Report to

Electricity Reform Implementation Group

Analysis of Productivity Factors in Transmission and Generation for the National Electricity Market

28 December 2006

McLennan Magasanik Associates

Ref: J1404 V12

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ABBREVIATIONS

The following abbreviations are used in this report.

ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
AER	Australian Energy Regulator
ESAA	Energy Supply Association of Australia
ERIG	Energy Reform Implementation Group
NEM	National Electricity Market

EXECUTIVE SUMMARY

The Energy Reform Implementation Group (ERIG) is seeking evidence that changing the structure of the National Electricity Market or its regulations will produce economic benefits in terms of increased efficiency. Two reports have been prepared by McLennan Magasanik Associates (MMA). This report examines published data on inputs of the transmission and generation sectors in the National Electricity Market (NEM) to examine recent trends in capital and labour productivity. The other report entitled "Evaluation of Economic Benefits of Reform" simulates the development of the NEM to provide a basis for estimating the economic benefits of various mechanisms for reform.

Questions to be answered in this part of the study are:

- Have productivity levels improved in recent years (noting that the study only covers the period FY2000 to FY2005)?
- Is there evidence that some state jurisdictions are making a dissimilar contribution to the efficiency of the NEM?

For the transmission sector productivity measures have been developed for Queensland, NSW (excluding transmission assets owned by Energy Australia) and Victoria. For the generation sector, measures of labour productivity have been developed for NSW, Victoria, South Australia and Queensland, while for capital productivity, measures have been developed for NSW, South Australia and Victoria combined and Queensland Government Owned Generators.

The challenge in developing the productivity measures was determining the exact nature of the outputs. For transmission networks capacity, the level that covers the expected peak demand which has a 1 in 10 probability of being exceeded in any one year was considered the most appropriate output. In addition to providing information on capital and labour productivity, MMA has calculated a Transmission to Load Factor (TTLF) for each transmission network for the period FY2000 to FY2007. The TTLF is a simple measure of the geographical size of a system relative to its peak demand and provides some estimation of network utilisation.

For generation the output measure is GWh sent out.

An examination of the TTLF suggests that the network in NSW has been extended ahead of expected growth in peak demand which could indicate a network that is becoming less productive (at least in the short term) or that has had significant catch up investment to maintain supply reliability.

A number of difficulties were experienced in obtaining data for inputs. These difficulties are explained in some detail in section 2.3.6 of this report. A further difficulty is that the data necessary to normalise the productivity measure for the transmission networks, thereby enabling a proper comparison between the transmission networks in each state, is not publicly available. Therefore, comparisons of trends and levels of productivity across States cannot be easily made and it is only possible to discuss the trends in productivity in each state.

Data issues aside, it was found that in the transmission sector, Queensland experienced improvement in both labour and capital productivity. Victoria's transmission sector experienced growth in capital productivity but had little or no growth in labour productivity. The transmission sector in NSW saw capital productivity decrease and labour productivity either decreasing (when using estimates derived from ABS data) or a small rate of increase (when using data supplied by Transgrid).

Turning to the generation sector, labour productivity remained constant over the period for South Australia and Victoria while it decreased marginally in NSW. Capital productivity in the combined Victoria and South Australia generation sector increased over the period FY99/2000 to FY03/04 while in NSW and Queensland it remained flat (noting that the study was restricted to government owned generators in Queensland). However, capital productivity levels remained higher in NSW than in either Queensland or Victoria/South Australia. Comparative analysis of capital productivity is made difficult by the inclusion of fuel supply in the capital values of the coal fired power stations in South Australia and Victoria. However, the improving trend in the southern states is consistent with the improvement in the efficiency of the plant mix achieved by refurbishing Playford Power Station and building open cycle gas turbine plant and upgrading the Snowy to Melbourne interconnection in 2002.

1 INTRODUCTION

The purpose of the study is to provide evidence that changing the structure of the National Electricity Market or its regulations will produce economic benefits in terms of productive and allocative efficiency. The focus of this work excludes dynamic efficiency considerations due to their complex nature.

1.1 Efficiency objectives

Productive efficiency is realised by using the least amount of resources to produce a give amount of goods or services. In terms of the electricity market this means that:

- Generation and demand side resources are dispatched to meet the load in order from lowest cost to highest short-run marginal cost or shadow value as appropriate. This is the normal basis for ordering the dispatch by means of bid prices but to be certain of productive efficiency it is necessary that competition is sufficient to provide incentive for generators to bid close to their short-run marginal costs or at the least in the order of their costs.

- Resources are employed and maintained using the most efficient use of inputs. Such matters relate primarily to on-going operational and maintenance activities, such as the effect of staffing levels, and use of in-house services versus external contracting.

Allocative efficiency occurs when firms produce those goods and services most valued by society. This means scarce resources are allocated to the production of the goods and services so that consumer wants and needs are met in the best way possible. If a market is allocative efficient then any reallocation of resources to make some customers better off will make other customers worse off. Put in another way marginal cost must equal marginal benefit.

Where possible, competitive pricing (price equal to marginal cost) is the best mechanism for ensuring allocative efficiency. In electricity the dispatch process must be designed so that supply matches demand and that marginal cost equals marginal benefit such that the maximum levels of producer and consumer surplus are generated.

Two reports have been prepared by McLennan Magasanik Associates (MMA). This report examines published data on inputs of the transmission and generation sectors in the National Electricity Market (NEM) to examine recent trends in capital and labour productivity. It therefore has the narrow focus of examining productive efficiency as it relates to the use of inputs. The other report entitled “Evaluation of Economic Benefits of Reform” simulates the development of the NEM to provide a basis for estimating the economic benefits of various mechanisms for reform.

Questions to be answered in this part of the study are:

- Have productivity levels improved in recent years (noting that the study only covers the period FY2000 to FY2005)?
- Is there evidence that some states are making a dissimilar contribution to the efficiency of the NEM?

1.2 Assessment of productivity changes

Productivity is a measure of the efficiency with which inputs are being used to produce outputs. ERIG is seeking to understand changes in productivity in the generation and transmission sectors of the market and whether any jurisdictional differences have arisen. To this end MMA has constructed indicative partial productivity measures of labour and capital.

For the transmission sector, productivity measures have been developed for Queensland, NSW (excluding transmission assets owned by Energy Australia) and Victoria. The AER is yet to consider the revenue cap for the South Australian and Tasmanian transmission networks and therefore these states have been excluded for the purpose of this analysis in order to maintain consistency in comparing productivity measures. Nevertheless some overlap between decisions made by the ACCC and AER is required because of the mismatch between regulatory periods.

For the generation sector, measures of labour productivity have been developed for NSW, Victoria South Australia and Queensland, while for capital productivity NSW is compared to a combined measure for South Australia and Victoria and to the Queensland Government owned generators. Queensland privately owned generators were excluded from the analysis given the difficulty in obtaining capital costs for the private sector generators. A combined index of South Australian and Victorian assets is developed rather than separate measures for each state because of the number of privately owned generation companies with assets in both states (necessitating the need for a single measure of capital productivity for these states).

Fuel efficiency was not considered because it is the opinion of MMA that fuel productivity measures will not provide meaningful results. It is unlikely that the new owners of the privatised assets would have undertaken significant measures to improve thermal efficiency since privatisation given the expense of such activity and the comparatively low fuel costs incurred. Some efficiency measures have been progressed under the Generator Efficiency Standard Scheme. Improvements would amount to fuel reduction of several percent at most with perhaps 1 percentage point improvement in efficiency.

2 HISTORICAL PRODUCTIVITY

2.1 Developing Partial Productivity Measures for Transmission

The challenge in developing a measure for productivity is determining the exact nature of the outputs. Typically, output measures fall into two categories, supply side or demand side. Demand side measures have the advantage of measuring something that is tangible in the sense that there is a certain demand for a product and it should be met at lowest cost. It can be argued however, that this provides an unfair assessment of the performance of the business, as demand side measure of output can be affected by factors that may well be outside the control of the firm. On the other hand, using supply side measures suffers from the problem of identifying an appropriate level of future demand upon which decisions on the level of capacity can be measured against.

For transmission networks, MMA believes that transmission capacity is the most appropriate measure of output. Specifically, transmission capacity needs to be at a level that covers the expected peak demand which has a 1 in 10 probability of being exceeded in any year (called 10% probability of exceedance - POE). The 10% POE is calculated using the peak load data from NEMMCO which is provided as part of the *Statement of Opportunities* publications as a forecast quantity. Therefore, 10% POE peak demand has the advantage that it is an estimate derived independently from the transmission service operators, it is derived in a consistent manner for each state and is published in a very transparent environment. However, it is still not a perfect measure in the sense that it does not take into account the geographical dispersion of load centres across States.

For the capital productivity measure, information on the capital base for each of the networks is sourced from the relevant regulatory decision of the AER on the network revenue cap. Adjustments have been made to these estimates to reflect actual capital expenditures wherever possible. Capital productivity is measured in peak MW per million dollars invested. To calculate the labour productivity measure, employees were approximated using data on employees in the electricity by state provided by the ABS, which is then disaggregated into each sector using data on the number of employees by sector in 2004 provided by the ESAA. Labour productivity was measured as peak MW capacity per employee. Using the ABS data rather than employee data derived from annual reports provides a better basis for including resources that are contracted to the sector rather then directly employed. To show the difficulty in this analysis we show the employee number provided by TransGrid with the employee number derived from the ABS data in Table 2-1. The two series have different trends with the TransGrid employee number stable and the estimated employment increasing. Stable employment within the sector and increasing employment overall is not unexpected. However the difference in the trend underlies the difficulty of assessing trends with such limited data. Similar issues are experienced in comparing this analysis with the employee numbers provided for in Powerlink's annual report which is also shown in Table 2-1.

Table 2-1 Employee number estimates

Staff Numbers	99/00	00/01	01/02	02/03	03/04
Number of employees from TransGrid Annual Reports as provided by TransGrid 15 December 2006	969	945	958	964	974
MMA Estimate of sector employment used for ERIG based upon ABS data	871	883	933	972	1018
Difference	10.1%	6.6%	2.6%	-0.8%	-4.5%
Number of employees from Powerlink's Annual Reports		467	499	520	590
MMA Estimate of sector employment used for ERIG based upon ABS data		627	655	633	661
Difference		-25.5%	-23.8%	-17.9%	-10.7%

In addition to providing information on capital and labour productivity MMA has calculated a Transmission to Load Factor[1] ratio (TTLF) for each transmission network for the period FY2000 to FY2007.[2] The TTLF ratio is a simple measure of the geographical size of a system relative to its peak demand. It is measured in millions of ohm-m and is calculated using the formula:

$$TTLF = \frac{\sum_i V_i^2 \bullet d_i}{D}$$

Where: V_i is the nominal voltage level for transmission assets in kV

d_i is the length of transmission lines in km

D is the 10% POE peak demand supplied into the network in kW.

In calculating the index we included all assets of 110kV nominal voltage and above. We do not distinguish according to regulatory designations such as whether they perform the role of transmission, sub-transmission or distribution or whether the assets are meshed or radial in network configuration. Transmission assets in Tasmania operate at 110kV, so it is reasonable to use this level as a threshold level for this indicative comparison. Using this threshold also captures 132kV assets in NSW which contribute transmission services in the rural parts of the state.

TTLF is useful for comparing the transmission line intensity of a transmission system. Typically thermally limited systems which are normally more compact have lower TTLF

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1 This index was developed by I P Bates, R A Gawler and K Frearson in a CIGRE paper entitled "Review of Power System Defence Plans" published in Electra No 128, January 1990. The formula was shown incorrectly in the paper with the square index on the wrong variable. It typically varies between 13 for very compact systems to well over 100 for geographically diverse systems.

2 An alternative measure to the TTLF is the system line capacity (total MVA kilometers). It is MMA's understanding that the data requried to construct the system line capacity is not accessible in the public arena.

than longer stability limited systems. Systems with limited or no interconnection have higher TTLF values. The reason that the square of the voltage is used in the formula is that power carrying capacity of a power line usually varies approximately as the square of the rated voltage because conductor size or the number of conductors must also increase to limit electrical breakdown of the air at the conductor surface. A reduced level of TTLF in the absence of network development would indicate increased asset utilisation. The ESAA provides the number of km of transmission line at each level of voltage for each state. Therefore, for NSW, the data contains transmission lines owned by Transgrid and EnergyAustralia. It is the view of MMA that the inclusion of EnergyAustralia in the data will not significantly bias the result given the small size of the EnergyAustralia transmission network.

As each of the networks operates in significantly different geographic regions it is difficult to make any firm comparisons between the productivity levels for each of the jurisdictions analysed in this study. Lawrence and Diewert (2004)[3] identify energy and customer densities as two important operating environment variables in normalisation studies for distribution networks. The first is a measure of energy per customer (the higher the energy per customer the less infrastructure is required to deliver the same volume), while the second variable measures the number of customers per unit of area. It is not immediately clear that such measures transfer across to transmission networks or that other measures of geographic diversity are of equal or higher importance (for example accounting for higher storm activity in North Queensland). Nevertheless, if such a measure was considered to provide at least some method of comparison then one possibility would be to consider each transmission terminal station a customer and the MVA rating per terminal station as a measure of energy intensity. A second possibility would be to create a benchmark TTLF for each state. However, this would require determining the costs of an ideal transmission network system for each state based on the geographic loading requirement and the geography itself. This would be a significant piece of work and would amount to redesigning the transmission from scratch. Further, making comparisons between the ideal and existing network suffers the same problems as identified for demand type measures of output, in that it incorporates factors that may well be outside the control of the firm. In addition, due to the long lived nature of the assets, any deviation in network expansion away from the ideal network can have long lasting effects on productivity and/or significant revaluation of assets.

In the absence of normalised data it is not possible to make any absolute comparisons between the productivity of the transmission networks in NSW, Victoria and Queensland. However it is possible to consider the trend for each state and compare this trend for the period of the analysis. The focus of the report is therefore on trends in productivity rather than trying to compare absolute values between states.

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[3] Lawrence and Diewert (2004) "Measuring Output and Productvity in Electricity Networks" presented to SSHRC Conference on Index Number Theory and the Measure of Prices and Productivity, Vancouver 30 June – 3 July 2004.

2.2 Developing Partial Productivity Measures for Generation

Output from the generation sector is measured as GWh sent out. The data were obtained from www.erisk.net.

Information on employee numbers is obtained in the same manner as undertaken in the analysis of transmission. As for the analysis of the transmission sector, labour productivity is measured in the number of GWh sent out per employee.

A number of approaches can be taken to measuring capital productivity for generation. As for the transmission services, changes to the value of the capital asset base is one measure. Finding data on capital asset value was difficult. It has been constructed from a variety of sources specifically:

- Financial reports of the state owned corporations, which is provided by the ESAA;
- Annual reports of the various private sector participants;
- MMA's own knowledge of the prices paid for generators as they were privatised;
- MMA's own knowledge on the estimated costs or stated costs in media releases of new generators built or purchased since privatisation; and
- MMA's own knowledge of significant CAPEX costs undertaken since privatisation.

With this measure, the capital productivity is measured in the number of GWh sent out per $M change in the capital asset base value.

The list of generators shown in Table 2-2 was used in developing capital productivity measures for NSW, Victoria/South Australia and Queensland. The prices paid for those generators privatised in Victoria and South Australia is tabulated in Appendix A . This list excludes those generators wholly owned by AGL, Origin and International Power as well as Loy Yang A. For these assets, reported capital values were obtained from annual reports. It also includes any capital expansion undertaken since privatisation. For the intervening periods between sales and major upgrades a real depreciation rate of 3.33% is used to update capital values. This assumes a capital life of generation assets of 30 years.

The analysis excludes Anglesea (141.7 MW) and Energy Brix (195 MW) in Victoria, Lake Bonney Wind Farm (80.5 MW), Cathedral Rocks Wind Farm (66 MW) in South Australia and Appin and Tower (96.8 MW), Redbank (141 MW) and Smithfield (161 MW) in NSW. This enables a more meaningful comparison between the generators in NSW and those in South Australia and Victoria.

It was not possible to disaggregate the employee figures, provided by the ESAA and the ABS, by station or company. Therefore in developing the labour productivity measure, all GWh sent out were included in the analysis.

Table 2-2 Generators included as part of the analysis of Capital Productivity in the Generation Sector.

Victoria

Station Name	Owner in 2006	Fuel Type	Sent Out Capacity (MW)
Jeeralang Power Station	Babcock and Brown	gas	484
Newport Power Station	Babcock and Brown	gas	484
Hazelwood Power Station	IP	coal	1472
Loy Yang B Power Station	IP	Coal	920
Loy Yang A Power Station	LYP	Coal	1881
Yallourn W Power Station	TRUenergy	coal	1368
Valley Power Peaking Facility	Snowy Hydro	gas	334
West Kiewa Power Station	AGL	Hydro	62
Somerton Power Station	AGL	gas	151
McKay Power Station	AGL	hydro	50
Bairnsdale Power Station	Alinta	gas	80

South Australia

Station Name	Owner in 2006	Fuel Type	Sent Out Capacity (MW)
Wattle Point Wind Farm	AGL	wind	90.75
Canunda Wind Farm	IP	wind	46
Osborne Power Station	Babcock and Brown	Gas	187.4
Northern Power Station	Babcock and Brown	Coal	494.9
Playford B Power Station	Babcock and Brown	Coal	222
Ladbroke Grove Power Station	Origin Energy	gas	84
Quarantine Power Station	Origin Energy	gas	92
Torrens Island Power	TRUenergy	gas	1262

Station Name	Owner in 2006	Fuel Type	Sent Out Capacity (MW)
Station			
Pelican Point	IP	gas	463
Synergen	IP	Gas	334
Hallett	AGL	Gas	191

NSW

Station Name	Owner in 2006	Fuel Type	Sent Out Capacity (MW)
Mt Piper Power Station	Delta Electricity	coal	1240
Munmorah Power Station	Delta Electricity	coal	576
Vales Point "B" Power Station	Delta Electricity	coal	1240
Wallerawang "C" Power Station	Delta Electricity	coal	940
Broken Hill Gas Turbine Station	Eraring Energy	gas/fuel oil	50
Eraring Power Station 330kV	Eraring Energy	coal	1240
Eraring Power Station 500kV	Eraring Energy	coal	1240
Warragamba Power Station	Eraring Energy	Hydro	50
Bayswater	Macquarie	coal	2592
Hunter Valley Gas Turbine	Macquarie	gas/fuel oil	51
Liddell	Macquarie	coal	1955
Blowering	Snowy Hydro	hydro	70

Queensland

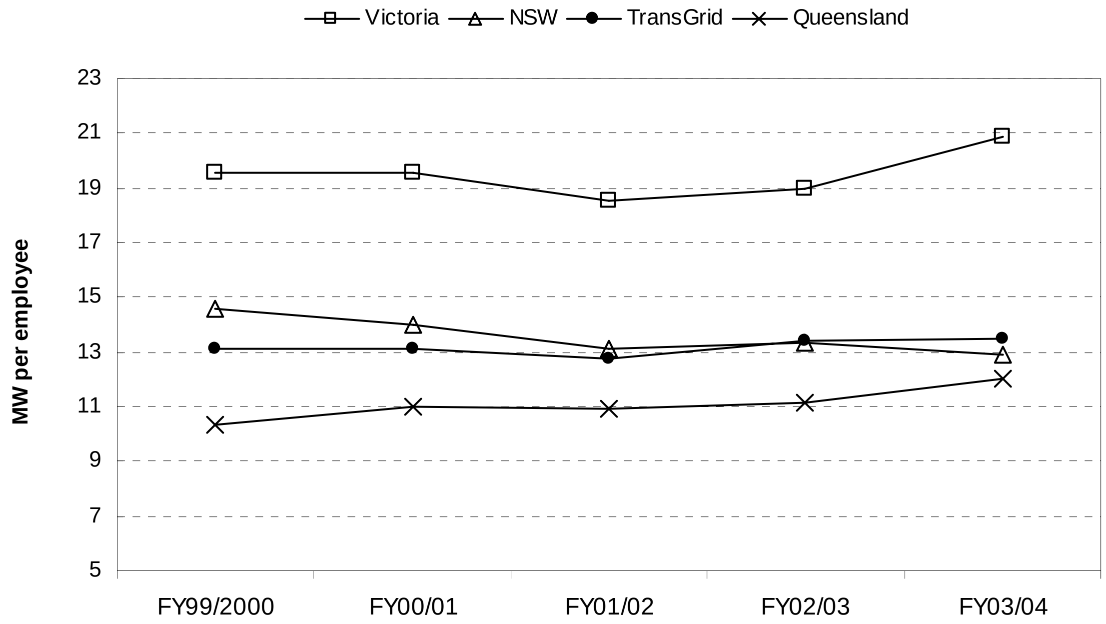
Station Name	Owner in 2006	Fuel Type	Sent Out Capacity (MW)
Callide A Power Station	CS Energy	Thermal - Coal	114
Callide B Power Station	CS Energy	Thermal - Coal	658
Swanbank E Gas Turbine	CS Energy	Gas Turbine - Gas (CC)	373
Barron Gorge	Stanwell Corporation	Hydro	60
Kareeya (incl Kareeya 5)	Stanwell Corporation	Hydro	72
Mackay Gas Turbine	Stanwell Corporation	Gas Turbine - Fuel oil	33
Stanwell Power Station	Stanwell Corporation	Thermal - Coal	1354
Wivenhoe Small Hydro	Stanwell Corporation	Hydro	500
Tarong Power Station	Tarong Energy	Thermal - Coal	1316
Tarong North Power Station	Tarong Energy	Thermal - Coal	416
Wivenhoe Power Station	Tarong Energy	Hydro	500
Wivenhoe Power Station No. 1 Pump	Tarong Energy	Hydro	240
Wivenhoe Power Station No. 2 Pump	Tarong Energy	Hydro	240

2.3 Productivity Analysis

2.3.1 Transmission – Labour Productivity

For the period of the review, Victoria has had by far the most productive transmission network with respect to labour. In part this is because the Victorian transmission network is less geographically spread than both NSW and Queensland. In turn Queensland has had the least productive network being the most geographically spread. This is illustrated by Figure 2-1. The figure also shows the productivity trend based upon TransGrid employment data as provided. It shows a more favourable trend than that derived from the ABS employment data but is still less favourable than indicated in the other regions.

Figure 2-1 Labour Productivity in Transmission Sector

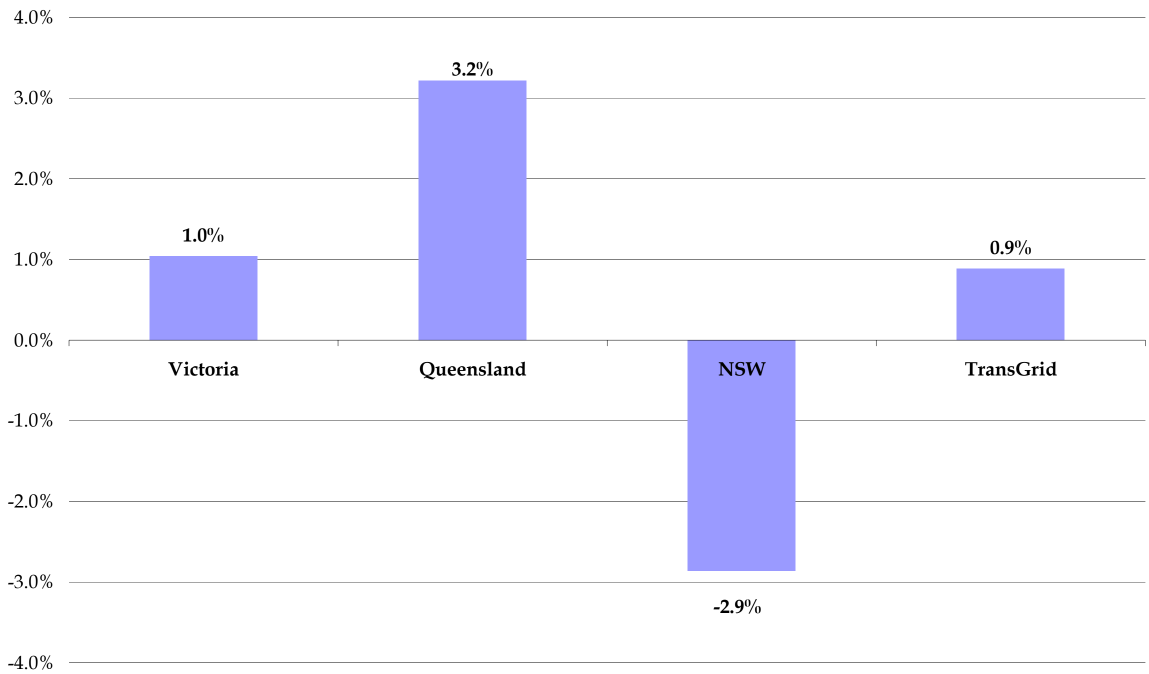


In order to focus on the growth in productivity, indicators of productivity growth were developed using the same methodology as employed by the *Productivity Commission*. The percentage growth is calculated as the percentage growth in outputs minus the percentage growth in inputs. The growth in labour productivity in the transmission sector is illustrated in **Figure 2-2**. Again the analysis based on the TransGrid employment data as well as the ABS data is shown for TransGrid and NSW. The TransGrid employment data shows a more favourable trend but this may not fully account for changes in contracted services over this period.

Queensland has experienced modest increases in productivity over the time frame FY99/2000 to FY03/04. Victoria had an average growth rate of around 1.0%, but because the year to year variation in the growth rates this estimate of the growth rate was found to be not significantly different from zero. It can be seen that in both States the growth in labour productivity was not negative in three out of the four years, with both experiencing negative growth in FY01/02. However, the reasons behind the drop in productivity in these states were quite different. In Victoria the negative growth was a result in a fall in 10% POE peak demand while in Queensland employment rose. It is therefore important not to focus on the fall in productivity. It could be argued that the fall in Victoria was unavoidable based on previous years' forecasts of 10% POE peak demand, while in Queensland a more accurate assessment of the changes in employment in the transmission sector would be required.

The growth in labour productivity in Queensland and the steady level of productivity in Victoria contrasts with NSW with the latter having experienced negative (based on MMA employment estimates) or a small rate of growth in each year (using TransGrid employment numbers).

Figure 2-2 Growth in Labour Productivity in Transmission Sector



At this stage it is difficult to establish whether the difference in labour productivity between states is solely due to the differences in geographic nature of the transmission network or due to privatisation or a combination of the two factors. In order to establish the root causes of the difference more accurate data on employee numbers and resources contracted in through outsourcing would be required to be collected and analysed. The only way of obtaining this data would be to request it from the transmission network owners. Time and resources were not sufficient during this project to take this next step.

2.3.2 Transmission - Capital Productivity

In FY 99/2000 NSW had the most capital productive network out of the eastern states. However, by FY05/06 Victoria had taken that mantle. Figure 2-3 also shows that Queensland is behind the other states due to the large geographical spread of its transmission network relative to peak demand. While capital productivity in Queensland rose over the period due to strong demand growth, it remains lower than the other two states.

Growth in capital productivity has been quite volatile over the period FY00/01 to FY05/06. However, tentatively some trends can be seen (as illustrated in Figure 2-4). Victoria has experienced growth in every year while NSW experienced either no growth or negative growth throughout the period. The data on NSW is affected by a significant reset upwards of the capital base in FY04/05 resulting in a significant decrease in capital productivity over that year. Excluding the capital revaluation from the analysis indicates that capital productivity in NSW has remained relatively stable over the period of the analysis. In Queensland there was moderate growth in productivity over all periods from FY01/02.

Figure 2-3 Capital Productivity in Transmission Sector

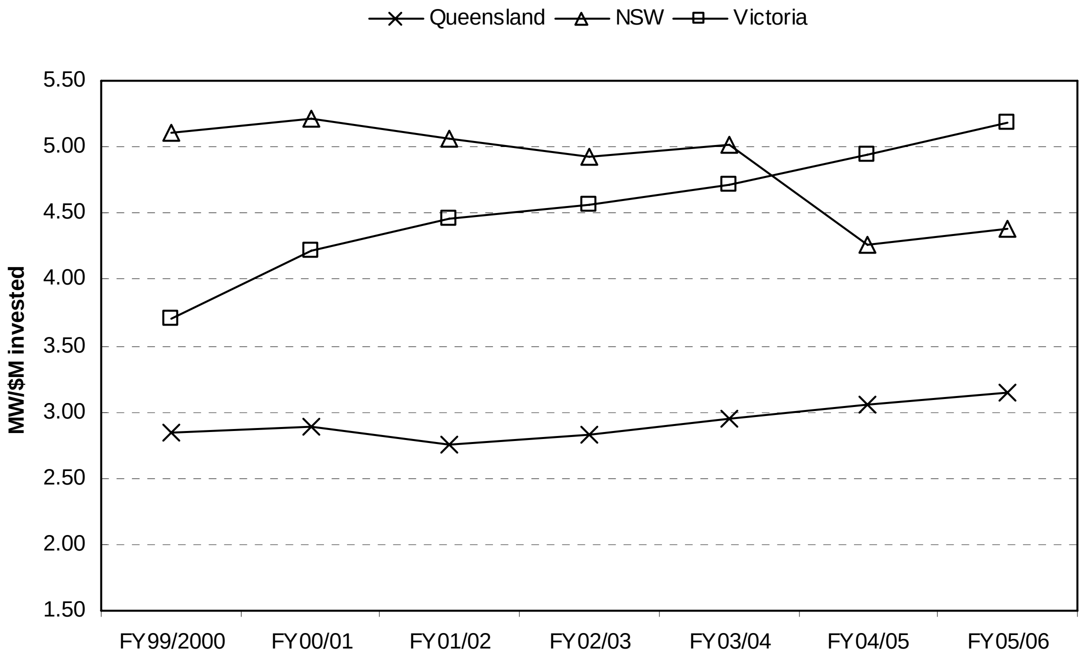
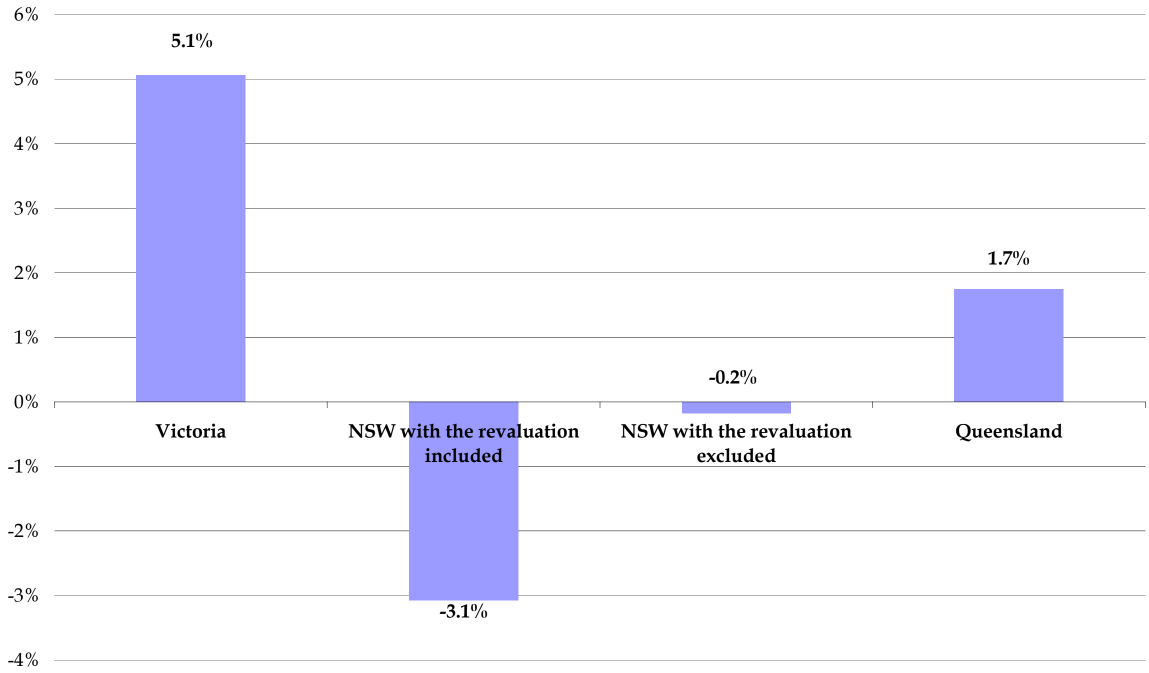


Figure 2-4 Growth in Capital Productivity in Transmission Sector, % per annum



Overall, Victoria experienced the most growth in capital productivity over the period FY00/01 to FY05/06 outperforming both Queensland and NSW (particularly NSW). Part of this difference could be because there has been little requirement to expand the transmission network in Victoria with peak demand growth leading to better utilisation of the network and a declining TTLF (refer to section 2.3.3 for a more detailed review of the TTLF for each of the states). This could be due to previous overinvestment in transmission in the State. However, it is unlikely that the extent of geographical network development or previous overinvestment would explain the full difference between Victoria and the other two states and that other factors are playing some role in increasing capital productivity growth.

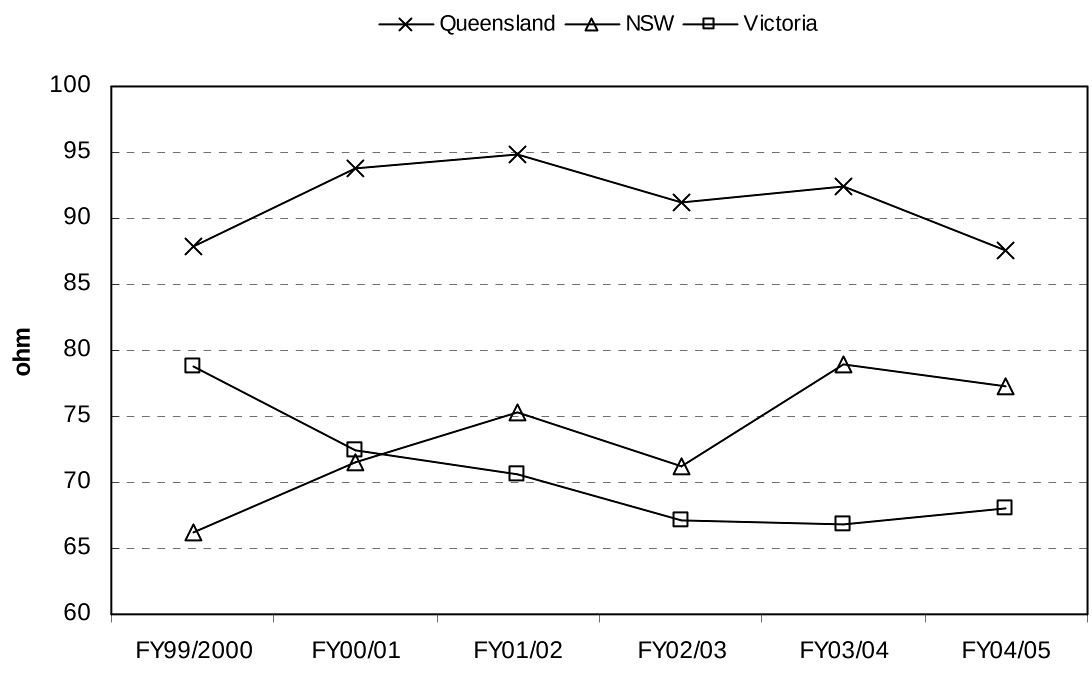
The improved performance could be due in part to privatisation of the transmission assets in Victoria. It is also possible that the adoption of probabilistic planning principles by VENCorp is a major factor in the improvement of capital productivity in Victoria. Such principles may lead to more efficient use of assets compared with using deterministic reliability approaches such as N-1 planning criteria based on 10% or 50% probability of exceedance peak demands.

2.3.3 Transmission to Load Factor

The Transmission to Load Factor (TTLF) is a measure of the capacity in the network relative to the peak load delivered. It is a measure of the geographic extent of the network relative to peak demand supplied.

Figure 2-5 shows the TTLF for the three main state regions that have been assessed in this productivity analysis. Analysis of the change in TTLF indicates that the change over time has been not significantly different from zero for Queensland, and a steady decrease of 2.9% per annum for Victoria. For NSW there has been a steady increase in the TTLF of around 2.9% per annum.

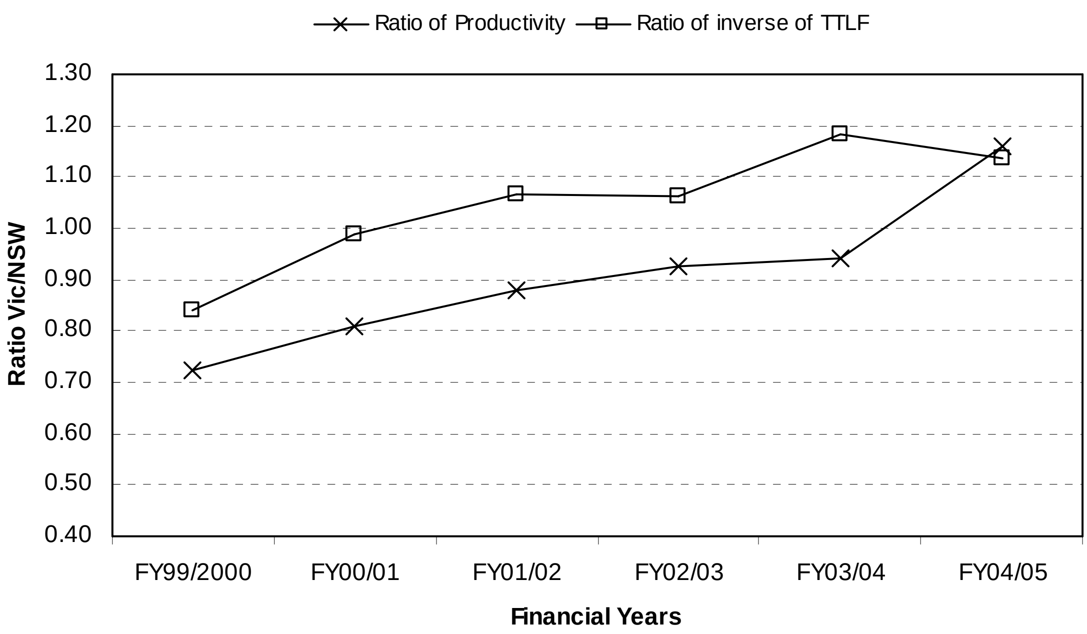
Figure 2-5 Transmission to Load Factor



The assessment shows that the Queensland network is more geographically spread than for NSW and Victoria and on that basis alone would be expected to have a lower capital productivity based on the measures used in this study. There has been little development of new transmission lines in Victoria over the review period and therefore the TTLF for Victorian has been declining. That the NSW index has been increasing suggests that the network has been extended in advance of commensurate growth in peak demand.

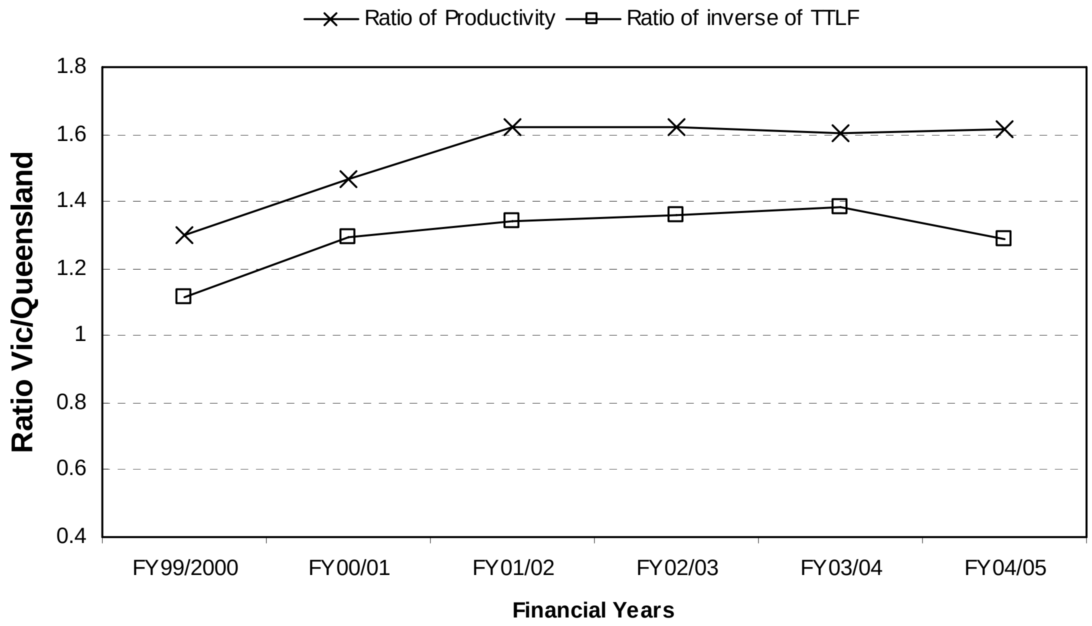
NSW's declining productivity in the last two years (refer Figure 2-3) is matched in mirror image with its increasing TTLF in Figure 2-5. This is further explored in Figure 2-6 below which considers the relationship between the ratio of capital productivity and the ratio of network utilisation (as measured by TTLF) for Victoria against NSW.

Figure 2-6 Ratio of the inverse of TTLF and capital productivity for Victoria against NSW



As expected both the ratio of productivity and the inverse of the TTLF in Victoria to NSW are rising indicating better use of capital as well as better utilisation of assets. Unless there has been some significant changes in the geographical factors over this period, such as significant investment in rural NSW that can be proved to be justified based on new demand or maintaining supply reliability, then the analysis suggests that NSW transmission sector has become less productive over the period compared to Victoria. However, based on the available data MMA cannot eliminate the possibility that the NSW transmission sector was more productive at the start of the period. However, in comparison the ratio of productivity and the inverse of TTLF in Victoria to Qld is relatively stable as shown in Figure 2-7.

Figure 2-7 Ratio of the inverse of TTLF and capital productivity for Victoria against Queensland



2.3.4 Generation – Labour Productivity

Victoria has by far the most productive generation sector with respect to labour as illustrated by Figure 2-8. This may reflect the benefits of the competition and privatisation achieved from the mid 1990s and the higher proportion of assets which operate in a base load role.

Trends in labour productivity are shown in Figure 2-9. Queensland experienced the highest and most consistent level of growth in labour productivity, at level of 5.2% per annum. South Australia experienced significant volatility in labour productivity in the period FY 00/01 to FY 03/04 including falls in the middle two periods. Over the whole period, the trend growth was not significantly different from zero. It is difficult to interpret any underlying trend in productivity given that the electricity assets in South Australia were privatised around this time; that the sale of the asset classes were staged; and that employment figures are based on aggregate data. It may reflect the outage of Playford Power Station during the refurbishment project and the series of mild summers and winters between 2002 and 2004. Nevertheless there has been significant growth in labour productivity in South Australia in FY03/04 and it will be interesting to see if this continues.

Victoria has also experienced a trend growth rate not significantly different from zero.

Unlike the other three states, NSW has experienced a decline in labour productivity over the period (albeit that moderate gains were achieved in FY03/04) or around 3.0% per annum. This is a similar situation to that being experienced in the transmission sector.

Figure 2-8 Labour Productivity in Generation Sector

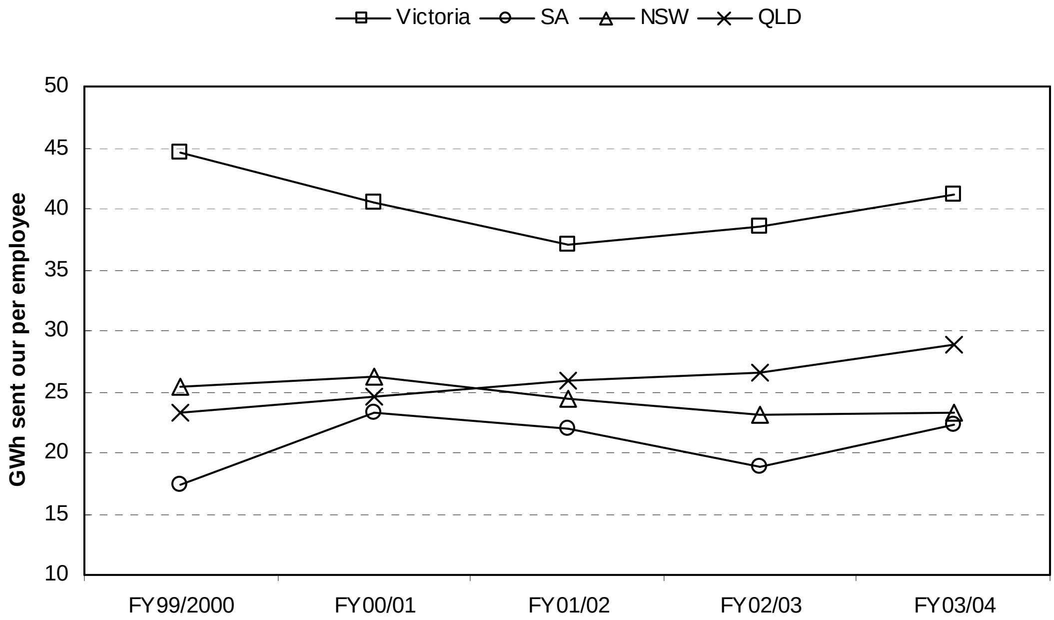
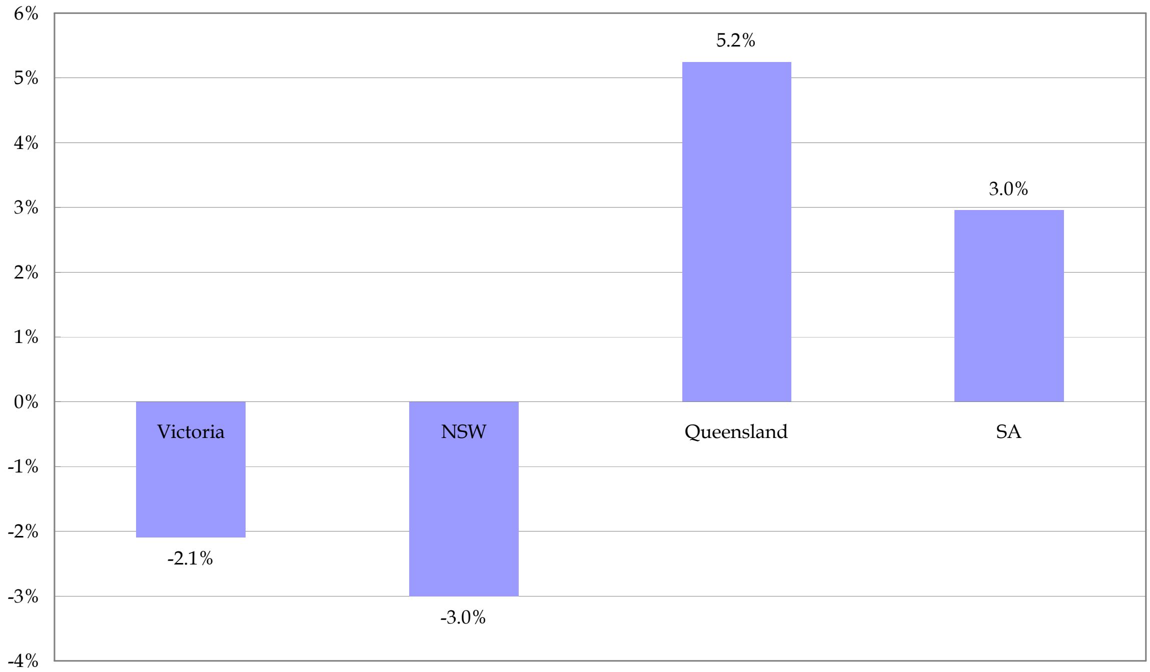


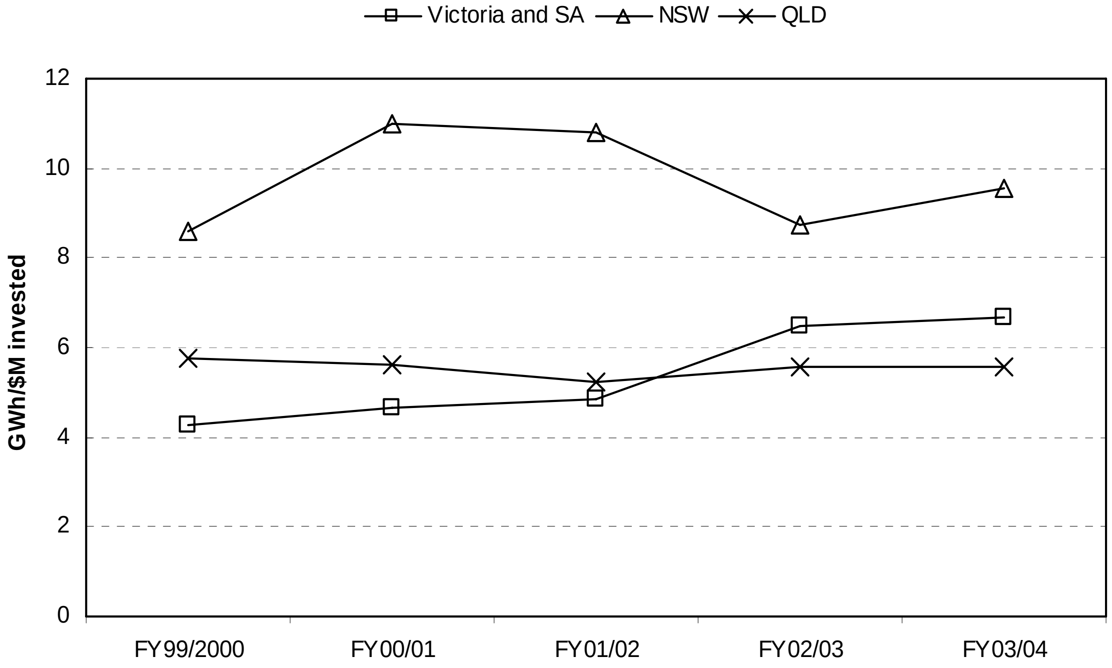
Figure 2-9 Growth in Labour Productivity in Generation Sector



2.3.5 Generation - Capital Productivity

Figure 2-10 shows that capital productivity in NSW is higher than South Australia /Victoria and Queensland but it declined in the latter two years. Victoria/South Australia on the other hand steadily increased over the period.

Figure 2-10 Capital Productivity in Generation Sector

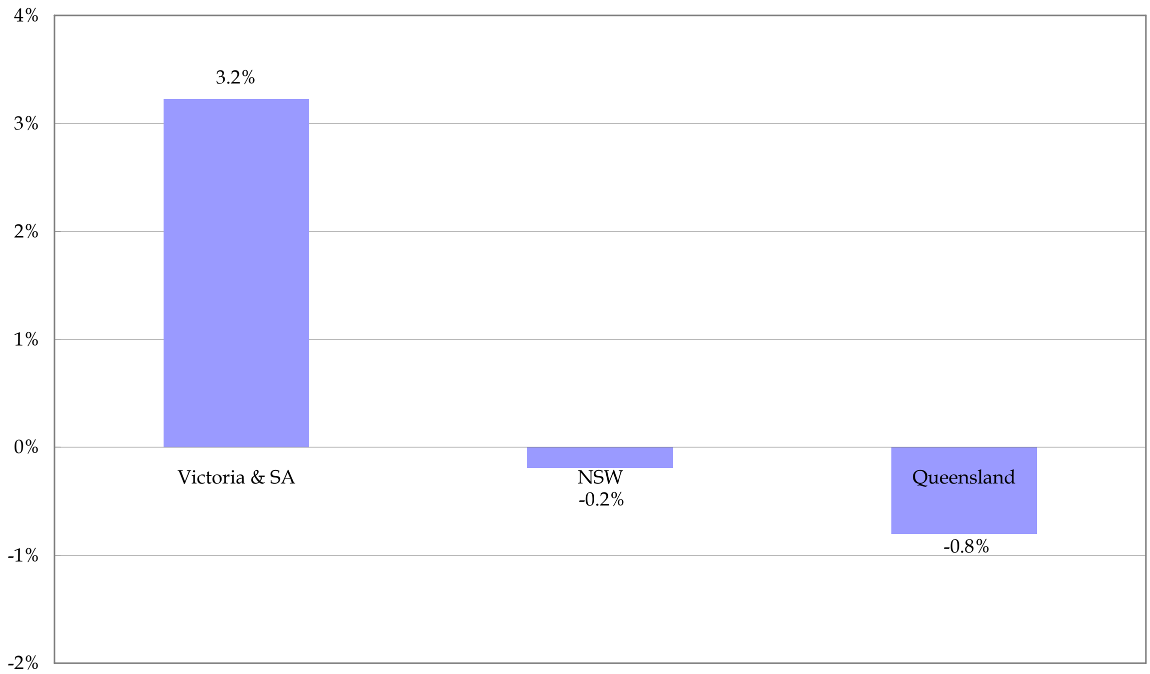


There are a number of factors which need to be considered when considering this result:

- NSW Generation assets were valued significantly lower than the combined assets in Victoria and South Australia even though the amount of capacity is higher in NSW
- The valuation of the Victorian and South Australian coal fired assets also includes a life-time fuel supply whereas the Queensland and NSW coal fired power stations do not own fuel supply assets. This would create a significant difference in the productivity values even if all other factors were equal.
- The Victorian and South Australian coal fired power stations burn a much lower quality fuel which requires much larger boilers and therefore higher capital values. This higher cost is offset by the lower fuel cost in the case of the Latrobe Valley. This gives a lower measure of capital productivity in Victoria.
- The plant mix in Victoria has been moving towards a more efficient position over the last five years. Recent investment in peak generation and an upgrade in the Vic/Snowy interstate transmission line is addressing what was an inefficient plant mix dominated by base load generation. The improving performance of the older brown coal plants from the late 1980s to the late 1990s addressed the modest requirement for increased base load power without building new power plants as had been forecast to be required during the 1985 Victorian Parliamentary review of Supply and Demand Beyond the Mid 1990s. The improvement in the performance of the brown coal plants contributed to the increase in capital productivity in Victoria leading up to this period of review. The development of peaking plant since 2001 has contributed to the continuing trend of improvement in Victoria.

- The difference between the capital value of the NSW and Queensland Government Owned Generators is small (For example the Queensland Government owned assets were valued higher than the NSW generators in 2001/02).
- Part of the measured decline of capital productivity in NSW was due to re-evaluation of the generation assets in FY02/03 (see Figure 2-11). The NSW generation assets had previously been devalued in the mid 1990s in preparation for the more competitive NEM environment. As a result of the subsequent revaluation, NSW experienced significant volatility in the growth of capital productivity over this study period. These revaluations should be excluded from the analysis as it is not likely to reflect changes in underlying productivity. Excluding the impact of the revaluation and the capital productivity in NSW shows a slight positive growth rate.
- The level of capital productivity of the Queensland government owned generators has been steady over the period.

Figure 2-11 Growth in Capital Productivity in Generation Sector



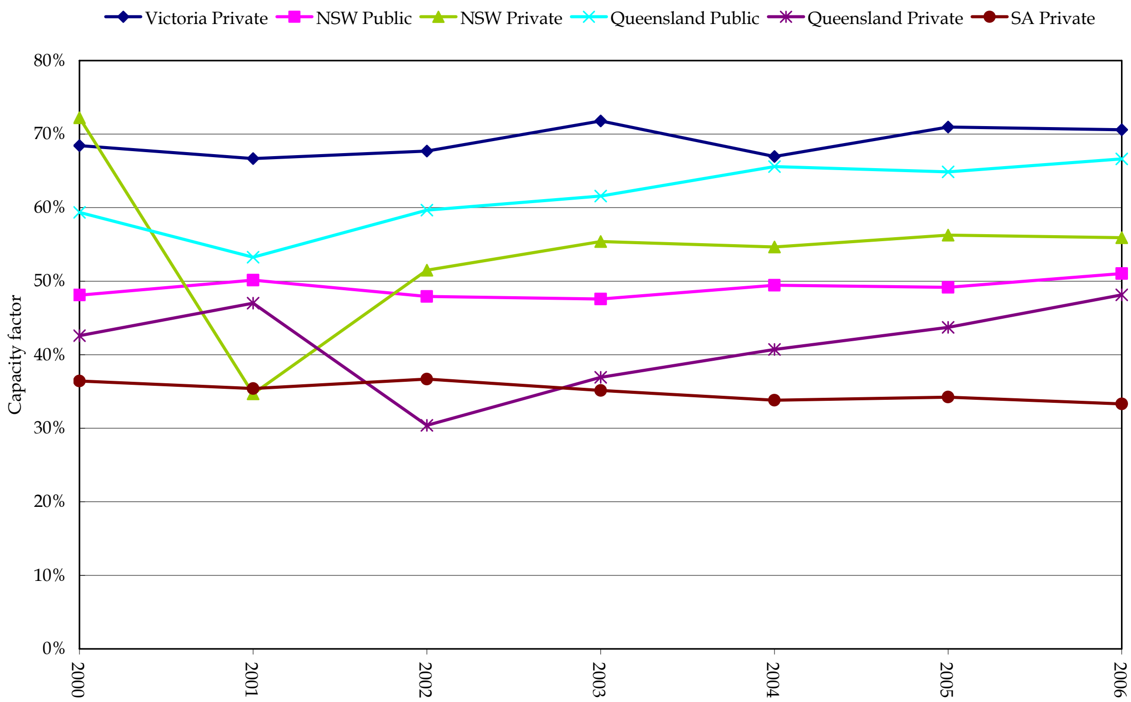
Because of the poor quality data on capital values, alternative measures of capital productivity were also assessed. These measures included:

- Capacity factor: the capacity utilisation of generating plant. Higher capacity factor implies more energy is produced per unit of output. However, because the load is not even, not all plant can operate at high capacity factors. The analysis was confined to capacity utilisation of all plants within each State.
- Availability: the amount of time the generator the plant is available to generate. Estimates of availability were based on dispatch data for each generating unit and with the number of trading intervals the plant did not generate at all. The analysis was

confined to high load duty plant as low duty plants are unlikely to be dispatched due to lack of market demand. Availability may be affected by a number of factors including level of upkeep of maintenance of generating unit, fuel quality, pattern of operation of generating and the deliberate withdrawal of capacity as a part of a bidding strategy.

Trends in capacity utilisation by state and by privately owned and publicly owned generators are shown in Figure 2-12. The trends indicate and statistical analysis of the data confirms that capacity utilisation has tended to remain fairly static, with no growth or no decline in capacity utilisation evident in most states. Only two categories exhibited any trend: public generators in Queensland exhibited a significant rate of increase in capacity utilisation of around 2.9% per annum, whilst the private generators in South Australia exhibited a trend decline in capacity utilisation of about 1.5% per annum. All other generators did not have growth or decline significantly different from zero.

Figure 2-12 Trends in capacity factor

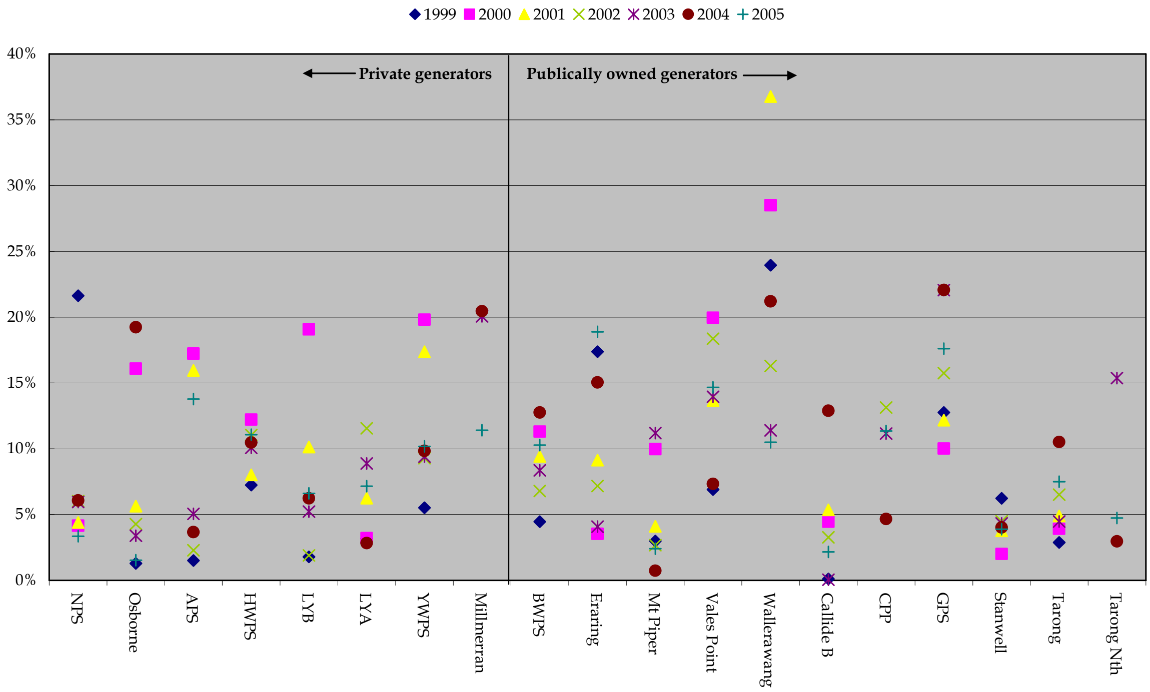


The increase in capacity utilisation of Queensland public generators could be due to a number of factors, including high load growth in that State and the decommissioning of surplus capacity (Swanbank A). It is also evident that most of the growth has occurred since 2001, when the Queensland grid is connected to the south east Australian grid suggesting that transmission interconnection is an important component in improving capital productivity of generation.

The decrease in capacity utilisation in South Australia is probably due to high level of new capacity entering the market and the increase in import capacity as a result of the commissioning of Murraylink interconnector with Victoria. Demand in South Australia is also highly weather dependent, with variations in summer temperatures resulting in big swings in generation levels from year to year. Some plants like Pelican Point and Torrens Island A also have large swings in generation levels from year to year.

Trends in availability for high load duty plant[4] are shown in Figure 2-13. Statistical analysis of the mean unavailability between private and public generators indicates that there is no significant difference in availability between private and public generators. This result was consistent across all years of the analysis.

Figure 2-13 Trends in availability factors by generating plant – proportion of time plants were not dispatched at all.



2.3.6 Data quality

Before concluding it would be useful to consider some of the quality issues with data which is publicly available and some of the limitations of the analysis that result.

Employee numbers by state and sector have been obtained by applying the percentage of employees per sector in 2004 collected by the ESAA and disaggregating the number of employees in the electricity industry by state over the period FY99/2000 to FY03/04 obtained from the ABS catalogue number 8226.0. Clearly this is not ideal and this needs to be taken into account when interpreting the labour productivity measures (as has already been indicated in the report).[5] The data on employment is one of the main shortcomings of the report. While some data on employment is available, from sources such as annual reports of publicly listed companies, there does not appear to be enough data to assemble

[4] High load duty means plant with capacity factors typically higher than 55%.

[5] Comparision with actual data for NSW (from Transgrid Annual Reports) for the years 30 June 02 to 30 June 04 shows that the data constructed from the ABS and ESAA reports, while less than 5% out from actual data, provides a misleading indication of the historic trend in labour growth.

a series that would be more accurate than the rough data series constructed in this report. It is the view of MMA that the only way to develop an accurate measure of labour productivity would be to survey the appropriate businesses asking for historical and current data on employee numbers and classifications of labour. In many cases, labour has been outsourced through contracting arrangements which can distort productivity measures when measured as a business level rather than an industry level.

As discussed the productivity measures for the transmission networks have not been normalised making any meaningful comparison on the absolute value of productivity difficult. Nevertheless some trends can be established and are considered in this report. It should also be noted that recent changes in the regulatory environment, with regulation of transmission revenue only recently been given to the AER, means that asset values have not been bedded down. This increases the variability of the productivity measures and in the extreme introduces discontinuities in the capital productivity measures.

Data on capital asset values for generation assets using sale prices, and then depreciating the assets using a depreciation rate of 3.33% to update capital values is also not considered ideal. The main issues associated with the estimates of capital costs are where discontinuities arise This can be the result of a re-evaluation of assets such as what happened with NSW generation assets in FY04/05, or a re-evaluation of regulated assets as the beginning of review periods, or the sale of assets that results in a significant change in the understood value of the asset (in other words the ‘market’ is of the opinion that the value was expensive, or undervalued).

3 CONCLUSIONS

Victoria has experienced growth in both capital and labour productivity in recent years. In the transmission sector Victoria and Queensland experienced improvement in both labour and capital productivity, while NSW saw decreases in both measures. Turning to the generation sector, labour productivity remained constant over the period with the possible exception of NSW. Capital productivity in the combined Victoria and South Australia generation sector increased while for NSW and the Queensland Government owned generators it was flat. However, productivity levels in NSW remain higher than in either Victoria/SA or Queensland.

Not withstanding the data issues outlined in Section 2.3.6 it appears that Victoria has been a good performer with most measures of productivity increasing over the period. Queensland has experienced gains in most measures of productivity as well. In addition to this evidence the ratio of the inverse of the TTLF and capital productivity in the transmission sector was examined. For Victoria over NSW both these ratios increased over the period. As noted in this report some of this improvement in productivity in transmission in Victoria is due to the compact geographic nature of the network in Victoria combined with the fact that little investment has been required in the network since the mid 1980s. The ratio of the inverse of the TTLF and capital productivity in the transmission sector was also constructed for Victoria over Queensland. Unlike the case of Victoria over NSW, the ratio of Victoria to Queensland was relatively flat suggesting that Queensland and Victoria have experienced similar levels of productivity growth.

As a final note, an examination of the TTLF suggests that the network in NSW has been extended in advance of commensurate growth in peak demand which is indicative of a network that is either becoming less productive (at least in the short term) or that significant catch up investment has been required to improve the reliability of the network in NSW. The analysis cannot distinguish between these two possible causes.

APPENDIX A PRICES PAID FOR GENERATORS IN VICTORIA AND SOUTH AUSTRALIA

Station	Current Owner	Year Sold	Price	Year Sold	Price	Year Sold	Price
			$ mil		*$ mil*		*$ mil*
Loy Yang B	IP	1997	1500				
Jeeralang and Newport Power Station	Babcock and Brown	1999	350	2003	206	2006	282
Osborne Power Station	Babcock and Brown	2000	202	2006	100		
Northern and Playford Power Station	Babcock and Brown	2000	313	2006	685		
Yallourn W Power Station	CLP	1996	2400	2000	1840	2003	529.1
Torrens Island Power Station	TRUenergy	2000	315				
Valley Power Peaking Facility	Snowy Hydro	2002	165	2005	243		
Bairnsdale Power Station	Alinta	2001	40	2002	36		

Notes: The conditions of the privatisation of Loy Yang B make it difficult to estimate a capital value. For the purposes of this exercise it was assumed that the smelter contract had a negative value equivalent to $11/MWh over 8,060 GWh which is about $90M per annum or $900 M capitalised. This was added to $600 M estimated sale value.

Sale of Flinders by NRG to Babcock and Brown in 2006 $314 million cash, 471 elimination of debt and 100 non-current liabilities for the purchase of power form Osborne

18.4% of Yallourn W was sold to CLP for 41 million pounds valuing station at 222.8 million pounds. Based on 0.4211 GBP to the $AUS this is valued at $529.9 mill. However, given the size of this figure it is likely that the 529.1 Million is only the equity portion of the sale (thereby ignoring debt consideration). In light of this the value has not been included in the analysis.

Bairnsdale was purchased by Alinta from Duke as part of a portfolio of assets and data on the price of Bairnsdale is not available

The Price for Bairnsdale for 2002 is a CAPEX value only