Project Report

Investigation into the Potential Shortfall of Skilled and Experienced Test and Power Technicians across the Generation Industry

ENMG 680: Report

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For

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Abstract

The New Zealand Generation Industry is concerned there is going to be a potential shortage of Power Technicians whose skills are critical to the functioning of generation assets.

The systemic nature of the situation is recognised in the development of a framework that is used as both a diagnostic of the current situation and as a platform for future management. The framework is a synthesis of the Perpetual Inventory Model, Total Quality Management, Manpower Planning best practice and Capability Maturity Assessment, with the associated governance considerations being further addressed through the Viable Systems Model and the responsibility alignment tool RASCI.

The demographics of the current working population of Power Technicians were identified through the use of surveys and interviews. The results showed that there is an ageing cohort of Power Technicians in the South Island, especially within the Hydro-specific Power Technician resource pool. Recommendations have been made from both a short-term response to the current situation, as well as a long-term strategic response to ensure that management systems and business processes are in place to achieve the necessary and sustainable levels of Power Technicians across the industry.

Acknowledgements

I would like to acknowledge the following people and organisations for assisting me with the development and completion of this project:

- Paul Churton – Industry Supervisor: Paul has gone above and beyond to aid me in the process of completing this project, without his guidance in regards to the specifics of the industry this would not have been possible
- Richard Griffiths – Industry Sponsor lead
- The staff of Meridian Energy Ltd
- The EEA: The Electrical Engineers' Association has taken a form of responsibility in ensuring this topic continues to be brought up within the industry
- Staylive' Group Sponsors – Provided support for the action of this project:
  - Contact Energy Ltd
  - Mercury Energy Ltd
  - Genesis Energy Ltd
  - Pioneer Energy Ltd
- Contracting Providers – Contracting providers have made this project possible by providing me access to Power Technicians and their corresponding demographics:
  - UGL Ltd
  - Broad Spectrum Ltd
  - Think Delta Utilities Ltd
  - ABB Ltd
  - PBA Ltd
  - Powernet Ltd
  - Electrix Ltd
  - Machine Monitor Ltd
  - MB Century Ltd

Executive Summary

1.1 Purpose

This research project has been prepared for a collective of industry representatives, with the purpose to identify if there is going to be a shortage of skilled and experienced Test and Power Technicians across the generation industry. The objectives involved in this project were:

- Identify the demographics of the current working population to outline if there is going to be a shortfall of Power Technicians.
- Understand the drivers to people both entering and exiting the industry.
- Provide a cost benefit analysis on the possible options that could change the inputs and outputs to the inventory of Power Technicians.
- Provide a future thinking toolkit to aid with resource planning in the future.

The problem is systemic in nature and a systems perspective is therefore required. To this end, a framework is developed that is anchored in the systems closure identity, namely the stocks and flows relationship of the perpetual inventory model.

The five key flows and their drivers are articulated using the Ishikawa (fishbone) model. This then is folded into a total quality management framework so that one can be obvious around the enabling policies and processes that will be required to deliver the desired outcomes. This leads to the use of capability maturity assessment benchmarking in regards to current performance, which shapes the agenda for lifting performance towards best practice in the future. Alignment, governance and information flow aspects are considered using the Viable Systems Model and the use of RASCI responsibility mapping (appendix 11.1.9).

1.2 Key Outcomes

<u>There is an Ageing Demographic</u>

Survey and interview results showed that the following percentage of Power Technicians were over the age of 50, in each given type of generation:

Generation Type (Location Specific)	Percentage of Workforce Over 50
Hydro – South Island	50%
Hydro – North Island	25%
Wind – South Island	39%
Wind – North Island	28%
Thermal – North Island	15%

As shown in the table depicted, the key area of immediate risk is within the Hydro Power Technician resource pool, however Wind-specific Power Technicians in the South Island also contains a high percentage of individuals over 50. This would show that the problem is South Island specific.

<u>Drivers to the Industry</u>

The drivers to Power Technicians either entering or exiting the resource pool were identified as being the 5Rs: Retention, Retraining, Recruitment, Retirement and Resignations. In all cases these are influenced to varying degrees by the connection between the broad set of incentives facing individuals and information on possibilities and current capabilities. These in turn are shaped by organisational policies, processes and procedures.

Investing in Skills - Business Model Implications
Prior to the deregulation of the electricity sector, Power Technicians in New Zealand were all trained under the Ministry of Energy, which provided transparency in the quality and quantity of Power Technicians entering the resource pool. Following deregulation, a competitive market place was created for both electricity generation companies and engineering contracting providers. Since deregulation there has been significant use of contractors, who have very little incentive to invest in the upskilling of their staff because of the uncertainty of future work and the strong profit motive. With tight margins and ongoing uncertainty around contract renewals, they do not have sufficient certainty around the time horizons necessary to realise the required benefits that offset the upfront investment.

Benchmarking
Currently the risk of a shortfall is not being adequately addressed within organisations and the impending shortage of Power Technicians is only expected to become more apparent. Best practice manpower planning and capability maturity assessment showed that there is significant room for improvement.

1.3 Recommendations

Generation Companies Need to Hire or Train Power Technicians in Order to Lower the Likelihood of a Potential Shortfall
Hydro Power Technicians in the South Island are ageing as a population and it is advised that generation companies hire younger Power Technicians in order to provide timely continuity and allow for inter-generational knowledge transfer. This needs to occur before the large cohort of older Power Technicians leave the industry, to provide lead time for training of new technicians. Or alternatively, provide the resourcing for the training of these individuals if hiring is not a practical option.

Action
Provide the resourcing necessary to hire and train young Power Technicians. Target those who are suitable for progression to the Power Technicians course, from the current trade apprentice programme.

Risk
If this recommendation is not actioned there is the risk that there will not be enough time to train new Power Technicians to the required standard before the ageing cohort of experienced Power Technicians leave the industry.

Design and Implement a Management Information System for Power Technicians – Long Term Solution
A Management Information System for Power Technicians needs to be implemented by the EEA Asset Management Group. The information that is required to be collected needs to be mandatory from all industry stakeholders who hire Power Technicians. This will provide a real time view of the situation and allow for the framing of strategic responses to the issue.

Action
The EEA Asset Management group is to be given the designated authority and responsibility to implement and maintain the necessary data bases to ensure that there is a baseline for a strategic response to an impending shortfall and to support the following recommendation.

Risk
Failure to do so will maintain the status quo and its inherently increasing risk levels.

Implement Knowledge Retention Programmes within Generation and Contracting Companies

Knowledge retention programmes will aid in the transfer of industry critical knowledge and allow for the transfer of this information from older to younger Power Technicians through a formal process. The following points should be discussed internally with generation companies and as an industry wide action:

- Flexible working options for Power Technicians nearing the end of their working life to ensure they are retained to assist with training new technicians.
- Competency matrices and training assessments will provide a formal process to ensure that information is being passed on.
- Sharing key resources such as experienced Power Technicians whom have key technical knowledge will be beneficial for the industry.

Action

Generation companies and contracting providers need to discuss the aforementioned factors within their organisations. This discussion should involve highly skilled Power Technicians who have a good understanding about the needs of the industry. This discussion needs to be actioned further by the EEA Asset Management Group.

Risk

There is the risk that the resources put into training Power Technicians will not equate to the reward, if those Power Technicians depart the industry. Management can often lack the technical understanding required to implement knowledge retention programmes, or see the value in them.

Promote the Power Technician Role within the Generation Industry – Long term Solution

Promote the generation industry within relevant institutions, in order to increase the perceived career opportunities as a Power Technician. This will have an effect by increasing the amount of young Power Technicians coming into the workforce and therefore prevent a decline in the working population. An example of current promotion within the wind sector is shown in appendix 11.11.

Action

The following courses have been identified as promotion pathways.

- National Certificate in Electricity Supply (Electrical) (level 4) - Will be replaced by the New Zealand Certificate in Electrical Engineering Theory and Practice (level 4)
- National Diploma in Engineering – Will be replaced by the New Zealand Diploma in Engineering (level 6)
- Bachelor of Engineering (level 7)

Risk

If promotion of the Power Technician role within the industry is not actioned, there is a risk that very few students will complete the generation strands of the New Zealand Certificate in Electricity Supply. The result being that very few Power Technicians will be entering the industry with generation specific knowledge.

Include a Training Incentive within Project Contracts – Long Term Solution
Including a training incentive within project contracts, especially those designated as industry critical areas of knowledge, will incentivise contractors. This should result in industry-critical knowledge being imparted by highly experienced Power Technicians to younger technicians entering the industry.

Action
Discussions around this topic need to be raised within the industry and importantly in relation to the threat which they believe a shortage in the future will impose to their business.

Risk
There is a risk that the money would get added to a given contracting company's profit margin, without any training occurring. Project managers can however coordinate with onsite staff to ensure that the trainee technicians are present. Repercussions for this could be added through penalty clauses.

Wind – Training Pathways
Formal training pathways for Wind-specific Power Technicians do not exist. It is advised that planning for future wind farm development will include a skills component designed to identify where the required technicians would be sourced from. Large future investment in wind farm development should occur in conjunction with a sector-wide push to have a formal training pathway produced via an ITO in relation to Power Technician-specific work.

Action
Currently the resourcing for Wind-specific Power Technicians is appropriate, however if wind farm development increases in the future, this needs to be addressed.

Seek to Develop a Constituency within the Industry for the Collective Resolution of this Emerging Industry Risk – Long Term Solution
Formal workforce planning should be completed by all industry stakeholders, as a collective in order to gain a clearer picture of the industry. This will allow for transparency in the quantity of technicians within the resource pool.

Action
The EEA Asset Management Group should discuss this issue and ensure that regular monitoring occurs through the process outlined in appendix 11.5. Using information systems set up by Human Resources would be a practical approach to continual monitoring of the situation.

Risk
Unless someone is held accountable for this task, it may not happen.

Bring Power Technicians Back In-House if the Industry does not React Proactively - Long Term Solution
It is advised that if the recommendations aforementioned do not incentivise the industry to hire more Power Technicians, then the only way to ensure control over the resources is to bring Power Technicians back in-house. This would provide many benefits whereby available training time would increase, which would in turn have similar effects on the resource pool itself.

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Glossary of Terms/Acronyms

SOE	State Owned Enterprise
MECE	Mutually Exclusive, Collectively Exhaustive
OEM	Original Equipment Manufacturer
The Industry	The electrical generation industry
NZED	New Zealand Electricity Department
TQM	Total Quality Management
CMA	Capability Maturity Assessment
RASCI	Responsible, Approve, Support, Consult, Inform
EWRB	Electrical Workers Registration Board

1 Introduction

1.1 Purpose

This report has been prepared for a collective of Industry representatives; Lead by Meridian Energy Ltd, with the involvement of the Electricity Engineers' Association and four other key members of the Staylive Group; Contact Energy Ltd, Pioneer Energy Ltd, Mercury Energy Ltd, and Genesis Energy Ltd for the partial fulfilment of the Master of Engineering Management Programme at the University of Canterbury. This project involved the analysis of Power Technician Resources across the generation industry, with recommendations made on upon the analysis undertaken.

1.2 Project Objectives

The aim of this project is to identify whether or not there is going to be a potential short fall of skilled and experienced Test and Power Technicians across the generation industry, with recommendations to be made given the outcome of the initial hypothesis;

There is going to be a shortfall of skilled and experienced Power Technicians across the generation industry within the coming future

The objectives of this project are to:

- Identify the demographics of the current working population.
- Understand the drivers to people both entering and exiting the industry.
- Provide a cost benefit analysis on the possible options that could change the inputs and outputs to the inventory of Power Technicians.
- Provide a future thinking toolkit to aid with resource planning.

<u>The government currently has the following objectives:</u>

"The Government's key objective in the energy area is to ensure that energy services continue to be available at the lowest cost to the economy, consistent with sustainable development."

"This will be achieved by the efficient and effective provision of energy services through properly functioning commercial systems with competitive incentives. These systems will work within an effective and stable regulatory environment and take energy conservation into account (Chronology of New Zealand Electricity Reform, 2015)."

These statements align with what is currently seen in the generation companies, whereby they are running competitive businesses to ensure that maximum profit is returned to shareholders.

The initial shortfall of Power Technicians was thought to be within the hydro sector, however Wind – specific and Thermal/Geothermal Power Technicians have also been included.

2 Background

2.1 Overview of the Industry

New Zealand's electricity is produced via a multitude of different assets across the country. The assets which comprise this make up and their approximate overall generation capacity are as follows (Electricity generation, 2015):

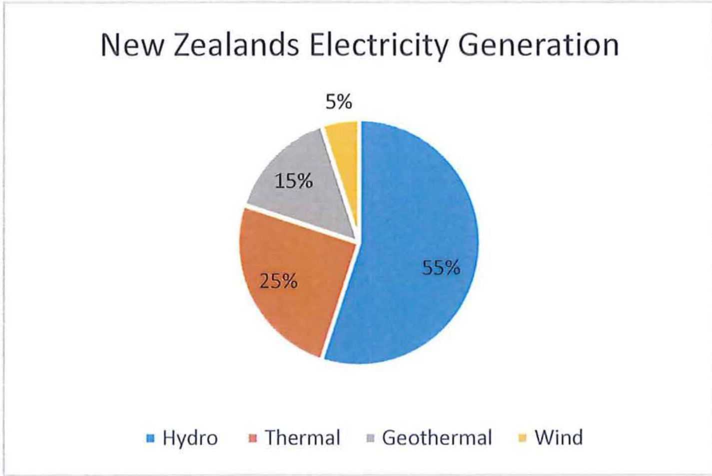

Figure 1: New Zealand's Electricity Generation

2.2 History of the New Zealand Electricity Sector

<u>Pre 1987</u>

Before 1987 electricity distribution and generation was the responsibility of the Ministry of Energy, and it was entirely state owned and operated (Chronology of New Zealand Electricity Reform, 2015). During this time Power Technicians were all trained under the Ministry of Energy, which allowed for transparency in the quality and quantity of Power Technicians entering the resource pool.

<u>Post 1987</u>

In 1987 the ECNZ was established as a company under the SOE Act and was intended to operate the generation assets of the Ministry of Energy (Chronology of New Zealand Electricity Reform, 2015). The aims of the energy sector reforms were to create a competitive market place designed to improve the commercial performance of government assets. Moving from a monopoly to a competitive market place was a complex process. The major changes occurred between 1987 and the late 1990's, before other large changes occurred under the current National government. By creating a competitive market place, SOE's performance was from then on measured by profitability metrics. (Chronology of New Zealand Electricity Reform, 2015).

Changes under the National Government have meant that dividend payments to shareholders have even more importance, with a wide variety of shareholders requiring a return on their investment. Whereas when SOE's were entirely government owned there was some 'wiggle room' in the context of generation companies holding onto cash for investment reasons. With a wider variety of investors, there is a higher degree of importance placed on providing high dividend payments to shareholders (Treasury, 2016). One of the effects that the energy sector reforms had was that Power Technicians were no longer all trained under the Ministry of Energy.

2.3 Current Situation of the Generation Industry

The structure of the electricity industry in New Zealand looks vastly different to what it was prior to privatisation. There are now 5 main generators who make up 94% of the electricity produced in New Zealand (figure 2), compared to what was once a completely state owned enterprise.

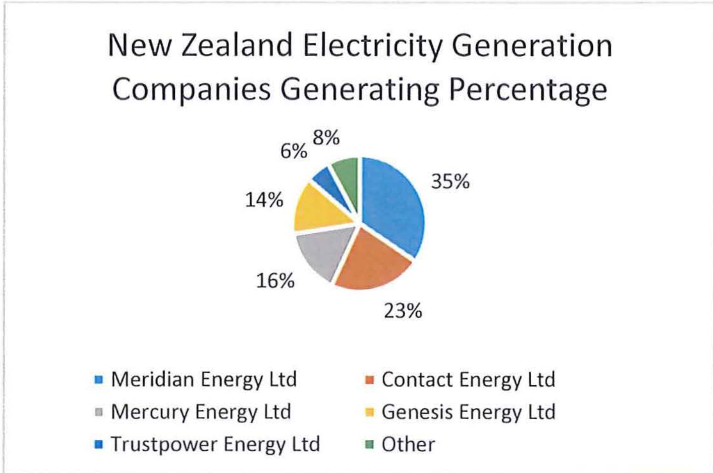

Figure 2: New Zealand Electricity Generation Capacity - Company Specific

The initial governance changes between 1987 and 1994 had the biggest effect on industry business models, by forcing companies to run leaner operations because of the newly enforced performance regulations. One of the natural consequences made apparent by industry generators was the move to outsource work.

Contracting Services

Another competitive market was then created for electrical contracting providers, as observed through the contracting model currently seen in the generation industry. Contractors within the industry are based all over New Zealand and generally switch between maintenance work for the generating companies and project work during the installation of new assets. The contracting model currently in play forces companies to tender for contracts.

The pool of electrical contracting companies servicing the industry is large and those used in this research are as follows:

- **UGL Ltd**
- **Broad Spectrum Ltd**
- **Electrix Ltd**
- **Power Net Ltd**
- **PBA Ltd**
- **ABB Ltd**
- **Think Delta Utilities Ltd**
- **MB Century Ltd**

2.4 The Role of a Power Technician within the Generation Industry

Power Technicians have a unique role within the New Zealand power generation industry, because they fill the gap between Industrial Electricians and Electrical Engineers. They aid in the process of maintaining, commissioning and operating electricity generation assets throughout New Zealand. The environment in which Power Technicians work is highly complex because of the potential consequences associated with exposure to high voltage assets, the economic risk associated with the high value of the assets and their generation obligations.

As aforementioned, New Zealand's power is produced by a multitude of different assets and thus requires Power Technicians with specialist knowledge in each of the following fields:

2.4.1 Hydro Power Technicians

New Zealand's hydro generation capacity is predominantly found in the South Island however some smaller schemes also exist in the North Island. Power Technicians within this environment typically alternate between maintenance work on generation assets and project work. This can involve new generation assets (major project investment) or more commonly the refurbishment of existing assets.

2.4.2 Thermal Power Technicians

Thermal power plants mainly exist in the North Island where New Zealand's geothermal activity is viable for energy generation, namely within Taupo Volcanic Zone. Power Technicians within the thermal environment have a similar skillset to that of Hydro Power Technicians.

2.4.3 Wind Power Technicians

Wind specific Power Technicians are more difficult to define, with the varying abilities individuals have to work on specific assets. For the purpose of the study, only Power Technicians have been included and not 'Wind Technicians'.

Power Technicians in New Zealand are spread across both contracting companies and generation asset owners. The need for Power Technicians in specialised environments is obvious because of the various types of generation assets that operate in New Zealand and their isolated locations.

3 Previous Studies within the Electricity Industry

A potential labour resource shortage is not something new, and has been investigated in other parts of the world.

This issue was raised by the EEA in 2012, and Hays recruitment agency in 2014, highlighting that Power Technicians were in the top five skills in greatest demand (Hays, 2014), however no further action has been taken until now.

The previous studies in this field provided insight into the state of other resource pools and also what actions were taken to fix the given issue. Reports and toolkits (appendix 11.6) aimed at labour resource shortages within the Electricity Industry had the following key findings:

- There is an ageing working population within the electricity industry in America and Europe.
- New Zealand's problems are not unique.
- Loss of critical knowledge was outlined as a major issue within the coming years.

<u>Key Recommendations from the Research of Others</u>

Governing bodies in foreign industries have taken the following actions to prevent the effects of an ageing workforce:

- Age management strategies.
- Knowledge retention programmes.
- Increased 'fit for purpose' training courses.
- Leverage and expand partnerships.

4 Current Power Technician Resource Situation

Research has been carried out between Oct 2016 and January 2017 in order to meet the objectives previously mentioned. This section of the report summarises the data collected and the state of Power Technician resources in New Zealand.

4.1 Data Collection Methodology

The qualitative and quantitative data referenced herein, was provided by the relevant power generation companies and their contracted service providers in the form of surveys and interviews (appendix 11.9, 11.10). Much of the information included within this report has been sourced through interviews with industry stakeholders and some through general exchanges. To promote the disclosure of accurate primary data, interviews were designated as anonymous, with interviewed stakeholders found in appendix 11.15.

Given the nature of the problem, the Power Technicians who have been identified fall within the parameters of the generation industry and have the ability to work on generation assets. Despite this, it cannot be assumed that all Power Technicians have been accounted for, so the sample shown is only a representation of the resource pools in question. The technicians that have been accounted for are those which were provided by the major industry stakeholders.

Interviews during the initial stages of the project provided insight into the issue and allowed for a greater understanding thereof. Providing a structured form of research that aligns with the McKinsey problem solving process was the intention, to allow for a much more focused approach to the issue (appendix 11.1.1). Surveys were sent out to industry participants in order to populate the cause and effect diagrams, that create the incentive systems to Power Technicians entering the labour pool, and in turn act as the control levers to the system. As they were anonymous, they provided a valuable source of information.

As these surveys have been completed voluntarily, the results have been analysed to ensure that personal or company activities are not considered perverse in the context of industry cooperation with regards to Power Technicians. Many of the respondents did not answer all of the questions, so comments will be made where applicable to ensure that the correct conclusion is conveyed. Age demographics of Power Technicians and their relevant fields of generation expertise have been gathered through the managers of the aforementioned HV contracting providers and voluntary surveys.

4.2 Hydro Generation

4.2.1 South Island

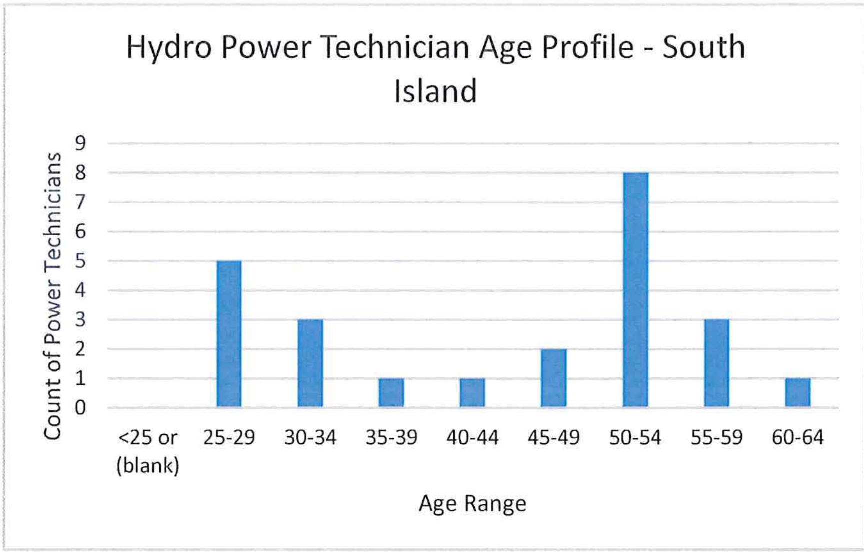

Figure 3: Hydro Power Technician Age Profile - South Island

The above graph shows the age distribution of Power Technicians within the hydro generation industry for the South Island. The graph clearly shows that a large cohort of Power Technicians is going to be leaving the industry within the next 10-15 years, with 12 of the 24 technicians identified being over the age of 50 (50%). Yet there is also a much younger group entering the resource pool between the ages of 25-29.

4.2.2 North Island

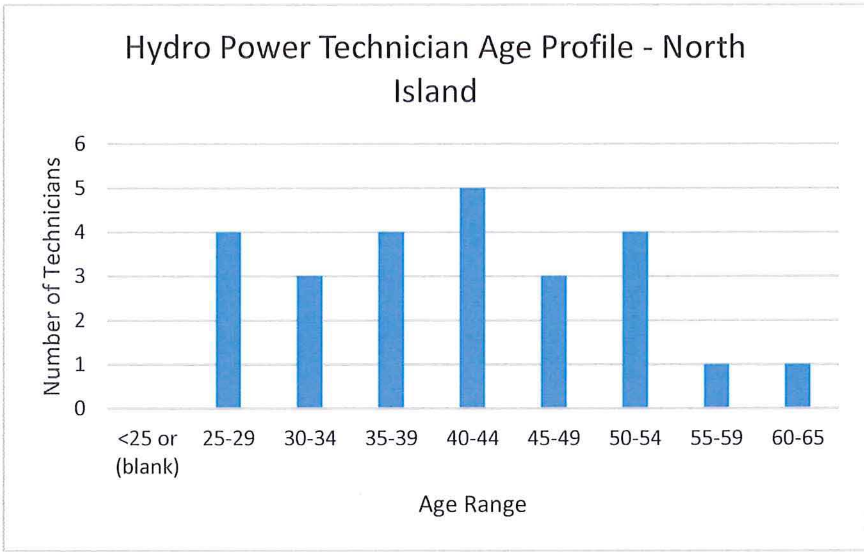

Figure 4: Hydro Power Technician Age Profile - North Island

The above graph represents the age distribution of hydro Power Technicians in the North Island. As shown by the graph, the age profiling of Power Technicians is close to a normal distribution with only six out of 25 Power Technicians over the age of 50 (25%).

4.3 Wind Generation

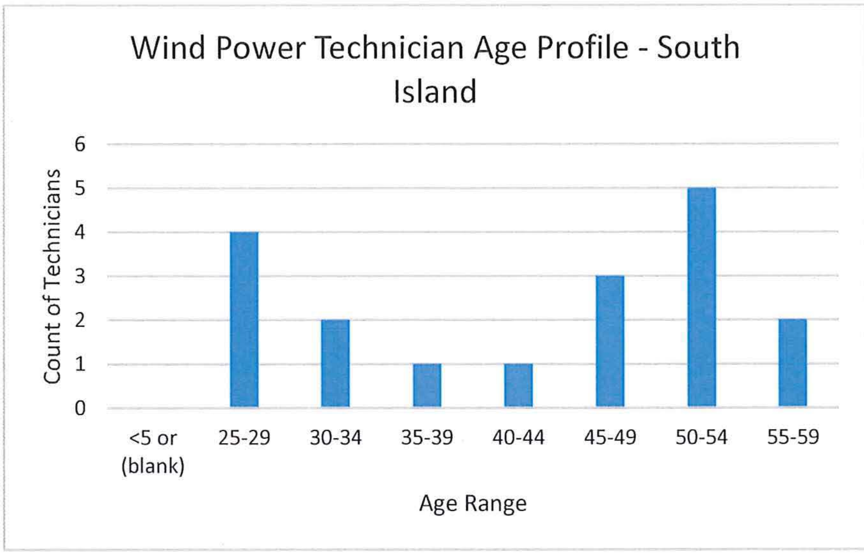

Figure 5: Wind Power Technician Age Profile – South Island

4.3.1 South Island

Wind – specific Power Technicians within the South Island show a similar pattern to that of Hydro Power Technicians, in that they have an ageing workforce. The results show that seven out of 18 technicians identified are over the age of 50 (39%).

4.3.2 North Island

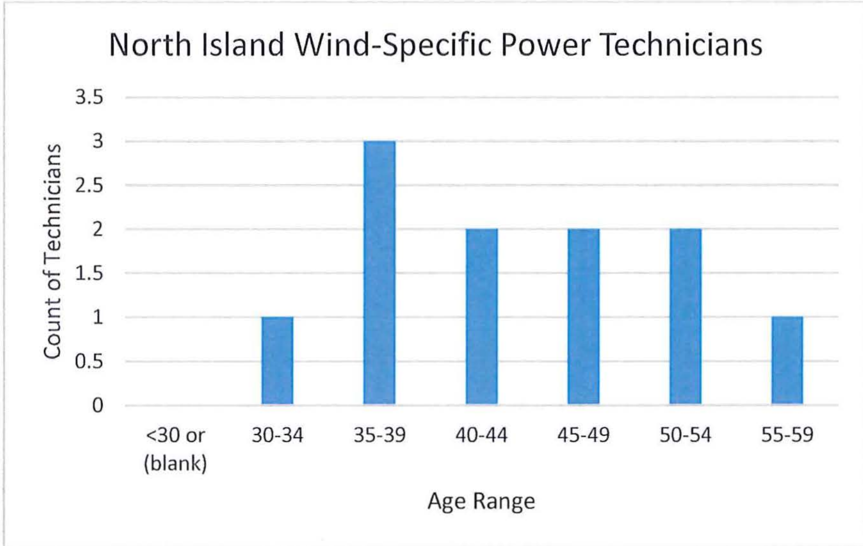

Figure 6: Wind Power Technician Age Profile - North Island

The results show that three out of 11 (28%) Wind – specific Power Technicians in the North Island are over the age of 50. The age distribution shown has a lower age profile than that of the South Island.

4.4 Thermal/geothermal generation

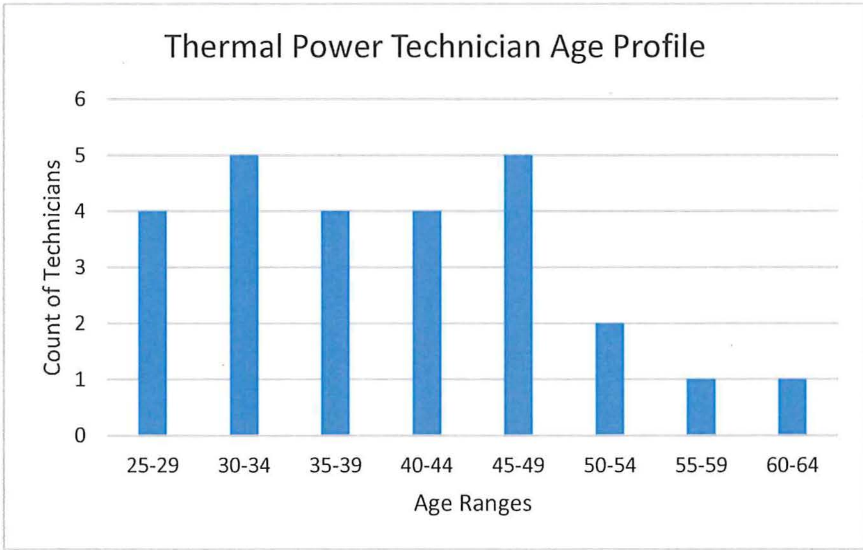

Figure 7: Thermal Power Technician Age Profile

Thermal/Geothermal Power Technician resources in the North Island show a much younger age distribution. With only 4 out of the 26 technicians identified, being over the age of 50 (15%).

Comments

The results within the South Island would indicate that there is a large group of Power Technicians expected to leave the industry and a relatively young group entering. This is perceived to have come about from companies taking on Power Technicians in recent times. Within interviews there was one case where a young Power Technician had left because there had not been the perceived progressive pathway they had hoped for.

The distribution of Power Technicians in the North Island has a slightly different profile, with only 11 Wind-specific Power Technicians identified, compared to Thermal and Hydro with their respective 26 and 25 Power Technicians. The very similar age distribution between Thermal and Hydro Power Technicians in the North Island provides evidence to the fact that many of the Power Technicians can work across both Thermal and Hydro generation assets. This is also the case for the similar age distribution between Hydro and Wind specific Power Technicians in the South Island.

4.5 Skills Shortage Areas Identified from Survey

The skills shortage survey was used to gain an understanding of the competencies within the industry. As this is based on self-perceived competence and does not cover all of the technicians within the industry, the answers may contain inherent bias. The scoring system is based from 1 – 5, from no competence to fully competent. The areas of interest were:

Table 1: Skills Shortage Areas - Survey Competency

	Competency Score 1 - 5				
Task area	1	2	3	4	5
Generator/turbine efficiency/performance testing.			2	2	2
Generator/turbine load refection testing			3	3	2
Generator/turbine control and sequencing – New Installs and commissioning			13	3	0
Governor systems – New installations/ EPIC testing			4	1	1
Governor systems – Fault finding and analysis			4	1	1

The results would show overall that there is a lack of Power Technicians who perceive to have full competence in the areas depicted above.

It should be noted that not all survey respondents chose to fill in the survey and self-perceived competencies will vary from technician to technician. Graphs regarding the specifics of the survey results can be found in appendix 11.13.

Assumptions/Comments

- New Zealand citizens are eligible to receive the pension at age 65 and it is assumed people will work until eligible. Survey results showed that five respondents were planning on either leaving the industry or finding work elsewhere within the industry, who were not yet approaching 65. As a result, consumers of data must take into account that not all Power Technicians will work until retirement when making labour resource pool projections.
- Many Power Technicians work across different types of generation due to the diversity that is required of contracting providers, so they have been included in both data samples.

4.6 Key Findings

1. **Ageing Working Population**
   Hydro and Wind Power Technicians in the South Island are going to face the biggest issues in the coming future, with the percentage of Power Technicians over 50 being 50% and 39% respectively. The North Island age profiling of Power Technicians showed a much healthier distribution, with 25% and 28% of the individuals over 50 in their respective generation types. Assuming these technicians stay within the industry and work through to the retirement bracket, they have another 10-15 years left within the workforce. It is not however practical to assume this because as aforementioned not all Power Technicians will work until retirement age. There is also the possibility that technicians could move into managerial roles, as was the case with several interviewees from both generating companies and contracting providers.

2. **Loss of knowledge within the industry**
   With a large group of technicians expected to leave the industry within the coming 10-15 years, there is the potential for a 'brain drain' to occur where industry critical knowledge is lost. This is evident in that nearly all survey respondents highlighted that they look to NZED trained Power Technicians for advice. Fifty percent of Power Technicians currently employed in the Hydro generation resource pool are expected to leave within 10-15 years, based on an assumption that they will remain employed until at least the age of 60. The same issue was highlighted as a risk by industries with similar situations to that presented. This could be emphasised through project managers' risk aversion models when using key resources within their project work (cherry-picking technicians).

   According the EPRI survey, managers from the American Electricity industry expected the following type of knowledge to be lost (EPRI, 2006):

Table 2: EPRI Survey - Expected Knowledge Lost

Area of knowledge thought to be lost	Respondent percentage
Historical knowledge of equipment, design, and systems	75%
Lessons learned from previous events of activities	72%
System engineering knowledge	67%
Troubleshooting skills	67%
Maintenance techniques	58%
Knowledge of design (or operational) changes	47%
Organizational history	19%
NDE (non-destructive examination) inspection skills	11%

The foregoing evidence would suggest that there is going to be a loss of industry critical knowledge due to the large amount of Power Technicians over the age of 50, the lack of self-perceived competence within given task areas and the knowledge that is expected to be lost according to the EPRI survey (Table 2).

5 Driving Forces to the Power Technicians Entering or Exiting the Resource Pool

5.1 Incentives and Barriers to Power Technicians Entering the Resource Pool

The following incentives and barriers have been highlighted as possible influences for future Power Technicians and can act as control levers for incentivising people to enter the industry, or conversely preventing them. Incentives which have been communicated via technicians personal comment have been highlighted by an asterisk and where there is a count for number of respondents, this is from the multi choice tick box:

Table 3: Incentives for Power Technicians to Enter the Industry

Incentive	Respondents (Total = 35)	Comments
Nature of work	27	Many respondents chose nature of work as an incentive to enter the industry. This was highlighted in interviews as the problem solving aspect of being a Power Technician and the general nature of work was a highlight for many.
Pay	17	Pay was highlighted as another incentive for young people entering the industry, especially compared to that of an electrician.
Certainty of long term career	14	Certainty of a long term career has been highlighted, but it is contradictory as many managers were concerned with future work.
Location of work	9	Location of work has been noted as an incentive for some, but for others it is also a barrier. It is important to find the right person to commit to living in isolated area.
Being able to travel around NZ	7	The combination of isolated generation assets and the contracting model currently in play enables technicians to travel around parts of New Zealand.
Opportunity to gain extra qualifications	*	Many technicians enjoyed the fact that they were not just a standard electrician.
Power Technicians need a higher status	*	Many believe that if Power Technicians were held at a higher status, it would entice young people to enter the industry.
Less manual work as a Power Technician compared to an electrician	*	Power Technicians complete far less manual labour than that of an electrician.
Overtime pay	*	It was said that overtime pay was a highlight of the job, but that it was diminishing.
NZE used to hold positions for technicians if they wanted to go on an OE	*	During the NZED times, Power Technicians would have their position held onto if they wanted to go on an OE.

Table 4: Barriers to Power Technicians Entering the Generation Industry

Barrier	Respondents (Total = 35)	Comments
Not being aware of opportunities in the industry when first choosing a career	26	Many young people don't know what a Power Technician does and aren't aware of the opportunities within the generation industry.
Pay	12	Many technicians don't believe they get paid the equivalent to the effective responsibility they take on as a Power Technician.
Location of work/travel	8	Many of New Zealand's generation assets are in isolated locations.
Narrow field of work once trained	10	A Power Technician is a high level technical position, with much of the theory being specific to the industry, with very little cross over once trained.
Perceived opportunities/long term career opportunities	7	Very little information regarding the potential opportunities there are as a Power Technician and the current outlook for a long-term career isn't guaranteed.
Expectation to travel for work	8	With the nature of project work, Power Technicians are expected to travel and live away from home for periods of time.
Lack of guaranteed work	8	Future work insecurity is playing a role in preventing young people from entering the generation industry.
Consequence of accidental tripping/pay relative to responsibility	7	The pay relative to the responsibility, does not match up according to respondents.

5.2 Incentive Comparison – Electrical Engineer versus Power Technician

As aforementioned, the incentive system which encourages people to enter the industry is something that has a huge amount of value to the industry and money is the primary incentive.

Table 5: Salary Comparison - Engineer versus Power Technician

Title	Entry	Median	Senior
Electrical Engineer	$60,000	$91,000	$130,000
Power Technician	$62,000	$89,000	$130,000

Engineering graduates are now perceived by some in the industry as good candidates for Power Technicians and it is important to understand the incentives which face those individuals to make the decisions they do. As depicted in the table above, the comparison of engineering professionals expected earnings versus Power Technicians expected earning is not too dissimilar. The range of pay varies hugely between Power Technicians, due to experience, negotiation abilities and other factors including overtime pay (which some contractors do not offer to their staff). This could reflect the reasoning for the conflicting results within the survey.

It was highlighted in surveys that many of the Power Technicians believe they are not considered in the same high regard as in other countries. In England for instance, commissioning engineers are also included in the design phases of project work so they can increase the ease of project commissioning.

Pay rates between Electrical Engineers and Power Technicians are not vastly different, at both ends of the scale. This could be seen as one of the reasons to follow the engineering pathway rather than the Power Technician pathway, as once trained there are very few other options for a Power Technician.

5.2.1 Survey and Interview Key Findings:

Maintenance – Project Work Balance

1. Many technicians currently working on maintenance, indicated that the mixture between project work and maintenance work could increase. However, those already completing high amounts of project work, did not wish the mixture to change. This would suggest that project work is much more favoured.

   Benefits:

   - Power Technicians gain a lot of their understanding of plant and equipment during the installation and commissioning phase of work. A higher percentage of project work would increase the maintenance staff knowledge of plant and equipment. This would allow for a better understanding of the generation assets in the future, when they are required to maintain those assets.
   - Project work is perceived as more interesting than maintenance work and therefore would increase the job satisfaction of Power Technicians and as a consequence improve retention rates.

   Weaknesses:

   - Power Technicians who already complete a large amount of project work, will in theory have more knowledge of new generation equipment, due to higher exposure to different types of assets.
   - Changing the schedules of maintenance work, to allow for some technicians to complete project work would require management to adjust their labour resource allocation.

Potential Source

2. It was noted during interviews that a good electrician could do some of the work that a Power Technician is required to do, especially if they had trained in a high voltage automation environment.

3. **Contracting Model – Work Insecurity**
   The outsourcing model currently in place within the New Zealand generation industry has its benefits and weaknesses. The key findings in relation to this were:
   - The boom and bust nature of project work has meant that many companies have had to diversify their work, which in theory means less time spent on generation and more on distribution and transmission. In turn, lowering individual exposure to generation assets. The nature of project work was also noted in several occurrences as a barrier to being able to validate hiring new Power Technicians. This was also backed up in one case, where a contractor could not have a permanent technician within the lower South Island.

4. **Location Specific Workforce Issues**
Initially location was thought to be one of the problems to attracting Power Technicians to isolated locations, however the application numbers for other positions within the same area would indicate that this is not the case (appendix 11.14). However, the results do show that the age distribution issues of Hydro and Wind-specific Power Technicians are unique to the South Island.

5. **Lack of Workforce Planning/Industry Collaboration**
The New Zealand generation sector is unique because of the small nature of the country and the isolated locations of its assets. Under the current contracting model, very few companies have strategic workforce planning strategies in place because of the small nature of Power Technician teams.

6. **Gender Diversity**
A reoccurring topic during interviews with managers, which is backed up by evidence collected from surveys, show that there is a serious lack of gender diversity within the technician resource pool. A Power Technician has never been traditionally identified as a woman's job, however the industry is missing out on another potential source of Power Technicians.

7. **The Incentive System**
Various underlying issues within the incentive system, are having, or will have, impacts on the way in which the Power Technician resource pool will operate:

   a. Many of the technicians highlighted that the pay to responsibility ratio does not align, but the pay differences between technicians various hugely.
   b. An increase in the amount of project to maintenance work was highlighted as a 'draw card' to keeping Power Technicians enthused and up to date on knowledge.

3. **Recognition**
In New Zealand, Power Technicians are held in a much lower regard than that of overseas, specifically the UK, where commissioning engineers are also a part of the conceptual and detailed design stages of projects. This point was highlighted on several occurrences during interviews and that Power Technicians should be involved in the design stages of project work.

4. **Foreign Technicians**
It was noted on several occurrences that acquiring foreign Power Technicians from overseas to work in New Zealand was often difficult because of the following reasons:
   - Language barriers.
   - Foreign Power Technicians are often specialised in either primary or secondary plant and do not have the broad skill set which is favourable to New Zealand.
   - They can take two years to be able to work in New Zealand, because they do not having the correct qualifications.
   - The following countries were cases where the employment process had been highly successful:
     - South Africa
     - England

Even though there were successful cases of importing Power Technicians, it was highlighted within interviews that this is not always feasible, because Power Technicians in foreign industries often being paid more than New Zealand.

> There were several occasions where New Zealand companies could not attract foreign technicians because of pay rate. There were cases where Power Technicians had taken a pay cut in order to gain, as what they perceived, a better quality of life. New Zealand had been highlighted as a 'stepping stone' to Australia on previous occasions.

There is a variety of reasons that are creating the current situation where there is a shortfall of Power Technicians. The points aforementioned all have certain implications but the most important being that the current contracting model doesn't provide enough of an incentive to upskill staff and the recruiting of foreign Power Technicians isn't always feasible. This will change between Power Technicians because of their corresponding abilities and the incentive system which drives those individuals.

6 How Technology could affect the Industry

Technology changes are effecting Power Technician resources in two separate ways. That being:

- Changing technology, which is effecting technicians currently in practice and;
- Future changes to technology that could affect the demand for technicians.

The main changes to the way in which technicians in practice operate, pertains to the increased requirement of computer literacy. This change has been perceived within the industry to have an effect on the knowledge of Power Technicians and their understanding of certain anomalies. Changing from mechanical to electrical protection relays has also been noted as reducing the demand for technicians in the past.

New technologies are coming into the market that would effectively diminish some requirements of a Power Technician. For example, there would be much less diagnosis required if there was more remote diagnosis equipment installed. However, as cybersecurity is second only to reliability among important industry issues, this may be a long time coming yet before it is introduced (Smith, 2016).

Remote diagnosis is now being offered in the following areas:

- Excitation
- Protection
- Synchronization
- Turbine regulator

6.1 Risks Associated with Remote Connection

Although this technology does provide the sector with the opportunity to remotely monitor their generation assets and identify problems earlier, it was noted by a representative of Control Systems Security Information Exchange that the following risks are associated with remote connection:

- Reputational risks associated with security breaches.
- Economic issues that could arise given security breaches.
- Contractual issues with stakeholders such as Tiwai Point smelter.
- Life support systems could stop if generation was to be breached because of security issues.
- The technology implemented may be outdated and impose security issues in the future.

If technology advances in this area meet the requirements of the industry, remote diagnosis could act as a disruptive innovation that could affect the existing demand for Power Technicians (Christensen, Raynor, & McDonald, 2015).

7 Power Technician Training

Training and education are key factors in the context of the given problem, as they are ones that directly relate to the performance of the industry. Understanding the training which is currently available to the industry is important for ensuring that new Power Technicians are entering the resource pool and the knowledge they are attaining is what the industry is requiring. The initial split up between the generation sectors is that of hydro, thermal and wind technicians and those who are entering the industry vs those who are current Power Technicians and upskilling.

7.1.1 Pathways to becoming a Power Technician

The current pathway to becoming a qualified Power Technician is to complete the National Certificate in Electricity Supply (Power technician) (Level 5), from the following entry pathways:

1. National Certificate in Electricity Supply (Electrical - level 4) (Will be replaced by the New Zealand Certificate in Electrical Engineering Theory and Practice (level 4)
2. Diploma in Engineering, either the old National Diploma in Engineering or the new, New Zealand Diploma in Engineering at level (6)
3. Bachelor of Engineering (level 7)

Qualified electrician trainees who have completed the National Certificate in Electricity supply (Electrical) (level 4), or the future New Zealand Certificate in Electrical Engineering Theory and Practice (level 4), can gain direct entry into the level 5 New Zealand Certificate in Electricity Supply, as it is seen as the traditional pathway. Whereas Diploma and Bachelor of Engineering graduates can cross credit some of the theoretical knowledge gained through previous study, but they also have to complete the on job practical requirements of the qualification. In the new qualification (appendix 11.12), the trainee produces a portfolio of evidence to a set of competencies in a unit standard, against eight individual competency units in the old qualification. Allowing for a much quicker transition to a Power Technician qualification. Bachelor of Engineering graduates are now becoming sought after within the industry because of the processed thinking which university graduates often attain from their studies and the complex problem solving nature of Power Technician work.

7.1.2 Qualification changes – National Certificate in Electricity Supply

The National Certificate in Electricity Supply (Power Technician) (level 5), has recently undergone changes as required by NZQA's targeted review of qualifications. The replacement New Zealand Certificate in Electricity Supply (Power Technician) (level 5), has been made more 'fit for purpose' for the next five years. The common core papers have been shortened to allow for an increase in optional strands such as generation, as per the requirement of the increase in complexity and skills required by Power Technicians. This allows for trainees to specialise earlier as the old qualification was perceived to be taking too long to get trainees through.

The National Certificate in Electricity Supply will be retired when the current group of trainees complete the course. Currently, the Electrical Workers Registration Board (EWRB) employers licence allows Diploma in Engineering and Bachelor of Engineering graduates to work as a Power Technician for certain New Zealand companies who hold this EWRB licence. Many asset owners of electricity plant and equipment are now requiring proof of qualifications and personal electrical registration, and won't allow work on their assets, because of the risks that come with having someone with very little practical and theoretical knowledge. Contrary to the point however, many employers are hiring University graduates due to the industry shortage of Power Technicians and their abilities to understand modern technology being installed in the electricity industries plant and equipment. The replacement qualification will allow diploma and degree trainees to obtain a limited scope EWRB registration to work legally as a power technician.

7.1.3 Current training within the industry

On the Job Training

On the job training is currently the only technical training that many of the technicians receive and because of the contracting model the industry currently uses, training is decreasing while focus remains profit centred. Respondents highlighted that a lot of the training required was done so through the OEM and during the commission phases of various projects.

Competency and training matrices are being created by some of the contracting companies to facilitate a formal method to ensuring that critical knowledge is getting passed on. This however needs to occur within all companies, as specialised knowledge is held by only a few individuals within this relatively small industry as aforementioned.

Key Findings:

1. **Generation Specific Training:**
    - Contractors don't see the requirement to train Power Technicians in the generation strand, as there is currently a larger amount of work within the distribution and transmission sector. Evidence for this is shown in the number of trainees pursuing the generation strands of the Certificate in Electricity Supply (0).
    - None of the Polytechnics in New Zealand offer specialist training in generation, in part because of the difficulty of finding people to teach it. Instead Polytechnics are moving away from power engineering and moving towards electronics engineering.
    - The number of students who have been completing the 400 level Electrical Machines and Electrical Power Systems papers at the University of Canterbury are down from 42 and 44 in 2013 to 25 and 26 respectively, in 2016 (appendix 11.7).

2. **Missing Industry Presence Within the Learning Pathway for Power Technicians**
   There is a missing industry presence within the learning pathway for Power Technicians, as there is very little awareness to the perceived opportunities within the industry. This is evident in that there has been no one complete the generation strand of the National Certificate in Electricity Supply in the last two years.

3. **Skills Competency**
   There are many areas noted that are lacking in specialised skills or in which the industry is relying only on a select few individuals, many of whom will be approaching retirement age within the next 10-15 years. As shown in the age profiling of Hydro Power Technicians, there will be a large group of people leaving the industry and taking with them their specialised skills. On many occurrences it was highlighted that pre privatisation, NZED trained Power Technicians had a far broader skillset than that which is seen coming into the resource pool post privatisation.

4. **Viability**
   The viability of the New Zealand Certificate in Electricity Supply (Power Technician) (level 5), is decided during the development phase of the programme and only applies to the 'off job' courses. The cost of the course per year, will change with given student enrolments but on average it is expected that the course needs 7-8 enrolments per year to operate. It was noted during an interview with a representative from Connexis that there are currently sufficient numbers completing the Power Technician qualification to meet this demand.

5. **Wind Pathway**
   Currently there is no formal training pathway for Wind-specific Power Technicians within New Zealand.

7.2 Analysis of Results – Systems Perspective

7.2.1 Viable Systems Model

The viable systems model analysis (appendix 11.2) was used from two separate standpoints; that being from and industry perspective and an organisational perspective. This ensures that there is cohesion within the system.

Industry Perspective

From an industry perspective there are missing links within the system that relates to control over the industry. The incentive system drives the long-term outlook on Power Technicians from a contractor's perspective due to; there not being enough work within the industry to incentivise organisations to employ new Power Technicians, as the industry so far has relied heavily on pre privatisation trained technicians that were driven off a different incentive system. One that ensured long term job security and a different training scheme that continually added to the resource pool. Companies are continually competing for maintenance and project tenders, so the incentive for contractors to continually hire without a guaranteed workload isn't feasible.

If cohesion were occurring between organisations there would be knowledge of what was occurring within the resource pool. Strategic risk in regards to Power Technician resources, needs to be conveyed upwards within generating companies. Currently maintenance contracts in play are arguably too short sighted to incentivise contractors to bring more young people into the industry, this is also being hampered by the model itself where training time on assets is limited.

Organisational Perspective

From an organisational perspective the two invested parties (generation owners and contracting providers) coordinate their work through the use of the tendering process and contracts. This process has worked so far, but with an ageing cohort of Power Technicians and the corresponding time taken to train Power Technicians being 7+ years, there needs to be an incentive within the contract to allow for the training of Power Technicians.

This missing link of information and incentives, is preventing the system from acting self sustainably, as it once would have pre privatisation, when there were fewer constraints to the training of technicians. There needs to be an understanding of the issue within organisational management, without this the flow of information in regards to the risks perceived do not make their way up the hierarchal chain. This is where the issue can be highlighted as a strategic risk to the business. There needs to be an understanding of the issue and ultimately information regarding this issue moving vertically within the business, until it reaches a point where there is the authority to provide the necessary resourcing.

7.2.2 The 5 R's Analysis – Identifying Common Themes/Causes to the Issue

Following the framework presented in appendix 11.1 and that of the McKinsey based scientific method, comparing the information collected against the falsifiable working hypothesis, allows one to understand which areas of the system are weak and need improving. The initial stages of the McKinsey method endeavoured to frame the problem, followed by the collecting of data through surveys and interviews, which identified the causes and effects against the drivers of the given issue. From the data collected through both interviews (which carry a much more personal account), surveys and the analysis of the VSM, show that the main interplaying factors that are causing this problem originate from:

1. Information flow
2. Capability and;
3. The incentive system

The interplaying factors identified are in hierarchal order, in terms of perceived impact on Power Technician resources. The above factors have been identified as the main causes of the issue from their involvement, or lack thereof in the following areas:

- Lack of information flow between stakeholder parties. Primarily being:
    - The perceived lack of opportunities or industry awareness of Power Technicians within training institutions and the industry.
    - The lack of information flow between asset holders, who collectively bear the consequences of a short fall in Power Technicians and contracting providers.
    - The lack of information flow within organisational units (Power Technician teams and their respective management).

- Lack of capability understanding:
    - There is a lack of industry understanding in regards to the task specific knowledge that is within the system.
    - There is a lack of understanding within organisations to what the consequences a shortfall of skilled and experienced Power Technicians would be.

- There is a lack of understanding in regards to the incentive system which is the driving force to the resource pool, and the incentive system itself is not in correct balance to ensure that the system is self-sustainable.
    - As shown in the results of the survey, many believe that pay is not equal to what responsibility the job carries, however to the contrary they also said that it was an incentive to the system.
    - The reputation of a Power Technician isn't held in the same regard here as it is overseas.
    - There aren't sufficient incentives to train Power Technicians under the current contracting model.

In order to prevent one 'boiling the ocean', these three factors have been identified as the causes to the problem and will have the most affect if actioned in the correct way (20% of causes generate 80% of results). The three interplaying factors all fall within the context of process related issues and follow Edward Deming's point that organisational underperformance is 15% people related and 85% process related (W. Edwards Deming: The man behind the Q, 2017).

If the correct processes were in place that ensured the monitoring of Power Technicians (strategic workforce planning), then the lack of understanding shrouding the industry's capability would not be apparent and the incentive systems which are driving these individuals wouldn't need to be assessed. The reason for this, is the relationship between the system acting self-sustainably and the high number of players within the industry, consequence to the governance changes during the 1980's and 1990's.

8 Conclusions

This report was set out to address an emerging perception within the electricity generation sector, which in principle postulates that:

There is going to be a shortfall of skilled and experienced Power Technicians across the generation industry within the coming years

From the initial stages of the project it was assumed that the problem was systemic in nature and that an analytical framework embedded with systems concepts would need to be created in relation to the assigned topic. This has occurred at two distinct levels:

a) At the sector level, the Industrial Economics Model is used to show the linkages between the structure, conduct and performance of a sector to provide evidence of the systemic nature of the problem, and also allow for understanding of where the incentive system fits into the problem.
b) At the organisation level, a synthesis of the Perpetual Inventory Model, Root Cause Analysis, TQM, VSM, CMA and RASCI was constructed to provide a management systems perspective that shaped both the analysis of the current situation and provide a tool for the sponsors to guide their thinking processes for future decision making.

Key Findings:

The energy sector reforms of the 1980's and 1990's, which aimed to create a competitive marketplace for generation assets within New Zealand is perceived to have been the most important factor in shaping what is now the current situation. Prior to 1986 all technicians were employed and trained within a single organisation, with significant job security and a larger ability to employ and train staff to a higher standard than today. As there was a lower constraint on cost and a larger exposure time to assets, as the performance of the SOE's at the time was not measured by profitability.

The current situation is an emergent wicked problem resulting from industry reforms.

Post 1986 the interplay of market forces is reflected in the current situation where the following issues have occurred:

a) At the sector level it was clear that the liberalisation/privatisation of the electricity sector has caused many companies to outsource their work. One of the effects of this is that often labour pools decrease in order to cut costs. The high proportion of workers over the age of 50 within the Hydro and Wind sector, reflects this theory and it presents a potential risk to the performance of the industry, where there could be a loss of critical knowledge.

b) It should also be highlighted that there is significant risk in that contractors have very limited incentives to invest in training, because of the nature of contracting work and its uncertain future demand. With very little major projects in the coming future this issue is only expected to increase, especially for those contractors without maintenance work to cover downtimes.

c) There is a disconnection between the industry training bodies and perceived career opportunities to people within the industry. The nature of project work, which can often be politically driven due to the 51% stake hold in assets, leads for difficulties in justifying employing new Power Technicians. This is causing for very few new Power Technicians to come into the resource pool with the required skill set.

d) The analytical framework which is presented in appendix 11.1, highlighted the need to look at the issue as a closed system and also from the sector to organisational level. The problem presented is clearly a systemic issue that was not foreseen or accounted for by the government during the privatisation of the energy sector. The industry is still relying on the skill set which was produced via the NZED pre 1987, this is apparent in the number of Power Technicians who look to NZED trained technicians for advice. When those individuals leave the sector all together they will take with them a vast wealth of knowledge in relation to both specific generation assets within New Zealand and also general troubleshooting knowledge that has taken a long time to attain.

The foregoing evidence would suggest that the problem has come about from a variety of interplaying dimensions that have set the scene, namely; economic, political and technical. With the similar underlying issues of information flow, understanding of capability, and the incentive system which is driving the resource pool in question. The perceived problem has become far more complex than initially thought, because of the many complicating factors that Power Technicians' encounter within the environment in which they operate.

The Industrial Economics Model highlighted in appendix 11.1.2, eluded to the connection between external shocks to a sector and the consequent run-off effects that it has on the structure, conduct and performance of the industry. This is shown in the current situation whereby outsourcing is now performed by all industry stakeholders, reflecting the way in which the industry has structured itself to exploit free market opportunities. The ageing population of Hydro and Wind-specific Power Technicians in the South Island and the potential loss of critical knowledge are the most concerning outcomes of this investigation. This is supported by an industry survey from the EPRI (appendix 11.8) and the data from section 4.

The issue presented is very much a collective industry issue, as the consequences of a lack of skilled technicians in the future will lie with that of the generation companies. Many of the issues within the resource pool have occurred because of stakeholder's short-term outlook on perceived problems and a lack of accountability across the industry. As the perceived problem is only seen as critical within the Hydro generation industry, the report is designed as a future thinking toolkit for the on-going monitoring of the issue and recommended actions following the results of monitoring. The actions which are recommended, have the same reoccurring themes highlighted in section 7.2.2, that of information, capability and the incentive systems. The recommendations align with Edward Deming's findings, that 85% of organisational underperformance is process related and 15% people related. The degree of action to which the industry takes will lie with the risks in which the industry stakeholders are wishing to take, that being; either take a risk and hope that the resource pool will sort itself, or follow some of the given recommendations to ensure that the Power Technician resource pool can act self sustainably in the future. The resultant effects of either of the situations are difficult to quantify, given the many variables which make up the generation industry and the many resulting possibilities that can occur with a lack of experienced Power Technicians.

9 Recommendations

9.1 Generation Companies Need to Hire or Train Power Technicians in Order to Lower the Likelihood of a Potential Shortfall – Short Term Solution

The short term solution is to increase the number of Power Technicians in the South Island, as the Hydro Technician resource pool has a low number of technicians in the first place. Therefore, the number of technicians required to increase the resource pool to a semi-stable state is not a large amount (Six new trainee Power Technicians will lower the amount of individuals over 50 from 50% to 40%). Resourcing young technicians within New Zealand will ensure that the age distribution will come down and provide a self-sustaining system.

This would allow some 'buffer' room in regards to the ageing population of Hydro Power Technicians in the South Island and their looming retirement. The main benefit that this would provide is a decreased workload across the technician team, allowing for a buddy system to be set up in regards to knowledge retention within the industry.

Action
Hire young Power Technicians based on the risks outlined within this report. It is necessary to highlight the importance that Power Technicians have within this niche industry, to gain some traction from management. Target those who are suitable for progression into the Power Technician course, from the current trade apprentice programme (Certificate in Electricity Supply level 4), who may be looking to complete the level 5 course.

Risks
- If this recommendation is not actioned, there is the risk that the ageing demographics will only increase and it will be more difficult to pass on the industry critical knowledge that is necessary to ensure high performance within the industry.
- Hiring previously trained Power Technicians from overseas is only a short-term solution and does not fix the given issue.

9.2 Design and Implement a Management Information System for Power Technicians – Long Term Solution

A management information system for Power Technicians needs to be implemented by the EEA Asset Management Group. The information that is required to be collected needs to be made mandatory from all industry stakeholders. This will provide a real time view of the situation and allow for the framing of a strategic response to the issue. The EEA Asset Management Group has been identified as the governing body to take responsibility of this issue. This because of their collective view of interests across the Electricity Supply Industry.

Action
Human Resources/Capability Development needs to be given the designated authority and responsibility to implement and maintain the necessary data bases to ensure that there is a baseline for a strategic response to an impeding shortfall and to support the following recommendation 9.3.
By applying the RASCI responsibility matrix to the job requirements of Human Resources, this will ensure that someone is held accountable for the problem to prevent it from 'slipping through the cracks'. More information regarding the specifics of this process can be found in appendix 11.5.

Risk
Failure to do so will maintain the status quo and its inherently increasing risk levels in the context of a shortfall of Power Technicians.

9.3 Implement Knowledge Retention Programmes within Generation and Contracting Companies – Long Term Solution

Knowledge retention programmes will aid in the transfer of industry critical knowledge and allow for the transfer of this information from older to young Power Technicians in a formal process. The following points should be discussed internally with generation companies and as an industry wide action.

- Flexible working hours for technicians nearing the end of their working life will assist with the training of new technicians. The older working group of Power Technicians have been identified as the group which is often seen to for advice within this highly technical industry, and should be utilised whilst they can.
- It is important to remember that although pay is the initial incentive, there are other factors that drive employee's job satisfaction.
- Competency matrices and training assessments should be implemented, for those who do not already have them in play.
- Collectively, resources need to be shared because there are currently people within the industry that have specialised knowledge and this could be passed onto other stakeholders. Practical work experience on assets has been noted as the best way to learn and the sharing of resources needs to be discussed within the industry.

Action

Generation companies with in-house Power Technicians and contracting providers need to discuss the aforementioned factors. This discussion should involve highly skilled Power Technicians who have a good understanding about the needs of the industry. This discussion needs to be actioned further by the EEA Asset Management Group.

Risks

If this is not actioned there is the risk in that the resources put into training Power Technicians will not equate to the reward, if those Power Technicians depart the industry. Management can often lack the technical understanding required to implement knowledge retention programmes, or see the value in them.

9.4 Promote the Power Technician Role within the Generation Industry – Long Term Solution

Promote the generation industry within relevant institutions, in order to increase the perceived career opportunities as a Power Technician. This will have an affect by increasing the amount of young Power Technicians coming into the workforce and therefore prevent a decline in the working population. An example of the current promotion within the wind sector is shown in appendix 11.11.

Action

The following courses have been identified as promotion pathways:

1. National Certificate in Electricity Supply (Electrical) (level 4) (Will be replaced by the New Zealand Certificate in Electrical Engineering Theory and Practice (level 4)
2. Diploma in Engineering either the old NDE or the new NZDE at level (6)
3. Bachelor of Engineering (level 7)

Risks
If promotion of the Power Technician role within the industry is not actioned, there is a risk that very few students will complete the generation strands of the New Zealand Certificate in Electricity Supply and as a consequence result in very few Power Technicians entering the industry.

9.5 Include a Training Incentive within Project Contracts – Short Term Solution

Include a training incentive within project contracts, especially those that are discussed as industry critical areas of knowledge. This should incentivise contractors to increase training and recruitment within an ageing resource pool, ensuring that knowledge that is currently held by the ageing cohort of Power Technicians is passed onto younger Power Technicians entering the industry. This should have a resultant affect that industry critical knowledge is not lost.

Action
Discussions need to be raised around this topic and importantly in relation to the threat which they believe a shortage of Power Technicians in the future will impose to their business.

Risk
There is a risk that the money would get added to a given company's profit margin, without any training occurring. Project managers can however coordinate with onsite staff to ensure that the trainee technicians are present. Repercussions for this could be added through clauses or by simply stopping the incentives.

9.6 Wind – Training Pathways – Long Term Solution

Formal training pathways for Wind-specific Power Technicians are not available in New Zealand. Planning for future farm development should include a skills component in order to identify where the technicians needed would be sourced from. In conjunction, if future windfarm investment is going to occur the sector needs to push to have a formal training pathway produced via an ITO in relation to Power Technician Specific work.

Action
Currently the resourcing for Wind Technicians is appropriate, however if wind farm development increases in the future this needs to be addressed.

Risks
As investment in renewable energy is expected to increase in the long term, without the training institutes available to formally train these individuals, there may be a shortfall of supply.

9.7 Seek to Develop a Constituency within the Industry for the Collective Resolution of this Emerging Industry Risk – Long Term Solution

Formal workforce planning should be completed by all industry stakeholders, as a collective in order to gain a clearer picture of the industry. This will allow for transparency in the quantity of technicians within the resource pool.

Action
The EEA Asset Management Group should to discuss this issue and ensure that regular monitoring occurs through the process outlined in appendix 11.5. Using information systems set up by Human Resources would be a practical approach to continual monitoring of the situation.

Risk
Unless someone is held accountable for this task, it may not happen.

9.8 Bring Power Technicians Back In-House if the Industry does not React Proactively - Long Term Solution

It is advised that if the recommendations aforementioned do not incentivise the industry to hire more Power Technicians, then the only way to ensure control over the resources is to bring Power Technicians back in-house. This would provide many benefits whereby available training time would increase, which would in turn have similar effects on the resource pool itself.

Currently this is not a recommendation that needs to be actioned, instead the industry should provide the incentives aforementioned to entice the industry to hire and train more young Power Technicians. Future discussions are required if the industry does not react as anticipated.

Risks

There is a huge financial risk associated with bringing Power Technicians back in-house, as the training required is complex and time consuming. The estimated cost to train a new Power Technician is approximately $109,000 accumulated over 4 years. This cost does not account for other requirements such as a vehicle and test equipment. The risk associated with this is that the Power Technician in training could leave upon completion of the course. One potential way to prevent this is to bond Power Technicians to the company for a set amount of time upon the completion of the Certificate in Electricity Supply and internal training, and charge those who leave early a percentage of their study costs.

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11 Appendices

11.1 Analytical Framework – Self-Sustainable Resourcing

The analytical framework presented in this section is a synthesis of various management models and tools that allow for the analysis of the problem from the industry level (the generation companies and the system to which it operates) down to the organisational level (specific stakeholders within the technician environment). The framework is comprehensive in that it allows for reasoning of how the current situation has occurred, and doubles as a future thinking toolkit to aid in the area of manpower planning.

At the industry level, the Industrial Economics model is used to describe the current state of the industry and the effects that a change in governance has had (appendix 11.1.2). At the individual organisational level, the approach used can be considered slightly backwards, in that the systems Closure-Identity (Perpetual Inventory Model) is first defined and then falsifiable hypotheses are formulated for the variables in the model itself. From there the data collection is analysed against these hypothesis to either prove or disprove the hypothesis, and find common themes contributing to those factors.

This method is used by the McKinsey consulting group and gains its foundations from the scientific method, in combination with the concept of structuring the problem (i.e. analytical framework) and MECEing (mutually exclusive, collectively exhaustive drivers to the issue) of the variables which create the problem in question.

11.1.1 Scientific Method – Complex Issue – McKinsey and Co Problem Solving Process

McKinsey and Company has long been considered one of the best consulting firms in the world, because of their culture and the emphasis put into shaping their employees (Adams, 2015). 'The McKinsey Mind' is a book which has been released with the purpose of understanding and implementing problem solving techniques from the McKinsey Consulting firm. Rasiel and Friga (2002), used their own experiences as a "McKinsey-ite" and previous employees to break down the use of various problem solving tools and other general applications used in the McKinsey consulting firm, to frame and analyse the problem and then make sound recommendations on the issue.

The initial stages outlined by (Rasiel & Friga, 2002) is that the problem needs to be framed by defining the boundaries to the problem and breaking the problem down into its various components. This provides structure to the problem, so that it can be seen in a holistic manner but diagnosed in the correct way, within the time and resource constraints. By structuring the problem into its drivers which are mutually exclusive but collectively exhaustive, this provides a way to ensure that the issues identified are non over lapping issues with which recommendations can be made on.

The second stage is that of designing the analysis to the problem at present, which is done in order to identify the drivers behind the problem and not 'boil the ocean', which is often seen with complex issues such as the one presented. Rather than 'boiling the ocean', where a large amount of information is collected and used ineffectively in the given time period, the Pareto Principle of the 80/20 rule would be seen as having the most benefit in a complex situation. The principle states that 80% of the effects come from 20% of the causes (Lavinsky, 2014). This applies to the project directly, as it gives a sense of the problem and allows for the correct interview questions to be designed before getting too far into the project.

The final stage taken from McKinsey consulting is that there is no need to 'reinvent the wheel', which refers to creating your own analysis tools, when often those tools may have been applied to another situation which is very similar to the one identified. By looking for these forms of analysis that have been successfully implemented it provides assurance that the tools selected will also work for the given situation. By creating an initial hypothesis to the problem and solution, this provides structure to the consultant's way of thinking to increase the efficiency and effectiveness of decision making (Rasiel & Friga, 2002).

11.1.2 Sector Analysis – The Industrial Economics Framework

According to Edward Mason's Structure-Conduct-Performance model (figure 8), the market environment has a direct short-term impact on the overall market structure of the industry in question (Stucky, 2008). This in turn goes onto effect the way in which the industry conducts itself and as a consequence can affect the market performance. This flow can also reverse and market performance will in turn affect the industry structure. As seen on the far left of the model, external shocks such as legal or political governance changes (energy sector reforms) can also affect the market framework and have the same flow on affects aforementioned.

Pre-Privatisation

The NZED was the sole provider of generation in the market, effectively having a monopoly over New Zealand. At this point it was not required to pay a dividend to its shareholders because there weren't any, instead its main focus was ensuring supply of electricity in a cost effective manner (Chronology of New Zealand Electricity Reform, 2015). Without any competition in the market, the NZED could invest larger amounts of money into training, as they could be reasonably certain the investment would pay off, unless the technician left the country. The pathway for training pre privatisation was flexible in that the NZED could take on students and put them through the NZCE programme whilst working. There was also the opportunity to go to University on full pay and complete Bachelor of Engineering degrees, providing they agreed to be bonded to the company for four to five years post completion of training. This allowed for transparency in the quantity and quality of technicians within the industry, preventing any concerns in regards to a shortfall of skilled and experienced Power Technicians.

Privatisation – A Structural Change

Post privatisation, the sector was split up into various generating companies to create a competitive market place and ensure that electricity was supplied to customers at the best possible price. This external shock changed the way the sector was structured and then had a flow on effect to how the industry conducted itself, because of the performance of SOE's now being measured by profitability. For a number of years the companies employing technicians from the old NZED training scheme benefited from the training they received under the old system. The ageing of this group and the reliance some generating companies have on these individuals is now becoming clearer, and its future implications on the performance of the market are becoming apparent. The reasons for this are clear in that there is now a need to return profits to shareholders, there are difficulties in putting up the business case for longer term training when there are other short term needs for capital resources.

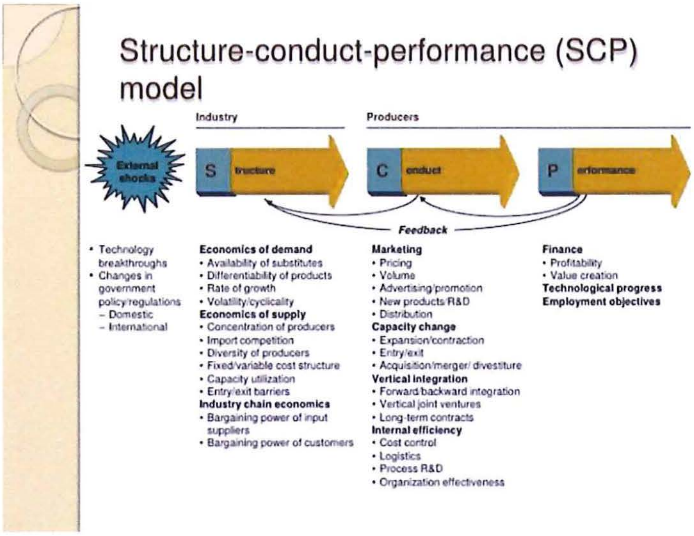

Figure 8 - Structure Conduct Performance Model (Stevens, 2009)

11.1.3 The Technician Resource Pool – Systems Perspective

The inventory model is used as a representation of the current 'stocks' and 'flows' of Power Technicians within the resource pool. In its most basic form it states that closing stock, equals opening stock, plus additions in the intervening period, minus losses in the same period (Perpetual Inventory, 2016) .

The inventory model relates directly to man power planning as:

- **As additions = recruitment and;**
- **Losses = retirements and resignations**

The 'control levers', which in one form or another affect the Power Technician resource pool through either the performance of the system (competency of the technicians within the industry) or the amount of technicians within the system, are going to be described throughout the report as the **5 R's**, which stand for the following:

- **Retention**
- **Retraining**
- **Recruitment**
- **Retirement**
- **Resignations**

The 5 R's identified above represent the first level of MECEing in McKinsey terminology, which refers to the mutually exclusive, but collectively exhaustive drivers to the given issue.

11.1.4 The Drivers of the 5 R's

Each of the 5 R's (drivers to the Power Technician resource pools quantity and quality) can be placed into their own cause and effect diagram (appendix 11.3), which is used within quality management. This is in effect, root cause analysis and it is able to identify how an outcome occurs in relation to the underlying people, processes, policies, procedures and any additional organisational incentive systems that shape the Power Technician resource pool. This is described as the second level of MECEing.

11.1.5 Integration into a Wider Management System – TQM

Given William Edward Deming's view that 85% of organisational underperformance is process related and only 15% people related (W. Edwards Deming: The man behind the Q, 2017), this fits well within the TQM framework as people and processes are enablers of outcomes. Furthermore, they provide the links by which one can start and asses/benchmark current practice against recognised best practice. A capability maturity assessment (CMA) diagnostic will be tabled to aid this aspect of the analysis (appendix 11.4).

11.1.6 Systems Alignment – VSM

The total quality management model does not allow one to analyse the alignment/coordination of an organisation in a structured way. Due to this, Stafford Beer's Viable System's Model is used to identify missing flows of information between various parts of the system that are necessary for it to act in a self-sustainable manner. This model has been adopted because of its successful implementation within Britton, G.A, McCallion, H (2002) 'Application of the VSM to the Trade Training Network in New Zealand' in 'Interpretations and Applications of Stafford Beer's VSM' edited by Espejo, R, Harnden, R (1989).

11.1.7 Trade Training Network – Validation of the VSM

Britton and McCallion (2002), used the Viable Systems Model to identify organisational deficiencies within the trade training network in New Zealand. The main issue which was highlighted for the application of the VSM, was that bureaucratic structures were failing to adapt to the turbulence of modern times. This theory has since been highlighted by the change in management models which has been seen around the globe, the slow movement from the industrial age management model to the innovation age management model, of which some companies have adapted slightly.

Britton and McCallion (2002), applied the VSM model to the trade training network, specifically the electrical and electronic areas. By breaking the levels of the network down into four separate areas of interest, that being the training system for trades, the training system for AAVA technicians, the training system for university graduates, and the training system for other training programmes.

The conclusion was that none of the levels of recursion were effectively viable, and recommendations were made on the flow of information and support that various units received (Espejo & Harnden, Interpretations and Applications of Stafford Beer's VSM, 1989).

11.1.8 Responsibility Mapping – RASCI Matrix

Given the flows of information through the VSM are critical to the systems coordination and overall function of an organisation, the RASCI responsibility matrix is a useful tool to identify and fix any of the missing linkages. It is an acronym from the initial letters of words (Agreeing on Roles and Responsibilities: Summary of RACI, 2017):

- R – **Responsible** – who is responsible for carrying out the entrusted task.
- A – **Accountable** – who is accountable for the task.
- S – **Support** – who provides support during the implementation of the activity/process/service.
- C – **Consulted** – who can provide valuable advice or consultation for the task.
- I – **Informed** – who should be informed about the task progress or the decisions in the task.

When nested within the VSM, this provides a well-focused lens for identifying systemic governance/management systems weakness, that are likely causes of the problem identified and will need to be addressed as part of the future thinking toolkit.

11.1.9 Analytical Framework Overall Synthesis

Figure 9, shows the overall synthesis of the management models and tools used to create the analytical framework.

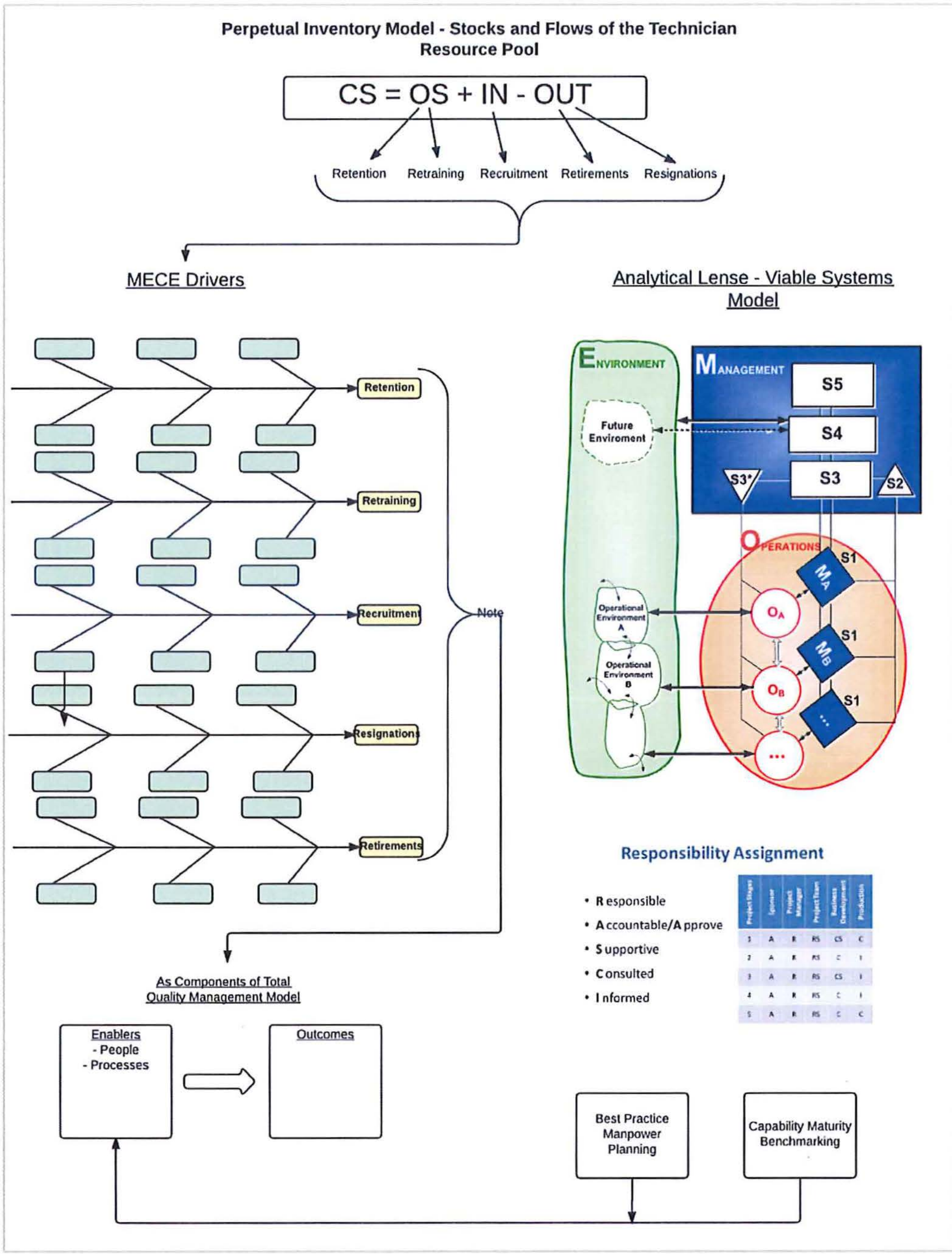

Figure 9: Analytical Framework - Overall Synthesis

11.2 Viable Systems Model

The Viable Systems Model is what is seen as the 'ideal world' in terms of information flow between operational and management levels, to ensure that the system can be self-sustaining within an organisation, or in this case an industry. The primary requirements for a system to be self-sustaining in this context are (Espejo & Gill):

- Implementation
- Coordination
- Control
- Intelligence and;
- Policy

The VSM model attempts to ensure that the system is reacting to its environment through the aforementioned factors. Often organisations are made up of many complex sub-systems and the VSM model will continue to analyse through each sub-system until it reaches the small business units which are producing the problem in question (Espejo & Gill).

<u>Contractor Model</u>

At the operational level (S1), the contractor can be split up into three separate hi-rachial groups, that being the technicians on the 'shop floor' who are completing the work, moving onto their direct technical management and then finally the contracting company as a whole, or more specifically their senior management. Coordination through the levels of S1 is achieved through face to face mutual facilitation.

In this context the management level of the VSM covers the generating companies, moving from hydro, wind or thermal maintenance onto strategic asset maintenance, to the company's board of directors who have the highest level of authority and can make financial decisions.

The information flow between operational and management levels within the VSM is conducted through the use of contracts and the tendering process. This can be seen in the model by the triangles labelled S2 and S3*. For the model to perform as the name implies, a 'viable' system, it must have the correct information flows going back and forth in a timely fashion to be able to adapt to a changing market environment. A market environment which as aforementioned, has been shaped by governance changes of the 1980's and 1990's. At the industry level, it seems there is not sufficient incentives on offer to allow training of new technicians, with factors such as; lack of future project investment, and a short viewed outlook on the industry, contributing to this.

Currently the system is not acting a viable manner, due in part to the decentralization of operational units and also the lack of control currently in play via the contract (S3*).

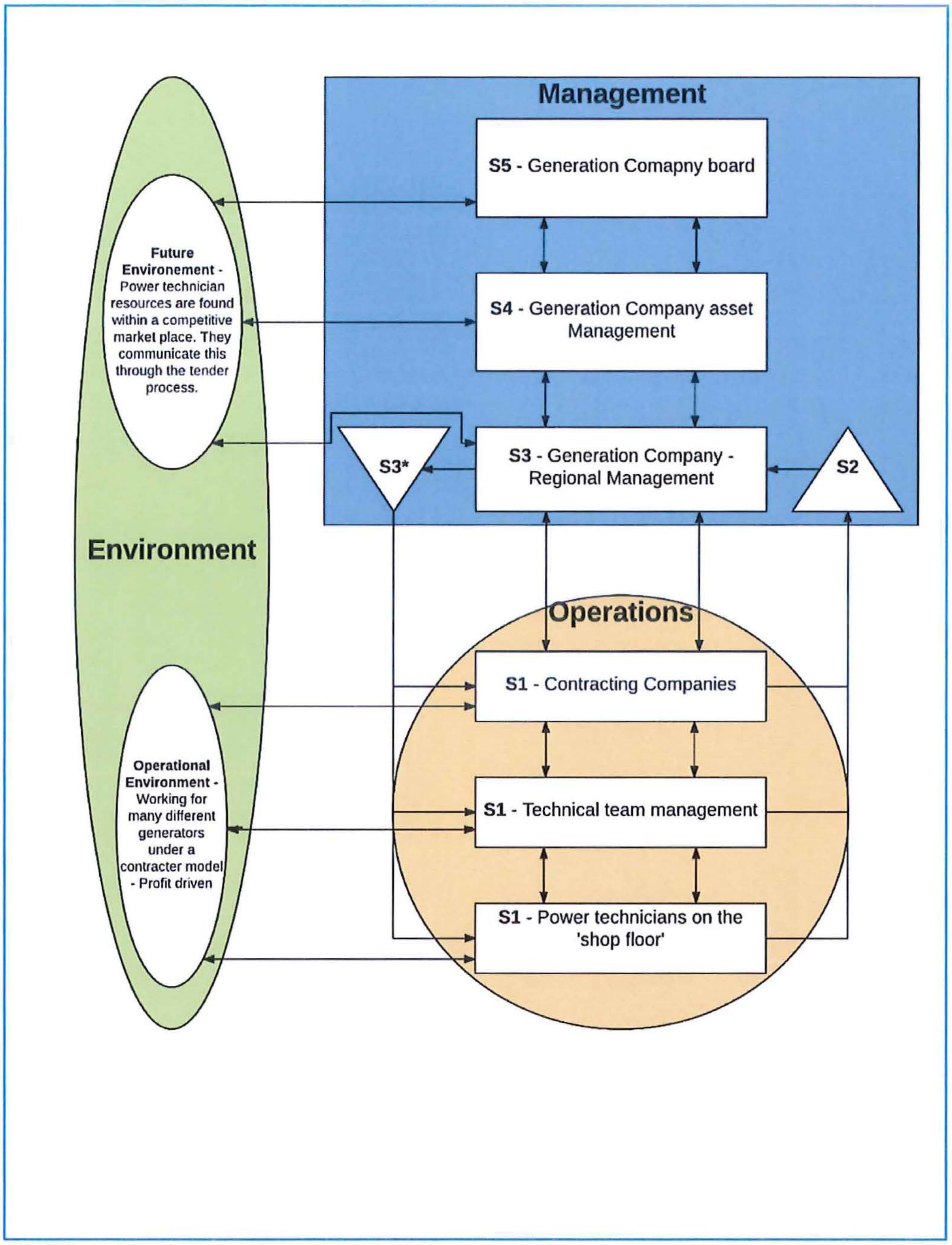

Figure 10: Viable Systems Model

11.3 Cause and Effect Diagrams

The cause and effect diagrams shown are a powerful tool used to visually describe the potential root causes for problem in question.

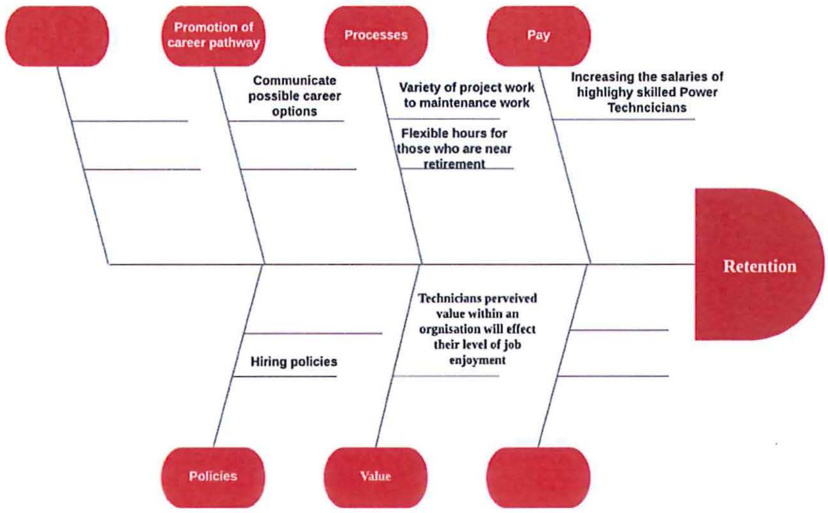

Figure 11: Cause and Effect Diagram: - Retention

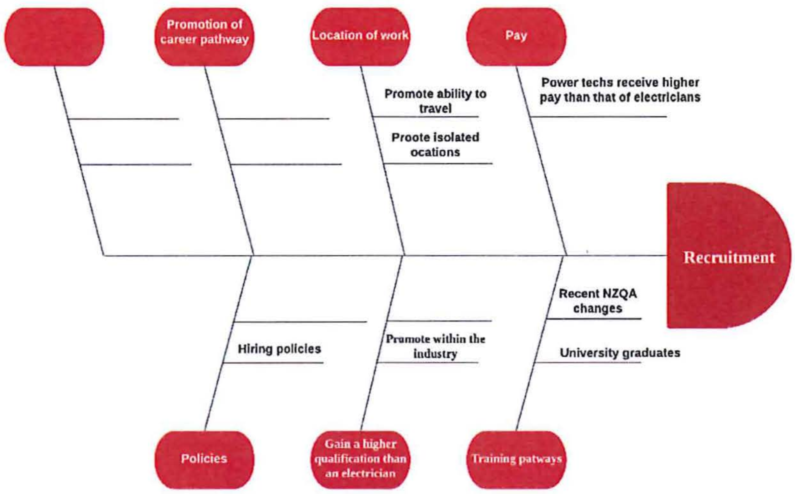

Figure 12: Cause and Effect Diagram - Recruitment

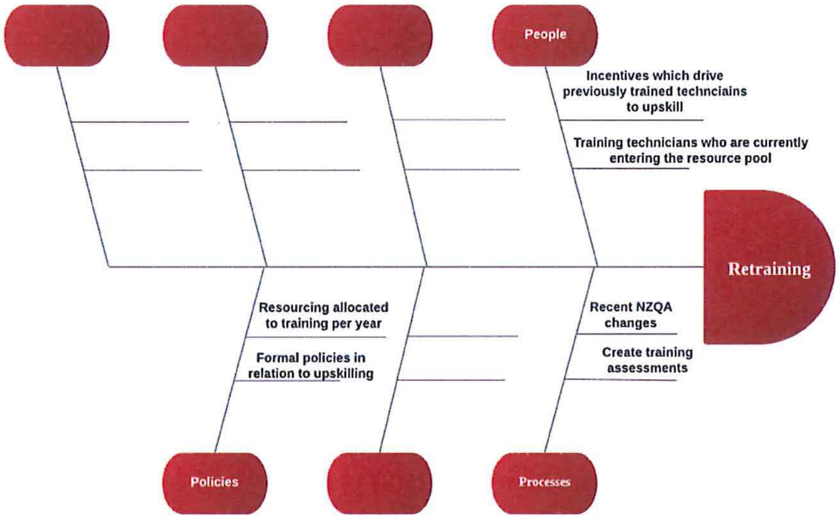

Figure 13: Cause and Effect Diagram - Retraining

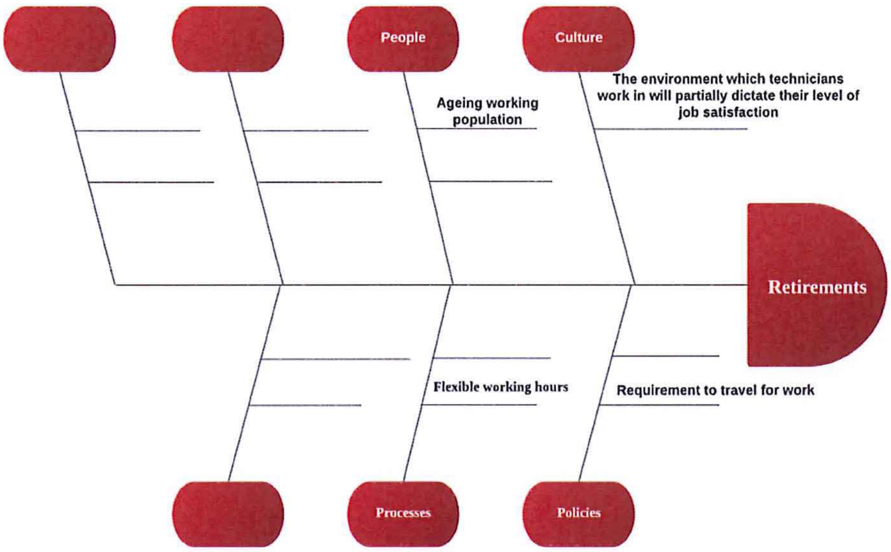

Figure 14: Cause and Effect Diagram - Retirements

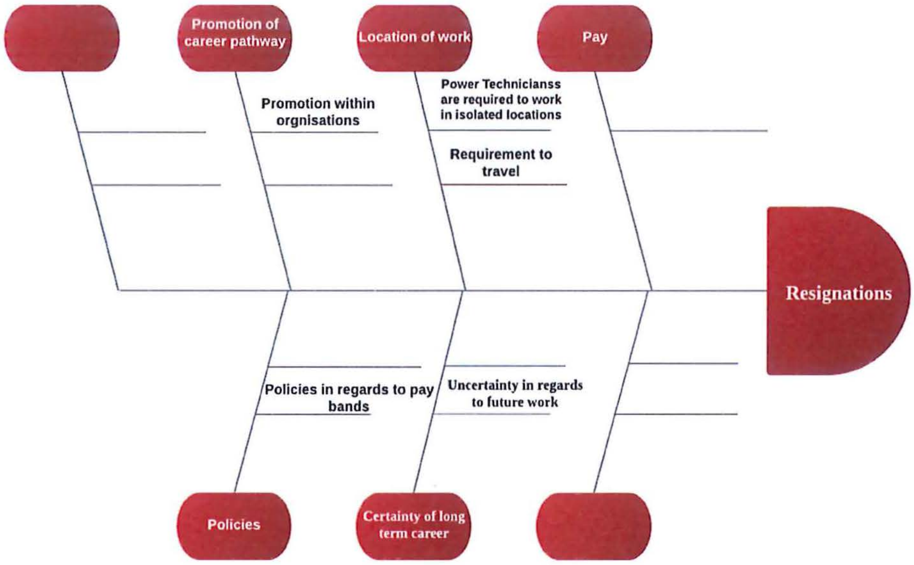

Figure 15: Cause and Effect Diagram - Resignations

11.4 Capability Maturity Assessment

Strategic workforce planning is a crucial part of the strategic planning process and is often something that is overlooked within organisations. The strategic workforce planning maturity index seeks to answer the question 'to what extent is the strategic workforce plan laying foundations for a high performing sustainable workforce, aligned to the future of customers, stakeholders and the organisation?' (Government, 2017).

This assessment is one of the final parts to the analytical framework outlined in section 4 and assesses the organisations current capabilities in the area of manpower planning by comparing the current state against best practices. This allows for each company to set strategic direction in terms of workforce planning. The current situation would depict that the industry is moving towards a more cohesive structure in terms of sharing information around strategic risks associated with a shortfall of Power Technicians, given the sponsors to this project. But the next step in actioning this is ensuring that the industry moves towards the leading edge side of the maturity index (table 6). This final step takes a workforce plan, to strategic workforce plan and allows for planning in collaboration with other stakeholders.

The following is an advised Strategic Workforce Planning Maturity Index that should be implemented within organisations, to ensure sustainable resourcing in the future (Government, 2017). Meridian Energy's current perceived position in terms of Power Technicians, is highlighted in yellow and it is advised that HR uses the following framework to push the current state towards strategic workforce planning. This is done so through the management information system recommendation outlined in section 9.2. As an organisation, HR perceived Meridian Energy to be within the range of administering to competent. This outlines the disconnection between operational and strategic management.

Table 6: Strategic Workforce Planning Maturity Index

	1. Awareness	2. Administering	3. Competent	4. Expert	5. Leading edge
Macro * It is assumed that lower levels are attained and included in higher level achievements	There is some understanding as to what workforce planning is in pockets of the organisation. However, there is not always a consistent understanding of what it means or how it affects the organisation as a whole. Often little or no dedicated resource.	The organisation has a workforce plan in place which is supported by management however there is limited understanding and commitment to system wide issues. Typically a siloed approach to looking at the organisation in segments.	There is a common approach across the organisation that clearly links to strategic plans. There is a clear vision of the workforce of the future to drive and deliver services to customers and stakeholders. An assessment of future needs is clearly articulated and strategies are driven by robust evidence based research. There is a deliberate emphasis on improved productivity, organisational culture, and 'One Government'.	The organisation has an integrated approach and understanding in driving workforce strategies and embeds proactive people management at the heart of the organisational strategy. There is a strong capability and know-how in how to lead and shape strategic workforce planning activities that are future focused, and a commitment to outcomes through agreed metrics. Leaders are engaged in outcomes and nurture fertile ground for workforce activities. Opportunities for cross-agency activities to build, buy and borrow capability and capacity are identified. Reporting is strategic and meaningful, and all levels of the organisation have ownership.	Used as a strategic business tool that is fully integrated into strategic and business planning processes and there is direct line of sight to all other strategic documents. Sophisticated scenario based demand forecasting of future business and service design is undertaken regularly. Plans contain breakthrough ideas and are agile enough to quickly respond to the changing environment. Considers the organisation as a part of an entire enterprise that transcends traditional boundaries and understands how changes in that organisation affect other parts of the system. Sector-wide issues are shared in a systematic joined up approach.

Table 7: Strategic Workforce Planning Maturity Index

	1. Awareness	2. Administering	3. Competent	4. Expert	5. Leading edge
Organisational design	There is an ad hoc approach to day to day workforce matters.	There are minor shifts in the business and service delivery models with minimal disruption to current workforce designs and practices.	Major shifts in the way business is delivered requiring a fundamental rethink of existing systems and models. Typically this would have significant job redesign and considerable efforts in reviewing service delivery.	Major paradigm shift in the way the needs of the workplace and community are matched to the workforce. These unleash potential and often involves pilots and trials as well as major stakeholder consultation and high level engagement with government.	Workforce strategies 'break the mould' of traditional structures, classifications, design, management, capability and capacity. These are innovative workforce designs and practices that are revolutionary and have rarely been tested in a public sector environment. There is a complete culture shift, for example from a steady 9-to-5 paradigm to an agile 'cloud-workers' paradigm.
Scenario planning and time horizon	Planning is focused on the immediate future (i.e. the next year's activities).	Planning looks at where the organisation needs to be in one to two years' time and typically assumes a single future as its goal. Typically departments with minor workforce agendas can fall into this area.	Departments are looking at three to four year cycles and are using scenarios to predict needs. Often this links into other strategic document cycles and is used to drive a high performance workforce.	Departments regularly use predictive analytics to forecast workforce needs for the next five years and typically undertake extensive scenario planning exercises to provide clarity of vision. Leaders are insightful, bold and courageous in their thinking about options and opportunities for more effective business models.	Planning not only considers the short term needs of the organisation but takes a longer term view and extends well beyond five years with future forecasting and blue sky thinking, and includes a clear vision of how to get there. Balances diverse information and analytical models to optimise a collection of tactics for different futures and are confident with complexity and uncertainty. Often global push/pull factors are taken into account in clarifying the future.

Table 8: Strategic Workforce Planning Maturity Index

		1. Awareness	2. Administering	3. Competent	4. Expert
Data inputs	Foundational demographic data is considered at a point in time, however rarely shapes the activities of the organisation. No benchmarking is done.	An expanded assessment of demographic trends and analysis is undertaken including manipulating data sets and lines of enquiry. Staff survey results inform workforce activities.	Translating data into information, finding connections, testing hypotheses and identifying root connections. There are common definitions across the enterprise. The department uses benchmarking to other public sector entities and relevant industry standards to analyse performance.	Inputs from all data sources including MOHRI, ABS, data warehouses, staff surveys, state of the service reports and economic modelling of skills supply and demand. Local analysis and improvements feed into sector wide data enhancements. Projections and trend analysis is integrated into strategies.	Complete understanding of lead and lag indicators across the organisation and coupled with other data, they are used as a solid evidence base to inform workforce strategies. Leverages analysis in business decisions and process improvement. Benchmarks are not only with other public sector entities, but also like industries around the world. Staff are experts or informed by experts on data analysis, how to forecast and project workforce data and undertake supply and demand analysis.
Engagement	Workforce plans are developed internally by a few key people.	Top down input in the development of workforce strategies.	People are empowered to provide input from across the organisation. Feedback is sought on draft plans and there is an iterative approach to design and implementation.	Stakeholder engagement strategies are in place to glean input from several strategic sources. Diagnostic tools are used effectively to extract relevant information from engagement results to inform workforce activities.	Deep engagement from not only across the organisation, but all key stakeholders including Ministers, private sector, NGOs, volunteers and other stakeholders external and internal to the organisation. There are effective feedback loops in place.

Table 9: Strategic Workforce Planning Maturity Index

	1. Awareness	2. Administering	3. Competent	4. Expert	5. Leading edge
Contingent workforce	Workforce deliberations are internally focused with no consideration beyond those on the departmental payroll.	Primary focus is on the paid workforce, however there is an appreciation of what working with external providers means for the organisation.	There is a deliberate focus on how to improve service delivery and business outcomes by working more effectively with the contingent workforce however, the depth of understanding is in its nascent stages.	The intrinsic public value of the organisation is clearly articulated. There is a complete understanding of the capabilities, capacities, attributes and positioning of other sectors. There is a holistic capability building model that partners to lift capability across industry with mutually beneficial outcomes.	The organisation maximises efficiencies with the contingent workforce by co-designing and co-producing outcomes through mutually beneficial approaches. This includes, but not limited to, proactive engagement with volunteers, contractors, NGO's, private sector and educational institutions. There is a strategic approach leveraging these skills to deliver government services that includes feeding into sector-wide strategies.
Governance and reporting	Ownership of the planning, development and implementation of workforce strategies sit with the HR Unit. Reporting is done on an ad hoc basis.	There is an understanding of who makes decisions and by what process. Regular reports are prepared but are not always used in a strategic way to inform workforce practices.	Managers have ownership of workforce strategies and their implementation. Governance frameworks are in place that illustrate the connections amongst all elements of the system. Regular progress reports using both quantitative and qualitative measures are tabled and discussed.	The authorising environment is clearly understood and articulated. Leaders own the workforce strategies and implementation. They understand their role in driving the workforce agenda and are able to respond to changing needs. Reporting is used in a strategic way to inform workforce practices.	The whole organisation knows and understands the vision for the workforce and their role in contributing to those outcomes. There is a clear line of sight to all strategic inputs. Reporting is aligned with other strategic reporting cycles and budget papers, and is examined in light of useful and meaningful output and outcome data. Decision making is devolved to the appropriate level and effective governance systems are in place to guarantee accountability.

Table 10: Strategic Workforce Planning Maturity Index

	1. Awareness	2. Administering	3. Competent	4. Expert	5. Leading edge
Risk assessment	There is an understanding of the risk factors in achieving the workforce strategies however there is a general sense of risk aversion.	Workforce risks have been articulated in the plan though there is varying levels of engagement in mitigating those risks.	Risk mitigation strategies are in place and link to organisation wide risk strategies. Roles are assigned and understood.	The organisation has a complete understanding of workforce risks, the costs, likelihood and impacts. Leadership teams have responsibility for primary oversight. There is a clear understanding of protocols for escalation and appropriate responses.	The organisation balances the need to take risks outside the normal paradigms with pushing the boundaries of a risk averse culture. A compliance culture is balanced with innovation and challenging the status quo. There is confidence in the ability to rapidly react to unanticipated futures. Assessments are realistic, evidence based and purposefully considered. Where appropriate, strategic risks feed into sector wide risk management strategies.
Change and transitions	There is a general awareness of change management processes included in any workforce strategies.	A change management strategy has been developed that looks at the granular detail of specific actions required.	There is a clear understanding of what model of change is being applied, as well as roles and responsibilities. All parties are informed and able to address staff uncertainties and community concerns.	The organisation takes a proactive strategic approach to planning for change. Actions are designed to be sufficiently agile and flexible to be adjusted to suit the emerging context. Staff receive ongoing support. Structures may need modification and organisational strategic plans are refined.	Change management is seen as a continuous improvement process in a constant state of adjustment and fine tuning that is an integral component of business. Major change agendas feed into sector wide strategies and are well prepared for with a complete understanding of the new business drivers. Unpredictable events are handled smoothly and with minimum disruption. There is a robust evaluation and review mechanism in place to enable ongoing learning.

11.5 Future Thinking Toolkit

The future thinking toolkit is the thought process that the reader has gained from this report. The report has touched on many of the interplaying factors that make up this complex issue and has set the direction to which action needs to be taken. This report is a dynamic report that requires ongoing research, where industry leaders need to take responsibility of the issue.

11.5.1 Accountability - RASCI

RASCI responsibility mapping will ensure that tasks regarding the ongoing monitoring of Power Technicians are actioned. The matrix ensures that people are held accountable for their actions, or lack thereof and can be assigned to HR that takes ownership of the issue.

Table 11: RASCI Responsibility Task Map

Task	Responsible	Accountable	Support	Consulted	Informed

The acronym stands for the following:

- **R – Responsible** – who is responsible for carrying out the entrusted task.
- **A – Accountable** – who is accountable for the task.
- **S – Support** – who provides support during the implementation of the activity/process/service.
- **C – Consulted** – who can provide valuable advice or consultation for the task.
- **I – Informed** – who should be informed about the task progress or the decisions in the task.

11.5.2 Process

The process shown outlines the general approach that should be used for monitoring of Power Technician Resources.

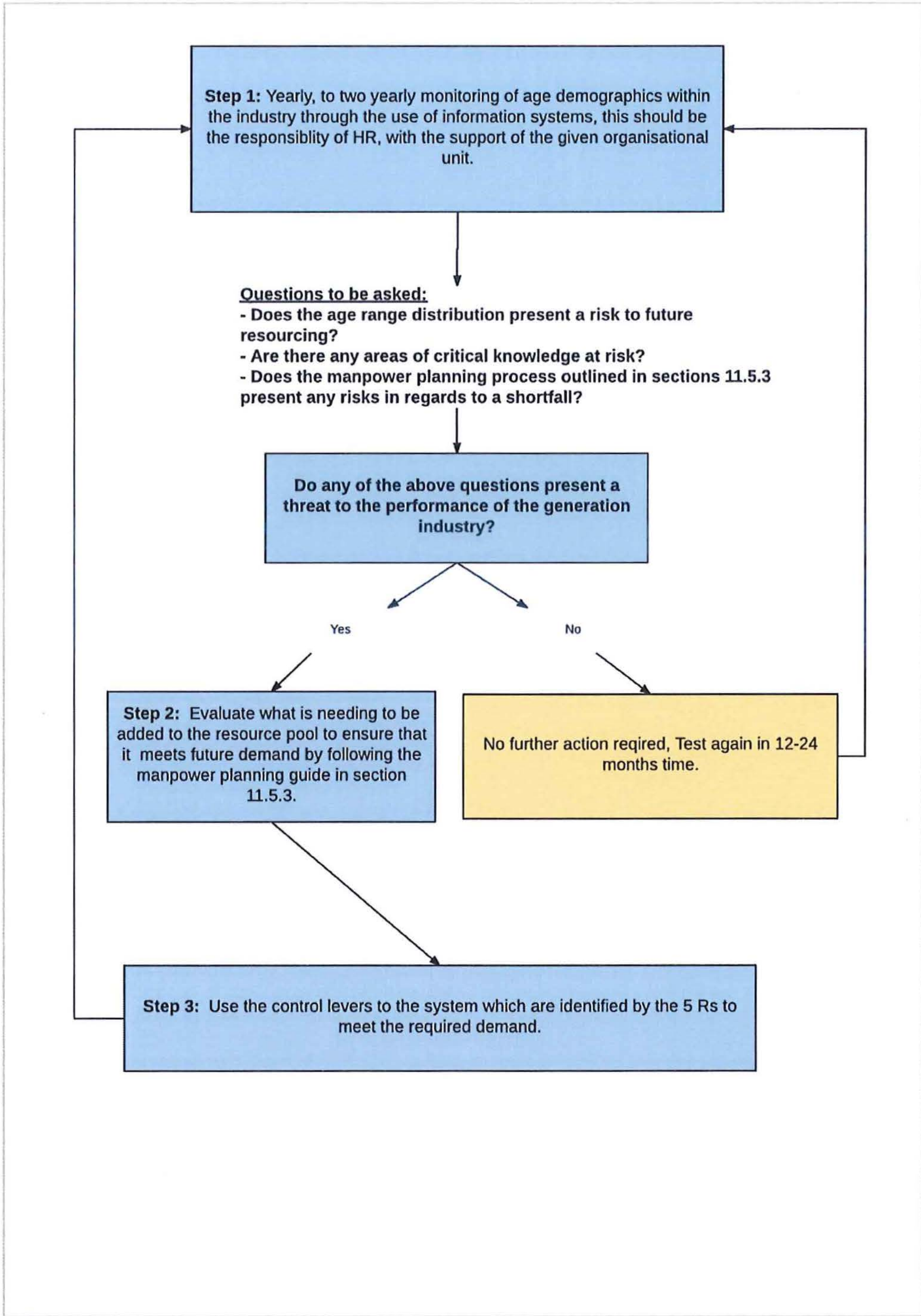

Figure 16: Task Group Flow Diagram

11.5.3 Manpower Planning

Man power planning in its most basic form is the theory of having the right people with the right skills, in the right place at the right time (Tripp & Ward, 2013). Because of the change in the industry structure after the privatisation of the energy sector and the contracting model which the industry currently uses, manpower planning at an organisational level is something that has only been adopted by a few stakeholders. Manpower planning for such small business units is very difficult and is often done on a one in one out basis. The situation that this creates is that the industry loses transparency in the quantity and quality of Power Technicians within the resource pool. The follow steps have been adopted from the 'Workforce Planning Guide' (Robinson & Hirsh, 2008) for the purpose of monitoring the state of the Power Technician labour resource pool:

Step 1: Analysing the workforce

Gather data on the workforce in question, and review the data to ensure they are relevant (Cillie-Schmidt, 2012).

- Personal details – Gender, age, ethnicity
- Job specific details such as; years of experience within each given field of generation, location, and perceived competence in given task areas as specified by the industry.
- Future plans

Step 2: Identifying skills gap

Identifying skills gaps is of paramount important to ensuring the tasks are completed to a high standard and the necessary skills are available when required. During this step, the industry should identify any changing technologies that are going to affect the way in which a technician completes their job. At this stage the group should have discussions with industry stakeholders on the possible areas of knowledge loss.

Step 3: Assessing future workforce demand

In order to match up the current workforce against future demand, it is necessary to identify what the demand will be. Given the break-up of the sector, collaboration at this level is difficult. All major project work from generating companies should be measured and collaboratively, demand should be measured to ensure that supply will match. Planning for the future in this regard is always uncertain and varying things can occur which will add for confusion such as political factors which often have short sighted objectives. Because of this, workforce planning should be seen as a framework on which recruitment strategies and training plans can be built off.

Step 4: Match recruitment and retention plans to the requirement of the shortfall or surplus

The previous three steps outline assessing the current workforce and its capabilities. This step is the process of matching what is missing from the system by identifying the wastage that is expected during the monitoring time period (this needs to align with the time taken to train technicians), including profiling of ageing cohorts (Robinson & Hirsh, 2008). The drivers to this step have been outlined within the report as the 5 R's.

Step 5: Understanding the labour markets and planning for succession

The final step involves analysing the markets to which the required resourcing will come from and how succession planning can aid in the prevention of knowledge loss within the system.

11.5.4 Workforce Strategy Matrix

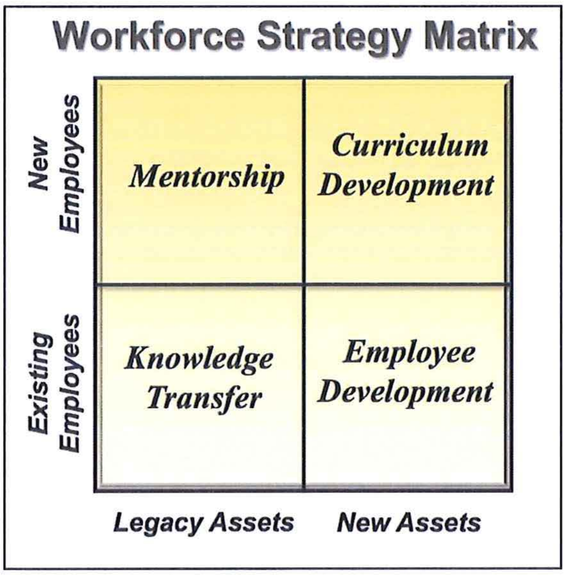

Figure 17: Workforce Strategy Matrix

The workforce strategy matrix above is a simple representation of the direction in which education and training should be going (Ray, 2013) . The matrix shows the relationship which is needed for certain individuals within the workforce, from old employees working on old assets, to new employees working on new assets. This strategy is very high level but has the same underlying principles outlined in many of the workforce age management strategy reports. The workforce strategy matrix should be tailored to each of the generation types and align with the skills areas which are lacking within each organisation and then conveyed to the task group for further action.

11.6 State of Foreign Industries

11.6.1 North America – Hydropower Technology Roundup Report - Summary

The Hydropower Technology Roundup Report: Meeting Hydro Staffing Challenges, by Hosko and Vansant (2003) summarises the state of hydro power resources in the Northern American hydroelectric power industry. There has been a combination of factors that have caused the workforce crisis, but the main one is that of the retirement of the 'baby boomers' generation, who were responsible for looking after the generation assets throughout the 1970's – 1990's (EPRI, 2006). In combination with the ageing demographics of the baby boomers, there was the privatisation of the energy sector and deregulation of electric utilities, which caused for the emergence of market competition and in turn forced companies to run far leaner operations, which reduced staffing numbers and intake. Also another part of running leaner operations, was that of keeping the more experienced staff who can operate the assets to a high and efficient standard.

It was noted that the average age of a hydro plant worker was 46 years in the US, in 2003.

Hosko and Vasant (2003), explore various approaches that some of the hydro operators can take to prevent the effects of some of the challenges aforementioned. Because the hydro plant operators face higher demands but with a reduced workforce and tighter budgets, the requirements of time and expense for employee training is becoming a major concern. It was suggested that these operators need to take advantage of practical methods of learning such as eLearning programmes and web casts that reduce the time and expense pressures aforementioned.

The report represents a large proportion of Americas Hydro industry, as the 17 generators included in this research make up an approximate total of 49% of the industry itself. The following points were deemed as priorities to many of the generators interviewed: (EPRI, 2006).

- Large number of impending retirements.
- Knowledge transfer concerns as personnel are lost to attrition (or retirement).
- Training new and existing employees for upper-level positions.
- Providing employees with adequate training (including both course content and scheduling training time).
- Retaining new employees and providing them with rapid advancement.

The report involved a three step approach to providing tools to meet the challenges aforementioned. The first step involved interviewing the 17 generation companies involved to identify the reoccurring problems as seen by the industry, followed by workshops which were designed to provide a collaborative approach to providing satisfactory hydro plant staffing. Some of the challenges which were presented which apply to the Power Technician resources in New Zealand are that of:

- The need for succession planning and knowledge transfer programs to deal with expected retirements. Acknowledged skills gaps were to be addressed through mentoring of newly hired staff and candidates for senior level positions.
- As apprentice programmes were already in place, it was identified that methods for measuring competency of these individuals were necessary.

Knowledge transfer had many feasible recommendations that could be used to prevent the loss of knowledge:

- The use of retirees as mentors and consultants: Replacements should be hired some months in advance to essentially train the replacement before leaving. Also bringing back retirees in order to act as consultants is seen as favourable.
- Developing a standardised set of work orders, check sheets and facility manuals would act as a formal documentation to prevent any knowledge lost in specific areas.
- Creating formal information filing system for processes, procedures and policies to capture and retain important information.

Maintaining a skilled hydro workforce was seen as an important challenge to the industry and the workshops produced a variety of methods, including:

- Training on new equipment through the use of the OEM.
- Extensive use of on the job training.
- Video and computer based training aides.

Recruiting new staff was also seen as an important aspect to ensuring the future staffing resources within the industry were satisfactory and for that the following practices were mentioned:

- Relocation bonuses, retention bonuses, or bonuses for working in remote locations.
- Flexible working conditions.
- Rotation programs to expose new technical personnel to all aspects of the hydro business.

11.6.2 Pacific Northwest – Workforce Challenges of Electric Power Employers in the Pacific Northwest - Summary

The report "Workforce Challenges of Electric Power Employers in the Pacific Northwest" (Hardcastle, Jull, & Hanson, 2013) has been produced by Washing State University for the purpose of identifying employment and workforce educational needs. The study itself involved 16 regional electric power employers from Idaho, Montana, Utah, and Washington.

Noted recruiting and hiring challenges:

Hardcastle et al (2013), highlighted that many of the employers interviewed had concerns over the lack of qualified applicants to the positions available within the industry. In the American system there were many factors thought to be attributing to this problem but the major causes being:

A limited secondary labour pool has occurred because of reductions in other industries and has negatively impacted the energy sector who would have once looked into these resource pools.

The paper outlined that employers were having to recruit much more widely than previously and this has had effects on the hiring costs. It was noted that because of the shortfall of qualified applicants, employers were having to offer much higher compensation packages to attract the skilled workers.

<u>Solutions and actions: Short – term</u>

- Employers should be encouraged to delay their planned retirements by providing better incentives to keep skilled workers on longer.
- Restructure the work of near-retirees to allow more time to mentor and train replacements
- Attempt to re hire people who are retiring or have retired to fill imminent skills gaps.
- Create a formal documentation of the competencies and critical work functions to ensure that knowledge isn't lost and is passed onto new employees.
- Recruitment should be seen as an important aspect to adding new employees to the resource pool.
- Expand the use of incentives and other drivers such as flexible work schedules and benefits to retain highly skilled individuals.

<u>Solutions and actions: Long - term</u>

- Leverage and expand partnerships. As resource constraints are the driving force to many of the problems occurring, by leveraging and expanding partnerships between the industry, education, organised labour and the government this will allow for an environment that would promote the workforce.
- Enhance education and training capacity and responsiveness. Employers and their respective training organisations need to continually asses the current state of skills across the industry in order to allow for a timely response, given there is an issue. Connections between the industry and education need to be strengthened to ensure that programmes develop as does the conditions individuals work in.
- Adapt the future labour supply. Hardcastle et al (2002), highlighted that companies were wanting to hire experienced personal, however the power industry needs to ensure that the supply is there in the future to meet the required demand. This can be done by inspiring young people to work in the energy sector and improving the recruiting and hiring practices currently used.

11.6.3 European Toolkit for Ageing Demographics - Summary

The ageing demographics of labour resource pools is evident in Europe, as outlined in the 2005 European Working Conditions survey, with 40 percent of workers in the electricity, gas and water sector being over the age of 45 (Thirion, Fernandez, Hurley, & Vermeylen, 2005).

Many of the electricity companies with demographic issues will be starting to notice the challenges and problems occurring within the industry currently. As this issue was identified back in the early 2000s, many companies have started to take proactive approaches to this issue, to ensure that the labour resources will be available in the future. Recruiting and retaining older workers is seen as one of the strategic moves to prevent the short-term affects of an ageing labour force.

<u>Recruiting and Retaining Older Workers – Short Term Solution</u>

Age friendly recruiting:

As the older working population often hold a wealth of knowledge within their area of speciality it is important to try and attract and retain these workers to prevent the 'brain drain' as aforementioned. Good practices noted in the toolkit include job advertisements that promote age diversity; interviewing and selection procedures that focus on skills, competencies and experience.

Lifelong learning, training and developing the skills of older workers:

As the environment in which the industry operates is continuously changing, the need to train older workers is important to the productivity of the employer. Employees need to be committed to learning and developing their skillset throughout their entire working lifetime. If companies put a priority on training and development of their older workers, they will be able to meet the skills deficit which is often seen in older workers, who often perceive up skilling a waste of time and effort.

<u>Knowledge management and transfer</u>

The toolkit has identified the need to have processes in place to transfer knowledge which is seen as critical to the business. These processes can be things such as using technology in the transfer and documentation of knowledge and also mentoring programmes.

Planning for the correct skills matrix

Hiring new employees is important to organisations as it provides new forms of talent, however relying on these individuals to meet all skills needs is not practical. Retaining older workers to allow knowledge transfer is paramount to ensuring that industry critical knowledge is passed on. This is emphasised more within highly technical professions.

Flexible working time and work-life balance

As employees approach retirement age, their preference for more flexible working hours increases and the industry needs to be able to accommodate this in order to prevent losing valuable knowledge. Some of the practices included within the toolkit were things such as (Pillinger, 2008):

- Company-wide flexible working time policies.
- A company culture of work-life balance.
- Working time credit schemes.
- Flexible retirement.
- Training for managers on how to manage flexible working time.
- Workplace surveys of working time preferences of workers.

Recruiting and retaining younger workers

Increasing the interesting among young people in schools and colleges was noted as important to recruiting and retaining younger workers. Some of the methods outlined are:

- Giving presentations in schools and colleges and at careers fairs.
- Informing young people of the career opportunities.
- Promoting the industry during recruitment days.
- Taster sessions for young people

11.7 Students Enrolled in Electrical Engineering Courses - UC

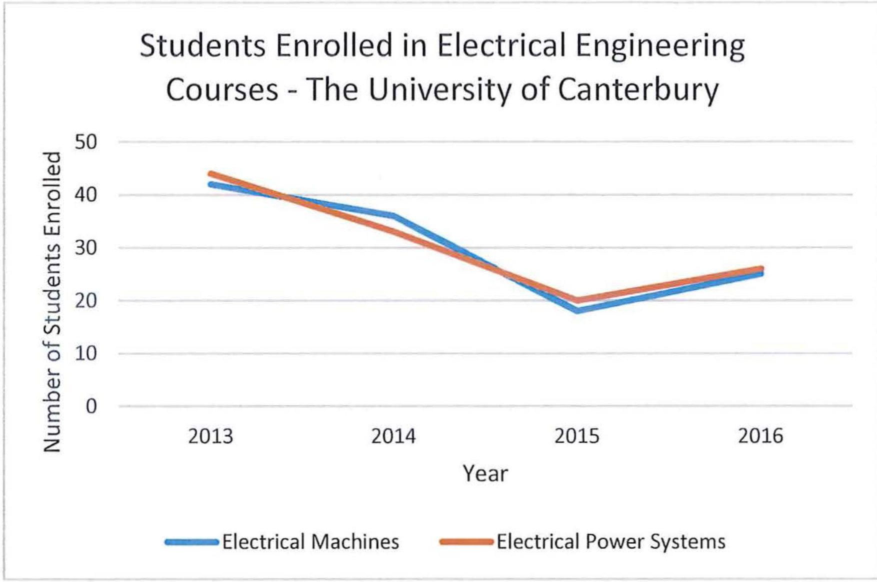

Figure 18: Students Enrolled in Electrical Engineering Courses at UC - Electrical Machines - Electrical Power Systems

The graph depicted shows the number of students completing the Electrical Machines and Electrical Power Systems papers at The University of Canterbury. As shown, the numbers have dropped in recent years.

11.8 EPRI Survey – Expected Type of Knowledge Lost

Table 12: EPRI Survey - Expected Type of Knowledge Lost

Types of Knowledge	**Percentage of Respondents**
Historical knowledge of equipment, design, and systems	75%
Lessons learned from previous events of activities	72%
System engineering knowledge	67%
Troubleshooting skills	67%
Maintenance techniques	58%
Knowledge of design (or operational) changes	47%
Organizational history	19%
NDE (non-destructive examination) inspection skills	11%

11.9 Technician Manager Generic Questions

Questions for technician managers

General

- Tell me about your position?
  - Formal job description
  - Who do you report to etc.? (Flow of information)
- Tell me about your recruitment process for technicians
  - Have you had any experience with recruiting foreign technicians?
  - If so can you tell me about why you did this and your experience in doing so?

State of resource pool

- Tell me about the state of your technician resource pool
  - How would you describe the competency of your resource pool?
- What is the age distribution of your technicians?
- Tell me about the training your technicians do
  - ITO's etc.
- Do you think the correct training is on offer to ensure that your technicians are meeting the safety, reliability and quality that the industry expects?
- Can you tell me about the variety of work your technicians do?
- What processes are in place which look at the state of your resources compared to the demand of the industry?
- Have you noticed any changes in technology that have changed the way your technicians complete their job?

Future

- Do you have contingency plans in place for when some of your more experienced technicians leave?
- Do you plan on recruiting any Power Technicians in the coming future and if so where from?
- If not already a problem can you see there being a problem with the amount of Power Technicians in New Zealand or the training currently in place?

11.10 Technician Survey Questionnaire

Demographic/Technician Info

- Name/company
- Age
- Ethnicity
- Please list your formal job description and if that description came with a list of capabilities and competencies that were required to complete the job
- Please describe the tasks you undertake
- How many years have you worked as a technician and in what generation sectors? E.g. hydro, thermal, wind. (If you're an industrial electrician, but completing some technician tasks, please comment outlining this)
- Where are you based from and where do you travel to work?
- What is the mix of the work you undertake? E.g. 50% project work/50% maintenance work
- Could the mix of project to maintenance work change to better optimise your skill set? If so, how?
- What incentives are there in place to becoming a technician?
- What barriers are in place to becoming a technician? Please add to 'other' option if not already noted
- Level of job enjoyment

- What are the HR processes in place (if any) to identify the future training which is needed to keep your skill set to the required standard?
- Are you given the opportunity (time and resources) to complete this training?
- Are you aware of better ways of doing things that have allowed you to be more efficient in completing your job (processes and/or new technologies)?
- Where you have identified there to be an opportunity to do something better or more efficient within the business, how hard has this been to implement?

Where you have identified there to be an opportunity to do something better or more efficient within the business, how hard has this been to implement?

Please rate your level of competence in the following areas from 1-5:

- Generator/Transformer protection – Fault finding and analysis
- Generator/Transformer protection – New installations and commissioning
- Governor systems – Fault finding and analysis
- Governor systems - New Installation/EIPC testing
- Excitation systems – Fault finding/Analysis
- Excitation systems – New installations and EIPC testing
- Transformers (Power) – Routine testing (IR, PF, ratio, resistances Etc.)
- Transformers (Power) – New installs and commissioning
- Generator/Rotor testing
- Generator/Rotor New installs and commissioning
- C & I calibrations (pressure switches, transducers, level devices)
- Generator/turbine - Load rejections test
- Generator/turbine - Efficiency/performance testing
- Generator/turbine control and sequencing (PLC, SCADA, hardwired logic) – Fault finding, investigations and analysis.
- Generator/turbine control and sequencing (PLC, SCADA, hardwired logic) – New installs and commissioning.
- LV/HV circuit breakers – Fault finding and analysis
- LV/HV circuit breakers – New installs and commissioning
- DC Systems / VPS – Fault finding and repair
- DC Systems / VPS – New installs and commissioning

Future Plans

- What are your plans within the next 5 years?
- Given the opportunity would you be willing to change from your current generation sector to another? E.g. Thermal to Hydro

11.11 Advertisement as seen on Polytechnic Website

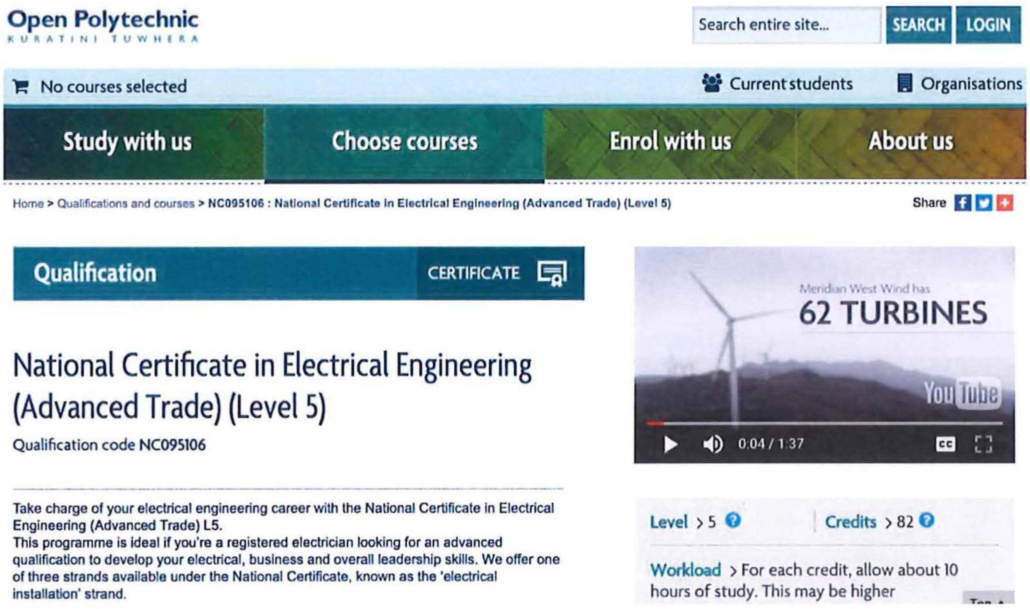

Figure 19: Polytechnic Advertisement Example

The above screenshot from the Open Polytechnic shows a good example of wind technician promotion within New Zealand (Open Polytechnic, 2017) . Highlighting the possible career paths on training institution websites as shown above will increase the exposure of the generation industry.

11.12 New Zealand Certificate in Electricity Supply

Qualification details

Title	New Zealand Certificate in Electricity Supply (Power Technician) (Level 5) with optional strands in Communications Systems, Generation, Metering, and Transmission and Distribution		
Version	1	**Qualification type**	**Certificate**
Level	5	**Credits**	**135**
NZSCED		031311 Engineering and Related Technologies > Electrical and Electronic Engineering and Technology > Power System Maintenance	
Qualification developer		Infrastructure ITO (Connexis)	
Next review		31 December 2021	
Approval date		Dd Mmmm 2016	

Strategic purpose statement		This qualification is suitable for people entering into, or who are currently employed in the electricity supply industry. They may be changing their career path from elsewhere in the electricity supply industry. This qualification is designed to provide the electricity supply industry with Power Technician graduates who have sufficient technical and theoretical knowledge, practical skills and experience to work safely to industry practices. Graduates will be able to take responsibility for their work and that of others, and be capable of working with self-management. The optional strands recognise specialist skills and knowledge specific to specialised roles and contexts within the power technician sector of the electricity supply industry.
Outcome Statement	**Graduate profile**	Graduates of this qualification will be able to: - Apply knowledge of power engineering and protection theory and principles to power systems when working as a power technician. - Apply theory, codes, legislation, and industry procedures for the wiring, testing and commissioning of electricity supply assets to work as a power technician. - Apply a range of communication skills relevant to work in the field of power technology. - Ensure that health and safety requirements are met while carrying out network operations in the electricity supply industry. Graduates of the Communications Systems optional strand will also be able to: - Apply skills and knowledge of communication systems used in the distribution, transmission and generation sectors of the electricity supply industry. Graduates of the Generation optional strand will also be able to: - Apply skills and knowledge of electricity generation systems in the electricity supply industry. Graduates of the Metering optional strand will also be able to: - Apply skills and knowledge of electricity metering and installation standards to electricity supply metering installations. Graduates of the Transmission and Distribution optional strand will also be able to: - Apply skills and knowledge of specialist plant and equipment used in the electricity supply industry.
	Education pathway	Bachelor in Engineering graduates may seek entry into this qualification, as a specialist pathway. Graduates may progress to the following qualifications:

		- New Zealand Diploma in Engineering with strands in Civil Engineering, Electrical Engineering, Electronic Engineering, and Mechanical Engineering [Ref: 2612] - New Zealand Diploma in Engineering Practice (Level 6) [Ref: 1714] - Higher level study in electrical or telecommunications.
	Employment pathway	Graduates of this qualification will be eligible for employment as a Power Technician in the electricity supply industry. Graduates will be eligible to apply for EWRB registration as a limited scope electrical engineer.

Qualification specifications

Qualification award	This qualification can be awarded by any organisation with an approved programme or accredited to deliver an approved programme leading to the qualification.
Evidence requirements for assuring consistency	Core evidence requirements for demonstrating consistency for the qualification will include: - internal and external moderation results relating to the assessment of graduate outcomes - feedback and actions taken in response to feedback - programme completion data and results - any other relevant evidence.
Minimum standard of achievement and standards for grade endorsements	Achieved.
Other requirements for the qualification (including regulatory body or legislative requirements)	None.

General conditions for the programme leading to the qualification

General conditions for programme	Tertiary Education organisations (TEOs) offering programmes leading to this qualification must maintain currency with amendments to, and replacements of, relevant legislation, regulations, rules, and Australia/New Zealand standards. Programmes must ensure that the competencies required for registration with the EWRB as a limited scope electrical engineer are met. It is recommended that programme developers refer to the more detailed condition guidelines related to this qualification. For a copy of the guidelines document contact the qualification developer at: qualifications@connexis.org.nz.

Conditions relating to the Graduate profile

Qualification outcomes	**Conditions**

1	Apply knowledge of power engineering and protection theory and principles to power systems when working as a power technician. Credits 90	
2	Apply theory, codes, legislation, and industry procedures for the wiring, testing and commissioning of electricity supply assets to work as a power technician. Credits 35	
3	Apply a range of communication skills relevant to work in the field of power technology. Credits 5	
4	Ensure that health and safety requirements are met while carrying out network operations in the electricity supply industry. Credits 5	
Communications Systems optional strand		
5	Apply skills and knowledge of communication systems used in the distribution, transmission and generation sectors of the electricity supply industry. Credits 45	
Generation optional strand		
6	Apply skills and knowledge of electricity generation systems in the electricity supply industry. Credits 55	
Metering optional strand		
7	Apply skills and knowledge of electricity metering and installation standards to electricity supply metering installations. Credits 25	
Transmission and Distribution optional strand		
8	Apply skills and knowledge of specialist plant and equipment used in the electricity supply industry. Credits 25	

Transition information

Replacement information	National Certificate in Electricity Supply (Power Technician) (Level 5) with an optional strand in Generation and Sustainable Energy [Ref: 1260].

Candidates currently working towards the replaced qualification may either complete the requirements for that qualification by 31 December 2019 or transfer to this qualification.

The last date for entry into programmes leading to the replaced qualification is 31 December 2017.

The last date for assessment is 31 December 2019, at which stage the replaced qualification will be discontinued.

It is the intention of Infrastructure ITO that no existing trainee should be disadvantaged by these transition arrangements. Any person who considers they have been disadvantaged may appeal to the qualification developer - Infrastructure ITO (Connexis) at qualifications@connexis.org.nz, or 04 499 9144.

11.12.1 Added Optional Generation Strands.

		Optional Strand Generation		
XX12PT	DE5404	Demonstrate knowledge of electrical machines	5	15
XX13PT	DE5403	Demonstrate knowledge of electronics engineering in the electricity supply industry	5	15
XX16PT		Demonstrate and apply knowledge of excitation systems on electrical machines.	5	6
24692		Demonstrate knowledge of water turbine governors for hydro-electric power plant	4	10
XX18PT		Demonstrate and apply knowledge of complex protection systems	6	12

Table 13: Added Optional Generation Strands

11.13 Skills shortages

Skills shortages were identified through self-perceived competence in the given task areas. Technicians competency being based on a scale from 1-5, no competence, to fully competent.

Comments

The sample size does not reflect what is exactly within the resource pool and was focused towards hydro and thermal generation.

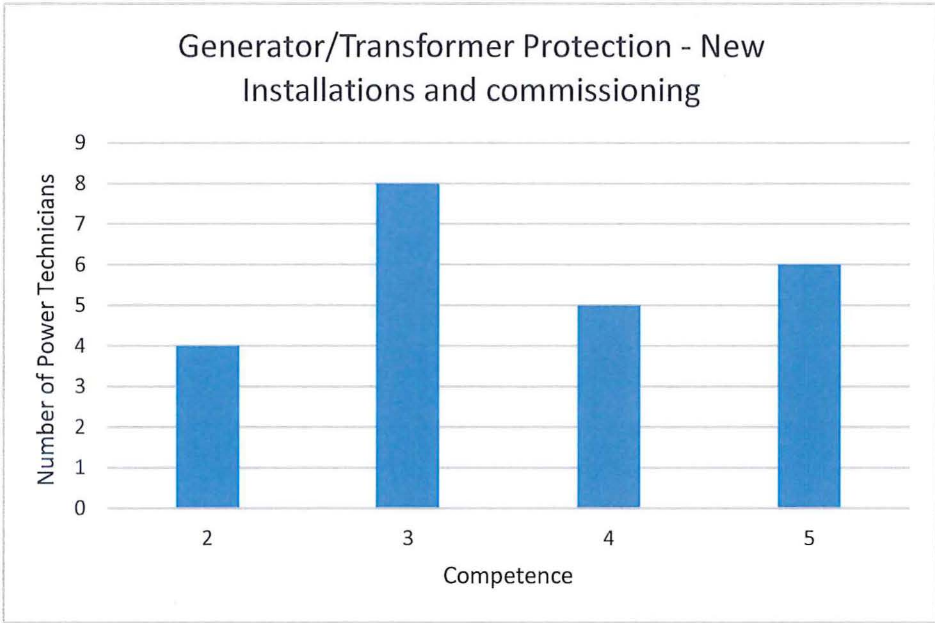

Figure 20: Generator/Transformer Protection - New Installations and Commissioning

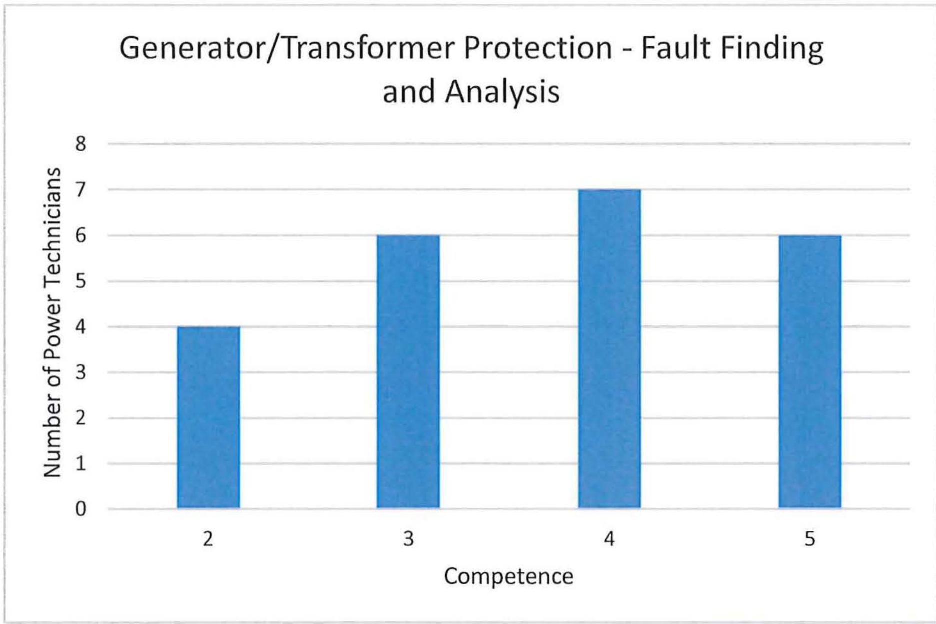

Figure 21: Generator/Transformer Protection - Fault Finding and Analysis

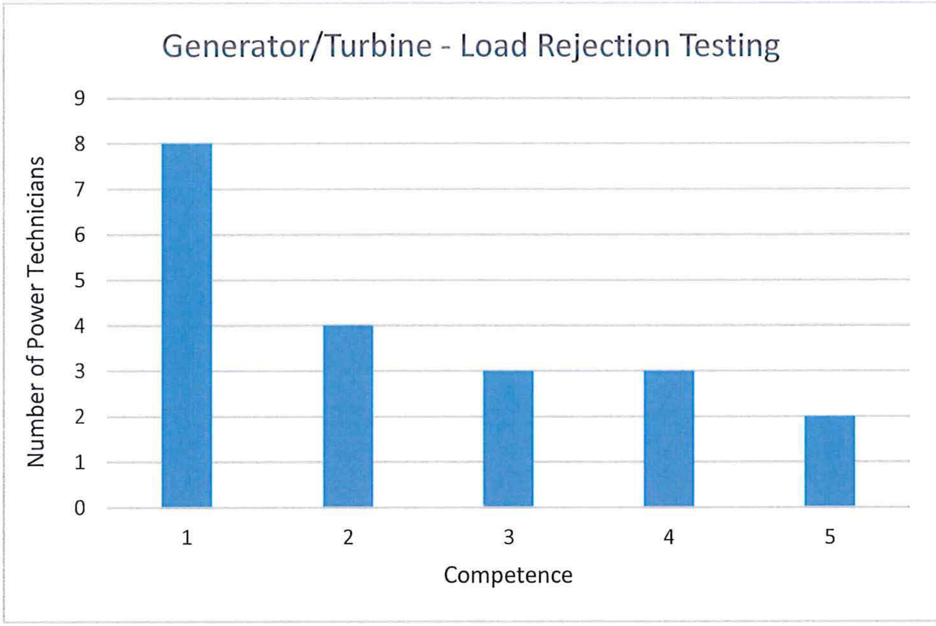

Figure 22: Generator/Turbine - Load Rejection Testing

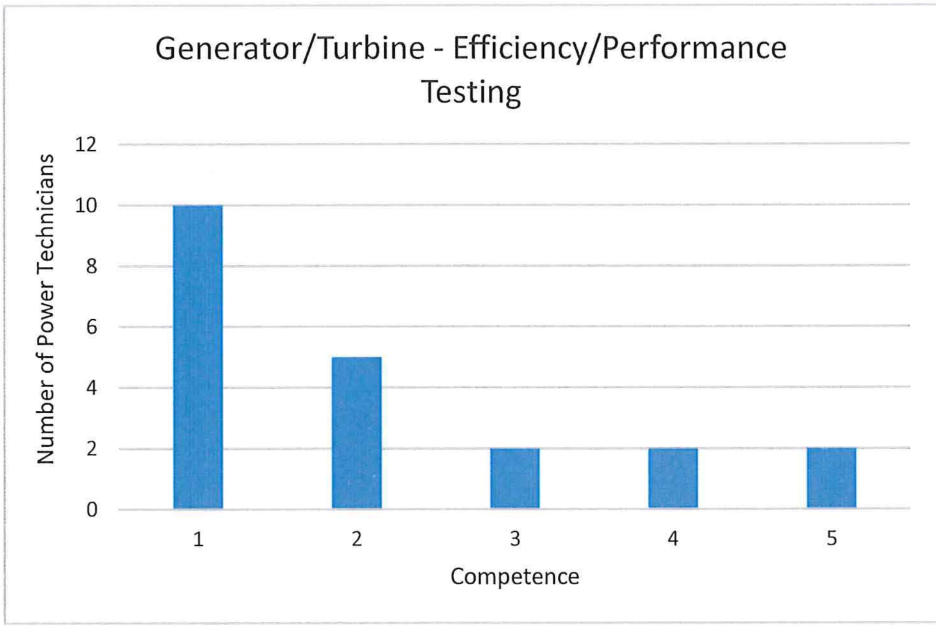

Figure 23: Generator/Turbine - Efficiency/Performance Testing

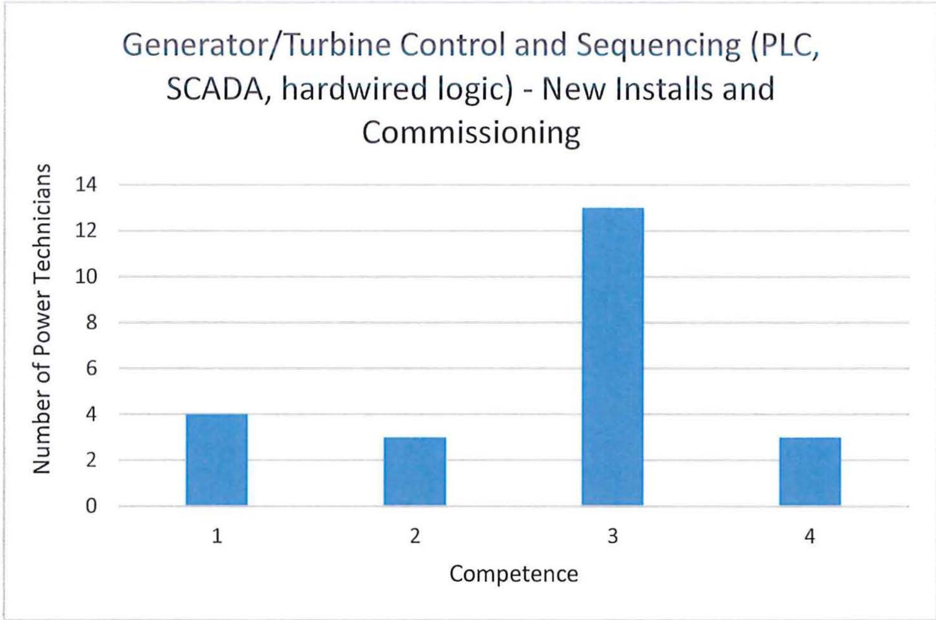

Figure 24: Generator/Turbine Control and Sequencing (PLC, SCADA hardwired logic) - New Installs and Commissioning

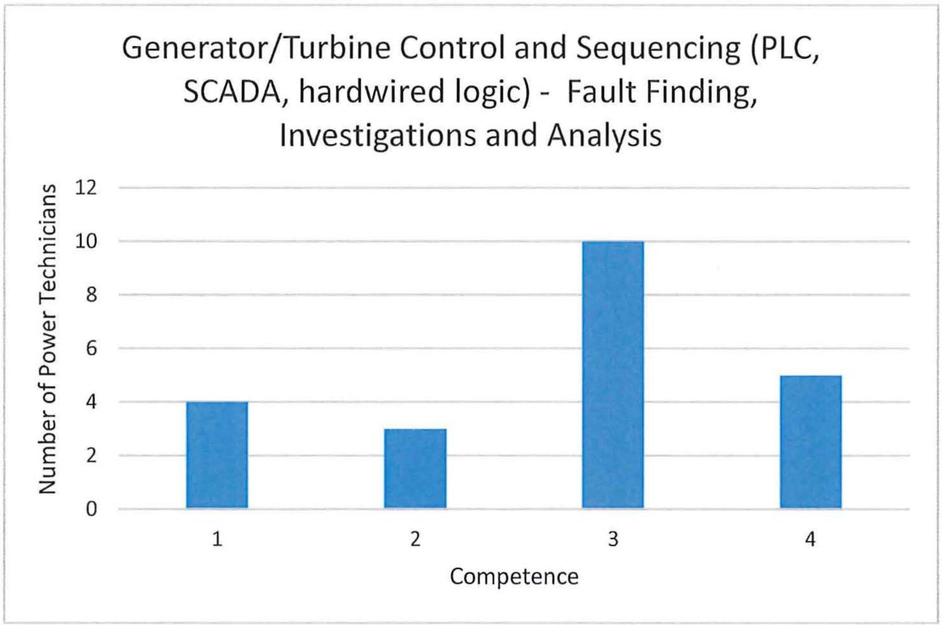

Figure 25: Generator/Turbine Control and Sequencing (PLC, SCADA, hardwired logic) - Fault Finding, Investigations and Analysis

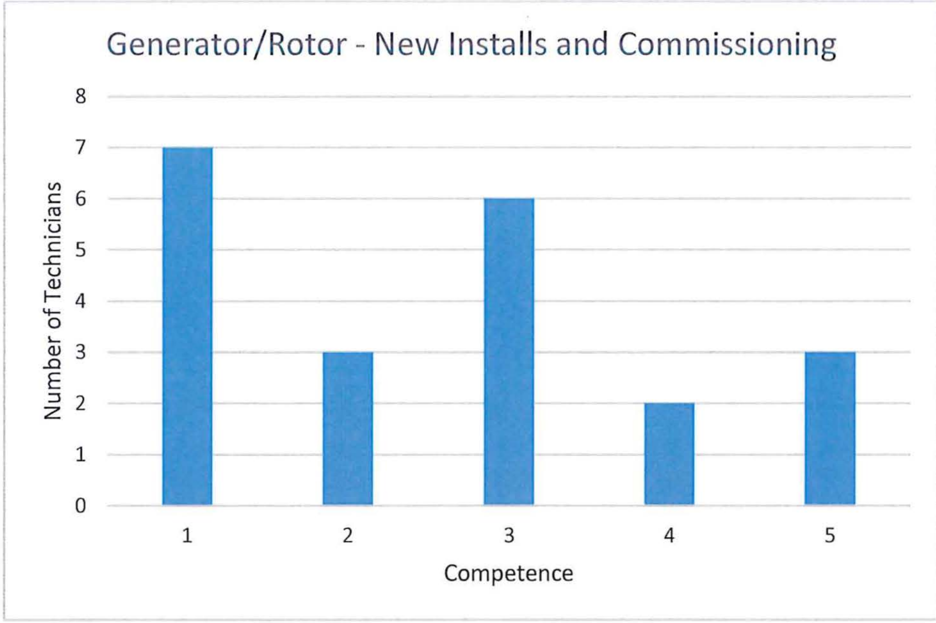

Figure 26: Generator/Rotor - New Installs and Commissioning

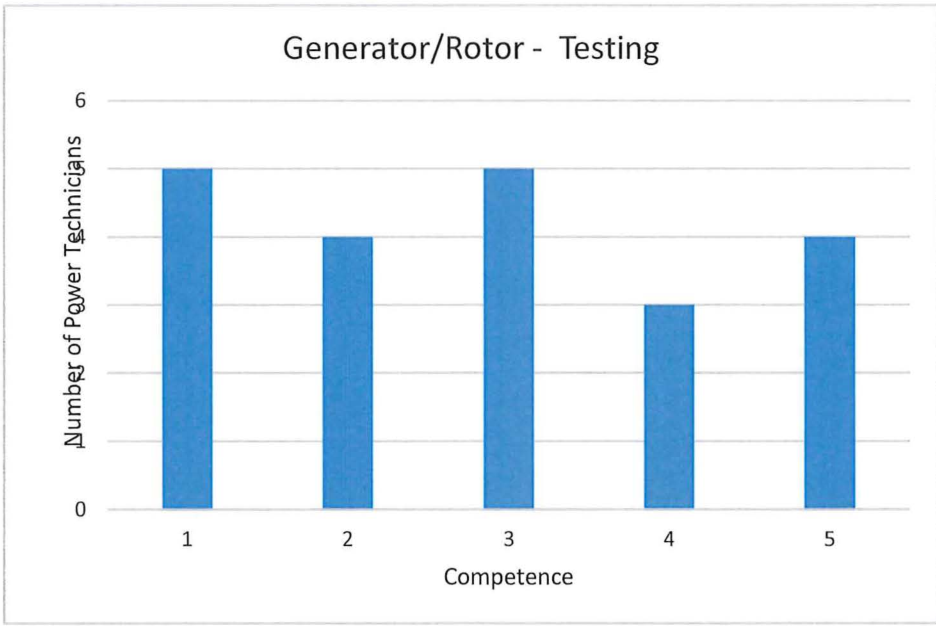

Figure 27: Generator/Rotor - Testing

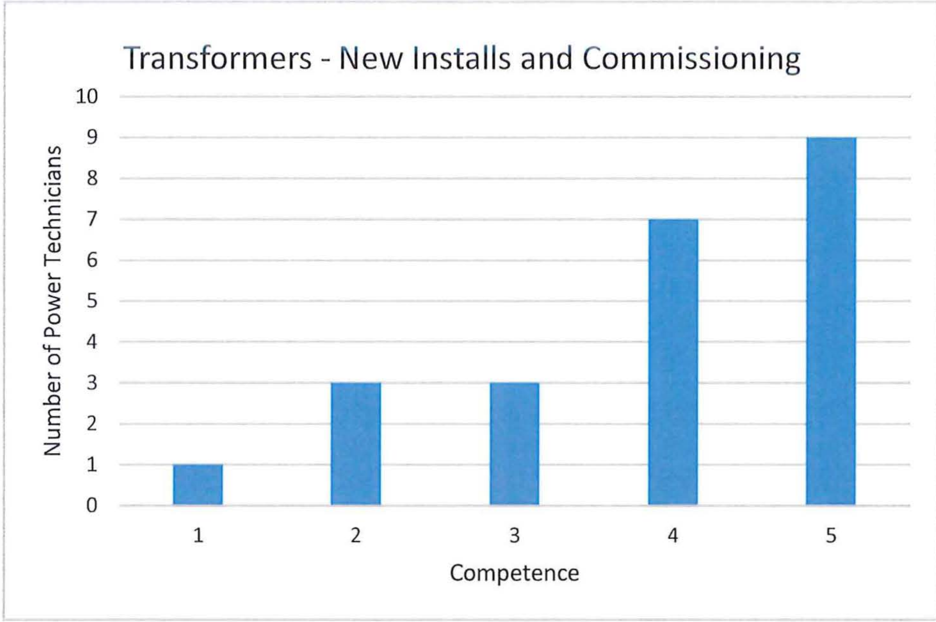

Figure 28: Transformers - New Installs and Commissioning

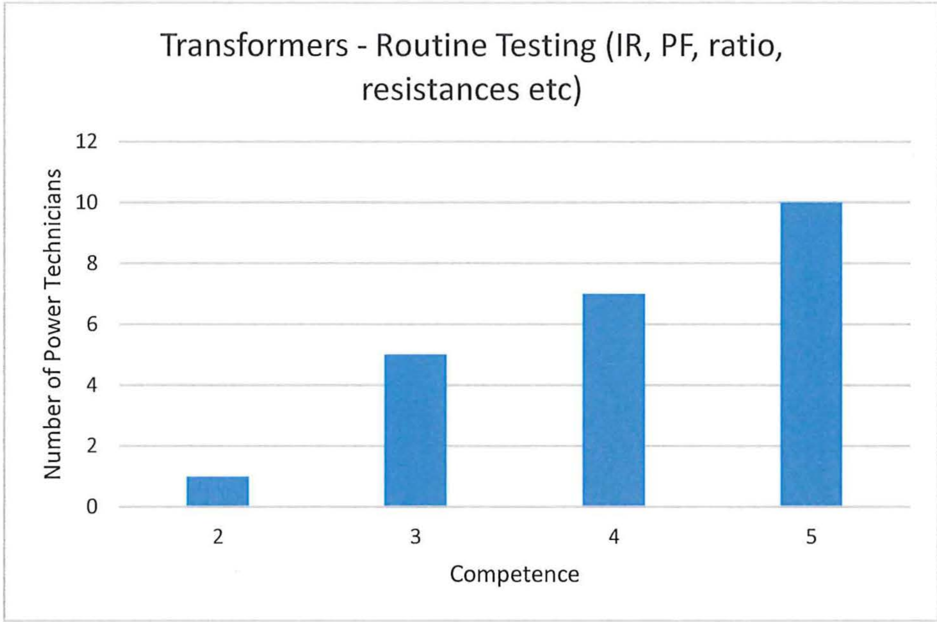

Figure 29: Transformers - Routine Testing (IR, PF, ratio, resistances etc.)

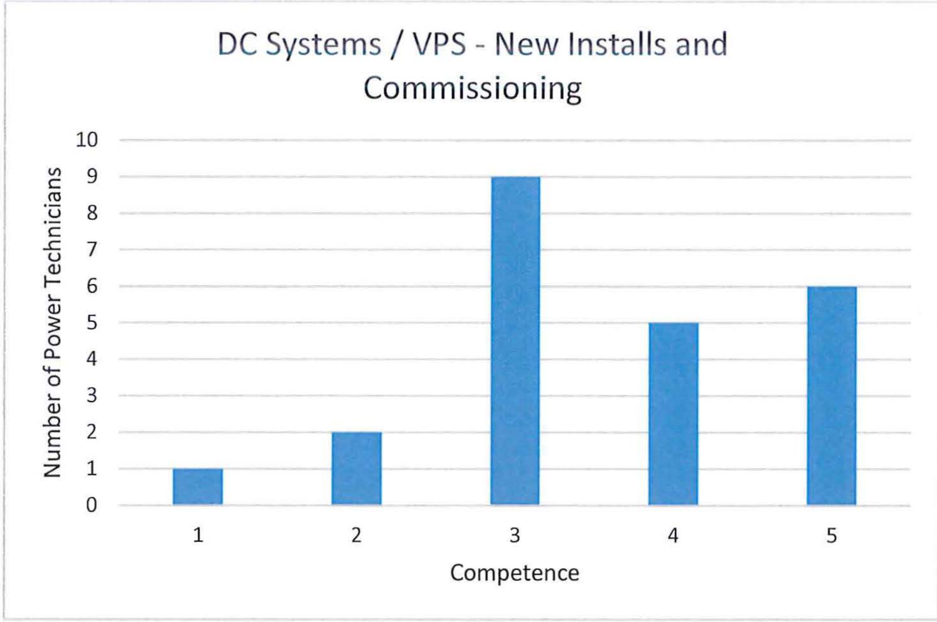

Figure 30: DC Systems/VPS - New Installs and Commissioning

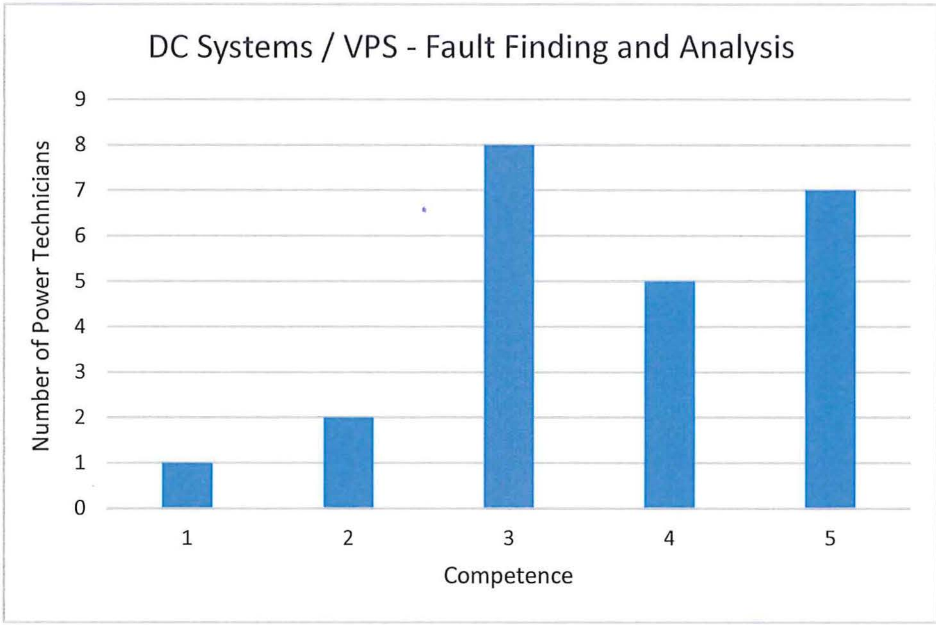

Figure 31: DC Systems/VPS - Fault Finding and Analysis

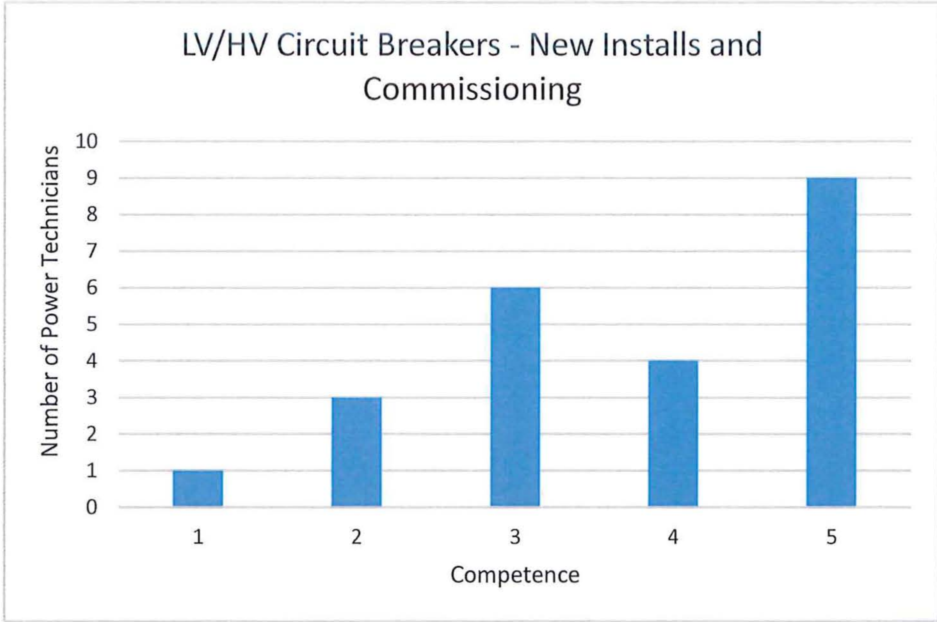

Figure 32: LV/HV Circuit Breakers - New Installs and Commissioning

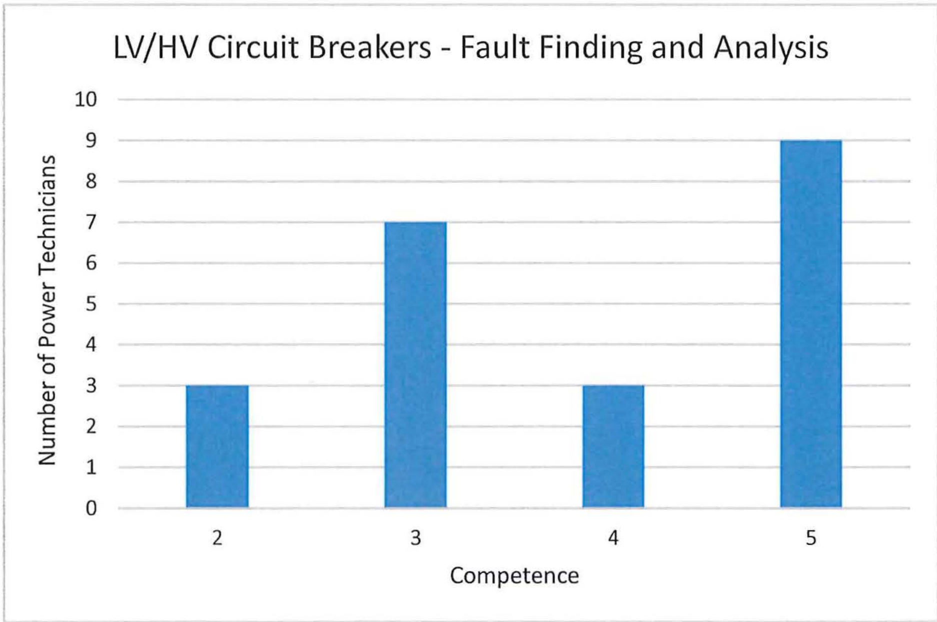

Figure 33: LV/HV Circuit Breakers - Fault Finding and Analysis

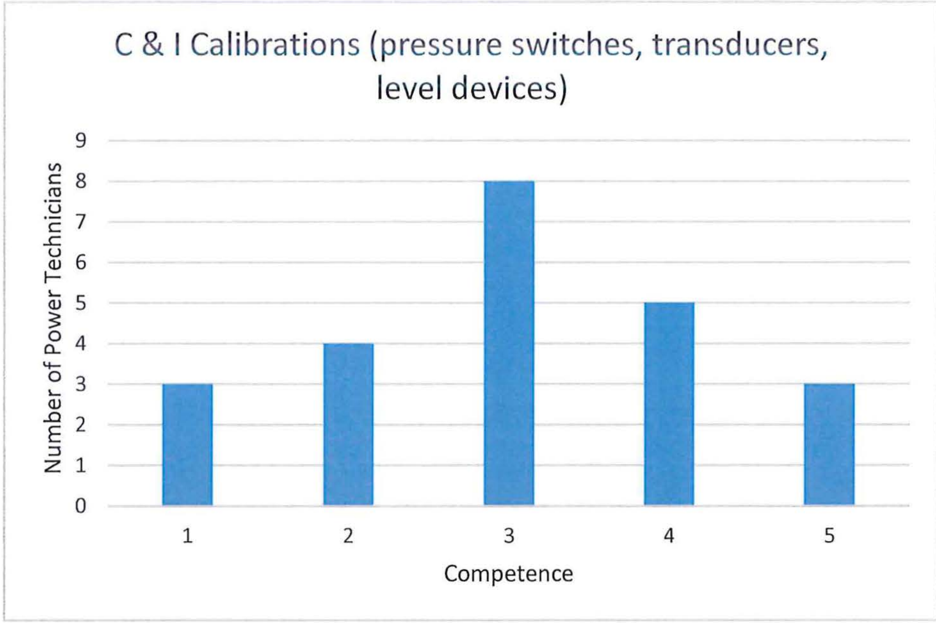

Figure 34: C & I Calibrations (pressure switches, transducers, level devices)

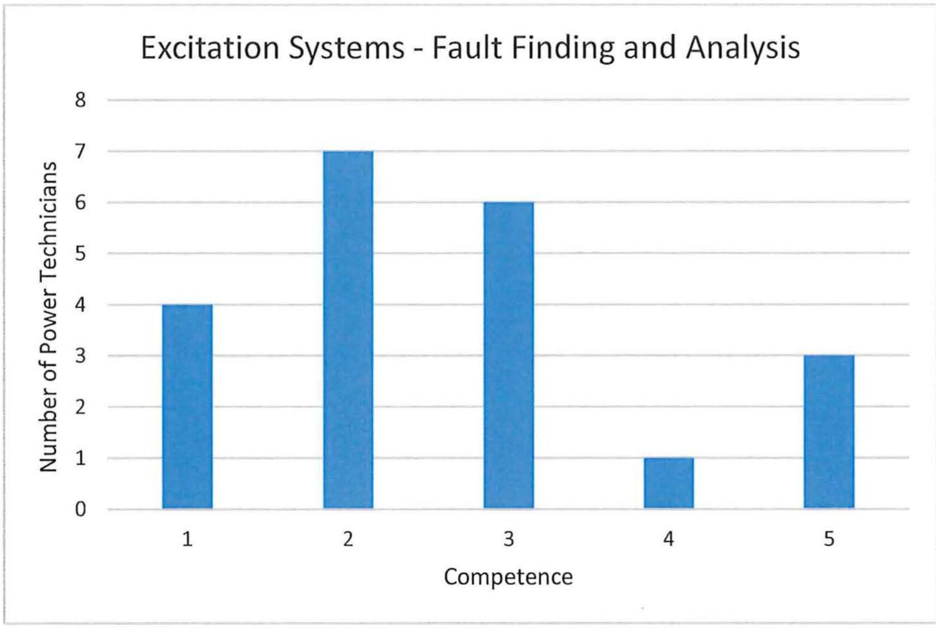

Figure 35: Excitation Systems - Fault Finding and Analysis

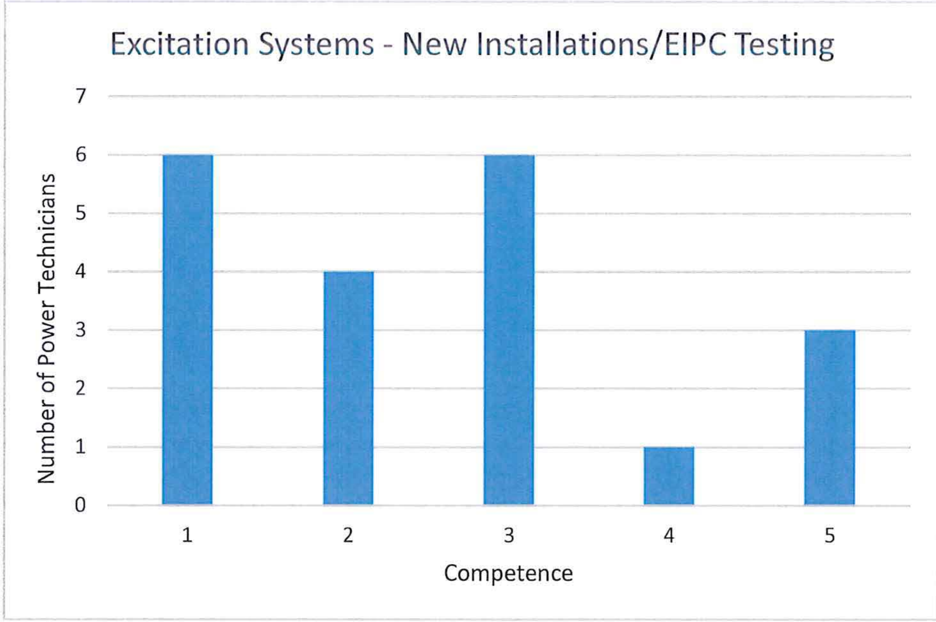

Figure 36: Excitation Systems - New Installations and EIPC Testing

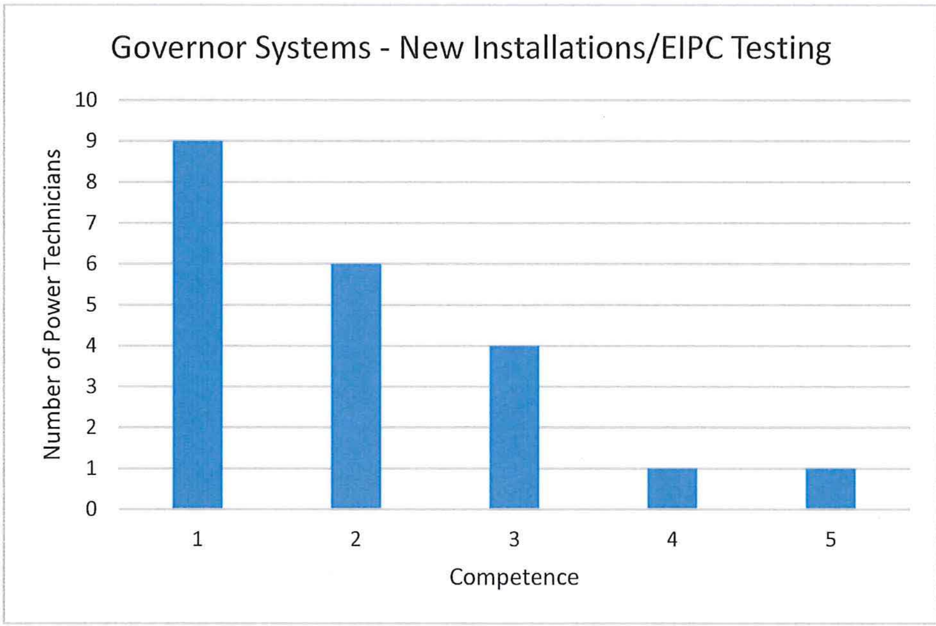

Figure 37: Governor Systems - New Installations/EIPC Testing

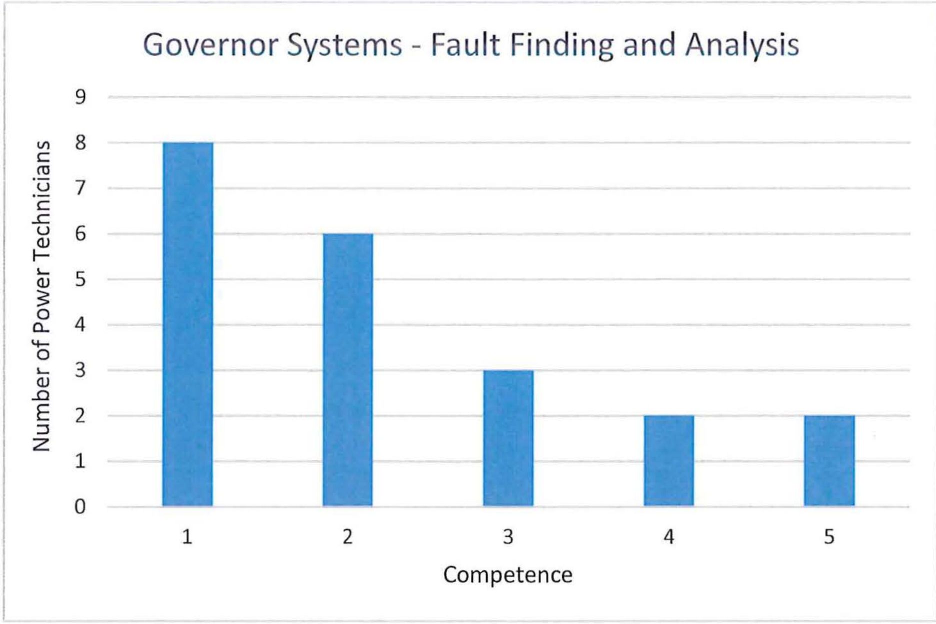

Figure 38: Governor Systems - Fault Finding and Analysis

11.14 Meridian Energy Applications Numbers for the Twizel Area

Table 14: Meridian Energy Application Numbers for the Twizel area

Job Title	Application Numbers
Mechanical Engineer	215
Customer Consultant	64
Safety and health specialist	38
Mechanical fitter	14
Electrical fitter	17
Design engineer draughtsperson	9

The above table highlights the number of job applications for the given positions within the Waitaki and Mackenzie area. As shown there is a large number of applicants, contrary to this Meridian Energy had advertised for a Power Technician in the same area for 2 years before they found a suitable candidate. From this an assumption can be made that location was not the issue in regards to attracting Power Technicians to the area.

11.15 List of Stakeholders Interviewed

- Broad Spectrum Ltd
- Electrix Ltd
- Think Delta Ltd
- Powernet Ltd
- UGL Ltd
- PBA Ltd
- ABB Ltd
- Machine Monitor Ltd
- Contact Energy Ltd
- Meridian Energy Ltd
- Genesis Energy Ltd
- Mercury Energy Ltd
- Pioneer Energy Ltd
- Vestas Ltd
- Connexis Ltd
- The University of Canterbury
- Andritz Hydro Ltd
- Ex Meridian Employee

12 Self-Reflection

This project has proved a very challenging task due to the complex and uncertain nature of the given issue. Many different concepts I have been taught throughout the year were intertwined within the project from 'soft skills' of engagement with different stakeholders, to identifying inefficiencies within a system. I have learnt many things throughout this project but the lessons which I have learnt, the challenges I have faced, the things I would do differently next time are:

- Not having any knowledge of the electricity industry proved challenging throughout the project, as what a Power Technician is capable of was difficult to grasp, given the highly technical profession.
- The nature of the project required communication with a huge variety of stakeholders and one thing that I have learnt, is that people will prioritise you as they see necessary. Relying on stakeholders to provide the correct information within the given timeframe proved to be difficult. Next time I would ensure that industry sponsors provide leverage to aid in the process.
- Researching into an issue that is well known industry wide, has had some effects on people's perceptions of the problem and also their attitude towards my research. I found it increasingly important to not portray my view of the issue, before the individual I was interviewing had.
- In some cases there was a disconnection between operational management and what their Power Technicians were capable of. This proved to be challenging as operational management was often my point of contact.
- One of the most important learning aspects I found through the course of the project was that of asking the right questions and to keep on 'digging'. By continually asking questions, I found that eventually I would get to the answer. Next time I would ensure that my original questions are those which get the correct answer and also not allow the interviewee to dictate the interview.
- I thoroughly enjoyed the experience of conducting interviews. This process has allowed for a better understanding of interviewees body language and the responses which follow. Information collected through interviews was far more valuable than that of phone contact.
- If I was to complete this project again I would concentrate on one specific type of generation in order to dive deeper into the skillset available to the industry. The scope of the project was slightly too broad and next time I would push to refine it down to one specific type of generation Power Technician.
- Coming from a completely un-biased position allowed me to see what is going on within organisations in terms of their culture and attitude towards their work force. Having been provided interviews with staff members with the condition that they remain anonymous, allowed for a much more personal conversation in regards to the culture and feel of the workplace. It became apparent that there was missing links between operational units which was having an effect on the way in which information was passed between employees. Withholding information will prevent the business from operating to its fullest potential.
- During the project I learnt a personal lesson about myself in terms of how to deal with stress. Prioritising tasks in terms of their importance to both myself and other invested parties was difficult at times but I found a middle ground where I could achieve both outcomes. Ensuring to keep stakeholders happy was a priority as I believe it is important to never 'burn your bridges'.
- I have also learnt the importance of 'doing things once and doings things right'. If I had followed this throughout the project I would not have had to re write multiple sections in the report.
- Lastly and most importantly I have learnt a lesson which I am sure will apply to many competitive industries around the world, that being; Politics is involved in many aspects of a business, even if it doesn't seem so on the surface.

In summary I have really enjoyed the challenge which this project has presented, and the people which I have engaged with along the way. The Masters Project itself has proven to be a true learning curve and has shaped my way of thinking in a much more structured manor.