

Integrating Research into Practice (In conjunction with NZ Lifelines Utilities Forum)

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RNC-QuakeCoRE FUNDED PROJECTS (2016-19)

Focus of these 2 resilience projects are downstream the CORE-GRID maintained by Transpower

Electricity Distribution/Communication Resilience Framework through West Coast Alpine Fault Scenario (RNC: 2017-19)

Nirmal Nair (PI), Andrew Austin (AI), Farrukh Latif (ME, Chorus), Samad Shirzadi (PhD), Duncan Maina (PhD), Yang Liu (Postdoc), Daniel Blake (Postdoc), Liam Wotherspoon (RNC DI, Lead)

Performance of Underground Electricity Cables during the 2010-2011 Canterbury Earthquake Sequence: Insights for assessing Criticality and Resilience (QuakeCoRE)

Nirmal Nair (PI), Ebad Rehman (PhD), Matthew Hughes (UC), Peter Elliott (Orion), Liam Wotherspoon (RNC DI, Lead)

Co-aligned University of Auckland Supported Research Project (2017-19)

Focus on inter-dependencies of distributed infrastructure networks

- Preliminary investigations highlighted connectivity based vulnerabilities at a national scale
- Characterisation and representation of networks at a more detailed level of complexity to make investment decisions.
- Incorporate electricity power flow and water distribution system hydraulics

International Collaboration with Oxford Infrastructure Group: Increasing our research “mana”

Resilience of Infrastructure Networks following Natural Hazard Events: Novel System of Systems Framework

Liam Wotherspoon (PI), Nirmal Nair (AI), Asaad Shaamseldin (AI), Anthony Downward (AI), Conrad Zorn (Collaborator), Yang Liu (Postdoc)

Electrical Power System Resilience

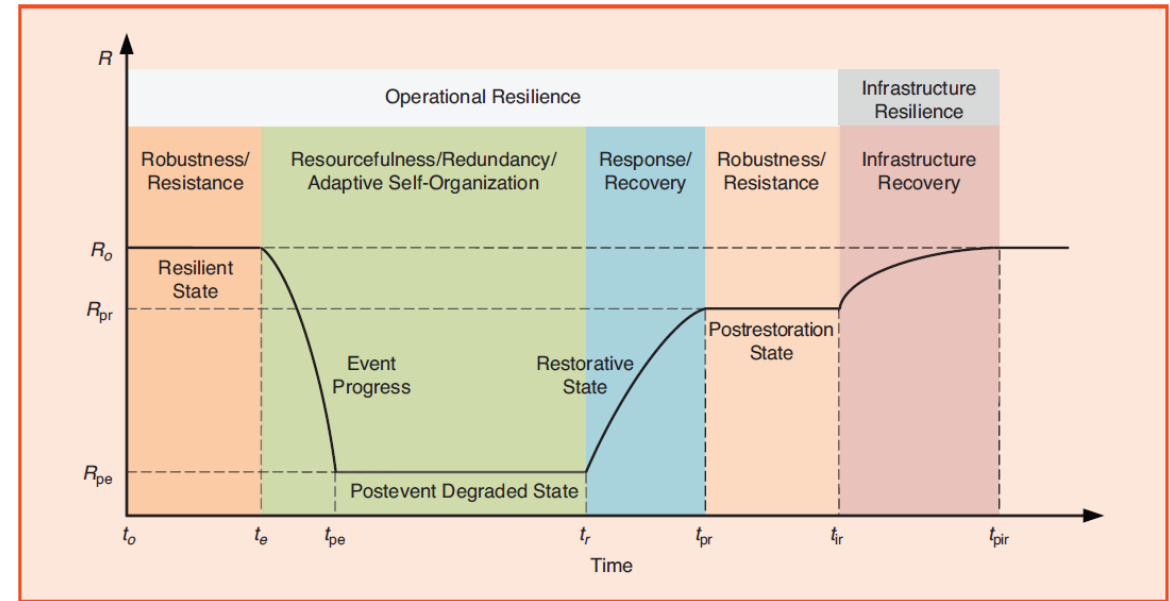
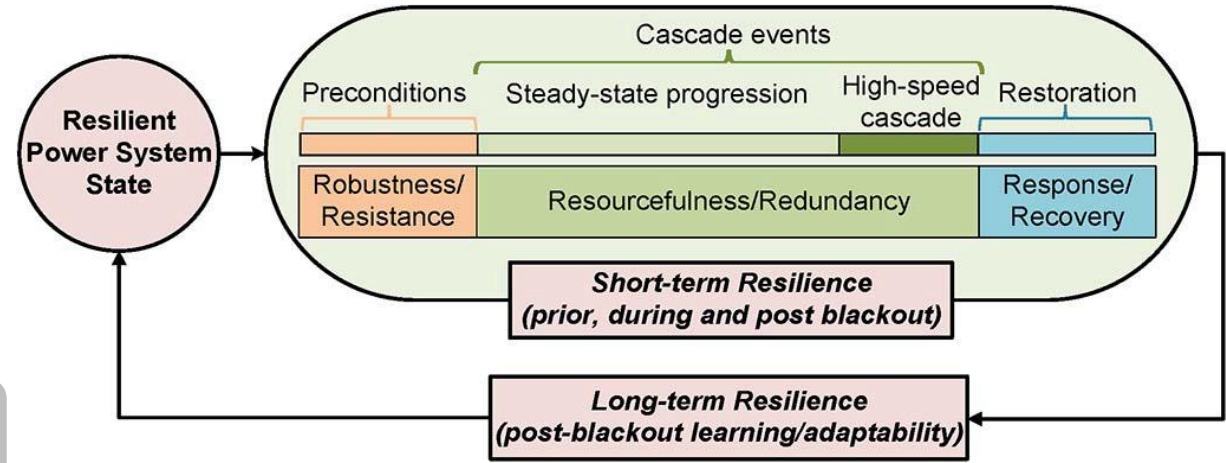
Terminologies, Metrics, Practice Notes

High Impact Low Probabilities (HILP)

Aligned with existing RELIABILITY metrics

- 4 R's according to CDEM:

Reduction	<ul style="list-style-type: none"> Identification and mitigation of asset vulnerabilities to disasters
Readiness	<ul style="list-style-type: none"> Assessment of adaptive capacity and specific contingency planning
Response	<ul style="list-style-type: none"> Immediate loss of quality of service-immediate actions and stakeholder
Recovery	<ul style="list-style-type: none"> Long term restoration of service levels



Deliverables from the projects (2017-19)

Power system resilience is new, interdisciplinary and hazard sensitive

RNC Westpower distribution network for operational resilience “Micro-grid”

Help develop the electricity distribution led “Resilience Taxonomy” for enabling Commerce Commission needs

Formulation of resilience in power system analysis:

- Geo-spatial mapping of the network and spatial-temporal mapping of hazard
- Fragility analysis from component level up to system level

Developing Resilience metrics and framework

Introducing a different type of power system analysis

Network operation in islanded mode

New operation schemes

- Adaptation of new
- Protection and control
- techniques in the network

Another closely related infrastructures is communication

Ongoing Westcoast project

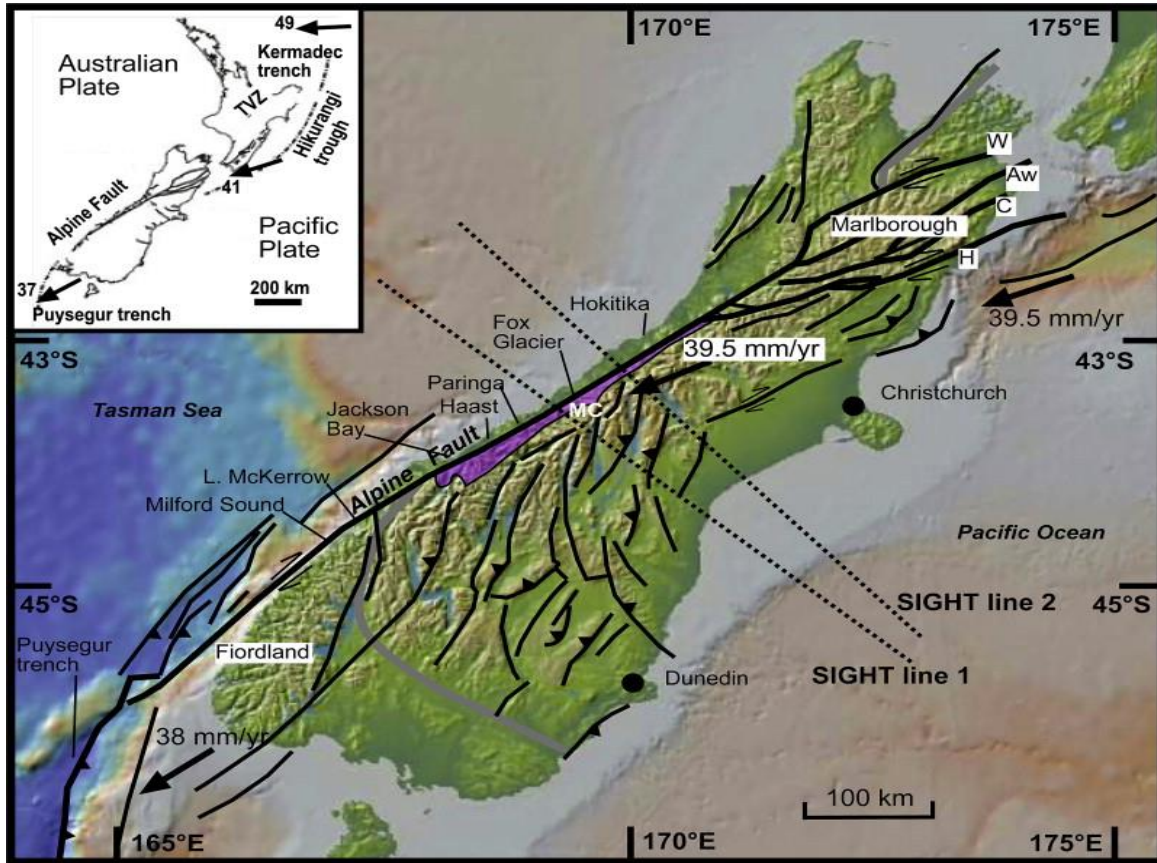
Working with 29 NZ Distribution Utilities with varying asset base & criticality

Aiming for robustness

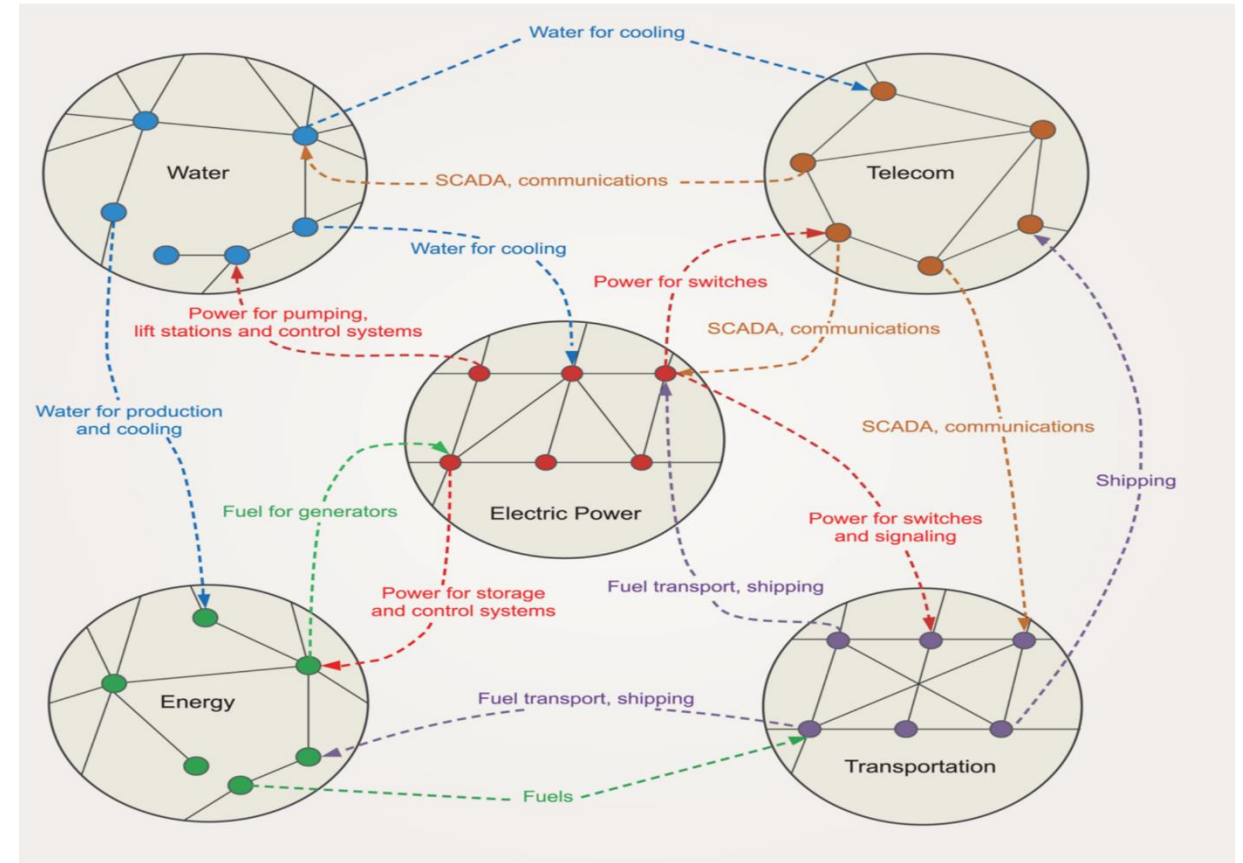
- providing guidelines for NZ-wide electricity infrastructure resilience

Project Milestones

Analysis of possible hazard trajectories should be mapped on the Network. **(complete)**

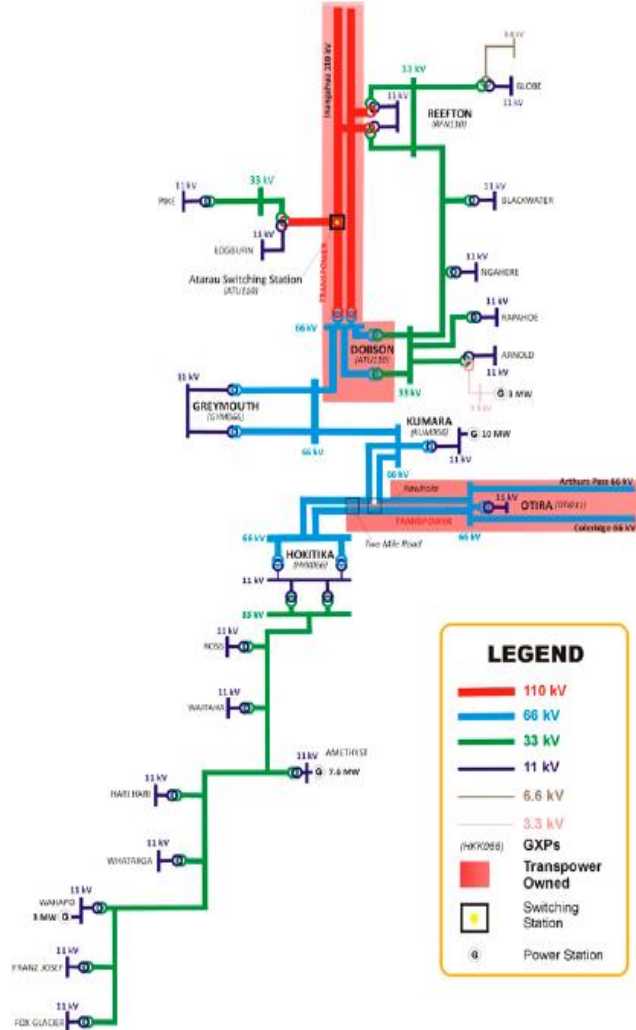


Power-Communication Interdependency assessment **(Midway)**

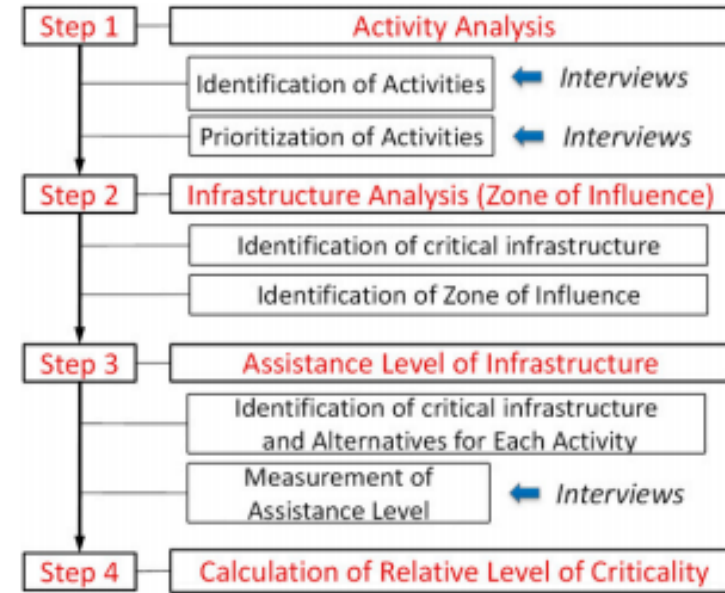


Project Milestones

Microgrid Assessment and lab testing using industry grade equipment (midway)



Criticality Framework Development



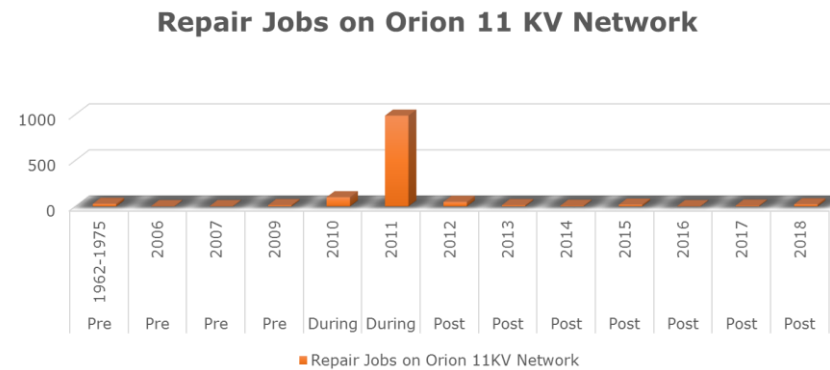
C1	Low Criticality	0% to 75% of Avg
C2	Average Criticality	75% to 125% of Avg
C3	High Criticality	125% to 200% of Avg
C4	Very High Criticality	>200% of Avg

Assessing underground cable seismic Resilience

Study involves 11KV underground cables distributed through a wide region of Canterbury.

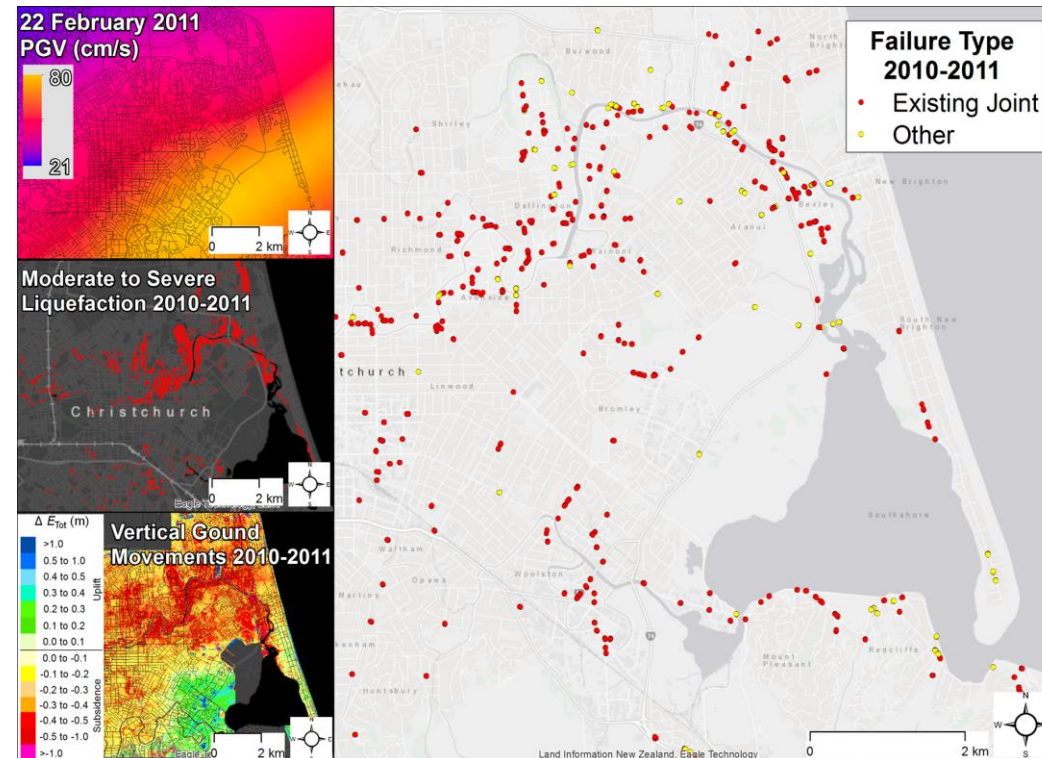
Impact of earthquake on underground cables:

- Bending
- Stretching
- Insulation Damage
- Joint Breaks
- Connections pulled-off equipment



Expected Outcome

- Digitalizing the 11KV network on geospatial map
- Assessing the fault types and fault locations
- Plot fragility curves
- Highlight the critical assets
- Determine the resilience of the network
- Identify which assets needs strengthening



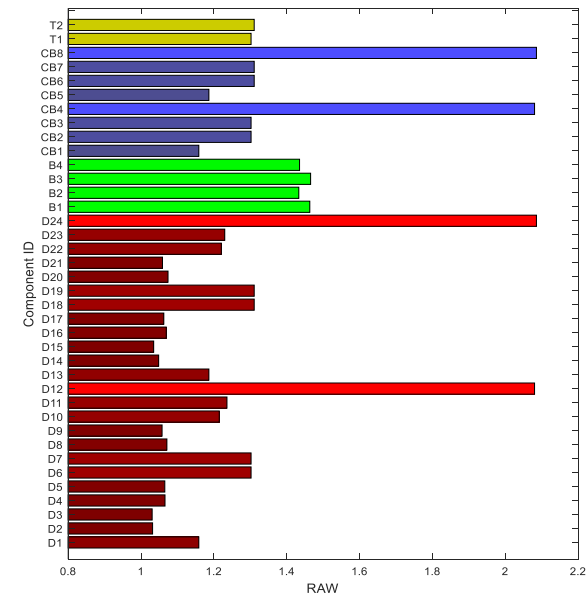
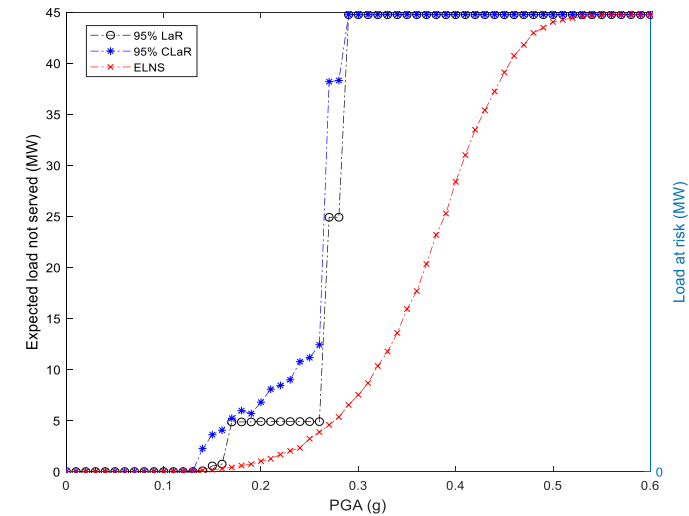
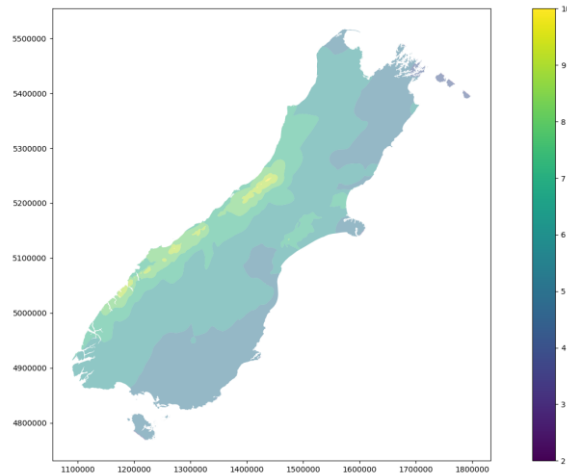
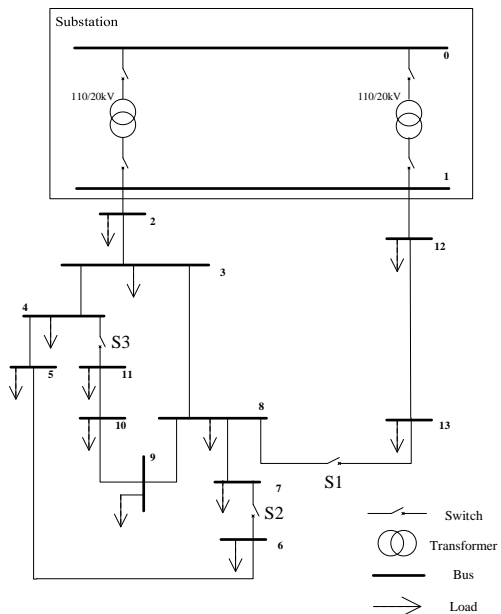
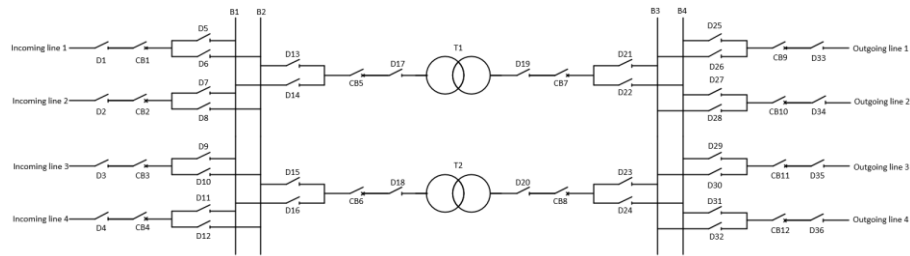
Distribution system seismic resilience characterization toolbox

Takes into account

- substation configurations
- Network characteristics
- Seismic hazard mapping

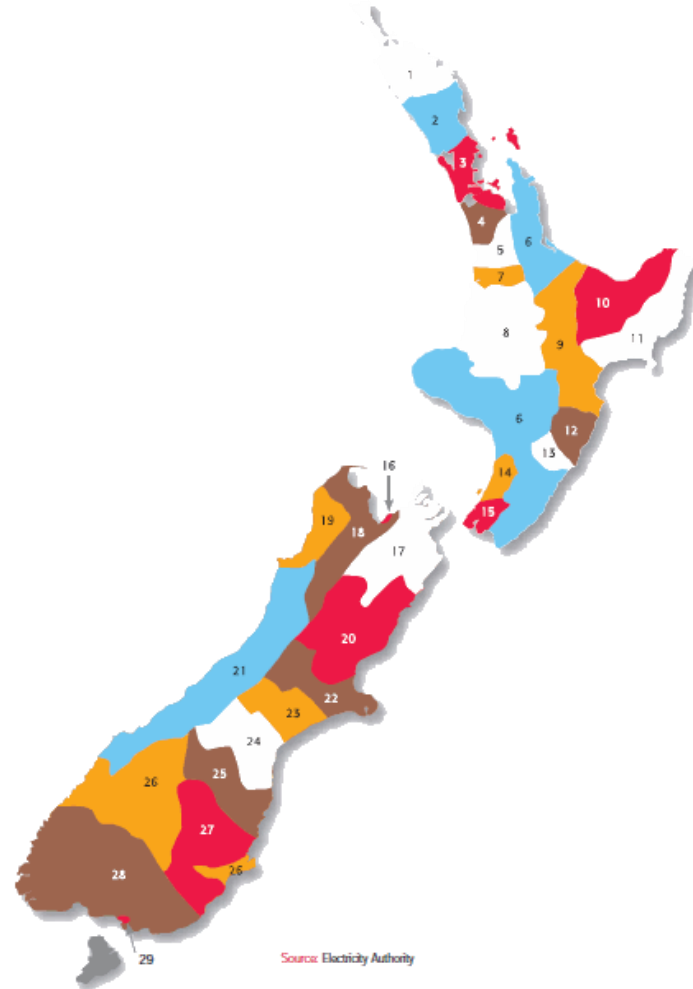
Perform

- System seismic risk evaluation
- Component criticality characterization



Integrating Research into Practice

- Development of a standardised 'Infrastructure resilience rating' metric applicable to all distribution networks.



1. Top Energy
2. Northpower
3. Vector
4. Counties Power
5. WEL Networks
6. Powerco
7. Waipa Networks
8. The Lines Company
9. Unison Networks
10. Horizon Energy Distribution
11. Eastland Network
12. Centralines
13. Scanpower
14. Electra
15. Wellington Electricity
16. Nelson Electricity
17. Marlborough Lines
18. Network Tasman
19. Buller Electricity
20. Mainpower New Zealand
21. Westpower
22. Orion New Zealand
23. Electricity Ashburton
24. Alpine Energy
25. Network Waitaki
26. Aurora Energy
27. OtagoNet Joint Venture
28. The Power Company
29. Electricity Invercargill

NZ EDB Resilience Metrics Development Workshop alongside AUPEC 2018



Thursday, 29th November 2018

7:00 - 8:30	Breakfast with CEOs* Organised by CIGRE NZ	
8:30 - 10:00	CIGRE NZ Panel Session	
10:00 - 10:30	Morning Tea Break	
10:30 - 12:30	Resilience Heat Talks	
12:30 - 14:00	Lunch Break	
14:00 - 15:30	Resilience Panel Session	
15:30 - 16:00	Afternoon Tea Break	

<https://aupec2018.org.nz/>
27-30 November, 2018

Registration: @ \$290 (TBD)

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