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Down to the wire: A sustainable electricity network for Australia

Technical supplement

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Overview

This technical supplement to the report *Down to the wire* describes the estimate of excess growth in network assets that underpins our analysis of policy options to achieve a more sustainable asset base for electricity networks.

Down to the wire proposes a government write-down of publicly-owned network assets as well as other reforms to prevent unsustainable asset growth in future.

Chapter 1 of this document describes how we define 'excess growth' and the main limitations of our approach.

Chapter 2 outlines our estimate of excess growth and the data sources and assumptions that underpin the estimate.

Chapter 3 describes some of the potential drivers of over-investment in network assets.

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Acronyms

AER	Australian Energy Regulator
Augex	Augmentation expenditure (a category of capex)
Capex	Capital expenditure
DNSP	Distribution Network Service Provider
DORC	Depreciated Optimised Replacement Cost (method of valuing RABs)
NEM	National Electricity Market (grid linking Queensland, NSW, ACT, Victoria, South Australia and Tasmania)
Opex	Operational expenditure
PTRM	Post-Tax Revenue Model
RAB	Regulated Asset Base
Repex	Replacement expenditure (a category of capex)
RIN	Regulatory Information Notices (data provided by network businesses to the regulator)
TNSP	Transmission Network Service Provider
WACC	Weighted Average Cost of Capital

1 How we define excess growth

1.1 Purpose of this analysis

It has been widely claimed that some of the growth in Australian networks over the past decade has not been in the long-term interests of consumers (so called 'gold plating').[1] Yet few have attempted to define exactly how much growth was 'excessive'.[2]

The purpose of this analysis is to put a number on excess growth to understand the size of the problem and develop policy options for dealing with it.

We recognise that an exact, incontrovertible number will never be possible because there is no definitive way to measure efficient investment. Instead we aim to provide an outcomes-focused 'sense check' on network growth to challenge the existing inputs-focused models that enabled over-investment to occur.

1.2 What we mean by 'excess growth'

The concept of 'excess' growth is tricky in networks. All assets might be used at some point in time, but some are under-utilised and/or overvalued, for example because of redundancies in the network that help to manage worst case (but unlikely) scenarios. Some redundancy is essential to the safety and reliability of network infrastructure. But the cost to the consumer means that there is always a trade-off to be made.

We define excess growth as the growth in assets that exceeds growth in network usage. Network usage is our threshold because it is indicative of the value consumers place on network assets and how this value has changed over time.

Network usage is not a direct determinant of costs. Regulators and network businesses have models to estimate the costs of specific upgrades associated with changing usage and replacement projects to maintain existing services. Our analysis does not attempt to replicate these bottom-up assessments of costs.

Our analysis instead provides a top-down 'sense check'. Growth in network usage represents a sustainable level of asset growth. Real asset growth greater than use, over the long term, is unsustainable for the customer and therefore the business too. Asset growth above this threshold places additional costs on the consumer, without a clear improvement in service or benefits.[3]

[1] Garnaut (2011), Productivity Commission (2013), Wood and Carter (2013), CME (2015), Senate Committee (2015), and ACCC (2017).
[2] CME (2015) and Grant (2016).

[3] Reliability improvements have been achieved in some networks, and the main report highlights these, but relative to the costs involved the value to the customer is highly questionable.

1.3 Our method: a top-down estimate

We use regulatory determinations to assess total growth in assets by network. Our start point is when a network's Regulatory Asset Base (RAB) was initially valued, or as early as publicly available data allows.

We then compare the growth of networks' RABs to growth in customers' usage of each network. We define network use as the aggregate of growth in customer numbers and growth in maximum demand. For example, a one per cent increase in each equates to a two per cent increase in 'network use'.

We allow for networks' RABs to grow, in real terms, by the same percentage as growth in network use. Any RAB growth above this we consider to be 'excess growth'.

1.4 Alternative methods and why we didn't choose them

Benchmarking

A benchmarking approach would use the growth of the most efficient businesses as a benchmark for identifying excess growth in other businesses. For example, CME (2015) used the average capex per customer of private networks to estimate stranded assets in Australia's public networks, and also compared Australian networks to networks in the UK and New Zealand.[4]

We did not choose this approach because it presumes that privately-owned businesses have invested prudently. While our findings were similar (we did find more excess growth in public networks than private networks), we did so using a method that could be equally applied to all networks.

Our method also allows for the 'uniqueness' of individual networks by comparing a network only to itself over time.[5]

Bottom-up assessment

A bottom-up assessment would account for all the inputs required for efficient investment in networks, including assessment of which projects were 'necessary' and fair costs for capital and labour. A line-by-line assessment of the efficiency of past spend would require specialist expertise and significant resources. Even then it would be subjective. Such an assessment was neither practical nor desirable.

1.5 Limitations of our approach

We rely on publicly available data

We only have access to publicly available data and therefore do not have the same level of detail as the AER or network businesses themselves have.

[4] CME (2015).

[5] For example, customer density differs by network and can drive cost, but customer density has not changed substantially within a network over time.

Our estimate is an upper bound

RAB growth above network usage may be justified in some circumstances, for example where it offers significant improvement in reliability that consumers actually want. But the value to the consumer should be explicitly considered before the investment is made and the benefits should be clearly communicated.

RAB growth above network usage may also be justified for a short period, if it is followed or preceded by an equivalent period of RAB growth below network usage. We recognise the 'lumpiness' of capital expenditure and have chosen the longest possible analysis window to better account for this. However, some periods of under-investment (or further over-investment) may fall outside our analysis window.

For the above two reasons we report our estimate of excess growth as an upper bound estimate, and our recommendations that state governments should rectify over-investment *up to* our estimate reflects this.

We use different start points for different networks

Our analysis window ranges from 12-21 years, depending on the network. The average length of analysis is 17 years. Start points differ because network assets were originally valued at different times, and in many cases the availability of network usage data has determined the start point.

Differing start points enabled us to conduct the longest possible analysis for each network. Network assets last for decades so a longer time frame encompasses more of the asset replacement cycle and is therefore more appropriate for assessing excess growth.

It was possible to use different start points because our analysis compares change in RAB to change in usage within a network. The analysis makes no comparisons between networks.

Comparable data was only available for all networks from 2006. Our estimate would be about $3 billion larger if we had used this common starting point (see Section 2.6.1).

We accept the initial DORC valuations

When network assets were valued in the 1990s and early 2000s, Australian regulators accepted the depreciated optimised replacement cost (DORC) method in determining the size of RABs.[6]

The optimised replacement cost method values assets just short of the cost to a new entrant of providing the same service as the assets (system duplication), and therefore aims to emulate a contestable market.[7] This value is then depreciated as per the

[6] Abbott and Tan-Kantor (2014), page 68.

[7] Johnstone (2003).

age of assets to get a DORC valuation. Alternative valuation methods include the amount that assets cost when they were acquired (historical cost) or scrap value.[8]

DORC valuations tend to inflate asset book values relative to other methods and DORC valuation is also quite subjective.[9] Arguably, the most efficient and fair valuation lies somewhere between scrap value and DORC but is impossible to precisely pinpoint.[10]

We accept the initial DORC valuations as representing an efficient value of each network business's RAB. While this assumption may be incorrect, it is more likely to overinflate than underinflate original RAB values.

In some cases, the original DORC valuations were artificially inflated or deflated to maintain parity of network tariffs between urban and regional areas. All five distribution networks in Victoria were affected, as well as Essential Energy in NSW. The regional Victorian networks, AusNet and Powercor, had their RABs artificially deflated by 21 per cent and 13 per cent respectively in 1995. The urban networks, Jemena, United and Citipower were artificially inflated by 17, 18 and 27 per cent respectively at the same time.[11] In NSW, Essential Energy's RAB was deflated by 1 per cent in 1998.[12] We use the unadjusted values as the start point of our analysis to correct for the impact of artificial inflations and deflations.

We use a simple measure of usage

The aggregate of customer growth and maximum demand, at a whole-of-network level, is a simple measure for sustainable growth. It is not intended to be used on an annual basis to guide capex (given the lumpiness of capex). It is useful as a sense check over time.

As a whole-of-network measure, it hides that some parts of a single network might be growing while others are shrinking. We deliberately choose a whole-of-network measure because shrinking demand represents under-utilised assets.

But we recognise that maximum demand might be low in one year and then high in the next. For this reason, we use the highest maximum demand of the past five years in assessing appropriate growth.

There are also many ways to measure maximum demand. Coincident maximum demand captures peak demand across the whole network at a single point in time. Non-coincident maximum demand allows for high use of one part of the network at one time and another part at another time of year. We use a coincident maximum demand measure because this was reported

[8] See Johnstone (2003).
[9] Johnstone (2001) and (2003).
[10] SA Centre for Economic Studies (1998).
[11] Victorian Government (1995).
[12] IPART (1999a).

historically. However, a non-coincident maximum demand measure would have been preferable, had it been available.

Data on non-coincident maximum demand is only available from 2006 so would have shortened the analysis. Section 2.6.1 shows that a longer analysis is important to capture more of the asset replacement cycle, and Section 2.6.2 shows that the maximum demand measure does not make much difference to the overall estimate of excess growth anyway.

Finally, if either growth in customer numbers or maximum demand is negative, they are treated as zero. This means that negative growth in one type of usage does not discount the other.

We note that the aggregate of customer growth and maximum demand may actually *overestimate* the need for network growth because maximum demand is likely to be a function of increasing customer numbers. Some networks indeed grew less than this measure.

We have consulted with network businesses and the Australian Energy Regulator on our approach and data sources; however, any errors or omissions are the responsibility of the authors.

2 Estimating the amount of excess growth

2.1 Data sources

Our analysis relies on data from current and historic regulatory determinations by the Australian Energy Regulator (AER) and state-based regulators. We also draw on the AER's network performance data and historic regulatory reports to understand changes in network usage over time.

RAB values

Regulatory determinations for each network cover a final decision on closing RAB values by year, up until the current determination period.

We use the final decisions on RAB values wherever possible. For the most recent one to three years, that the regulator is yet to decide on, RAB values are taken from:

- Draft determinations where available; or
- Regulatory Information Notices (RIN) data.[13]

RAB values were adjusted using the ABS Consumer Price Index to allow for inflation over time.[14] 'Real' values are June 2017.

Network usage data

We use RIN data and historic reports to understand network usage over time. RIN data includes customer numbers and maximum demand by year, since 2006. There are several maximum demand measures reported, we use the measure that lines up with available historical demand data, which is typically coincident maximum demand, but use non-coincident maximum demand where we have a choice (as per AER benchmarking).

Prior to 2006, we rely on historic determinations and reports that include data on customer numbers and maximum demand for specific years.[15]

We use the earliest available data for each network, which means our analysis has different start points depending on the network (see Tables 1 and 2).

[13] RAB values for standard control services for DNSPs. RAB values in RIN data were not used for TNSPs because RIN data only captures asset values when they are in the ground, rather than when the money is spent, and there can be a significant delay for TNSPs.

[14] ABS 6401.0, All Groups CPI Australia, Series A2325846C

[15] See Key Sources list.

2.2 Analysis start point

The analysis start point differs by network because initial RAB valuations were conducted at different times and because network usage data is only available in certain years.

We start with the initial RAB valuations by network as summarised in Table 1 for transmission and Table 2 for distribution. We use these RAB values if network usage data is also available for the same year. Otherwise we use the earliest year where network usage data is available as the analysis start point.

The starting RABs of Victorian networks are the unadjusted values (i.e. without artificial inflation/deflation). The starting RAB for Essential Energy is adjusted up by 1.26 per cent to compensate for artificial deflation applied to the original valuation in 1998 (see Section 1.5).

Table 1: Analysis starting point by transmission network

TNSPs	*State*	*Initial valuation*	*DORC value ($m)*	*Analysis start year*	*Starting RAB ($m)*
ElectraNet	SA	Jul-98	679	2003-04	884
Powerlink	QLD	Jul-99	1,842	2000-01	2,277
AusNet (T)	VIC	Jul-94	1,391	2002	1,836
Tas (T)	TAS	Jul-98	333	2000-01	522
TransGrid	NSW	Jul-99	1,935	1998-99	1,935

Notes: All values are nominal.
Source: ACCC determinations.

Table 2: Analysis starting point by distribution network

DNSPs	*State*	*Initial valuation*	*DORC value ($m)*	*Analysis start year*	*Starting RAB ($m)*
ActewAGL	ACT	Jul-98	437	1997-98	437
Jemena	VIC	Jul-94	361	2000	481
Tas (D)	TAS	Jul-98	690	2005-06	908
CitiPower	VIC	Jul-94	482	1996	549
Essential	NSW	Jul-98	1,747	2000-01	2,004*
Energex	QLD	Jul-04	3,964	2003-04	3,964
Ausgrid	NSW	Jul-98	3,767	1997-98	3,767
Ergon	QLD	Jul-04	3,884	2003-04	3,884
SA Power	SA	Jul-99	2,301	2004-05	2,466
Endeavour	NSW	Jul-98	1,732	1997-98	1,732
Powercor	VIC	Jul-94	1,227	1996	1,302
AusNet (D)	VIC	Jul-94	1,046	2000	1,346
United	VIC	Jul-94	743	1996	803

Notes: All values are nominal. DORC values and starting RABs for Victorian networks are the unadjusted asset values (asset values for Victorian networks were artificially adjusted at the time to even out tariffs between urban and regional areas). The starting RAB for Essential Energy is adjusted up by 1.26 per cent to compensate for artificial deflation applied to the original valuation in 1998. The starting RAB for Essential Energy also includes the assets formerly under Australian Inland Energy.
Source: Historic determinations.

2.3 RAB growth since start point

Our analysis captures RAB growth for each network up until the most recent year of data, which is 2016 for Victorian networks and 2016-17 for other networks.[16]

We allow for inflation when comparing RAB values over time, so as to only capture real growth.[17]

Real growth in RAB values over time is listed by network in Appendix A.

2.4 Change in usage since start point

We estimate change in network usage as:

> *Growth in customer numbers (%) + Growth in maximum demand (%)*

But if change in either customers or maximum demand is negative, then it is treated as zero (i.e. negative growth in one type of usage does not discount growth in the other).

Customer growth is based on the percentage difference in customer numbers between the start and end years of the analysis.

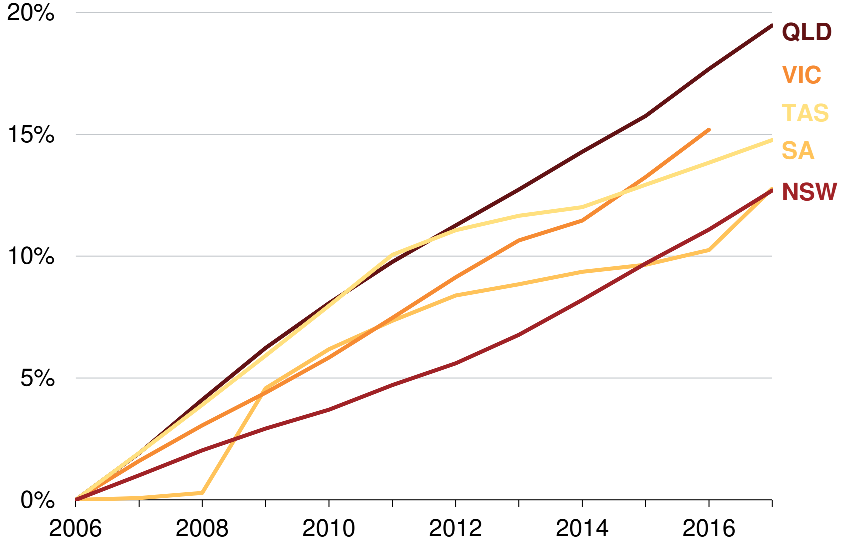
Maximum demand growth is based on the percentage difference in coincident raw system annual maximum demand between the start year and the highest maximum demand of the past five years.[18] This allows for some year-to-year variability in maximum demand.

We use coincident maximum demand rather than non-coincident demand because non-coincident demand was not reported prior to 2006.[19] This choice is tested in Section 2.6.2. Maximum demand is reported net of exports so may exclude some transmission capacity necessary to support demand in other regions. The report's recommendations make specific allowances for this.

All regions experienced steady growth in customers over the analysis period. Maximum demand is more variable year-to-year, but still increased for all networks. Figures 1 and 2 illustrate change in customer numbers and maximum demand by region since 2006. Figure 3 illustrates aggregate change in usage for each network over the period of analysis.

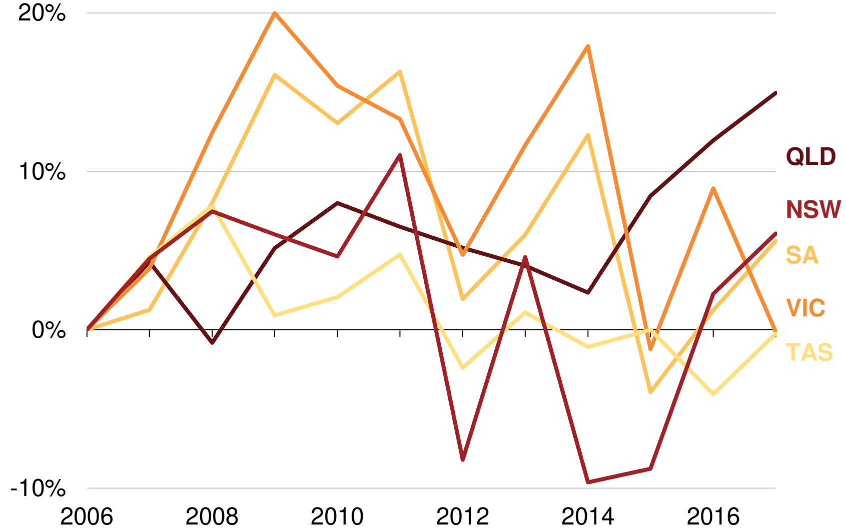
[16] With one exception: a draft decision on the RAB of TasNetworks transmission is not yet available for 2015-16 and 2016-17 so our analysis for this network ends in 2014-15.
[17] RAB values are adjusted using the ABS Consumer Price Index, 6401.0, All Groups CPI Australia, Series A2325846C.
[18] Coincident maximum demand is measured in megawatts for all networks except the Queensland DNSPs, where coincident maximum demand is measured in MVA (to align with historical data availability).
[19] The analysis for TasNetworks distribution begins in 2006 so in this case we use non-coincident maximum demand in megawatts, as per AER benchmarking.

Figure 1: All regions have experienced steady customer growth
Per cent change in customer numbers from a 2006 base



Source: AER economic benchmarking data.

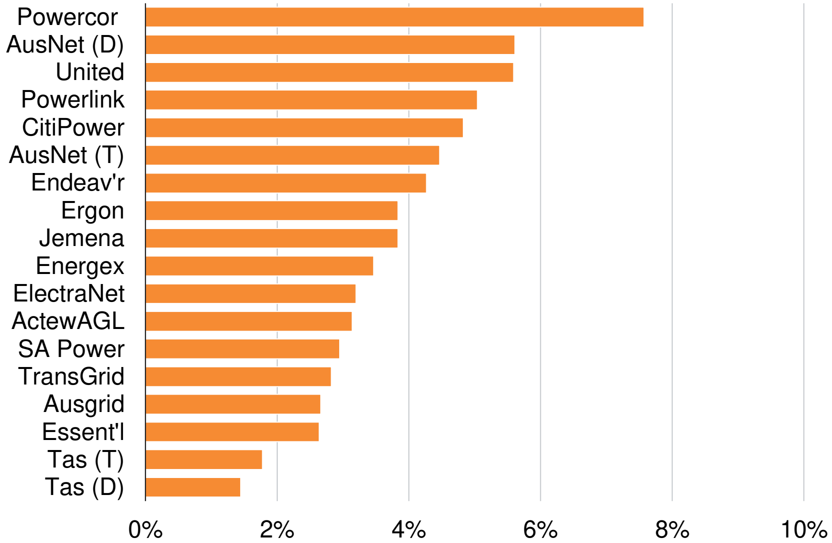
Figure 2: Maximum demand can vary substantially year to year
Per cent change in maximum demand from a 2006 base



Note: Coincident maximum demand by region.
Source: AER wholesale statistics.

Figure 3: Usage has grown across all networks

Average annual growth in network use over analysis period



Notes: Network use refers to the aggregate growth in customer numbers and maximum demand.
Source: Grattan analysis of AER economic benchmarking data and historic reports.

2.5 Net result

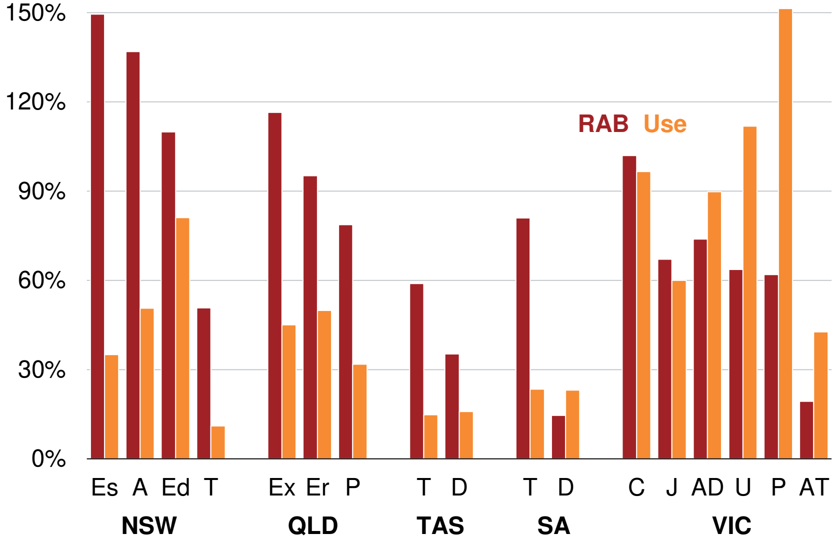
We estimate total excess growth of up to $20 billion. This is the difference between growth in RABs and growth in network usage for each distribution and transmission network in the NEM, summed.[20]

RABs outgrew usage for most networks (see Figure 4). But some networks grew far more than others. Figure 5 shows that most of the excess growth (92 per cent) is in NSW and Queensland. Those two states total $18.5 billion alone.

Specific inputs to the calculation for each network are listed at Appendix A. Figure 6 illustrates our excess growth estimate by network.

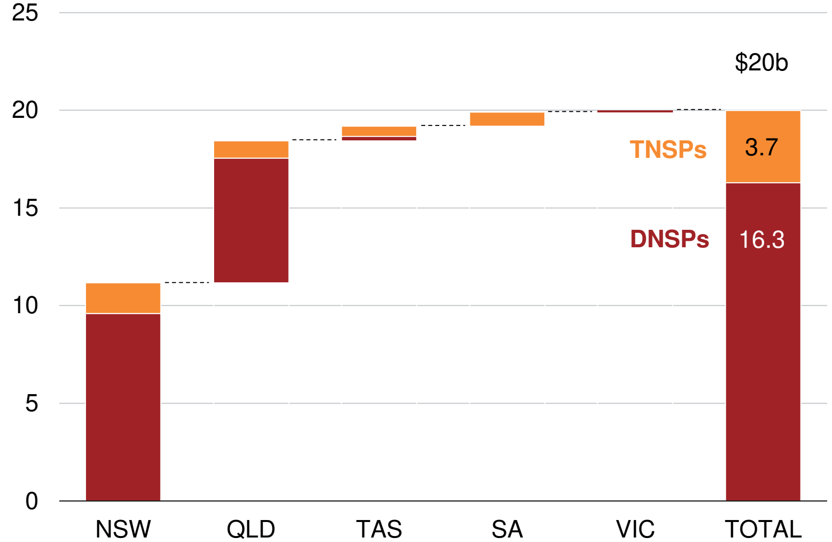
[20] Not including interconnectors. Overs only.

Figure 4: RABs outgrew usage in most networks
Change over analysis period, per cent



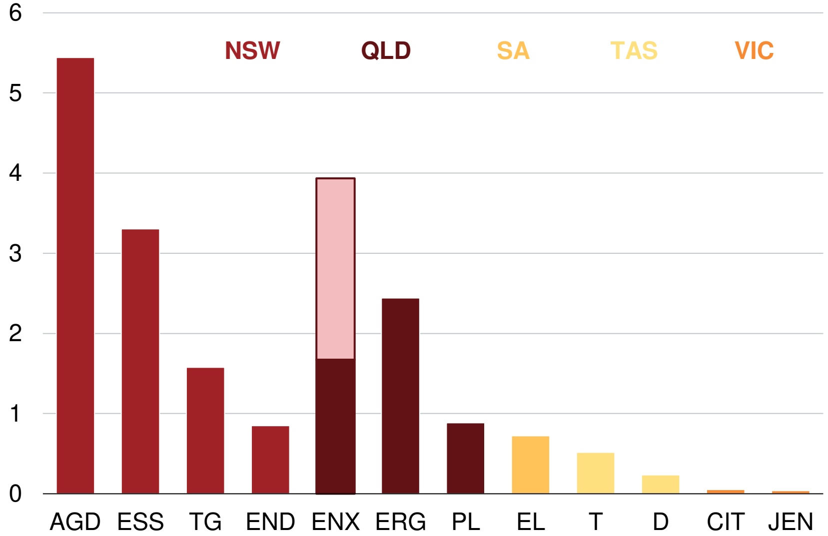
Notes: Length of analysis ranges from 12-21 years depending on the network, with an average of 17 years. Es = Essential, A = Ausgrid, Ed = Endeavour, T = TransGrid, Ex = Energex, Er = Ergon, P = Powerlink, Tas T = TasNetworks transmission, Tas D = TasNetworks distribution, SA T = ElectraNet, SA D = SA Power Networks, C = Citipower, J = Jemena, AD = AusNet distribution, U = United Energy, P = Powercor, and AT = AusNet transmission.
Source: Grattan analysis.

Figure 5: Excess growth is highly concentrated in NSW and QLD
Our estimate of excess growth by state, 2017$ billions



Source: Grattan analysis.

Figure 6: Excess growth by network
Our estimate of excess growth, $ billions



Notes: AGD = Ausgrid, ESS = Essential, TG = Transgrid, END = Endeavour, ENX = Energex, ERG = Ergon, PL = Powerlink, EL = Electranet, T = TasNetworks transmission, D = TasNetworks distribution, JEN = Jemena, CIT = Citipower. For the remaining networks not shown, RABs grew less than network usage. A range is provided for Energex as discussed in Section 2.7.1.
Source: Grattan analysis.

2.5.1 Impact on bills

If excess growth had not occurred, then we might expect today's RAB to be $20 billion less. Under these circumstances, consumers would be paying $174 less per year, on average.[21]

Bill impacts are estimated based on the average revenue reduction per customer if RABs today did not include excess growth.[22] Bill impacts vary by network depending on the amount of excess growth (see Figure 7).[23]

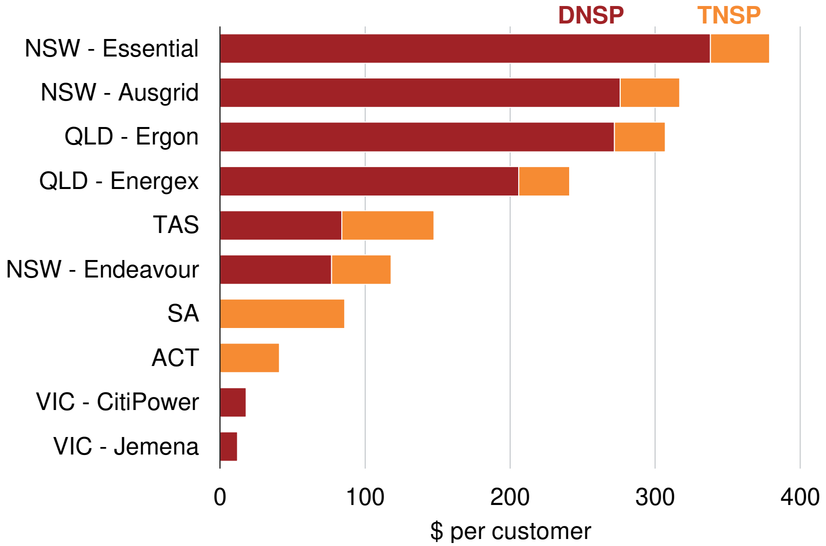
While Tasmania's total excess growth of $750 million looks small relative to other states (Figures 5 and 6), the cost is spread over a small population so it makes a big difference per customer (Figure 7).

Excess growth has had an impact on customers' bills in South Australia and Victoria too, but to a lesser degree. Excess growth affecting ACT customers is in the TransGrid transmission network which serves customers across both NSW and the ACT.

[21] Average across networks, weighted by customer numbers, estimated as the reduction in revenue per customer (households and businesses).
[22] Under current tariff structures though, there would be greater savings for high-use customers (such as industrial consumers) than for low-use residential consumers, particularly for the transmission component.
[23] Note the Queensland Government subsidises Ergon though, so the full value of reduced revenues may not pass through to consumers.

Figure 7: Customers in NSW, Queensland and Tasmania would pay a lot less today if excess growth had not occurred

Average impact per customer per year of excess growth



Notes: The average customer impact is estimated based on the combined revenue reductions for DNSPs and TNSPs in each region if excess growth had not occurred, divided by the total number of customers (residential and business). Under current tariff structures, there would be greater savings for high-use customers (such as industrial consumers) than for low-use residential consumers, particularly for the transmission component. An adjustment is made to the transmission component for Tasmania because in this state a few large industrial consumers represent 60 per cent of total demand, so would benefit from most of the transmission savings. The chart shows only the 40 per cent of transmission savings expected to flow through to households and businesses.

Source: Grattan analysis of AER Post-Tax Revenue Models.

To estimate the impact of a lower RAB on customers' bills we used the AER's Post-Tax Revenue Model for each network.[24] RABs were lowered across all asset classes by the same proportion. This reduced both return on capital and regulatory depreciation, resulting in a lower revenue requirement. We then calculated a per customer share of the new transmission and distribution revenue requirements, averaged over the current determination period.

As a separate check, we also calculated revenue by network for a single year (2017-18) using the WACC, regulatory depreciation, opex, and other pass-through allowances as published in the current determinations. We removed our estimate of excess growth from the RAB (in aggregate) and regulatory depreciation was shrunk by the same proportion. Opex and all other pass-through costs remained the same. This calculation produced a similar estimate of bill impacts, as you would expect, with consumers paying $172 less per year on average.

2.5.2 Impact on network businesses

Had excess growth ($20 billion) not occurred, the collective annual revenue of network businesses would reduce by $1.7 billion.[25] For individual businesses this ranges from no effect to the loss of almost a third of their annual revenue. Among the

[24] PTRM models are published online with each network's final determination (https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements). We used the latest models available as at January 2018.

[25] This is the sum of the average annual reduction in revenue over the current determination period by network.

businesses that would lose revenue, the average annual loss is 16 per cent (see Table 3).

Reducing RABs is not a simple process though, and not without consequences for consumers. Table 3 is therefore intended to be illustrative of what revenue might have looked like if the growth had not occurred. In the main report, we discuss the consequences of reducing RABs and acknowledge that this has an impact on the rate of return.

2.6 Choices and sensitivities

2.6.1 Starting point

The analysis start point is a key sensitivity. We initially conducted the analysis for 2006 to 2015 only, where the best data is available for all networks.[26]

This shorter time period increases our estimate by $3 billion (see Table 4). The estimate is higher because the shorter period captures most of the RAB growth but misses some of the earlier usage growth. Demand grew strongly in the early 2000s, while catch-up investment came later for some networks. We allow for this investment lag by taking the longest possible analysis window as our primary estimate.

Table 3: The impact of a lower RAB on network businesses' revenue requirements

		RAB reduction	*Change in revenue req.*	
DNSP	*State*	*$m*	*$m*	*%*
Jemena	VIC	- 38	- 4	-2%
TasNetworks	TAS	- 235	- 24	-10%
CitiPower	VIC	- 52	- 6	-2%
Essential	NSW	- 3,304	- 298	-29%
Energex	QLD	- 3,935	- 298	-14%
AusGrid	NSW	- 5,442	- 471	-30%
Ergon	QLD	- 2,442	- 203	-16%
Endeavour	NSW	- 849	- 75	-9%
TNSP				
ElectraNet	SA	- 723	- 76	-24%
Powerlink	QLD	- 885	- 78	-10%
TasNetworks	TAS	- 516	- 46	-26%
TransGrid	NSW	- 1,577	- 152	-20%

Notes: Values are expressed in 2017 dollars. Change in revenue is the average annual change over the current determination period.
Source: Grattan analysis using the AER's current PTRM models.

[26] This period would have enabled us to use non-coincident maximum demand for all networks and final RAB values rather than RIN data (except in 2015 for NSW networks).

Table 4: A common start and end point increases the estimate

DNSPs	*State*	*Start*	*End*	*Change in RAB*	*Change in use*	*Excess ($m)*
ActewAGL	ACT	2006	2015	32%	25%	48
Jemena	VIC	2006	2015	69%	33%	257
Tas D	TAS	2006	2015	35%	18%	204
CitiPower	VIC	2006	2015	61%	22%	437
Essent'l	NSW	2006	2015	90%	11%	3,075
Energex	QLD	2006	2015	76%	31%	2,986
Ausgrid	NSW	2006	2015	105%	18%	6,476
Ergon	QLD	2006	2015	66%	21%	2,776
SA Power	SA	2006	2015	15%	22%	-
Endeav'r	NSW	2006	2015	71%	22%	1,745
Powercor	VIC	2006	2015	18%	43%	-
AusNet D	VIC	2006	2015	39%	46%	-
United	VIC	2006	2015	47%	34%	199
TNSPs						
ElectraNet	SA	2006	2015	71%	26%	616
Powerlink	QLD	2006	2015	87%	24%	2,493
AusNet T	VIC	2006	2015	19%	31%	-
Tas T	TAS	2006	2015	56%	18%	367
TransGrid	NSW	2006	2015	51%	21%	1,279
TOTAL						**22,958**

Notes: RAB values are expressed in 2017 dollars.
Sources: Grattan analysis of determinations data for RABs and benchmarking data for usage.

2.6.2 Measuring maximum demand

We made two main choices regarding maximum demand: the measure itself, and which years are counted. Both choices had a small effect of *reducing* the total excess growth estimate.

There are many ways to measure maximum demand. We use coincident maximum demand because this was reported historically, so using this measure allows a longer analysis. The importance of a longer time-frame is highlighted in the previous section.

However, a non-coincident maximum demand measure would have been preferable, had it been available. Non-coincident maximum demand allows for high use of one part of the network at one time and another part at another time of year. By contrast, coincident maximum demand captures demand across the whole network at a single point in time.

Unfortunately, data on non-coincident maximum demand is only available from 2006. We therefore use non-coincident maximum demand for analyses starting in 2006[27] and coincident maximum demand for longer analyses.

When comparing the two measures since 2006, the choice of measure makes only a small difference to the total excess growth estimate. Using non-coincident maximum demand increases the

[27] This affects TasNetworks distribution only.

total estimate of excess growth by $240m when compared to an equivalent analysis using the coincident measure.[28]

We measure growth in maximum demand up to the highest maximum demand of the past five years, rather than simply maximum demand in the last year of analysis. Using maximum demand in the last year of analysis would have increased our total estimate of excess growth by $200m.

Our choice to use the highest maximum demand of the past five years allows for maximum demand to vary from year to year. Networks are built to meet peak demand, and a peak experienced in the past five years could be expected to be experienced again. However, we do not use the highest maximum demand at *any* point in time because our analysis seeks to identify where peak demand is truly in decline (as this represents under-utilised assets).

2.6.3 Measuring use of transmission networks

Transmission networks serve both consumers and generators. An alternative way of estimating network use for transmission networks would be to replace customer growth with growth in the voltage of entry/exit points over time. The voltage of entry/exit points was not reported before 2006, so using customer growth allows a longer analysis. But using this measure since 2006 reduces the total estimate of excess growth by $450 million.[29]

The AER no longer recommends using this measure and has replaced voltage of entry/exit points with end users as the key output measure for transmission.[30]

2.7 Extenuating circumstances

Box 1 summarises what our methodology does and does not account for. There are three areas where ‘extenuating circumstances’ might apply to reduce the estimate of excess growth for a network:

- Historic under-investment (best estimated through asset utilisation data that is not in the public domain)
- Valuable reliability improvements
- Transmission developments that reduce wholesale prices

2.7.1 Historic under-investment and current utilisation

We account for historic under-investment as far as publicly available data allows, first by estimating excess growth over the

[28] This is the overall result; the change of measure has a different effect for different networks.

[29] This is the overall impact; three networks increase, while two decrease.

[30] AER (2017) annual benchmarking report.

longest possible period, and second, by incorporating additional information into our estimate where available.

Where there was evidence that initial valuations were substantially altered for political reasons, as in the Victorian networks, we have adjusted for this in the starting RAB values.

Queensland RABs were revalued later, in 2003-04, so the analysis window for Queensland DNSPs is shorter than most (14 years). Energex provided data illustrating capital under-investment of $1.12 billion in the decade prior to 2004, which is consistent with the findings of an independent review at the time.[31] We have incorporated this information to create an estimate range for Energex.[32] We have not replaced our original estimate for Energex though because other data shows Energex's RAB per customer per kilometre was already above average in the mid-2000s (see Section 3.4.4).

Our approach still carries some risk of historical under-investment (or over-investment) prior to the analysis window. This is one of the reasons we refer to our estimate of excess growth as an upper bound and recommend government write-downs of *up to* our estimate.

In assessing whether a write-down should be smaller because of historic under-investment, the best indicator would be current asset utilisation. If under-investment occurred prior to over-investment, then assets should be fully utilised today. Asset utilisation data is not publicly available but should be assessed.

2.7.2 Valuable reliability improvements

Our method does not specifically account for reliability improvements because it is not clear that they were in the long-term interests of consumers. As the main report describes, NSW and Queensland state governments lifted reliability standards in the mid-2000s but did not consider consumers' preferences and willingness to pay.[33]

Reliability improved a little in some networks and not in others, but there was no fundamental change in service. The average improvement across all distribution networks was 22 minutes less in outages per customer in 2016 compared to 2006.[34] The largest improvement was 100 minutes less in outages on the Ergon network in Queensland, while TasNetworks experienced 18 *more* minutes of outages in 2016 than 2006.

Two things need to be established for reliability improvements to justify some asset growth above network use:

[31] Somerville et al. (2004).
[32] Excess growth of 1.67 billion to 3.94 billion. The lower bound represents an estimate based on a higher starting RAB, to reflect the historic under-investment that 'should' have occurred. The upper bound represents our original estimate for Energex.
[33] Productivity Commission (2013).
[34] System Average Interruption Duration Index, AER (2017) benchmarking data.

1. Were reliability improvements in the long-term interests of consumers and at what cost?

2. Did improving reliability require additional network capacity? (Beyond what was needed to meet growth in customers and maximum demand)

It is not clear that either of these hold. The ‘value of customer reliability' (VCR) can be used to assess the potential value of reliability improvements, if indeed they were in the consumer interest and if additional capacity was required. But VCR is challenging to define because different customers place different value on the reliability of the system.

In 2014, the Australian Energy Market Operator (AEMO) estimated that customers, on average, place a value of $34 per kilowatt hour on reliability.[35] In the wholesale market, the market price cap sets the value of demand forgone at $14 per kilowatt hour. Two further assumptions substantially impact the value of reliability improvements: the expected lifetime of additional assets/capacity required for reliability improvement and the discount rate applied.

If we assume a 50-year asset life and a 5 per cent discount rate[36] then the present lifetime value of reliability improvements in NSW and Queensland distribution networks would range from $2-4.8 billion (see Figure 8).[37]

This range is substantially less than the $16 billion in excess growth identified in these networks. But it is also a wide range and rests on critical assumptions about whether reliability improvements were in the long-term interest of consumers and what represents value for money for consumers. The report concludes that it is ultimately a political decision whether reliability improvements justify any of the excess growth.

2.7.3 Transmission that delivered wholesale benefits

A final consideration is that some investment in transmission may have delivered lower costs in wholesale markets. The impact of transmission developments on wholesale market outcomes was beyond the scope of this analysis, but if wholesale benefits can be demonstrated, then this may justify some of the excess growth in transmission.

[35] AEMO (2014).
[36] Terrill and Batrouney (2018).
[37] Alternatively, using the NEM average remaining life of assets of 28 years gives a range of $1.6-4 billion.

Box 1: What our estimate does and does not account for

Our estimate accounts for:

- Inflation in line with consumer purchasing power (CPI);
- Growth in demand for electricity: RABs are allowed to grow for both maximum demand and customer numbers;
- The ‘uniqueness’ of networks: a network is compared only to itself over time neutralising key differences between networks such as size and customer density (see Figure 9); and
- Cycles of investment: our analysis goes back as far as publicly available data allows (average is 17 years).

On principle, our estimate does not account for:

- Change in reliability: because it is not clear that this was in the long-term interests of consumers (see Section 2.7.2);
- Cost escalation above CPI: higher labour and materials costs may have inflated capital costs at certain times. CPI is the best available indicator though because long-term cost growth above the buying power of customers is unsustainable; and
- Locational load diversity: shrinking demand in some parts of a network represents under-utilised assets (see Section 1.5).

Beyond available data or scope:

- Under-investment and over-investment prior to analysis period (see Section 3.4.4);
- Asset age: not available at analysis start point and the link to capital expenditure is unclear (see Section 3.4.4); and
- Wholesale benefits of transmission developments (see Section 2.7.3).

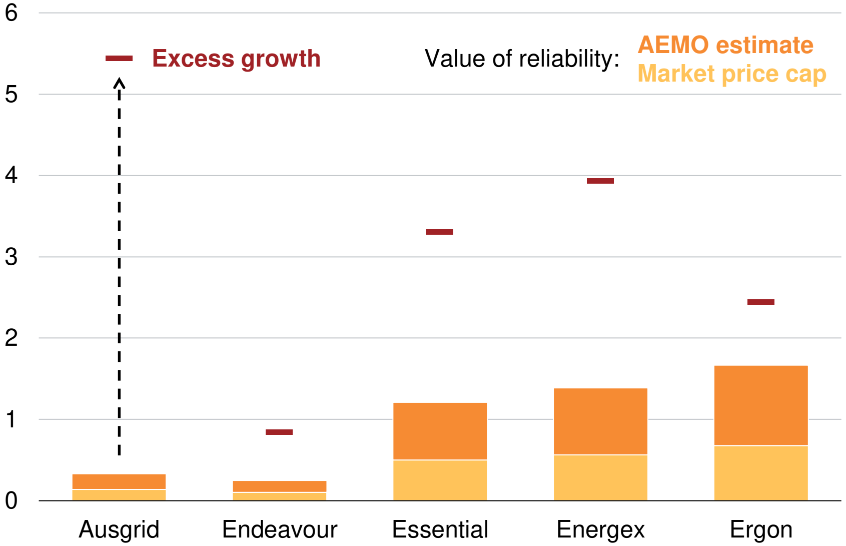
Our recommendations allow for three types of adjustment:

- Adjustment for current and expected future utilisation (utilisation data should reflect any meaningful historic under-investment or asset age issues not captured in our analysis); [a]
- Adjustment for reliability improvements where governments judge them to be in the long-term interest of consumers; and
- Adjustment for transmission assets that have delivered lower costs in wholesale markets.

Notes: (a) Granular data on current utilisation levels is not publicly available; and expected future utilisation is a judgment call for governments.

Figure 8: There is judgment involved in the value of reliability but all estimates are substantially less than excess growth

Real annual capex, 2017$ billions

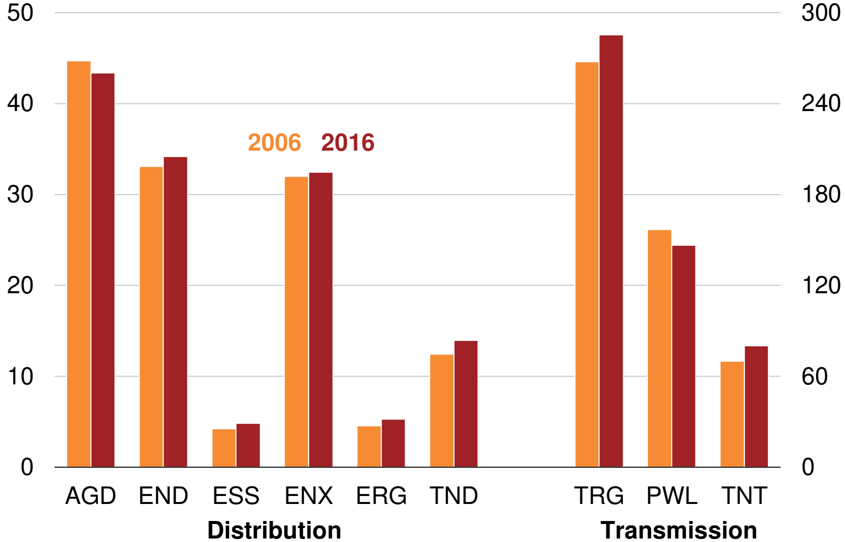


Notes: TasNetworks distribution not included because reliability did not improve. Value of reliability is the value of the change in System Average Interruption Duration Index (SAIDI) between 2006-2016, calculated over a 50-year life of assets at a 5 per cent discount rate, based on two estimates of reliability value: the market price cap which sits at $14.2/kWh and AEMO's estimate of $34.15/kWh for customers in NSW and $34.91/kWh for customers in Queensland.

Source: Grattan analysis.

Figure 9: Customer density varies substantially between networks but hasn't changed much over time in NSW, Queensland and Tasmanian networks

LHS: Distribution customer density (#/km); RHS: Transmission connection density (kV/km)



Notes: AGD = Ausgrid, END = Endeavour, ESS = Essential, ENX = Energex, ERG = Ergon, TND = TasNetworks distribution, TRG = TransGrid, PWL = Powerlink, and TNT = TasNetworks transmission.

Source: Grattan analysis of AER (2017) benchmarking data.

3 Understanding causes of excess growth

This section presents our analysis of capital expenditure over time, to understand causes of excess growth. We used network businesses' capex proposals and RIN responses to try to understand how capex was spent and the potential drivers of excess growth.

Unfortunately, publicly available data is limited and inconsistent between networks and over time (see Box 2). This makes it difficult to draw conclusions on the causes of excess growth. Instead, we present capex trends and how they may relate to hypotheses for excess growth.

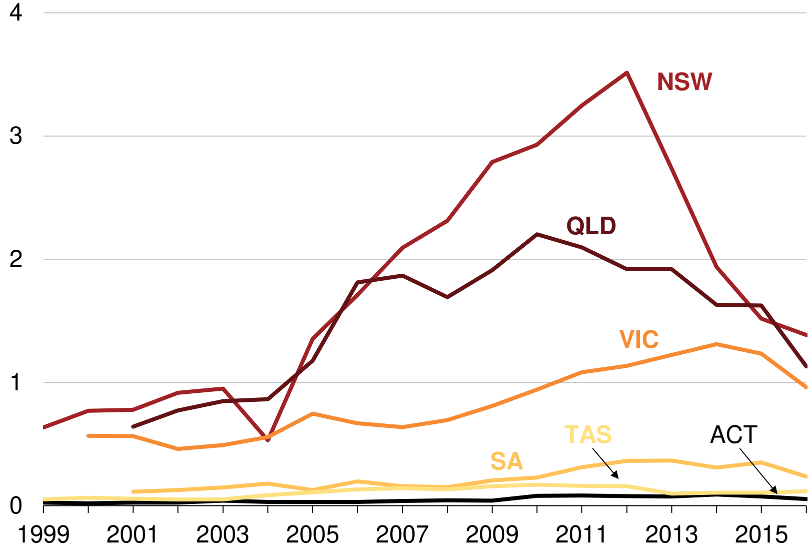
In the following sections, we present what we can piece together from publicly available data. We focus on NSW and Queensland, as the states where excess growth was most significant. We also consider Tasmania, where overall spending was small but excess growth on a per customer basis is on par with NSW and Queensland.

3.1 Capex over time

Data on capex is available by network from around 2000 onwards and shows that in the early 2000s, most states had a relatively stable capex trajectory, but then capex increased dramatically between 2005 and 2014 (see Figure 10).

Figure 10: Capital expenditure ballooned between 2005 and 2014

Real annual capex, 2017$ billions



Note: Distribution networks only.

Source: Grattan analysis of network determinations.

The rise and fall of capex in NSW and Queensland particularly stands out. Networks in Victoria, South Australia, Tasmania and the ACT increased (and more recently decreased) more steadily and less significantly.

The steady increase in Victoria from 2009 to 2014 appears partly due to the introduction of safety requirements following the Victorian bushfires in 2009.[38] Capex peaked later for Victorian networks, but has been on a downward trend since 2014. Capex in South Australia increased between 2009-2015, dropping back somewhat in 2016. Capex in Tasmania increased between 2003-2012, levelling off since. And in the ACT, capex increased between 2010-2014 but has since fallen back. These three states represent very little of the overall growth.

State-level figures hide some important outliers. In particular, while all networks in NSW and Queensland spent more over the 2005-2014 period, Ausgrid's extreme rise and fall in capex is an outlier that distorts the overall pattern for NSW (see Figure 11).

3.2 Patterns in overspending and underspending

Overspending regulatory allowances does not explain excess growth in capex. While there was a period of significant overspending, it does not coincide with peak capex, and is mirrored by a period of significant underspending.

Box 2: Data challenges

It is surprisingly difficult to conclude from publicly available data what the money was spent on. Networks report their capital expenditure using different categories and include different kinds of spending in categories of the same name.[39]

Capex is proposed by networks for the upcoming determination period. The AER then reaches its draft and final decisions with further input from businesses, stakeholders and consultants. Determination documents track the process but there is insufficient (and inconsistent) information to form a clear picture on the necessity and specific drivers of capex.

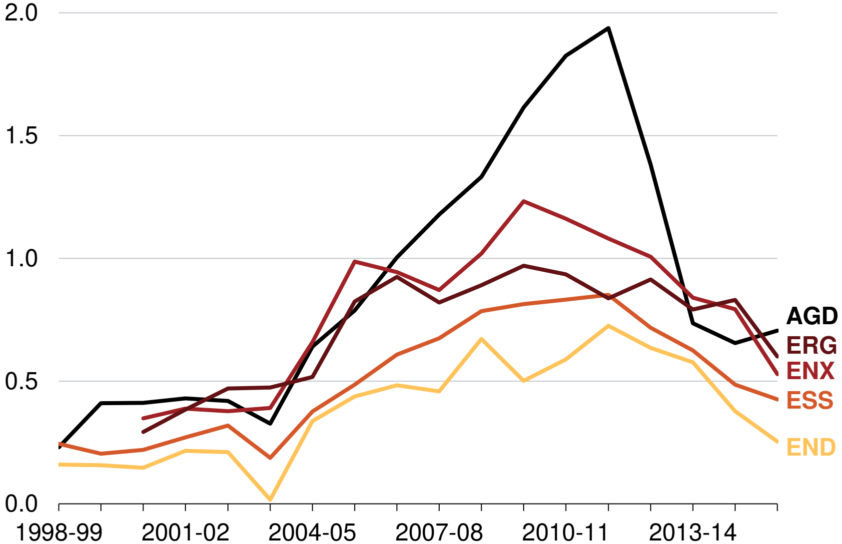
Networks appear to report similar spending in different categories. For example, from 2002 to 2010, Energex reported spending 33-38 per cent of capex per year on reliability. Over the same period Ergon reported 1-4 per cent of capex on reliability. Both networks were subject to the same reliability standards, suggesting that the difference was at least partly due to similar spending being recorded in different categories. Energex then reported reliability spending dropping to zero in 2011 and 2012 (before reliability standards were repealed in 2014) suggesting that Energex itself may have recorded similar spend in different categories over time.

[38] The AER approved additional capex for the regional networks, AusNet and Powercor, to replace overhead lines in bushfire prone areas. These measures resulted in at least $600m in additional safety-driven capex between 2009 and 2015 (Victorian distribution determination 2010).

[39] This may be partly due to transitioning from earlier regulators to the AER framework; however, even within AER RIN reporting, especially from earlier years, different networks use different categories.

Figure 11: Ausgrid spent beyond the level of other NSW and QLD networks

Real annual capex, 2017$ billions

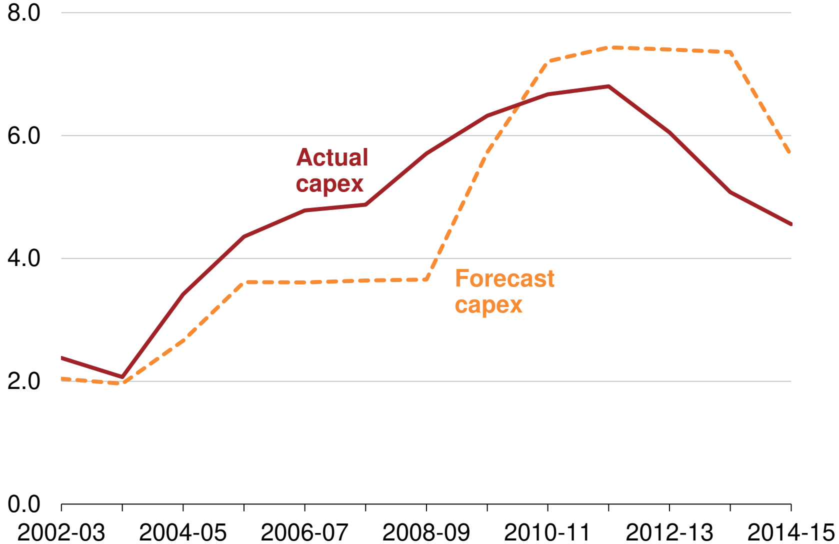


Notes: AGD = Ausgrid, ERG = Ergon, ENX = Energex, ESS = Essential, END = Endeavour.
Source: Grattan analysis of network determinations.

From roughly 2003, states, in aggregate, increasingly overspent their capex forecasts, most significantly from 2005 to 2010 (see Figure 12). This pattern then reversed from 2010, with distribution networks underspending their capex allowances.

Figure 12: Overall trends in forecast vs. actual capex over time

Real annual capex, 2017$ billions



Note: Does not include SA Power Networks as some forecast data is missing.
Source: Grattan analysis of network determinations for DNSPs.

In some of the years of highest capex, NSW and Queensland networks were actually on forecast or *under*-spending. For example, Ausgrid's peak spending occurred in 2010-11 and 2011-12 – years where actual capex was broadly in line with forecast capex. Energex's spending peaked in 2009-11, a mix of overspend and underspend years.

3.3 Trends in augmentation vs. replacement

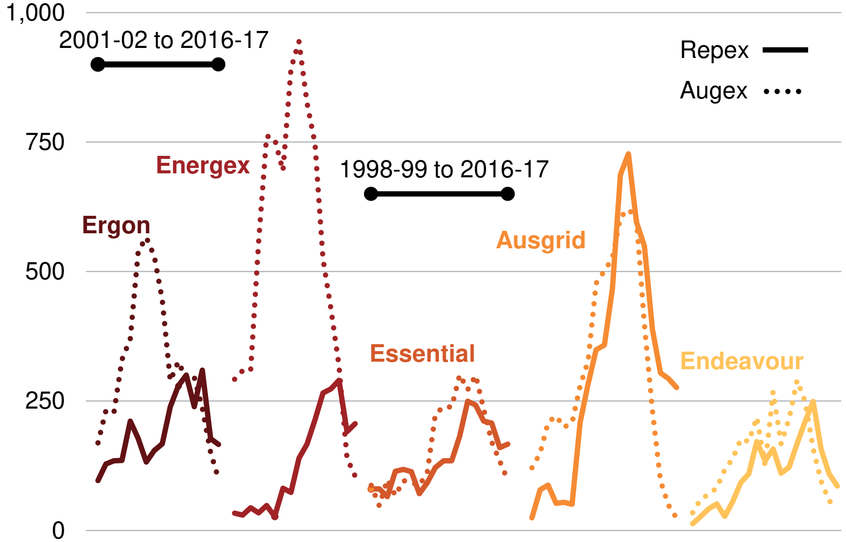
Augmentation expenditure (augex) and replacement expenditure (repex) tend to be the major buckets of reported capex.

The period of high capex from 2005-2014, appears to have been largely driven by growth in augex for Queensland networks and both augex and repex for NSW networks (see Figure 13).[40] In Tasmania it looks like when augex is high, repex is low, and vice versa (Figure 14). Augex has generally been higher than repex over the analysis period, although the trends vary by network.

Some augex would be needed to meet growing customer and peak demand over the period and likely some to meet reliability standards too. Repex usually refers to asset replacement but the distinction between augex and repex is not always clear cut.[41]

For networks in NSW, Queensland and Tasmania, repex has increased as a percentage of total capex over time. But the growth in repex does not follow the peaks and troughs in overall capex.

Figure 13: Repex and augex in Queensland and NSW networks
Real annual capex, 2017$ millions

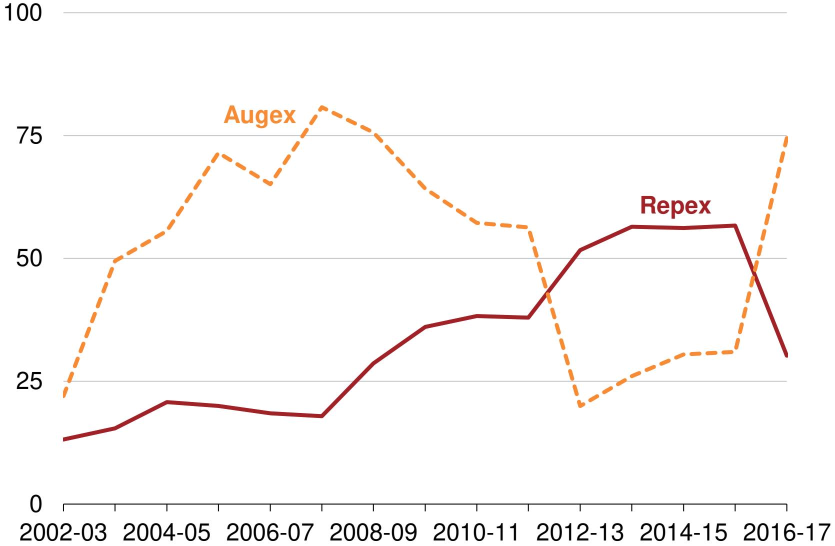


Source: Grattan analysis of reporting by networks and consultants to the AER and earlier regulators.

40 In compiling figures for augex, we included capex reported as augmentation, demand-related growth and connections.

41 For example, if an existing asset is replaced with a larger version, should this count as augex or repex?

Figure 14: Augex and repex for TasNetworks
Real annual capex, 2017$ millions



Source: Grattan analysis of reporting by networks and consultants to the AER and earlier regulators.

3.4 Potential drivers of excess growth

The main report outlines five hypotheses for excess growth:

1. Incentive structure: a high WACC may have encouraged over-investment.
2. Ownership: Publicly-owned businesses have a greater incentive to spend more;
3. Higher expectations: new reliability and safety standards were imposed;
4. Changing demand: usage was expected to grow more than it actually did; and
5. Cycles of investment: asset replacement can be lumpy over time, so high investment in one period may be 'catch up' for previous under-investment.

It was not possible to pinpoint precisely how much excess growth is attributable to each of these categories, because capex is not reported this way and the potential drivers are not mutually exclusive. However, some capex trends do suggest support for (or against) specific hypotheses and we discuss these instances below.

3.4.1 Capex attributed to incentive structure and ownership

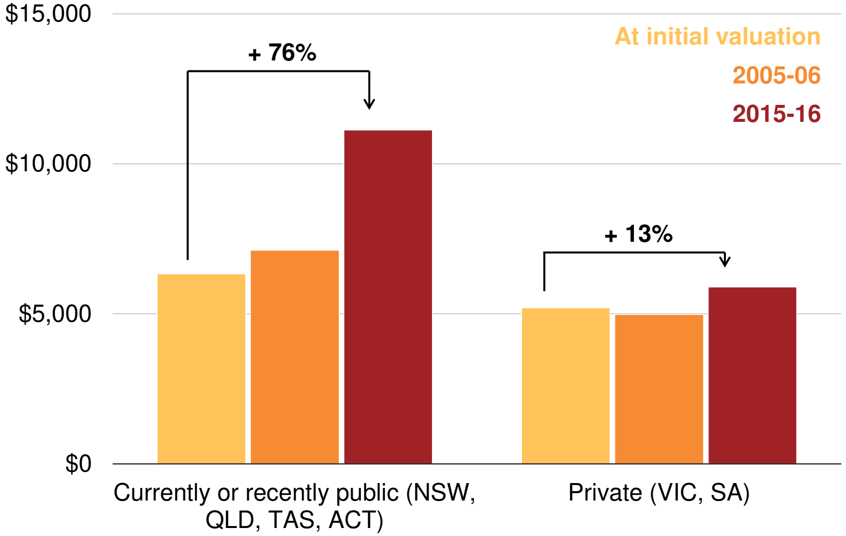
Most of the period of high capex coincided with a high WACC. But if a high WACC was responsible, there should have been excess growth across all networks, as the WACC is calculated in the same way for all network businesses. Yet most of the excess growth occurred in public businesses rather than private businesses (see Figure 15).

This implies ownership, rather than the WACC itself, is the key issue.

3.4.2 Capex attributed to reliability standards

If new reliability standards were responsible for some part of the excess growth, then we would expect to see an increase in capital expenditure immediately following the introduction of reliability standards. Reliability standards were introduced in NSW and Queensland in 2005 and repealed in 2014. This matches closely with the high spending periods in these states. Figure 16 illustrates spending patterns by network, before and after the introduction of reliability standards.

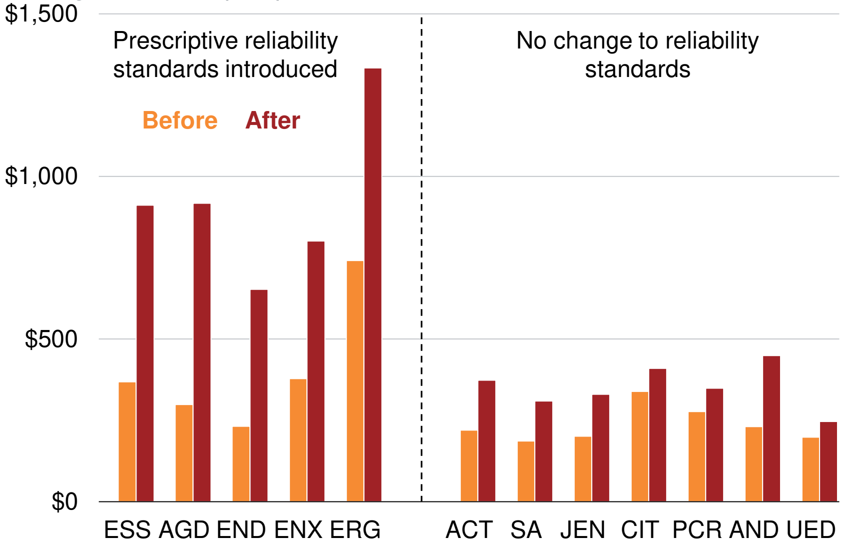
Figure 15: Public networks grew far more than private networks
RAB per customer, 2017$



Note: Three of the four NSW networks were partially or fully privatised between 2015-2017 but are counted here as public networks because growth in RAB occurred while they were publicly-owned.
Source: Grattan analysis of network determinations.

Figure 16: Significant capital expenditure followed the introduction of reliability standards

Average annual capex per customer, 2017$



Note: The period pre-reliability standards was 2000-01 to 2004-05; the period post-reliability standards was 2006-07 to 2012-13.
Source: Grattan analysis of network determinations.

Reliability standards were introduced in Tasmania and South Australia later, in 2008.[42] These coincide with increased capex in both Tasmanian networks and in South Australia's transmission network, ElectraNet. The transmission networks attribute increases in their expenditure proposals to the new standards, so the standards appear to be responsible for some of the excess growth.[43]

Overall, these top-level trends suggest that reliability standards were a significant driver of capex. However, this is not clear from the spending categories reported by networks.

Most networks do not report increased spending in the 'reliability' category following the introduction of the standards. The exception is Essential Energy in NSW, where reliability capex increased from 1 per cent per year prior to 2005 to between 16 and 25 per cent per year up until the standards were repealed.

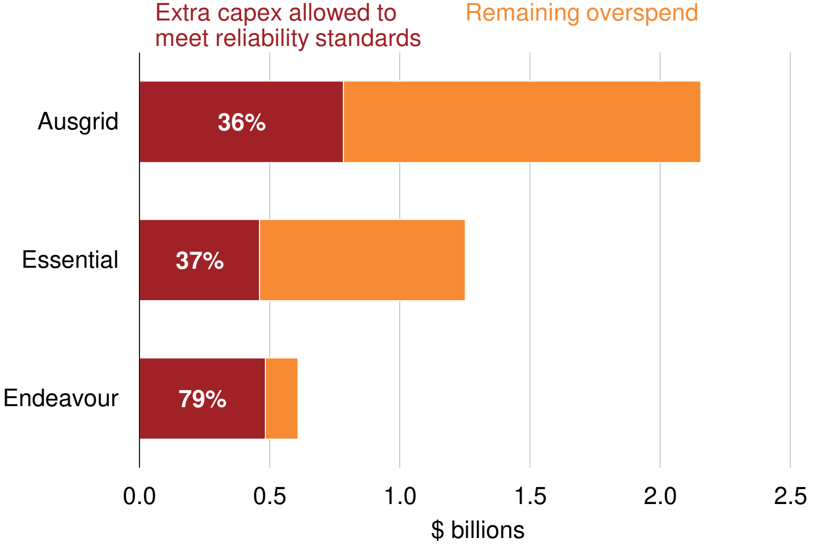
This suggests either (1) reliability standards drove spending that was recorded in the more general categories of augex and/or repex rather than the specific category of 'reliability'; or (2) that the increase in capex following reliability standards was mere coincidence.

There is some evidence for the former in the case of NSW, where the AER specifically approved extra spending for 2005-06 to 2008-09 in order to meet the new reliability standards. This approved extra spending accounted for a significant portion of above-forecast spending by NSW networks in these years (see Figure 17).

[42] In South Australia, the new standards were for transmission only.

[43] AER draft decision on Transend (2008) and AER final decision on ElectraNet (2008).

Figure 17: Reliability standards were responsible for some of the overspend by NSW networks in the late 2000s
Capex overspend between 2005-06 and 2008-09, 2017$



Source: Grattan analysis of network determinations and IPART (2006).

Ausgrid, for example, was allowed over $200 million extra capex per year from 2006-07 to 2008-09. However, Ausgrid's reported spending on reliability in this period was $49-58 million per year – or less than one quarter of its allowed *extra* reliability budget.[44] It is unlikely that Ausgrid significantly underspent its reliability allowance, given that the new standards were prescriptive and legally-binding and its total above forecast overspend was $500-800 million per year. Instead, it is more likely that expenditure on reliability was reported as augex and/or repex.

3.4.3 Capex attributed to expected demand

Peak demand is a major driver of network costs, and networks often (but not always) need to build in advance of expected increases to meet them. Across all states and all networks, including NSW, Queensland and Tasmania, expected peak demand far exceeded actual peak demand over the period of excess growth. Getting the forecasts so wrong is likely to have contributed to some excess growth.

In the early 2000s, peak demand grew strongly and forecasts suggested it would continue. However, peak demand levelled off in the late 2000s.

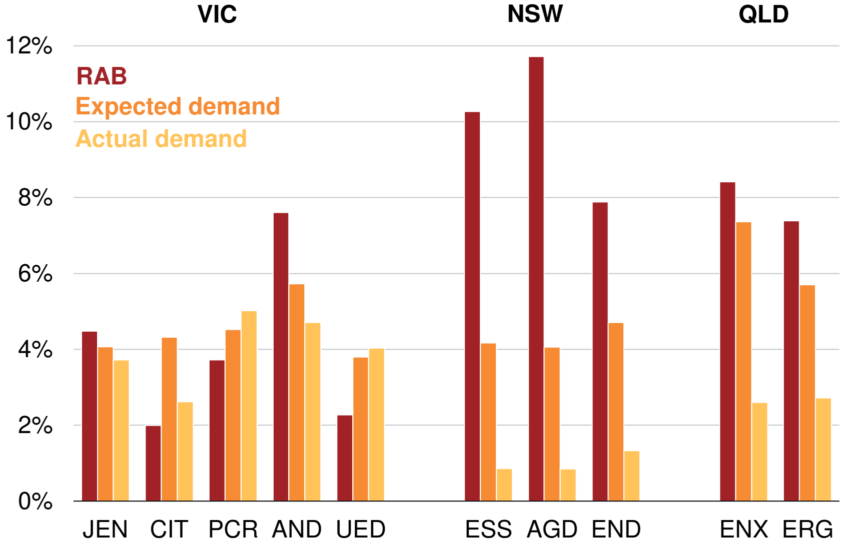
If expected demand was a major driver of excess growth, we would expect to see augex grow in the early 2000s and then fall off around 2012. This trend is visible in NSW, Queensland and Tasmania (see Figures 13 and 14 above).

These trends lend support to the hypothesis that changing demand contributed to excess growth. Yet networks, especially in NSW and Queensland, vastly outspent even expected demand

[44] In addition to capex reported under the category of 'reliability', we included 'compliance' and 'environmental, safety, statutory obligations' in our calculation of 'reliability' figures.

(including customer growth, see Figure 18), so this does not explain all excess growth.

Figure 18: RAB growth exceeded even expected demand for many distribution networks
Average annual growth, 2006-2014, per cent



Notes: Demand growth is both customer numbers and maximum demand; or where maximum demand was negative then customer growth only.
Sources: Grattan analysis of expected demand in determinations and actual demand from AER benchmarking data.

3.4.4 Capex attributed to historical under-investment

Available data on asset age and replacement expenditure do not point to historic under-investment as a major driver of the high capital spend between 2005-2014.

If under-investment prior to 2005 was a major driver of over-investment between 2005-2014, then we would expect to see repex grow from 2005, and decline again from 2014. The data does not support this. All NSW and Queensland networks record their highest share of spend on repex from 2013-14 onwards (see Figures 13 and 14). Either historical under-investment was not a major driver of excess growth, or this spend was reported in other categories such as augex.

Asset age is another indicator – an older fleet might imply that, historically, replacement did not keep up. Across the NEM the average remaining life of assets grew from 25 years in 2006 to 28 years in 2016.[45] Most of the networks that overinvested between 2005-2014 were *younger* than the NEM average in 2006.[46]

Figure 19 compares asset age in 2006 to capital expenditure in the following years and shows that asset age was not a consistent driver of capital expenditure. It may have been a factor for individual networks, such as the country network in NSW

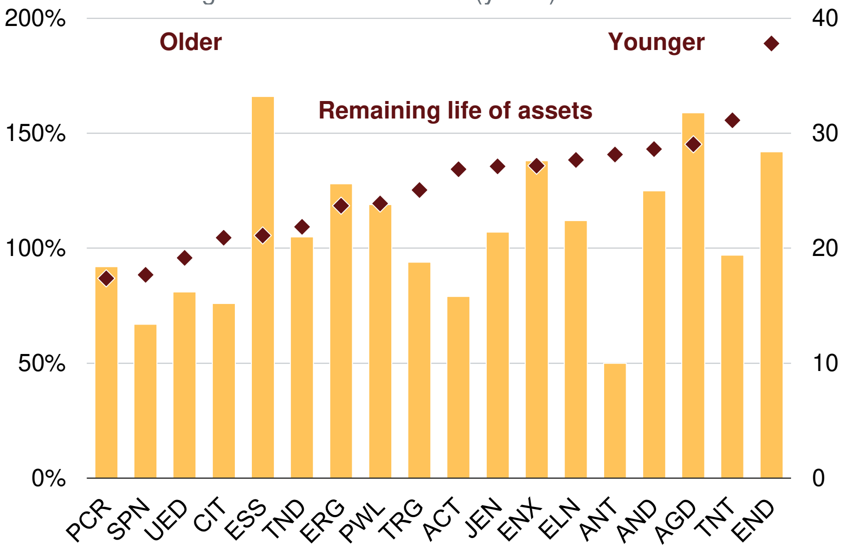
[45] 2006 was the earliest year that asset age information was available for all networks. The average residual life of a network's assets is the residual service life by asset class, weighted by asset value. Networks self-reported residual service life by asset class in RIN responses and may have reported the number of years remaining to pay off the asset rather than the number of years that assets were expected to remain in service.

[46] $11.5 billion of excess growth occurred in networks younger than average (i.e. networks with a longer residual life of assets, on average); $8.5 billion in networks older than average.

(Essential), but other older networks spent much less over the same period.

Figure 19: No consistent trend to suggest asset age is a major driver of capital expenditure

LHS = Total capex 2006-2014 (as a per cent of 2006 RAB, 2017$); RHS = Remaining life of assets in 2006 (years)

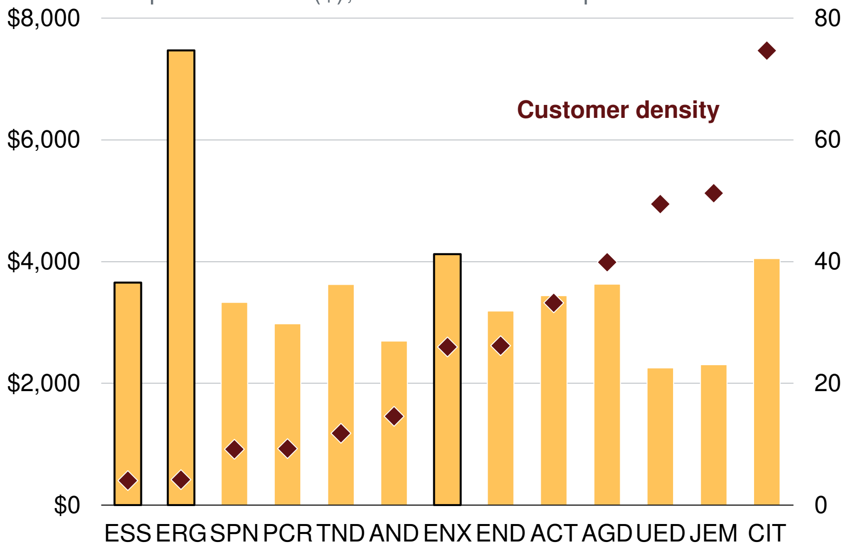


Notes: This chart compares the remaining life of assets (in red) as at 2006 (before most of the excess growth occurred) to total capital expenditure per customer over the following years (in orange). The average residual life of a network's assets is the residual service life by asset class, weighted by asset value.
Sources: Grattan analysis of actual capex in determinations and residual life of assets reported in RIN data.

We also compared RAB per customer in 2006 to customer density to understand if any networks were 'behind' on investment, relative to their peers, at the beginning of the period of high capex (Figure 20). There is potentially evidence that Essential underinvested prior to 2006 (or alternatively that Ergon overinvested). Our analysis for Essential goes back to 2000-01.

Figure 20: Essential's RAB much smaller than Ergon's in 2006 for the same customer density

LHS = RAB per customer ($); RHS = Customers per km of line



Notes: DNSPs only, 2006 data.
Sources: Grattan analysis of determinations and benchmarking data.

The only network to provide evidence of historic under-investment was Energex, but Figure 20 casts doubt on that given Energex's

RAB per customer was already high in 2006 (Energex may have invested inefficiently).

A further test of the historical under-investment hypothesis is illustrated in Section 2.6.1, where we compare our estimates of excess growth to a shorter analysis (2006-2015). The shorter analysis increases our estimate, highlighting that there was some historical under-investment, but it does not explain most of the excess growth.

3.5 Ownership, changing demand and reliability standards appear to have been the major drivers

All five hypotheses are likely to have contributed to excess growth to some extent, but public ownership, changing demand and reliability standards appear to have played a bigger role. We therefore pitch the recommendations in the main report to state governments that own (or recently-owned) network businesses and who set reliability standards.

Appendix A: Data by network

DNSPs	*State*	*Start year*	*End year*	*Total years*	*Start RAB real $m*	*Start Customers*	*Start MD MW*	*End RAB real $m*	*End Customers*	*End MD MW*	*Change in RAB*	*Change in Use*	*Exp. RAB $m*	*Excess growth $m*
ActewAGL	ACT	1997-98	2016-17	20	724	130,003	556	921	191,482	625	27%	60%	1,156	-
Jemena	VIC	2000	2016	17	759	255,349	742	1,263	327,386	988	66%	61%	1,225	38
Tas D	TAS	2005-06	2016-17	12	1,200	250,643	1,063	1,625	287,652	1,075	35%	16%	1,390	235
CitiPower	VIC	1996	2016	21	911	235,218	925	1,843	336,070	1,422	102%	97%	1,791	52
Essent'l	NSW	2000-01	2016-17	17	3,035*	725,409	2,009	7,620	891,935	2,396	151%	42%	4,317	3,304
Energex	QLD	2003-04	2016-17	14	5,519	1,160,112	4,037	11,941	1,448,247	4,853	116%	45%	8,006	1,673 - 3,935*
Ausgrid	NSW	1997-98	2016-17	20	6,243	1,366,348	4,480	14,845	1,706,914	5,631	138%	51%	9,402	5,442
Ergon	QLD	2003-04	2016-17	14	5,408	584,717	2,231	10,546	745,501	2,730	95%	50%	8,105	2,442
SA Power	SA	2004-05	2016-17	13	3,350	772,694	2,394	3,934	878,300	2,915	17%	35%	4,537	-
Endeav'r	NSW	1997-98	2016-17	20	2,870	732,281	2,800	6,047	984,230	4,107	111%	81%	5,198	849
Powercor	VIC	1996	2016	21	2,161	541,773	1,150	3,506	799,540	2,344	62%	151%	5,432	-
AusNet D	VIC	2000	2016	17	2,123	509,976	1,250	3,677	712,767	1,875	73%	90%	4,028	-
United	VIC	1996	2016	21	1,333	540,184	1,100	2,185	669,826	2,066	64%	112%	2,823	-
TNSPs							(MVA)			(MVA)				
ElectraNet	SA	2003-04	2016-17	14	1,231	760,334	2,602	2,466	878,300	3,280	100%	42%	1,743	723
Powerlink	QLD	2000-01	2016-17	17	3,448	1,610,000	6,584	7,114	2,193,748	9,508	106%	81%	6,229	885
AusNet T	VIC	2002	2016	15	2,720	2,248,232	7,581	3,060	2,845,589	10,308	12%	63%	4,421	-
Tas T	TAS	2000-01	2014-15	15	790	247,801	1,596	1,503	283,059	1,766	90%	25%	987	516
TransGrid	NSW	1998-99	2016-17	19	3,159	2,964,558	11,424	6,342	3,774,561	14,107	101%	51%	4,765	1,577
NEM-wide														**19,998**

Notes: All RAB values are expressed in 2017 dollars. MD = coincident maximum demand in megawatts for DNSPs and mega volt amps for TNSPs except for Tas D which is non-coincident maximum demand in megawatts. The end MD value is the largest of the past 5 years. The starting RABs of Victorian networks are without artificial inflation/deflation. The starting RAB of Essential is adjusted up by 1.26 per cent to compensate for artificial deflation applied to the original valuation in 1998. A range for excess growth is provided for Energex, see Section 2.7.1.
Sources: Grattan analysis of regulatory determinations, AER network performance data, and historic reports.

Key sources

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- AER annual benchmarking report 2017, available at: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/annual-benchmarking-report-2017/initiation
- Historic determinations and network performance reports (pre-AER), sourced online or by request from state regulators:
  - New South Wales: IPART https://www.ipart.nsw.gov.au/ and http://www.archive.ipart.nsw.gov.au/
  - Queensland: QCA http://www.qca.org.au/
  - Victoria: ESC https://www.esc.vic.gov.au/
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