing projects to remedy this.

12.40pm **Lunch**

1.15pm **Joshua Rich, *Mitton ElectroNet***

Joshua Rich graduated from Canterbury University with First Class Honors in Electrical Engineering in 2016. Joshua is currently working as a consultant with Mitton ElectroNet, providing technical expertise in the field of Earthing, Lightning Protection & EMF. Joshua enjoys all things outdoors, including but not limited to snowboarding and surfing. Joshua also enjoys thoughtful discussions involving politics and religion.

CDEGS Model Matching

Testing is the gold standard in all areas of engineering. However, testing is not always possible, particularly during the design stage of a new greenfield site, or an extension at a brownfield site. Therefore, modelling is often required, including for the site earthing. We all know that the accuracy of a model is dependent on the inputs, which can sometimes be vague, uncertain or downright questionable. Consequently, how do we know if the model is simulating what would happen in real life? This presentation will discuss the importance of earthing, and investigates how test data, where available, can be used to prove (or improve) the accuracy of the model. This then gives confidence in the modelling of any future installations, upgrades or changes to the earthing system. This presentation will investigate case studies where model matching in CDEGS has been used to prove the accuracy of the earthing system model.

1.40pm **Jesse Stuart, *Transpower***

Jesse Stuart is a Power Systems Engineer at Transpower Operations, where he carries out power system analysis, software development and event investigations.

Jesse completed his degree in Electrical and Computer Engineering at the University of Canterbury and completed internships with Trustpower and Mercury before joining the Transpower Graduate Program in 2017. His work has included assessing power station electrical systems, project management and electricity market analysis.

Smart tool development for power system operations

As the Transpower Operations Power Systems Group, we carry out power system analysis, software development and event investigations, ensuring the secure, reliable and economical operation of the New Zealand power system.

To assist Transpower's power system operations and planning, we run simulations with detailed computer models, representing various power system components. Our decision making relies heavily on collaboration with asset owners, ensuring our models are updated with the latest test data to help us track the power grid's capabilities.

Our team of power systems engineers are computer analysis experts. We use our engineering and programming skills to determine the grid impact from system failures and from new technologies such as wind generation, solar PV, battery storage and electric vehicles. We also use these skills to develop smart software, improving our ability to analyse historical data and give Transpower better insights into the future.

Recent software developments include an adaptive optimisation tool that fine tunes generator governor models and a tool that analyses the accuracy of load and wind generation forecasts at the press of a button. Work is now underway to incorporate machine learning and AI into Transpower's operations to ensure we continue to deliver smarter solutions into the future.

2.05pm **Patrick Coombe, *Mitton ElectroNet***

Patrick Coombe has two years' experience in the power systems industry. Patrick's core work lies in the earthing space, including the modelling, design and testing of earthing systems, by analysing the performance of the earthing system under various fault conditions. He has also undertaken numerous projects for the wider team, often involving power system modelling, arc flash studies and basic protection design. Patrick is also involved in project management, including the routine earth testing programme for one of our largest clients.

Smart tools for efficient earthing studies

On site earth testing is a core component of Mitton ElectroNet's business. Historically the test team would record results using pen and paper, take photos on a camera and make GPS measurements using a separate device. On return to the office, these measurements would be manually organised. This process could be quite onerous and easily lead to errors. In an effort to develop smarter solutions and improve efficiencies, we have developed dedicated tools to facilitate the collection and processing of data. Firstly, a dedicated smartphone app which is used for record measurements. This provides easily correlation of data and allows for analysis on the fly, leading to a better understanding of the site conditions and allowing a more accurate and efficient test. Secondly, a set of processing scripts which work directly with the output of the app. These produce a set of appropriately scaled data in seconds, which the engineer can begin working with immediately. Both these allow us to spend more time on engineering aspects, removing the need for repetitive tasks and ultimately leading to a better product for our customers.

2.30pm **Robert Sawrey, *Beca***

Robert Sawrey studied Biomedical Science and Electrical Engineering at The University of Auckland, graduating in 2017.
He works as a Power Systems Engineer in Beca's Wellington Power team. He has worked on a variety of substation and rail improvement projects across New Zealand and Australia.

Smarter Ways of Designing High Voltage Substations

Parametric 3D design not only reduces design effort, but also increases design visibility for all stakeholders throughout the project lifecycle. Beca provides ongoing design support to many power system asset owners, some of which are completed over multiple stages. One particular substation was designed in two entirely separate stages with a 3D model of a section of the switchyard which proved very useful for demonstrating the complexities of the project as a 2-stage brownfield design.

The use of 3D design in Stage 1 two years ago has allowed us to rapidly reconfigure parts of our design. The parametric and modular approach to the past design has yielded tremendous efficiencies. Detailed new equipment arrangements were simple to create and clearly demonstrated relevant ideas to the client early in the design process.

Refurbishment in other parts of the site has relied a lot on existing drawings. These can be inaccurate or incomplete, so the availability of a 3D point cloud survey and 2D feature survey was critical. Adhering to a unified CAD process across disciplines and combining many survey and design files in a 3D design review software product allowed the design team to produce a robust design.

The availability of all of these digital resources, the ubiquity of high definition conference calling and screen sharing capabilities enabled the international project team to share insights and implement feedback swiftly.

2.55pm **Afternoon Tea — Cast your vote for the Best Presentation - People's Choice Award**

3.20pm **Panel Discussion — *'Is there an app for that?'***

Panellists: **Cameron Chapman, *WEL Networks*** **Rebecca Marx, *Mitton ElectroNet***
Moonis Vegdani, *Vector*

Panel facilitator: **Terrence Ibasco, *Beca***

Overview: The panel will discuss the new technology transition in the power industry: what technology could make our work easier and better, and how? It is also an opportunity to reflect on the millennial app generation and how the young engineers in the audience could drive change in the future of work.

4.20pm **Awards Results — Joint EEA / CIGRE Best APEX Presentation Award and People's Choice Award**

4.40pm **Social Function**

6.00pm **Close of APEX 2018**

The EEA would like to formally acknowledge and thank our sponsors for their support:

Venue and organisational support ***Presentation Prize Co-Sponsor***

Summit Sponsors