PUBLIC INFRASTRUCTURE

Government Reference to the Productivity Commission

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ENGINEERS AUSTRALIA

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INTRODUCTION

Engineers Australia is the representative body for the engineering profession in Australia. With over 100,000 members across Australia, we represent all disciplines and branches of engineering. Engineers Australia is constituted by Royal Charter to advance the science and practice of engineering for the benefit of the community.

On the 13 November 2013, Treasurer Hockey asked the Productivity Commission to inquire into funding and financing options for public infrastructure and options for reducing infrastructure costs. At the request of the Commission, Engineers Australia put forward preliminary views in a telephone meeting with Commissioner Mundy, Mr Ralph Lattimore and members of the inquiry team on 19 November 2013. Engineers Australia has had long standing views on Australia's economic infrastructure and appreciated this opportunity. This Submission reiterates those views and communicates additional points relevant to the inquiry.

Engineers Australia believes the assessments made in its Infrastructure Report Cards and in subsequent reviews of infrastructure trends show that Australia's infrastructure overall is barely adequete to meet current and future requirements and does not meet this standard in some asset classes. These assessments suggest that infrastructure inhibits rather than enhances productivity, for example the costs of urban transport congestion are not yet addressed.

A major problem inhibiting policy design for infrastructure is accurate information about the stock of existing infrastructure assets and how these are utilised. Engineers Australia believes that effective contribution to productivity growth begins with effective and economic management of existing infrastructure assets. The message from the Infrastructure Report Cards is that at present infrastructure assets management is patchy at best and basic matters like maintenance are routinely neglected leading to higher than necessary costs and demands for additional infrastructure ahead of optimal requirements.

Engineers Australia notes that neglect of infrastructure productivity is a global problem and that principles articulated by the authoratative McKinsey organisation to turn this situation around are remarkably similar to those advanced by Engineers Australia over the years. Engineers Australia once again draws attention to the importance of productively managing current infrastructure assets as the key to economic infrastructure costs. In this regard, Engineers Australia points to the practical guidance available in the Australian Infrastructure Financial Management Guidelines produced by the Institute of Public Works Engineers, a Technical Society affiliated with Engineers Australia, in 2009. More widespread adherence to the principles outlined in this publications can lead to a significant dampening of infrastructure cost pressures.

The central issue in the terms of reference for this Inquiry is that infrastructure costs have escalated. Just as the information base about the stock of infrastructure assets is poor, so too is information about infrastructure costs. So little information is available that it has been accepted at face value in many quarters. However, when carefully examined, this information is seen to be flawed and the directions it points to are unreliable. Choosing similar but different data sources leads to an entirely different story. Engineers Australia cautions against undue reliance on cost data that has not been subjected to rigorous scrutiny, that cannot be replicated or that is not available from official sources.

In recent years, infrastructure activity in Australia, as measured by engineering construction statistics, has been at unprecedented levels and has shown extraordinary annual growth rates. There appears to be a presumption among some commentators that this extraordinary expansion is achievable without cost pressures. Careful examination of time series statistics shows that there have been periods when infrastructure costs have grown more slowly than growth in general prices and that recent cost escalations coincide with the resources boom.

Infrastructure costs vary for numerous legitimate reasons. Cost engineering offers principles and approaches that can limit cost outside those bounds through more appropriate inclusion of engineering design and technical decision making in all facets of infrastructure project development and implementation. Engineers Australia argues that competent technical decisions cannot be made without the decision makers having the expertise to make them. A series of Auditor-General reports into defence acquisitions in Australia have emphasized this matter and there are direct parallels in infrastructure development. Short-sighted decisions that have stripped engineering expertise from public sector agencies have contributed to cost increases. There are several alternatives to addressing this situation to ensure that appropriate infrastructure decisions are made in future.

At a more practical level, Engineers Australia points to the success achieved by Infrastructure Australia in promulgating and insisting upon the application of its reform and investment framework, including rigorous cost-benefit analysis. Along similar lines, Engineers Australia commends an approach used by the European Commission (cited in the submission) to put infrastructure cost analysis in member countries onto a common basis and structure. The approach used embodies the principles of cost engineering into a practical, hands-on methodology that deals with most immediate sources of infrastructure cost pressures and offers the means for continuous improvement. In the absence of reliable bench-marking information, an approach like this can lead to rapid improvements, especially when used in tandem with more effective management of existing infrastructure assets.

The final part of the submission provides Engineers Australia responses to specific questions from the Commission.

INFRASTRUCTURE AND PRODUCTIVITY

Engineers Australia's interest in economic infrastructure relates to the critical link between economic infrastructure and Australian productivity growth. There are two elements to this link: first, whether there are sufficient economic infrastructure assets to meet Australia's needs and second, whether the utilisation of existing economic infrastructure assets is being optimised, and the related issue of optimising available public and private sector investment in new assets.

In a recent speech, the Deputy Govenor of the Reserve Bank of Australia noted that the circumstances that compensated for the gap between growth in real domestic income per hour worked and growth in labour productivity (favourable terms of trade and an increase in the population aged 15 to 64 years) were unlikely to be repeated in the medium term future[1]. Instead, Australia will need to focus more closely on policies to increase productivity, particularly through improved infrastructure. This is not a novel point having been repeatedly stressed in the Treasury's Intergenerational Reports[2] as crucial to overcome the costs of an aging population.

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[1] Philip Lowe, Deputy Governor, Productivity and Infrastructure, 26 November 2013, www.rba.gov.au
[2] See 2002-03 Budget Paper No 5, www.treasury.gov.au for the first Intergenerational Report and Australian Treasury, Australia to 2050; Future Challenge, 2010, www.treasury.gov.au for the most recent.

Productivity Commission Reference on Public Infrastructure

As an engineering organisation, Engineers Australia has focused on the adequacy of existing infrastructure assets in meeting present and future needs in its Infrastructure Report Cards. These complex documents synthesise large volumes of qualitative and quantitative information about the nation's infrastructure into readily understood assessments[3]. The synthesis includes the considered views of engineers with expertise and experience in infrastructure matters in all states and territories. The scale used for the assessments is as follows:

A (Very Good); Infrastructure is fit for its current and anticipated future purposes.

B (Good); Minor changes are required to enable infrastructure to be fit for its current and anticipated future purposes.

C (Adequate); Major changes are required to enable infrastructure to be fit for its current and anticipated future purposes.

D (Poor); Critical changes are required to enable infrastructure to be fit for its current and anticipated future purposes.

F (Inadequate); Inadequate for current and anticipated future purposes.

The 1999 Infrastructure Report Card assessed Australian economic infrastructure as 'D', subsequent reports saw sufficient improvement to lift assessments to 'C' in 2001 and 'C+' in 2005 and again in 2010[4]. While there is some evidence of improvement here, a "C+" assessment means infrastructure is barely adequate and major changes are necessary for infrastructure to be fit for present and future purposes. This history coincides with decreasing labour productivity in Australia and cannot be regarded as a sufficient basis for future growth.

The 2010 recommendations to improve Australia's economic infrastructure included:

All governments must:

- Deliver more efficient infrastructure outcomes and develop innovative funding models to provide the required infrastructure.
- Harmonise infrastructure planning and regulation through improved cooperation and collaboration between all levels of government, business and the community.
- Address the imbalance between urban and rural and remote communities regarding access to high quality, reliable infrastructure.
- Develop plans and implement projects in all sectors in advance of need, and either build in capacity for growth or preserve land in all infrastructure sectors, particularly for ports, airports and transport corridors.
- Encourage private sector funding for infrastructure and where infrastructure delivery models include the private sector, have the appropriate allocation of risk to deliver the best project outcome.

State and territory governments must:

- Develop long-term infrastructure visions and plans that accommodate projected economic growth and population increases.
- Establish independent planning infrastructure advisory groups to provide advice on infrastructure priorities and provide infrastructure planning and funding advice.

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[3] See www.engineersaustralia.org.au/infrastructure-report-card
[4] See: www.engineersaustralia.org.au/infrastructure-report-card.

Infrastructure owners and managers must:

- Improve the maintenance of existing assets, through adequate funding and asset management plans.
- Integrate climate change mitigation and adaptation into infrastructure plans.
- In 2013, Engineers Australia published an interim review of progress since 2010, *Analysing Australia's Infrastructure Trends 2013*.[5] This report is a comprehensive work assessing the current state of Australia's key infrastructure, including roads, ports, railways, bridges, water, electricity and telecommunications assets. Since 2010, there has been significant investment in Australia's infrastructure, but, a large amount of this work was specific to the resources sector. This tends to obscure the wide variability in infrastructure investment across the various asset classes in states and territories. This variation was particularly noticeable in Western Australia and Queensland where spending on resource-related infrastructure, such as ports and railways, masks the lack of attention given to non-resource projects. Hence, while investment in infrastructure may be at record levels, this analysis showed us that spending has not necessarily been spread evenly across public assets such as water and transport infrastructure. The quantum of investment necessary to materially impact productivity growth is still to come.

Productivity improvements are also needed in the infrastructure system itself. This is a global problem and not confined to Australia and was summarised in a recent McKinsey Report as follows:

> *"The potential to improve productivity is so large because of failings in addressing inefficiencies and stagnant productivity in a systemmis way. On the whole, Countries continue to invest in poorly conceived projects, take a long time to approve them, miss opportunities in how to deliver them, and then don't make the most of existing assets before opting to build expensive new capacity"*[6]*, and*
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> *"All too often, a surprisingly stable status quo persists in which inaccurate planning and forecasting lead to poor project selection. A bias among public officials to build new capacity, rather than make the most of existing infrastructure, is common, leading to more expensive and less sustainable infrastructure solutions. A lack of incentives, accountability, and capabilities as well as risk aversion has prevented infrastructure owners from taking advantage of improvements in construction methods such as the use of design-to-cost and design-to-value principles, advanced construction techniques and lean processes. Infrastructure authorities frequently lack the capabilities necessary to negotiate on equal terms with infrastructure contractors, rendering them unable to provide effective oversight and thereby drive performance."*[7]

Although dealing with a global perspective, the McKinsey prescription for achieving improvements is remarkably similar to Engineers Australia's views and include:

- Close coordination between infrastructure authorities responsible for different types of infrastructure with common socioeconomic goals and how each class of infrastructure contributes to achieving them.
- Clear separation between political and technical responsibilities is necessary.

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[5] See: www.engineersaustralia.org.au/sites/default/files/shado/Representation/Research_and_Reports/analysing_australias_infrastructure_trends_2013_1.pdf
[6] McKinsey Global Institute, Infrastructure Productivity: How to save $1 trillion a year, 2013, www.mckinsey.com.mgi
[7] McKinsey, op cit

- The roles of the public and private sectors must be clearly spelt out to clarify market structure, regulation, pricing and subsidies, ownership and financing, in other words, there is more to private sector participation than PPPs.
- Trust based engagement of stakeholders is critical.
- Reliable data for day to day oversight and long term planning are essential.
- Strong public sector capabilities in planning, delivery of infrastructure assets and services are essential.

Engineers Australia has consistently raised these issues in its assessments of Australia's infrastructure. While some improvements, such as the formation of Infrastructure Australia, have been made, other infrastructure decisions, such as the rush to construct desalination plants throughout Australia, reflect the essence of the criticism reviewed above. Above all else, what has been overlooked is the need for a long term, systemmatic approach in which infrastructure is accorded the importance it deserves.

PUBLIC OR PRIVATE OWNERSHIP

There is considerable confusion in the community about the ownership and operation of infrastructure assets. Engineers Australia believes that commonwealth, state and territory governments have not done enough to explain the essentials of infrastructure development and operations to the community. In particular, for most users of infrastructure services, the link between the cost of those services and the development, construction and operation of infrastructure assets is obscure, at best. Similarly, the basis of the relationship between asset ownership, provision of services and financial arrangements must be clarified. To reiterate, Engineers Australia believes that the roles of the public and private sector in infrastructure planning, development and operations need to be fully spelt out and political involvement in infrastructure development should primarily focus on strategic goals and objectives.

Engineers Australia notes that arguments that economic pricing of infrastructure services are often opposed because they may result in adverse impacts on some socioeconomic groups. Situations of this nature are often further confused through political intervention, seemingly supporting those impacted. Confusion about the impact of infrastructure pricing has resulted in some prices held below economic levels. When this occurs, there is no incentive for public investment in the asset type involved. In addition, additional demand due to low prices creates pressure for investment in new assets by the government when additional capacity is not warranted. Engineers Australia believes that these issues are not well understood in the community, nor is the notion of "community service obligation" often suggested as an appropriate remedy. These are comparatively straight-forward issues to explain to the community and until this is successfully undertaken, private sector participation in infrastructure development will languish.

Recently, the Treasurer proposed an incentive to encourage states and territories to consider privatising infrastructure assets to free up resources which could then be reinvested in new and needed infrastructure assets. Engineers Australia broadly supports this direction but notes that the arguments put in the preceeding paragraph remain major problems. Indeed, the merits of the Treasurer's suggestion are unlikely to be fully appreciated in the confused environment among the community.

INFRASTRUCTURE COSTS

Just as official statistics on current infrastructure assets are limited, so too are official statistics on infrastructure costs.The inquiry terms of reference refer to both the level of costs and to cost movements over time. Both dimensions were addressed in a 2012 report from the Business Council of Australia (BCA)[8]. This report compared the costs of construction in Australia to the US Gulf region using statistics sourced from private consulting companies. The focus was on the period from 2001 to 2011 with forecasts provided for the period 2011 to 2021. In Australia, costs components and their rates of change were given as:

- Materials, 42% of project; increase 2001-06, 3.8%; increase 2006-11, 3.9%; increase 2011-21, 3.8%.
- Labour, 27% of project; increase 2001-06, 5.2%; increase 2006-11, 7.0%; increase 2011-21, 5.8%.
- Plant, 6% of project; increase 2001-06, 1.9%; increase 2006-11, 2.5%; increase 2011-21, 2.8%.
- Services and other inputs, 10% of project; increase 2001-06, fuel 8.3%, services 1.9% and other inputs 3.7%; increase 2006-11, fuel 0.5%, services 2.5% and other inputs 3.5%; increase 2011-21, fuel 2.6%, services 2.9% and other inputs 3.5%.
- Gross operating profit 15% of project.

When project costs were bench marked against the US gulf coast states, the following differences were observed:

- Australian resources projects were 40% more expensive
- Australian schools were 26% more expensive
- Australian shopping centres were 43% more expensive
- Australian hospitals were 62% more expensive, and
- Australian airports were 90% more expensive to build.

On the face these are large differentials and if valid justify the concern that has been expressed. However, Best[9] has argued that despite the prominence accorded the BCA report, the above comparisons are flawed because:

- The inter-country comparison did not observe the caveat articulated by the data producers that costs were for functionally similar structures rather than for identical ones and costs would differ according to designs, inclusions and exclusions. As well different building methods and standards for costing, measurement and construction are important.
- Average monetary exchange rates were used to convert Australian prices into US dollars. This process has largely been discredited by economists and major world agencies use purchasing power parity instead.

Best demonstrates that applying purchasing power parity to the data used by the BCA reduces the differences appreciably. Overall it shows that there was no difference in building costs between the US and Australia and in some cases Australia was cheaper. Furthermore Best points out that there were radical differences between the data used by the BCA and data obtained from other industry sources.

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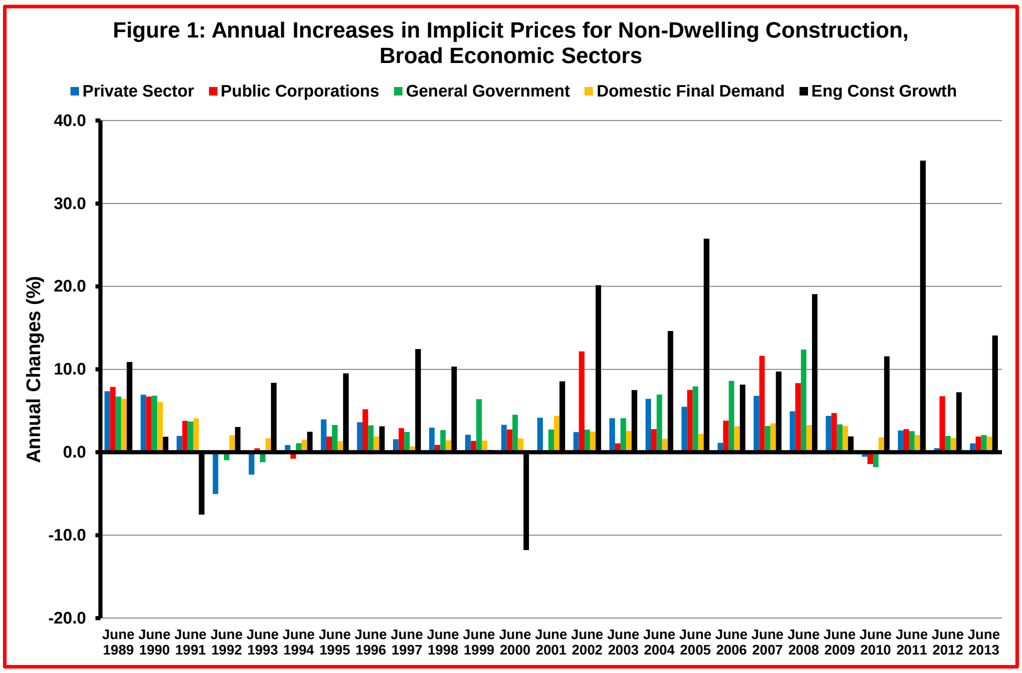
[8] Business Council of Australia, Pipeline or Pipe Dream? Securing Australia's Investment Future, 2012, www.bca.com.au
[9] Rick Best, International Comparisons of Cost and Productivity in Construction: A Bad Example, Australasian Journal of Construction Economics and Building, Vol 12, No 3,2012

On balance what the BCA/Best comparison demonstrates is that without decent statistics, the policy arguments cannot be substantiated. Engineers Australia believes that construction costs for infrastructure are important and can always be improved. Public policy towards that end is highly desirable but unless firmly based on reliable measurement is not likely to suceed.

The BCA study covered the period since 2001 and comparing the index of non-dwelling construction chain prices to the headline CPI, demonstrated that non-dwelling construction costs generally increased much faster than the CPI, particularly in the period just before the global financial crisis. Figure 1 extends this comparison to annual changes in implicit prices for non-dwelling construction by sector, including the private sector, public corporations and general government since 1988. Instead of comparing these movements to the CPI an alternative general price index, the implicit prices of domestic demand, is used and an additional comparison, annual changes in engineering construction work done[10], is introduced.

Several distinct periods can be indentified in Figure 1:



- From 1991 to 1996, price changes for non-dwelling construction were less than prices changes for domestic final demand.
- 1997 to 2000 was a period when non-dwelling construction prices grew faster than the prices of final domestic demand, in several cases substantially faster.
- 2001 was a repeat of the first period when non-dwelling construction price changes were less than price changes for final domestic demand.
- 2002 to 2009 was the period that present perceptions are based on; non-dwelling construction prices increased much faster than prices for final domestic demand. This period coincides with the construction boom in the resources sector and the resurgence of infrastructure development by commonwealth, state and territory governments.

[10] Implicit price changes were estimated from ABS 5204.0 Australian System of National Accounts, Table 51 and various others. The ABS electronic data were used. Changes in engineering construction work done were from the reference in Footnote 4

- The impact of the global financial crisis in 2010 saw reductions in non-dwelling construction prices in all sectors while prices for final domestic demand continued to rise.Since then, government sector non-dwelling construction prices have grown faster than prices of final domestic demand but private sector prices have stopped increasing and have been falling.
- In other words, infrastructure costs have not always moved faster than prices in general but over the past decade the extraordinary growth that accompanied the resources boom, and at times, an upsurge in infrastructure development led to levels of engineering construction that were uprecidented in Australia, pressures that manifested themselves in observed price changes.

IMPROVING COST MANAGEMENT

Engineers Australia strongly supports policies and programs to improve the management of existing infrastructure assets and to improve the management of new infrastructure development. Although it is commonly accepted that Australia has moved a long way over the past thirty years, many areas have yet to benefit from some more obvious improvements. In each of its Infrastructure Report Cards, Engineers Australia has reported deficiencies in infrastructure maintenance. Although maintenance may not be the most news worthy topic, appropriate maintenance is the difference between an asset providing the designed level of service for its economic life economically and unnecessary costs due to remedial work to deal with breakdowns and the asset requiring replacement before its normal economic life.

Neglect of maintenance is symptomatic of the wider environment that characterises the management of infrastructure assets. Public infrastructure is managed and developed by the three tiers of government as well as the private sector. The Institute of Public Works Engineers of Australia (IPWEA), one of the technical societies affiliated with Engineers Australia, has developed and published the Australian Infrastructure Management Guidelines[11] to assist asset intensive organisations to plan and manage their responsibilities. This practical guide has drawn upon the expertise of engineers, accountants, local government agencies, state government agencies, federal agencies including the Department of Finance and the Auistralian Procurement and Construction Council. All issues relevant to sustainable asset management are addressed to ensure effective and economic practices are utilised.

Engineers Australia strongly supports this type of practical assistance to improving the management of infrastructure assets. By ensuring Australian get the most out of existing infrastructure assets, the costs of replacement and/or augmentation can be deferred and new resources can be directed towards other priorities. Engineers Australia believes that this type of practical assistance is under-valued and more extensive uptake can make a difference to containing infrastructure costs.

One of the most important contributions made by Infrastructure Australia has been its reform and Investment framework. Although many of the framework components are familiar to project analysists, when the framework was adopted it was far from clear that all projects were scrutinised under each component heading prior to being considered for approval. The incorporation of rigorous cost-benefit analysis in the framework and insistence that the full framework be applied to all nationally significant projects were particularly important.

In the telephone meeting with Commissioner Mundy and Commission staff, Engineers Australia drew attention to the potential of cost engineering to manage and minimise infrastructure costs. The principles of cost engineering have been incorporated into a practical user guide by the European Commission[12].

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[11] IPWEA, Australian Infrastructure Financial Management Guidelines, 2009, www.ipwea.org/bookshop
[12] European Commission, Understanding and Monitoring the Cost-Determining Factors of Infrastructure Projects; A User's Guide, ec.europa.eu/regional_policy/sources/docgener/evaluation/pdf/5_full_en.pdf

Engineers Australia believes that complementing the Infrastructure Australia with a similar guide tailored to Australian conditions would extend examination of infrastructure costs to a broader personnel base, providing:

- Steps are taken to intergrate appropriate engineering expertise in public sector teams charged with the design, procurement and construction supervision of infrastructure projects.
- A common approach is adopted throughout Australian jurisdictions, including at local government level and in the private sector.
- Clear distinctions are drawn between adoption of common methodologies to analyse infrastructure costs and the cost differences that arise due to locational differences, type of infrastructure asset and land acquisitions.

THE PROBLEM OF PROJECT INTERMITTENCY

Infrastructure projects are typically discreet projects and conclude when the asset under construction has been completed. Frequently, there are time gaps between projects, sometimes relatively long gaps. In many instances, they are long enough for engineers who have been engaged on them to look for other work. The general presumption is that engineers find new work on other infrastructure projects or some other type of engineering. However, this is not always the case and some engineers accept employment outside of engineering because of financial and family pressures and personal locational preferences.

In mid-2013, Engineers Australia conducted a survey of its members to establish their views on a range of matters. Results showed that an absolute majority of survey respondents, including non-response, believed that intermittency in infrastructure projects was detrimental to engineering employment and to engineering careers. Intermittency in employment is not compatible with modern lifestyles and responsibilities and may lead some engineers to leave the profession. This boom-bust cycle is the genesis of the next engineering skills shortage.

It is important to appreciate that, in recent times, Australia did not have a shortage of people qualified to be engineers, but had a shortage of qualified engineers who actually work in engineering. Research by Engineers Australia[13] identified 52 of 358 four digit ANZSCO occupations as engineering occupations. In 2006, the labour force individuals qualified to be part of the engineering team (professional engineers, at least a four year full time bachelor degree in engineering; engineering technologist, at least a three year full time bachelor degree in engineering and associate engineers, at least a two year full time associate degree or an advanced diploma in engineering) was 200,615. However, only 122,258 or 60.9% were employed in engineering occupations. In 2011, the comparable figures were 263,890, with 163,912 or 62.1% in engineering occupations[14]. In other words, over one third of qualified engineers were employed in work other than engineering.

These issues are further compounded by two factors:

- The division of the profession into numerous disiplines of engineering practice with little or low substitution between them. Often engineering specialisation occurs through engineering practice following the completion of tertiary engineering courses.

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[13] Engineers Australia, The Engineering Profession in Australia; A Profile from the 2006 Population Census, September 2010, www.engineersaustralia.org.au

[14] Engineers Australia, The Engineering Profession: A Statistical Overview, Tenth Edition, September 2013, www.engineersaustralia.org.au

- Demand is highest for engineers who are competent to make independent engineering decisions; tertiary qualifications are just the entry point to engineering and a further three to four years of professional formation is necessary to be accepted as an independent practicing engineer.

INFORMATION REQUESTED BY THE COMMISSION

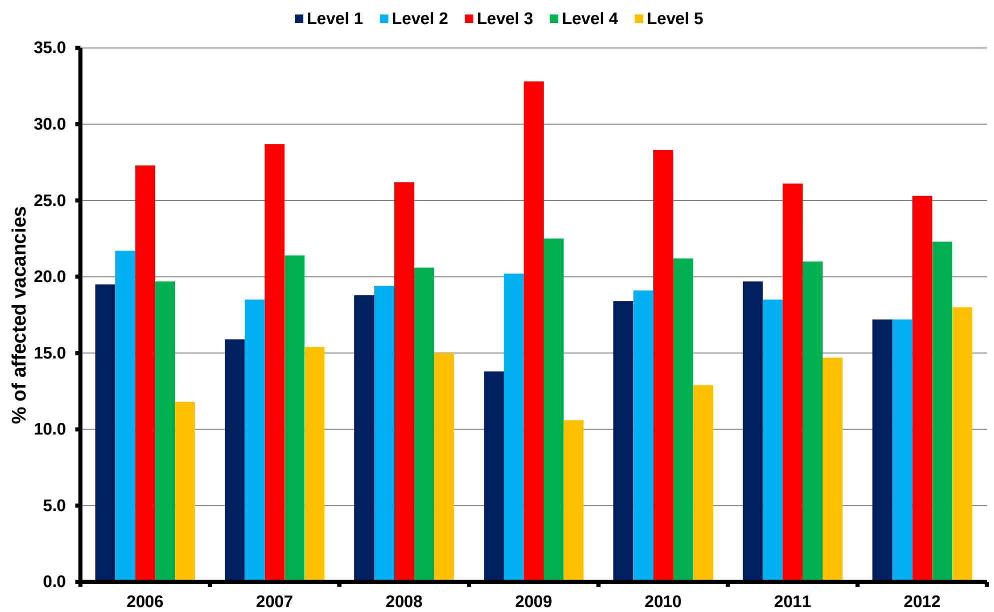
In an email on 18 December 2013 Mr Hudan Nuch requested information related to three matters. Engineers Australia's responses are as follows.

1) *Are skills shortages still apparent? To what extent are they dissipating with the slowdown of the resources boom?*

By way of background three factors are important to consideration of these questions.

Engineering specialisation is a key factor in periodic skills shortages. In most discussions engineering is treated as a set of homogeneous skills. There are, however, numerous engineering disciplines and distinct labour markets for them. To some extent engineering disciplines are defined by the choice of entry level course subjects. The main way in which specialisation occurs is through post-graduate professional experience and practice. In most engineering specialisations there are only limited degrees of substitutability. While it may be true to suggest that a civil engineer who has specialised in bridge construction could also in theory build steel framed sky scrapers, a move of this nature is generally not possible because in this example the engineer can claim expertise and thus status in his/her area of specialisation but not in the second area. Few engineers would see such a move as feasible.

Figure 2: Engineering Responsibility Levels and Recruiting Difficulties



A second factor is an engineer's depth of experience. Earlier in the submission the process of attaining professional experience and expertise was discribed. In many cases, excess demand for engineers occurs primarily at more senior experience levels with less of the problem at more junior level. This is evident in Figure 2 which charts the proportion of employers experiencing difficulties recruiting engineers at different responsibility levels[15].

Consistently the greatest difficulties were experienced in recruiting engineers level 3. In the private sector the average experience level of this group is about 14 years and in the public sector about 18 years. In the framework of responsibility levels used, level 3 is when engineers are sufficiently experienced to independently exercise engineering decisions and supervise other engineers supporting such work.

Since 2007, the group experiencing the second highest degree of recruiting difficulties was engineer level 4. In the private sector this group has average experience of 20 years and in the public sector 24 years.

It is in the context of these results that the consequences of employment intermittency (see above) are most serious.

A third important factor is the geographic location of demand. Some discussions of engineering skill shortages in recent years almost seem to suggest that most engineers work in the mining and construction industries. An Engineers Australia study of 237 four digit industries using 2006 and 2011 census statistics showed that engineers were employed in all but 10 industries in 2011[16]. These industries were widely distributed throughout Australia. In contrast, many of the industries experiencing acute shortages were located in remote areas and had experienced sudden and very large increases in demand for engineers. Indeed the increase in demand was unprecedented and well beyond what the Australian education system could support.

Are skill shortages still apparent? Available statistics provide mixed messages. First, DEEWR statistics show that vacancies for engineers have fallen for the past 20 months. Recently, there have been signs that this situation is turning around in NSW and Victoria. On the whole, however, the message from these statistics is about a significant weakening in the engineering labour market and an easing of skills shortages.

But immigration statistics tell a different story. In the year ending 30 June 2013, the intake of engineers on permanent visas was a record high, far higher than prior to the GFC when it was widely accepted that Australia faced severe engineering skill shortages. Permanent migration is not primarily concerned with skills shortages. Under prevailing government policy, short term shortages are to be handled using temporary 457 visas.

Table 1 shows statistics for the number of temporary 457 visas granted in respect to engineering occupations on the SOL. Although the SOL is not relevant to temporary migration it provides a convenient framework to compare temporary migration to permanent migration of engineers. Temporary migration was designed to act like an automatic stabiliser; when demand falls as it did in the GFC, temporary migrants are let go and the intake is reduced and when demand rises the opposite occurs.

Table 1 shows that consistent with statistics that show the engineering labour market has weakened, the number of 457 visas granted in 2012-13 fell. However, the number of visas granted was the second highest on record and far higher than during the pre-GFC skill shortage. The Table shows that many traditional engineering occupations were granted temporary visa but new occupations have also emerged in recent years. When this information is considered against the three background points above, it is clear that some areas are still experiencing shortages even though more broad based

[15] These results were obtained from the Engineers Australia Skills Survey described in Chapter 11 of the Engineering Profession, op cit

[16] Engineers Australia, Engineers in Industry; The Size, Growth and Character of Employment in Australia, April 2013, www.engineersaustralia.org.au

evidence suggests that shortages have eased. The alternative, of course, is that the 457 process is being misused.

Table 1: Temporary Visas Granted to Engineers on the SOL in the Skilled Migration Program

Professionals

ANZSCO	Occupation	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
233111	Chemical engineer	50	70	120	160	250	190	140	140	120	88
233112	Materials engineer	10	20	30	40	50	50	30	50	40	22
233211	Civil engineer	190	330	580	750	1190	1040	560	820	1160	642
233212	Geotechnical engineer	0	0	0	0	0	0	0	110	210	82
233213	Quantity surveyor	50	60	100	130	180	180	170	250	380	218
233214	Structural engineer	0	0	0	0	0	0	0	100	150	78
233215	Transport engineer	0	0	0	0	0	0	0	50	40	33
233311	Electrical engineer	110	130	320	400	460	380	210	320	450	324
233411	Electronic engineer	100	170	210	310	240	180	120	110	190	124
233511	Industrial engineer	10	30	30	40	60	60	50	130	150	103
233512	Mechanical engineer	280	360	640	620	840	670	400	510	690	612
233513	Production or plant engineer	70	80	130	120	180	130	90	150	180	142
233611	Mining engineer (excl petroleum)	70	80	160	170	270	200	70	170	380	188
233612	Petroleum engineer	70	110	130	190	180	160	160	200	230	222
233911	Aeronautical engineer	20	40	40	30	50	40	40	30	40	23
233912	Agricultural engineer	< 5	< 5	< 5	< 5	10	< 5	< 5	< 5	10	<5
233913	Biomedical engineer	10	10	20	10	10	20	10	20	20	17
233915	Environmental engineer	0	0	0	0	0	0	0	60	100	59
233916	Naval architect	< 5	10	10	10	20	20	10	20	20	16
233999	Engineering professionals nec*	160	200	300	350	440	370	220	450	660	507
261313	Software engineer	670	610	450	900	860	810	760	880	940	1020
263311	Telecommunications engineer	0	0	0	0	0	0	0	20	60	55
263312	Telecommunications network engineer	0	0	0	0	0	0	0	50	180	142
263111	Computer network & systems engineer*	0	0	0	0	0	0	0	150	0	202
263213	ICT Systems Test engineer*	0	0	0	0	0	0	0	180	400	451
	Total professionals	1870	2310	3270	4230	5290	4500	3040	4970	6800	5370

Technologists

ANZSCO	Occupation	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
233914	Engineering technologist	100	160	250	310	360	330	150	150	190	80

Associates

ANZSCO	Occupation	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
312211	Civil engineering draftsperson	20	50	80	140	210	270	100	130	170	104
312212	Civil engineering technician	10	10	30	40	90	90	30	110	210	158
312311	Electrical engineering draftsperson	20	30	50	110	180	150	90	70	140	154
312312	Electrical engineering technician	30	40	100	180	230	230	130	310	400	370
313211	Radiocommunications technician	0	0	0	0	0	0	0	10	150	44
313212	Telecommunications field engineer	0	0	0	0	0	0	0	30	100	18
313213	Telecommunications network planner	0	0	0	0	0	0	0	< 5	<5	<5
313214	Telecommunications technical officer	0	0	0	0	0	0	0	10	60	52
312411	Electronic engineer draftsperson*	10	60	50	220	60	60	50	20	10	14
312412	Electronic engineers technician*	30	40	50	100	140	200	120	150	230	183
312511	Mechanical engineering draftsperson*	70	100	110	160	200	220	120	120	180	104
312512	Mechanical engineering technician*	40	80	230	290	410	540	440	630	1080	1273
312912	Metallurgical or materials technician*	10	20	40	80	140	90	40	70	180	174
312913	Mine deputy*	10	10	30	40	30	20	20	20	20	15
312999	Building & engineering technicians nec*	40	40	120	160	150	200	130	140	240	163
	Total associates	290	480	890	1520	1840	2070	1270	1820	3170	2826
	TOTAL SOL	2260	2950	4410	6060	7490	6900	4460	6940	10160	8276

Source: Statistics supplied by DIAC

2 Are there examples of projects where skill shortages have led directly to delays or postponement of infrastructure projects? How much of a delay was there and for what size project?

Specific examples are not available nor are responses to the second part of the question available. However, the results of the Engineers Australia Skills Survey (mentioned above) can provide some broad information.

Table 3 shows the responses to the question "what have been the consequences of difficulties you experienced in recruiting engineers?" It is fair to say that the majority indicated that recruiting difficulties resulted in irritation and some minor monetary consequences. However, as recently as 2012, 31% of respondents indicated that recruiting difficulties caused major problems and project delays and costs.

Although this proportion has fallen over time, consistent with evidence of some easing of skills shortages, it is far too high to ignore. Furthermore, some projects have not proceeded at all. In this category the most recent evidence shows that this problem has eased considerably. The 2013 survey is in the field at present.

Table 3: The Consequences of Difficulties Recruiting Engineers (% Respondents)

Consequence	2006	2007	2008	2009	2010	2011	2012
Minor irritation but no monetary issues	12	10	16	21	10	13	12
Moderate problems with some monetary problems	39	40	43	43	57	54	54
Major problems, including project delays & costs	43	42	33	28	29	28	31
Did not proceed with available project	6	7	8	8	4	6	3

3 Is there evidence where specific skill shortages have led to observable wage pressures? Do wages fall after shortages disappear?

There has been little research into engineering wage movements, certainly not at the level of detail needed to respond to these questions. Engineers Australia has undertaken a comparison of growth in size of salary packages for different responsibility levels to growth in average weekly earnings. These results are summarised in Table 4.

Table 4: Average Growth in Professional Engineer Salary Packages

Period	Level 1	Level 2	Level 3	Level 4	Level 5	Above L5	Graduate	AWE
Private Sector								
5 years to 2004	3.4	3.2	2.5	3.6	2.9	3.4	3.5	5.0
5 years since 2008	3.9	5.0	3.9	5.1	6.2	8.5	4.7	4.8
12 years since 2000	4.4	4.5	4.5	5.3	6.3	6.8	4.6	4.8
Last year	6.4	5.3	-0.8	4.5	3.7	21.1	4.5	4.9
Public Sector								
5 years to 2004	4.7	3.4	2.6	3.9	3.5	-0.5	3.5	5.0
5 years since 2008	5.0	3.3	3.8	4.1	4.7	6.8	4.7	4.8
12 years since 2000	4.8	3.9	4.1	4.2	4.8	2.8	4.6	4.8
Last year	2.3	3.7	1.4	0.5	5.2	14.9	4.5	4.9

The research was based on the Engineers Australia/APESMA December salary surveys for professional engineers (not the engineering team) from 2000 onwards. Consider the private sector first:

- In the 5 years to 2004, average increases in salary packages for all responsibility levels were less than the average increase in full time adult earnings.
- Over the 12 years covered in Table 10.6, average increases in salary packages for Levels 1,2 and 3 were less than the average increase in full time adult earnings.
- In the 5 years 2008 to 2012, average increases in salary packages for Levels 1 and 3 were less than the average increase in full time adult earnings, but average increases for Levels 2, 4, 5 and above Level 5 exceeded average increases in full time adult earnings.
- In 2012, increases for Level 1, 2 and above Level 5 were higher than the increase in full time adult earnings but the increases for Level 3, 4 and 5 were less, indeed, salary packages appeared to fall for Level 3.

The results for the public sector were also patchy but there were some differences to the private sector:

- In the 5 years to 2004, salary package increases for all levels were below the increase in full time adult earning, but the highest increase was at Level 1.
- In the 12 years since 2000, Levels 1and 5 have kept pace with increases in full time adult earnings but the increases for all other responsibility levels were less than the increase in full time adult earnings.
- In the 5 years from 2008 to 2012, increases for Level 1 and for above Level 5 were above the increase in full time adult earnings, but the increases for all other levels were less.
- In 2012, the increase in salary packages for above Level 5 were higher than the increase in full time adult earnings but all other responsibility levels experienced lesser increases.

These changes do not conform to expected patterns in a tight labour market. Certainly there were some changes that did, but these were typically at the most senior level. Although, Professional Engineers are well paid in absolute terms, for many of them salary packages did not keep pace with full time adult earnings. A factor not examined was the impact of skilled migration which between the census years of 2006 and 2011 accounted for over 70% of the growth in the engineering labour force.

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