HYLAND MCQUEEN LIMITED
web www.hylandmcqueen.co.nz
email info@hylandmcqueen.co.nz

Electricity Supply Sector Workforce Forecast 2010-20

Report Prepared For:

Electricity Supply Industry Training Organisation (the ESITO)

By Hyland McQueen Ltd
P.O. Box 1003
Dunedin
New Zealand

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Revision Log

Report Extension	Description	Issue Date
draft_rv0	Progress as at 13 May 2009	13 May 2009
draft_rv1	Minor corrections; previous reports section added	14 May 2009
draft _rv2	Numerous additions and structure change	Not issued
draft _rv3	Completed sections and described model method	4 June 2009
draft_rv4	Added first scenario output table	10 June 2009
draft_rv5	Added current workforce numbers estimate and charts	15 June 2009
draft_rv6	Revision of expected volume drivers, GDP error and revision of expected numbers charts	30 June 2009
draft_rv7	Final draft including client requested changes and summarising conclusions and recommendations	2 July 2009
final	Forth revision to client comments	8 July 2009
final_rv1	Minor amendments	10 July 2009
final_rv2	Minor amendments + altered transmission numbers in response to TP comments	14 August 2009
final_rv3	Minor amendments on Transpower's training policy in response to Transpower comments	24 September 2009

Executive Summary

This report describes forecasting workforce numbers in the New Zealand electricity sector for the period 2010 to 2020 (ten years).

This report reflects our opinion of the matters before us given the information available to us and the time frame in which we were able to consider that information. However, we note that the data is not complete, especially from the company returns.

Caution is noted in that the methodology used is particularly sensitive to the accuracy of the make-up of the current workforce as the percentage drivers of growth and attrition are determined then applied against the present skill and sector numbers to derive the forecast changes. As the present workforce numbers are only determined approximately, the results presented here must be considered as “indicative only” at this time. It is noted that this is the first issue of this report in this format and deficiency in the data is recognised, With the co-operation of the industry, it is hoped future revisions of this report will improve in this respect.

This report develops and executes a methodology for forecasting the training requirements in the electricity supply industry. It is principally based on the assessment of two aspects, attrition from the existing workforce and the requirement for new positions due to growth in the physical work required.

Attrition, which includes loss to retirements, is considered by analysis of the historic progression of the demographics reported in successive census returns. Issues of productivity are also considered through this same analysis.

Work volume changes are assessed on a sector basis (generation, transmission and distribution, and with retail activities included in the generation sector) from either direct correlation to underlying economic drivers, or through the assessment of forecasts by others, in particular the Electricity Commission for the generation forecasts and Transpower for its own internal forecasts of opex and project labour requirements in the transmission sector.

Summary of conclusions:

1. Our model of net loss, derived from a demographic assessment of attrition and a sector analysis of future work volumes based on economic drivers, appears roughly correct as the per annum deficit is in keeping with the current training output plus an assessment of net migration into the industry.
2. No significant productivity changes are foreseen in the trades and professional skill groupings, although a continuance in the short term of productivity improvement in the administration area, at the level that is evident historically, is assumed in our models.
3. Attrition shows as the most significant factor for loss from the industry. The rate of attrition is forecast to be most acute in the professional groupings due to the higher age of the mode of the age profile for this group.
4. Levels of net migration is not considered as a key factor as it is largely self-controlling, although, as it derives from the difference of large numbers (immigration and emigration) this aspect needs to be monitored and in particular emigration out of the sector and the continued ability to secure skilled persons from overseas.

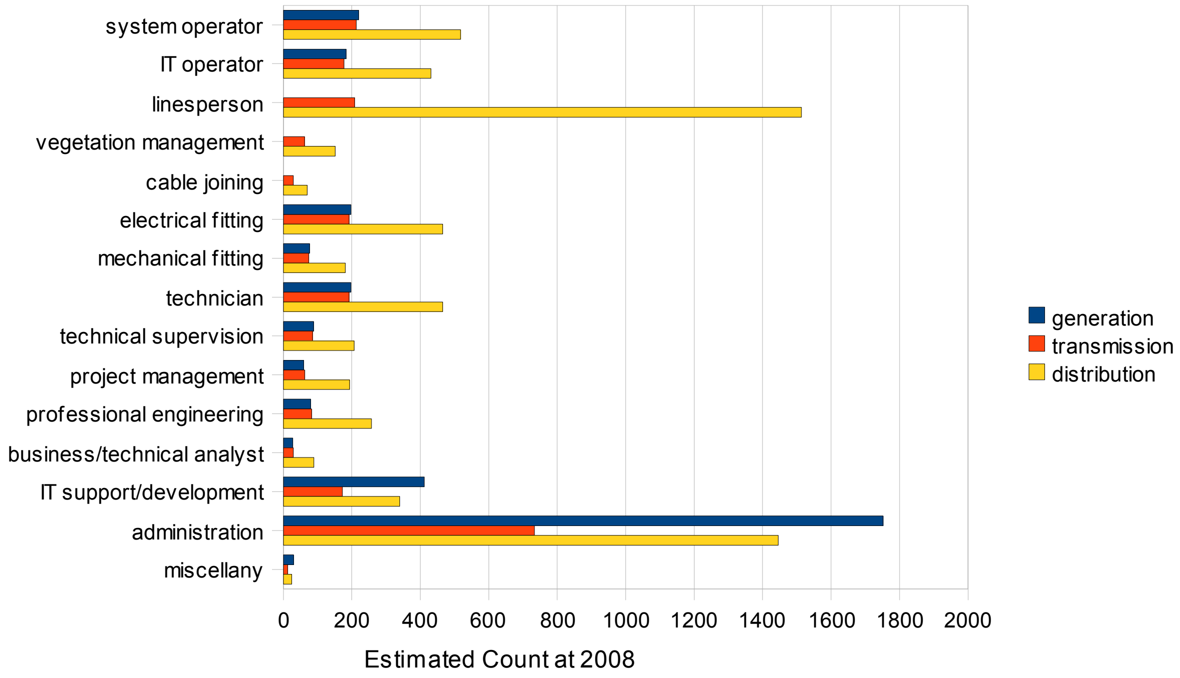
5. The work volume models are most sensitive to variance in the GDP forecast as this is the key driver of the energy demand forecast and network extension and is highly correlated to population numbers which affects distribution network customer numbers.
6. The ageing of distribution networks is not considered a significant factor in the distribution network work volumes being forecast, based on current evidence.
7. The risk around net deficit or surplus of trainees given the current training output under variance in the growth forecasts is invariably on the deficit side, as the reduction in the work volumes under the low GDP scenario is less than the assumed present level of migration into the industry and is therefore controllable. Under the high growth scenario, a net deficit of approximately 110 persons p.a is estimated.
8. The future issues appear not to be around training more or less persons, but in meeting the changing skills requirement, particularly the training of transmission linesmen (largely due to a combination of work and Transpower training policy changes), the increasing requirement for mechanical skills as the generation portfolio shifts towards more wind, geothermal and thermal fuel types, and the evident increase in the IT skills requirement.

Summary of Recommendations:

1. There is much uncertainty about the true nature of the current workforce in both total numbers and the splits by sector and skill. Further detailed investigation of the current numbers, skills and demographics of the industry is strongly recommended.
2. The evolving nature of the migration to and from the industry should be monitored on a regular basis. This may require specific metrics to be developed in this area and measured and reported on a regular basis.
3. The management of attrition in all sectors of the industry needs to be promoted as a key focus going forward.

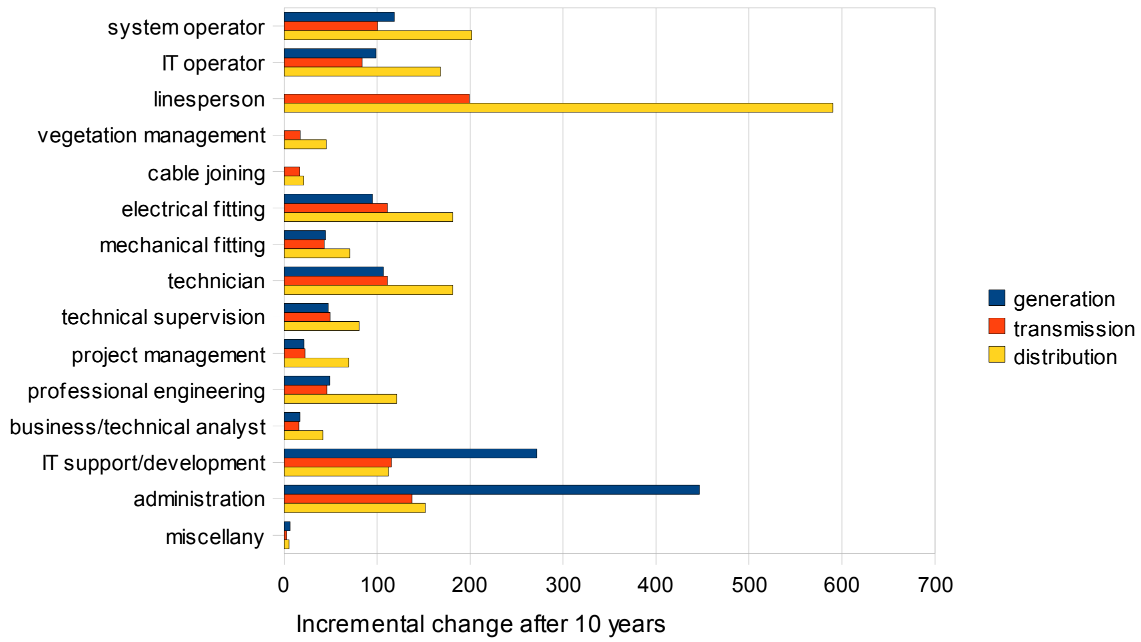
Summary of Information

The present disposition of workforce numbers is illustrated in the following chart and is based on the estimation methods discussed within this report. Caution on the accuracy of this information is again emphasised; later issues of this report will include data based on industry survey returns and provide a better platform to project future changes.

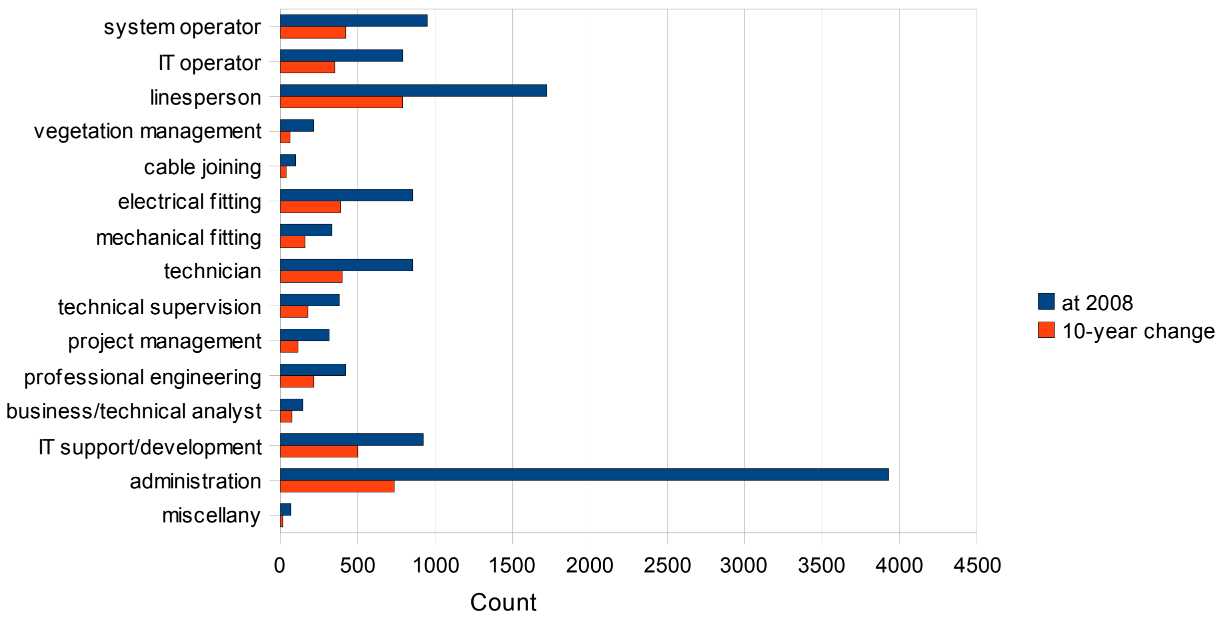


The results of our modelling are illustrated in the following charts:

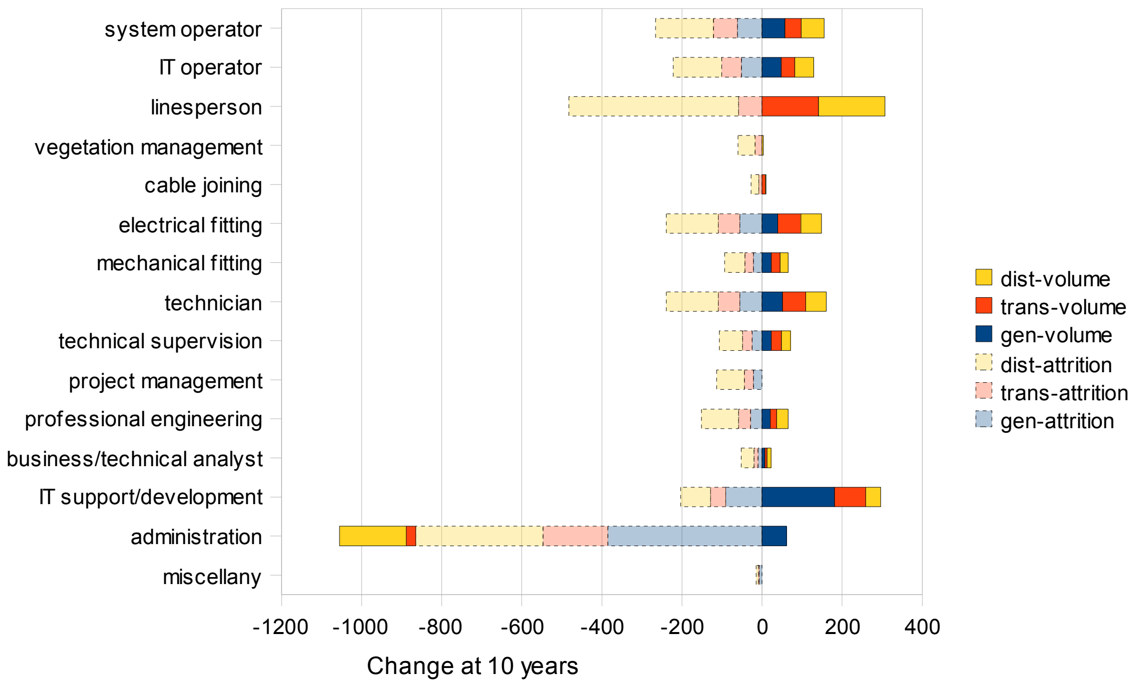
Cumulative number of positions by skill and sector required over 10 years [showing linespersons, administration and IT as key skill areas]



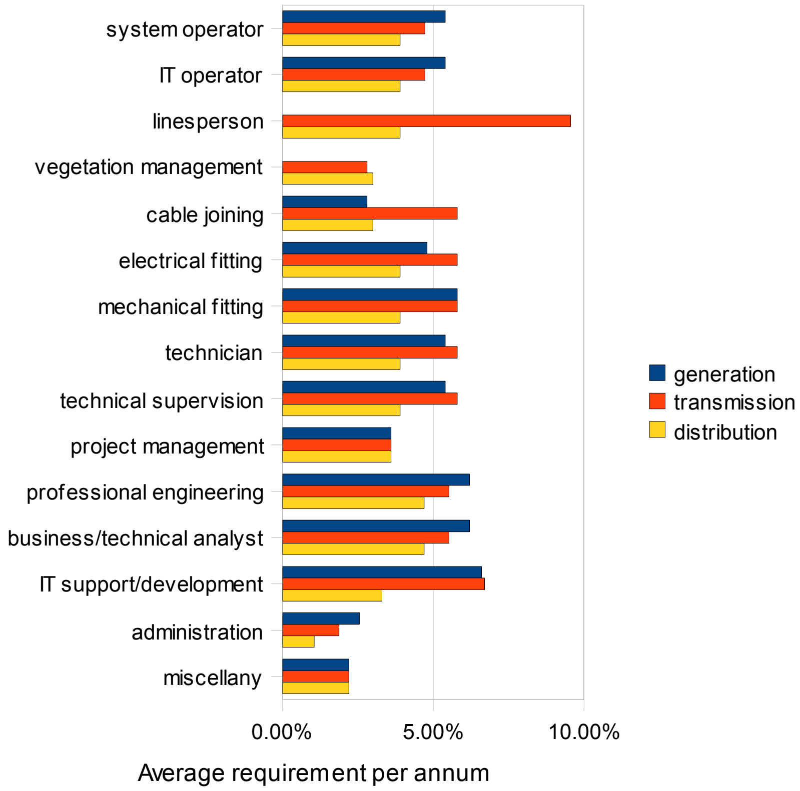
Cumulative number of positions required by skill over 10 years in comparison to current numbers [showing the future requirements are not exactly in proportion to the current numbers and therefore the skills training mix may need to shift]



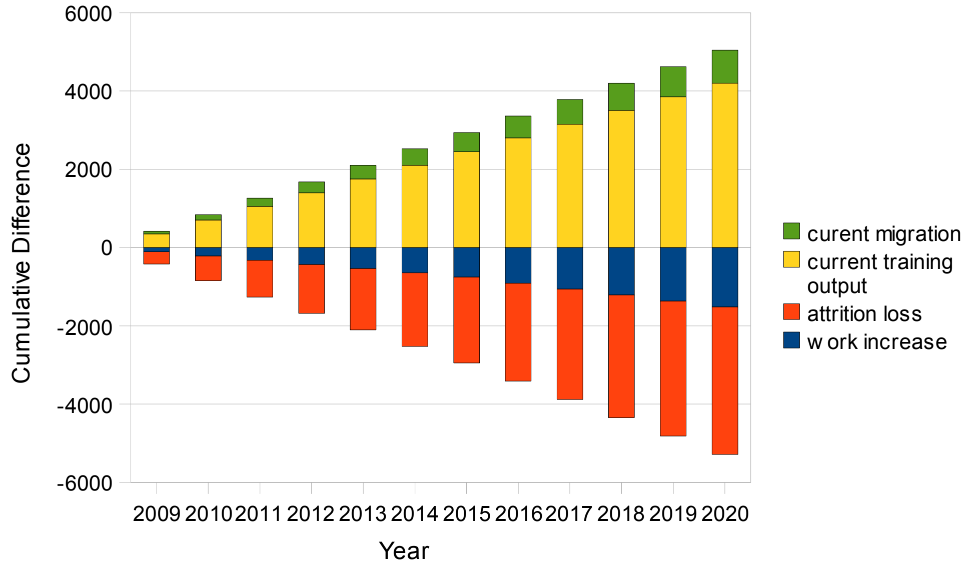
Breakdown of 10-year cumulative requirement by skill, sector, and driver [showing that attrition is the key driver]



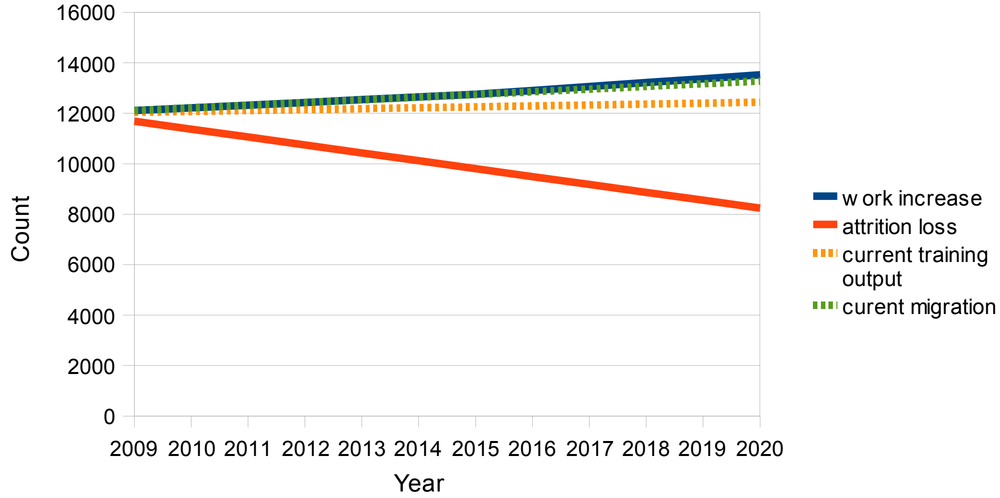
Average per annum increase by skill and sector as percent [showing the generation and transmission sectors having the greatest need for skills development (on a relative basis)]



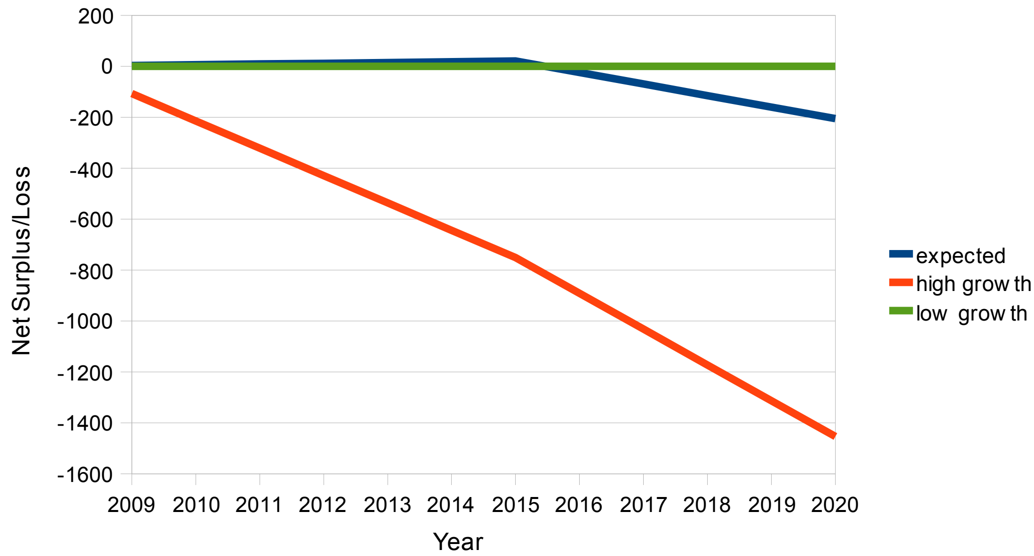
Match of cumulative total deficit (attrition and work volume) against supply (training output and net migration) [showing that attrition is the key deficit driver; that net migration is not a key supply issue; and that the net difference is small]



Cumulative workforce numbers showing attrition and work volume projecting separately off the current workforce numbers and the training make-up though current training output and estimated current net migration [again showing that attrition is the key deficit driver; that net migration is not a key supply issue; and that the net difference is small]



Cumulative forecast of net difference (supply – deficit) under low, expected and high growth scenarios [showing the risk is on the deficit side]



The expected per annum requirement by skill class is set out in the following table and compared to the current training output.

Class	Requirement p.a.	Current Output p.a.
system operator	42	26
IT operator	35	unknown
linesperson	82	105
vegetation management	6	
cable joining	4	25 (large difference noted for further analysis)
electrical fitting	39	30
mechanical fitting	16	11
technician	40	25
technical supervision	18	From pool of trained technicians and fitters
project management	11	unknown
professional engineering	22	20
business/technical analyst	7	unknown
IT support/development	53	unknown
administration	45	unknown
miscellany	1	n/a
Sum p.a.	**417**	**350**

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1 Background

1.1 Invitation and Scope of Work

An invitation to make a proposal was received from the Electricity Supply Industry Training Organisation (the ESITO) on 18 February 2009 with a subsequent addendum on 19 February 2009. The invitation provided a work scope and included examples of previous work undertaken.

The scope of work required was set out as:

1. determine the future numbers of employees by sector and trade needed, out at least 10 years;
2. correlate model of employee numbers with a mix of current employers to validate assumptions;
3. complete the forecast with current industry numbers assuming there is no shortage at present;
4. do error bounds high/low;
5. comment of trends and impacts from technology changes; and
6. include the demographics of the industry and losses to estimate net new employees needed (by sector and trade).

1.2 Previous Reports

The work of assessing the skills gap in the electricity supply industry has been undertaken on an annual basis since 2002. From 2002 to 2006 the work was undertaken by Dr. Koslow at the Management Research Centre at the University of Waikato. In 2007, the work was undertaken under the leadership of Professor Geare at the University of Otago.

These previous reports have focused on identifying the skills gap amongst trade and professional classifications existing at the time, through a process of interview and survey on the industry. Asset management plans were reviewed to consider future spending plans as a means of estimating future demand. Reasons for the evident skills gaps were examined, based on the surveys and interviews undertaken, and included pay, job satisfaction, training, career path, etc.

For this review, the focus has changed towards quantifying the skills needed over the next ten years. Whilst this report considers workforce demographics and attrition, we do not investigate the underlying motivational causes for these.

1.3 Interim Report

To satisfy the reporting date in the face of delays in receiving back the industry demographic surveys sent out, this report makes a number of assumptions based on more generalised information than had been hoped for. As such, the conclusions presented in this report remain in an interim state pending return and analysis of the full information requested.

2 Methodology

This section sets out the methodology applied in meeting the scope of work.

2.1 Nature of Electricity Supply Industry

Whilst the nature of electricity supply is one of physical connection from generation to load, the nature of the industry sectors is not homogeneous in terms of plant employed, workforce and workforce skills required, service models, commercial incentives, and governance. In developing relationships upon which to project workforce numbers, we are cognizant of these different factors.

It was originally proposed to us that forecasts could be made from consideration of cost forecasts in disclosed asset management plans. We have not taken this approach as:

1. due to the capitalisation of project labour costs, and the inherent confounding of labour/material splits, exchange rate variance and real cost escalation, it is problematic in all sectors, but particularly generation and transmission, to project workforce numbers off expenditure projections; and

2. whilst the forecasts are disclosed and show better consistency between annually presented forecasts than has been evident in the past, the manner in which on-costs are allocated, and the degree to which works are contracted out, make direct comparisons between different companies problematic[1]; and

3. the cost forecasts of others seldom reveal the underlying assumptions those cost forecasts are build on (ie customer growth, generation growth, inflation rate, GDP increase, etc.) and there is a danger of combining cost forecasts with completely different fundamental assumptions underpinning them.

Generation Sector

Generation is characterised by small numbers of high value plant, capital works tendered to external service contractors, specialist skills related to generation fuel mix, environmental protection and audit requirements, and no regulatory information disclosure regime. In-house generation company trade skills comprise mostly technicians and operators and operator-fitters with (usually) electrical and mechanical fitters and other technicians furnished through contractor companies. New development is also infrequent and of variable size leading to “lumpy” cost projections which ultimately impact on labour requirements.

For the generation sector we look to develop the workforce forecast models off industry-wide forecasts of generation installed capacity, mainly through the Electricity Commission forecasts of energy demand and consideration of generation type and age.

Transmission Sector

Transmission is characterised by high value, capital intensive plant geographically spread. Specialist skills are required in tower-line maintenance, protection systems and extra high voltage plant. Capital works and maintenance are tendered to external contractors. The regulatory information disclosure regime makes the transmission asset management plans available as an

1 Koslow – Light at the End of the Tunnel? The 2006 revision of the annual skills gap analysis pg. 6 shows variability between annual forecasts but notes improvement in forecast consistency in the more recent disclosures.

information source. As with generation, new development is also infrequent (the last new transmission line built was the Timaru extension circa 1992) and of variable size leading to “lumpy” cost projections which ultimately impact on labour requirements.

For the transmission sector we develop our capital works labour projections against projected workforce numbers as estimated by Transpower itself. For maintenance related workforce requirements we consider the disclosed opex cost projections of Transpower together with other anecdotal information on future policy changes affecting training requirements on the contractor workforce.

Distribution Networks

Distribution is characterised by large numbers of geographically distributed low value assets. Line maintenance and capital works is undertaken by a mix of in-house and external contractors. Because of its homogeneous and extended nature, a combination of line length and customers numbers shows as a reasonable predictor of workforce requirements, apart from vegetation management which relates more closely to just network overhead line length.

Information disclosure for regulatory purposes provides a useful and consistent data set to calibrate the work volume models and make future projections against.

Other Networks

This sector comprises industrial and large commercial internal distribution networks and electrical plant, usually supplied with trade skills from a mix of in-house and external contractors. Although this sector is significant, the drivers of work volume are diverse (as the underlying production ranging from agricultural to industrial) and there is little in the way of available forecast information. Additionally, we were unable with the information to hand, to allocate number splits to this sector. As such it has been amalgamated into the generation and distribution sectors (*i.e.* co-generation plant into generation, and site/factory HV distribution under distribution).

2.2 Sector and Skill Categories

The workforce forecast estimates are made in a matrix of industry sector and skill category. Industry sectors are classified as generation, transmission, distribution, and other networks. Workforce skill is considered rather than employee designation as it is training requirement for the skills to undertake the work required that is sought. This also avoids the issue of multi-skilled persons designated under a single designation that then disguises the true need for skills training.

Skill categories considered are:

- System operator duties,
- Linesperson duties,
- Vegetation management duties,
- Cable joining,
- Electrical fitting,
- Mechanical fitting,
- Technician duties,
- Technical supervision,
- Project management,
- Professional engineering,
- Business/technical analyst duties,

- IT support/software development duties,
- Administration/legal/accounts/regulatory duties,
- IT application operator duties [specifically GIS, CAD, and CMMS]

2.3 Forecast Workforce Numbers Against Scale and Growth

The methodology applied is to relate changes in work force numbers under each sector and skills category to work volume drivers, primarily based on scale to reflect operations and maintenance activity and on growth and replacements to reflect capital activity.

Our original proposal foresaw these relationships being determined evidentially by regression of work force numbers against work volume predictors (ie network line length) and using historic workforce data. However, workforce numbers are only available through the census and examination of the census data revealed it was insufficient for this purpose. For example, the census data provided through the ESITO noted only 3 cable joiners in all of New Zealand and arose from changing classifications at source and all workers engaged in the electricity supply sector not being allocated to the electricity supply sector.[2]

As such, the approach adopted is to assign work volume drivers to skill categories under each industry sector and forecast relative skill growth based on relative work volume indicators. The numbers of skills are then calculated from the ratio of the existing workforce numbers (by employer survey and based on the previous work of Koslow) and the work volume indicators associated to those sectors and skills.

2.4 Consideration of Productivity, Attrition and Retirements

The workforce numbers by category and sector that are forecast reflect the expected numbers required to meet the work volumes being forecast. This, however, implies an unchanging level of productivity. Productivity issues are considered through analysis of numbers employed historically and productivity inferred based on the observed trends.

In forecasting the workforce new employee requirements, as opposed to just the workforce numbers required, the effects of retirements and attrition are overlaid. Based on census data (and eventually the returned survey information) describing workforce age demographics by sector and skill, we model the expected retirements and attrition under a number of assumptions discussed later.

Attrition is also considered under scenario analysis that includes for a net loss or gain of trained personnel to outside the industry (generally by way or emigration/immigration to other countries, notably Australia). However, as discussed later, net migration cannot be easily forecast as it depends on the net difference in circumstance between countries and so is dealt with by way of identification of the leverage this aspect holds on the forecasts.

2.5 Technology Change Considered Under Two Aspects

We consider and comment on the impact of technology change under two categories; impact on the structure and development of the electricity supply industry and impact on the skills

2 An example of a change in classification is the number of persons who would now describe themselves as a project manager that previously would have been described differently. An example of persons working in the electricity sector but classified otherwise would arise for those employed by general contractors or consultancies.

requirements of the workforce. The degree to which technology change affects the workforce forecast numbers is not explicitly included in the models at this time as we have no means to effectively decompose the model to separately identify this aspect, which, in any case, we anticipate to be minor in most regards.

2.6 High and Low Scenarios

Whilst data errors in the regression models of workforce indicators may be accounted through statistical techniques, it is meaningless to do so and so has not been undertaken as the errors of assumption have far greater impact and cannot be readily quantified. These include assumptions on attrition rates, impact of technology, variability arising from singular development projects (i.e. new generation and transmission projects), and forecasting error on economic growth.

We conclude a high and a low boundary about the forecast predictions by applying scenario analysis whereby the impact of the assumptions are included numerically at different levels and the combined impact tested. The high and low boundary marks on the workforce number forecasts are then decided by the envelope created by the scenarios.

3 Demographics, Productivity, and Attrition

This section describes our assessment of the issues of workforce demographics, productivity and attrition. As the survey returns from industry have been sporadic and incomplete, we form our view based on a combination of the survey data collected, the 5-yearly census data for the years 1991 to 2006, anecdotal evidence provided to us in our industry interviews, and the assessment of likely bounds made in agreement with the ESITO.

3.1 Census Data for Demographics and Productivity

3.1.1 Multiple Occupations and Changing Classifications

A key difficulty with the census data is that industry classifications do not identify all the workers of interest to this study.

Individuals in the census are attributed an occupational classification (OC) and an industry classification (IC). The IC of an individual is made on the basis of the classification of the organisation for which the individual works. In recent years, much of the direct trades work on the electricity network and plant has been contracted out to general contracting companies. These companies may provide contracting services to a wide variety of industries and so are not generally classified as being within the electrical supply industry classification. Hence the numbers of workers within the various occupational classes within the electrical supply industry classification are actually underestimates of the real numbers of interest to us. Also, apart from the linesperson group, occupational classifications do not exclusively identify workers within the electricity supply sector.

Additionally, errors arise at source as individuals describe themselves in various ways, e.g. a cable jointer may describe themselves as an electrical fitter, an engineer may describe themselves as a manager or consultant etc. and errors arise through input errors of misspelling or misclassification.[3]

3 Occupations identified in the electrical supply industry include bartenders, knitting machine operators and police,

Although we examined 4 of the 5-yearly census returns from 1991 to 2006, a change in occupational classifications rendered the 1991 census data incomparable with the later census returns for all skill categories except linespersons.

Of the approximately 150 occupational classifications reported under the electricity supply industry, we have allocated these occupational classes into the skill groups used in this review, as per section 2.2 , as described in appendix 1.

3.1.2 Demographics and Attrition

In this review we consider the demographics of age only. Other issues of gender, ethnicity, level of education, remuneration etc. are not considered.

In developing the age profiles by skill group, we assume that, although the numbers associated to the electricity industry in the census data are not complete, they represent an unbiased sample and so the age profiles from the census data are representative.[4]

Due to lack of sufficient numbers in some skill categories to make reasonable comparisons, we only consider 7 skill groups being system operators, linespersons, electrical fitters, technicians, professional engineers, IT support, and legal/accounts/regulatory support.

The age profiles for the 7 skill categories are illustrated in figure 1 below where the progression from 1996 to 2001 to 2006 is represented by the red, green, and blue curves respectively. Charts to the left are for the electricity industry while those to the right are for the same skill category but include all industries.

although the numbers are small for the occupational groups that are clearly in error.

4 Although we have no evidential basis to make this assumption, we also have no evidential basis to deny it.

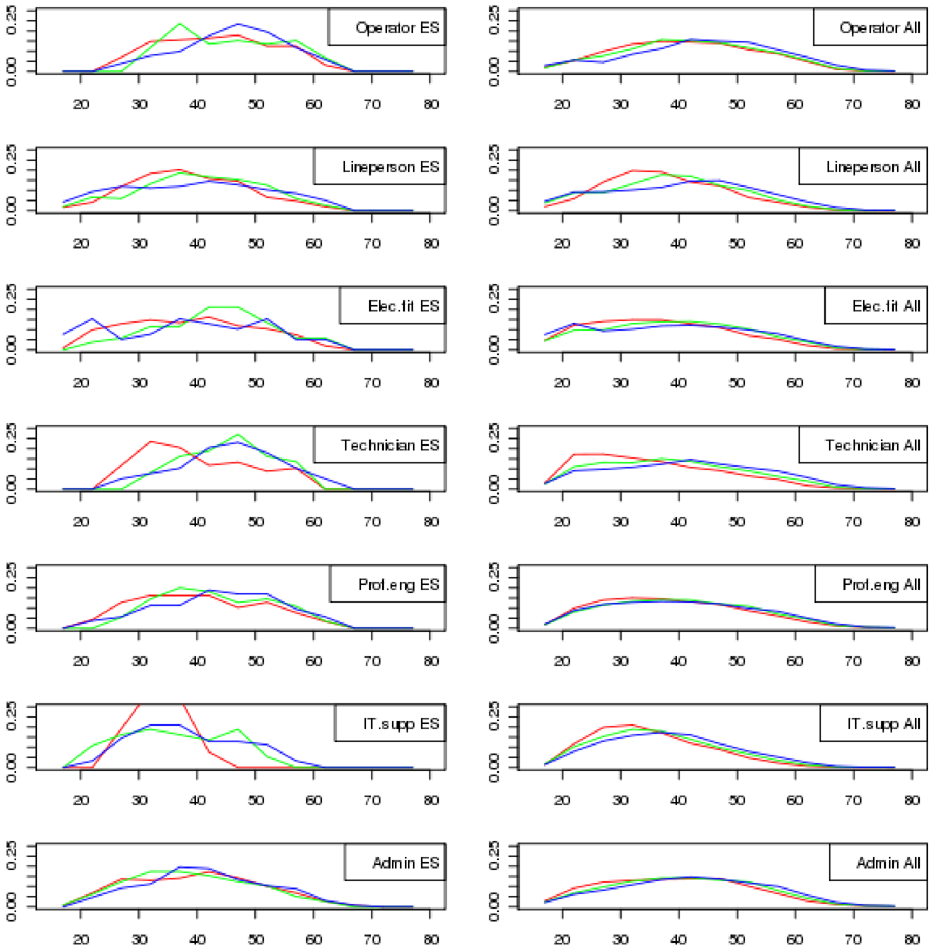

Figure 1: Age Profiles by Skill: at 1996 red; at 2001 green; at 2006 blue. Left charts for electricity industry; right charts for all industries combined

General Observations

There is a distinct progression in the age profile mode values (the peaks of the age distribution curves) to shift right in each progressive census. This is particularly evident in the electricity sector (left-side) curves. In many cases, the degree of shift is (or is close to) year-for-year i.e. a 10-year shift over the 10 years between the 1996 and 2006 census returns. This would indicate a low net change (gain or loss) in the age groups at or about these mode values (approximately 35 to 45 years old).

The profile shapes of the older cohorts of the curves (50 to 70) show less volatility of shape indicating that the factors influencing attrition/retirement in these age groups is relatively constant. Based on this observation, and the numeric data underlying it, we develop an expectation for the loss rates for the age group transitions from 50-54 onwards based on the 2006 age profile maintaining a constant shape for the cohorts from 50 onwards.

The majority of the age profile shape variability from census-to-census arises for the cohorts in the ages 20 to 40. The issues within these cohorts are many and varied and include:

- greater job mobility and location mobility of persons in these cohorts[5];
- propensity of young workers to leave for overseas experience after finishing training[6]; and
- these cohorts also represent the majority of the age profile of overseas migrants seeking

5 Anecdotal evidence only.

work permits into New Zealand[7]

We estimate the expected attrition for the various skill classes to be as shown in table 1 below under the following assumptions:

1. The demographic is stable over the range of our projection. The calculations are from the 2006 census data to which we ascribe three general demographics for trades, professionals, and administration as illustrated in figure 2 below.[8]
2. Each worker is active in only one skill class.
3. We average the attrition rates making them constant over the forecast period.

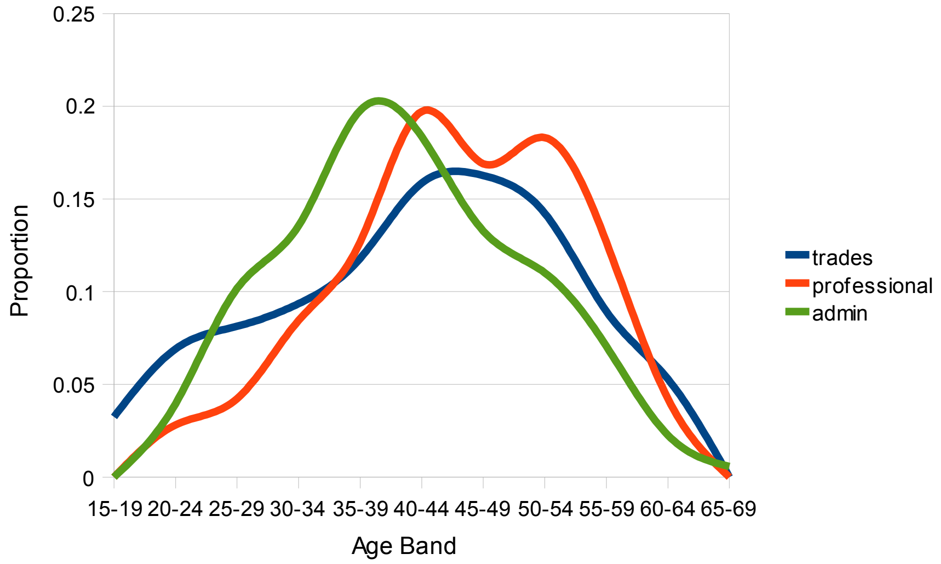

Figure 2: Age demographic by major grouping

The chart of figure 2 shows that the professional group has the highest anticipated attrition as the mode of this distribution is shifted to the right and the attrition gradient is therefore steeper.

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6 Anecdotal evidence based on company interviews.

7 Source: Work permit holders

age <16	16-19	20-29	30-39	40-49	50+
<1%	38%	38%	10%	6%	7%

8 The three groups also align with our ability to split the total workforce by number based on Koslow's work.

Class	Group	Attrition p.a.
system operator	trade	-2.8%
IT operator	trade	-2.8%
linesperson	trade	-2.8%
vegetation management	trade	-2.8%
cable joining	trade	-2.8%
electrical fitting	trade	-2.8%
mechanical fitting	trade	-2.8%
technician	trade	-2.8%
technical supervision	trade	-2.8%
project management	prof	-3.6%
professional engineering	prof	-3.6%
business/technical analyst	prof	-3.6%
IT support/development	prof	-3.6%
administration	admin	-2.2%
miscellany	admin	-2.2%

Table 1: Expected attrition by skill based on group demographic

3.1.3 Effect of Migration

We have been unable to obtain any direct data on the net migration of skills into and out of the sector. However, comment from the NZ Department of Statistics regarding overseas migration leads us to believe that any effect is small. [9]

The chart of figure 3 shows the New Zealand immigration, emigration and net difference (migration) from 1998 to 2008. This shows net migration is the difference of large numbers (immigration and emigration in the order of 60,000 to 90,000 and the net difference in the region of 0 to 40,000 and with a general bias of migration being into the country.

While implicitly net migration is sensitive, to small percentage changes particularly in emigration, to an extent, net migration is controllable in the sense that New Zealand issues work permits in response to skills shortages. Given this, and the relatively low net migration, we do not consider migration a key element in our skills model, although we note an implicit assumption that there is a pool of overseas skills able to be tapped, which may not always be the case particularly in the face of a world-wide ageing of skilled workers.

9 Source: http://www.population.govt.nz/myth-busters/BrainDrain.htm

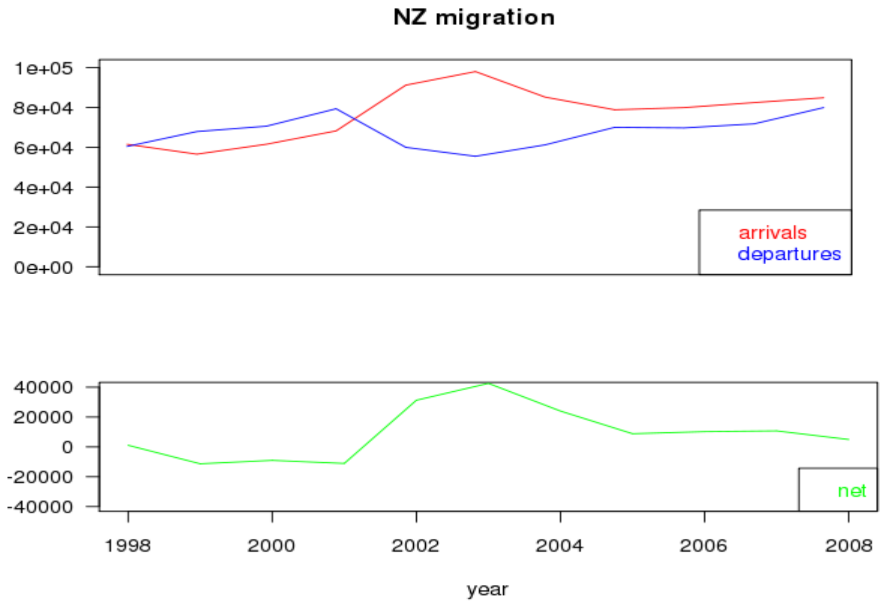

Figure 3: New Zealand immigration, emigration, and net difference (note – 2009 is estimated at approximately 20,000)

Even if there is zero net migration it may be the case that newly skilled workers (20 to 25 years) leave the sector resulting in a loss of skills but these are compensated for by employment of marginally older skilled immigrants (or returning New Zealand workers) in the range 20 to 35 years, based on assessment of ages for work permit holders. While it might be the case that this replacement represents a loss of skill-years to the sector, this loss is somewhat compensated for by the fact that older workers employed from overseas will generally have a higher level of skills and experience than those who leave.

We do not consider that, in the current circumstance, net migration will materially affect our results, however we recommend that net migration and the ability to attract overseas skilled workers be continuously monitored in this regard.

3.1.4 Productivity and Contracting-Out of Services

To gain an insight into the issues of productivity, we examine the ratio of skill group numbers in the electricity industry to the 1996 census as a baseline. We then examine the confounding influence of companies contracting out services and draw some generalised conclusions.

Figure 4 below charts, for the 7 skill categories being examined, the ratio of the total number in the skill group to the total number in the skill group identified in 1996. The left-hand charts are for the electricity industry and the right-hand side for all industries combined.

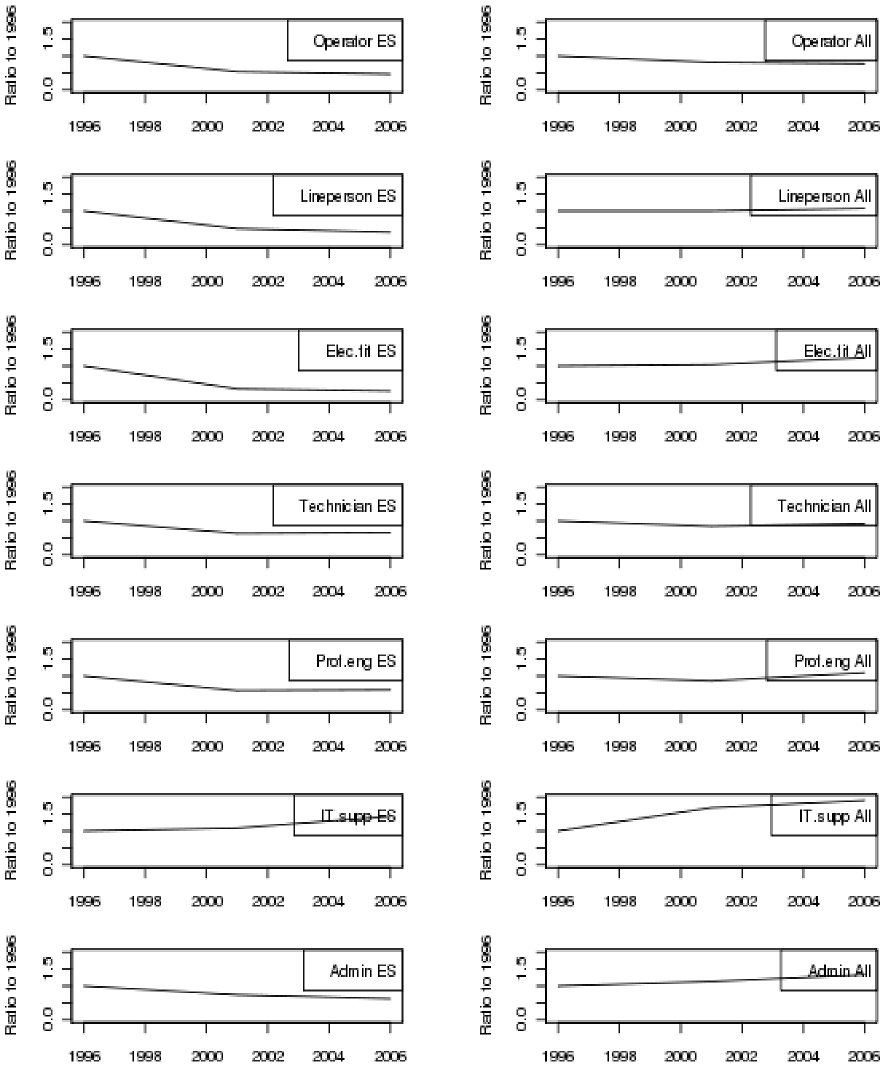

Figure 4: Skill Group Totals as Ratio to 1996 Data. Left charts for electricity industry; right charts for all industries combined

General Observations

For the electricity industry we observe a (generally) declining ratio from 1996 to 2001, then a flattened or lower rate of decline. We conclude this arises from a combination of increased productivity and re-classification in industry sector due to contracting out policies as contracting companies are not generally classified to the electricity supply industry.

Evidence of this may be seen by more detailed examination of the linesperson category as this is exclusive to the electricity industry. Figure 5 charts the ratio of electricity industry numbers to all industry numbers for linesmen, and the ratio of linesmen (all industry) to the number in 1996.

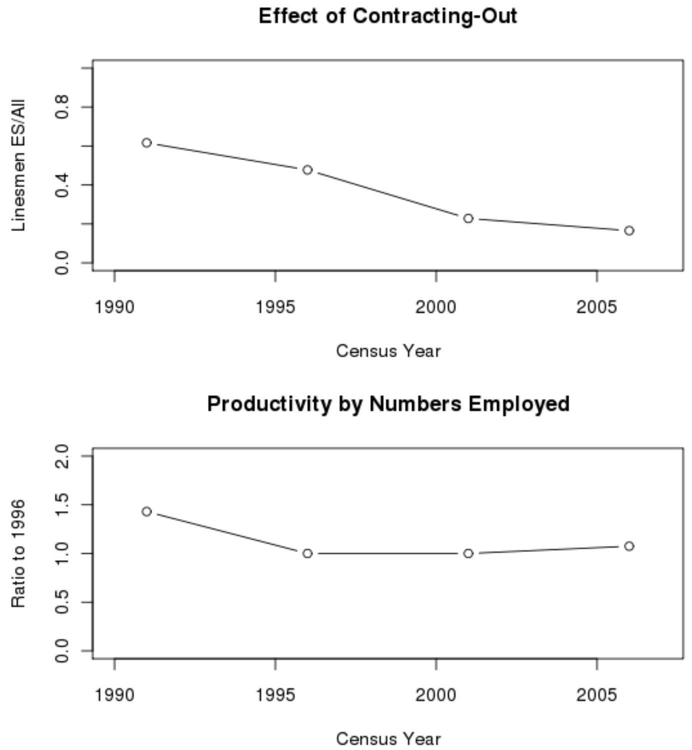

Figure 5: Linesmen Detail: by census year; ratio electricity industry to all industry; all industry numbers as ratio to 1996 total

As all linesmen effectively work in the electricity industry, the top chart of figure 5 reveals the effect of linesmen shifting into contracting companies.[10] In 1991 approximately 60% of linesmen were employed by a company directly associated to the electricity industry but this had fallen to approximately 20% by 2006. We would anticipate similar trends for other trade staff like technicians and electrical fitters, less so for system operators, and to a lesser extent again for the admin/accounts/legal/regulatory group as these activities more relate to the core functions of the electricity businesses.

Because all linesmen work in the electricity industry, this group provides a better measure on the underlying productivity. The lower chart of figure 5 plots all linesmen as a ratio to the total recorded in 1996. We postulate the decrease from 1991 to 1996 arises from the industry restructuring around that time. From 2001 to 2006 the linesmen numbers increased approximately 7.4% or roughly 1.5% p.a. As this is comparable with the distribution network composite size growth over this period, and as linesmen could be considered typical for trades work, we therefore assume a nil productivity change going forward for the trade categories *i.e.* the new work requirements change in relation to the work volume indicators only.

We also assume a nil productivity change for the technician categories as we have no evidence to suppose otherwise.

Skill Group Observations

Professional Engineering

A recognised trend in the electricity industry over the last 10 years has been the contracting out of some professional engineering skills to consultancy firms. We attribute the observed trend in near

10 We cannot confirm this evidentially but it seems a reasonable proposition.

flat engineering numbers (approximately 0.7% p.a. increase form 2001 to 2006) to arise from the contracting out of some services and so we assume a nil productivity change for this skill group.

Admin/accounts/legal/regulatory

Given this skill group is generally regarded as core work and, with few exceptions, is not contracted out, we interpret the observed reduction in numbers, despite increasing sector size over the measured period, as mainly arising from increases in productivity in this group.[11] We assume this trend will continue at the observed rate of approximately -3% p.a. for this skill group in the near-term, however, it would be unreasonable to assume this decline will continue indefinitely. By way of compromise, and for want of better information, we assume a decline due to productivity for the first 5 years of -3% then nil productivity change for the remainder of the 10-year forecast. We assume the work volume indicators act independently from the productivity indicators.

IT Support

The provision of IT support in the electricity industry is varied between in-house and contracted services, or a mix of both. We note an increase in numbers from 2001 to 2006 averaging approximately 6.4% p.a. however, this period may not be indicative of the future and we are reticent to ascribe continued high growth in a sector above the base GDP increase and over a long period. In recognition of this, we assume here a linear increase in this skill category of 5% p.a. over the first 5 years then dropping back to the nominal increase reflective of the general work volume increase in the particular sector.

3.2 Survey and Interview Data

As the majority of the company staff surveys have not been returned, this section awaits the completion of this aspect. It is noted that this is the first issue of this report in this format and deficiency in the data is recognised, particularly in respect of the current workforce numbers and skill allocations. With the co-operation of the industry, it is hoped future revisions of this report will improve in this respect.

4 Effects of Technology Changes

This section examines potential changes in technology and the likely impact on skills requirements in the electricity industry of these potential changes. The potential changes discussed are:

- distributed generation, in particular wind and solar;
- electric vehicles;
- network automation;
- smart metering; and
- changing fuel mix in contemporary generation.

11 We suspect this improvement in productivity arises as a result of investment in business information systems, but it may also be compounded by out-sourcing of call-centre staff and re-classifications towards IT support *e.g* a records clerk becomes re-classified as a GIS operator.

4.1.1 Distributed Generation – Wind and Solar

Distributed generation has been much discussed within the electricity industry for over 10 years. The changing cost structure of generation fuels and particularly the flattening of the cost per installed megawatt with installation installed capacity, caused many in the industry to question the long term viability of contemporary electricity infrastructure design.[12] While there has been some increase in co-generation plants utilising waste heat from industrial processes, a shift to smaller, distributed generation has not eventuated. Key reasons behind this are the price points for contemporary generation have not yet been achieved by the smaller plants; lack of distributed fuel infrastructure, in particular gas, and the draw-down of New Zealand's natural gas reserves; site consenting hurdles; and the economics of wind generation that favour large turbines on favourable wind sites.[13]

Given the impediments to moving to significant portions of generation within the distribution networks, we do not consider this possibility relevant to the skills requirements in the near term.

The economics of wind power will also, we believe, preclude large uptake of small wind turbines at the domestic level.[14]

We consider that domestic solar may impact in two ways; direct solar water heating reducing national generation demand and widespread installation of solar panels for domestic electrical supply with net-metering into the supply mains. The impact of solar water heating, as well as the rise of electric heat pumps replacing other forms of space heating, is already considered in the generation and transmission demand forecasting under demand-side participation that forms the basis of our work volume drivers for generation and is therefore not discussed further here.

The potential uptake of domestic and commercial solar panels for electric supply will largely depend on the economics of this plant. Current prices are in the order of $15,000 per kW installed, with the energy delivered being dependent on the site and average sunshine hours. The potential for production cost decreases and efficiency improvements cannot be discounted and the recent advent of continuously produced cadmium telluride solar panels is projected to offer in the long term (10 to 20 years) installed costs of approximately NZ$3 per watt giving energy costs in the region of NZ14c/kWh on a favourable site.[15] However, we also note the US secretary of energy recently being quoted as believing solar will not be a significant contributor to US energy supply in the near term.

The effect on training requirements of a large-scale uptake of solar panels is difficult to gauge. Given the relatively new commercialisation of this technology, and the current price points, we conclude it will not be a significant factor in the sector work skills over the next 5 years and in the

12 The cost advantages of scale in generation drove the contemporary structure of large isolated power stations connected through a high voltage transmission grid to the distribution networks.

13 Energy from a wind turbine relates to the swept volume as rises as a power of 3 to the wind speed. This shifts the economics to installing large diameter turbines on sites with average wind speeds generally exceeding 6 m/s.

14 An article in Low-tech Magazine (http://www.lowtechmagazine.com/2009/04/small-windmills-test-results.html) reports on a test on 12 domestic-sized wind turbines erected in open ground on towers and run over a calendar year. The article concludes “...that small windmills are a fundamentally flawed technology”. The averaged power outputs ranged from 8.3 watts continuous to 307 watts continuous, with output generally in accordance with the turbine rotor diameter, and with 3 of the turbines breaking during the trial. The more capable machines cost in region of 18,000 euro (approximately NZ$40,000) [although the costs of locally produced turbines in New Zealand has not been explored and may be significantly different].

15 Source: http://en.wikipedia.org/wiki/Cadmium_telluride_photovoltaics and http://www.industryweek.com/articles/new_low_cost_solar_panels_ready_for_mass_production

longer term the effect will more likely impact contemporary generation through displacement rather than direct involvement as installation and maintenance of domestic and commercial solar panels may well be undertaken by workers operating outside the electricity supply industry sector *e.g.* domestic electricians.

We also consider that commercial solar generation facilities are unlikely in New Zealand over the next 10 years as they would be uncompetitive with alternative fuel technologies like wind and geothermal. We note the Electricity Commission 2008 statement of opportunities anticipates no solar power stations within its forecasts.

The installation of domestic solar water heaters will impact on domestic demand and we assume here that this aspect has been considered and incorporated in the Electricity Commission electricity demand forecasts that underpin the generation sector workforce estimations.

4.1.2 Electric Vehicles

A shift in the New Zealand transportation fleet towards electric-powered vehicles is considered in the Electricity Commission forecasts but is not considered significant until after 2020 and so is not considered further in this review.[16]

4.1.3 Network Automation

This technology development mainly impacts distribution networks and incorporates greater automated switching in these networks and well as increased data communications for fault diagnostics. The drivers for these technologies are largely around service improvement in network reliability rather than seeking productivity improvements, therefore the effect on workforce numbers in general is anticipated to be small. The main areas for change we anticipate to be in:

- increased data flows requiring capture, processing and analysis so affecting engineering and IT support requirements, and
- greater penetration of electronics and communications equipment into the networks increasing the requirements for technician skills.

We do not anticipate these requirements to be significant to the extent we would need to allocate a separate factor for the distribution sector, noting there is already a significant increase evident in IT support functions.

4.1.4 Smart Metering

The advent of smart metering, that is customer meters with increased capabilities including time of use metering, remote communications for automated reading, net power metering, and power quality monitoring, have been discussed in the industry for a number of years but only recently have the purchase price points been achieved to allow increased installation to other than high-use customers. Changes in the metering compliance standards have also impacted in making replacements of meters older than 15 years more attractive.[17]

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16 Source: Electricity Commission 2008 statement of opportunities.

17 The costs of the testing regime to ensure meters greater than 15 years of age are compliant with class accuracy requirements often makes replacement with new meters on a 15 year cycle economically more attractive.

The anticipated impacts of this on the workforce are:

- reduction of meter-readers;
- potential increase for faultmen to change-out meters as they shift from a meter life cycle of approximately 45 years to 15 years[18];
- increased data flows requiring data capture, processing and analysis with implications for IT support and business analysts;
- the new generation of electronic meters are non-repairable so there will likely be a diminished requirement for metering technicians to refurbish and calibrate changed-out meters.

We do not anticipate these requirements to be significant to the extent we would need to allocate a separate factor for the distribution sector, noting there is already a significant increase evident in IT support functions.

4.1.5 Changing Fuel Mix in Contemporary Generation

Based on the generation mix scenarios described in section 3.2.2 being based on the Electricity Commission 2008 forecasting for conventional generation *i.e.* generation at grid connected stations, there is an evident rise in wind generation, geothermal generation, and thermal generation (generally as gas-fired peaking plant).

Based on this evidence, and the results of the industry participant interviews, we anticipate this trend will give rise to:

- an increased need for mechanical engineering and mechanical trade skills in particular;
- increased need for specialist engineering skills for wind generation;
- increased skills in engineering and IT support to deal with the large information flows back from wind plant in particular;
- increased skills to manage the consenting issues for the new wind plant in particular; and
- an increased need for thermal plant operators.

Whilst some of these issues are dealt with through our generation sector work volume model discussed in following sections, new issues particularly around the on-going management of the wind plant may give rise to additional skills that are not adequately represented within the existing workforce.

5 Economic Drivers

The workforce forecasting model developed has two key macro-economic drivers – GDP and population. These drivers, and especially GDP, affect the model at multiple levels and so are discussed separately.

5.1.1 Population Forecast

The population forecasts provided by Statistics New Zealand (DoS) describe nine scenarios

18 It seems likely this will not be a significant issues as this type of work may be arranged as fill-in for faultmen and therefore may be accommodated as a productivity improvement.

depending on assumptions about fertility, mortality, and net migration etc.[19] The forecasts out to 2021 are illustrated in figure 8 following.

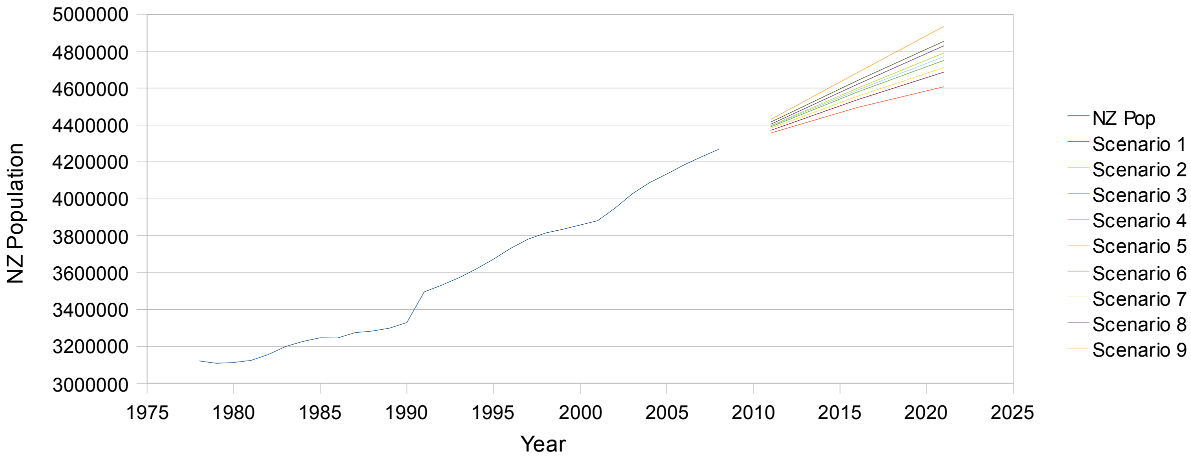

Figure 6: NZ Population forecast to 2021 by DoS

A middle scenario (5) is assumed as the mid-range expectation which sees the New Zealand population increase from 4268900 in 2008 to 4770800 by 2021.[20] Table 2 sets out our expectation.

Year	Pop.NZ
2008	4268900
2020 expected	4770800
2020 low	4607600
2020 high	4935600

Table 2: Population forecast over period

5.1.2 GDP Forecast

The GDP forecast by Treasury is illustrated in figure 9 below.[21] The forecast sees a negative GDP in 2009 (-0.1%) then rising to 4.1% by 2012. As the Treasury forecast only extends to 2013, we have assumed a continuing compounding trend at 2.0% p.a. from 2014 to 2020, as per the assumption made in the Electricity Commission demand model.[22] As the Treasury forecast does not describe error bounds, for the purpose of this review and in the absence of better information, we have assumed the year to year variance varies by +/- 0.5%. As GDP is a key driver in most of the sector forecasts, including generation energy demand and transmission peak demand, we apply the GDP forecasts as scenario inputs to the work volume models.

19 Source: http://wdmzpub01.stats.govt.nz/wds/TableViewer/tableView.aspx?ReportName=Population Projections/Projected Population of New Zealand by Age and Sex, 2006 (base) - 2061

20 Series 5: Assuming medium fertility, medium mortality and long-run annual net migration of 10,000

21 Source: http://www.treasury.govt.nz/budget/forecasts/eff2008/21.htm

22 Source: Electricity Commission 2008 Statement of Opportunities.

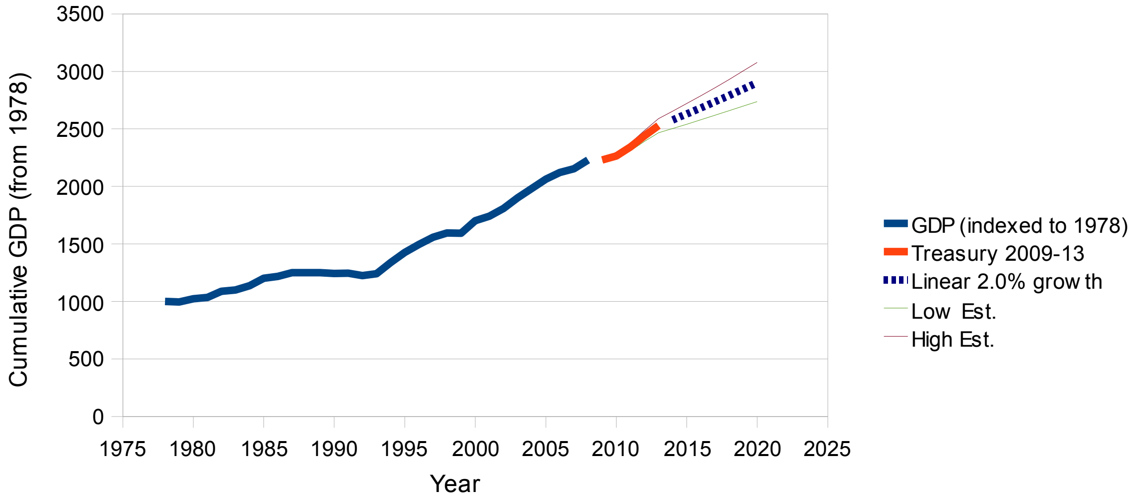

Figure 7: GDP Forecast (indexed to 1978 at 1000)

Table 3 give our expectation of GDP including bounds.

Year	GDP (indexed to1978)
2008	2231
2020 expected	2903
2020 low	2738
2020 high	3079

Table 3: GDP forecast

6 Work Volume Indicators by Sector

6.1 Distribution Sector

For the distribution sector we assign work volume index indicators to the skill categories as follows:

Skill Category	Work Volume Index
System operator duties	Composite size
Linesperson duties	Composite size
Vegetation management duties	Overhead system length
Cable joining	All cable length growth
Electrical fitting	Composite size
Mechanical fitting	Composite size
Technician duties	Composite size
Technical supervision	Composite size
Project management	Composite size
Professional engineering	Composite size
Business/technical analyst duties	Composite size
IT support/software development duties	Census data numbers increase
Administration/legal/accounts/regulatory duties	Customer count (ICP) (less evident productivity)
IT application operator duties [specifically GIS, CAD, and CMMS]	Composite size

Table 4: Distribution Sector Work Volume Indicator Map

The composite size index, defined in section 3.1.2 following, is derived from regression analysis on the FY2008 distribution company disclosure data based on prediction of the direct operational costs supporting the fixed assets. This value is used as direct cost is approximately 75 to 80 percent wages and is therefore a good indicator of the labour required and hence the number of persons employed either by the distribution companies or through contracting service companies.[23]

Administration etc. is considered more closely related to the number of customer connections serviced by the distribution sector as measured by the ICP count.

Overhead system line length that sums both HV and LV overhead lines is considered the best indicator for vegetation management services. Note that linesmen are indexed against composite size rather than line length in our model as connections and disconnections and faults work make up a significant aspect of the work required and analysis of the census data, discussed later, suggests linesmen numbers have been changing closer to the index suggested by composite size rather than line length.

As the majority of new cable installed in New Zealand is anticipated to have a long and maintenance free life, cable joining skills are indexed on the anticipated installation rate of new underground mains cable that requires these specialist skills.[24] [25]

Whilst composite size is a useful measure of work volume, it assumes the composition of that work

23 The assumption of opex comprising 75 to 80 percent wages is based on assessment of Australian distribution companies and we assume here that a similar ratio will apply to New Zealand companies.

24 We assume here that LV cable installation requires specialist cable joining skills especially with cables above 16 sq.mm, which all LV mains cable distributors are.

25 As the proportion of networks run in underground cable increases, the call on cable joining skills will increase to manage the increasing maintenance and fault aspects. However, cable faults (mainly being cable dig-ins) on most networks account for a small fraction of the network faults at present and we do not see this aspect becoming a significant driver in the near term when considered over all networks.

remains unchanged. A key factor of interest and debate in the distribution industry is the degree to which asset replacements and/or maintenance will increase over time as networks age which will increase labour requirements. This issue is considered further in the following sections.

6.1.1 New Zealand Distribution Sector Disclosure Data

Disclosure data from the (circa) 30 New Zealand distribution companies has been collated and totalled for the years FY1998 to FY2008 (11 years).[26] The chart of figures 1 below describes the changes in system length by high and low voltage and overhead and underground lines. The chart of figure 2 shows the changes in ICP count, transformer capacity, and system maximum demand. All values are normalised to the FY2008 values so relative changes may be compared. The charts of figures 3 and 4 repeat figures 1 and 2 but reveal detail in the last 4 years FY2005 to FY2008 as prior to the FY2004 asset valuations undertaken by all companies, the data is somewhat variable and the recent trends are more consistent.

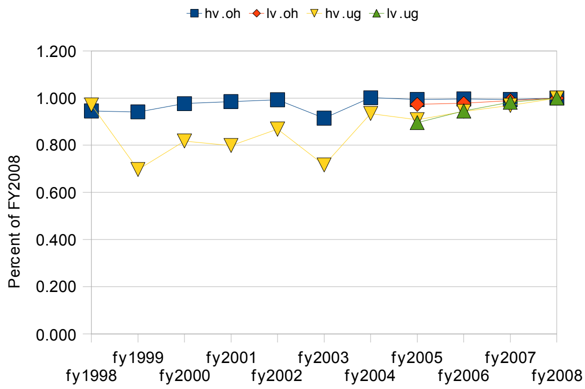

Figure 8: Distribution System Lengths FY1998-08

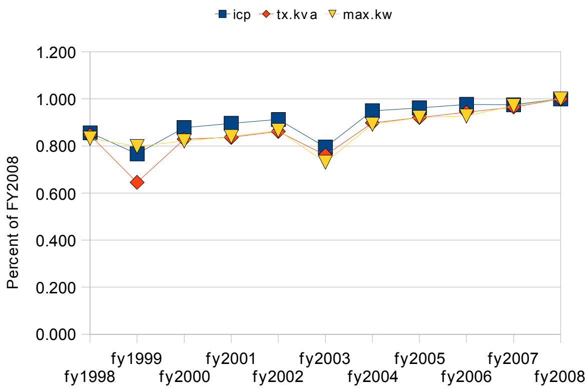

Figure 9: Distribution Customers and Demand FY1998-08

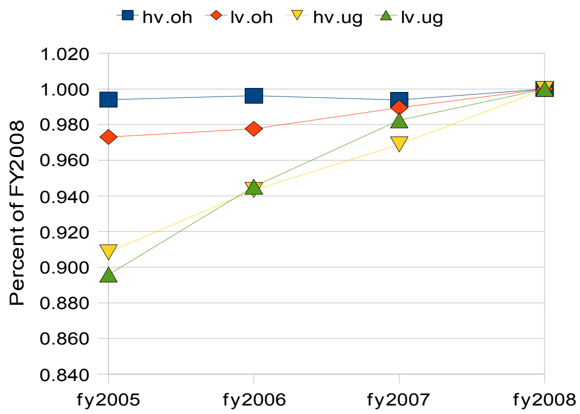

Figure 10: Distribution System Lengths FY2005-08

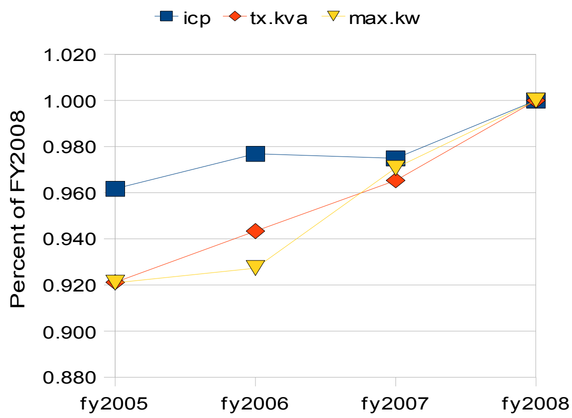

Figure 11: Distribution Customers and Demand FY2005-08

Allowing for data error and normal variance, we can only conclude a linear (not compounding) increase in the key parameters of system length, customer count, transformer capacity and system maximum demand. The implication for forecasting the labour requirements for growth, as opposed to system maintenance and management, it that there is no clear indicator that significant labour increases are required for construction work in this sector. That is, the present workforce numbers

26 Source: Compiled disclosure data purchased from Electricity Engineers Association for years FY1998-06; individual company disclosures (published on company web sites) for FY2007 and FY2008.

that are building new network should be adequate into the near future as the rate of build for distribution networks appears constant.

Of note is the near flat trend for HV overhead lines length and where only a modest increase in LV lines is evident. This indicates the maintenance work requirement for vegetation management services also appears stable into the near future.

6.1.2 Composite Size

Direct operational expenditure on system fixed assets (direct cost) is assumed to comprise 75 to 80 percent wages, as discussed in previous section, and is therefore taken as a good indicator of the direct labour required and hence the number of persons employed directly on the networks, as opposed to business support functions, by the combined distribution companies and contracting service companies.

We explored a number of predictors for direct cost the best of which was HV underground cable length. However, we believed this finding was more serendipitous than causal and so we concluded a predictor related to the number of connections raised to the power of 0.72 multiplied by the combined HV system length raised to the power of 0.25, that is:

direct cost <> icp^0.72 * all.hv^0.25.

This relationship was concluded after examination of the log values of the parameters. We were guided in this matter by the findings of the Office of the Gas and Electricity Markets in the United Kingdom (ofgem) who concluded a finding for UK distribution companies of:

direct cost <> icp^0.5 * length^0.25 * energy^0.25

but noting in the New Zealand situation the number of connections and energy supplied are highly correlated, which we expect to continue, and so only one length parameter is used raised to an increased power.

The correlation chart of the direct cost and calculated predictor, referred to here as composite size, is illustrated in figure 12 below where each point plots the correlation between calculated and actual by company.[27]

27 Note that this is not a regression chart in itself (as the regression is multi-dimensional) but a map of the calculated variable from our regression analysis to the actual target variable being estimated.

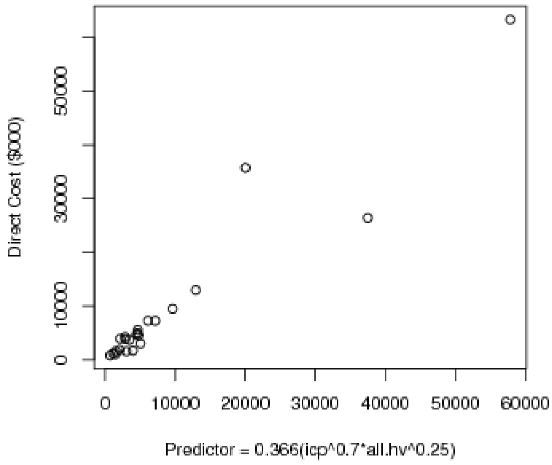

Figure 12: Correlation of Composite Size and Direct Cost (FY2008 data) for distribution companies.

In order to use the composite size as a predictor of work volume we must forecast the ICP count and the HV system length. To do this we regress these parameters against New Zealand population and cumulative Gross Domestic Product (GDP) as developed in previous sections. We do this in order to pin our forecasts against likely predictor variables generally forecast by government agencies.

After analysis, we concluded the most reasonable regression (within the constraints of the data and predictor variables available to us) of relating ICP numbers to GDP and HV system length to New Zealand population count, the latter relationship being less reliable.[28] Figures 13 and 14 illustrate the degree to which the regression maps the calculated variables to the target variables.

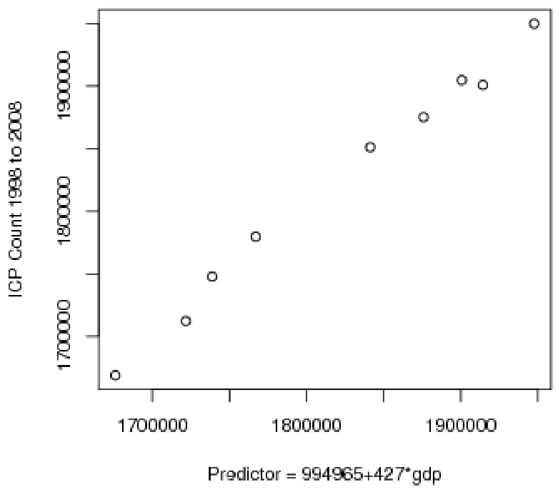

Figure 13: ICP Count as predicted by GDP

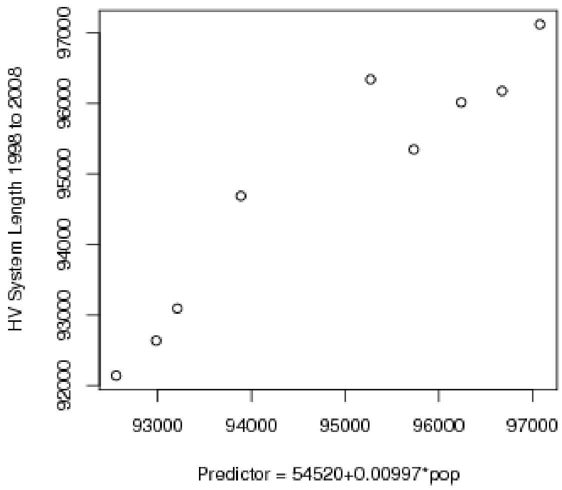

Figure 14: System HV Length as predicted by NZ Population

Based on our earlier assessment of population and GDP growth, we calculate the following work volume measures at 2020.

28 This is evident from the scatter of the regression. We note, however, that as HV length is applied in our composite variable formula at a ¼ root, the impact of error by this parameter is reduced.

Year	Pop.NZ	GDP (1978)	ICP	All.HV (km)	Composite	Overhead (km)
2008	4268900	2231	1949720	97121	218318	109723
2020 expected	4770800	2903	2234546	102085	243858	112356
2020 low	4607600	2738	2164091	100458	237342	111040
2020 high	4935600	3079	2309698	103728	250735	113673

Table 5: Distribution Sector - Forecast Predictor Quantities

6.1.3 Asset Replacements

There is a perception within the distribution industry that asset replacements will play an increasing role in the work of distribution companies as assets built in the post-war boom of the '50s and '60s come due for replacement. Fortunately, in the changed company disclosure requirements for FY2008, published in April 2009, companies additionally disclose the average network age, expected average life of the networks, and the replacement and depreciated replacement costs of the networks rolled forward from FY2005.[29] This enables trending of the average age of the networks expressed on the basis of expected asset lives.

As well as this, a few companies disclosed capital expenditure allocations from which we have made an assessment of the current asset replacement expenditure as a percentage of replacement cost of the networks, and all networks disclosed the percent of the assets expected to be replaced over the next 10 years.[30] Our findings are set out below.

The trend in average network age is described in the following table:

Year	FY2005	FY2006	FY2007	FY2008
Average Network Age (all NZ - yrs)	28.49	28.40	28.33	28.30

Table 6: Distribution Sector - Network Weighted Age Trend

The average network age is being maintained (and slightly decreased) by the combination of growth and replacements balancing asset ageing. From the small number of companies that disclosed capital expenditure allocations, the average replacement as a percentage of replacement cost is 1.82%. The average quantities of assets noted for replacement over the country over the next 10 years (weighted by the company replacement cost) is 16.4% or 1.64% per year on a linear basis. This, together with the stable average age of the networks, implies that the present level of asset replacement appears sufficient to continue maintaining the average network age into the near future. **As such, and based on the factual evidence we have before us, we are not predicting an increase in the workforce numbers (on a combined country-wide basis) due to distribution network ageing.**

29 Information disclosure information prepared according to subpart 3 of the Part 4A Commerce Act 1986.

30 Disclosure of allocation of capital expenditure is optional in FY2008 and compulsory from FY2009.

6.1.4 Work Volume Indicators Assumed

From the increases in key variables noted in section 3.1.3, and noting the arguments of section 3.1.4 that asset replacement is not considered change significantly in the near term, we calculated the following work volume indicator indices, noting that the per annum averages are linear increases, not compounding increases.

	ICP	Composite	Overhead
2020 expected	115%	112%	102%
Expected per annum	1.33%	1.06%	0.22%
Low per annum	1.00%	0.79%	0.11%
High per annum	1.68%	1.35%	0.33%

Table 7: Distribution Sector - Work Volume Indicator Ranges

These increases are applied to the skill categories in the distribution sector as per the map of table 4 to derive the work volume-based changes as per table 8 following.

Distribution	**Attrition**		**Work Volume**		**Total Count p.a.**	
Class	**2009 – 2014**	**2015 – 2020**	**2009 – 2014**	**2015 – 2020**	**2009 – 2014**	**2015 – 2020**
system operator	-2.80%	-2.80%	1.10%	1.10%	20	20
IT operator	-2.80%	-2.80%	1.10%	1.10%	17	17
linesperson	-2.80%	-2.80%	1.10%	1.10%	59	59
vegetation management	-2.80%	-2.80%	0.20%	0.20%	5	5
cable joining	-2.80%	-2.80%	0.20%	0.20%	2	2
electrical fitting	-2.80%	-2.80%	1.10%	1.10%	18	18
mechanical fitting	-2.80%	-2.80%	1.10%	1.10%	7	7
technician	-2.80%	-2.80%	1.10%	1.10%	18	18
technical supervision	-2.80%	-2.80%	1.10%	1.10%	8	8
project management	-3.60%	-3.60%	0.00%	0.00%	7	7
professional engineering	-3.60%	-3.60%	1.10%	1.10%	12	12
business/technical analyst	-3.60%	-3.60%	1.10%	1.10%	4	4
IT support/development	-2.20%	-2.20%	1.10%	1.10%	11	11
administration	-2.20%	-2.20%	-1.90%	-0.40%	4	26
miscellany	-2.20%	-2.20%	0.00%	0.00%	1	1
Sum p.a.					**193**	**215**

Table 8: Work volume drivers for distribution (% and count p.a.)

The change in numbers caused by cumulative attrition and work volume changes (including growth and productivity) are illustrated in figure 15 below for the distribution sector.

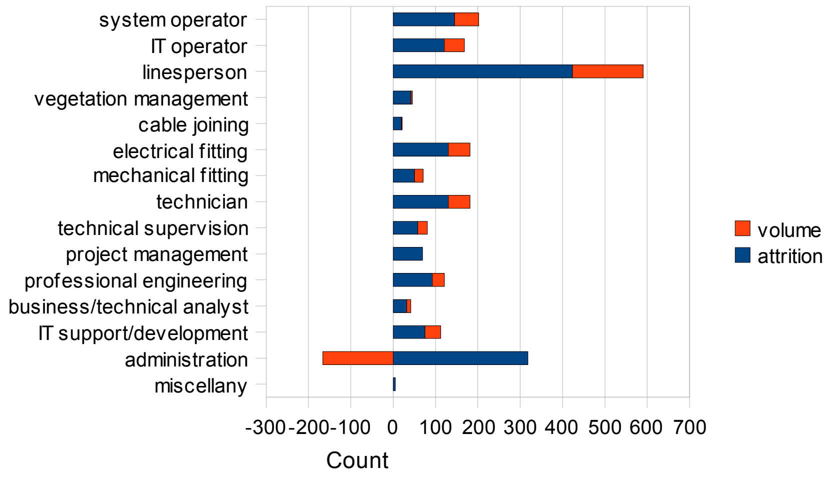

Figure 15: Cumulative attrition and work volume at 10 years for distribution

The change off the current estimate of workforce numbers (at 2008) is illustrated in figure 16 below.

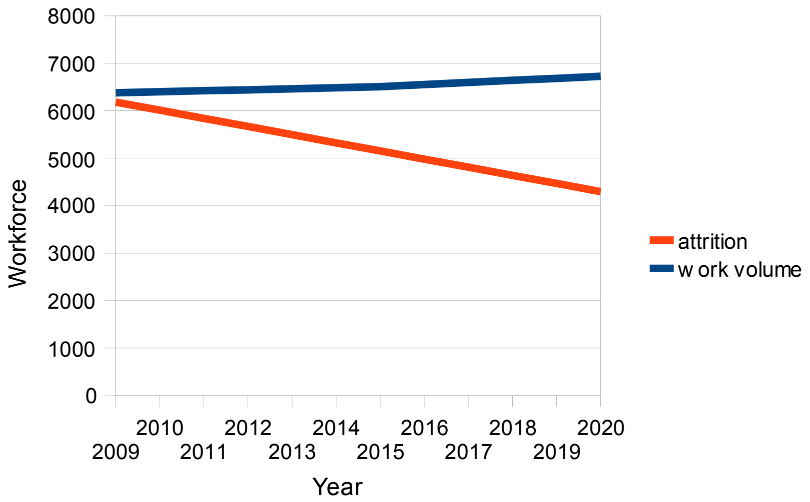

Figure 16: Workforce projection of current numbers for distribution

6.2 Generation Sector

For the generation sector, and for want of more detailed information, we assign a single work volume index indicator to all skill categories based on the installed generating capacity.

6.2.1 Energy Forecast and Installed Capacity Calculation

The historic and forecast electricity supplied, in GWh, based on the 2008 Electricity Commission (EC) forecasts, is illustrated in figure 10 below that includes the Commission's high and low estimates.[31] Figure 17 also plots the ratio of energy supplied (in GWh) to installed capacity (in MWs) assuming the expected energy demand forecast. The ratio forecast bounds represent the

31 Source: Electricity Commission 2008 Statement of Opportunities

Commission's assessment of the build scenarios to meet the expected energy forecast.[32] The values are also expressed in table 9 following.

	Expected	Low	High
Linear GWh demand increase per annum	1.74%	1.23%	2.2%
Ratio GWh/MW	4.12	3.86	2.29

Table 9: Generation Forecast GWh Growth and Demand to Capacity Ratio

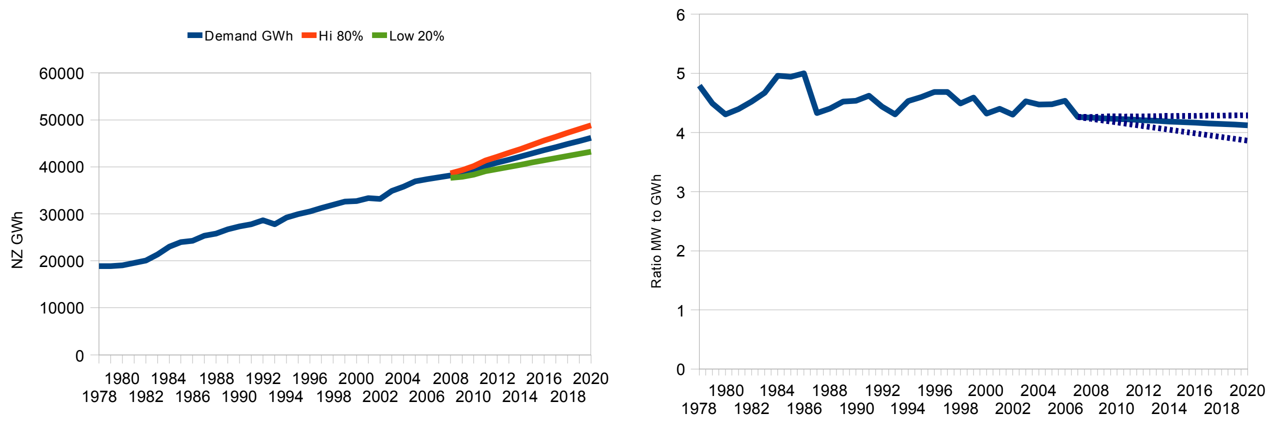

Figure 17: Forecast Energy Demand (with bounds) and Energy to Capacity Ratio for Expected Energy Forecast

Note that we prefer a smoothed installed capacity forecast for our purpose of workforce forecasting as the work involved mostly precedes the plants commissioning dates and organisations tend to build their capabilities in advance of and over a longer duration than may be suggested by the suggested plant commissioning dates.

6.2.2 Generation Mix

The chart of figure 18 following illustrates the historic build of generation plant by fuel type together with the average projection of installed capacity by fuel type (under the expected energy demand forecast and average of the fuel-type scenarios).[33]

32 In the 2008 statement of opportunities the Commission describes 5 scenarios being: Sustainable path – New Zealand embarks on a path of sustainable electricity development and sector emissions reduction; South Island surplus – Renewable development proceeds at a slightly more moderate pace. Considerable increase in wind and hydro particularly in lower South Island: Medium renewables – Middle of the road scenario; Renewables developed in both islands with North Island Geothermal playing an important role. Tiwai smelter assumed decommissioned in the mid-2020s; Demand Side Participation – Demand Side Participation becomes a more important feature of the market. ; High Gas Discovery – Major new indigenous gas discoveries keep gas prices low to 2030 and beyond.

33 Source for existing build profile: Energy Data File June 2008; section G – Electricity, table G.3a

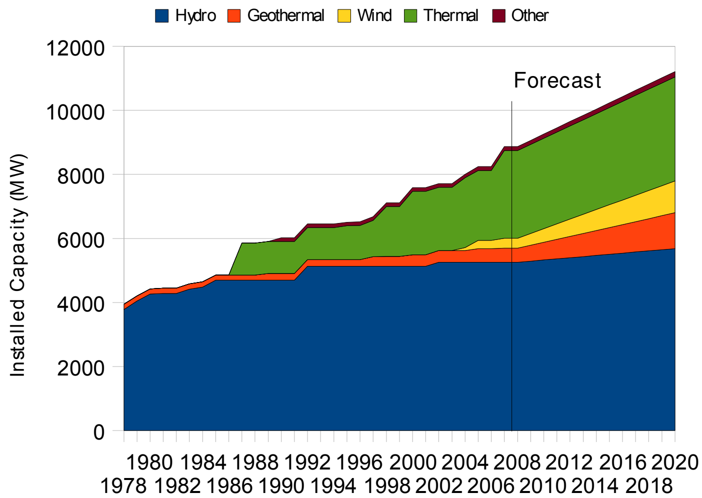

Figure 18: Generation Build by Type

Based on the Electricity Commission's developed scenarios, the mix of generation types as incremental builds on current installed capacity is set out in the following table.[34]

Fuel Type	Expected	Low	High
Hydro	8%	4%	14%
Wind	222%	62%	502%
Thermal	18%	-3%	33%
Geothermal	155%	126%	181%
Other (Co-gen etc.)	31%	0%	92%

Table 10: Forecast Installed Capacity Increase 2008 to 2020 by Fuel Type

The different fuel types for the new generation require differing levels of workforce requirement to manage them. For example, more staff are required per installed MW of thermal generation than for hydro generation. The proportions of persons, and by implication skills, by fuel type are based on staffing ratios published for European generating facilities and this has been developed into table 11 following, expressed relative to the generation mix at 2008.[35]

34 Developed from EC 2008 statement of opportunities appendix 6 - build scenario tables.

35 It is hoped to update this information to be more specific once staff surveys are returned from the generation companies approached.

	Hydro	Wind	Thermal	Geothermal	Other (co-gen etc.)
Relative workforce to service the generation mix at 2008	51%	4%	37%	6%	2%
Staff per MW installed capacity relative to hydro	1.0	1.41	1.41	1.42	1.41

Table 11: Leverage on Generation Workforce due to Fuel Type

From table 11 it is evident that a shift in build towards more geothermal, thermal, and wind plant will will require greater staffing resources relative to the present generation mix.

The forecasting model applied to forecast the generation sector workforce is illustrated as:

GWh forecast (=GDP scenario) → MW build (by ratios) → Fuel Mix → Workforce change

That is, from the driver of GDP we take the energy forecast (in GWhs), apply the build ratio derived from the Electricity Commission's scenario analysis to yield the expected increase in generation capacity (in MW), subdivide this capacity increase into fuel types, then consider the workforce increase required by fuel type.

On this basis, we estimate the relative change in workforce numbers in the generation sector, for the scenario of expected GDP and expected fuel mix, as per table 12 (percent per annum over the forecast period).

Fuel Type	Hydro	Geothermal	Wind	Thermal	Other	**Total**
Linear percent p.a. against total generation workforce	0.34%	0.78%	0.79%	0.56%	0.04%	2.5%

Table 12: Generation Sector Workforce Change (expected scenario)

The overall increase in the generation sector is expected to be approximately 2.6% p.a. However, the greatest increase is anticipated in the geothermal, wind, and thermal plant. We note that all of these categories generally require greater skills in the mechanical disciplines and accordingly we have increased the per annum requirement for mechanical fitters to 3% in the base (expected) scenario and a corresponding lower growth rate for electrical fitters at 2%.

The drivers and total count for the generation sector are set-out in table 13 following.

Generation	**Attrition**		**Work Volume**		**Total Count p.a.**	
Class	**2009 – 2014**	**2015 – 2020**	**2009 – 2014**	**2015 – 2020**	**2009 – 2014**	**2015 – 2020**
system operator	-2.80%	-2.80%	2.60%	2.60%	12	12
IT operator	-2.80%	-2.80%	2.60%	2.60%	10	10
linesperson	-2.80%	-2.80%	0.00%	0.00%	0	0
vegetation management	-2.80%	-2.80%	0.00%	0.00%	0	0
cable joining	-2.80%	-2.80%	0.00%	0.00%	0	0
electrical fitting	-2.80%	-2.80%	2.00%	2.00%	9	9

mechanical fitting	-2.80%	-2.80%	3.00%	3.00%	4	4
technician	-2.80%	-2.80%	2.60%	2.60%	11	11
technical supervision	-2.80%	-2.80%	2.60%	2.60%	5	5
project management	-3.60%	-3.60%	0.00%	0.00%	2	2
professional engineering	-3.60%	-3.60%	2.60%	2.60%	5	5
business/technical analyst	-3.60%	-3.60%	2.60%	2.60%	2	2
IT support/development	-2.20%	-2.20%	5.00%	3.80%	30	25
administration	-2.20%	-2.20%	-0.40%	1.10%	32	58
miscellany	-2.20%	-2.20%	0.00%	0.00%	1	1
Sum p.a.					**122**	**143**

Table 13: Attrition and work volume drivers (% and count p.a.) for generation

The change in numbers caused by cumulative attrition and work volume changes (including growth and productivity) are illustrated in figure 19 below for the generation sector.

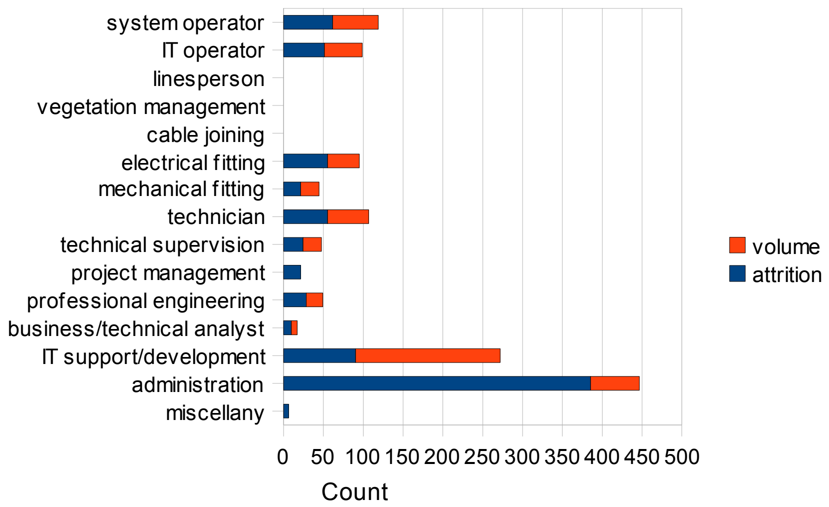

Figure 19: Cumulative attrition and work volume at 10 years for generation

The change off the current estimate of workforce numbers (at 2008) is illustrated in figure 20 below.

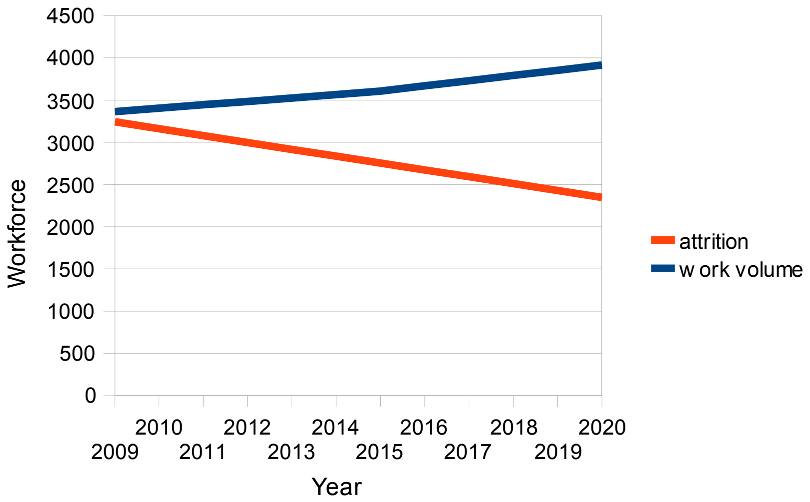

Figure 20: Workforce projection of current numbers for generation

6.3 Transmission Sector

Forecast workforce numbers for work volume in this sector are based on a combination of:

- the forecast increase in maximum demand on the transmission network supply points as an indicator of increasing routine works requirements, in combination with;
- Transpower's operational expenditure forecasts; and
- Transpower's own estimate of workforce numbers for its currently identified major network projects.

Transpower recognise future work requirements for replacements, particularly in its ageing transformer and substation assets. Workforce requirements to deal with these replacements fall largely into the construction sector, for which, as per generation, we assume a constant pool of labour.

Of all the sectors, transmission appears in the greatest state of change given the large capital programme before it and the reversion of Transpower to an internally managed training policy (discussed following). As such, we recognise that forecasting off the status-quo is difficult and our forecasts in this sector may change in subsequent revisions of this work.

6.3.1 Routine Works

The Electricity Commission forecast transmission network maximum demand to increase at 2% p.a. out to 2020 in the North Island and 1.8% p.a. to 2012 then 0.6% p.a. to 2020 in the South Island.[36] We approximate this forecast to be 2% to 2012 then 1.7% to 2020 on a national basis.[37] We further assume that the transmission network “size” to be operated and maintained increases in proportion to the network maximum demand, but temper this expectation by also considering Transpower's operational expenditure forecast as disclosed in its asset management plan.[38]

36 Source: Electricity Commission grid planning assumptions workshop – demand forecasting, Feb 2008

37 We assume a 3:1 ratio contribution based on a rough order population split between the islands.

38 Source: Transpower Asset Management Plan – December 2008; table 5-1 pg 65

The Transpower operational expenditure forecast, illustrated in figure 21 following, shows an increasing (linear) trend of 6.3% p.a. in lines maintenance, 6.8% p.a. in substation maintenance and approximately 3.7% p.a. in other operations and maintenance (that includes indirect costs) over the period FY2009 to FY2018. The real price escalation included in these figures is not disclosed by Transpower, but we assume here that a figure of approximately 3% p.a. is realistic. On this basis a general increase in the order of 3% per annum in the maintenance workload is anticipated in the areas of substations work (*i.e.* electrical fitters and technicians) and lines area (*i.e.* linesmen).

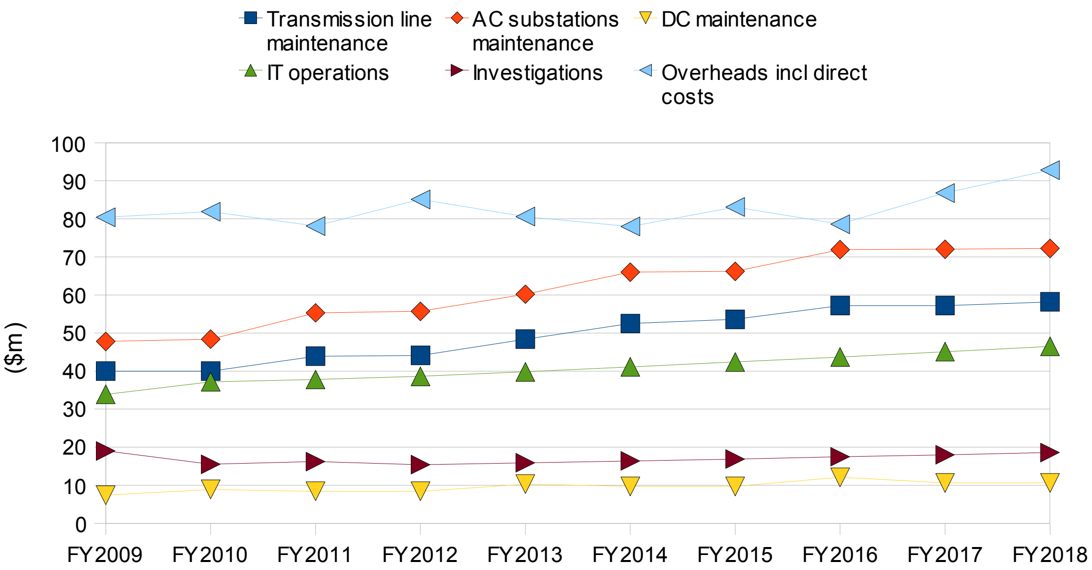

Figure 21: Transpower Opex Forecasts From AMP - Opex by Category

In addition, we note that Transpower are currently implementing a policy of requiring contractor personnel to comply with Transpower's competency specifications in order to work on Transpower plant and Transpower will directly fund this training. This establishes a consistency of skill sets across the sector and will, at least in the short term, require an increase in contractor training. We assume this is reflected in the Transpower opex costing figures.

Based on the industry total workforce and proportionate splits from Koslow and the 2006 Census, the number of linesmen, including trainees, is estimated at approximately 470. However, based on the Transpower transmission line maintenance budget of approximately $40M for FY2009 and assuming $200k/head (incl. overheads) yields a rough-order head count of 200. We assume the lower figure as the base count for linesmen.

6.3.2 Transmission - New Construction Works

At the time of writing, Transpower are recalculating its own estimate of workforce requirements to meet its major projects works that it currently has on its books. While not complete, the estimate for linesmen numbers are described in the chart of figure 22 following.

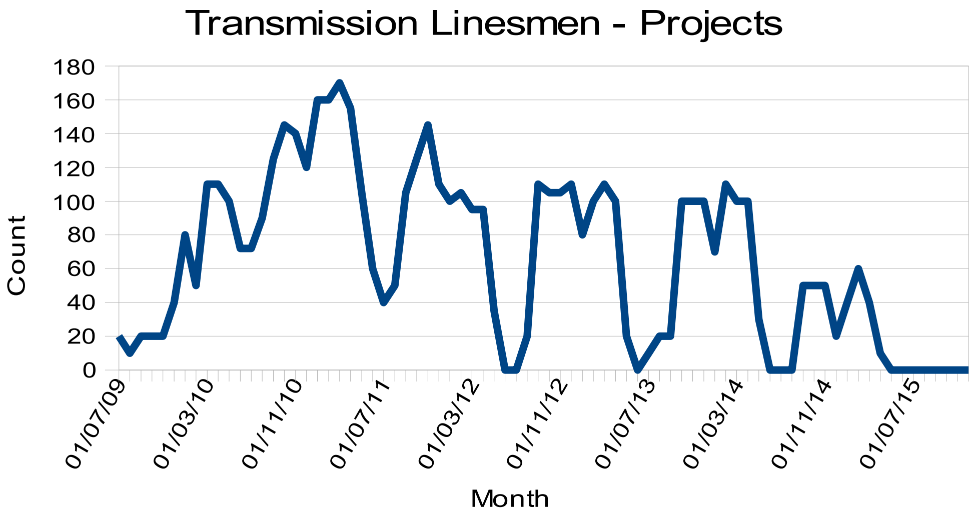

Figure 22: Transpower linesmen requirements for capital projects

For the construction workforce, we are mainly concerned with the requirement for transmission linesmen which is disclosed in the Transpower forecast of figure 22. We note the near-term requirement peaks in the autumn of 2011 (approximately 1 and a ½ years hence) at approximately 170 linesmen. Dependant on the current number of transmission linesmen training, it seems likely the workforce for these projects will have to derive from part diversion of the present workforce (transmission and distribution) plus overseas sources, particularly in the near-term. In recognition of this need, however, we allow an additional 5% per annum on the workforce driver over the first 5 years of the forecast yielding an additional 10 transmission linesmen per year, then 2.5% in the following 5 years. Table 14 following sets out the drivers applied to the transmission sector.

Transmission	**Attrition**		**Work Volume**		**Total Count p.a.**	
Class	**2009 – 2014**	**2015 – 2020**	**2009 – 2014**	**2015 – 2020**	**2009 – 2014**	**2015 – 2020**
system operator	-2.80%	-2.80%	2.00%	1.85%	10	10
IT operator	-2.80%	-2.80%	2.00%	1.85%	9	8
linesperson	-2.80%	-2.80%	8.00%	5.50%	23	17
vegetation management	-2.80%	-2.80%	0.00%	0.00%	2	2
cable joining	-2.80%	-2.80%	3.00%	3.00%	2	2
electrical fitting	-2.80%	-2.80%	3.00%	3.00%	11	11
mechanical fitting	-2.80%	-2.80%	3.00%	3.00%	4	4
technician	-2.80%	-2.80%	3.00%	3.00%	11	11
technical supervision	-2.80%	-2.80%	3.00%	3.00%	5	5
project management	-3.60%	-3.60%	0.00%	0.00%	2	2
professional engineering	-3.60%	-3.60%	2.00%	1.85%	5	5
business/technical analyst	-3.60%	-3.60%	2.00%	1.85%	2	2

IT support/development	-2.20%	-2.20%	5.00%	4.00%	12	11
administration	-2.20%	-2.20%	-1.00%	0.35%	9	19
miscellany	-2.20%	-2.20%	0.00%	0.00%	0	0
Sum p.a.					**106**	**108**

Table 14: Attrition and work volume drivers (% & count p.a.) for transmission

The change in numbers caused by cumulative attrition and work volume changes (including growth and productivity) at 10-years are illustrated in figure 23 below for the transmission sector.

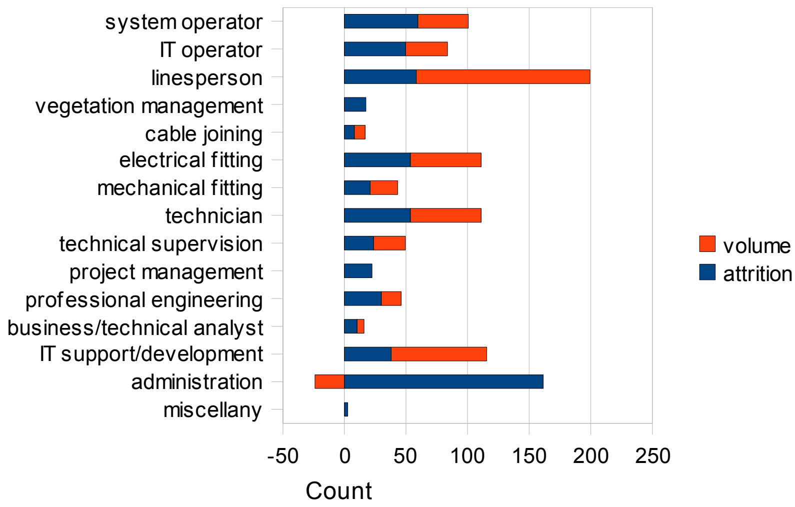

Figure 23: Cumulative attrition and work volume at 10 years for transmission

The change off the current estimate of workforce numbers (at 2008) is illustrated in figure 24 below.

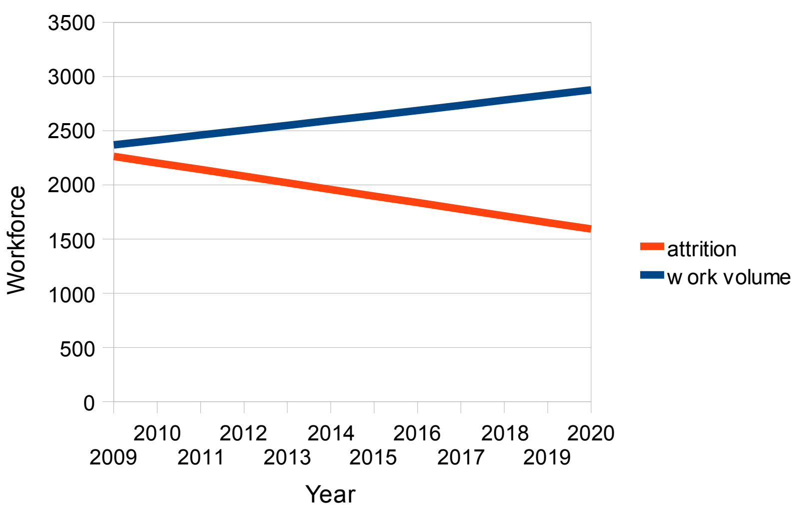

Figure 24: Workforce projection of current numbers for transmission

7 Combined Sectors Workforce Forecasting Model

7.1 Model Methodology

The model seeks to predict training needs of the ES sector by estimating the numbers of new entrants to the sector who will require training.

There are two aspects to this requirement.

Firstly is the total requirement for the workforce to service the needs of the electricity supply sector and second, the attrition of the workforce due to retirement and migration from the industry.

7.1.1 Total Workforce Requirement

It is assumed that the current levels of the workforce are sufficient for the industry. As the sector expands the workforce must increase to meet the needs of this expansion.

A number of factors drive the growth in the skills requirement for the electricity sector. These include: economic and demographic factors, supply side technology, demand side technology, and the physical implementation of the resulting work. It is the last of these that directly drives the skills requirement, but this is, in turn, driven by the first three. These are the principal parameters of our workforce forecasting model.

Examination in the previous sections leads us to conclude that:

1. Changes in demand side technology will not be significant
2. The mix of generation types in the generation sector (generation mix) is the only significant factor with regard to supply side technology.

It is beyond the scope of this work to make detailed predictions of economic and demographic changes, other than taking the forecasts of other agencies as discussed earlier and, in some cases, applying what appears as reasonable bounds to those forecasts. We therefore take the primary drivers of work volume to be: GDP, population, and generation mix. These factors are not independent, in particular GDP and population are correlated, so we take a scenario approach to the modeling.

The model is first applied to a basic growth scenario of expected GDP and population growth and an average of the generation mix scenarios considered by the Electricity Commission. We then examine the effects on the basic model of variations in GDP and generation mix. (We do not show effects of population growth separately because of its high correlation with GDP.)

The numbers for the skill classes in the model are based on a fractional estimation on the workforce total from Koslow and from the 2006 census data and assumes an absolute number of workers in the industry of 12,000 at 2008. Whilst the model is based on percentage changes, and therefore independent of the starting position, the translation to actual training requirements requires setting both a total workforce number and the allocation of that number by sector and skill category. This has been one of the most difficult tasks in this review and has highlighted this area as mostly devoid of hard numbers. The sector and skill group percentage splits, although based on the previous work of Koslow for the sector splits and splits by trade, profession and administration, and the census data for the skill splits under each of the categories of trade, profession, and administration, this split information is approximate at best. Our estimation of the total workforce number at 12,000 is simply the average of the generally discussed range of 8,000 to 16,000 workers. This area is clearly in need of further detailed investigation.

7.1.2 Attrition and Migration

This includes the combined effect of the ageing of the workforce and migration to non electricity supply sector industries including migration of workers to overseas destinations.

We estimated attrition from age profiles of the different skill groups under the assumption of stability of the older section of the workforce as detailed earlier. We also assume additions to the workforce occur in the younger age groups and therefore do not enter into the retirement and attrition part of the age demographic within the projected timespan. This gives a fractional attrition of the current workforce by age group.

Migration has been, historically, highly variable and we do not consider it to be predicable into the future, as, to a large extent, it is driven by the relative position of New Zealand to other countries in both the political and economic climate. However, we believe that given net migration into New Zealand of 15,000 per year, that half of these migrants will enter the workforce and as the electricity supply sector makes up 0.6% of the New Zealand workforce, an estimate of a net gain of 45 to 90 workers per year appears reasonable.

7.2 Base Scenario

We assume the following inputs for the base (expected) model.

GDP growth rate average of 2.2% p.a., a GWh growth of a constant 1.74% p.a. over the projection period, a build ratio (GWh/MW) for generation of 4.12, and an incremental generation build mix as per the expected mix column of table 10 in the generation section.

Input to the model is an estimate of the total number in the industry and the split of that number by sector and skill as discussed in previous sections. The chart of figure 25 below illustrates this split by skill and sector.

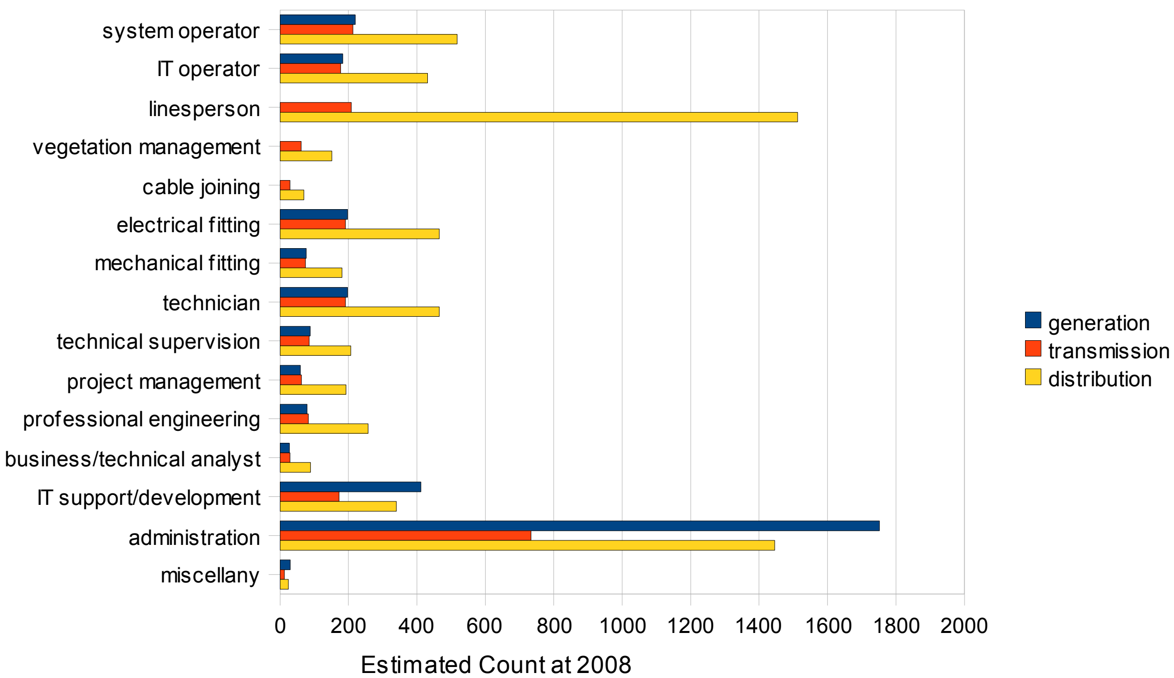

Figure 25: Estimate of current (2008) industry workforce numbers by skill and sector

Running our model on these inputs, and combined with the other analysis and assumptions discussed in previous sections, yields table 17 (in Appendix 1) that shows the fractional increase per annum in requirements for all skill classes in each sector of the industry. Each sector is individually shown and also the total across the whole industry for the 2009 -2014 and 2015 – 2020 time periods.

Running these annual percentage increases on the current workforce numbers split by sector and skill as discussed earlier yields table 18 (in Appendix 1) that shows the absolute numbers required per annum over the two time periods.

To illustrate the requirement for new or replacement requirements, the chart of figure 26 below shows the expected cumulative numbers (combining work volume and attrition) by skill and sector after 10 years. Note that, as discussed in following text, the requirement is driven approximately 60/40 between attrition and work volume.

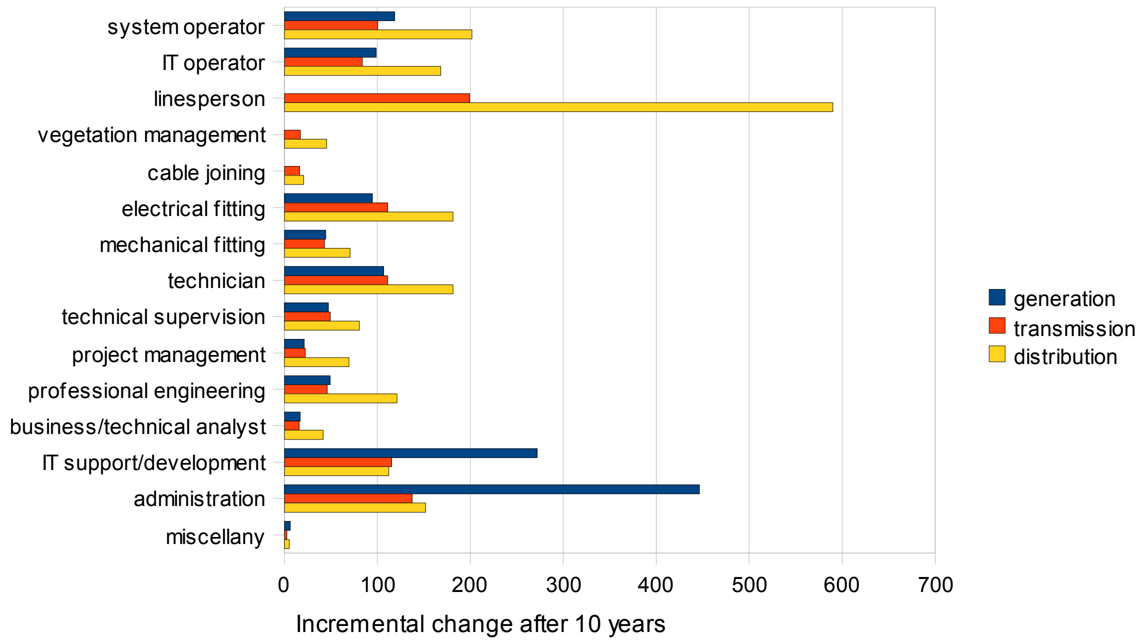

Figure 26: Incremental change (volume + attrition) at 10 years by skill and sector

The relative impact (percentage changes by skill and sector) are further illustrated in figure 27 following that also combine both attrition and work volume changes.

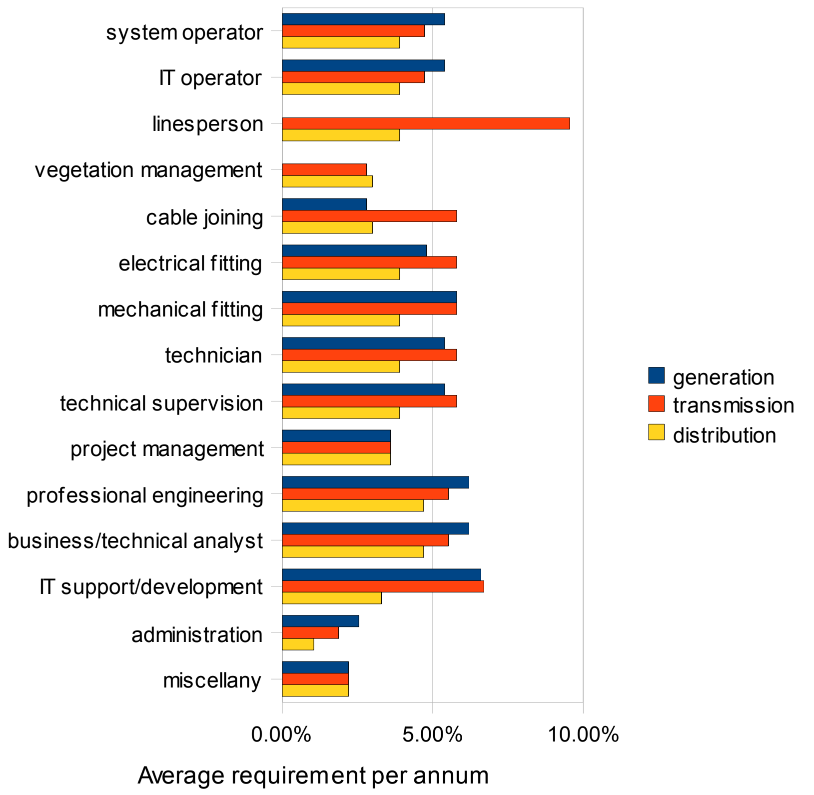

Figure 27: Relative percent changes by skill and sector (expected case); attrition and volume combined

We note the relatively large increase in transmission linesmen, IT support in general, generation sector in general and the higher relative increase in mechanical fitters in the generation sector.

The relative impact on current numbers is illustrated in figures 28 and 29 and 30 following, Figure 28 charts the current (2008 estimate) of numbers by skill and the change in total numbers at 10 years. Figure 29 charts the difference in numbers at 10 years where attrition is represented as a loss and work volume a gain (that may be negative depending on productivity). Figure 30 is the same as figure 29 but the 10-year gain is plotted stacked on current workforce numbers to show relativity of total size.

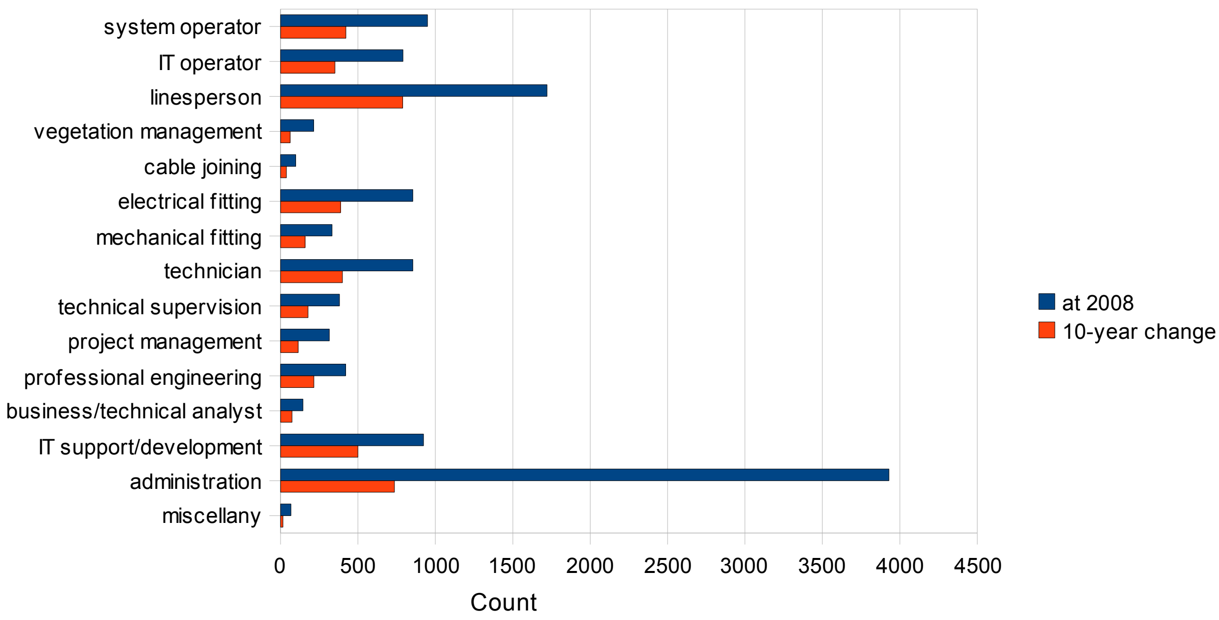

Figure 28: Comparison of change in workforce numbers by skill after 10 years against current numbers

From figure 28 we note that the change in the workforce numbers after 10 years is roughly 50% in most of the skill classes *i.e.* we anticipate approximately 50% of the current workforce numbers in these skill classes will be new persons after 10 years.

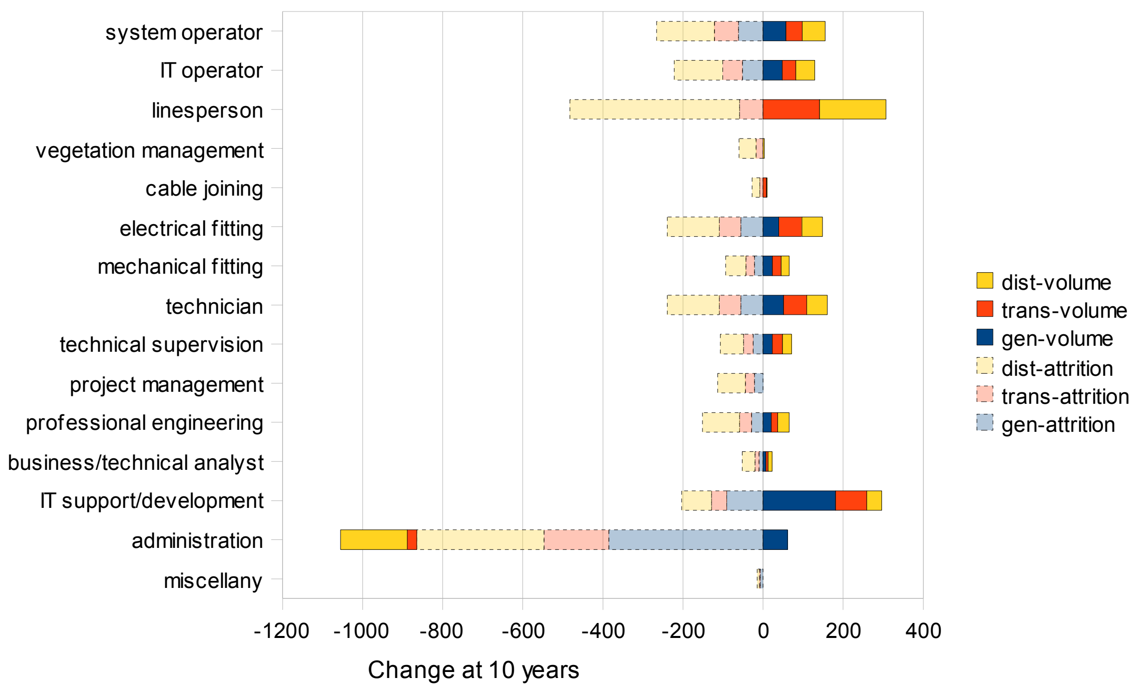

Figure 29: Differential numbers by skill and sector at 10 years

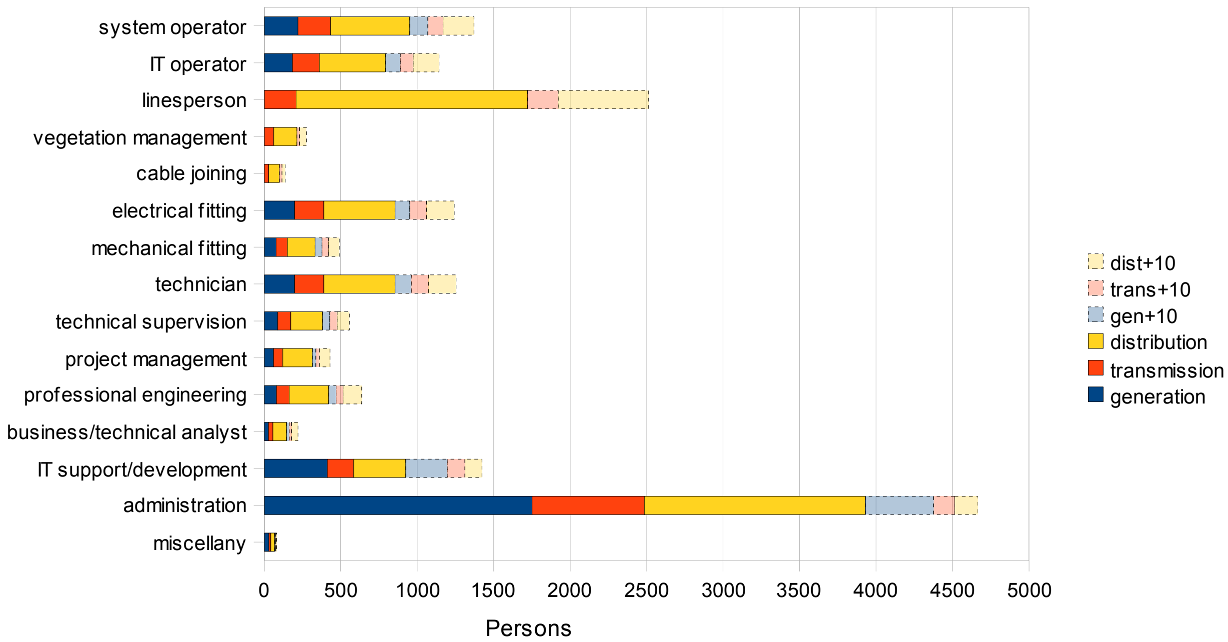

Figure 30: Cumulative change at 10 years by skill and sector (note- change includes attrition so this chart does not represent workforce numbers after 10 years)

We observe the attrition is expected to be the most significant overall factor in driving the net requirement for new trained persons. The largest change by numbers is in linespersons.

Table 15 following sets out the indicated per annum requirement by skill class and compares it to the current estimated output of trainees.

Class	**Requirement p.a.**	**Current Output p.a.**
system operator	42	26
IT operator	35	unknown
linesperson	82	105
vegetation management	6	
cable joining	4	25
electrical fitting	39	30
mechanical fitting	16	11
technician	40	25
technical supervision	18	From pool of trained technicians and fitters
project management	11	unknown
professional engineering	22	20
business/technical analyst	7	unknown
IT support/development	53	unknown
administration	45	unknown
miscellany	1	n/a
Sum p.a.	**417**	**350**

Table 15: Comparison of calculated requirement and estimated current output per annum

Due to the provisional nature of the requirements forecast, being based on only an approximate current numbers estimate, we make no comment on the differences in the table for the different skills at this stage. However, the difference in cable joiners is clearly an area where closer scrutiny of the model needs to be undertaken for future revisions of this work.

On a total basis, the net loss is expected to be made up from new trainees and net immigration. As discussed previously, we estimate the current net immigration into the electricity supply sector at between 45 to 90 (say 70 for our model). The current trainee output is between 300 and 400 persons per annum (say 350 for our model). Plotting these on a cumulative basis as a positive gain against the total loss, made up as attrition and work volume, produces figure 31 following. We see that the net gain and net loss are approximately equal. This indicates that:

- our model of net loss (attrition and work volume) appears roughly correct in total;
- attrition loss from the industry is the most significant factor (as deduced earlier); the management of attrition by the industry will need to be a key issue going forward;
- migration is not a key factor, although, as discussed earlier, it derives from the difference of large numbers and therefore this aspect need to be monitored and, in particular, emigration out of the sector and the ability to secure skilled persons from overseas; and
- the future issue is not necessarily around training more or less persons, (but in meeting the changing skills requirement).

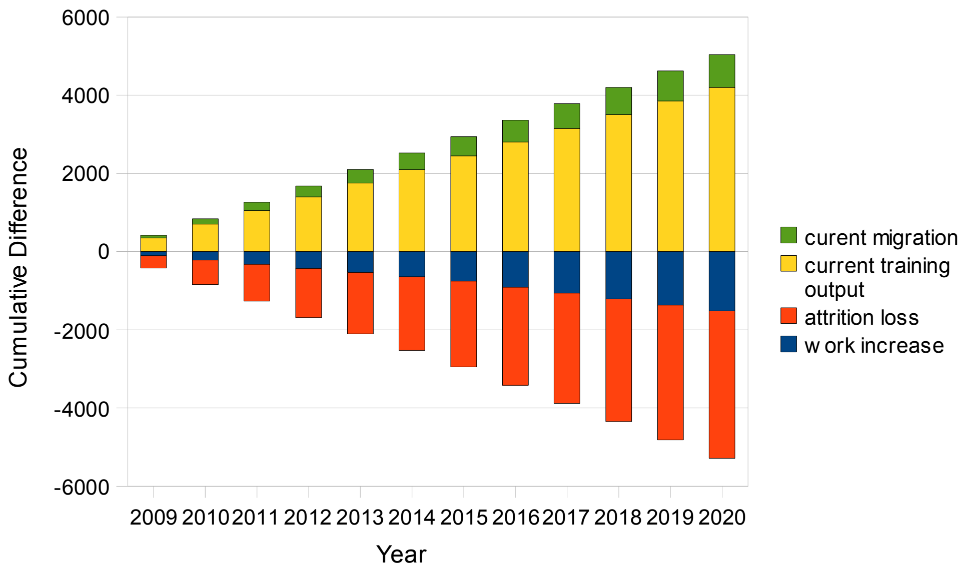

Figure 31: Net cumulative change in workforce requirement

Figure 31 is repeated in a different manner in figure 32 following that shows the loss and growth as a expanding cone off the current workforce total to show relativity to current workforce numbers and with the make-up from training and net migration filling this space.

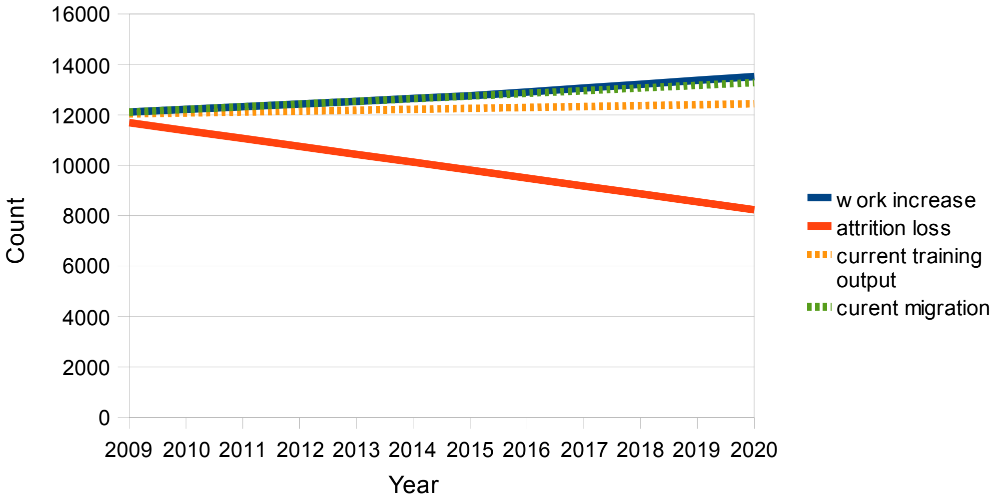

Figure 32: Cumulative change in workforce

Figure 33 below plots the net loss or gain under the expected (base), high, and low growth scenarios (discussed in the next section and largely based on +/- 0.5% variance on GDP.)

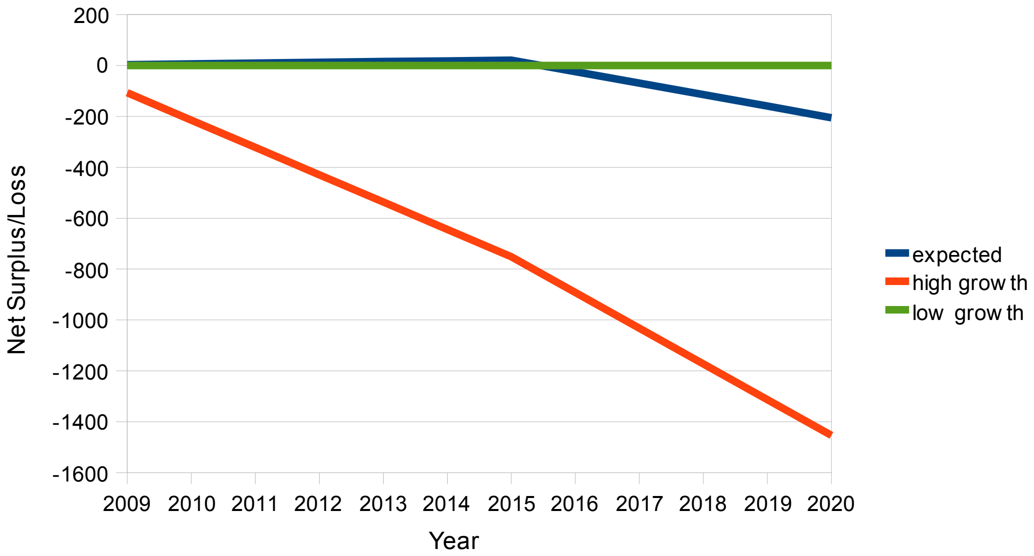

Figure 33: Net gain/loss with current trainee output under growth scenarios

The high growth scenario assumes high GDP, the MDS2 generation build scenario, a net migration into the industry of 45 p.a and the current trainee output of approximately 350 p.a. remaining unchanged. Under this circumstance there is a net deficit of approximately 110 trainees p.a. The low growth scenario assumes low GDP growth and the current trainee output unchanged, however, as the surplus calculated is less than the current net migration, we assume the migration intake would be cut back to achieve a nil balance.

7.3 Effects of variation of the assumed drivers

7.3.1 GDP

The principal driver of growth is GDP. Figure 34 repeats the data of table 17 in bar graph form and also shows the uncertainty introduced by a 1/2% deviation of the GDP around the assumed value (being the assumed error in the GDP forecast as discussed earlier).

The figure shows the total percentage skill replacement requirement due to attrition in red, skill increase due to expansion of the electricity supply sector in blue, and a variation due to a ½ % variation in the assumed GDP in light blue. Thus the top of the light blue part of this bar indicates the total new skill requirement under an assumed average GDP growth of 2.7% pa while the bottom of the light blue bar indicates the requirement under an assumption of a 1.7% GDP growth pa.

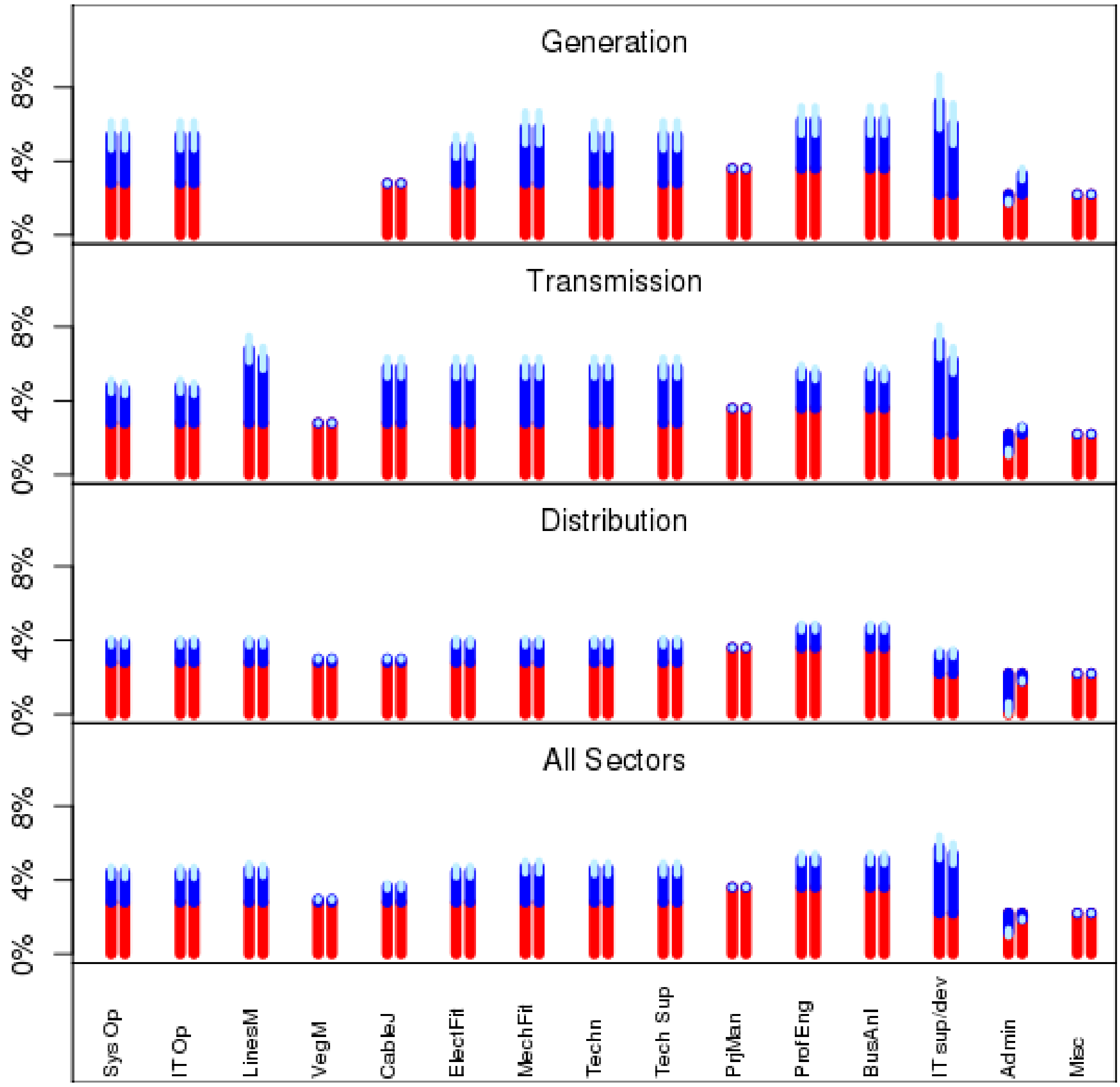

Figure 34: Fractional percent per annum change dependant on GDP forecast bounds. Legend: red- attrition; dark blue work volume growth; span of light blue is bound on growth with +/- 0.5% variance on GDP; two vertical bars per skill category represent first and second 5-year casts of the 10-year forecast.

Generation Mix Scenarios

The Electricity Commission projects scenarios which include different mixes of generation fuel types. These result in different build ratios and varying percentages of the fuel types. They are shown in table 16.

	Build Ratio	Hydro	Wind	Thermal	Geothermal	Other
MDS1	4.06	13.76%	351.29%	-3.10%	168.49%	24.00%
MSD2	3.86	9.27%	501.61%	13.50%	126.03%	92.00%
MSD3	4.13	6.28%	99.03%	33.45%	171.92%	0.00%
MSD4	4.27	3.61%	94.84%	23.71%	181.05%	0.00%
MSD5	4.29	7.86%	61.94%	24.74%	126.03%	40.00%

Table 16: Generation MW build make-up by EC scenario

These different scenarios present different requirements for the skill force of the generation sector.

The resulting variation on our workforce forecasting model (by percentage) is illustrated in figure 35. On comparison with figure 34, it can be seen that, for the generation sector, the uncertainty resulting from the generation mix possibilities is approximately the same as that due to the GDP variation discussed. However, across the whole sector the variation is less and is equivalent to a GDP variation of about 1/3%.

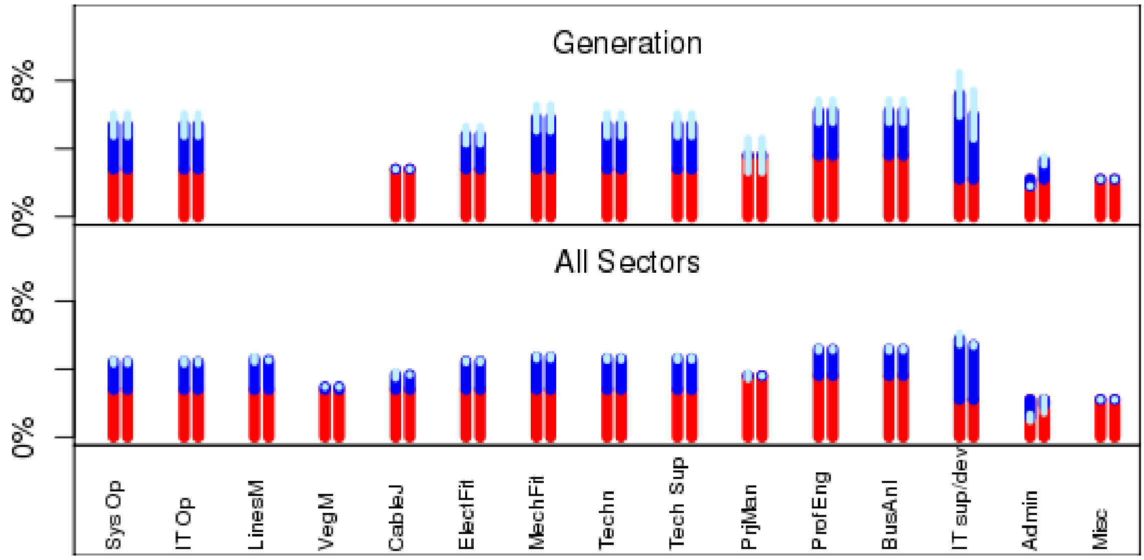

Figure 35: Effect of generation fuel mix and build ratio on workforce forecast The red bars indicate the replacement required for attrition, the blue the increment due to expansion, and the light-blue the uncertainty in the expansion due to differing generation mixes. The two vertical bars per skill category represent the two 5-year casts on the 10-year forecast.

We conclude that the uncertainty in the generation fuel mix, while impacting on the generation sector skill requirements, has a diminished effect overall, and the key variability in the model derives from variability in future GDP.

8 Summary of Conclusions and Recommendations

Summary of conclusions:

1. Our model of net loss, derived from a demographic assessment of attrition and a sector analysis of future work volumes based on economic drivers, appears roughly correct as the

per annum deficit is in keeping with the current training output plus an assessment of net migration into the industry.

2. No significant productivity changes are foreseen in the trades and professional skill groupings, although a continuance in the short term of productivity improvement in the administration area, at the level that is evident historically, is assumed in our models.
3. Attrition shows as the most significant factor for loss from the industry. The rate of attrition is forecast to be most acute in the professional groupings due to the higher age of the mode of the age profile for this group.
4. Levels of net migration is not considered as a key factor as it is largely self-controlling, although, as it derives from the difference of large numbers (immigration and emigration) this aspect needs to be monitored and in particular emigration out of the sector and the continued ability to secure skilled persons from overseas.
5. The work volume models are most sensitive to variance in the GDP forecast as this is the key driver of the energy demand forecast and network extension and is highly correlated to population numbers which affects distribution network customer numbers.
6. The ageing of distribution networks is not considered a significant factor in the distribution network work volumes being forecast, as based on current evidence.
7. The risk around net deficit or surplus of trainees given the current training output under variance in the growth forecasts is invariably on the deficit side, as the reduction in the work volumes under the low GDP scenario is less than the assumed present level of migration into the industry and is therefore controllable. Under the high growth scenario, a net deficit of approximately 110 persons p.a is estimated.
8. The future issues appear not to be around training more or less persons, but in meeting the changing skills requirement, particularly the training of transmission linesmen (largely due to a combination of work and Transpower training policy changes), the increasing requirement for mechanical skills as the generation portfolio shifts towards more wind, geothermal and thermal fuel types, and the evident increase in IT skills requirement.

Summary of Recommendations

1. There is much uncertainty about the true nature of the current workforce in both total numbers and the splits by sector and skill. This aspect is the most fragile part of our model estimation process. Further detailed investigation of the current numbers, skills and demographics of the industry is strongly recommended.
2. The evolving nature of the migration to and from the industry should be monitored on a regular basis. This may require specific metrics to be developed in this area and measured and reported on a regular basis.
3. The management of attrition in all sectors of the industry needs to be promoted as a key focus going forward.

Appendix 1 – Base Scenario Tables

Percentage per Annum Requirements for Skill Classes of Sectors

	All Sectors	Generation		Transmission		Distribution	
Class	**Attrition**	**Growth**	**Total**	**Growth**	**Total**	**Growth**	**Total**
2009 – 2014							
system operator	-2.80%	2.60%	5.40%	2.00%	4.80%	1.10%	3.90%
IT operator	-2.80%	2.60%	5.40%	2.00%	4.80%	1.10%	3.90%
linesperson	-2.80%	0.00%	0.00%	8.00%	10.80%	1.10%	3.90%
vegetation management	-2.80%	0.00%	0.00%	0.00%	2.80%	0.20%	3.00%
cable joining	-2.80%	0.00%	2.80%	3.00%	5.80%	0.20%	3.00%
electrical fitting	-2.80%	2.00%	4.80%	3.00%	5.80%	1.10%	3.90%
mechanical fitting	-2.80%	3.00%	5.80%	3.00%	5.80%	1.10%	3.90%
technician	-2.80%	2.60%	5.40%	3.00%	5.80%	1.10%	3.90%
technical supervision	-2.80%	2.60%	5.40%	3.00%	5.80%	1.10%	3.90%
project management	-3.60%	0.00%	3.60%	0.00%	3.60%	0.00%	3.60%
professional engineering	-3.60%	2.60%	6.20%	2.00%	5.60%	1.10%	4.70%
business/technical analyst	-3.60%	2.60%	6.20%	2.00%	5.60%	1.10%	4.70%
IT support/development	-2.20%	5.00%	7.20%	5.00%	7.20%	1.10%	3.30%
administration	-2.20%	-0.40%	1.80%	-1.00%	1.20%	-1.90%	0.30%
miscellany	-2.20%	0.00%	2.20%	0.00%	2.20%	0.00%	2.20%
2015 – 2020							
system operator	-2.80%	2.60%	5.40%	1.85%	4.65%	1.10%	3.90%
IT operator	-2.80%	2.60%	5.40%	1.85%	4.65%	1.10%	3.90%
linesperson	-2.80%	0.00%	0.00%	5.50%	8.30%	1.10%	3.90%
vegetation management	-2.80%	0.00%	0.00%	0.00%	2.80%	0.20%	3.00%
cable joining	-2.80%	0.00%	2.80%	3.00%	5.80%	0.20%	3.00%
electrical fitting	-2.80%	2.00%	4.80%	3.00%	5.80%	1.10%	3.90%
mechanical fitting	-2.80%	3.00%	5.80%	3.00%	5.80%	1.10%	3.90%
technician	-2.80%	2.60%	5.40%	3.00%	5.80%	1.10%	3.90%
technical supervision	-2.80%	2.60%	5.40%	3.00%	5.80%	1.10%	3.90%
project management	-3.60%	0.00%	3.60%	0.00%	3.60%	0.00%	3.60%
professional engineering	-3.60%	2.60%	6.20%	1.85%	5.45%	1.10%	4.70%
business/technical analyst	-3.60%	2.60%	6.20%	1.85%	5.45%	1.10%	4.70%
IT support/development	-2.20%	3.80%	6.00%	4.00%	6.20%	1.10%	3.30%
administration	-2.20%	1.10%	3.30%	0.35%	2.55%	-0.40%	1.80%
miscellany	-2.20%	0.00%	2.20%	0.00%	2.20%	0.00%	2.20%

Table 17: Per annum percent drivers of workforce numbers (base case)

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Total Numbers per Annum Requirements for Skill Classes of Sectors

2009 – 2014

Class	**Generation**	**Transmission**	**Distribution**	**Total**
system operator	12	10	20	42
IT operator	10	9	17	35
linesperson	0	23	59	82
vegetation management	0	1	5	6
cable joining	0	2	2	4
electrical fitting	9	11	18	39
mechanical fitting	4	4	7	16
technician	11	11	18	40
technical supervision	5	5	8	18
project management	2	2	7	11
professional engineering	5	5	12	22
business/technical analyst	2	2	4	7
IT support/development	30	12	11	53
administration	32	9	4	45
miscellany	1	0	1	1
Sum p.a.	**122**	**106**	**193**	**421**
2015 – 2020				
system operator	12	10	20	42
IT operator	10	8	17	35
linesperson	0	17	59	76
vegetation management	0	2	5	6
cable joining	0	2	2	4
electrical fitting	9	11	18	39
mechanical fitting	4	4	7	16
technician	11	11	18	40
technical supervision	5	5	8	18
project management	2	2	7	11

professional engineering	5	5	12	22
business/technical analyst	2	2	4	8
IT support/development	25	11	11	47
administration	58	19	26	103
miscellany	1	0	1	1
Sum p.a.	**143**	**108**	**215**	**467**

Table 18: Per annum numbers required (attrition + work volume) for base case

Appendix 2 – Skill Classes

The following table allocates the census occupational classes into the skill groups used in this review.

Group	Skill Class	Reference	Occupation Class
A	system operator duties	81611	Power Generating Plant Operator
A	system operator duties	81541	Other Chemical Processing Plant Operator
A	system operator duties	81211	Metallic Furnace Operator
A	system operator duties	81522	Water Treatment Plant Operator
A	system operator duties	81612	Boiler Attendant
B	linesperson duties	82923	Linesperson
C	vegetation management duties	0	none
C	vegetation management duties	32121	Agricultural Technician
D	cable joining	0	none
E	electrical fitting	82924	Electric Cable Jointer
E	electrical fitting	72411	Electrical Fitter
E	electrical fitting	71311	Electrician
F	mechanical fitting	72231	Fitter and Turner
F	mechanical fitting	72124	Fitter and Welder
F	mechanical fitting	84112	Pipe Fitter
F	mechanical fitting	72311	Machinery Mechanic
F	mechanical fitting	72314	Heating, Ventilation and Refrigeration Mechanic
F	mechanical fitting	82111	Machine Tool Operator
F	mechanical fitting	72123	Boiler Maker
G	technician duties	31131	Electrical Engineering Technician
G	technician duties	31151	Mechanical Engineering Technician
G	technician duties	31143	Other Electronics Engineering Technician
G	technician duties	31191	Other Engineering Technician
G	technician duties	31111	Physical Science Technician
G	technician duties	31161	Chemical Engineering Technician
G	technician duties	31192	Non-Destructive Testing Technician

G	technician duties	72421	Electronics Servicer
H	technical supervision	12219	Engineering Technical Manager
H	technical supervision	12213	Production Manager (Manufacturing)
H	technical supervision	12218	Construction Manager
H	technical supervision	31516	Quality Inspector
H	technical supervision	12282	Quality Assurance Manager
H	technical supervision	31123	Clerk of Works
H	technical supervision	72316	Mechanical Products Inspector and Tester
H	technical supervision	31511	Safety Inspector
I	project management	0	none
J	professional engineering	21431	Electrical Engineer
J	professional engineering	21455	Other Mechanical Engineer
J	professional engineering	21426	Other Civil Engineer
J	professional engineering	21461	Chemical Engineer
J	professional engineering	21425	Structural Engineer
J	professional engineering	21441	Electronic and Telecommunications Engineer
J	professional engineering	21423	Public Health Engineer
J	professional engineering	21142	Geophysicist
J	professional engineering	21131	Chemist (other than Pharmacist)
J	professional engineering	22117	Environmental Scientist
J	professional engineering	12281	Research and Development Manager
J	professional engineering	21141	Geologist
J	professional engineering	21451	Heating, Ventilation and Refrigeration Engineer
J	professional engineering	21481	Surveyor
J	professional engineering	33634	Industrial Designer
K	business/technical analyst duties	33241	Organisation and Methods Analyst
K	business/technical analyst duties	24422	Policy Analyst
K	business/technical analyst duties	24131	Market Research Analyst
K	business/technical analyst duties	21412	Resource Management Planner
K	business/technical analyst duties	12281	Research and Development Manager

L	IT support/software development duties	21313	Systems Manager
L	IT support/software development duties	31213	Computer Support Technician
L	IT support/software development duties	21311	Systems Analyst
L	IT support/software development duties	31141	Telecommunications Technician
L	IT support/software development duties	31142	Computer Systems Technician
L	IT support/software development duties	31211	Computer Programmer
L	IT support/software development duties	12271	Information Technology Manager
L	IT support/software development duties	24322	Information Services Administrator
L	IT support/software development duties	31143	Other Electronics Engineering Technician
M	administration/legal/accounts/regulatory duties	12222	Administration Manager
M	administration/legal/accounts/regulatory duties	41443	General Clerk
M	administration/legal/accounts/regulatory duties	12111	General Manager
M	administration/legal/accounts/regulatory duties	41213	Costing Clerk
M	administration/legal/accounts/regulatory duties	24133	Financial Adviser
M	administration/legal/accounts/regulatory duties	41211	Accounts Clerk
M	administration/legal/accounts/regulatory duties	24111	Accountant
M	administration/legal/accounts/regulatory duties	12291	Office Manager
M	administration/legal/accounts/regulatory duties	12224	Finance Manager
M	administration/legal/accounts/regulatory duties	33211	Administration Officer
M	administration/legal/accounts/regulatory duties	41141	Secretary
M	administration/legal/accounts/regul	11311	Chief Executive and/or Managing Director

	atory duties		
M	administration/legal/accounts/regulatory duties	41311	Stock Clerk
M	administration/legal/accounts/regulatory duties	12231	Human Resources Manager
M	administration/legal/accounts/regulatory duties	24121	Human Resources Officer
M	administration/legal/accounts/regulatory duties	41221	Finance Clerk
M	administration/legal/accounts/regulatory duties	41321	Material and Production Planning Clerk
M	administration/legal/accounts/regulatory duties	41445	Human Resources Clerk
M	administration/legal/accounts/regulatory duties	42213	Information Clerk and Other Receptionist
M	administration/legal/accounts/regulatory duties	41111	Typist and Word Processor Operator
M	administration/legal/accounts/regulatory duties	24231	Other Legal Professional
M	administration/legal/accounts/regulatory duties	24211	Barrister and Solicitor
M	administration/legal/accounts/regulatory duties	24132	Public Relations Officer
N	IT application operator duties [specifically GIS, CAD, and CMMS]	21312	Computer Applications Engineer
N	IT application operator duties [specifically GIS, CAD, and CMMS]	31181	Draughting Technician
N	IT application operator duties [specifically GIS, CAD, and CMMS]	41121	Data Entry Operator
N	IT application operator duties [specifically GIS, CAD, and CMMS]	31212	Computer Operator
O	miscellany	99999	miscellany