

THE DEMAND FOR AND SUPPLY OF ENGINEERS

Purpose: The purpose of this paper is to project the future demand for and supply of engineers in New Zealand.

1. SUMMARY

The aim of the National Engineering Education Plan (NEEP) Project is to develop a coherent national plan to produce the right number of the right types of engineering graduates to meet New Zealand's needs.

One of the work-streams in the project is to research the demand for and supply of engineers with levels 6, 7, and 8 qualifications. The project consortium used four sources of data to reach estimates of the likely future demand for engineering graduates. Two scenarios were selected; "business as usual" – based on historic patterns, and "innovation-led economy" – based on increased participation by engineers in building innovation-led businesses (Table 1).

Table 1 Demand estimates from the project consortium

Qualification Type	Actual qualification completions in 2008	Estimated annual needs – "business as usual"	Estimated annual needs – "innovation led economy"	% growth required
Level 6 Engineering Technicians (Dublin Accord)	270	500	750	85% to 178%
Level 7 Engineering Technologists (Sydney Accord)	180	400	600	120% to 233%
Level 8 Professional Engineers (Washington Accord) ¹	1050	1100	1400	5% to 33%
Total	1500	2000	2750	33% to 83%

¹ IPENZ is a signatory to the Washington Accord for the four-year BE degree, the Sydney Accord for the three-year BEngTech degree and a provisional signatory to the Dublin Accord for the two-year diploma. Through these international agreements, IPENZ accredited engineering qualifications are recognised in member countries of the Accords, thereby giving graduates international portability.
http://www.ipenz.org.nz/ipenz/Education_Career/accreditation/

A significant number of new engineering technicians are needed to alleviate the severe shortages on infrastructure projects that industry has experienced in recent years. In relative terms, more of the new degree-holding engineers should be engineering technologists rather than professional engineers. More graduates with Bachelor of Engineering Technology (BEngTech) degrees working in the field or in production allow graduates with Bachelor of Engineering (BE) degrees to work on more complex engineering problems.

The required total number is 2000-2750 new engineers per year. The lower end of the range does not allow for any major increase to drive new high technology industries, or in “out of field” employment (career diversity). The higher figure allows for a level of “out of field” employment considered desirable for the New Zealand economy. Even at the higher figure, New Zealand would still not reach the OECD norm of 12% of tertiary graduates being in engineering. It would be at a similar level to that of the United Kingdom (9%). All OECD countries graduating less than 9% of their graduates in engineering have been experiencing shortages. Therefore the project consortium recommends the target be set at the higher level, 1.8 times the present supply.

2. BACKGROUND

During 2008 and 2009, a consortium of representatives from NZCED², CETTENZ³, Industry Training Organisations (ITOs), the Institution of Professional Engineers New Zealand (IPENZ) and industry has been undertaking a project with funding from the Tertiary Education Commission (TEC) to develop a national engineering education plan.

The overarching issues behind the project are the long-term shortage of engineering skills in New Zealand and the need to ensure that New Zealand’s engineering education offering meets international best practice and can be delivered effectively by a nationally co-ordinated network of provision.

The focus of this paper is to summarise the outcomes from the work-stream within the Project and to research the demand for and supply of engineers in New Zealand. Four sources of information are available as a result of work carried out in the project:

- a joint study by the Department of Labour, IPENZ and the Association of Consulting Engineers (ACENZ) resulted in the report - *Engineers in the New Zealand Labour Market (2008)*⁴
- the Ministry of Education report *Advanced Trade, Technical and Professional Qualifications – Trends in Supply (2009)*⁵
- data from the OECD which allows international benchmarking
- feedback from engineering sectors arising from consultation on the first and third of the other information sources.

In this document, the findings from each of these information sources are summarised, and then a statement is presented representing the consortium’s best estimates of the needs of New Zealand for engineering graduates.

² NZCED is the NZ Council of Engineering Deans, for tertiary providers offering four-year professional engineering qualifications.

³ CETTENZ is the Council for Engineering Technician and Technologist Education New Zealand, a bipartite council of the Engineering Deans or Heads of Department from the ITP and university sector responsible for three-year degrees (Sydney Accord criteria) and two-year Diplomas (Dublin Accord criteria).

⁴ <http://www.dol.govt.nz/services/LMI/tools/skillsinsight/ipenz/index.asp>

⁵ http://www.educationcounts.govt.nz/publications/tertiary_education/47719

3. THE PRESENT SUPPLY

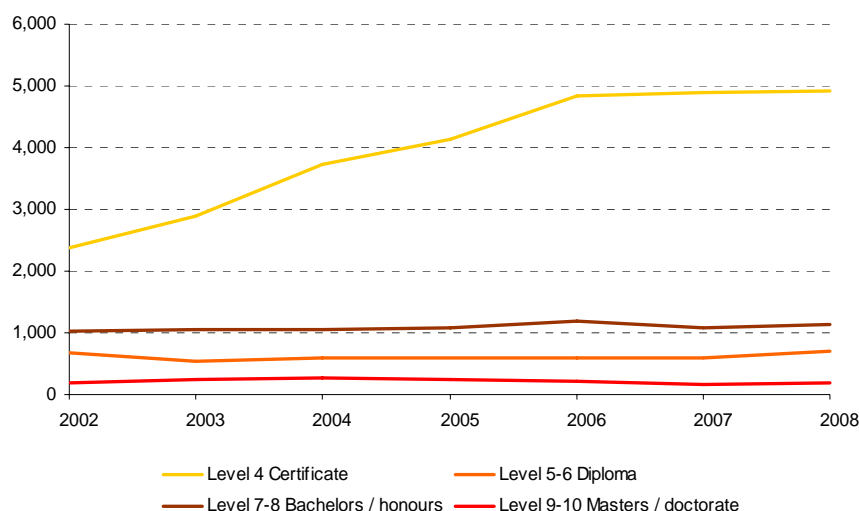
The Ministry of Education has provided information on qualification completions between 2002 and 2008 in the field of engineering and related technologies (Figure 1). Unfortunately this field used by the Ministry during the 2002–2008 period groups Level 5 qualifications with Level 6, Level 7 qualifications with Level 8 and Level 9 qualifications with Level 10. Some of the qualifications are engineering informed e.g. surveying and food technology, and there are qualifications in engineering at levels 6, 7, and 8 which are intended to meet the internationally benchmarked graduate profiles of the Dublin, Sydney and Washington Accords. The field at Levels 5-8 includes national certificates, diplomas, bachelor degrees, graduate diplomas, and postgraduate certificates.

Although not part of the study, it is interesting to note that the number of people completing Level 4 certificates for advanced trade work averaged 3971 in this period. There was a steady increase up until 2006 then a levelling off until 2008. The supply of engineering trades has significantly improved.

Completions in Level 5-6 diplomas for engineering technician roles averaged 615, but not all of these are at Level 6. The Level 7-8 bachelors/honours (average 1083) and Level 9-10 masters and doctorates (average 217) for professional engineering roles remained steady for the same period.

It should be noted that these numbers cannot be simply added to obtain the total graduate supply. Many of the Level 9 and 10 graduates will have graduated in earlier years from a New Zealand University as a bachelor/honours graduate. However, there will be some migrants who entered New Zealand for postgraduate study and some will not study engineering. Further, some of the Level 6 diploma holders progress to degrees, so again the actual number of workforce entrants may be lower than expected.

Figure 1 Number of qualification completions by level in engineering and related technologies



The NEEP Project is only interested in Level 6 and above qualifications which are intended to meet the internationally benchmarked graduate profiles of the Dublin, Sydney and Washington Accords. Further data supplied by the Ministry of Education provided a breakdown of the qualification completions in 2008 for levels 6, 7, and 8. When the data were analysed, the actual engineering qualification completions (excluding engineering-informed qualifications like surveying) in 2008 were:

Level 6 Dublin Accord diplomas	270
Level 7 Sydney Accord BEngTech	180
Level 8 Washington Accord BE	1050
Total	1500

This is the best estimate of supply, not the 1915 obtained by adding the total field data above.

4. JOINT STUDY WITH THE DEPARTMENT OF LABOUR

4.1 FINDINGS

The study carried out by the Department of Labour predicts the total number of additional engineers required each year for the next five years is 1700-1800. These numbers consist of 1200-1300 additional engineering professionals each year for the next five years and a further 500 new engineers each year to replace engineers leaving the profession.

The Department of Labour findings used the New Zealand Standard Classification of Occupations (NZSCO) category for architects, engineers and related professionals and the NZSCO physical science and engineering technician category as its basis – this is a wider classification than that of interest in the NEEP Project.

In the Department of Labour's review of the economic outlook for the next five to ten years of industry sectors that employ engineers, continued expenditure on infrastructure (transport, rail, electricity, gas and telecommunications) means demand for engineers is ongoing and in some cases will increase. The manufacturing sector is expected to remain flat and possibly experience a small decline. The commercial and development construction sector is affected by the property market and is expected to decline then remain flat for two to three years.

The Department of Labour used recent historical growth as an indicator of likely future demand as one approach to assess present and future demand for engineers. The architects, engineers and related professionals had twice the rate of employment growth at 4.8% than the average (2.4%). The rate of growth over this period for physical science and engineering technicians was only 1.2%.

In terms of supply, the Department of Labour found that the average annual percentage changes in tertiary enrolments and qualification completions for domestic students show steady increases between 2002 and 2007. In 2006, the training rate as an indicator of supply⁶ for all occupations was 3.0% while for architects, engineers and related professionals, the training rate was 3.3% and for physical science and engineering technicians the training rate was lower at 2.5%.

4.2 COMMENTARY

The forecasts of industry-led demand which predict continuing demand for the professional occupations but not for technicians are counter to the experience of large and small engineering firms that have critical shortages of engineering technicians.

The net replacement demand for engineering occupations found by the Department of Labour is lower than the average rate for all occupations (1.4%) which suggests that

⁶ The training rate is calculated by showing the number of graduates completing qualifications in the relevant subjects as a percentage of the total employment in that particular occupation.

engineers are staying in the profession. This may be an indicator of under-supply – career diversity by engineers is seen as highly desirable by engineers, but this may be suppressed by under-supply to fill “in-field” employment roles.

Engineers move internationally but migration statistics are only collected for about 30% of long-term and permanent migrants so the numbers of arrivals and departures and the occupational groupings of immigrants seeking work permits are understated. Despite this, the trends show that from 2003 to 2008 there were net inflows of migrant engineers but not all were likely to gain employment. Hence the extent to which migration has really been filling shortages in recent years is not accurately known.

It is not known how many engineering graduates take up engineering positions in their first year of graduation nor how many leave to work overseas within one to three years of graduation. It is not known how many New Zealand engineers living overseas plan to return to New Zealand to work in the next five years. Hence the forecasts can only be regarded as broad-brush and potentially low.

5. MINISTRY OF EDUCATION

5.1 FINDINGS

The Ministry of Education used the data on tertiary qualification completions by field of specialisation between 2002 and 2006 to identify which areas the tertiary education system should focus on more to address skill shortages. The report does not specifically predict the numbers of graduates required in the next five years.

Section Five of the report covers engineering and related technologies which includes manufacturing, mechanical, industrial, civil and electrical/electronic engineering and technology. It reviewed the number of people who graduated with Level 4 certificates, diplomas, bachelors/honours and masters/doctorates between 2002 and 2006 inclusive then estimates how well the number of graduates has met demand from occupational growth and retirements. There is also comment on the effect of migration on skill shortages.

The key findings in the report are that there are shortages of engineering and technology graduates across all levels of study. The greatest shortage is at the diploma level particularly in the civil field which concurs with anecdotal information from civil industries. The manufacturing, process and resourcing field has shortages at the bachelors/honours level; in the automotive, mechanical and industrial field, shortages have occurred at Level 4 and at the diploma level; the civil field also has shortages at the bachelors/honours level; the electrical and electronic fields have shortages at the diploma and bachelors/honours levels; and the maritime field has shortages at Level 4.

In terms of migration between 2002 and 2006, the findings are that the percentage of migrants employed with sub-degree qualifications is almost the same as the average for all fields of study. This means there has been little significant contribution to the easing of shortages at this level. However, the higher percentages of migrants employed with degree level qualifications than the average across all fields of study indicates the migrants may have contributed to easing some shortages.

5.2 COMMENTARY

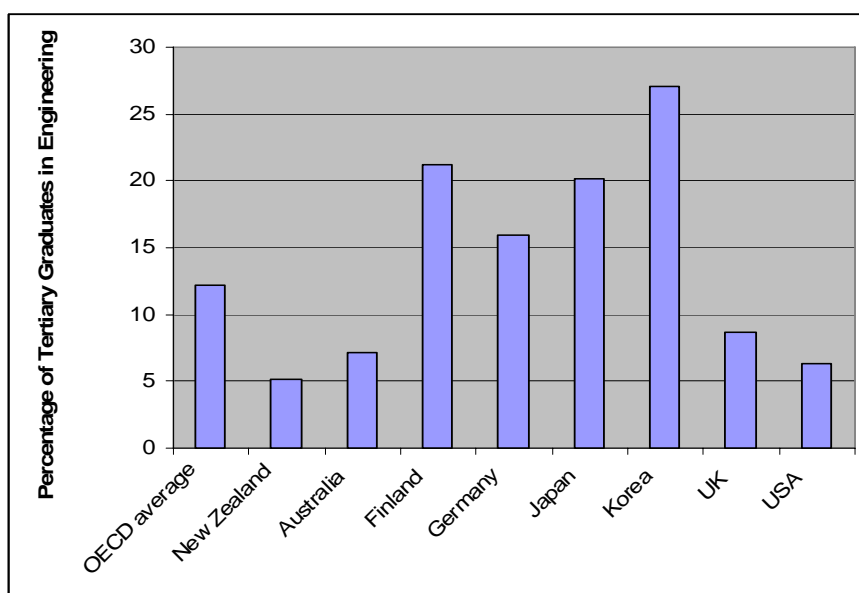
The findings are much broader than those from the Department of Labour, but generally consistent with perceptions from the engineering sector.

6. OECD COMPARISONS

OECD comparisons in Figure 2 show that in terms of the proportion of total graduates who are in engineering, New Zealand has less than half the number of engineering graduates than the OECD average. In other disciplines, New Zealand produces about the OECD average except for business, law and the services where the percentage produced is higher than the OECD average.

Yet our difficult geography and dispersed population might indicate the need for greater numbers rather than fewer engineers compared to other countries. The percentages below reflect to some extent the nature of the different economies – some are highly industrialized countries (Finland, Germany, Japan and Korea) and those countries are typically above the OECD average. For a lightly industrialized country like New Zealand, and in spite of complex infrastructural needs and a highly mechanized biological sector, it is hard to argue that New Zealand should be above the OECD average of 12% unless there is a strong drive towards an innovation-led economy based on a greater proportion of hi-tech industries.

Figure 2 Percentages of Tertiary Graduates in Engineering by Country (2007, from OECD) ⁷



Other countries such as Australia and the USA that also produce graduates below the OECD average, have reported severe shortages in engineering. This suggests that even if the OECD average is not achieved by New Zealand, being below the level of 9% achieved by the UK is not satisfactory. The UK is the country with the lowest percentage of graduates in engineering not to have experienced substantial engineer shortages. If 9% of the graduates were to be in engineering, New Zealand needs 1.8 times the number of engineering graduates it currently produces.

7. INDUSTRY FEEDBACK

Five consultation meetings with a range of stakeholders were conducted during September 2009, at which the Department of Labour and OECD benchmark data were presented. The general views were that the Department of Labour estimates tended to under-predict the real demand from industry, that the supply was insufficient to support a satisfactory “out of field”⁸ level of employment or career diversity for engineers, and

⁷ OECD 2008: *Education at a Glance 2007*, www.oecd.org/edu

⁸ Engineers working in occupations outside engineering.

that the technician situation was much worse than predicted, particularly in the civil field.

Other anecdotal evidence is that many BE graduates are in employment roles in which they do not get significant opportunities to work with the complex engineering problems that professional engineering (Washington Accord) graduates are educated for. Rather their work aligns more closely to the “broadly defined engineering problems” which characterize the three year Sydney Accord degree. This suggests that in relative terms, the need for Sydney Accord degrees is greater than for Washington Accord degrees.

8. BEST ESTIMATES OF DEMAND

Taking into account the various sources of data and the commentary, best estimates have been made by the project consortium. Because some of the data are qualitative, these estimates are based on judgement rather than determined quantitatively.

- New Zealand presently produces in the order of 1500 graduates per year at levels 6 and above, (taking out double counting through dual qualification holders).
- The consortium considered two scenarios :
 - “business as usual” – based on historic patterns, and
 - “innovation-led economy” – based on increased participation by engineers in building innovation-led businesses with consequences also for career diversity.
- Table 1 shows the estimates.

Table 1 Demand estimates from the project consortium

Qualification Type	Actual qualification completions in 2008	Estimated annual needs – “business as usual”	Estimated annual needs – “innovation led economy	% growth required
Level 6 Engineering Technicians (Dublin Accord)	270	500	750	85% to 178%
Level 7 Engineering Technologists (Sydney Accord)	180	400	600	120% to 233%
Level 8 Professional Engineers (Washington Accord) ⁹	1050	1100	1400	5% to 33%
Total	1500	2000	2750	33% to 83%

⁹ IPENZ is a signatory to the Washington Accord for the four-year BE degree, the Sydney Accord for the three-year BEngTech degree and a provisional signatory to the Dublin Accord for the two-year diploma. Through these international agreements, IPENZ accredited engineering qualifications are recognised in member countries of the Accords, thereby giving graduates international portability.
http://www.ipenz.org.nz/ipenz/Education_Career/accreditation/

- The “innovation-led economy“ figure would barely achieve the 9% of total graduate level that occurs in the United Kingdom, and so even at this level New Zealand would lie well below the OECD norm of 12%.
- In terms of Level 6 diplomas, a significant rise is required. The total number was 270 in 2008. The consortium considers that 500 or 750 graduates completing each year is the best estimate of real need in the two scenarios, if there are going to be enough skilled technicians to work on the infrastructure projects proposed for transport, rail, electricity, gas and telecommunications and in the hi-tech industries.
- In terms of degree holders, the requirement is for 1500 or 2000 graduates, up from the present 1230 graduates per year. What is less clear is the division between the Sydney Accord BEngTech (engineering technologist) and the Washington Accord BE (professional engineer). Given that some Washington Accord degree holders seem to be adopting roles as engineering technologists, the balance between the two types of qualification probably needs to change. Hence the growth in graduate numbers would be expected to be more aligned to need if it was differentially greater in the BEngTech. Thus the best estimates are:
 - 400-600 Sydney Accord (BEngTech) graduates per annum
 - 1100-1400 Washington Accord (BE) graduates per annum.
- The numbers of professional engineering graduates relative to engineering technology graduates proposed for New Zealand is higher than in many developed countries. For example in the United Kingdom, the percentage of professional engineering graduates (53%) was slightly higher than the percentage of engineering technology graduates (47%) in the 2007/2008 year¹⁰. The reason for proposing a greater proportion of professional engineers in New Zealand, is that in small companies where only one person can be employed, a professional engineer will be employed to do both the engineering technologist and professional engineer work. Nevertheless it is more cost-efficient to produce more engineering technologists at Level 7 who can take on the less complex work than to employ BE graduates for this work in larger companies.
- A higher number of BE graduates is healthy for the New Zealand economy in a wider sense. When there is an under-supply, professional engineers tend to focus in a narrow technical area or on less complex problems because that is where their knowledge and skills are needed. A greater supply of professional engineers allows for “out of field” employment or career diversity. They are valued in different occupational groups for their engineering mindset and problem solving abilities. In other professional groups such as law and accounting where there is an over-supply, career diversity is the norm. Such professions make a significant contribution to many different occupational groups in the New Zealand economy.
- At postgraduate level, it is anticipated that a number of BE graduates will progress onto studying masters and doctorates. If there is a higher number of BE graduates, it is logical that the numbers at postgraduate level will increase to an estimated 300 per year. Again this is a positive because postgraduate engineers can be expected to be at the forefront of a drive to a hi-tech innovation-led economy.
- The projected 33% or 83% increase could largely be met by increasing participation of under-represented groups. If the participation rates of Maori, Pasifika and female students were brought closer to those of male students and those of Caucasian or Asian ethnicity the demand would be met.

¹⁰ United Kingdom Higher Education Statistics Agency

9. CONCLUSION

New Zealand requires at least 33% more (on a business as normal basis), and ideally 83% more engineering graduates (for an innovation-led economy) to meet its future needs. The largest increases are in technician and engineering technologist graduate numbers.