Nuttall Consulting

Regulation and business strategy

Review of Transend Revenue Proposal
Asset Renewal Capital Expenditure

A report to the Australian Energy Regulator

Final Report – Public Version

November 2008

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1. Introduction

The Australian Energy Regulator (AER), in accordance with its responsibilities under Chapter 6A of the National Electricity Rules (NER), is determining Transend Networks Pty Ltd (Transend's) maximum allowed revenue for its prescribed transmission services during the 2009/10 to 2013/14 period.

Transend is the electricity Transmission Network Service Provider (TNSP) in Tasmania. Under chapter 6A (Economic Regulation of Transmission Services) of the NER, Transend is required to submit to the AER a revenue proposal in relation to the regulatory control period that commences on 1 July 2009.

Transend is presently subject to a revenue cap in accordance with a decision made by the Australian Competition and Consumer Commission (ACCC) in December 2003. That revenue cap is due to expire on 30 June 2009.

1.1. Terms of reference and methodology

The AER has engaged Nuttall Consulting in relation to Transend's capital expenditure (capex) on asset renewal as set out in Transend's revenue proposal and supporting documents. The services required of the consultancy include:

- to inform the AER on Transend's asset renewal program that has occurred (or is predicted to occur) in the current regulatory period and the program Transend has forecast in the next period; and
- to recommend to the AER the prudent and efficient level of asset renewal capex for the current period (i.e. an ex post review of asset renewal capex in the current period) and the next period (i.e. an ex ante review of forecast asset renewal capex in the next period).

For the purposes of this review, asset renewal is defined to include works to replace or refurbish prescribed transmission system assets to maintain the reliability and quality of electrical service. This definition is consistent with that utilised by Transend in its revenue proposal.

The AER has commissioned WorleyParsons to review the overall Transend proposal with the specific review of asset renewal capital expenditure to be undertaken by Nuttall Consulting.

WorleyParsons is also responsible for the review of the business-wide aspects of the Transend proposal that may impact, but are not specific to, renewal capital expenditure. These include:

- capital governance systems and/or processes;
- the overall asset management strategy, the processes to develop this, and the underlying information systems;
- deliverability and resourcing requirements associated with the renewal program; and

- the project/program cost estimation processes and systems of Transend, including labour and unit rate escalations.

Nuttall Consulting and WorleyParsons have undertaken co-ordination meetings throughout the review process. However, the draft reports have been written without reference to each other due to the parallel nature of the reviews.

Our methodology has entailed a desktop review of Transend's proposal and supporting information. In undertaking this review, we have held a number of meetings with Transend to discuss its renewal program and the supporting material. We have also requested additional information from Transend to aid our understanding and considerations on its asset renewal programs.

Our analysis of capital expenditure on asset renewal in the current regulatory period (2004 to 2008/09) and the next regulatory period (2009/10 to 2013/14) has involved:

- the high level analysis of the age and replacement lives of key asset classes in the current and next regulatory periods;
- a review of the asset strategies driving the renewal program in the current and next regulatory periods;
- a review of a sample of asset renewal projects Transend has undertaken (or is due to undertake) in the current period; and
- a review of a sample of asset renewal projects Transend has forecast that it will undertake in the next period.

In undertaking our review, we have been mindful of the following:

- the prudency test provided in the ACCC's statement of regulatory principles, which defines the ex post assessment of Transend's capital expenditure in the current period; and
- the capital expenditure objectives, criteria, and factors provided in clause 6A.6.7 of the NER, which defines the ex ante assessment of Transend's capital expenditure forecast for the next period.

1.2. Structure of report

The report is structured as follows:

- In section 2 we provide some historical context to Transend's asset renewal programs presented in its proposal, including a summary of the historical development of the Tasmanian power system, and an overview of relevant matters in Transend's last revenue decision by the ACCC in 2003.
- In section 3 we summarise Transend's asset renewal programs, including the key asset classes and strategies, comparisons between the current and next periods, and the reconciliation with the ACCC's 2003 revenue allowance.
- Our analysis and considerations of Transend's capital expenditure requirements on asset renewal are discussed in Section 4.

- Finally, Section 5 presents our overall findings on Transend's asset renewal in the current and next regulatory periods.

2. Background and appreciation

Transend's proposal indicates that $217 million of its $420 million (nominal) on capital expenditure in the current regulatory period (2004 to 2008/09) has been allocated to the AER's asset renewal category. This suggests a significant overspend in real terms to the forecast used as the basis for the Transend's revenue allowance for this period, which was $307 million ($2002/03) in capital expenditure in total.

Transend's forecast capital expenditure on asset renewal in the next regulatory period (2009/10 to 2013/14) appears to be set to increase further in real terms, with a total capital expenditure on asset renewal of $226 million ($2008/09 – as incurred) over the 5 year period.

To provide some historical context to these matters, this section summarises our appreciation of the historical development of the Tasmanian power system, and the salient matters in Transend's last revenue decision made by the Australian Competition and Consumer Commission in 2003.

2.1. Tasmanian Transmission History

The assets that Transend has replaced in the current regulatory control period and is likely to replace in the next regulatory control period were constructed during the previous century of development of the electricity system in Tasmania. The timing and nature of this historical development has a direct impact on the renewal activity that we see today.

The major development of electricity services in Tasmania began with the installation of power distribution to Hobart's suburbs in 1911 and the creation of the Hydro-Electric Department in 1914. Electrification of areas outside of Hobart began in earnest in the 1940s with the arrival of migrants during and after the Second World War and the great post war development boom. These levels of development continued through to the 1970s.

Tasmania has a climate and geography that is well disposed to the development of hydro-electric power, and the evolution of Tasmania's transmission system has been influenced by the location of geographically dispersed hydro power stations from the load centres.

The 1970s and 1980s saw the rise of the environmental debates and signalled a reduction in the expansion of the electricity network and the end of the dam construction era in the 1990s.

Transend was formed on the dis-aggregation of the Hydro Electric Corporation on July 1, 1998. This resulted in the division of the formerly government owned department into three companies: Hydro Tasmania, which generates the power; Transend Networks, which transmits it across the state; and Aurora Energy, which distributes and sells it to customers.

The late 1990s to the present day has seen significant increases in the replacement of aging transmission infrastructure.

Tasmania joined the National Electricity Market in May 2005 and became electrically coupled with the Australian mainland when the Basslink interconnector commenced commercial operations on 28 April 2006.

Today Transend's transmission system comprises 3,650 circuit kilometres of transmission line connecting power stations to customers in Tasmania and the National Electricity Market. The Tasmanian transmission system includes 47 substations, nine switching stations and two transition stations.

2.2. Transend's previous revenue application

In March 2003, Transend submitted a Revenue Application describing its expenditure plans and revenue requirements from 1 January 2004 to 30 June 2009.

This document set out Transend's principal submission to the Australian Competition and Consumer Commission (ACCC), the regulator responsible for determining Transend's maximum allowed revenue as a transmission network service provider (TNSP).

The ACCC commissioned engineering consulting firm GHD to, among other things, inform the ACCC on the:

- appropriateness of Transend's method to forecast Capex and budgets; and
- adequacy, efficiency and appropriateness of the actual Capex projects planned by Transend to meet its present and future service requirements.

In relation to renewal expenditure, GHD concurred with the majority of the proposed Transend expenditure. However, GHD noted that renewal capital expenditure was mostly developed on the basis of condition assessments, but some asset renewal forecasts remained as age-based. GHD stated that the overall Transend renewal forecast was less than would have been expected on an age-based assessment alone.

GHD expressed the opinion that the renewal capital expenditure should be adjusted for the "*potentially extended life of some assets*"[1]. GHD also identified an error in substation development costs and recommended that the allowance in 2008/09 be reduced by $2.5 million.

GHD also suggested that Transend was expected to "*rapidly develop new approaches to renewals through implementation of new technology, which will deliver reductions in renewals capital expenditure over the* [regulatory period]"[2].

From the overall capital expenditure perspective, GHD considered that Transend had not followed an adequate cost-risk trade-off or budget rationalisation process involving its customers. GHD also identified that Transend had not adequately identified the reliability impacts of the capital works program in the current period.

[1] Capital Expenditure and Asset Base Operational Expenditure and Service Standards - Final Report, GHD – June 2003.
[2] Capital Expenditure and Asset Base Operational Expenditure and Service Standards - Final Report, GHD – June 2003.

GHD considered that the effect of an "*appropriate rationalisation process*" could be the deferral of projects or lower cost/service level solutions to projects, resulting in possible reduction in total capital expenditure.

GHD did not make an expenditure recommendation in relation to the budget rationalisation process. Instead, GHD recommended that the Capex rationalisation process must be assessed on a subjective basis as part of the ACCC's decision.

In its final decision, the ACCC considered that a 10% reduction should be applied to Transend's capital expenditure to reflect an improved budget rationalisation process.

The ACCC also stated that Transend should "*demonstrate that its renewal expenditures are economically justified and that there are no other, more cost effective, alternatives*."[3]

[3] Tasmanian Transmission Network Revenue Cap: Decision, ACCC – 10 December 2003.

3. Transend's asset renewal program

Nuttall Consulting's terms of reference require it to inform the AER on Transend's renewal program, both in this regulatory period and the next. Important matters are:

- the most significant asset classes, and the associated issues, drivers, strategies, and projects;
- comparisons and contrasts between regulatory periods; and
- the reconciliation of asset renewal in the current period with the forecast that underpins ACCC's 2003 allowance.

This section sets out our understandings on these matters, based upon Transend's proposal and the documents made available during the course of the review. The aim of this section is to highlight to the AER the key matters that are most relevant to Transend's asset renewal program and our considerations.

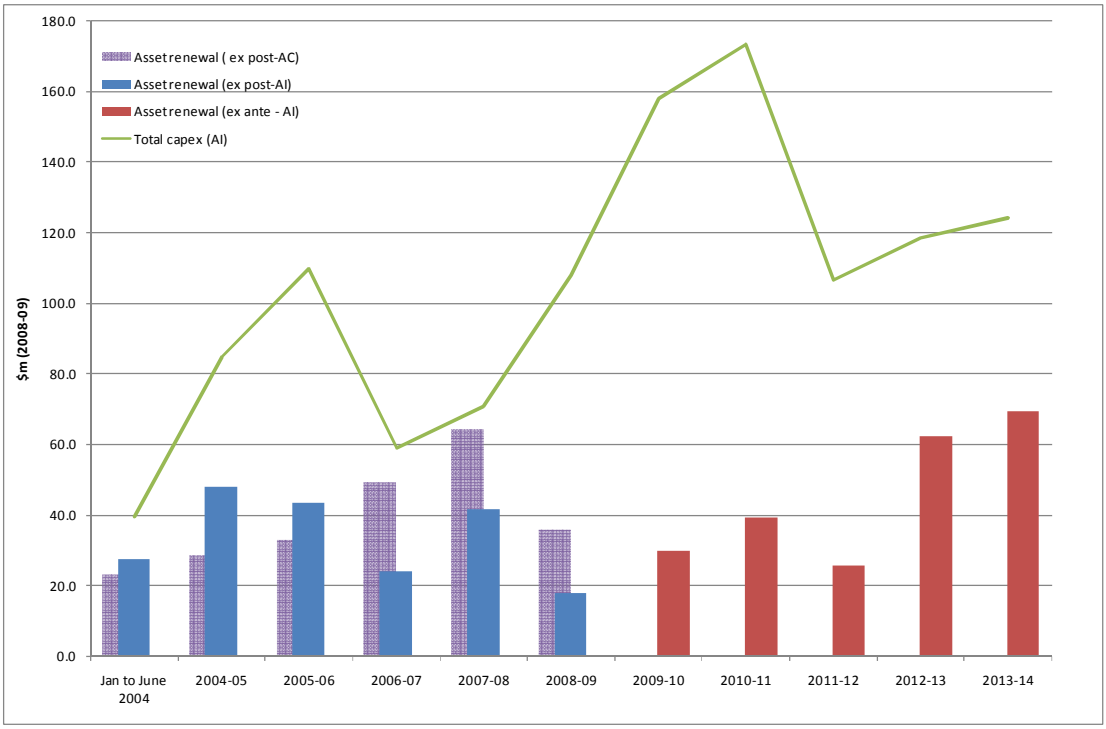
Key documents that have informed this stage of the review are:

- Transend's proposal;
- Transend's Transmission System Management Plan 2007-2012 (Appendix 9 of the proposal);
- the ex post and ex ante project lists in the cost information templates (Appendix 3 of the proposal);
- asset management plans and condition assessment reports provided during the course of the review[4];
- the paper prepared by Transend during the course of the review that provides a reconciliation of the capital expenditure in the current period with the ACCC's 2003 allowance[5]; and
- presentations on key assets and strategies provided by Transend during the course of the review[6].

It is important to note that nothing in this section should be interpreted as our agreement, acceptance or otherwise of any views expressed. Our considerations on these matters will be discussed in the later sections of this report.

[4] Requested Asset Management Plans provided in response to WorleyParson's information request number 18, Condition Assessment Reports were provided with individual projects packs
[5] Provided in Transend email, dated 27/8/08 – Request for information log number 74
[6] Provided in Transend email, dated 12/8/08 – Request for information log number 156

3.1. Overview of Transend's proposal



Key: AC – as-commissioned
AI – as incurred

Figure 1 Transend's asset renewal capital expenditure

Figure 1 shows Transend's asset renewal capital expenditure for this regulatory period and the next, and the total capital expenditure. The asset renewal expenditure in this period is shown "as-commissioned" and "as-incurred" to allow a more meaningful comparison with Transend's forecast in the next period. There are a number of important points that can be deduced from this chart:

- Asset renewal expenditure in the current period is a significant portion of the total expenditure, 43%. This proportion is forecast to decrease significantly in the next period to 33%. However, this reduction is driven by the significant increase in other capex categories, particularly the augmentation and connection categories. For example, if the Waddamana-Lindisfarne augmentation project ($118 million) is excluded from this calculation, then the proportion of asset renewal rises to 40% in the next period.
- The average annual asset renewal expenditure in the next period is forecast to increase by $8.6 million to $45.3 million from the equivalent average over this period of $36.7 million. This represents a 23% increase in asset renewal expenditure.
- There has been a fairly significant peak in asset renewal (as-commissioned) during 2006/07 and 2007/08, but this is less pronounced if viewed as-incurred. This is indicative of the number of larger projects that were commissioned in these years (e.g. Devonport 110 kV development, George Town transformers, Burnie to Port

Latta line reconductor) that we assume would have incurred expenditure in the earlier years.

- Asset renewal expenditure in the first 3 years of the next period is forecast to be at a level lower than the average over this period (14% lower). However, Transend is forecasting a significant increase in asset renewal expenditure in the last two years of the next period, whereby the average expenditure on asset renewal in these years will be 80% greater than the average during this period, and $18 million higher than the peak as-incurred level during this period. This increase is largely driven by the large number of substation redevelopment projects forecast in these years, particularly the redevelopments of the Creek Road and Tungatinah substations.

Transend's proposal provides little discussion supporting the level of asset renewal in the current period or the shape of the profile. The proposal does summarise Transend's views of the major investments during the period[7], identifying 3 programs relevant to asset renewal, namely:

- the high-voltage (HV) switchgear replacement program, indicating HV switchgear at 11 substations have been replaced during this period;
- substation redevelopments, indicating 6 substations have been redeveloped during this period; and
- the transmission line compliance program, which addresses sub-standard clearance issues with existing transmission lines.

More details of the HV switchgear and substation developments are discussed in the sub-sections below. The transmission line compliance program was approved, commenced and largely completed prior to the current period. The remainder of the general program only resulted in $4.5 million in the early years of this period. Therefore, this program has not been a major focus of our review.

With regard to the prudency of the asset renewal expenditure, Transend considers that its investment governance processes described in its proposal "*demonstrate that Transend has the robust processes in place to ensure that prudent and efficient investments are made at the right time*"[8].

With regard to Transend's forecast asset renewal expenditure in the next period, the proposal states that:

"*The asset renewal program is a long-term program that comprises a combination of targeted asset replacements and substation redevelopment projects that are critical to sustaining transmission system performance and the reliability of electricity supply to customers. This program is a continuation of the comprehensive asset renewal program that has progressed in the current regulatory control period. A number of asset renewal projects have been deferred from their optimal timing early in the forthcoming regulatory control period, primarily because of access constraints to the transmission system while the Waddamana–Lindisfarne 220 kV transmission line is being constructed.*"[9].

[7] Table 4.5 pg 42, of Transend's proposal
[8] Section 4.4, pg 42, of Transend's proposal
[9] Section 5.7.2, pg 89, of Transend's proposal

With regard to the explanation for the increase in average asset renewal from the level in the current period, the proposal states that this is due to the "*continuation of established asset renewal programs, but with increasing input costs*"[10].

The drivers for capital expenditure are discussed[11], noting a range of factors most relevant to its asset renewal needs, including:

- asset condition and performance where it considers it has "*comprehensive condition assessment and performance monitoring regimes in place that provide a detailed understanding of condition and performance of its assets*";
- the "*availability of spare assets and parts, together with adequate product support from manufacturers has a significant impact on system performance, particularly in the event of asset failure*";
- "*(r)enewal driven by technical obsolescence is particularly relevant to secondary systems due to issues encountered when interfacing new equipment with existing equipment*"; and
- "*(c)ompliance with technical, safety and environmental obligations*", which it considers is critical to meeting its "*licence obligations as well as sustaining a reliable, safe and secure electricity supply*".

The methods of determining the need for asset renewal and the development of solutions are also discussed[12]. With regard to the need it states that the "*detailed assessment of asset condition and performance ... together with feedback from product suppliers regarding spare parts availability and obsolescence, forms the basis for developing the asset renewal component of the capital expenditure forecast*". It then goes on to say that "*potential solutions are identified, scoped and high level cost estimates prepared to enable the net cost of each viable alternative option to be analysed and assessed*"[13].

3.2. Strategies, processes, procedures

Transend has continued to develop its asset management processes over the current regulatory control period. Transend has developed an asset management framework that is modelled around the total asset management process described in the International Infrastructure Management Manual (IIMM[14]).

Transend has also developed, and continues to refine, its asset management information system (AMIS) program. The objective of the AMIS program is to "*deliver improved business systems and business processes to further improve the efficiency of asset management activities on an ongoing basis*"[15].

The following figure (Figure 2) provides an overview of Transend's approach to asset management and the documents that support the process. It is clear from the documentation

[10] Table 5.17, pg 94, of Transend's proposal
[11] Section 5.5.1, pg 65, of Transend's proposal
[12] Section 5.5.2 and 5.5.3, pg 66-68, of Transend's proposal
[13] Ibid
[14] http://www.ipwea.org.au/AM/Template.cfm?Section=Member_Services
[15] Transend Transmission Revenue Proposal for the Regulatory Control Period 1 July 2009 to 30 June 2014.

provided by Transend that this is an area where significant effort has been placed into developing and improving the information in the respective documents. The diagram highlights the hierarchy and linkages between the strategic, tactical and operational planning documentation.

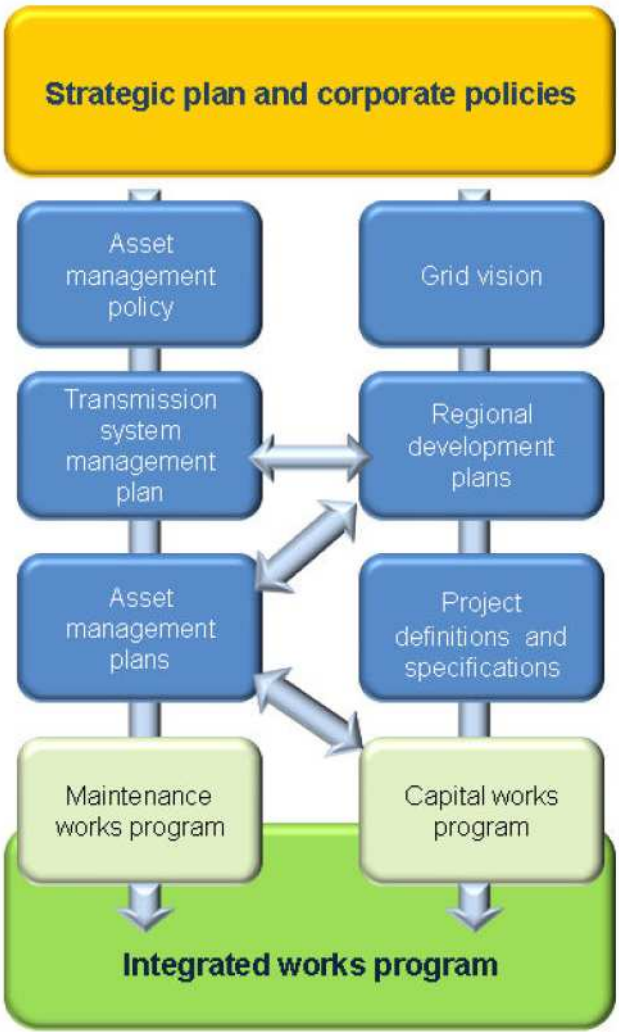


Figure 2 Transend's asset management documentation[16]

Renewal and refurbishment processes are identified and linked at each level of the document hierarchy. Examples of renewal consideration include the following:

- The Transend Strategic Plan 2008 identifies the criteria for the assessment of renewal expenditure as "Replace or enhance existing plant based on economic justification (incorporating consideration of safety, compliance and customer requirements)."
- Transend's Transmission System Management Plan (TSMP) identifies the integration of renewal processes with development and augmentation processes and provides specific high-level details of a number of asset replacement programs.
- The regional development plans deal predominantly with augmentation projects for each of the five Transend regions.

[16] Copy of Fig. 3.1, pg 29, of Transend's proposal .

The identification of renewal projects is articulated in the asset management plans. These plans provide coverage for major asset classes and include assessments of condition, performance, risk and expenditure. The objectives of the asset management plans (generally) include:

- maintain business risk to within acceptable limits;
- achieving reliable performance consistent with prescribed service standards;
- quantifying the risks and identify corresponding risk mitigation strategies;
- ensuring the effective and consistent management and coordination of asset management activities throughout the asset life-cycle;
- demonstrating that assets are being managed prudently throughout their lifecycle;
- ensuring asset management issues and strategies are taken into account in decision making and planning; and
- defining future operation and capital expenditure requirements.

The capital works program is composed of individual capital projects that have been developed to meet the criteria identified and developed in the above documentation.

3.2.1. Project evaluations, justification and approval

Renewal projects are identified, developed and assessed at the business unit level. Transend has developed a number of processes and systems to support consistency and quality of information that is collected and presented to support project decision making. These include:

- Business case manual - Transend uses the business case as a mechanism to enable decision-makers to analyse the rationale for the project, assess the economics of the project (financial and strategic), analyse the impact of the project and compare impacts against other factors.
- Investment Evaluation of Network Projects[17] (process guidelines) - Transend's investment decision process encompasses the evaluation and consideration of:
  - all relevant investment factors including legislation, regulation, policies, service level outcomes, network availability and reliability, and internal standards;
  - whole-of-life cycle cost and benefit analysis, including capital and operating cost trade-offs (using discounted cash flows);
  - asset replacement and augmentation investment optimisation;
  - opportunities to maximize synergies and efficiencies through consolidation or project grouping;
  - improved service and system security;
  - greater customer responsiveness and the long-term interests of both electricity consumers and the power system;

[17] This guideline was approved in July 2008.

- efficiency and prudency; and
- alignment with priorities contained in Transend's Strategic Plan.

The investment evaluation process also identifies that the NPV criterion is the preferred one in decision making regarding capital work projects.

- Transend delegation framework, which provides principles, guidelines and general governance for Transend's delegations as well as general and reserved functions.
- Investment process governance framework, which summarises the current Transend investment process and specifies responsibilities and approvals.

In 2005, Transend implemented a Capital Review Team (CRT) to support the decision-making associated with investment-planning . The stated purpose of the CRT is to assist the Managing Director (MD) in his corporate governance and oversight responsibilities in relation to the management of the capital plan and investment decisions.

The scope of the CRT is to:

- provide advice to business case authors based on a synopsis of a business case;
- review and endorse business cases that are submitted for MD or board approval, and amend as appropriate, to ensure consistency and completeness of information to support and justify the recommendations;
- review the overall capital program on a quarterly basis (or as required) to identify any issues that may have an impact on the successful delivery of the program, and to suggest revisions to the program as required;
- review completed prudency check lists and project finalisation reports;
- assist the Manager System Development in prioritisation of individual projects contained in the capital program should any conflicts arise; and
- identify areas for improvement in the whole project delivery process.

3.3. Asset management strategies

Information on Transend's current assets is contained within the Transmission System Management Plan 2007-2012[18]. This document discusses the asset population, the main issues, and strategies to address the issues, by each asset class. More detailed information has been provided during the review in the form of individual asset management plans (AMPs) for the main asset classes[19].

The assets and associated strategies can be considered as falling into two main categories: substations and lines. Table 1 indicates the approximate proportion of asset renewal associated with these two categories in the current and next regulatory periods. This shows that the major focus of Transend's renewal program is on substation assets.

[18] Appendix 9, of Transend's proposal.
[19] Transend has provided the most important AMPs for the renewal review. It is Nuttall Consulting's understanding that the other AMPs are still being reviewed by Transend.

Table 1 Asset renewal on substation and lines

	Current period $m (nominal)	Next period $m (2008/09)
Transmission lines	52.8	58.5
Substations	164.2	168.1

There are a number of key asset classes that are a significant driver of the asset renewal program on substation assets. These are:

- **Power transformers**, covering the network transformers (220/110 kV) and supply transformers (110 kV/HV i.e. the connection voltage of customer)
- **EHV circuit breakers**, which switch Transend's main transmission voltages of 220 kV and 110 kV
- **HV switchgear**, which switch Transend's various HV connection voltages of 6.6 kV to 44 kV.

These form the key asset classes, partly due to their significant value in the make-up of a substation, but also as often their replacement is a significant factor for timing the replacement of other poor performing assets in a substation.

The other main substation asset classes that form the asset renewal program are:

- Other primary assets, including instrument transformers (VTs and CTs), disconnectors, post insulators, and busbars and structures
- Secondary assets, including protection and control systems, auxiliary supplies (AC and DC supplies), and SCADA systems.

The main asset classes associated with the renewal programs for transmission lines cover conductors, insulators, structures (e.g. towers and poles), and the structure foundations.

The renewal strategies associated with these substation and transmission line asset classes are targeting older vintage assets. The TSMP and AMPs detail a range of issues associated with each asset type. Broadly, these issues fall within the following three main categories:

- **Condition** - either in terms of the poor condition of the assets and the risks of failure, or the effort to maintain acceptable condition;
- **Substandard design, arrangements, or performance** - often resulting in assets and associated facilities not meeting current standards or practices (e.g. in terms of performance, safety and the environment); and
- **Fleet management** – which covers matters such as, technology obsolescence, lack of manufacturing support, unavailability of spares, and unavailability of suitably skilled resource.

These asset issues in turn result in higher maintenance costs and poorer system performance (e.g. supply reliability and circuit availability), and affect the risk profile of the business (e.g. safety, environmental, system performance).

It is also important to note that the OPGW program, included in the transmission line strategies, relates to the roll out of earth wires with optical fibres on existing transmission line. The earth wire provides protection to the transmission line to lightning strikes, improving the performance of the system. However, the optical fibre component is used for communication purposes. The important point here is that the majority of this program, and its major driver, does not relate to the renewal needs of existing earth wires. Instead, the main driver is the need for redundancy/diversity in Transend's communication system, with the secondary benefit of the earth wire coverage this solution provides.

Due to the significance to Transend's asset renewal expenditure of the strategies associated with EHV circuit breakers, HV switchgear, power transformers and protection, these asset classes are discussed in more detail below.

3.3.1. EHV circuit breakers

Overview of strategies

Transend currently has 314 EHV circuit breakers: 79 at 220 kV and 235 at 110 kV. Since the late 90s, Transend has been undertaking the renewal of its older EHV circuit breakers. This began with a strategy to replace the air blast and bulk oil breaker types, particularly targeting the 220 kV system. The 220 kV program was largely completed before this period, and appears to have contributed to the significant improvement in the performance of the network up to that time.

The strategies most relevant to the current period and the next concerns the completion of the 110 kV air blast and bulk oil programs, and the commencement of the replacement of the older 110 kV minimum oil breakers. The two most significant types for our review are the Reyrolle OS10 and Sprecher and Schuh HPF.

Population and population changes

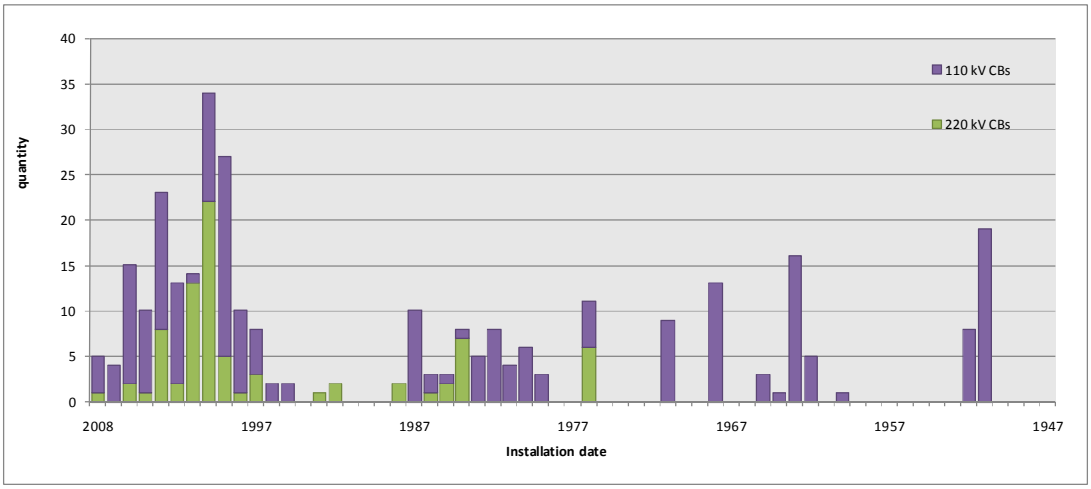


Figure 3 EHV circuit breaker installation profile

Figure 3 shows the installation dates for the current EHV circuit breaker population[20]. The following important points can be deduced from this age profile:

- There had been a lack of investment in the late 80s to mid 90s.
- There was a significant increase in investment, particularly in the 220 kV network, from the late 90s, which then tailed off up to the beginning of this regulatory period. Due to this renewal program, the oldest 220 kV breaker is only 32 years old. Moreover, 70% of the 220 kV breakers are only 10 years or younger.
- There has been a more modest, but still significant, level of investment in the current period, particularly on the 110 kV network. Due to the 110 kV renewal program to date, 47% of the 110 kV breakers are 10 years or younger.
- The Reyrolle OS10 breakers (53 breakers) are the oldest breakers remaining on the network, with an age of between 43 and 57.
- The Sprecher and Schuh HPF (20 breakers) represent one of the next oldest types, with an age of between 31 and 40.

Furthermore, 31 EHV circuit breakers (10% of the population) have been, or are due to be, replaced in the current period. 8 of these are the remaining air blast and bulk oil breakers. The remaining 23 relate to the minimum oil programs, including 14 of the Sprecher and Schuh breakers and 2 of the Reyrolle breakers.

The majority of the remaining Reyrolle and Sprecher and Schuh breakers (approximately 65 of the remaining 73) are forecast to be replaced or decommissioned during the next regulatory period. Table 2 indicates the average age of the 220 kV and 110 kV breakers at the start of this period, at the end of this period, and the end of the next period, based upon Transend's current and forecast renewal program.

Noting that even a conservative estimate of a typical life for a EHV circuit breaker may be 40 years, the important points from this table are:

[20] Based upon the circuit breaker age profile provided by Transend in the email dated 14 August 2008 - Request for information log number 160.

- the young age of the 220 kV population due to the past renewal program, which has reduced by a modest 4 years during this period, but is due to increase by around 5 years during the next period – although remaining still at a modest level overall.
- the much older age of the 110 kV population, but the much more significant reduction in age during the current period; and
- the further significant forecast reduction in the age of the 110 kV population during the next period, effectively to an average age that is 15 years younger than that entering the current period.

Table 2 EHV circuit breaker average age changes

	2003	2008	2014[21]
220 kV	16	12	18
110 kV	30	23	15

Issue, drivers and projects

The table below indicates the substations where the most significant renewal of EHV circuit breakers has, or is forecast to, occur.

Table 3 EHV circuit breaker projects

Type	Current period	Next period
Sprecher and Schuh	Devonport, Savage River, Sheffield, Ulverstone	Burnie, Emu Bay, Paloona, Port Latta, Railton, Wesley Vale
Reyrolle	Kermandie	Creek Road, Tungatinah, Burnie, Arthurs Lake, Knights Road, Meadowbank, Palmerston, Rosebery, Temco
Other	Waddamana	

Due to the significance of the Sprecher and Schuh and Reyrolle renewal programs to this review, further details of these two programs are discussed separately below.

- ***The Sprecher and Schuh replacement strategy*** A major factor driving the Sprecher and Schuh 110 kV HPF replacement strategy concerns the performance of this breaker type. These circuit breakers are considered to be the most unreliable circuit breaker in Transend's EHV fleet. Due to these reliability issues, these breakers are inspected after every operation.

  The breakers also have high maintenance costs and are no longer supported by the manufacturer's agent, and as such, the availability of spares is an issue.

[21] Estimated by Nuttall Consulting based upon Transend's age profile. This does not include new circuit breakers via augmentations or connections during the next period, and as such, it should be a conservative estimate i.e. the actual average age would be younger.

That said, the breakers do not appear to have any significant safety or environmental issues.

- ***The Reyrolle OS10 replacement strategy.*** A major factor driving the Reyrolle OS10 replacement strategy is the maintenance costs associated with this breaker type. Preventative maintenance costs are approximately 4 times greater than a new breaker. There are also ancillary systems associated with these breakers that require regular maintenance, and safety hazards due to the pressure vessels required to operate these breakers and the possible failure modes of the breaker.

  The breakers also have reliability issues, although not to the extent of the Sprecher and Schuh breakers. Similar to the Sprecher and Schuh breakers, these breakers are no longer supported by the manufacturer's agent and have associated fleet management issues.

Clearly, from the above, the impact of these renewal programs should be to improve network service levels and reduce existing maintenance costs. It would also be expected that these strategies would reduce overall risks associated with system performance and safety.

3.3.2. HV switchgear

Overview of strategies

Transend currently has 525 HV switchbays: 505 indoor and 20 outdoor. A strategy to renew the HV switchgear has been ongoing since 1999. As with the EHV circuit breakers, the initial focus of this program prior to this regulatory period was the older air blast switchgear. The focus during this period has been on the outdoor oil insulated switchgear and a number of indoor types. The majority of this renewal program has occurred in this regulatory period, with a smaller amount forecast to occur in the next.

Population and population changes

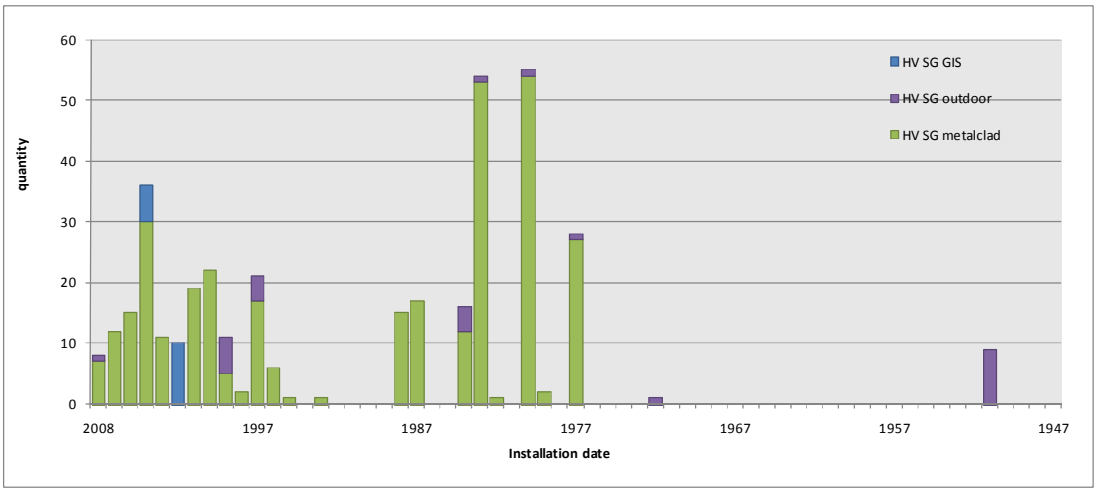


Figure 4 HV switchgear installation profile

Figure 4 shows the installation dates for the current HV switchgear population. The following important points can be deduced from this age profile:

- As with EHV circuit breakers, there had been a lack of investment in the late 80s to mid 90s.
- There was a significant increase in investment from the mid 90s in HV switchgear.
- This level of investment has continued through this regulatory period. Due to the HV switchgear renewal program to date, 55% of the HV switchgear is only 10 years old or younger.
- The 9 outdoor oil insulated switchbays at Tungatinah are the oldest remaining HV switchbays on the network, at an age of 57. The next oldest, significant population is 31 i.e. 26 years younger than the assets at Tungatinah.

Furthermore, 93 HV switchbays (18% of the population) have been or are due to be replaced in the current period, comprising of 55 outdoor switchbays and 38 indoor switchbays. A further 13 switchbays are forecast for replacement in the next period, including the oldest units at Tungatinah.

Table 4 indicates the average age of the HV switchgear at the start of this period, at the end of this period, and the end of the next period, based upon Transend's current and forecast renewal program.

Noting that a conservative estimate of a typical life for modern HV switchgear may be 40 years, the important points from this table are:

- comparing the average age across periods of indoor or outdoor switchgear can be a little misleading as outdoor switchgear is being replaced with indoor units;
- there has been a relatively significant 10 year reduction in the average age of the population during the current period, driven by the significant replacement program; and
- as this program is at a much reduced scale in the next period, the average age is increasing during this period by approximately 5 years; however, it is still much lower than the age at the commencement of this period.

Table 4 HV switchgear average age changes

	2003	2008	2014[22]
Outdoor	34	34	n/a
Indoor	22	11	13
Overall	27[23]	13	18

Issue, drivers and projects

The table below indicates the substations where the renewal of HV switchgear has, or is forecast to, occur.

[22] Estimate by Nuttall Consulting based upon age profile. This does not include new circuit breakers via augmentations or connections during the next period, and as such, it should be a conservative estimate i.e. the actual average age would be younger.
[23] Indicative estimate by Nuttall Consulting.

Table 5 HV switchgear projects

	Current period	Next period
Outdoor	Burnie, Derby, Devonport, Electrona, Kermandie, Queenstown, Scottsdale, Triabunna	Tungatinah, Rosebery
Indoor	Lindisfarne, Palmerston, Port Latta, Savage River, and Wesley Vale	

A major issue with the outdoor HV switchgear concerns risks to the safety of personnel within the switchyard. In this regard, the current arrangements are not up to current standards with respect to safety clearances. As such, these switchyards have a greater electric shock hazard to personnel within the site.

The indoor switchgear also has certain design aspects that are not up to current standards (e.g. arc fault containment). These issues increase the risks to personnel safety and system performance during a fault of the switchgear.

The condition and fleet management issues, such as lack of manufacturing support, and difficulties with the availability of spares for the various switchgear types, is also resulting in poorer performance and higher maintenance costs compared to new units.

3.3.3. Transformers

Overview of strategies

Transend currently has 109 power transformers. This population consists of:

- 16 network transformers (220/110 kV) ranging in rating from 90 MVA to 200 MVA; and
- 94 supply transformers (110/HV) ranging in ratings from 4 MVA to 90 MVA, with an average rating of 33 MVA.

A strategy to replace older network and supply transformers has been ongoing since the late 90s. This has essentially targeted transformers based upon accepted transformer condition assessment practices.

The replacement of transformers due to condition is forecast to reduce from the levels replaced during this regulatory period.

Population and population changes

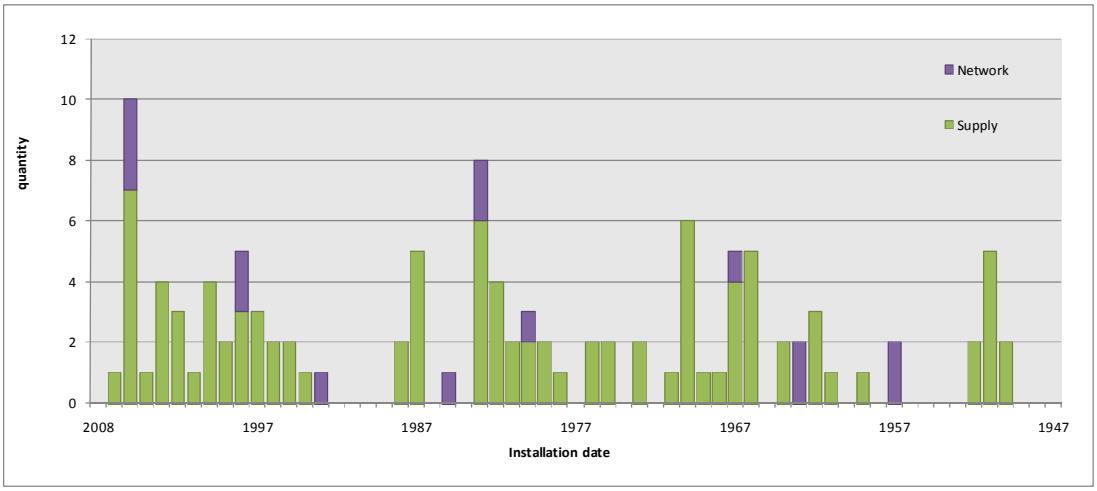


Figure 5 transformer installation profile

Figure 5 shows the installation dates for the current power transformer population. The following important points can be deduced from this age profile:

- As with switchgear, there had been a lack of investment in the late 80s to mid 90s.
- There was a significant increase in investment in transformers from the mid 90s.
- This level of investment has continued through this regulatory period. However, the proportion of young transformers within the population is not as prominent as the EHV circuit breakers and HV switchgear, whereby only 33% of network transformers and 26% of supply transformers are 10 years old or younger.
- There are 4 network transformers and 18 supply transformers over 45 years old (20% of the population). The oldest transformers are 58 years old.

Furthermore, 12 transformers (11% of the population) have been or are due to be replaced in the current period, comprising of 5 network transformers and 7 supply transformers. A further 3 transformers are forecast for replacement due to their condition in the next period, comprising 1 network transformer and 2 supply transformers.

Table 4 indicates the average age of the transformers at the start of this period, at the end of this period, and the end of the next period, based upon Transend's current and forecast renewal program.

Noting that a conservative estimate of a typical life for modern transformers may be 40 years, the important points from this table are:

- there has been a relatively significant reduction in the average age of the network transformers during the current period; however, the average age is forecast to be maintained during the next period; and
- the average age of supply transformers increased marginally during the current period, and is forecast to increase further during the next period.

Table 6 Power transformer average age changes

	2003	2008	2014
Network	32	24	24
Supply	25	27	31

Issue, drivers and projects

The table below indicates the substations where transformer replacements have occurred or are forecast to occur in the current and next periods (brackets indicate the number of replaced transformers).

Table 7 Power transformer projects

	Current period	Next period
Network	Chapel Street (3), George Town (2)	Burnie (1)
Supply	Derwent Bridge (1), Palmerston (1), Triabunna (2), Que (1), Queenstown (2)	Arthurs Lake (1), Tungatinah (1)

The major issue with power transformers relates to the degradation of the insulation during the life of the asset. This degradation increases the risk of failure in service, which can lead to significant outages and increased system performance risks should a major failure occur.

Transend uses standard transformer condition assessment techniques to predict the likely end of life of each power transformer. Transformers are then replaced in anticipation of this event.

Certain transformer types also have other technical and design issues that can lower their performance and increase maintenance costs. These issues are not the main drivers for replacement, but can provide additional benefits following replacement.

3.3.4. Protection and control

Overview of strategies

Transend currently has over 5000 protection and control relays. This population consists of:

- 11% of the original electromechanical technology;
- 43% of static/electronic technology; and
- 45% of a modern microprocessor technology.

Transend has had a strategy to replace the poorer performing electromechanical and static relays since the late 90s. To a large extent, this strategy has been incorporated with the projects associated with other renewal programs and other augmentation and connection works. However, targeted replacement has occurred for some poor performing relay types.

Population and population changes

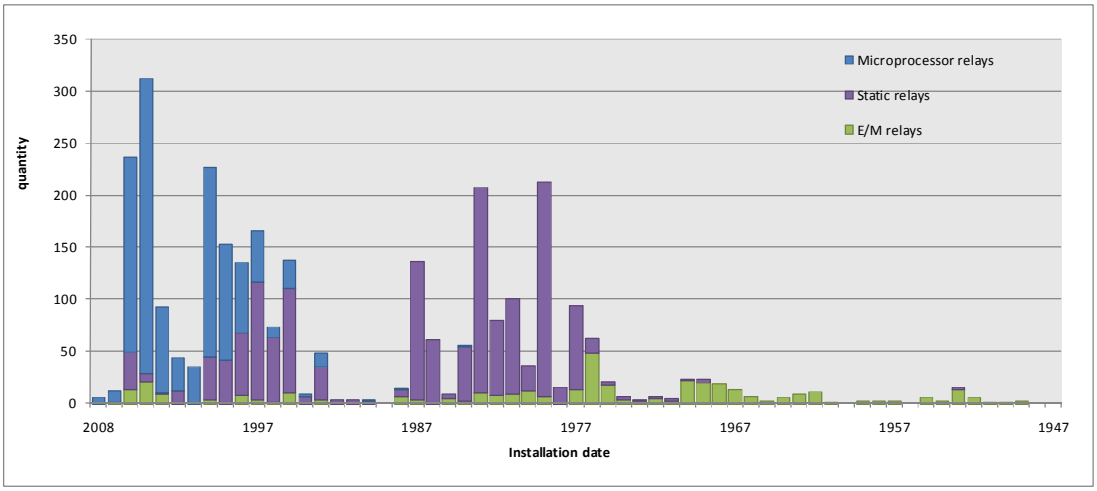


Figure 6 protection and control installation profile

Figure 6 shows the installation dates for the current protection and control population. The following important points can be deduced from this age profile:

- There was a significant increase in investment in relays from the mid 90s. This level of investment has continued through this regulatory period, such that over 50% of the relays have been installed over the last 10 years.
- There is only a small population of very old electromechanical relays (i.e. over 45 years old), but a fairly large population of static relays between 20 and 30 years.

As the renewal of most protection relays occur within other projects, it has not been possible to determine the level of renewal in the current and next regulator period, or the average age changes.

Issue, drivers and projects

Transend considers that its electromechanical and static relays have a number of issues related to their performance and the management of this older obsolete fleet, which consist of many different types and manufacturers.

Furthermore, the design and arrangement of some protection and control schemes and their physical housings do not meet current standards, including certain NER requirements related to the redundancy of the schemes.

These issues mainly affect the cost to maintain the fleet and risks to system performance.

Transend's strategies entail replacing these older relay types with modern microprocessor relays with self diagnostic systems, and ensuring the overall scheme complies with current standards. Generally, these replacements are coordinated with the replacement of associated primary assets (i.e. circuit breakers and transformers) or at the time of other significant works at a substation.

3.4. Projects and expenditure profile

Figure 7 shows the annual profile of Transend's capital expenditure in the asset renewal category in the current and next regulatory periods, with details of the most significant projects in each year. The important points related to this chart are as follows:

- The projects associated with the HV switchgear replacement program make up a significant portion of asset renewal expenditure in the first half of the current period (i.e. up to and including 2006/07). These projects include other strategies, most notably protection and control and other secondary system strategies. In some cases, these projects also include supply transformer replacements.
- From 2006/07 onwards, the EHV (220 and 110 kV) switchyard redevelopments are more significant.
- The Burnie to Port Latta transmission line reconductoring project, in 2007/08, is the largest single transmission line project ($20 million). It is also notable that this project was commissioned in the year during this regulatory period with the largest amount of asset renewal expenditure. Moreover, a significant portion of the $20 million for this project was driven by augmentation needs (see project summary in Section A.5.1).
- The transmission line renewal strategies are mainly contained within a single general program of works in the current period. However, in the next period, the works program is broken down into individual strategies related to various asset classes.
- The substation redevelopment projects in the first 3 years of the next period mainly relate to the Sprecher and Schuh circuit breaker replacement strategy.
- The substation redevelopment projects in the last 2 years of the next period mainly relate to the Reyrolle circuit breaker replacement strategy.
- A significant level of forecast expenditure in the last 2 years of the next period, $48 million in total, relates to two substation redevelopment projects: Creek Road 110 kV and Tungatinah 110 kV.

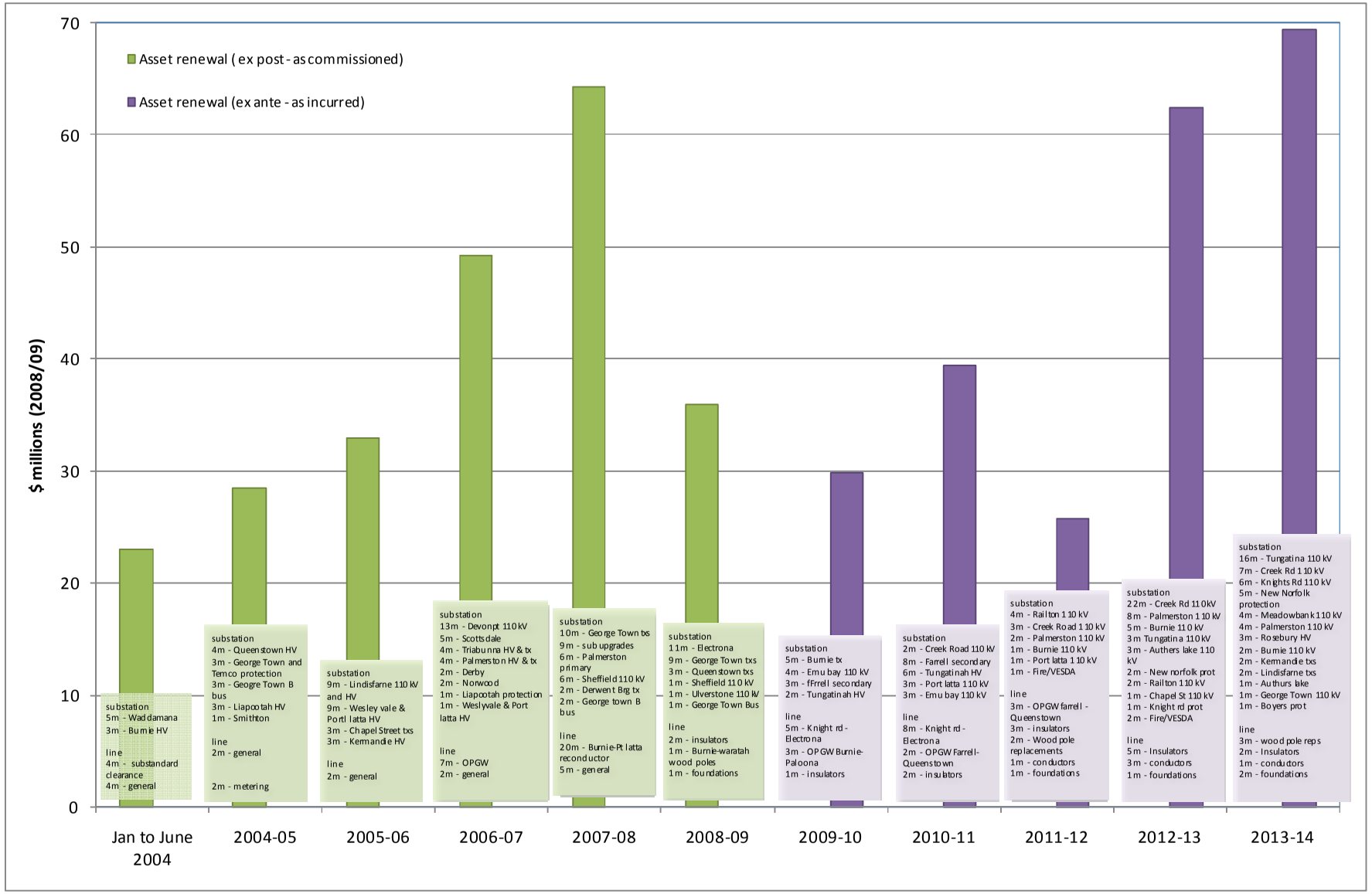


Figure 7 Asset renewal capital expenditure and significant projects and programs

3.5. Impact of renewal on risk levels

The Transend proposal identifies that risk management is a key function and is considered at all levels of the business and across all processes, including renewal. The Transend proposal does not directly address the overall quantum of business risk as it relates to renewal expenditure levels. However, the following points may be useful as qualitative gauges of the affect of renewal on Transend's business risks.

- It would be expected that the 220 kV circuit breaker renewal program that commenced in the late 90s, and was largely completed prior to this period, would have reduced risks on system performance. It is assumed that this program must have had a significant impact on the reduction in Transend's contribution to "system minutes off supply" that has occurred since the mid 90s.
- The HV switchgear renewal program is partly driven by safety concerns. As such, it would be expected that the scale of this program during this period must have reduced overall safety risks considerably, at least for HV substations.
- Finally, it is assumed that the large level of targeted replacements that have occurred since the late 90s would have removed many of the assets that were identified as high risk at that time.

Detailed information on Transend's risk-focused systems and processes is provided in the Transend Strategic Plan (2008). This document identifies that Transend's risk management processes are governed by its risk management policy and risk management framework documents.

The Transend audit and Risk Committee is responsible for reviewing and endorsing these documents, which are periodically approved by the board.

The risk management policy established the expectations of management in relation to risk management. The risk management framework outlines the structures, responsibilities and processes that are established in Transend to ensure its risk management objectives are met.

Transend conducts a formal business risk review every two years to identify and evaluate the key risks facing the business. The most recent review was undertaken by Ernst and Young and completed in 2007.

The 2008 Strategic plan identifies that the 2007 Strategic Business Risk Review was considered by the board in September 2007[24]. There is evidence of the use of the 2007 Strategic Business Risk Review in subsequent business cases.

The 2007 Strategic Business Risk Review identifies four business risks that have increased since 2005, one that has reduced and three that are no longer applicable. The identified business risk relate primary to transmission system augmentations and not renewals[25].

[24] Transend has advised that the 2007 Strategic Risk Review was accepted by the Board in September 2007 – Email "Draft Nuttall Consulting Report - Asset Renewals" dated 16 October 2008.
[25] Email "Draft Nuttall Consulting Report - Asset Renewals" dated 16 October 2008.

3.6. Reconciliation of asset renewal expenditure in the current period to the ACCC's 2003 allowance

Based upon a simple comparison between the renewal categories in the 2003 ACCC decision and the overall renewal category in the cost information template associated with the proposal (i.e. asset renewal, physical security, inventories/spare, and operational support) then it appears that Transend has overspent the renewal portion of the allowance by approximately 60%.

Transend's proposal provides summary information to meet the NER requirements regarding the 2003 allowance and its asset renewal expenditure proposed in the current period. Both Worley Parsons and Nuttall Consulting requested that Transend provide a detailed reconciliation of expenditure over the periods[26]. In response to this, Transend prepared a paper to address this matter[27].

This section summarises the main points raised by Transend in this paper.

- **Overall capex overspend**. Across all capital expenditure categories, Transend considers that it has overspent in real terms by only 21% ($78 million), of which 12% ($45 million) is due to input cost (labour and material) escalations above CPI during the current period.
- **Not renewal elements**. With regard to the renewal component, Transend has advised that it is difficult to reconcile with accuracy as the forecast of renewal expenditure in its 2003 application was based upon an asset class programs of work, whereas the actual projects reported in the proposal involve multiple asset classes related to the project location (e.g. a specific substation). Furthermore, many projects include elements associated with other expenditure categories, most notably augmentation and connections. Based upon an analysis of these non-renewal components in each project, Transend estimates that actual renewal is only 13% above the 2003 ACCC allowance, in real terms.
- **Non asset renewal changes**. The main change in the components of renewal outside the asset renewal category (i.e. physical security, inventories/spare, and operational support) appears to have occurred to expenditure on physical security (which is not part of our review scope). The substation physical security strategy has increased from an estimate of $9.4 million used in the 2003 application to cost of $25.3 million.
- **Categorisation**. Transend considers that some elements of renewal in the proposal where not classified as renewal in the 2003 application. The two most significant examples of this were as follows:
  - The Burnie-Port Latta line reconductor ($20 million in the proposal) was recognised as having some element of renewal in the 2003 application, but was

[26] Requested in the Nuttall Consulting email dated 15/7/08. It is our understanding that the initial request on this matter was provided by WorleyParsons.
[27] Provided in the email dated 6/8/08 - Request for Information log number 74, and then revised by Transend to include asset renewals and resubmitted in the email dated 27/8/08.

identified as a "variable" augmentation project due to the uncertainty in the level of additional capacity the line would require[28].

- Elements of the George Town 3rd network transformer installation (approximately $4.4 million) are part of the George Town network transformer replacement project. However, these elements do not represent a replacement of a transformer, rather they had been identified during the current period as a method of improving the security of the system during the replacement project.

- **Project movements**. Transend has advised a number of significant movements of projects that have either advanced projects into the current period or deferred projects into the next period. These are:

  - **Deferred projects**. Both the Creek Road and Tungatinah substation redevelopment projects were included in the 2003 application ($22.3 million). Both of these projects have been deferred into the latter half of the next period. This deferment was due to the need to coordinate with other development projects, particularly the Southern Power System Security program. In the case of Tungatinah, consultation with the associated customer also appears to have had a significant role in the deferment of this project.

  - **Advanced projects**. A number of projects have been advanced, most notably the Electrona and Sheffield substation redevelopments ($18 million). The Sheffield project has been advanced due to the re-prioritisation of the Sprecher and Schuh EHV circuit breaker strategy, due to the poor performance of these breakers.

- **Estimation accuracy**. Transend considers that its estimates that formed the 2003 application were too simplistic and underestimated the level of work. The projects most significantly impacted by this was the Devonport substation redevelopment, which was estimated as $5.9 in the 2003 application but cost $14.3 million.

  It is also worth noting that the Creek Road and Tungatinah substation redevelopments, which were deferred from the current period, both have a significantly increased estimate from that assumed in the 2003 application, $22.3 million to $53 million. Transend has advised this is due to more recent evaluations of issues not considered in the previous estimate (e.g. cost escalation factors, refinement of project scope, space restrictions and costs associated with outage management during construction). These have resulted in the redevelopments most likely requiring an indoor GIS design.

[28] Section 2.3.2, Appendix 6 of Transend's 2003 revenue application

4. Nuttall Consulting's analysis and considerations

This section discusses Nuttall Consulting's analysis and considerations that support our views and findings on Transend's asset renewal capital expenditures. This section covers matters concerning asset renewal in the current and next periods. Our overall views and findings are provided in Section 5.

This section discusses, in turn, our assessment of the following:

- high level analysis and benchmarking of the key substation asset classes;
- the review of the asset renewal strategies and associated plans;
- the review of a sample of Transend's projects in this regulatory period that have been classified as asset renewal; and
- the review of a sample of Transend's projects forecast for the next regulatory period that have been classified as asset renewal.

4.1. High level analysis and benchmarking

We estimate that Transend is renewing substation assets in the current and next period at the rate of approximately 4% of the replacement cost[29]. The equivalent rate for transmission lines is only around 1%. Long term investment at this level indicates an average life of around 25 years for substation assets and 100 years for transmission lines.

This demonstrates that Transend's renewal focus is on substation assets. Furthermore, noting that substation assets may have typical lives of 40 to 60 years, this indicates that Transend's renewal of substation assets is presently higher than the long term average.

Table 8 shows our analysis of the ages and lives of the 3 main substation assets[30]. This table indicates the average age of the various populations at particular points in time, the average replacement life of assets in the current and next periods, and two typical benchmark lives for comparative purposes. The benchmark lives are based upon:

- **NZ**. The asset lives applied in New Zealand for regulatory valuation purposes[31].
- **UK**. Average replacement lives developed to review the replacement forecasts of the UK electricity distribution businesses[32].

[29] This is based upon our allocation of asset renewal project expenditure to either substations or transmission lines (see Table 1), and information on the replacement cost of these two categories provided in Transend's latest statutory valuation (see Table 1 on page 3 of the valuation report), provided in the Transend email, dated 16/7/08 – Request for Information Log number 102.
[30] This has been produced based upon average age information extracted from presentations provided by Transend (see Transend email dated 12/8/08 – Request for Information Log numbers, 156, 159) and asset age profiles provided by Transend (see Transend email dated 14/8/08 – Request for Information Log number 160).
[31] 2004 ODV Handbook, available on the Commerce Commission, NZ, website.

Table 8 Benchmark ages and lives

	Average age			Average life		Benchmark lives	
	2003	2008	2014	current	next	NZ	UK
HV SG	27	13	18	41	51	45	52/53
EHV CB - 220 kV	16	12	18	42	52	45	49
- 110 kV	30	23	15				
Transformers: Network	32	24	24	50	49	55	55
Supply	25	27	31				

This analysis indicates the following:

HV switchgear

- The average age at the beginning of the period was reasonably high, 50-60% of the benchmark lives. However, the reduction in average age during this period appears aggressive, reducing to around 25 to 30% of the benchmark lives.
- The average age in the next period should rise, based upon Transend's forecast level of asset renewal.
- The average life of the replaced assets in the current period is lower than the benchmark lives, particularly the UK benchmarks. This also supports the view that the HV switchgear replacement program in the current period may have been too aggressive.
- The average life of the assets forecast by Transend for replacement in the next period is significantly higher. These lives are at the top end of the benchmarks, indicating a far more reasonable level of replacement.

EHV circuit breakers

- The average age of the 220 kV circuit breakers was relatively low at the commencement of the current period, but still reduced further during this period. However, only one 220 kV circuit breaker was replaced, and so, the reduction appears to have been driven by new circuit breakers being installed through the augmentation program. It is also worth noting that, based upon benchmarking analysis provided by Transend during the review (ITOMs 2003 and 2007 analysis)[33], Transend presently has one of the youngest population of 220 kV circuit breakers amongst its peers.
- The average age of 110 kV circuit breakers at the beginning of the period was reasonably high, 61-66% of the benchmark lives. Transend's ITOMs 2003 analysis indicated that Transend had one of the oldest 110 kV populations amongst its peers.

[32] PB Power report, DPCR4 – FBPQ ANALYSIS AND CAPEX PROJECTIONS, 2004, available from OFGEM, UK

[33] Graphs of ITOMs benchmarking provided in the email dated 12 August 2008 – Request for Information Log numbers, 156

- However, the average life reduced significantly during the period, although it is still at around 47-50% of benchmark lives. The ITOMs 2007 analysis indicates that Transend's 110 kV circuit breaker population is still amongst the oldest of its peers. This supports the view that the level of renewal of 110 kV circuit breakers during this period was reasonable.
- That said, the average life of the replaced circuit breakers was lower than the benchmark lives.
- With regard to the next period, Transend's forecast level of asset renewal appears to be driving the average age of the 110 kV breakers down significantly further. Based upon the ITOMs 2007 analysis, the age at the end of the next period would result in Transend's 110 kV breaker population being one of the youngest of its peers, assuming that the overall age profile across the peer group remains similar to the 2007 analysis. This is a significant movement over one regulatory period. This supports the view that Transend's forecast level of EHV circuit breaker renewals in the next period may be too aggressive.
- However, the average life of the forecast breakers for replacement is higher than the benchmark lives, which supports the view that the forecast replacements may be reasonable.

Power Transformers

- The average age of network transformers has reduced during the current period. However, this reduction is from 58% to 44% of the benchmark lives, which does not appear unreasonable.
- Conversely, supply transformers have increased in average age marginally, from 45% to 49% of their benchmark lives.
- The average life is lower than the benchmark lives. Noting the reduction in the age of the network transformers, this could suggest an aggressive level of replacement.
- In the next period, the average age of network transformers is forecast to be maintained, while the age of supply transformers is increasing. The average life of the replaced transformers however is still lower than the benchmark lives.

In summary, the above analysis indicates that in the current period, the level of the renewal of HV switchgear and network transformers may have been too aggressive. In the next period, Transend's forecast level of renewal of the 110 kV circuit breakers may be too aggressive.

Furthermore, the reduction in average age across all asset classes during the current period, except supply transformers, suggests that overall risks related to substations may have reduced during this period. Noting the scale of the reduction, it may also be reasonable to assume that this would be visible in terms of improved system performance and reductions in average per unit maintenance needs during this period.

4.2. Review of asset management strategies

Nuttall Consulting has reviewed the TSMP and individual AMPs provided[34]. While we cannot claim that this review has been exhaustive in any way across the full set of asset management plans; broadly, we have seen no evidence that it is not prudent for Transend to be considering these strategies.

In this regard, the strategies appear to target older and poor performing assets. The AMPs indicates that Transend is considering the condition and performance of its various asset classes, assessing needs, and determining maintenance and replacement plans based upon the fleet issues and current practice across the industry.

It is also worth noting that we accept Transend's position that these are largely a continuation of strategies that commenced prior to the current period. The important point here is that most of these strategies have been reviewed at some level in previous regulatory resets, and accepted.

That said, our acceptance in principle of these strategies does not necessarily mean we consider all the works and projects resulting from them to be prudently scoped and timed. This is very much dependant on the specifics of the project and the detailed assessments that should be performed in accordance with appropriate asset management and governance practices.

As noted in Section 3, we consider the EHV circuit breaker, HV switchgear and power transformer replacement strategies to be the most significant to this review. The need to replace these assets is a significant driver of the timing of the replacement of other assets in many projects. In this regard, many of the AMPs related to other assets specifically note that their timing will be coordinated with the replacement of these key assets. Due to this significance, the basis of these renewal plans is discussed further below.

4.2.1. EHV circuit breakers

Transend appears to have completed its replacement programs of the earliest types of EHV circuit breakers during the current period. These programs relate to air blast and bulk-oil breaker types. We consider it reasonable to assume that these strategies were appropriate. This is partly because these programs commenced to a significant extent prior to the existing period, and as such, they have been subject to previous reviews; and because the replacement of these early types of breaker are well established across the industry. As such, the focus of our review has not been on these programs.

We have focused on the two programs that commenced, or are due to commence, in a significant way during the current and next periods. These programs concern the two 110 kV minimum oil breaker types discussed in Section 3: the Sprecher and Schuh HPF, and Reyrolle OS10 breakers. These two programs are a significant factor driving expenditure in the current and next regulatory period. The Reyrolle replacement program is particularly relevant to the large increase in forecast asset renewal in the latter half of the next period.

[34] The full set of AMPs has not been provided by Transend. However, we are satisfied that we have received the most relevant AMPs for our review.

The main documents Transend has provided to support these replacement programs are two condition assessment reports related to each of the breaker types[35]. These reports provide:

- a discussion on the various asset issues associated with these breaker types and the consequences;
- historical information over the last 10 years on the specific failures and defects of the population;
- an analysis of a number of asset management options, involving a maintain and defer, refurbish, and replace option; and
- a discussion of the future management strategy,

Originally, the options analysis in these reports was largely qualitative; however, at the request of Nuttall Consulting, the reports have been revised with more quantitative economic analysis of the options.

The main points concerning these breaker types gained from these condition reports are as follows:

- ***The Sprecher and Schuh replacement program.***

  Transend has a population of 23 Sprecher and Schuh type HPF 110 kV circuit breakers. These breakers range in age from 31 to 40 years old.

  The major issue with the Sprecher and Schuh 110 kV HPF breakers concerns their performance. These circuit breakers are considered to be the most unreliable circuit breaker in the Transend EHV fleet. There have been 34 recorded failures and defects of this breaker type since 1998, resulting in interruptions to supply on a number of occasions and affecting circuit availability. Due to the reliability issues, these breakers are inspected after every operation.

  The breakers also have high maintenance costs. Preventative maintenance costs are on average 195% of a new breaker. Corrective maintenance costs are also increasing to address a number of issues associated with this breaker type. The cost of the inspections following each operation of these breakers represents a significant portion of the overall maintenance costs associated with these breakers. Furthermore, these breakers are no longer supported by the manufacturer's agent, and as such, the availability of spares is an issue.

  That said, the breakers do not appear to have any significant safety or environmental issues.

  Transend has replaced a number of these breakers over this period, and is planning on replacing the remainder of the population over the next 5 years.

- ***The Reyrolle OS10 replacement program.***

[35] Initially provided in hard copy during meetings on the 23-27 June, and then attached to Transend email, dated 18/7/08- Request for Information Log number 101. The revised versions containing the economic analysis were provided in the Transend email dated 1/9/08 – Request for Information Log number 215.

Transend has a population of 53 Reyrolle type OS10 110 kV circuit breakers. 29 of these breakers are 56 or 57 years old, with the remaining 24 between 42 and 47 years old.

The major issue with the Reyrolle OS10 breakers is the maintenance costs associated with this breaker type. Preventative maintenance costs are approximately 4 times greater than a new breaker. There are also ancillary systems associated with these breakers that also require regular maintenance. Similar to the Sprecher and Schuh breakers, corrective maintenance costs are also increasing, and the manufacturer's agent no longer supports these breakers.

The breakers also have reliability issues, with 53 failures and defects of this breaker type since 1998. Although, it is worth noting that, the major failure rate appears to be much better than the Sprecher and Schuh breakers (i.e. approximately 30% of Sprecher and Schuh major failure rate).

Safety hazards are also associated with this breaker type due to the pressure vessels required to operate these breaker types and possible failure mode of the breaker. However, there is no indication in the condition reports that these risks are not manageable.

The condition report states that Transend is planning on replacing this population over the next 10 years. However, the substation redevelopment projects indicate that the majority of these breakers will be replaced in the last 2 to 3 years of the next period.

Based upon our review of these reports, we are satisfied that these breaker types are poor performing, particularly the Sprecher and Schuh breakers. It is difficult to confirm the accuracy of the high maintenance cost of these breaker types to newer models; however, the rationale provided in the report appears reasonable. As such, we are satisfied that it is prudent for Transend to be, at least, considering the replacement of these breaker types.

It is also important to note that it is our understanding that similar breaker types have been, or are currently being, replaced by other TNSPs[36].

We also agree that the Sprecher and Schuh types, although the younger breakers, are most likely a higher priority than the Reyrolle breakers due to their significantly poorer performance.

That said, we do have some concerns with the justification for the timescale of these programs, and particularly the economic analysis that supports this.

Firstly, the economic analysis compares the planned replacement option with one of deferring the whole program by 5 years. It has not examined the option of extending the program out over a longer period. In this regard, the evaluation is relatively high-level and does not consider the priority of the breaker replacements in terms of the poorest or better performing fleet cohorts and the criticality of the substations. It certainly seems reasonable to assume that a more detailed investigation of this form may find opportunities to extend the programs by deferring the lower risk circuit breakers.

[36] Information made available by the AER relating to the recent SP AusNet and the current TransGrid reviews indicates that programs to replace Reyrolle OS10 breakers have been occurring with these TNSPs.

Secondly, the economic analysis only considered the deferment benefit of the capital cost of the breaker. However, in most cases, the replacement of the circuit breaker could be considered the trigger for the much larger substation redevelopment project – or at least other bay or associated protection assets. As such, the benefits of deferral could be much greater, assuming the risk due to the deferral of the other substation assets are not increasing substantially. Noting the very high costs of some substation developments, such as Creek Road and Tungatinah, this deferral benefit could be significant.

As will be discussed in Section 4.4.1, the Investment Evaluation Summaries for the projects involving these breakers provided an economic assessment of deferment of the overall project. However, as is discussed in that section, in Nuttall Consulting's opinion this analysis has some limitations that may overstate the risk costs of that option. As a result, we do not consider that this project level analysis addresses our concerns expressed above.

Based upon the above it seems reasonable to assume that the Sprecher and Schuh replacements in the current period will have targeted the higher priority breakers, and as such, it is more likely that these replacements are prudent.

However, noting the large level of breaker replacements forecast to occur in the next period, we consider that there is a reasonable case that more detailed analysis at the breaker and substation level would find it prudent to extend these programs over a longer period without compromising the NER's capital expenditure objectives.

The extent of this would be best determined from the detailed evaluations at the project level. This however supports the view that some renewal expenditure in the next period could be prudently deferred.

It is worth noting that such an extension is most likely with the Reyrolle breakers where the fleet is larger and the reliability is still acceptable to the point that the majority of the replacement program is not due to commence until 2012/13. However, it is important to note that the Reyrolle breakers are very old. The oldest breakers are 57 years old; these will be around 63 years old by the end of the next period. That said, this age is not unreasonable, for example the UK benchmarks indicate a replacement life for outdoor 132 kV switchgear of 49 with a standard deviation of 10 years. Economic analysis of a particular 66 kV breaker type conducted by SP AusNet in support of its recent revenue proposal found the economic life for the average circuit breaker of that type to be 55 to 60 years[37][38].

Nevertheless, it is unlikely that the replacement of these Reyrolle circuit breakers could be prudently deferred for an extended period. In our view however, a deferral of 2-3 years for some breakers may be prudent, which takes some forecast replacements outside of the next period. It is also important to note that this modest deferral is not outside the timing stated in Transend's AMP, which considered that the Reyrolle replacements can occur over the next 10 years period i.e. to 2018. As such, we would not expect this modest deferral to result in an inefficient increase in risk.

[37] SP AusNet document, "66kV CB Replacement Support Paper 9Oct07.pdf", provided to the AER to support its revised proposal, dated 12 October 2007.
[38] The relevance of this comment relates to the possible range of lives for EHV circuit breakers. Nuttall Consulting is not claiming that the SP AusNet circuit breakers are of a similar type or technology.

4.2.2. Power transformers

The Transend power transformer assets consist of two major types: network transformers and supply transformers. Network transformers are typically of a higher voltage and support the Tasmanian transmission grid directly. Supply transformers are typically of a lower capacity and are used to deliver supply at lower voltages.

From the information provided by Transend, Nuttall Consulting considers that the systems, processes and documentation for managing power transformers are consistent with industry practice. We have also reviewed the results of the condition assessments on all transformer replacements in the current period and the latest condition assessment data for all transformers forecast for replacement in the next period. We have also reviewed the results of insulation tests performed on a number of the transformers following their removal during this period.

Based upon our review of this information, we are satisfied that the transformers replaced during the current period and forecast in the next were/are showing advanced aging to the extent that they may have failed in service. As such, we consider that it was/is appropriate for Transend to be considering their replacement.

Our review of power transformer systems, processes and documentation is described further below.

Network Transformers

The Transend "Network Transformers Asset Management Plan" describes the overarching practices and guidelines for managing Transend's power transformer assets. This AMP provides a sound basis for establishing the whole of life practices necessary to achieve the optimal balance between cost and performance.

Transend has a population of 16 network transformers. The average age of Transend's network transformer population, as at December 2007, is 24 years. There are currently five network transformers that will exceed the average technical service life of 45 years over the next four years. This technical service life is consistent with that used by other transmission providers in Australia and overseas. Transend notes that the age of a power transformer is not a determinant for replacement, but is used to trigger more detailed investigations.

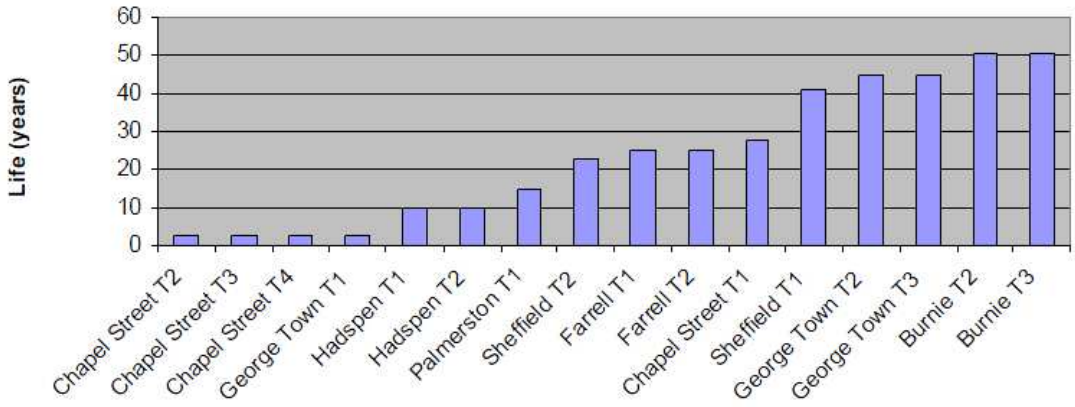


Figure 8 Transend network transformer age profile

Transend has identified the oldest four power transformers in its asset base as being considered for replacement: Burnie T2 and T3, and George Town T2 and T3. Following the release of the network transformer AMP, Transend has advised that Network Transformer T2 at George Town Substation was decommissioned in April 2008 at an age of 45 years[39].

Transend has undertaken detailed assessments of the condition of these assets including oil and gas tests, electrical tests and reviews of the physical condition of the assets.

The network transformer AMP clearly describes ranges of insulating oil and dissolved gas criteria that result in a rating of acceptable, marginal or poor for each measure. The values utilised by Transend to set the oil quality index rating measures are more conservative than those in the literature accessible to Nuttall Consulting[40]. However, given the consequences of an in-situ failure, these levels may be reasonable.

The rate of change of these measures is also identified by Transend as a key driver of the need for replacement. This is consistent with industry practice.

The results of the oil sample testing for both of the George Town transformers indicate oil in a very poor condition. The dissolved gas analysis (DGA) shows gas ratios at an acceptable level. The oil quality index for the Burnie Transformers was appreciably better than for the George Town units, although the DGA results were slightly worse. The improved oil results are due, at least in part, to an oil reclamation process undertaken in 2000.

Insulating paper tests were taken from one of the Burnie transformers at the time of the overhaul. These tests indicate that the strength of the insulating paper is significantly reduced from that assumed of a new transformer.

As a result of the above tests, the oil testing regime has been intensified pending the decision to replace the units.

Supply Transformers

The Transend "Supply Transformer Asset Management Plan" describes the overarching practices and guidelines for managing Transend's power transformer assets. This AMP

[39] Transformer Oil Test Results - Historic replacements in 2004 to 2009 period. PDF- Request for Information Log number 173
[40] Electrical Equipment Handbook: Troubleshooting and Maintenance, Philip Kiameh, McGraw-Hill, 2003

provides a sound basis for establishing the whole of life practices necessary to achieve the optimal balance between cost and performance.

Transend has a population of 105 supply transformers, including eleven spare supply transformers. These transformers operate at a primary voltage of 220 kV or 110 kV and supply side voltages of 44 kV, 33 kV, 22 kV, 11 kV or 6.6 kV. These units range in capacity from 4 to 90 MVA. The average age profile of Transend's supply transformer population is 25 years. Transend reports that there are currently 14 supply transformers that exceed the average service life of 45 years.

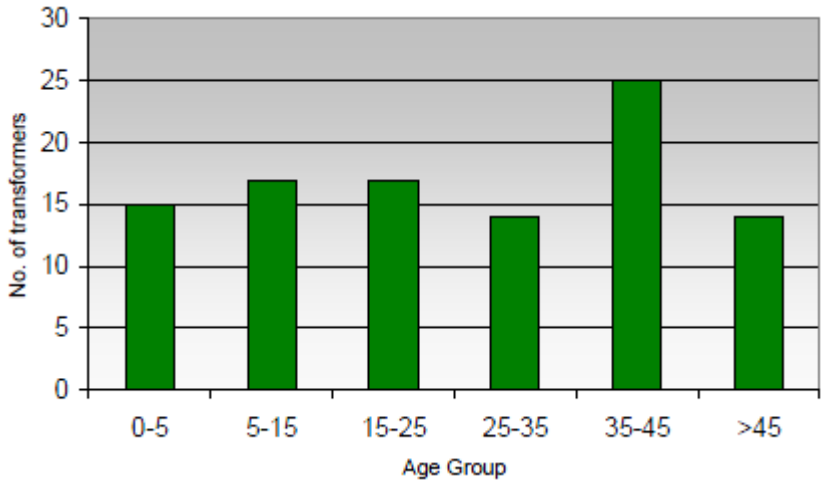


Figure 9 Transend supply transformer age profile

The supply transformer AMP is of a similar structure and content to that of the network transformer AMP. For that reason, commentary is not repeated where it is a duplicate of that provided above.

The condition assessment of Transend's supply transformers is based on analysis of the electrical and physical condition of the supply transformer. The condition of supply transformers is categorised as acceptable, marginal or poor.

The Transend condition assessment of the supply transformer population has identified that there is a total of ten transformers which are classified as poor, and a further twenty transformers as being of marginal condition. The remaining 73 transformers are in acceptable condition. Transend appears to have considered the materiality of risk in determining the oil and DGA condition limits for supply transformers, as a number of measures are less conservative than those for the more critical network transformers.

It is noted that the maintenance regime identified for supply transformers does not include "degree of polymerisation" testing, although this is referenced later in the document as having been carried out in at least one instance.

The supply transformer AMP provides significant detail on condition assessments of the various types of supply transformer. This information highlights that the condition assessments are consistently undertaken and provides a strong base for assessing future renewal needs.

4.2.3. HV switchgear

Transend has replaced HV switchgear at eight outdoor and six indoor[41] substations during the current period, requiring the replacement of 93 existing HV circuit breakers (and associated bay equipment). Of the indoor substations, four were outdoor designs that were subsequently housed in metal enclosures in the 1990s. Another of the indoor substations contained switchgear that was of an outdoor technology.

Transend is forecasting to replace outdoor HV switchgear at a further two substations in the next period.

The main information originally provided to Nuttall Consulting to support the HV switchgear replacement programs, were three independent reviews undertaken for Transend[42]. These reviews assessed renewal needs at three of Transend's HV substations, covering one outdoor substation, Smithton, and two indoor substations, Lindisfarne and Wesley Vale. The scope of these reviews covered:

- an appraisal of the relevant issues, including condition, risks, reliability, and costs;
- identification of asset management options;
- evaluation of options including economic analysis; and
- the recommendation of a preferred option.

These reports support Transend's need for the HV switchgear renewal program and its strategy to replace outdoor HV switchgear with indoor units. Originally, we had a number of concerns with these reviews and their scope across the overall HV switchgear replacement program. These concerns covered:

- the significance of the safety issues associated with the HV switchgear, and risk mitigation measures to address these safety issues;
- the economic analysis provided in the independent reports; and
- whether testing of the HV switchgear had occurred, as was recommended in two of the independent reports[43].

Therefore, we requested additional clarifications from Transend to address our concerns [44]. Further information has been provided by Transend in response to this request[45], including the current HV switchgear asset management plan and the program's status report.

[41] The HV switchgear at one substation, Risdon, was categorised as an augmentation project in Transend's proposal.
[42] Report provided in emails dated 20 August 2008 – Request for Information Log numbers 174, 175, and in Transend's project sample packs associated with the Lindisfarne and Triabunna projects provided in February 2008.
[43] It is noted that the recommendation to test the switchgear at one substation under review was withdrawn in a subsequent letter from the consultant, based upon revised information on the age of the HV switchgear under review.
[44] Requested in email dated 25 August 2008.
[45] Provided in email dated 5 September 2008- Request for Information Log number 196

These additional reports provide further supporting information on matters associated with this program covering, the asset issues, the substations affected, risk mitigation approaches, historical performance of the HV fleet, and the evaluation of options to address the issues.

Based upon the information provided it appears that Transend and the independent reviews considered two main factors are driving the need for the replacement program:

- the asset condition and performance, which is related to the age and type of the switchgear and associated assets; and
- the safety issues associated with existing substation designs and equipment e.g. "sub-standard clearances" in outdoor substations and "arc fault containment" in indoor substations. The status report clarified that these safety issues are considered by Transend to affect all substations involved in the program.

With regard to the asset condition and performance issues, all reports provide a reasonably detailed discussion of the issues associated with various asset types. It is noted from Transend's response to our queries that testing to confirm the condition of the HV switchgear has not been undertaken prior to replacements. However, Nuttall Consulting accepts Transend's reasoning that such testing may not have provided sufficient certainty on the condition of the assets in terms of predicting a failure.

The Transend status report also provides historical information on the system performance due to the HV switchgear, covering trends in failures and system minutes lost due to HV switchgear. Analysis provided in this report on the resultant value of the system minutes lost supports the view that a relatively extensive renewal program was required to improve system performance.

A discussion on safety issues is also provided in the status report. This provides some detail of the risk mitigation measures Transend has undertaken to address the substandard clearance issues e.g. barriers and signage. Nuttall Consulting also concurs that the safety issues associated with substandard clearances and arc fault containment are a significant factor in the need for this program.

Economic analysis of the program is also provided in the status reports. This analysis has considered the capital and operating costs, and the value of customer reliability, associated with the replace or maintain options. This analysis indicates a net benefit through the program; however, the basis of this analysis is not clear.

Based upon our review of the documents provided we are satisfied that the issues are appropriate and reflect assets of this age and type, and the existing substation arrangements. It is also worth noting that it is our understanding that similar issues with HV switchgear are being addressed by other DNSPs and TNSPs in Australia.

Although, we have been unable to validate Transend's economic analysis of this program, based upon the information available we consider it reasonable to consider that Transend's has been acting prudently in undertaking the overall program.

However, it is important to note that the prudent timing and prioritisation of specific replacements would depend upon project specific analysis.

4.3. Review of ex post projects

Nuttall Consulting has undertaken a review of a number of projects commissioned (or to be) in the current period. These projects have been selected from the projects categorised as asset renewal in Transend's cost information template (Appendix 3 of their proposal).

Our project review has covered 11 projects, accounting for 39% of Transend's asset renewal expenditure in the current period. The projects have been selected to cover the key asset strategies in this period.

The projects reviewed, the asset renewal expenditure in this period, and the business case allowance are summarised in Table 9 - this table is based upon Transend's cost information template.

Table 9 Ex post project reviews

ID	Project	Reason	Actual (nominal)	Business case[46] (nominal)
ND0326	Burnie Substation - 22 kV switchgear replacement	Safety / compliance and asset condition	$3.3m	$3.6m
ND0604	Burnie-Port Latta 110 kV transmission line re-conductor	asset condition, compliance	$20.0m	$18.0m
ND0552	Chapel Street Substation: replacement of network transformers	Compliance and asset condition	$3.3m[47]	$10.2m
ND0590	George Town Substation B bus replacement	Asset condition, compliance	$6.2m	$6.3m
ND0603 / ND0531	George Town Substation Network Transformers T1, T2 and T3 replacement	asset condition	$19.6m	$17.7m
ND0514	Lindisfarne Substation: 33kV switchgear replacement	Safety / compliance and asset condition	$3.4m	$3.8m
ND0592	West Coast and Mersey Forth OPGW project	Replacement, compliance, improve communications	$6.9m	$8.9m
ND0564	Palmerston Substation HV switchgear and transformer replacement	Safety/compliance and asset condition	$4.0m	$4.5m
ND0640	Palmerston 220 kV Substation: primary equipment upgrade	upgrade of primary equipment, security and compliance	$5.7m	$8.4m
ND0621	Sheffield Substation 110 kV redevelopment	Asset condition	$6.9m	$6.8m
ND0563	Triabunna Substation HV switchgear and 110/22 kV transformer replacement	Safety/compliance and asset condition	$4.3m	$4.5m

[46] Note these values exclude contingency funding allocation and IDC but include FDC.
[47] As discussed in A.2.2, Transend has advised that the actually project cost is $8.1 million (nominal), due to a misallocation of the project costs in the regulatory accounts.

The purpose of these reviews is to aid in our ex post assessment of Transend's asset renewal expenditure. It is important to note that discussions and views on prudency, based upon these project reviews, must be considered in the broader context of the strategy reviews discussed above. The overall discussion of the prudency of the asset renewal expenditure will be discussed in Section 5.

In the discussions that follow, we have attempted to align our considerations with the three stages of the ACCC's prudency test that must be applied in undertaking the ex post assessment i.e. the need, the efficient investment option, and the development.

- Our **assessment of the need** has considered the scope of the projects and the elements related to asset renewal needs, and those related to other factors (e.g. connection and augmentation). With regard to the renewal component we have considered matters such as:
  - The asset issues and commercial impacts
  - The alignment to renewal strategies
  - The key matters driving the need for the renewal element of the project

  With regard to components of the project that are not strictly renewal we have considered the basis for the need for these elements in the context of the overall renewal projects.
- Our **assessment of the selected investment option** has considered a number of matters covering:
  - the range of options considered by Transend and the basis of these options
  - the evaluation and justifications for the selected options, including the appropriate timing
  - the project level approval processes concerning the selection of the preferred option and variations to the approved project.
- Our **assessment of the development** has been of a limited form owing to our reduced scope, which does not include the review of broader efficiency matters related to project delivery and the governance issues surrounding this. These matters have been reviewed by WorleyParsons. Our review has only considered whether it is reasonable to assume that the scope of the project has been developed as approved.

It is important to note that in many renewal cases, the need, particularly the timing of the need, and the efficient investment option can be interrelated. This is different, for example, to reliability augmentations where it can be determined with some objectivity that a reliability obligation will not be complied with at a certain time based upon the available demand forecast, and therefore, the business is in a "must do something" situation.

In undertaking our assessments, we have viewed the following forms of project documentation:

- supporting reports and analysis, with a particular focus on asset condition and compliance assessments, and the development and analysis of options;

- project business cases, including the progression of business cases where variations have occurred; and
- board resolutions to approve project budgets and variations to these budgets.

Table 10 summarises the project scope of the 11 projects reviewed based upon the information in the respective business cases. This indicates the main components related to the renewal needs, and those driven by other needs. It is worth noting that the renewal component also includes some enhancements to existing arrangements, generally, to bring these to current standards. Appendix A provides more background information on these projects.

Table 10 Ex post project scopes

Category	Project	Scope of project	
		Renewal	Other
HV switchgear and supply transformers	Burnie Substation - 22 kV switchgear replacement	• Existing HV switchgear • Associated protection	• Installation of additional HV switchbays for Aurora
	Palmerston Substation HV switchgear and transformer replacement	• Existing HV switchgear • Associated protection • Existing 7.5 MVA supply transformer	• Installation of additional HV switchbays for Aurora • Upgrade to 25 MVA for replaced transformer • New SCADA system to cover EHV and HV assets at substation
	Lindisfarne Substation: 33kV switchgear replacement	• Existing HV switchgear • Associated protection • auxiliary supplies	• New SCADA system to cover EHV and HV assets at substation
	Triabunna Substation HV switchgear and 110/22 kV transformer replacement	• Existing HV switchgear • Associated protection • Existing 7.5 MVA supply transformer • auxiliary supplies	• Installation of additional HV switchbays for Aurora • Upgrade to 25 MVA for replaced transformer • New SCADA system to cover EHV and HV assets at substation
Network transformers	Chapel Street Substation: replacement of network transformers	• 3 x 120 MVA network transformers • Associated protection and control • SCADA	• Upgrade of replaced transformers to 200 MVA and associated works.
	George Town Substation Network Transformers T1, T2 and T3 replacement	• 2 x network transformers • Protection and control • DC supplies • SCADA	• Arrangements for installation of additional transformer
EHV CBs	Sheffield Substation 110 kV redevelopment	• 4 x 110 kV Sprecher and Schuh circuit breakers • Various VTs and post insulators • Protection and control associated with various lines • SCADA • AC and DC supplies	
Other substation	George Town Substation B bus	• 220 kV Bus gantry structures associated with B bus • Protection and control associated	• Protection and control associated with industrial customers lines

Category	Project	Scope of project	
		Renewal	Other
works	replacement	with various lines • Substation lightning protection	
	Palmerston 220 kV Substation: primary equipment upgrade	• Various 220 kV instrument transformers and post insulators • Protection and control associated with various lines • Substation lightning protection	
Transmission lines	Burnie to Waratah wood pole replacements	• A number of wood poles on the Burnie to waratah line	
	Burnie-Port Latta 110 kV transmission line re-conductor	• Burnie to Port latta conductor	• Uprating of line (raising and strengthening of ~50% of towers)
OPGW	West Coast and Mersey Forth OPGW project	• Earth wire on existing Farrell to Sheffield line	• Additional earth wire • Optical fibre component of earth wire

4.3.1. Assessment of the need

To assess the need for the asset renewal projects, we have reviewed the various business cases and supporting material. We have also compared the assets and issues discussed in these documents with the discussions and information in the associated asset management plans.

The business cases generally provide a qualitative discussion of the various asset issues and impacts on risks, system performance, and maintenance needs. These discussions agree with the asset type discussions in the associated asset management plans.

The renewal need for the projects was also supported by various condition and risk assessments. The condition and risk assessments for the HV switchgear, power transformer and EHV circuit breakers projects is as that discussed in the strategy section above. In addition to this, the George Town B bus, Burnie to Port Latta reconductor, and West Coast to Mersey Forth OPGW projects, all had independent condition reports that supported the poor condition of the main assets being replaced. We have performed a high level review of these reports, focusing mainly on the methodology and findings, and are satisfied that they were appropriate and do indicate the poor condition of these assets.

The one project for which the need is not supported by the latest condition assessment information concerns the Burnie to Waratah wood pole replacement project. This project has a *forecast* amount of pole replacement for 2008/09 – the last year of the current period. However, Transend stated during meetings that the latest pole inspection for that line, which occurred in 2007/08, did not condemn any poles[48]; as such, these pole replacements in 2008/09 will not be required.

Excluding the Burnie Waratah pole replacements, based upon our review, we are satisfied that in all other cases it was reasonable for Transend to be, at least, considering the need for

[48] Discussed during meeting with Transend on 11-13th August.

the renewal of these assets. Certainly, the condition information on the transformers and the Burnie to Port Latta conductor strongly supports the view that these assets may have failed in service if they had not been replaced during this period.

Referring back to Transend's reasons for the investment, summarised in Table 9 above, these factors appear reasonable based upon our review. However, it is important to note that the need for the projects are driven by a range of factors. We consider that strict compliance does not appear to be the sole driver of the timing of the need for the renewal projects i.e. cases where the overall project investment must be made to comply with a statutory or NER obligation at a specific time[49]. Rather, it appears that existing equipment and arrangements in some circumstances are not up to modern standards[50], and therefore, it is a matter of risk management as to whether to invest at a particular time on specific equipment or initiate some other action to optimise the timing and scope of a larger renewal project.

Furthermore, certain matters concerning non-compliance with NER obligations (e.g. protection and control, and auxiliary systems) are not strictly drivers of the need for replacement as it appear that provisions in the NER mean that Transend's existing assets are excluded from these obligations. However, these obligations do drive the enhancements that are required when these assets are replaced.

It is also clear that the need for some elements of the projects may be less than others i.e. without the main asset being replaced, other elements such as protection and auxiliaries would not be replaced at the time of the project.

Therefore, in our view, the prudent and efficient investment option and timing to *maintain* a safe, secure and reliable transmission network is dependent on the evaluation of the various options, including maintaining the existing assets. This matter is considered further in the section below.

With regard to the need for the non-renewal elements of the projects, this is more difficult to ascertain in the context of our *renewal* review. We have requested and been supplied further information from Transend on matters relating to:

- evidence of the requests by Aurora for the additional HV feeder bays[51]; and
- clarifications on the application of the regulatory test on the augmentation components of the project[52].

Based upon the information provided by Transend, we have no evidence that there was not a need for these elements of the projects. Relevant points on this matter are as follows:

- The additional HV switchbays were identified in business cases as being requested by Aurora. Transend has provided evidence of these requests.

[49] The relevance of this point on compliance is in comparison to statutory obligations that may be driving the timing of many of the projects in the augmentation category (i.e. statutory reliability standards). In these augmentation cases, it is a simpler process to determine the specific time that compliance is breached, and the project investment is required.
[50] For example, safety clearances and "arc fault containment" of the HV switchgear, and the "degree of protection (IP) rating" of protection panels (see summary details in Appendix A).
[51] Provided in the email, dated 5 September 2008 – Request for Information number 201, in response to our email, dated 25 August 2008.
[52] Provided in the email, dated 11 September – Request for Information number 224, in response to our email, dated 1 September.

- Transend undertook a regulatory test and associated consultation process on the augmentation component of the Burnie to Port Latta line reconductoring project – although we have not reviewed this material.
- Transend has provided evidence that NEMMCO considered that the extent of the outages required to replace the existing network transformers at George Town would be unacceptable without the additional transformer in service beforehand.
- An independent report, prepared for Transend, on the reliability of the supply to the industrial customer connected at George Town recommended the protection upgrade.
- The regulatory test was not applied on the augmentation component of Chapel Street as it was considered largely asset renewal, with the installation of standard equipment. Based upon the further clarifications from Transend, we consider a regulatory test could have been more explicitly applied to elicit non-network solutions for the increased capacity. However, noting that this project had been foreshadowed in Transend's prior APR's, we consider it unlikely that a suitable non-network solution would have been available.

4.3.2. Development and assessment of options

Development of options

Transend has documented procedures requiring, where possible, the consideration of three or more project options when developing a business case. The Transend documentation also identifies a "do nothing" option as being one of the options for consideration. This approach is described in the following Transend documentation:

- Transend Business Case Manual – Issue 1.0 July 2008
- Investment Evaluation of Network Projects Guideline – Issue 1.0 July 2008
- Investment Process Governance Framework Overview – Issue 2.0 March 2008

Nuttall Consulting considers that the options analysis process described in the Transend documentation is generally consistent with good industry practice.

We have also reviewed the business cases and supporting documents to determine the range of options considered by Transend in each project and the consistency with its stated processes.

In the majority of business cases reviewed, Transend has identified at least 3 options and has also consistently identified the "do nothing" option in the business case and project documentation. This is consistent with Transend's documented process requirements.

These options generally consist of a "maintain and assess existing assets" type option, a "targeted replacement or refurbishment of critical assets" options, or the "overall replacement" option. Non-network solutions have not been identified; however, other than the augmentation/connection components of the projects, we do not consider it reasonable to assume non-network options would have been the preferred option.

We have considered the range of options determined by Transend against the issues and needs specific to each project. Generally, we consider the range of options to be

appropriate. Although, noting our concerns with the evaluation of options discussed below, there may have been opportunities to further optimise some options i.e. in terms of staging options, and deferring some elements.

Risk evaluation

Transend has identified that risk evaluation is a critical component of project evaluations. Transend has a well documented approach to managing strategic business risks. These are documented in the 2007 Strategic Business Risk Review undertaken by Ernst & Young on behalf of Transend.

Transend has established processes and systems to apply risk evaluation at the project level. This is evidenced in the following documents.

- Investment Evaluation of Network Projects Guideline (Issue 1.0, June 2008)
  - Risk evaluation deals with the identification of current risks and the influence of the project on current risks. It also involves analysis of the risks that the project exposes during the project execution and the impact on risks following the implementation of the project.
- Investment Process Governance Framework (Overview, Issue 2.0, March 2008)
  - Detailed risk analysis underpins the option analysis. All major risks associated with the proposed investment are identified and assessed. Risks are considered from the customer, business, commercial, legal, technical and resource perspective.
  - Risks are assessed in line with Transend's risk management framework having regard to the likelihood or frequency of such a risk occurring, the consequence and the effectiveness of risk mitigation strategies and controls which could be put in place to manage such a risk

Both of the above documents identify the need to apply the risk evaluation methodology to specifically identify the risks that are applicable to the project in question.

The project documents provided to Nuttall Consulting as part of this review generally did not exhibit a specific project related risk review with regard to the options analysis. In most cases, the risk review was a duplication of excerpts from the previous strategic business risk review. The discussion of specific project risks only concerned those related to the delivery of the project.

These project documents are therefore not consistent with the Transend risk evaluation processes established in the Investment Evaluation of Network Projects Guideline or the Investment Process Governance Framework documents with regard to the options analysis.

Our concerns with the lack of a more thorough discussion of risks in the project business cases is dealt with further in the section below on the evaluation, justification and approval of projects.

Evaluation, justification and approval

In the 2003 revenue decision, the ACCC indicated that Transend should improve its processes in relation to the economic justification of renewal projects. Transend has established systems and processes that are aligned with the ACCC's position. However, the

business cases provided to Nuttall Consulting are generally not consistent with the ACCC's position or the Transend process and systems documentation.

The following section identifies the approach recommended by the ACCC, the Transend system and process documentation relating to the project financial evaluation and the Nuttall Consulting review of renewal projects.

In the 2003 revenue decision, the ACCC stated that Transend should "*demonstrate that its renewal expenditures are economically justified and that there are no other, more cost effective, alternatives*."[53] This statement was based on commentary provided by GHD, the ACCC's technical reviewer.

The systems and process documentation reviewed by Nuttall Consulting appears consistent with delivering the economic justification of renewal expenditure. The following documents highlight the internal focus on economic justification for renewal and other capital projects.

- The 2008/09 Transend Strategic Plan identifies a desired strategic outcome of achieving a "*Commercial focus at all levels in the organisation*".
- Investment Process Governance Framework (Overview, Issue 2.0, March 2008)
  - "*Transend must invest in electricity transmission infrastructure in a way that can be justified on safety, business, technical and economic grounds*"
  - *"Options analysis - Consistent criteria are applied so that a valid comparison can be made and the preferred option determined. ... Factors that are considered when undertaking options analysis include ... commercial considerations ... whole of life cost calculation/cost benefit analysis (using discounted cash flow) ... net present value of costs and benefits"*
- Investment Evaluation of Network Projects Guideline (Issue 1.0, June 2008)
  - *"Discounted cash flow analysis is a preferred methodology for financial analysis of different development options. Discounted cash flow focuses on estimates of costs and benefits that are expected to flow during period of analysis (usually it is 15 years time horizon but whole of life cost and benefits analysis could be required)"*
  - *"The preferred option should be the option with highest NPV of benefits delivered by the project, whilst delivering acceptable levels of risks."*
- Business Case Manual (Issue 1.0, July 2008)
  - *"Transend uses the business case as a mechanism to enable decision-makers to ... assess the economics of the project (financial and strategic)"*
  - *"Clearly demonstrating the prudency and efficiency of past investment decisions is an increasingly integral part of the revenue cap application process. Transend is also required to have defensible long-range capital forecasting processes and must demonstrate that processes are in place, and documentation exists, to support the prudency of future capital and operating expenditure."*

[53] Tasmanian Transmission Network Revenue Cap: Decision, ACCC – 10 December 2003.

- *"Costs and financials – consider: ... Cost/benefit analysis should take into account the cost of capital, time value of money (net present value), interest costs and cost of funds"*

- Capital Review Team Terms of Reference (Final, undated)
  - *"The CRT will assist the MD in reviewing board papers and providing a high level overview of the capital program delivery and will specifically ensure (where appropriate) that ... financial modelling has been correctly done (and) there is consistency with business and strategic plans."*
  - *"In undertaking these responsibilities the CRT will aim to improve the efficiency and effectiveness of Transend's business case approval process."*

The above documentation confirms that Transend considers the economic evaluation of projects and project options as a critical part of the approval process.

Nuttall Consulting has been tasked by the AER to review, among other things, the efficiency and economic impact of the renewal works program. As such, Nuttall Consulting has reviewed the business cases and supporting material provided by Transend. The majority of project documents reviewed did not contain financial or economic analysis that would support the justification of the options selected. Although economic evaluation is one of a number of factors that contribute to project justification, this position does not appear to be in accordance with Transend's documented processes and the ACCC's decision. The documents reviewed are listed below as well as a brief summary of the level of supporting economic justification.

Table 11 Ex Post Project Financial Evaluation Review

Project document	NPV or financial evaluation
Confidential board paper – replacement of switchgear at Burnie substation (September 2000)	No NPV or financial evaluation was apparent in the evaluation or investigation of options.
Confidential board paper – Chapel Street substation replacement of network transformers (November 2003)	Some assessment of the relative costs of options.
Confidential board paper – Palmerston substation: high voltage switchgear and transformer replacement (December 2003)	No NPV or financial evaluation was apparent in the evaluation or investigation of options.
Confidential board paper – George Town substation bus bar replacement (June 2004)	No NPV or financial evaluation was apparent in the evaluation or investigation of options
Confidential board paper – George Town substation network transformer replacements (September 2004)	No NPV or financial evaluation was apparent in the evaluation or investigation of options.
Confidential board paper – West Coast and Mersey Forth OPGW (December 2004)	NPV information provided at a summary level for the preferred option only.

Project document	NPV or financial evaluation
Confidential board paper – Palmerston substation: 220kV upgrade (May 2005)	No NPV or financial evaluation was apparent in the evaluation or investigation of options. Reference to cost-effectiveness, but no detail provided.
Confidential board paper – George Town substation transformer replacements (June 2006)	No NPV or financial evaluation was apparent in the evaluation or investigation of options. Reference to cost-effectiveness, but no detail provided.
Confidential board paper – Sheffield substation 110kV redevelopment (September 2006)	No NPV or financial evaluation was apparent in the evaluation or investigation of options.

Economic analysis has been undertaken by independent sources on elements of some of the projects reviewed, most notably the HV switchgear and George Town B bus projects. However, this analysis appears limited in form and does not reflect the project defined in the business case.

It is possible that more detailed economic justifications have been undertaken by Transend than is evident from the documents reviewed. However, if this is the case, some overview of the findings of these analyses should have been referenced in the above documents according to the Transend business process documentation. It is also worth noting that our request for supporting information advised that economic analysis should be provided if available[54].

In terms of the independent analysis performed for Transend (e.g. HV switchgear projects), we would expect some form of documented internal critique. We would also expect that this critique and the relevance of the analysis to the project under consideration would be summarised in the business case to ensure robust investment decisions are made.

We have raised the above items with Transend and Transend has provided a response on this matter[55]. The key points on this issue stated by Transend in its response are as follows:

- "*These business cases, without exception, provide a reasonably detailed assessment of the different options that were considered and the rationale for the preferred option. In many instances, the preference for a particular option rests on the unacceptable outcomes or risks associated with the competing alternatives. Typically, consideration is also given to Transend's broader strategy, which ensures that projects are aligned with the company's investment programmes and asset management strategies.*

[54] Email to Transend, dated 31/7/08.
[55] Provided in the email from Transend, dated 19 September 2008 - Request for Information Log number 237. This email was in response to a Nuttall Consulting email, dated 15 September 2008.

- *After consideration of these matters, it is often self-evident that only one option is viable, or one option is clearly the most economic option. In this context, inclusion of a formal NPV or financial analysis would not provide any additional information that would have a bearing on the investment decision.*"
- "*the [business cases] properly reflects the broad considerations that must be taken into account in making prudent and efficient investment decisions in accordance with good industry practice, sound asset management strategies and a soundly-based grid vision. In this regard, ... it would be a mistake to think of NPV and financial evaluation of options as being at the centre of all investment decision-making. Rather, it is an aid to decision-making, and whilst it provides substantial assistance as a decision-making aid in the case in certain projects (for example the Waddamana-Lindisfarne 220 kV transmission line project) it is certainly not the central consideration in many other situations.*"

We agree that in the context of some asset renewal projects, the need for full economic analysis in a business case is not always justified. The renewal of electrical assets is undertaken for a number of reasons including condition, performance, spares availability and product support, technical obsolescence, physical security, technical, safety and environmental compliance. Assets may be selected for renewal based on one or more of these factors. It can be difficult to quantify and compare these factors as they do not always lend themselves to direct translation into economic terms.

Furthermore, the effort to undertake an economic analysis has to be balanced against benefits to project selection; if risks can be *demonstrated* to be high then rigorous evaluations of options not addressing these risks will not be justified.

There is some case to support Transend's view that the economic benefits of its renewal projects were self-evident, as the cost or risks of maintaining the assets were unacceptably high in some projects, for example:

- condition assessment results indicated that its replaced transformers may have failed in service if maintained on the network, and running these transformers to fail would not be a prudent strategy;
- the existing HV switchgear was considered a significant safety risk to personnel; and
- the Burnie-Port Latta line was showing very poor condition, and was a significant public safety risk.

In these cases, we agree that the need for economic analysis was lower. However, we do not agree that this was as clear for other projects, such as the Sheffield and Palmerston substation redevelopments.

We do not consider that the scale of the risks associated with different issues, and the relationship of the risks to possible options, has been appropriately demonstrated in the business cases reviewed.

Furthermore, while we agree that the economic appraisal is only one element of the overall project evaluation and approval process, we consider that its role in asset renewal should be far more central than is suggested by Transend's response.

In our opinion, the objective assessment of relative costs and benefits, particularly of the larger projects, is important to ensure that the projects are scoped efficiently and do indeed provide a net benefit. For example, in all business cases reviewed, the "*do nothing*" option, although included, is not considered an acceptable option as it did not deal with the stated issues. However, the risks associated with individual issues, and the cost of options to address these, are not quantified. To make an informed decision on the prudency of a "*do nothing*" option, or any other limited replacement option, we would expect that the business cases discuss matters such as:

- incremental changes to specific risks in undertaking the "*do nothing*" option, and the time scales of these changes; and
- the context of these risks in terms of their historical and recent levels i.e. why are risks at the level they are.

On this basis, we consider that Transend has not met the standard proposed by the ACCC in 2003 of demonstrating "*that its renewal expenditures are economically justified and that there are no, more cost effective, alternatives*."[56]

It is important to stress however that nothing in the information we have reviewed has provided evidence that the preferred option selection and timing is not prudent. There is a real possibility that a more detailed economic appraisal would have indicated the need for project works to be undertaken earlier than they were, or that a different option may have been selected. Nevertheless, as the stated processes have not been followed, then opportunities to prudently defer some projects could also have been missed. In absence of this analysis, Nuttall Consulting is unable to confirm whether this issue could be material across the whole program.

4.3.3. Assessment of the development

As noted in the introduction, many factors concerning the efficient development of the projects are not part of our scope of work. These matters are being reviewed by WorleyParsons and relate to the efficient delivery of capital projects and governance issues surrounding this. We see no reason to consider that WorleyParsons' findings on these matters will not have coverage over the asset renewal projects we have reviewed.

Our review has focused on whether there is evidence that projects are not developed as approved. In this regard, we have assessed the business cases and related board resolutions, including those related to variations in the projects, to assess reasons for variations. We have also requested and received further information from Transend concerning the more significant differences between business cases and the expenditure in Transend's cost information template[57].

Although it is difficult in a review of this form to confirm what assets have been installed, based upon the information reviewed, and noting that overall the actual costs are broadly in line with the approved costs, we have seen no evidence that variations do not reflect prudent decisions that are in accordance with the approved business cases.

[56] Tasmanian Transmission Network Revenue Cap: Decision, ACCC – 10 December 2003.
[57] Requesting in email dated 1 September 2008. Responses received on 8 and 9 September 2008 – Request for Information Log numbers, 222, 223, 225, 226.

4.4. Review of ex ante projects

Nuttall Consulting has reviewed a number of projects forecast to incur capital expenditure in the next regulatory period. These projects have been selected from the projects categorised as asset renewal in Transend's cost information template (Appendix 3 of its proposal).

Our project review originally selected 15 projects, accounting for 65% of Transend's forecast asset renewal expenditure in the next period. The projects have been selected to cover the key asset strategies in this period.

Complete information for two of these projects was not provided in time for undertaking the review. However, we do not consider the absence of these project review should impact our findings in any significant way. The remaining 13 projects account for 63% of Transend's forecast asset renewal expenditure in the next period.

The projects selected, the forecast asset renewal expenditure, and Transend's stated reasons for the projects are summarised in Table 12 - this table is based upon Transend's cost information template. It is worth noting that the project costs shown reflect the expenditure incurred in the 2009-14 regulatory period; some of the listed projects have additional expenditure either before or after that period.

Table 12 Ex ante projects

ID	Project	Forecast ($m 2008/09)	Reason
ND0910	Arthurs Lake Substation Redevelopment	$4.1m	Asset condition, reliability of supply, safety and environmental issues
ND0966	Burnie - Waratah 110kV Transmission Line wood pole replacements	$5.8m	Asset Condition and reliability
ND0908	Burnie Substation 110kV Redevelopment	$8.2m	Asset condition, reliability and security of supply
ND0734	Burnie Substation Network Transformer Replacement[58]	$5.1m	Asset Condition and reliability, Capacity Issues
ND0733	Creek Rd Substation 110kV Redevelopment	$33.3m	Asset condition, reliability and security of supply
ND0907	Emu Bay Substation 110kV Redevelopment	$7.3m	Asset Condition, Security of Supply
ND0914	Farrell Substation Secondary Asset Replacements	$11.0m	Asset Condition, Reliability, Compliance
ND0937	George Town Substation 110kV Redevelopment[59]	$1.0m	Asset condition, reliability and security of supply

[58] Transend provided the project information for the Burnie Substation network transformer replacement too late for our review – Request for Information Log number 214. Nevertheless, we have reviewed condition information of all transformers due for replacement in this period and other aspects of this project should be relevant to findings elsewhere.

[59] Project information associated with the George Town redevelopment has not been provided. Nevertheless, this project is similar to other redevelopments, and the findings on these projects should be transferable.

ID	Project	Forecast ($m 2008/09)	Reason
ND0963	Knights Rd - Electrona Transmission Line Replacement	$12.6m	Asset Condition, reliability of Supply
ND0968	Knights Rd Substation 110kV Redevelopment & HV Protection Replacement	$6.8m	Asset condition, security and reliability of supply
ND0949	Meadowbank Substation 110kV Redevelopment	$4.7m	Asset condition, reliability and security of supply
ND0961	New Norfolk Substation 110kV protection replacements	$7.1m	Asset condition, compliance, protection co-ordination, operational efficiency
ND0953	Palmerston Substation 110kV Redevelopment	$13.8m	Asset condition, reliability and security of supply
ND0906	Railton Substation 110kV Redevelopment	$7.1m	Asset condition, reliability, safety and security of supply
ND0709	Tungatinah Substation 110kV Redevelopment	$19.9m	Asset condition, safety and reliability, operational efficiency

The following forms of project documentation, provided by Transend at our request, have formed the input to our project reviews:

- Transend's "Investment evaluation summaries" (IES) for all projects (and other project summary documents prepared by Transend), which summarise matters such as: the asset issues; options considered and costs; options evaluation and appraisal including economic analysis of options in most cases; and project risks;
- independent condition and risk assessment reports associated with a number of the projects; and
- independent options reports associated with a number of the projects.

Due to the level of expenditure on substations, we have selected 10 substation redevelopment projects for review.

We also consider Transend's supporting economic justification as an important factor in its demonstration of the prudency and efficiency of the projects reviewed. We advised Transend of this focus at the commencement of our project review, and requested that Transend provide economic analysis for the projects under review[60]. The majority of the IES provided by Transend have contained an economic analysis of various project options.

The scale of substation projects reviewed and the focus on the economic appraisal of these projects is consistent with the AER's position on this matter, noting the most recent AER decision on SP AusNet's revenue proposal, whereby SP AusNet was also forecasting a significant level of renewal of substation assets. In the case of SP AusNet, each substation redevelopment was assessed, including the economic analysis.

In the sub-sections that follow, we provide summary discussions of our ex ante review of the assessed projects. Appendix B provides more background information on these projects.

[60] Originally advised in the email dated 31/7/08, and then formally requested in the email dated 19/8/08.

4.4.1. 110 kV Substation redevelopments

Overview

Transend is proposing to complete seven 110 kV substation redevelopments in the next regulatory period and to commence work on an additional six redevelopment projects that will be completed in the subsequent period. These redevelopments address several needs, including the Reyrolle and Sprecher and Schuh circuit breaker replacement strategies discussed in section 4.2.1 above.

For the reasons discussed in the introduction above, Nuttall Consulting has included 9 substation redevelopment projects in its ex ante project reviews.

These selected projects include the two most significant projects in the asset renewal categories in the next period: the Creek Road and Tungatinah redevelopments. These two projects account for $53 million (23%) of Transend's expenditure in the asset renewal category. The remaining nine projects account for $60 million in total.

The Creek Road and Tungatinah redevelopments are significant due to the extent and form of the redevelopment planned by Transend. Transend considers that both substations have site restrictions that mean a redevelopment with outdoor "air insulated" switchgear is unlikely to be feasible, or would be very costly due to the extended network outages necessary to undertake such a redevelopment. Therefore, Transend considers that a complete redevelopment of the whole substation will be required using more expensive "gas insulated switchgear" (GIS) technology.

The remaining substation redevelopments generally propose the replacement of targeted poor performing assets "in-situ" or complete redevelopments of smaller substations (e.g. the Emu Bay redevelopment).

As noted above, the condition and performance of the 110 kV circuit breakers are significant factors driving the need for the projects. However, the projects also cater for other asset issues at the individual substations. To varying degrees in the different substations, these assets include:

- other 110 kV primary plant, including current and voltage transformers, disconnectors, and the post-type insulators within the switchyards; and
- associated secondary systems, which normally includes protection and control relays at the substation, and in some cases auxiliary supplies and SCADA.

Many of the issues associated with the primary plant and protection and control relays relate to the condition and performance of the older assets types. These asset types have increased maintenance costs and deliver poorer system performance compared to newer assets. Transend also considers that the specified voltage transformers and post-type-insulators potentially have an explosive failure mode, which imposes safety risks to personnel in the substation.

In the case of the Tungatinah redevelopment, a significant issue associated with the primary plant relates to the existing arrangements of the substation equipment, which do not comply with current standards associated with clearances. Transend considers that this imposes a significant safety risk. Other than the HV switchgear component of the Arthurs Lake

substation redevelopment, this clearance issue is not reported by Transend to be a driver for the other substations reviewed.

NER compliance is also raised as a factor associated with the need for certain elements related to the secondary systems.

With regard to the analysis of options, in all cases reviewed, a range of options had been considered by Transend. These options generally cover a "*maintain and defer*" type option and a selection of asset replacement options.

In all cases, other than the Tungatinah redevelopment, Transend provided economic analysis of the options in the project IES. This analysis assesses the capital and maintenance costs of the various options, and the risk costs associated with the loss of supply at the substation due to an asset failure. This analysis indicated that Transend's preferred option was the least cost option, in present value terms.

Independent reports have also been provided on various aspects of the Creek Road and Tungatinah redevelopments. These include:

- **Creek Road:** An independent assessment of the condition and future maintenance requirements of all assets at the Creek Road substation was undertaken in 1999[61]. The findings of this report were that the majority of the 110 kV assets were near their end of life, and the consultant considered that they may need replacing over the next 5 years. The consultant did not consider the assets were adequate to provide supplies for the next 15 years.
- **Tungatinah:** An independent analysis of the various options for the redevelopment of the Tungatinah and Tarraleah substations was undertaken in 2005[62]. This considered various brownfield and greenfield redevelopment options, and various switchgear technologies. This analysis recommended a greenfield development using an outdoor "hybrid" switchgear technology. The analysis included a life-cycle cost comparison between options, involving estimates of the capital and maintenance costs of each option.

  In 2006, Transend commissioned an independent review of its plans for the Tungatinah redevelopment[63]. The review followed further analysis by Transend of the costs of the various options, which found a greenfield option using indoor GIS would be the most likely least cost redevelopment option. This review agreed with Transend's preferred option and considered that the project was required to address issues at the Tungatinah and Tarraleah substations, most notably the issues associated with substandard clearances and poor asset condition.

Nuttall Consulting's summary considerations

Nuttall Consulting has reviewed the documentation provided by Transend to support these projects.

With regard to the asset issues, we have reviewed the various IES and other supporting material provided by Transend. We have also compared the assets and issues raised in these

[61] Ascension report provided in the email, dated 8 September 2008 – Request for Information Log number 212.
[62] SKM report provided in the email, dated 8 September 2008- Request for Information Log number 206.
[63] Ascension report provided in the email, dated 11 September 2008 – Request for Information Log number 209.

documents with the discussions and information in the associated asset management plans. Broadly, these documents agree.

The condition and performance of the identified assets appears to be a significant driver of the need for the substation redevelopments. With regard to the high maintenance costs associated with these assets, the IES provides information that supports this view. It is difficult in the context of this renewal review to validate these maintenance costs; however, we see no reason to discount them either.

With regard to the risks associated with the existing assets and substation arrangements, there is far less quantitative information to gauge their significance on the need for a replacement. In terms of the effect on supply reliability and system security, there is little quantitative information that demonstrates Transend's view that these risks are excessive. Estimates of the customer costs associated with the loss of a whole substations are provided in the IES for all but the Tungatinah redevelopments, with a general statement that a full failure of this sort could be expected over the next 10 years period. However, Transend's assumptions to arrive at this probability are not discussed, and it is not clear how the different assets contribute to this possibility i.e. the criticality of the various assets to these risks.

As discussed in Section 4.2.1, we concur that the 110 kV Reyrolle circuit breakers are old, and both the Sprecher and Schuh and the Reyrolle breakers are showing degraded performance. However, as discussed in that section, we do not consider that Transend has demonstrated that these circuit breakers will degrade to the point in the next period where there is a clear need for their replacement. Moreover, these assets alone do not appear to justify the probability of failure identified for each substation.

As noted above, risks to safety appear to be a factor in the need for some projects. However, important information to appraise the significance of these risks is not provided. Such matters we would expect to be discussed include the history of these risks, how they have been managed to this period, and how they may change from existing levels in the short to medium term if the renewal option is deferred. These matters are central to understanding what safety risks Transend has historically accepted at the site, the reasons why, and whether these risks will increase in a material way if actions are not undertaken.

The safety risks associated with the explosive failure of post type insulators and voltage transformers have been known for some time (i.e. circa 2000). As these assets have not already been replaced as part of a targeted program, it must be assumed that these safety risks must not be excessive at this time i.e. the benefit from removing the risk must be lower than the targeted replacement cost. It is most likely that these risks may be increasing as the asset age further, although the extent of this predicted risk increase is not discussed.

The one substation where we accept that safety risks may be far more material is Tungatinah, where existing clearances are below standards. Here it is noted that the independent review of the project considered these risks to be unacceptable. It is also noted that this substandard clearance issue is similar to the safety issue that was a significant factor in the need for the HV switchgear program. As such, we agree that in the case of Tungatinah the safety issue may be a primary driver for the overall redevelopment.

In terms of the compliance issues associated with the secondary systems, it is our understanding that "grandfathering" provisions in the NER mean that Transend's existing

assets are not affected by this. Therefore, in our view, this issue is more of a concern for the scope of the replaced assets. As such, we do not see this as a significant driver of the overall need for the redevelopment. However, we do accept that it may be the most efficient option to replace these secondary systems at the time of doing the more substantial redevelopment of substation.

Based upon our review, we are satisfied that the identified assets and associated issues are reasonable, and warrant consideration for their replacement. However, we do not consider that the costs and risks associated with these issues have been demonstrated to the point where there is a clear need to undertake some form of renewal investment in the next period. As such, we consider that the economic analysis of options, including a time-specific deferral option, is critical in justifying the need for the redevelopments.

As noted above, the only redevelopment where we see sufficient justification that a safety risk is a major factor is the Tungatinah redevelopment. However, even in this case and noting the scale of the redevelopment, a more rigorous discussion of the safety risk, including past risk mitigation measures and future mitigation options, would be beneficial.

With regard to the options considered in the substation redevelopments projects, these appear reasonable in principle. Due to the limited information provided on risks associated with each identified issue, it is difficult to assess the relative needs of various components of the projects, and whether some parts of the replacement options could be separated and prudently deferred.

With regard to the economic analysis, it is clear that the risk costs associated with the loss of supply play a significant role in defining the lowest cost option. These risk costs make up a large portion of the cost of the "*maintain and defer*" options. However, we consider that Transend's analysis is flawed in its treatment of risk costs in that the risk cost does not appear to be the probability weighted cost i.e. the probability of failure multiplied by the cost of the consequence. Rather, Transend has adopted a worst-case scenario, whereby it has assumed that a substation failure *will* occur in the year following the deferral date. In present value terms this appears to bias the comparison of this options in favour of the replacement options.

Unfortunately, as there is insufficient information on risks in the documentation provided, it is difficult to determine the materiality of this matter. Based upon the failure rate information on circuit breakers, it does appear that Transend's assumption may overstate the risks of supply failure. Noting that the cost difference between the *maintain and defer* option and Transend's preferred replacement option for all redevelopment projects is generally low then it appears that the NPV of the "*maintain and defer*" option may well be the lowest cost option if Transend's assumption was changed from worst-case to the most-likely failure scenario.

It is also worth noting that based upon our analysis of the benefits of a one-year capital deferral, the maintenance cost accounts for around 4-14% of this benefit with the circuit breaker risk costs accounting for another 10-40%. Therefore, there is over 50% of risk costs associated with other assets that are unaccounted for in terms of ensuring there is a net positive benefit in undertaking the renewals.

Counter to the points above, it is noted that Transend has not attempted to explicitly factor in an age relationship to the maintenance and risk costs. Noting that the assets are showing

signs of aging, particularly the circuit breakers, then it could be argued that the existing failure rates and maintenance needs may increase further during the next period. As such, maintenance and risk costs associated with the "*maintain and defer"* option may also increase. Unfortunately, it is difficult in the context of this review to attempt to gauge the materiality of this possibility. However, as Transend has not factored in this effect, it seems reasonable to assume that it is not expected to be significant.

On balance, noting the age and issues of the relevant assets, we consider it reasonable to assume that Transend will need to undertake some 110 kV substation redevelopments to meet the capex objectives. However, we do not consider that Transend has sufficiently demonstrated the need to undertake the volume of redevelopments it is proposing, particularly the large number in the last 2 to 3 years of the next period.

In keeping with our general finding on the 110 kV circuit breaker strategy (section 4.2.1), we consider that more detailed evaluations of the projects should allow a number of the redevelopments to be prudently deferred by 1 to 3 years, such that the "as-incurred" costs of these redevelopments will fall outside the next regulatory period. This would most likely affect the substations with the Reyrolle breakers, but should still allow alignment with the associated asset management plan, which indicates up to a 10-year period for the replacements (i.e. 2018). On the basis of the information received from Transend, we do not consider that the 1 to 3 year deferment would materially affect the performance of the assets or Transend's ability to meet its capex objectives.

It is also worth noting that both the Creek Road and Tungatinah redevelopments have the oldest 110 kV breakers in Transend's fleet. However, due to the higher cost of these projects, particularly the Creek Road project, greater benefits are required to achieve a net positive outcome (i.e. the age does not necessarily reflect the priority).

In addition to the above concerns with Transend's economic justification, there appears to be other uncertainties in the timing and costs of the substation redevelopments.

The first of these relates to the consultation necessary with affected customers and the possibility that this may result in delays in some projects. This appears to be particularly relevant noting the large number of redevelopments that are proposed to occur over the latter half of the next period.

The project that appears could be most significantly affected by this risk is the Tungatinah redevelopment ($19 million). The IES for this project indicates that the land required for the redevelopment is presently owned by Hydro Tasmania. Furthermore, the two existing sites associated with the redevelopment, Tungatinah and Tarraleah, both allow for the connection of Hydro Tasmania generation. (Text has been removed due to its commercial-in-confidence nature)

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(Text has been removed due to its commercial-in-confidence nature)

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It is accepted that Transend has compulsory acquisition powers to ensure it can obtain the required land. Nevertheless, there still appears to be significant regulatory and legal issues to be resolved concerning what will occur here, and when and how this may affect negotiations and the final scope of the regulated portion of the redevelopment. Furthermore,

delays in the resolution of this would affect the tendering process, which may then have a resultant impact on the Creek Road timing, as it is understood that both projects may be tendered as one package to achieve efficiencies.

The AER will need to also consider these matters with Tungatinah in light of clause 11.6.11 of the NER, and the competitive neutrality of Transend's proposal for this project.

The second matter concerns the possible scope and cost of the Creek Road and Tungatinah redevelopments. As noted above, both of these redevelopments assume an expensive indoor GIS option will be required due to space limitations and outage management issues, and this GIS option has been found to be the lowest cost option in the IES and supporting reports. However, the IESs for these projects indicate that Transend intends to tender these projects on a "functional specification" basis. Therefore, it may well be that the market may determine an innovative approach to the redevelopments that may reduce the costs if an outdoor AIS or hybrid technology option is found to be feasible.

Although, based upon the information available, it does appear reasonable to assume that the GIS option will be the most likely, this does appear to impose an asymmetry on the risks associated with the costs of these projects. It is noted that Transend applies a risk component to individual projects (i.e. the Evans and Peck risk model); however, it is not clear whether asymmetries of this type would be covered by this risk modelling.

On balance, based upon the information we have reviewed, we consider a 60% factor should be applied across all the 110 kV substation redevelopment projects associated with the Reyrolle breakers. This adjustment will account for the likelihood that more detailed analysis of the cost and risks associated with the various asset issues in the individual projects, and consultation with affected parties, will result in some projects being prudently deferred by 1-3 years.

This adjustment is also in line with our findings on the circuit breaker strategies, where we considered further analysis and prioritisation would defer the need for the replacement from the planned dates. The 60% reflects the position that over half the Reyrolle breakers will be replaced in the next period, with the remainder in the period that follows. It is important to note, that this modest deferral is still in accordance with Transend circuit breaker strategy for the replacement of these breakers over the next 10 year period.

4.4.2. Secondary system replacement projects

Overview

Nuttall Consulting has reviewed two projects concerning the replacement of secondary substation assets, primarily protection and control schemes. The scope of these projects are as follows:

- The Farrell substation secondary asset replacement project is forecast to be commissioned in 2010/11 for $11 million. It involves the replacement of a number of protection schemes associated with this substation, plus other secondary systems including the SCADA system, DC supplies, relays panels and control room alterations.

- The New Norfolk substation 110 kV protection replacement project is forecast to be commissioned in 2013/14 for $7 million. It involves the replacement of a number of protection schemes associated with this substation, plus some voltage transformers (primary assets).

The IESs for these projects summarise a range of issues related to these assets, mainly related to the condition, performance and fleet management associated with the protection schemes. These issues affect the maintenance costs and systems performance risks.

Economic analysis of a range of options has been undertaken indicating a "*maintain and defer*" option would be the lowest NPV for both projects. However, Transend has rejected this option as it does not address the stated issues.

Nuttall Consulting summary considerations

The asset issues associated with these projects appear reasonable, and align with the associated AMPs. However, as with the substation redevelopment projects, there is little quantitative discussion of how these issues relate to risks in monetary terms. As such, it is accepted that Transend should be considering the replacement option, but the IES do not provide sufficient justification that Transend must undertake the replacement option.

Furthermore, it is noted that the economic analysis only considers maintenance costs, risk costs are not included. This reflects why the "*maintain and defer*" option is the least cost, but provides no further insight as to what the risk cost must be to justify that a net positive benefit exists to undertake Transend's preferred option.

For both projects, it would be expected that certain issues would have higher risks associated with them (e.g. the busbar protection schemes), and therefore, there may be diminishing returns for certain elements of the overall project in terms of the costs and the reduction in risk.

For the Farrell substation project, the IES indicates that the overall project may result in increased costs in the order of 10% if it is staged i.e. some elements of the project are deferred. Transend had assessed this option and found it to have a higher NPV than the un-staged replacement option. However, it has only allowed for 3 stages which occur one year after another. It has not justified why the later stages cannot be deferred for a longer period.

Unfortunately, as Transend has not assessed the risk associated with the various elements separately, it is impossible to confirm that the overall replacement option is more prudent and efficient than an option involving the staging of the project.

Based upon the above, we do not consider that Transend has demonstrated that there will be a positive net benefit in undertaking the projects in their proposed form. We consider there is a reasonable case the projects could be undertaken in a staged manner; prioritising the highest risk elements first. The deferment of the later stages by a number of years may well offset the increased capital cost of the staged project.

On balance, based upon the information we have reviewed, we consider that it is reasonable to assume that only 50%[64] of the costs associated with the substation secondary projects will

[64] In the absence of more detailed information in the IES on the risk and capital costs associated with the various assets, the 50% has been chosen as the mid-point of the project capital costs, assuming that approximately half of the project scope will account for a large proportion of the risks being addressed.

eventuate in the next period. This will account for the likelihood that more detailed analysis of the costs and risks of these projects will result in the prudent deferral of components of these projects beyond the next period.

4.4.3. Burnie-Waratah 110 kV transmission line wood pole replacements

Overview

This project involves the replacement of number of existing wood pole structures of the Burnie to Waratah 110 kV line with new steel poles. This project is related to a similar project reviewed as part of the ex post project reviews. Transend is forecasting to incur $2.5 million in 2011/12 on this project, and $3.3 million in 2013/14.

The transmission line was commissioned in 1967 and the structures to be replaced will be identified via Transend pole inspection program, which inspects pole on this line every 3 years.

Transend has forecast expenditure for this project to allow for 30 structures to be replaced in 2011/12 and 40 structures in 2013/14[65]. This forecast is based upon the average failure rate curve for wood poles in Tasmania. This failure rate curve has been produced by Aurora, the main owner of wood poles in Tasmania, based upon its historical records of wood pole replacements. This curve suggest 30 poles per 3 year cycle may be required to be replaced – noting 2 poles per structure.

Nuttall Consulting summary considerations

Nuttall Consulting has reviewed the information provided by Transend to support the expenditure on this project. Based upon this review, we accept that it is likely some poles will be required to be replaced in the next period; however, we do not consider Transend's estimation is a reasonable assessment of the number of replacements that may occur and the timing of these replacements.

Firstly, recent inspection condemnation rates indicate that the poles of this line may be in a better condition than the average for their age. The last inspection did not condemn any poles, and the inspection prior to this only condemned 12[66].

Therefore, based upon the recent inspection results, and still allowing for a modest increase in the recent condemnation rate, we consider that a provision for the replacement of 15 structures is a reasonable estimate for the expenditure need in 2011/12 i.e. half the Transend forecast.

Furthermore, based upon the 3-year inspection cycle, and the historical trend that the pole replacements occur the following year, there does not appear to be any reason to allow for any expenditure in 2013/14, which is the same year as the inspection will occur. That is, even if poles will be condemned in the 2013/14 inspections, expenditure should not be

[65] See project definition forms for this project, provided in the email dated 9 September 2008 – Request for Information Log number 188, 220 .

[66] It is our understanding that no poles were condemned in the most recent inspection conducted in 2007/08. Furthermore, the project definition form for this project indicates that only 12 structures were required to be replaced in 2006 due to the previous inspection.

incurred in this year to replace these. Therefore, we do not consider there is a need for any expenditure allowance in 2013/14 for this project.

4.4.4. Knights Road to Electrona transmission line replacement

Overview

The Knights Road to Electrona transmission line replacement is forecast to be commissioned in 2010/11 for $13.3 million ($12.6 million of which will be incurred in the 2009-14 regulatory period). The project involves the replacement of the existing line (structures and conductor) with a new line of a higher capacity. The IES for this project indicates that Transend considers that an element of this project is an augmentation, and as such, will be subject to the regulatory test. However, the existing line has a number of issues, of which Transend considers relate to the need for renewal – hence the classification as renewal in Transend's revenue proposal.

These issues concern the following matters:

- the conductor condition, which is 67 years old, and considered to be in poor condition due to its age and the impact of recent bushfires;
- the poor condition of a number of tower structures;
- sub-standard clearance issues associated with a number of spans, which require the line to operate at 49 degree rather than its original design temperature of 70 degrees and
- environmental noise from the line (corona), resulting in a number of complaints.

The augmentation of the existing capacity is required to ensure Transend can comply with Tasmanian network performance requirements[67] for the forecast load in that area i.e. a statutory reliability standard under the regulatory test.

The IES examines a number of options, all involving the replacement of the conductor and various structure replacement options. A new steel pole line is considered by Transend to be the preferred option as it addresses all issues and is the least cost solution.

Two independent reports have been supplied to support this project[68]. These are:

- a condition assessment report on the existing towers, which determined the number of towers in poor condition and the spans that had substandard clearance; and
- an options analysis report that considered the various line replacement options.

Nuttall Consulting summary considerations

Nuttall Consulting has reviewed the various documents provided by Transend in support of this project, including the independent report identified above.

Based upon this review, we are satisfied that there are major issues with the condition of the existing line. The primary matter appears to be the condition of the old conductor, whereby

[67] Clause 5.(1)(a)(i) of the Electricity Supply Industry (Network Performance Requirements) Regulations 2007
[68] Provided in the emails, dated 18 August and 4 September 2008- Request for Information Log numbers, 168, 283.

the failure could affect system performance and public safety (as with the Burnie - Port Latte line reviewed in the ex post projects). However, the Transend documentation does not provide historical data of the reliability of this line or an assessment of condition of the conductor to indicate how the line has deteriorated since the last bushfire in 1991. For example, it is not clear how many sections are most severely affected, and as such, what is the minimum amount of reconductoring necessary to address this issue – even if this was only a short to medium term measure.

Similarly, there is support for the poor condition of tower and the substandard clearance issue with some spans, but without the other issues it must be assumed that targeted tower replacements or other works could address both of these issues. Furthermore, it must be assumed that environmental issues are a secondary consideration, as without the other issues, it is unlikely that this alone would necessitate the need for reconductoring the whole line at that time.

Based upon the above, it does appear that the augmentation need is a significant driver for the overall replacement of the whole line, as the need for the larger conductor appears to be requiring the complete replacement of the existing towers.

It is difficult to piece together the justification for the preferred solution in the IES, as the various options to address the individual issues are not discussed and evaluated in terms of their costs and benefits. This form of evaluation may be important in understanding the significance of each issue and the relative efficiencies of various solutions. This approach should also ensure an unbiased regulatory test is applied that can properly evaluate non-network alternatives to address the compliance with the statutory reliability standards and the additional works required to address the "pure" renewal needs.

On balance, considering the range of issues associated with this line, it does appear reasonable to assume that the new line development will be selected to be the least cost solution. However, there is still uncertainty in the timing, and in particular, whether the line could be rebuilt by 2010/11.

In this regard, the tendering for any projects to build the line is dependent on the outcome of the regulatory test and associated consultation process for a new large or small network asset. It is noted that the independent options report indicated that the option involving changes to the route or tower locations (i.e. Transend's preferred option) may incur planning delays.

Noting that it may take two years to re-build the line from the time of passing the regulatory test, it would appear that Transend would need to be commencing the consultation process very soon to achieve the 2010/11 commissioning date. As such, there appears to be a real possibility that the line will not be commissioned by 2010/11 even if it is required.

Although, we have concerns with the above, we are not recommending a specific adjustment to this project to account for this matter. Nevertheless, this position should be considered in terms of the overall ability of Transend to meet its capex objectives in light of other recommended adjustments to the overall capital program.

Further comments on the consultation process

In reviewing this report for errors of fact and confidentiality, Transend has advised[69]:

> "*The Knights Road-Electrona 110 kV transmission line replacement project was noted in the 2008 APR. The augmentation component of the Knights Road-Electrona 110 kV transmission line replacement project is under $10 million and as such is classified as a small transmission network asset in accordance with clause 5.6.6A(c) of the Rules. This project was identified in page 84 of the 'Transend 2008 Annual Planning Report'. No written submissions in respect to this proposal were received from any interested parties as part of the consultation process. Transend therefore considers that appropriate consultation has taken place, with no requirement for further consultation.*"

Nuttall Consulting has reviewed the relevant section of Transend's 2008 Annual Planning Report (2008 APR). It is noted that that this project is discussed at the reference indicated above. However, in the preceding section (pg 65 of the APR), the report states that there are no small network assets in the 2008 APR for consultation. It then goes on to state that the section, which contains the discussion referenced in Transend's comments above, is for information only. Furthermore, the estimated cost of the preferred option provided in the 2008 APR is $10.9 million, which may leave any interested parties with a view that a large network asset consultation process will occur.

Due to the uncertainty as to whether appropriate consultation on the augmentation component of this project can be considered to have occurred, in Nuttall Consulting's opinion its concerns expressed above are valid, unless the AER can confirm that the consultation on this project has been in accordance with the NER.

4.4.5. Summary findings

Based upon our review of the information provided by Transend to support its projects, we are satisfied that the range of issues to be addressed by the projects is reasonable and aligns with Transend's asset strategies. Nevertheless, we have concerns that the risks associated with these issues, in many cases, are not clearly discussed and quantified. In all cases, the risk costs are the primary driver of the project; however, in all cases these risks are not quantified, or Transend's determination of the risks is not clear.

This limitation impacts our understanding of the economic analysis provided by Transend to support the projects and Transend's selection of its preferred option. Due to these limitations, it is difficult to confirm that any projects would provide a net positive benefit.

As such, Nuttall Consulting is unable to say that Transend has demonstrated the need for each project we have reviewed, in terms of their requirement to meet the NER capex objectives in a prudent and efficient manner. Based upon the information we have reviewed, we consider that there is still uncertainty in the expenditure required and the timing of that expenditure. Moreover, in our opinion the likelihood that the expenditure will be lower, or the timing will be deferred, may be greater than the opposite position. Important considerations on this point are:

[69] First comment in Section 4.4.4 of the report provided in Transend email dated 16 October 2008.

- The risk costs in the economic analysis of the 110 kV substation redevelopment projects we have reviewed ($113 million) appears to be a worst-case failure scenario. As such, the results appear to be biased toward the preferred option of undertaking the redevelopment. Based upon the results provided, a less onerous position on the risks may well justify that a "*maintain and defer"* option has the lowest NPV overall if a modest level of deferral (e.g. 1-3 years) is assumed.
- There is a possibility that the consultation required to undertake the number of substation redevelopments over the latter half of the next period will result in delays in some projects. The project that may be most significantly affected by such matters is the Tungatinah redevelopment ($19 million). For this redevelopment, there still appears to be significant legal and regulatory issues that need to be addressed to ensure that the project will occur at the proposed time, and all the costs of the project will be rolled into the RAB (i.e. a significant portion of the project will concern connection assets).
- It is accepted that the expensive GIS options at Creek Road and Tungatinah ($53 million in total) are the most likely project outcomes. However, it appears more likely that a lower cost, innovative, AIS or hybrid technology approach may be determined through Transend's competitive tendering process than a higher cost option. It is noted that Transend applies a risk component to individual projects (i.e. the Evans and Peck risk model); however, it is not clear whether asymmetries of this type would be covered by this risk modelling.
- The substation secondary projects reviewed ($18 million) did not provide any quantitative measure of the risks associated with the stated issues. Moreover, the economic analysis supported a "*maintain and defer"* option; however, this was discounted by Transend as it did not address the risks. It would appear that there may be a good case that it would be prudent and efficient to stage these projects, such that the highest risk components are replaced first, with a modest deferral of the lowest risk components.
- Transend's forecast for the Burnie to Waratah wood pole replacements does not appear to be fully justified ($6 million). Based upon recent pole inspection results and the timing of the pole inspections, a reduced level of replacements appears far more likely.
- There appears to be a real possibility that the Knights Road to Electrona line replacement project ($12 million in the next regulatory period) could be delayed from its forecast date of 2010/11. This is due to the lead times associated with the consultation and planning associated with this project. This project appears to be largely an augmentation, and so will be a *large network asset* under the NER, and therefore, subject to the associated consultation and regulatory test provisions.

It is difficult to assess the above matters in terms of an overall level of renewal capital expenditure that will allow Transend to achieve its capital expenditure objectives in a prudent and efficient manner. However, on balance, across the projects, it is reasonable to assume that a large portion of the expenditure will be required.

Based upon the information we have reviewed, we recommend the following adjustments:

- We consider that a 60% probability should be applied across the 110 kV substation redevelopment projects associated with the Reyrolle breakers. This will account for the likelihood that more detailed analysis of the cost and risks in the individual projects, and the consultation with affected parties, will result in some projects being prudently deferred by 1-3 years. This is also in line with our findings on the circuit breaker strategies, where it was considered further analysis and prioritisation would defer the need for the replacement from the planned dates. The 60% reflects the position that over half the breakers will be replaced in the next period, with the remainder in the period that follows. It is important to note, that this modest deferral is still in accordance with Transend circuit breaker strategy for the replacement of these breakers over the next 10 year period.
- We consider it reasonable to assume that only 50% of the costs associated with the substation secondary projects will eventuate in the next period. This will account for the likelihood that more detailed analysis of the costs and risks of these projects will result in the prudent deferral of components of these projects beyond the next period.
- We consider that it is reasonable to assume that only 50% of the expenditure in 2011/12 for the Burnie to Waratah wood pole replacements will be required. This position reflects the recent pole inspection results, whilst still allowing a modest increase. Transend's forecast expenditure in 2013/14 should be removed completely as the previous pattern of replacement timing to inspection timing suggests that Transend would not undertake replacements in that year.

Table 13 indicates our recommended adjustments to Transend's proposed asset renewal capital expenditure. This represent a 22% reduction on Transend's forecast asset renewal expenditure in the next period. Based upon the information reviewed, we consider that our recommended allowance reflects the capital expenditure a TNSP would require for asset renewal to meet its capital expenditure objectives in a prudent and efficient manner.

Table 13 Nuttall Consulting's ex ante recommended adjustments

	$ million (2008/09)					
	2009-10	2010-11	2011-12	2012-13	2013-14	total
Transend's proposal	**29.8**	**39.4**	**25.7**	**62.4**	**69.3**	**226.6**
110 kV substation redevelopment reductions	-	-0.6	-2.3	-17.3	-16.3	-36.5
Secondary system adjustments	-1.3	-4.2	-	-0.8	-2.7	-9.1
Line reduction	-	-	-1.1	-	-3.3	-4.4
Recommendation	**28.5**	**34.5**	**22.3**	**44.3**	**46.9**	**176.6**

5. Summary and recommendations

5.1. Ex post summary and recommendation

In this section we summarise our considerations on the ex post review of Transend's asset renewal expenditure in the current period.

In order to place our ex post review in some context, we first discuss our consideration of the reconciliation between the ACCC's 2003 decision and Transend's expenditure on asset renewal during the current period.

Following this, we discuss the main matters relevant to our position on the prudency of Transend's asset renewal during the current period.

5.1.1. Reconciliation to 2003 allowance

As discussed in Section 3.6, Transend appears to have commissioned renewal projects during the current regulatory control period at a level in the order of 50-60% above that anticipated in the ACCC's 2003 decision. However, Transend considers that it has undertaken its renewal program, largely, as anticipated in quantum, with the cost variance being mainly due to three factors:

- the categorisation of projects or project elements to the asset renewal category that are not strictly renewal;
- input cost increases not anticipated when the ACCC made its revenue allowance; and
- project estimation errors due to the simplistic estimation processes employed by Transend at the time of the 2003 application.

With regard to the categorisation, Transend has estimated the proportion of non-renewal elements of the projects (i.e. augmentation or connections) and, based upon this analysis, considers that the resulting overspend in renewal is only 13%. This level of overspend is similar to the level of input cost increases, and as such, supports Transend's position.

As there is limited information on what specifically was allowed for in the renewal category in the 2003 decision it is not possible to confirm the validity of this analysis. That said, a number of matters raised by Transend do appear to be reasonable[70]:

- Additional projects may have been undertaken in the period (e.g. Electrona and Sheffield substation redevelopments), but these are offset to some degree by other project that have been deferred (e.g. Creek Road and Tungatinah). This movement of projects due to circumstances arising during the period appears entirely reasonable.

[70] Transend has provided further clarifications on the reconciliations in the emails, dated 8 and 9 September 2008 – Request for Information Log numbers 222, 223, 224, 225, 226

- A number of significant project elements in Transend's asset renewal category are not strictly asset renewal and do not appear to have been categorised as renewal in the 2003 application. These are:
  - The Burnie to Port Latta line reconductoring project, which cost $20 million in 2007/08. Transend has advised that an allowance of only $4 million would have been included in the 2003 application related to the renewal of the conductor. The appendices of Transend's 2003 application indicate that the augmentation element of this project was considered a "variable" augmentation and so would not have been included in the 2003 renewal allowance.
  - The Electrona substation redevelopment project, which is $11.2 million in 2008/09, is mis-categorised to the asset renewal category in appendix 3 of Transend's revenue proposal, and should be considered a connection project that was not anticipated in 2003.
  - The 3rd network transformer arrangements that are included within the George Town network transformer replacement project, which Transend has estimated as approximately $2.5 million of the total project cost. Transend's business cases for this project, which were developed during this regulatory period, appear to support the position that this portion of the project was not envisaged in 2003.
  - There are two general transmission lines and substation programs listed in 2007/08 in the cost information template. Based upon discussions with Transend during the course of this review[71], these capture works yet to be allocated to specific projects. Although these are defined in the asset renewal category, it is our understanding that these items include costs from a range of projects in other capex categories. For example, $2.8 million in the general line program was identified as relating to an augmentation project, the Norwood-Scottsdale-Derby 110 kV transmission line.
  - Connection works in the form of additional HV switchgear for Aurora feeders is included in the HV switchgear replacement projects. This appears to be confirmed by the business case documents. It is our understanding that the expenditure for these additional switchbays was not included in the renewal category in Transend's 2003 application.

Based upon the above, it seems reasonable to assume that the overspend of the 2003 allowance relating to asset renewal was likely to be in the order of 30%. This is much lower than the 60% deduced from the proposal; however, it is materially higher than the 13% indicated in Transend's later analysis.

Noting that 12% of this increase may relate to input cost increases, and assuming this will be broadly accepted[72], then the other 18% could be considered to be estimation error. These levels of estimation error could be reasonable if Transend's previous estimation processes were as simplistic as indicated - similar issues have been raised and accepted in previous proposals (e.g. the most recent SP AusNet revenue proposal).

[71] Discussed during meetings between 11th and 13th August 2008. It was expected that this would be addressed in the reconciliation paper; however, this does not appear to have occurred.
[72] The review of the input costs increases is not part of our terms of reference.

This, obviously, does not justify the prudency of the asset renewal during the current period. However, it does support Transend's position that the quantum of asset renewal has not significantly increased from that which formed the basis of the ACCC's 2003 decision. The prudency issue is considered below.

5.1.2. Ex post prudency test

Nuttall Consulting is required to undertake an ex post assessment of the prudency of Transend's asset renewal capital expenditure, based upon the prudency test defined in the ACCC's statement of regulatory principles. This test defines a 3-stage process, which involves:

- The assessment of a justified need for the investment against statutory and code obligations.
- The assessment of the most efficient investment, and in particular whether this was objectively and competently analysed by the TNSP to a standard consistent with good industry practice.
- The assessment of whether the selected project was developed, and if not, whether the difference reflects decisions consistent with good industry practice[73].

Our high-level assessment of Transend's asset renewal in the current period indicates that renewal of substation assets has been occurring at a much higher rate than transmission lines. In this regard, we estimate that the average annual substation asset renewal in the current period is approximately 4% of the replacement cost of the substations assets[74]. Investment at this level would indicates an average life of 25 years for substation assets, which is well below expectations.

For this reason, our review has focused on substation asset renewals, and in particular, the asset renewals associated with 110 kV circuit breakers, HV switchgear and power transformers. These programs represent a significant level of investment in the current period, and are often a trigger for renewals related to other asset classes.

Our analysis of the average age and life for these assets during the current period also indicates a high level of substation renewal. Information provided by Transend indicates a significant reduction in average life for these asset classes will have occurred from the commencement of this period to its conclusion. This is most significant for the HV switchgear, which has undergone an extensive renewal program during the period, resulting in almost 20% of the population being replaced.

With respect to the average life of the replaced assets, these lives are certainly not unreasonable, but in our opinion, they are on the lower end of what is achievable.

[73] It is important to note that Nuttall Consulting's terms of reference do not include the broader efficiency issues of project delivery, which have some relevance to the assessment in stage 3.

[74] Based upon the portion of asset renewal expenditure on substations and the 2007 replacement cost of the substation assets indicated in SKM's most recent statutory valuation of Transend – provided in the email, dated 16/7/08 – Request for Information Log number 102.

Nothing in the above is sufficient to say that Transend's renewal is not prudent. However, it does support the position that Transend's asset renewal during this period has been relatively aggressive.

Counter to this, our review of Transend's asset renewal strategies does provide significant support to the need for this level of renewal. Important findings from our review are:

- The various strategies employed by Transend are reasonable, in principle, and certainly support the view that Transend should be, at least, considering the renewal of the identified assets. In this regard, asset issues related to specific types are identified and the commercial impact considered in order to assess maintenance or renewal requirements.
- The 110 circuit breaker strategies appear to be in line with other TNSPs in terms of the focus on early breaker vintages (e.g. commencing with air blast and bulk oil types, and then moving to minimum oil types).
- Transformer replacement needs are identified based upon condition assessment processes, widely applied across the industry.
- Safety and performance risk issues, partly due to the design of the existing arrangements, are driving the HV switchgear replacements. A number of independent reviews conducted on behalf of Transend have confirmed these issues and the renewal need.

Furthermore, Nuttall Consulting's project reviews associated with the current period, with one exception, have found no evidence that Transend's projects were not prudent. Important findings from our project reviews are:

- There were identified issues of which it was reasonable to assume some management action was required. Transend's assessment of these issues was generally supported by independent asset condition reviews, and in a number of cases, independent option analysis.
- A reasonable range of options was considered in the business cases, generally involving a number of *maintain* and *replace* options. Although not explicitly stated, these options aligned with the capital expenditure objectives defined in the NER.
- All substation projects included the opportunistic replacement of other assets (e.g. protection relays, AC and DC supplies). However, these replacements appear to align with other replacement strategies and associated needs. Based upon the information reviewed, we see no reason to consider it was not prudent and efficient to undertake these works at the time of the main replacement.
- Projects appear to have been developed as scoped in the business cases. There are some cost increases; however, there is no evidence that these changes do not reflect decisions consistent with good industry practice.

The one exception to the above findings concerns a transmission line pole replacement project that has $1.1 million associated with it in 2008/09. During the course of our review, Transend indicated that the latest inspection of this line has found no poles needing replacement. As such, there is no justified need for this investment to be included.

Nuttall Consulting also has a number of concerns with Transend's historical processes for determining renewal needs and assessing options, including:

- the lack of a consistent economic evaluation of project options (e.g. NPV analysis) – refer to section 4.3.2;
- the use of a business-wide risk analysis framework for project business cases without specific consideration of the risks directly addressed by, or resulting from, the project – refer section 4.3.2; and
- the "do nothing" option analysis is not adequately considered in the business cases reviewed.

These matters, particularly the option evaluation issues, concern the interpretation of the ACCC's prudency test, and specifically the issue of whether the TNSP "*objectively and competently analysed the investment to a standard consistent with good industry practice*".

In this regard, Transend's stated processes could be reasonably considered to align with good industry practice. Transend has a robust and well documented governance framework in place. Nuttall Consulting recognises that Transend has continued to implement improvements in its governance process during the current regulatory period. Nuttall Consulting considers that the application of these improved processes should provide assurance that Transend's future investments will be prudent and efficient. The Transend documentation, from the strategic to the operational, is consistent in identifying the need for economic analysis and evaluations.

However, the information reviewed by Nuttall Consulting highlights a lack of economic evaluation relating to renewal projects and this is not consistent with Transend's own documentation and procedures.

Nuttall Consulting also considers that the evident absence of economic evaluation in many of the business cases reviewed is not consistent with the ACCC's comments in the 2003 determination.

In the absence of an economic evaluation of the options associated with more major renewal projects, it is not possible to state whether the options selected by Transend would have proceeded or whether they may have been brought forward or deferred for some period.

The fact that many renewal projects have already been deferred by Transend (e.g. to align with network needs or the timing or other projects) further complicates this assessment.

As these processes have not been consistently applied, it is not possible to gauge what the impact of this may have been – if any. As such, Nuttall Consulting is unable to provide positive assurance on the prudency of the historical renewal expenditure.

Based upon the above, Nuttall Consulting's findings are as follows:

- $1.1 million should be removed from 2008/09 as we do not consider that the associated project passes the prudency test in terms of a justifiable need for the replacements.
- For the remainder of the asset renewal expenditure during this period, Nuttall Consulting considers that it can only provide a negative assurance that it has found

no evidence to support the view that Transend's asset renewal is not prudent, and required to meet the NER's capital expenditure objectives.

The AER will need to consider our concerns with Transend's project evaluation and justification processes, in light of our estimation of the asset renewal overspend (20-30%), the significant level of renewal during this period, and the AER's interpretation of the prudency test.

5.2. Ex ante summary and recommendations

Nuttall Consulting is required to undertake an ex ante assessment of Transend's forecast of capital expenditure on asset renewal in the next regulatory control period. This assessment has been performed to be consistent with the AER's associated obligations defined in the NER, and specifically clause 6A.6.7. This clause provides for:

- a set of **capex objectives**, which Transend's capital expenditure forecast should be required to achieve;
- a set of **capex criteria**, which the AER must apply to be satisfied that it can accept Transend's forecast; and
- a set of **capex factors**, which the AER must have regard to in satisfying itself that the capex criteria are achieved.

Transend has forecast its average annual asset renewal expenditure in the next period will increase by $8.6 million to $45.3 million, from the equivalent average over this period of $36.7 million. This represents a 23% increase in asset renewal expenditure. A significant portion of this expenditure ($53 million) is due to two major substation redevelopments forecast to occur in the latter part of the next period: the Creek Road and Tungatinah 110 kV redevelopments.

Transend considers that its asset renewal is a continuation of established asset strategies, and the increase is largely due to input cost increases[75].

The following points are important in understanding our discussion of Transend's asset renewal expenditure:

- We agree that Transend's renewal strategies are broadly a continuation of established programs. However, the focus on specific asset types within an asset class is changing as the poorest performing asset types have been replaced on the network in the current and previous periods.
- As with the asset renewal in the current period, Transend are forecasting the largest portion of asset renewal expenditure to be on replacing substation assets. This appears to be a continuation of a trend that began in the mid to late 1990s. As such, the main focus of our review has been on substation assets, and particularly 110 kV circuit breakers, transformers and HV switchgear – for similar reasons discussed in the ex post summary above.

[75] Table 5.17, pg 94, of Transend's proposal.

- The 110 kV circuit breaker replacement program is forecast to increase significantly from the level in the current period, whereby approximately 65 circuit breakers are forecast to be replaced compared to 31 in the current period. Moreover, these circuit breaker replacements appear to be a significant driver of the large number of 110 kV substation redevelopments that are forecast to occur, or commence, in the next period, 14 in total of which many are forecast in incur costs in the latter half of the period.
- Conversely, the HV switchgear replacement program, which was a very significant program in the current period, is far less significant in the next period. This is due to the large number of renewals that were completed in the current period.
- The number of transformer replacements is forecast to reduce slightly.
- Accounting for inflation and input costs escalations, the expenditure on the general transmission line renewal programs is in-line with program levels in the current period. These levels appear to be low as a percentage of the asset base, as such, we have not focused our efforts on these programs.

Our high-level analysis of average lives and ages supports the view that the forecast level of renewal on HV switchgear and power transformers in the next regulatory period is reasonable. The average ages are increasing during the period, and the average life of the assets forecast for replacement is reasonably high (around 50 years).

However, for 110 kV circuit breakers the results are more mixed. The average age of the 110 kV circuit breakers is showing a significant reduction; dropping from 23 years entering the period to only 15 at the end of the period. Transend's benchmarking of the age of its circuit breaker population against it peers[76] indicates that this change would move Transend from having an older population to having one of the youngest populations amongst its peers in the space of one regulatory period.

This suggests that Transend's circuit breaker renewal plans are aggressive. However, the average life of the 110 kV breakers forecast for replacement is approximately 52 years, which could be considered fairly high – although not exceptional.

With regard to our review of the asset renewal strategies, there are a number of findings that support Transend's forecast:

- Similar to our findings on the ex post review, the various strategies are reasonable, in principle, and certainly support the view that Transend should be, at least, considering the renewal of the identified assets. In this regard, asset issues related to specific asset types are identified and the commercial impact considered in order to assess maintenance and renewal requirements.
- The latest transformer condition assessment results have been viewed by Nuttall Consulting, and these results confirm that the units identified by Transend are showing signs of advanced aging, and most likely will be required to be replaced during the next period.

[76] ITOMs circuit breaker age tables, contained in Transend's presentation, provided in the email dated 12 August 2008 – Request for Information Log number 156

- The majority of HV switchgear forecast for replacement are outdoor units with similar safety and performance issues to those replaced in the current period.
- The 110 kV circuit breaker types being forecast for replacement in the next period (Reyrolle OS10 and Sprecher and Schuh HPF) are types that are being replaced, or have been replaced, by other TNSPs[77].

However, we do have a number of concerns with the 110 kV circuit breaker strategies, particularly the economic analysis that supports the plans. These concerns relate to two matters:

- Firstly, the economic analysis compares its preferred option with one of deferring the whole program by 5 years. It has not examined the option of extending the program over a longer period. A more rigorous identification of the risks associated with individual substations may well find that it would be prudent to defer some replacements. In addition, Transend's condition assessment reports for the Reyrolle breakers, which form the majority of breakers forecast for replacement, indicate the replacement can occur over 10 years. This is in contrast to Transend's preferred option, which appears to undertake the majority of replacements over 7 years.
- Secondly, the economic analysis only considered the deferment benefit of the capital cost of the breaker. However, in most cases, the replacement of the circuit breaker could be considered the trigger for the much larger substation redevelopment project. As such, the benefits of deferment could be much greater, assuming the risk due to the deferment of the other substation assets are not increasing substantially. Noting the very high costs of some substation developments, such as Creek Road and Tungatinah, the deferral benefit could be quite large. The Investment Evaluation Summaries for the substation redevelopment projects provide an economic assessment of the deferment of the overall project. However, as discussed further below, in Nuttall Consulting's opinion this analysis has some limitations that may overstate the risk costs of that option. As a result, we do not consider that this project level analysis addresses our concerns expressed here.

Both these matters, suggest that there may be a reasonable argument that the scale of Transend's 110 kV circuit breaker replacement strategy may not be prudent and efficient.

With regard to our review of a sample of projects, due to scale of the forecast investment on substation redevelopments, 9 of the 13 projects reviewed have been these redevelopment projects. Furthermore, a specific focus of our review has been Transend's economic justification for the projects.

Based upon our review of the information provided by Transend to support its projects we are satisfied that the range of issues to be addressed by the projects is reasonable and aligns with Transend's asset strategies. However, we have concerns with the lack of quantitative detail on the risks associated with the various issues. This limitation affects our understanding of the economic analysis provided by Transend to support its selection of the preferred option. As such, Nuttall Consulting is unable to say that Transend has demonstrated the need for each project we have reviewed, in terms of their requirement to meet the NER capex objectives in a prudent and efficient manner.

[77] Based upon information available to Nuttall Consulting through the AER from other regulatory applications.

We have particular concerns with Transend's appraisal of its substation 110 kV redevelopments and secondary system projects, which appears to be biased towards the selection of the *replacement* options to that of a *defer* option.

With regard to the110 kV substation redevelopment, the risk costs in the economic analysis associated with the *defer* options appeared to be a worst-case failure scenario. It seems reasonable to assume that the risks associated with a most-likely failure scenario may well justify that a *defer* option will have the lowest NPV overall for some redevelopment projects, if a modest level of deferral (e.g. 2-3 years) is assumed.

The substation secondary projects (2 of the 13 projects reviewed) did not provide any quantitative measure of the risks associated with the various issues (e.g. the various protection schemes and other auxiliary systems). Moreover, the economic analysis supported a *defer* option; however, this was discounted by Transend as it did not address the risks. For these projects, it would appear that there may be a good case that it would be prudent and efficient to stage components of these projects, such that the highest risk components are replaced first, with a modest deferral of the lowest risk components.

In addition to the above concerns with the economic justification, we also consider that the consultation required with affected customers could also result in some delays in the timing of the substation redevelopments. This appears to be particularly relevant noting the large number of redevelopments that are proposed to occur over the latter half of the next period.

The most significant of these concerns relates to the Tungatinah redevelopment ($19 million), where there still appears to be significant legal and regulatory issues to be addressed to ensure that the Tungatinah redevelopment will occur at the proposed time.

(Text has been removed due to its commercial-in-confidence nature)

It is noted that compulsory acquisition of the land in question is also an option available to Transend. This option will also incur significant time constraints, particularly if it is contested by Hydro Tasmania.

Importantly, any delays in the agreements with Hydro Tasmania for this redevelopment may have a knock-on effect for the Creek Road redevelopment ($33 million), as we understand that these two projects may be tendered together.

With regard to the transmission line projects reviewed, our main concern relates to the Burnie to Waratah 110 kV transmission line wood pole replacement project. Based upon recent pole inspection results for this line and the timing of these inspections, we do not consider that Transend has demonstrated the need for the level of replacements it has forecast.

It is difficult to assess the above matters in terms of a reasonable overall level of capital expenditure that will allow Transend to achieve its capital expenditure objectives in a prudent and efficient manner. However, we do consider it reasonable to assume that a large portion of the expenditure will be required.

Based upon the information we have reviewed, we recommend the following adjustments to Transend's proposed capital expenditure in the asset renewal category:

- Firstly, we have assumed a 60% probability across the 110 kV substation redevelopment projects associated with the Reyrolle breakers that these projects will

be required in the next period. This adjustment reflects the likelihood that more detailed analysis and consultation undertaken by Transend during the detailed planning of these projects will result in some projects being prudently deferred by 1-3 years. This is also in line with our findings on the circuit breaker strategies and results in approximately half the breakers being replaced in the next period, with the remainder in the period after. It is important to note, that this modest deferral is still in accordance with Transend's circuit breaker strategy for the replacement of these breakers over the next 10 year period.

- Secondly, we have assumed that only 50% of the project costs associated with the substation secondary projects will eventuate in the next period. This will account for the likelihood that more detailed analysis by Transend of the costs and risks associated with the various components of these projects will result in the prudent deferral of some components beyond the next period.
- Finally, we consider that only 50% of the expenditure in 2011/12 for the Burnie to Waratah wood pole replacements will be required, based upon the recent pole inspection results. This reduction still allows for a modest increase from the recent pole inspection results. Transend's forecast expenditure in 2013/14 should be removed completely as the previous pattern of replacement timing to inspection timing suggests that Transend would not undertake replacements in that year.

Table 14 summarises the above recommended adjustments to Transend's proposed capital expenditure in the asset renewal category. This represents a 22% reduction on Transend's forecast asset renewal expenditure in the next period.

Based upon the information reviewed, we consider that our recommended allowance reflects the asset renewal capital expenditure required for a TNSP to meet its capital expenditure objectives in a prudent and efficient manner.

Table 14 Nuttall Consulting's ex ante recommended adjustments

	$ million (2008/09)					
	2009-10	2010-11	2011-12	2012-13	2013-14	total
Transend's proposal	**29.8**	**39.4**	**25.7**	**62.4**	**69.3**	**226.6**
110 kV substation redevelopment adjustment	-	-0.6	-2.3	-17.3	-16.3	-36.5
Secondary system adjustments	-1.3	-4.2	-	-0.8	-2.7	-9.1
Line adjustment	-	-	-1.1	-	-3.3	-4.4
Recommendation	**28.5**	**34.5**	**22.3**	**44.3**	**46.9**	**176.6**

It is also worth noting that, based upon our project reviews, we consider there are a number of other factors that may result in capital expenditure on specific projects either being lower or the timing of the expenditure being delayed. We have not attempted to make adjustments to account for these factors, and as such, it could be considered that there is some level of

conservatism in our recommendations above. The two most significant factors are as follows:

- Firstly, while we accept that the more expensive GIS technology for Creek Road and Tungatinah ($53 million in total) is the most likely project outcome, there appears a realistic possibility that a lower cost solution, involving an innovative AIS or hybrid approach, will be determined through Transend's competitive tendering process, rather than a higher cost solution. It is noted that Transend applies a risk component to its overall capex requirements (i.e. the Evans and Peck risk model); however, it is not clear whether asymmetries of this type would be covered by this risk modelling.
- Secondly, there appears to be a possibility that the Knights Road to Electrona line replacement project ($12 million) could be delayed from its forecast date of 2010/11. This project appears to have a significant augmentation component, and so may be considered a *large* or *small network asset* under the NER, and therefore, subject to the associated consultation and regulatory test provisions. Noting these requirements, it is not certain that there will be sufficient lead-time for the public consultation and land planning to ensure that this project will be commissioned by that date.

With regard to the interaction of our asset renewal recommendations with other elements of the AER's review of Transend's proposal, we make the following comments:

- **Operating expenditure forecast and STPIS impact**. We would expect that the deferral we have recommended above may have a modest effect in increasing operating expenditure. Conversely, it would improve the service targets affected by planned capital works. Unfortunately, we cannot advise on what these adjustments should be at this stage, as they are dependent on the modelling approach applied by Transend. We recommend that these adjustments are made in consultation with WorleyParsons, who were responsible for the review of these elements.
- **NER 11.6.11**. We expect that some elements of the projects reviewed will be affected by the AER's present position on Clause 11.6.11 of the NER. The most obvious of these relates to the Tungatinah redevelopment, where a significant portion of the redevelopment will concern switchbays to connect the existing Hydro Tasmania generators. For the avoidance of doubt, in this report, we have not recommended any adjustments to account for Clause 11.6.11 of the NER[78].

[78] The AER has engaged Nuttall Consulting to review Transend's proposal in the context of NER11.6.11. At this stage, Transend has only provided information to the AER noting the AEMC's draft decision on this matter- Request for Information Log number 73

A. Appendix: Summary of projects in ex post review

This appendix provides background information on the projects that have been reviewed as part of Nuttall Consulting's ex post review of Transend's capital expenditure in the current period.

The intention of this appendix is to provide summary details on the approvals associated with these projects, the asset issues being addressed by these projects, and the options considered by Transend.

The information in this appendix is based upon the business cases and other supporting material, provided by Transend during the course of our review.

It is important to note that nothing in this section should be interpreted as our agreement, acceptance or otherwise of any views expressed. Our considerations on these projects are contained in Section 4.3 of this report.

A.1. HV switchgear and supply transformer projects

A.1.1. Overview of ND0326 Burnie Substation 22 kV switchgear replacement

Summary

The project involved the replacement of:

- the existing 11 HV outdoor switchbays;
- the protection and control associated with the switchbays; and
- auxiliary AC systems.

The project also included the installation of:

- an additional 6 HV switchbays at the request of Aurora;
- an additional 2 HV switchbays for station service transformers; and
- the upgrade of the SCADA system to cover the 220 and 110 kV assets.

The actual capex for this project was $3.3 million (nominal), with the majority of this capex in the January to June 2004 period.

The original business case for this project, dated September 2000, was for an amount of $1.75 million during 2000/2001.

A revised business case was approved in December 2002. This business case recommended $3.26 million to be incurred during 2002/3 to 2003/04. This increase was stated to be due to the requirement for the additional Aurora feeders and additional work at the site due to more

detailed planning. The cost in the revised business case was based upon the lowest cost tenderer.

Asset renewal needs

The business cases define the asset renewal needs as follows:

- **HV switchgear**: The HV switchgear was 35 years old and of an outdoor oil type (English Electric OKW3). These were similar in age and type to those also replaced during this period at Devonport and Queenstown substations. The main issues with this switchgear were:
  - safety risks due to corrosion of the safety screens that were required because of substandard clearance issues associated with this outdoor switchgear – Transend considered that these screens were no longer adequate safeguards;
  - increased maintenance costs due to the age and type of switchgear;
  - safety and reliability risks due to the poor performance of current transformers and insulators, which had a history of failure;
  - reliability risks due to the substation arrangements, which were exposed to animals and the environment – with a recent history at Burnie of failures due to this exposure; and
  - Tasmanian Electricity Code compliance issues associated with feeder metering at the substations – tests undertaken in 2000 recommended upgrading the metering at Burnie.
- **Protection**: The existing feeder protection was approximately 34 years old and transformer protection was 45 years old. The type of protection relay is not indicated, but it must be assumed, based upon its age, that it would be electromechanical, or possibly an early static technology, and so would be subject to the issues discussed in Section 3.3.4.
- **AC system:** The existing AC systems were of an obsolete technology and did not meet current standards.

Non renewal needs

The business cases define the non-renewal needs as follows:

- **Additional Aurora feeders**, based upon requests from Aurora (i.e. connection assets); and
- **SCADA.** The enhancement was considered necessary to reduce operational risks by allowing the entire substation to be monitored and controlled from a local interface.

Options considered

The original business case considered the following options:

- "do nothing" – which did not address Transend's identified issues;
- Address safety issues and protection requirements – which Transend considered was only a short term solution; and

- Replacement project as scoped – which Transend considered addressed all issues and aligned with its strategic plans, and so was selected as the preferred option.

The option costs or an economic appraisal of these options was not included, or discussed, in the business cases. Nuttall Consulting has sighted no other information that provides any form of economic appraisal of these project options.

A.1.2. Overview of ND0564 Palmerston Substation HV switchgear and transformer replacement

Summary

The project involved the replacement of:

- the existing 6 HV indoor switchbays (originally outdoor);
- the existing 7.5 MVA transformer; and
- the protection and control associated with the switchbays.

The project also included additional works to cover:

- the increase in the transformer rating to 25 MVA;
- an additional 2 HV switchbays at the request of Aurora;
- an additional 2 HV switchbays for station service transformers; and
- the upgrade of the SCADA system to cover the EHV and HV assets.

The actual capex for this project was $4.0 million (nominal), with the project commissioned in 2006/07.

The business case for this project, dated December 2003, was for an estimated amount of $4.3 million, to be incurred during 2003/04 and 2004/05.

A subsequent board resolution in October 2004 reduced the funding for this project to $4.2 million, based upon the tendered cost for this project.

Asset renewal needs

The business case defines the asset renewal needs as follows:

- **HV switchgear**: The HV switchgear was 47 years old and of an outdoor oil type (Scarpa Magnano MT22-BSP), but installed indoors. This switchgear is similar in age and type to those also replaced during this period at Kermandie, Queenstown, and Scottsdale.

  The issues associated with this switchgear are similar to those discussed above with the Burnie switchgear i.e. safety and reliability risks, and increased maintenance costs due to the type and condition of the switchgear. However, it appears that the clearance issue only affected part of the substation (service transformers and associated switchgear), but there were additional safety and reliability risks due to the switchgear not being "arc fault contained" to current standards i.e. an internal fault could affect the entire switchgear installation.

Furthermore, the busbar and disconnector support insulators were considered to be a reliability risk, having failed on 5 occasions since 1990, which resulting in unplanned outages to carry out repairs.

- **Transformer**: The transformer was a 54 year old, 7.5 MVA unit that had been repaired in 1987. Condition assessments in the form of insulating oil tests indicated the winding insulation had deteriorated imposing a reliability risk should the transformer fail in service. Moreover, tests performed on the paper insulation following decommissioning of the unit confirmed that the transformer was at the end of its life. Nuttall Consulting has viewed these test results.

  The existing transformer design and arrangements were also considered to impose reliability risks.

- **Protection**: The existing protection systems were of an electromechanical type. The age is not provided, but noting the technology and age of the transformers and switchgear, it must be assumed they were over 40 years old and subject to the issues discussed in Section 3.3.4.

Non renewal needs

The business case defines the non-renewal needs as follows:

- **Additional Aurora feeders**, based upon requests from Aurora (i.e. connection assets).
- **Increase in transformer capacity**, was required to meet the expected load growth over the medium to long term; however, it is also worth noting that 25 MVA was also a standard size of Transend's.
- **SCADA.** The enhancement involved the installation of a screen based SCADA system at Palmerston to cover the EHV and HV assets. This enhancement was in line with similar SCADA additions at other substations being redeveloped.

Options considered

The business case considered the following options:

- "do nothing" – which did not address Transend's identified issues;
- Increased maintenance and condition monitoring of the switchgear and retain the transformer – which Transend considered would not fully address the issues; and
- Replacement project as scoped – which Transend considered would address all issues and align with its strategic plans, and so was selected as the preferred option.

The option costs or an economic appraisal of these options was not included, or discussed, in the business cases. Nuttall Consulting has sighted no other information that provides any form of economic appraisal of these project options.

A.1.3. Overview of ND0514 Lindisfarne Substation: 33 kV switchgear replacement

Summary

The project involved the replacement of:

- the existing 7 HV switchbays, which were predominately outdoor equipment within an aluminium clad building;
- the protection and control associated with the switchbays; and
- auxiliary AC and DC supplies.

The project also included additional works to cover:

- an additional 2 HV switchbays at the request of Aurora;
- an additional 2 HV switchbays for station service transformers; and
- the upgrade of the SCADA system to cover the EHV and HV assets.

The actual capex for this project was $3.4 million (nominal), with the project commissioned in 2005/06.

The business case for this project, dated June 2003, was for an amount of $3 million. A subsequent board resolution, dated October 2004, increased the amount to $3.5 million, based upon the results of the project tendering process.

Asset renewal needs

The business case defines the asset renewal needs as follows:

- **HV switchgear**: The HV switchgear was 42 years old and of an indoor oil type (Sprecher and Schuh HP307 and AEI LGIC). The business case states that this switchgear is a custom design and unique to the Lindisfarne substation.

  The issues associated with this switchgear are similar to those discussed above with the Palmerston switchgear (i.e. safety and reliability risks, and increased maintenance costs due to the type and condition of the switchgear). The most significant safety and reliability risks appear to be due to the switchgear not being "arc fault contained" to current standards i.e. an internal fault could affect the entire switchgear installation.

  The safety risks associated with substandard clearances does not appear to affect any parts of this substation. However, the switchgear enclosures were not considered to meet current standards associated with the degree of protection (i.e. the IP rating). This resulted in increased safety and reliability risks.

  As with the Burnie substation, the metering system at this substation was considered to be outside the limits prescribed in the Tasmanian Electricity Code. The replacement of the HV switchgear would provide a fully compliant metering system.

  The replacement of the switchgear associated with the supply transformers was also considered to allow for the up-rating of the switchgear to meet forecast load levels.

- **Protection**: The existing protection systems were of an electromechanical type. The age is not provided, but noting the technology and age of the switchgear, it must be assumed they were over 40 years old and subject to the issues discussed in Section 3.3.4.

Non renewal needs

The business case defines the non-renewal needs as follows:

- **Additional Aurora feeders**, based upon requests from Aurora (i.e. connection assets).
- **SCADA.** The enhancement involved the installation of a screen based SCADA system at Lindisfarne. This enhancement was in line with similar SCADA additions at other substations being redeveloped.

Options considered

The business case considered the following options:

- "do nothing" – which did not address Transend's identified issues;
- Increased maintenance and condition monitoring of the switchgear – which Transend considered would not fully address issues; and
- Replacement project as scoped – which Transend considered addressed all issues and aligned with its strategic plans, and so was selected as the preferred option.

The option costs or an economic appraisal of these options was not included, or discussed, in the business cases.

Independent assessment

A key document that has been provided to support this project is an independent assessment of the Lindisfarne HV switchgear conducted in 2002[79]. The scope of this assessment covered:

- an appraisal of the relevant issues, including condition, risks, reliability, and costs;
- identification of asset management options;
- evaluation of options including economic analysis; and
- the recommendation of a preferred option.

The discussion of issues and recommendation in this report broadly concurred with the HV switchgear replacement component of this project.

However, the economic evaluation did not consider the full project cost. Furthermore, the revised recommendation to replace the HV switchgear was due to new information becoming available that indicated that the HV switchgear was older than the reviewer had assumed in the original study. On this matter, the reviewer stated that following:

[79] The Ascension consulting / Meritec report, and subsequent revised recommendation, provided in the supporting documents for this project - Lindisfarne Substation 33 kV switchgear replacement sample project pack provided to the AER by Transend – 27 February 2008

"As the switchboard has now been in service for 40 years, we recommend that it be scheduled for replacement on the basis of it's having reached the end of its expected life. We expect this type of equipment to have maximum life of 45 years and that the probability of failure increases markedly from 40 to 45 years. While we had recommended that full diagnostic testing be completed to better determine present condition before making a decision on replacement, we withdraw this recommendation based on the increased operational age of the equipment.

As detailed in our report, there are maintenance and operational issues with the switchboard, which strengthen the case for replacement. The financial consequences of failure detailed in Section 6 of our report, also reinforce the need for replacement of assets at the end of their expected life."

A.1.4. Overview of ND0563 Triabunna Substation HV switchgear and transformer replacement[80]

Summary

The project involved the replacement of:

- the existing 3 HV outdoor switchbays;
- the existing two 7.5 MVA transformers;
- the protection and control associated with the switchbays and transformers; and
- the auxillary supplies.

The project also included additional works to cover:

- an additional 2 HV switchbays at the request of Aurora (plus 2 further switchbays to provide dedicated feeder switchbays);
- an additional 2 HV switchbays for station service transformers; and
- the upgrade of the SCADA system to cover the EHV and HV assets.

The actual capex for this project was $4.3 million (nominal), with this project commissioned in 2006/07.

The business case for this project, dated December 2003, was for an estimated amount of $4.6 million, to be incurred during 2003/04 and 2005/06.

A subsequent board resolution in October 2004 reduced the funding for this project to $4.2 million, based upon the tendered cost for this project.

Asset renewal needs

The business case defines the asset renewal needs as follows:

- **HV switchgear**: The HV switchgear was 55 years old and of an outdoor oil type (Westinghouse Rosebery GO/1/B). This switchgear is similar in age and type to those also replaced during this period at Derby, and prior to this period, at Smithton.

[80] Triabunna Substation HV switchgear and 110 kV transformer replacement sample project pack provided to the AER by Transend – 27 February 2008

The issues associated with this switchgear are similar to those discussed above with the Burnie switchgear (i.e. safety and reliability risks, and increased maintenance costs due to the type and condition of the switchgear). As with other outdoor HV switchgear, the main safety risk concerned substandard clearances at the switchyard.

- **Transformer**: The two transformers were 54 year old, 7.5 MVA, units. These were identical to the replaced unit at Palmerston, discussed above. Condition assessments in the form of insulating oil tests indicated the winding insulation had deteriorated, imposing a reliability risk due to the greater likelihood of the transformers failing in service. Moreover, tests performed on the paper insulation on one transformer following decommissioning of the units confirmed that the transformer was susceptible to failure. Nuttall Consulting has viewed these test results.

  The existing transformers' design and arrangements were also considered to impose reliability risks.

- **Protection**: The existing protection systems were of an electromechanical type. The age is not provided, but noting the technology and age of the transformers and switchgear, it must be assumed they were well over 40 years old and subject to the issues discussed in Section 3.3.4.

Non renewal needs

The business case defines the non-renewal needs as follows:

- **Additional Aurora feeders**, based upon requests from Aurora (i.e. connection assets).
- **SCADA.** The enhancement involved the installation of a screen based SCADA system at Triabunna to cover the EHV and HV assets. This enhancement was in line with similar SCADA additions at other substations being redeveloped.

Options considered

The business case considered the following options:

- "do nothing" – which did not address Transend's identified issues;
- Increased maintenance and condition monitoring of the switchgear and retaining the transformers – which Transend considered would not fully address the issues; and
- Replacement project as scoped – which Transend considered would address all the issues and align with its strategic plans, and so was selected as the preferred option.

The option costs or an economic appraisal of these options was not included, or discussed, in the business cases.

Independent assessment

A key document that has been provided to support this project is an independent assessment of the Smithton HV switchgear, conducted in 1999[81]. The HV switchgear at Smithton was the same type to that at Triabunna, and as such, this assessment was considered relevant to the Triabunna project. The scope of the assessment covered:

[81] The Ascension consulting / APC Worley report provided in the supporting documents for this project Provided as a sample project pack to the AER 27 February 2008.

- an appraisal of the relevant issues, including condition, risks, reliability, and costs;
- identification of asset management options;
- evaluation of options including economic analysis; and
- the recommendation of a preferred option.

The discussion of issues and recommendation in this report broadly concurred with the HV switchgear replacement component of this project. In this regard, the reviewer considered the safety issues associated with the substandard clearances to be a primary factor driving the need to undertake the redevelopment at Smithton.

Economic analysis of various options was provided in the report indicating that an option to maintain the switchgear was the lowest cost. However, as it did not consider any risk costs (reliability or safety), it was limited in its use for informing the final recommendation to replace the switchgear.

A.2. Network transformer projects

A.2.1. Overview of ND0603/ND0531 George Town substation network transformers T1, T2 and T3 replacement

Summary

The project involved the replacement of:

- two existing network transformers.

The project also included additional works to cover:

- additional switchbay works to allow for the installation of an additional transformer prior to the transformer replacements indicated above.

The project also included other minor enhancements, including upgrades to the DC supplies and work related to the improved system and physical security at George Town.

The actual capex for this project was $19.6 million (nominal), with components of the project being commissioned in 2007/08 and 2008/09.

The original business case for this project, dated September 2004, was for an estimated amount of $5.7 million, to be incurred during 2004/05 and 2005/06. This business case only allowed for the replacement of two existing units.

A revised business case, dated June 2006, was for an increased cost of $15.7 million. The increased cost was due to the additional works related to the installation of the 3rd transformer and increased procurement costs associated with the original works, particularly the two transformers.

It is also important to note that the $19.6 million actual cost includes another project for the procurement of the 3rd transformer, which was originally being purchased as a strategic spare. This component was approved under a separate business case, with an approved amount of $2.5 million. This project has not been the focus of Nuttall Consulting's review.

Asset renewal needs

The business cases define the asset renewal needs as follows:

- **Network transformer**: The two transformers were 45 years old. Condition assessments of these transformers indicate the insulation is in poor condition, and the units are susceptible to failure. Nuttall Consulting has viewed these test results.

  Furthermore, the business case also states other issues associated with these transformers, including:

  - Safety and performance risks due to the poor condition of the bushing; and
  - Operational inefficiencies due to the lack of on-load tap-changers on these units.

  It is also worth noting that a significant factor incurring costs in the replacement projects is the need for concrete enclosures for the replaced units to improve the physical security of the transformers.

Non renewal needs

The main non-renewal element of this project is the switchbay works to allow for the energisation of the spare transformer at George Town, prior to the replacement of the two units. Transend considered that this was required to minimise risks to supply reliability (for Aurora), while the transformers were being replaced. That is, if a transformer failed during the replacement of the other unit, a significant level of load would be lost. Such an event was valued as $248 million in the business case.

Transend has also provided evidence of concerns expressed by NEMMCO on Tranend's original plans, and the impact this would have had on system security and supply risks.

Options considered

The original business case considered the following options related to the replacement of the existing transformers:

- "do nothing" – which did not address Transend's identified issues;
- Refurbish the existing transformers – which Transend considered would not be cost effective due to the age of the transformers and the expected extended life i.e. generally, Transend considers refurbishment is effective for transformers aged between 20-30 years; and
- Replacement of the two transformers – which Transend considered would address all issues, and so was the preferred option at that time.

The revised business case considered the following options related to the need for the prior energisation of the 3rd transformer:

- Replacement of the two transformers (the preferred option in the original business case) – which Transend considered would not address the outage risks during the time of the replacement;
- Replacement of the two transformers with network support – Transend had identified a local generator suitable for the network support; however, this proponent had advised that it may not be available plus its advised support costs may not have made this option the most efficient (it is also worth noting that evidence provided by

Transend during this review indicated that NEMMCO considered that this support option may not be acceptable in terms of maintaining system security); and

- Project as scoped – which Transend considered would cost-effectively address all issues, and so was the preferred option at that time.

The option costs or an economic appraisal of these options was not included in either of the business cases.

A.2.2. Overview of ND0552 Chapel Street substation: replacement of network transformers

Summary

The project involved the replacement of:

- three existing 120 MVA network transformers; and
- protection and control panels associated with the transformers.

The project also included additional works to cover:

- the upgrade of the transformers to 200 MVA units; and
- an upgraded screen based SCADA system for the substation.

The actual capex for this project was $8.1 million (nominal) with this project commissioned in 2004/05 to 2005/06. Transend has advised that $4.8 million of this project has been incorrectly assigned in the AER's cost information template to project ND0554 (New Norfolk – South transmission line redevelopment)[82].

The business case for this project, dated November 2003, was for an estimated amount of $9.5 million, to be incurred during 2003/04 and 2004/05.

Asset renewal needs

The business case defines the asset renewal needs as follows:

- **Network transformer**: The three transformers were 46 years old. Condition assessments of these transformers indicated that the insulation was in poor condition, and the units were susceptible to failure. Moreover, testing undertaken on the paper insulation of two transformers following decommissioning indicated that insulation had degraded and transformers would have been susceptible to failure during a short circuit fault. Nuttall Consulting has viewed these test results.

  Furthermore, the business case also states other issues associated with these transformers, including:

  - Safety and performance risks due to the poor condition of the bushing; and
  - Operational inefficiencies due to the lack of on-load tap-changers on these units.

- **Protection**: The existing protection and control arrangement have a number of issues that impose reliability risks, including:

[82] Advised in the email, dated 8 September 2008 – Request for Information Log number 226.

- insufficient space for the voltage control relays of the new transformers;
- non-standard arrangement for the relays in the panels, which increases the likelihood of disrupting other transformer relays during maintenance and testing; and
- the panel enclosures are not compliant with current "degree of protection" standards (e.g. dust and moisture ingress).

Non renewal needs

The business case defines the non-renewal needs as follows:

- **Upgrade of transformer rating**. This was to allow Transend to meet the forecast load growth for that area. The original plan was to relocate one of the new transformers following the commissioning of the new Hobart injection point, which would off-load Chapel Street.

  However, Transend has advised that the new Tasmanian security standards (December 2007) will most likely result in this transformer remaining at Chapel Street[83].

- **SCADA.** The enhancement involved the installation of a screen based SCADA system at Chapel Street. This enhancement was in line with similar SCADA additions at other substations being redeveloped.

Options considered

The business case considered the following options relating to the replacement of the existing transformers:

- "do nothing" – which did not address Transend's identified issues, particularly the supply risks should a transformer failure occur;
- Install temporary generation – Transend included cost estimates for this option, which indicated that it would be a higher cost option than the replacement, with increased risks;
- Replacement of two transformers – which Transend considered would impose system security issues, provide less flexibility in the management of outages, and still not provide a firm supply; and
- Project as scoped – which Transend considered would address all issues in the most cost-effective way, and so was the preferred option.

An economic appraisal of these options was not included in the business case.

[83] Advised in email dated 11 September 2008 – Request for Information Log number 224.

A.3. EHV circuit breakers

A.3.1. Overview of ND0621 Sheffield Substation 110 kV redevelopment

Summary

Sheffield substation was constructed in 1968, and is considered by Transend to be critical for the secure and reliable supply to the north west of Tasmania. In 2004, other replacement works were undertaken at Sheffield, including the Sprecher and Schuh circuit breakers associated with the transformers and bus-coupler (not included in the Nuttall Consulting review).

The project reviewed involved the replacement of:

- the 4 remaining Sprecher and Schuh 110 kV circuit breakers;
- the voltage transformers associated with the 110 kV busbars and two 110 kV transmission lines (plus the installation of line voltage transformers on a number of 110 kV transmission lines);
- 99 post insulators;
- protection and control systems associated with 6 transmission lines;
- the SCADA system; and
- AC and DC supplies.

The actual capex for this project was $6.9 million (nominal), with this project commissioned in 2007/08 and 2008/09.

The business case for this project, dated September 2006, was for an estimated amount of $7.2 million.

Asset renewal needs

The business case defines the asset renewal needs as follows:

- **Sprecher and Schuh circuit breakers**. The four Sprecher and Schuh circuit breakers at Sheffield were 37 years old. These circuit breakers are considered by Transend to be the most unreliable 110 kV breakers in its fleet. Further details of the issues associated with these breakers are contained in Section 4.2.1 of this report.
- **Voltage transformers (VTs)**. The main issues with the VTs were as follows:
  - The busbar VTs (2 sets) were considered to be approaching the end of their life, and were the only ones of this type on Transend's network. The main issues with these units concerned their maintenance needs, both in terms of the cost and impact on availability when outages were required to maintain these units. This issue was expected to increase in the future as more condition monitoring would be required. The lack of spares for these units also increased system performance risks should a unit fail.
  - The existing line VTs (2 sets) were also considered to be approaching the end of their life. The main issue with these units related to safety risks as the units had

a history of explosive failure, with a recent explosive failure of this type at Palmerston. The units also required increased condition monitoring, incurring higher maintenance costs.

- The need for the additional line VTs related to existing VT arrangements on a number of lines, which was not in accordance with current industry practices of using dedicated line VTs. The existing arrangements could result in mal-operation, with Transend reporting a history of 6 incidents across its system since 1998 due to the existing arrangements.

- The **post insulators** (99 insulators replaced with modern units) were considered to be in poor condition. These types of insulator impose safety and system performance risks due to their potential explosive failure mode. Transend has reported one such failure occurring at another substation in 1999, while work was being undertaken at the substation. It is also Nuttall Consulting's understanding that many other mechanical failures of this population have occurred, although not all have presented a direct safety risk.

- **Protection and control**. The protection relays associated with the 6 identified lines was considered to be of an obsolete technology, and subject to the issues discussed in Section 3.3.4. The existing protection panels also did not comply with current enclosure standards, increasing the possibility of failure and supply risks.

- **SCADA**. The existing SCADA system was considered to have inadequate redundancy, increasing the possibility of not meeting data quality standards prepared by NEMMCO. This also imposed a greater risk of failure, impacting operations and, potentially, system performance.

- **Auxiliary systems (AC and DC supplies).** The AC and DC systems were considered obsolete, were not sufficient to cater for future needs, and did not meet current design standards. The DC system is also considered to increase safety risks due to its design, which allows for a greater possibility of electric shock.

Options considered

The business case considered the following options:

- "do nothing" – which did not address Transend's identified issues;

- Replace and install as individual projects – which Transend considered would not be the most cost effective as it would require multiple outages and incur increased design and mobilisation costs; and

- Replacement project as scoped – which Transend considered was the lowest cost option that addressed all the issues, and aligned with its strategic plans, and so was selected as the preferred option.

The option costs or an economic appraisal of these options was not included, or discussed, in the business cases. Nuttall Consulting has sighted no other information that provides any form of economic appraisal of these project options.

A.4. Other EHV substation projects

A.4.1. Overview of ND0590 George Town Substation B bus replacement

Summary

The project involved the replacement of:

- the 220 kV "B" bus at George Town;
- protection and control systems associated with 2 transmission lines; and
- lightning protection at 220 kV switchyard.

The project also includes the replacement of protection systems and the installation of dedicated line VTs on the lines that supply an industrial customer.

The actual capex for this project was $6.2 million (nominal), with elements of this project commissioned in 2004/05, 2007/08 and 2008/09.

The business case for this project, dated June 2004, was for an estimated amount of $5.9 million (exclusive FDC).

Asset renewal needs

The business case defines the asset renewal needs as follows:

- **220 kV bus gantry structures**. The 220 kV gantry structures were 40 years old and considered to be in poor condition. An independent review of these gantry structures was conducted in 2002[84]. This review involved a condition assessment of the structure, and recommended a series of refurbishment actions to maintain the structures in service.

  Following that review, a further independent report recommended that the replacement of the "B" bus was the most cost-effective option over the long term[85], rather than the refurbishment option.

- **Protection and control**. The protection relays associated with two transmission lines was considered to be obsolete technology, and subject to the issues discussed in Section 3.3.4. The existing panels also did not comply with current enclosure standards, increasing the possibility of failure and supply risks.

- **Lightning protection.** The existing lightning protection for the 220 kV switchyard was considered to be in poor condition. Due to its cantenary wire design, the failure of the system could result in a wire falling to live equipment, resulting in a significant outage. An independent review of this system recommended its replacement with a modern design that is not reliant on the overhead catenary wires.

- **Works for lines supplying the industrial customer.** An independent review of the reliability of the supply to the customer was undertaken in 2004[86]. This report

[84] Incospec and Associates report provided in the email, dated 25 August 2008- Request for Information Log number 187.
[85] GW Engineers report provided in the email, dated 18 August 2008 – Request for Information Log number 165

included a number of recommendations, one of which was that the protection systems associated with two 220 kV lines supplying this customer should be upgraded to improve the reliability of supply. It also agreed with Transend's strategy of installing dedicated line VTs on the lines to reduce the risks due to mal-operations – see discussion in section A.3.1

Options considered

The business case considered the following options:

- "do nothing" – which did not address Transend's identified issues;
- Maintain the existing "B" bus and separately address the industrial customer supply issue – which Transend considered would not be the most cost effective solution as it would require extended outages on an ongoing basis to maintain the bus structures; and
- Replacement project as scoped – which Transend considered was the lowest cost option that addressed all the issues and aligned with its strategic plans, and so was selected as the preferred option.

The option costs or an economic appraisal of these options was not included in the business case. Nuttall Consulting has sighted the option costs contained in the independent reports for the gantry structure element of this project. These broadly align with Transend's qualitative reasoning in its option selection in the business case.

A.4.2. Overview of ND0640 Palmerston 220 kV Substation: primary equipment upgrades

Summary

The project involved the replacement of:

- the voltage transformers for a 220 kV transmission line, and the installation of dedicated line voltage transformers on 6 other 220 kV transmission lines;
- the 220 kV current transformers associated with one network transformer and one transmission line;
- a number of 220 kV post insulators;
- protection and control systems associated with one transformer and two transmission lines, and the panels housing the transformer protection system; and
- lightning protection at the 220 kV switchyard.

The actual capex for this project was $5.7 million (nominal), with the project commissioned in 2007/08.

The business case for this project, dated May 2005, was for an estimated amount of $7.9 million.

[86] Ascension/Maunsell report provided in the email dated 28 August 2008 – Request for Information Log number 202

Asset renewal needs

The business case defines the asset renewal needs as follows:

- **Line VTs**. The one 220 kV line VT due for replacement was part of a small fleet of this type with no spares. The replacement of this set was to provide spares to allow the other units in that fleet to be maintained, and reduce the performance risks should a unit fail.

  The need for the additional line VTs on 6 other lines is as that already discussed in Section A.3.1 i.e. related to current practices that reduce the risk of mal-operation.

- The **current transformers (CTs)** arrangements of the network transformers had a number of design deficiencies due to it being located within the transformer. These resulted in the possibility of greater outages and more complicated restorations for various fault scenarios.

  The CTs associated with one of the transmission lines had increased safety risks associated with an explosive failure mode, and would require increased condition monitoring (i.e. increased maintenance costs) if they remained in service. Furthermore, they were the only 3 units of this type remaining on Transend's network.

- The **post insulators** were considered to be in poor condition. These types of insulator impose safety and system performance risks due to their potential explosive failure mode. Transend has reported one such failure occurring at another substation in 1999, while work was being undertaken at the substation. As noted above, it is also Nuttall Consulting's understanding that many other mechanical failures of this population have occurred, although not all have presented a direct safety risk.

- **Protection and control**. The protection relays associated with the network transformer was considered to be of obsolete technology, and subject to the issues discussed in Section 3.3.4. The existing panels also did not comply with current enclosure standards, increasing the possibility of failure and supply risks.

  Furthermore, the existing protection schemes associated with two lines at Palmerston will be inadequate following the commissioning of the Waddamana-Lindisfarne line, which will connect into these two lines.

- **Lightning protection.** The existing lightning protection for the 220 kV switchyard was of a similar design to that at George Town (discussed above), and so was susceptible to the same issues associated with that system i.e. risks of outages should a catenary wire fail.

Options considered

The business case considered the following options:

- "do nothing" – which did not address Transend's identified issues;
- Replace assets on an individual basis – which Transend considered would not be the most cost effective solution as it would require multiple outages and increased design and mobilisation costs; and

- Replacement project as scoped – which Transend considered was the lowest cost option that addressed all the issues and aligned with its strategic plans, and so was selected as the preferred option.

The option costs or an economic appraisal of these options was not included in the business case. Nuttall Consulting has sighted no other information that provides any form of economic appraisal of these project options.

A.5. Transmission lines

A.5.1. Overview of ND0604 Burnie to Port Latta 110 kV transmission line reconductor

Summary

The project involved the replacement of:

- The conductor of the Burnie to Port Latta 110 kV transmission line.

The project also included elements that were more specifically related to the augmentation of the line. These works included:

- The upgrade of the Burnie to Port Latta structures to allow the operation of the line at 64 degrees (involving raising and strengthening approximately 50% of the existing towers).

The actual capex associated with this project in the cost information template is $20 million (nominal), with the project commissioned in 2007/08. However, it is important to note that this amount includes another project to augment the line from Port Latta to Smithton. The business case for this component approved an estimated cost of $4.6 million (excluding contingency) to cover the augmentation works from Port Latta to Smithton[87]. This project has not been the subject of our review.

The original business case for the Burnie to Port Latta component, September 2004, was for an estimated amount of $3.9 million. The original business case only allowed for the replacement of the conductor with conductor of a similar rating.

A revised business case, dated June 2006, allowed for the reconductoring and upgrade of the Burnie to Port Latta line at an estimated cost of $13.8 million i.e. the replacement and augmentation components.

Asset renewal needs

The business case indicates the following with respect to the need for the replacement of the conductor.

The original Burnie - Port Latta - Smithton line was constructed in 1949 with copper conductor (i.e. 58 years old). A second circuit was installed in 1966 between Burnie and Port Latta, but second hand conductor was used that had been originally installed in 1936 (i.e. it is approximately 70 years old). The Port Latta to Smithton sections were replaced in

[87] Advised in email dated 8 September 2008 –Request for Information Log number 225.

1977/78 due to their poor performance. This project relates to replacement of the remaining 1966 and 1949 sections of the Burnie to Port Latta line.

The main issues with the conductor are safety and reliability risks due to the poor condition of the conductor. Three outages had occurred in the previous 5 years from the original business case; in all cases, the conductor broke and fell to the ground. One event in 1999 cascaded into a blackout at Burnie. A recent event in 2004 resulted in the conductor falling across a rural road. Fault data provided during onsite meetings with Transend supports the poor reliability of this line, indicating a number of line to ground incidents, with a 2006 incident resulting in 3.26 system minutes lost.

Transend also supplied an independent condition assessment report on the conductor strength, which was undertaken in 2003. This assessment conducted tests on samples of the failed conductor. The finding of these tests confirmed that the conductor had reduced strength and indicated annealing. However, the report did not draw any explicit conclusions as to whether the conductor should be replaced or not.

Non renewal needs

The augmentation requirements of this project were driven by the forecast load increases for that area. Following the time of the original business case, Aurora had advised of its intention to request an additional connection point that would increase the loading in that area further.

The need for additional capacity had been foreshadowed in Transend's 2005 Annual Planning Report. Moreover, Transend undertook the NER's process associated with a "small transmission network asset" for the augmentation component of this project. Transend states in its business case that no submissions were received on this consultation. Nuttall Consulting has not reviewed the planning documents associated with the augmentation component of the project.

Options considered

The original business case considered the following options:

- "do nothing" – which did not address Transend's identified issues with the condition of the conductor;
- Replace the conductor with one of a greater capacity – which Transend considered addressed the conductor issues, but the increased cost was not justified based upon the load forecast at that time; and
- Replace conductor with similar capacity – which Transend considered would address all needs and cater for the anticipated load growth, and as such, was the preferred option at that time.

The revised business case did not consider any options, rather it recommended the approval of the project as scoped, based upon the original business case and the findings of the NER's planning process, which had already been undertaken by that time.

The option costs or an economic appraisal of these options was not included in the business case. Nuttall Consulting has sighted no other information that provides any form of economic appraisal of these project options.

A.5.2. Overview of ND0592 West Coast and Mersey Forth OPGW project

Summary

The West Coast and Mersey Forth OPGW project is part of Transend's strategy to roll out optical ground wire (OPGW) across its transmission network. The project involves the installation of OPGW over 133 km of its transmission lines in that area.

A significant portion of the project concerns the replacement of the existing ground wire on the Farrell to Sheffield line with OPGW (85 km). The remainder involves the installation of OPGW on other transmission lines in that area, which do not currently have ground wire coverage.

The overall cost for this project was to be be recovered partly through the regulated shared and connection services, and unregulated activities through the sale of communication bandwidth. The unregulated portion was assumed to be 25% of the overall shared network component. This was based upon the communication element of the OPGW accounting for half the costs of the project, and only half of this component being required for regulated services of the shared network.

The actual regulated portion of the project cost is $6.9 million, occurring in 2006/07.

The original business case for this project, dated December 2004, was for $4.8 million, with the regulated component being $2.9 million for the shared services and $0.9 million for the connection services.

A variation to this business case occurred in January 2006 to raise the approved amount by $2 million, to $6.8 million.

This variation was required to account for cost increases that had occurred during the project. These increases were not due to changes to the functional scope of the project; rather, they were mainly due to insufficient detailed design prior to letting the project contracts and events arising during construction, which resulted in some costs being significantly higher than estimated at the time of the original business case. The most significant of these matters concerned increased steel works (estimated at an additional $1 million in this variation).

In August 2006, a 2nd and final variation occurred. This variation was for an additional $1.2 million, bringing the total project cost to $8 million with a further contingent amount of $0.2 million. The estimated portion of regulated costs associated with the project was $5 million for the shared services and $1.3 million for the connection services.

This final variation was due to similar issues as those raised in the 1st variation; however, certain matters had been resolved by this time, resulting in the differences to the 1st variation. Once again, the most significant issue concerned increased costs due to additional steel works, which had increase by $1.5 million from the original business case. Increased stringing and contractor "prolongation" costs also accounted for a significant increase in costs ($0.8 million) from the original business case.

Transend has provided information on a board level review of the increases that occurred in this project, and specifically whether the contractors were liable for these cost increases. The findings of this review were that the contract terms were unlikely to allow Transend to

recover the cost increases. It is worth noting that some of the issues resulting in the increased costs relate to Transend's broader contracting and project delivery approaches, the review of which is not part of our terms of reference.

Asset renewal need

In 2004, Transend commissioned an independent assessment of the earth wire on the Farrell to Sheffield line[88]. The finding of this assessment was that the existing earth wire was inadequate to withstand the likely maximum fault current.

It is noted that this issue does not appear to relate to the age or condition of the line. Moreover, developments due to fault level issues are often considered augmentations in a generic sense i.e. the replaced asset must be of a higher capability. This however does not affect the need for the replacement, only which expenditure category it could have been assigned.

Non-renewal needs

The main factors driving the need for the non-renewal elements of this project concerns the improved operational communications achieved with the OPGW, both in terms of the redundancy and diversity of Transend's communications in that region, and improved high-speed protection operation. Transend considers that these improvements should ensure it will comply with NEMMCO's communication standards and reduce network reliability and security risks associated with communication system failures.

In addition, the improved lightning protection of the transmission lines, due to the increased earth wire coverage, should also reduce network reliability and security risks.

Options considered

The original business case considered the following options:

- "do nothing" – which did not address Transend's identified issues with the adequacy of the existing earth wire on the Farrell to Sheffield line, and the benefits due to the improved communications and increased earth wire coverage.
- Contribute towards the extension of Hydro Tasmania's communication network – which did not address Transend's identified issues with the adequacy of the existing earth wire on the Farrell to Sheffield line, and the benefits due to the increased earth wire coverage. It was also noted that this option was unlikely to be the least-cost option as Hydro Tasmania had approached Transend to contribute to the OPGW solution.
- Project as scoped – which Transend considered addressed all the issues, and was the preferred option.

The 1st variation considered two options:

- Reduce the scope of the project – which was not considered possible due to its contractual obligations that would most likely have still resulted in the increased costs.

[88] The Hydro Tasmania report, provided in the email dated 21 August 2008 – Request for Information Log number 180.

- The variation in costs as proposed – which was considered the preferred option, particularly noting the above comments and the fact that a significant portion of the project costs were already sunk. It was also noted that the operational and compliance benefits of this project still remained, and as such, the increased cost should not affect the original decision. In this regard, the cost of the alternative option of extending the Hydro Tasmania communications systems was costed at $7.6 million, but was considered to have greater risks of cost overruns, higher ongoing maintenance costs, and poorer performance.

The final variation did not consider any options.

An economic appraisal of these options was not included in the business cases. Nuttall Consulting has sighted no other information that provides any form of economic appraisal of these project options.

B. Appendix: Summary of projects in ex ante review

This appendix provides background information on the projects that have been reviewed as part of Nuttall Consulting's ex ante review of Transend's forecast capital expenditure in the next period.

The intention of this appendix is to provide summary details on asset issues being addressed by these projects and the options considered by Transend.

The information in this appendix is based upon the project Investment Evaluation Summaries (IES), project definition forms, and other supporting material, provided by Transend during the course of our review.

It is important to note that nothing in this section should be interpreted as our agreement, acceptance or otherwise of any views expressed. Our considerations on these projects are contained in Section 4.4 of this report.

B.1. 110 kV substation redevelopments

B.1.1. Overview

Nine 110 kV substation redevelopment projects have been reviewed[89]. These are as follows:

ID	Project	Forecast	Commissioning date
ND0910	Arthurs Lake Substation Redevelopment	$4.1m	2013
ND0908	Burnie Substation 110kV Redevelopment	$8.2m	2014
ND0733	Creek Rd Substation 110kV Redevelopment	$33.3m	2014
ND0907	Emu Bay Substation 110kV Redevelopment	$7.3m	2011
ND0968	Knights Rd Substation 110kV Redevelopment & HV Protection Replacement	$6.8m	2014
ND0949	Meadowbank Substation 110kV Redevelopment	$4.7m	2014
ND0953	Palmerston Substation 110kV Redevelopment	$13.8m	2014
ND0906	Railton Substation 110kV Redevelopment	$7.1m	2013

[89] The George Town redevelopment project was also selected, but information was not received in time to undertake the review – Request for Information Log number 214 (sent 23 September 2008).

ID	Project	Forecast	Commissioning date
ND0709	Tungatinah Substation 110kV Redevelopment	$19.9m	2014

B.1.2. Asset issues

There are a range of issues associated with different assets at the various substations. These assets and issues affect different substations to varying degrees, but generally include:

- 110 kV primary plant, including the Reyrolle OS10 and Sprecher and Schuh HPF circuit breakers, current and voltage transformers, disconnectors, and the post-type insulators, within the switchyards; and
- associated secondary systems, which normally includes protection and control relays at the substation, and in some cases SCADA.

The main issues with the specific asset types are discussed in Sections 3.3, 4.2, and Appendix A of this report, and are not repeated here. The important points are as follows:

- The main issues associated with the primary plant and protection and control relays relate to the condition and performance of the older asset types. These asset types have increased maintenance costs and deliver poorer system performance compared to newer assets.
- The voltage transformers and post-type-insulators potentially have an explosive failure mode, which imposes safety risks to personnel in the substation.

The table below indicates how the various asset issues affect each substation. This table also indicates the number of Reyrolle OS10 and Sprecher and Schuh HPF at each substation and their existing age.

It is also important to note that in the case of the Tungatinah redevelopment, a significant issue associated with the primary plant relates to the existing arrangements of the substation equipment, which do not comply with current standards associated with clearances. Transend considers that this imposes a significant safety risk to personnel in the substation. However, other than the HV switchgear in the Arthurs Lake redevelopment, this safety issue is not reported by Transend to be a driver for the other substation redevelopments reviewed.

Project	Comm. date	Circuit breakers (age)		VTs	CTs	D/C	insulators	P/C	Other assets and issues
		S & S HPF	Reyrolle						
Arthurs Lake Substation Redevelopment	2013		1 (45)		yes		yes	yes	Supply transformer HV switchbay (safety)
Burnie Substation 110kV Redevelopment	2014	3 (38)	7 (56/57)		yes			yes	
Creek Rd Substation 110kV Redevelopment	2014		15 (56/57) 1 (45)	yes	yes	yes	yes	yes	Power cable Bus conductors Ring bus arrangements
Emu Bay Substation 110kV Redevelopment	2011	5 (31)		yes		yes		yes	Ring bus arrangements
Knights Rd Substation 110kV Redevelopment & HV Protection Replacement	2014		5 (45)	yes	yes		yes	yes	Girder mounted discon. HV P/C HV SCADA
Meadowbank Substation 110kV Redevelopment	2014		3 (47)	yes	yes		yes	yes	SCADA
Palmerston Substation 110kV Redevelopment	2014		11 (45)	yes	yes		yes	yes	
Railton Substation 110kV Redevelopment	2013	3 (38)						yes	Gantry structures
Tungatinah Substation 110kV Redevelopment	2014		6 (57)	yes		yes	yes	yes	Substandard clearances (safety) Bus conductors Ring bus arrangement

D/C – disconnectors
P/C – protection and control

B.1.3. Options

The IES for each project provides a range of options. These options cover a "maintain and defer" option and various replacement options.

In all cases, other than the Tungatinah redevelopment, economic analysis of the options was also provided by Transend. This analysis assesses the capital and maintenance costs of the various options and the risk costs associated with the loss of supply at the substation due to an asset failure.

For all projects the preferred option is selected based upon a qualitative and quantitative assessment of the issues addressed by the options, the capital cost of the options, and the economic analysis.

The preferred option for the Creek Road, Tungatinah, and Emu bay substations is a complete redevelopment of the switchyard. The preferred option for other redevelopments is the "in situ" replacement of the identified poor performing assets.

The Creek Road and Tungatinah redevelopments are significant in cost due to the extent and form of the redevelopment planned by Transend. Transend considers that both substations have site restrictions that mean a redevelopment with outdoor "air insulated" switchgear is unlikely to be feasible, or would be very costly due to the extended network outages necessary to undertake such a redevelopment. Therefore, Transend considers that a complete redevelopment of the whole substation is most likely to be required using more expensive "gas insulated switchgear" (GIS) technology.

The table below summarises for each substation redevelopment the options considered in the IES, the NPV of each option based upon Transend's analysis, and the basis for the selection of the preferred option (identified in bold type).

Project	Options	NPV
Arthurs Lake Substation Redevelopment	Maintain and defer by 5 years	$2.03
	Replace identified assets in situ	**$2.18**
	Replace all assets in situ	$2.29
	Replace all assets - greenfield	$4.56
	Preferred options selected as least cost to address all issues.	
Burnie Substation 110kV Redevelopment	Maintain and defer by 5 years	$6.09
	Replace identified assets in situ	**$4.52**
	Replace identified assets in new switchbay	$5.30
	Replace all assets in situ	$5.62
	Preferred options selected as least cost and addressed all issues.	
Creek Rd Substation 110kV Redevelopment	Maintain and defer by 5 years	$18.33
	Replace assets in situ	$18.55
	Redevelop AIS	$18.39

Project	Options	NPV
	Redevelop GIS	**$18.12**
	Redevelop Hybrid	$18.12
	Preferred options selected as least cost and addresses all issues, but noted that actual redevelopment option (i.e. AIS, GIS or Hybrid) will depend on tender process.	
Emu Bay Substation 110kV Redevelopment	Maintain and defer by 5 years	$5.60
	Replace identified assets in situ	$6.21
	Redevelop and rationalise (line CBs)	**$5.53**
	Redevelop and rationalise (transformer CBs)	$5.53
	Redevelop (line and transformer CBs)	$6.04
	Preferred options selected as least cost, addresses all issues, and better performance than transformer CB option.	
Knights Rd Substation 110kV Redevelopment & HV Protection Replacement	Maintain and defer by 5 years	$5.46
	Replace identified assets in situ	**$5.25**
	Replace all assets in situ	$6.18
	Preferred options selected as least cost to address all issues.	
Meadowbank Substation 110kV Redevelopment	Maintain and defer by 5 years	$3.44
	Replace identified assets in situ	**$3.35**
	Replace all assets in situ	$3.74
	Preferred options selected as least cost to address all issues.	
Palmerston Substation 110kV Redevelopment	Maintain and defer by 5 years	$7.82
	Replace identified assets in situ	**$7.61**
	Replace all assets in situ	$8.68
	Preferred options selected as least cost to address all issues.	
Railton Substation 110kV Redevelopment	Maintain and defer by 5 years	$4.92
	Replace identified assets in situ	**$4.07**
	Replace all assets in situ	$4.41
	Preferred options selected as least cost to address all issues.	
Tungatinah Substation 110kV Redevelopment **(includes assets at Tarraleah substation also)**	Upgrade both Tarraleah and Tungatinah switchyard in situ	No NPV analysis provided
	Consolidate at Tungatinah with fully selectable double bus AIS	
	Consolidate at Tungatinah with double bus AIS and back-to-back connections	

Project	Options	NPV
	Remote site using GIS Remote site using hybrid switchgear Preferred option selected as least cost to address issues.	

B.1.4. Independent assessments

Independent reports have been provided on various aspects of the Creek Road and Tungatinah redevelopments. These include:

- **Creek Road:** An independent assessment of the condition and future maintenance requirements of all assets at the Creek Road substation was undertaken in 1999[90]. The findings of this report were that the majority of the 110 kV assets were near their end of life, and the consultant considered that they may need replacing over the next 5 years. The consultant did not consider the assets were adequate to provide supplies for the next 15 years.
- **Tungatinah:** An independent analysis of the various options for the redevelopment of the Tungatinah and Tarraleah substations was undertaken in 2005[91]. This considered various brownfield and greenfield redevelopment options, and various switchgear technologies. This analysis recommended a greenfield development using an outdoor "hybrid" switchgear technology. The analysis included a life-cycle cost comparison between options, involving the capital and maintenance cost estimates of each option.

  In 2006, Transend commissioned an independent review of its plans for the Tungatinah redevelopment[92]. The review followed further analysis by Transend of the costs of the various options, which found a greenfield option using indoor GIS would be the most likely least cost redevelopment option. This review agreed with Transend's preferred option and considered that the project was required to address issues at the Tungatinah and Tarraleah substations, most notably the issues associated with substandard clearances and poor asset condition.

B.1.5. Tungatinah timing

An important matter that may affect the timing of the Tungatinah redevelopment concerns the consultation with Hydro Tasmania in order to undertake a complete redevelopment. The IES states the following on this matter[93]:

(Text has been removed due to its commercial-in-confidence nature)

[90] Ascension report provided in the email, dated 8 September 2008 – Request for Information Log number 212.
[91] SKM report provided in the email, dated 8 September 2008 – Request for Information Log number 206
[92] Ascension report provided in the email, dated 11 September 2008 – Request for Information Log number 209
[93] Page 11 of Tungatinah IES, provided in email dated 8 September 2008 – Request for Information Log numbers, 206, 207, 208, 210

(Text has been removed due to its commercial-in-confidence nature)

B.2. Substation secondary projects

B.2.1. Overview of ND0914 Farrell substation secondary asset replacement project

The Farrall substation secondary asset replacement project is forecast to be commissioned in 2010/11 for $11 million.

It involves the replacement of a number of protection schemes associated with this substation, plus other secondary systems including the SCADA system, DC supplies, relay panels and control room alterations.

The main issues identified in the IES with the various assets are as follows:

- **Protection schemes**. The protection schemes are stated to be of a "static" technology and subject to the issues discussed in Section 3.3.4. The schemes proposed for replacement are as follows:

- **220 kV and 110 kV busbar protection**. These schemes are the only ones of this type on Transend's network, and have recently suffered major failures. Transend is proposing to impose constraints on generation in the event of such a failure at Farrell. Transend has calculated that this may constrain 200 MW of generation.
- **110 kV transmission line protection**. Protection schemes associated with three 110 kV transmission lines use protection relays with a history of failure. One of these lines also has other issues related to the performance of the existing protection schemes.
- **Network transformer protection**. Some of the relays associated with the two network transformers at Farrell have a history of failure (same type to those on the 110 kV lines). Other relays have poor performance, which could lead to mal-operation.
- **220 kV line protection**. The relays associated with the two 220 kV lines at Farrell have a history of failure (same type to those on the 110 kV lines). These two lines represent 2 of only 3 remaining 220 kV lines on the Tasmanian transmission network that do not have modern microprocessor based relays.
- **Relay panels**. The existing relay panels are an "open rack" design, which increases the risk of failure due to factors such as moisture ingress and vermin.

- **SCADA**. The existing SCADA remote terminal units (installed in 1997) are not compatible with modern protection panels. As such, these will need to be replaced prior to the protection upgrades. The existing SCADA system also has some deficiencies compared to a modern system in terms of its operational ability. The upgrade of the system will also allow Transend to comply with NEMMCO standards on availability during the outages necessary for the protection replacements.
- **Disturbance recorders and fault location equipment.** This equipment is obsolete - the fault location equipment is no longer in operation. Replacement of the protection schemes with modern devices will fulfil these purposes.
- **DC supplies.** The existing DC supplies are of obsolete technology and insufficient to cater for future needs. There are also safety and operational risks associated with the existing design. The batteries are also considered to be in poor condition.

The project also includes works on the control room to allow for the installation of a fire suppression scheme in the control room.

The IES considers three options, as follows:

- "maintain and defer" option, which assumes a deferment of the project by 5 years;
- a staged project, which breaks the project into three stages and undertakes these one year after another; this option assumes an increase in the total capital cost of 10% to account for staging e.g. additional design and mobilisation costs; and
- the project as a single integrated project.

Transend provided an economic analysis of these options; however, this analysis only considered the capital and maintenance costs associated with each option i.e. risk costs were not considered

The table below summarises the results of this economic analysis:

Option	NPV ($millions)
Maintain and defer	$5.48
Stage project	$7.66
Single project	$7.27

Transend selected the single project option as it considered it to be the least cost option that addressed the issues.

B.2.2. Overview of ND0961 New Norfolk Substation 110 kV protection replacements

The New Norfolk substation 110 kV protection replacement project is forecast to be commissioned in 2013/14 for $7 million.

It involves the replacement of a number of protection schemes associated with this substation, plus some voltage transformers (primary assets).

The main issues identified in the IES with the various assets are as follows:

- **Protection schemes**. The protection schemes are stated to be of a "static" technology and subject to the issues discussed in Section 3.3.4. The schemes proposed for replacement are as follows:
  - 110 kV busbar protection; and
  - protection schemes for six 110 kV transmission lines.

  The protection schemes associated with these systems have various problems, which result in higher maintenance costs and increased risks to system performance through mal-operation.

  It is also noted that some of the replacements are proposed to coordinate with the substation redevelopments at Creek Road, Meadowbank and Tungatinah, and one of the schemes is consider to be non-compliant with NER fault clearance times.
- **Voltage transformers.** The voltage transformers associated with one of the lines are considered to be in poor condition. This type of voltage transformer is considered a safety risk as it has a history of explosive failure, although not on Transend's network.

The IES considers two options, as follows:

- a "maintain and defer" option, which assumes a deferment of the project by 5 years; and

- the project as a single integrated project.

Transend provided an economic analysis of these options; however, this analysis only considered the capital and maintenance costs associated with each option i.e. risk costs were not considered.

The table below summarises the results of this economic analysis:

Option	NPV ($millions)
Maintain and defer	$3.14
Single project	$4.11

Transend selected the single project option as it considered it to be the least cost option that addressed the issues.

B.3. Transmission line projects

B.3.1. Overview of ND0966 Burnie – Waratah 110 kV Transmission line wood pole replacement project

This project involves the replacement of number of existing wood pole structures of the Burnie to Waratah 110 kV line with new steel poles.

Transend are forecasting[94]:

- $2.5 million in 2011/12 for the replacement of 30 structures, and
- $3.3 million in 2013/14 for the replacement of 40 structures.

The transmission line was commissioned in1967 and the structures to be replaced will be identified via Transend's pole inspection program, which inspects the poles on this line every 3 years. The last inspection was undertaken in 2007/08, with the next due in 2010/11.

The forecast number of replacements is based upon the average failure rate curve for wood poles in Tasmania. This failure rate curve has been produced by Aurora, the main owner of wood poles in Tasmania, based upon its historical records of wood pole replacements.

This curve suggest that 30 poles per 3 year cycle may be required to be replaced for a line of this age and number of structures– noting 2 poles per structure[95].

The number of poles replaced to this date is slightly more than average; however, the failure curve for this line indicates that a large number of these replacements occurred during the 90s. More recently, the number of replacements has been lower than suggested by the curve. In this regard, it is our understanding that the last inspection, undertaken in 2007/08,

[94] See project definition form for this project, provided in the email dated 9 September 2008- Request for Information Log numbers 188, 220
[95] See Figure 2 in the condition assessment report, provided in the email dated 9 September 2008 – Request for Information Log numbers 188, 220

did not condemn any poles[96]. The inspection prior to this resulted in the replacement of 12 structures[97].

B.3.2. Overview of ND0963 Knights Road to Electrona transmission line replacement project

The Knights Road to Electrona transmission line replacement is forecast to be commissioned in 2010/11 for $12.6 million.

The project involves the replacement of the existing line (structures and conductor) with a new line of a higher capacity. The IES for this project indicates that Transend considers this project is partly an augmentation, and as such, will be subject to the regulatory test. However, the existing line has a number of issues, which Transend considers relate to the need for renewal.

The line is 67 years old and strung with 7-strand copper conductor. The IES summarises the following issues with the line:

- **Poor condition of the conductor**. The copper conductor is considered to be in poor condition due to its age and the impact of recent bushfires. The line was damaged by a bushfire in 1991, and has been damaged by bushfires on prior occasions. Transend considers that the exposure to bushfires has caused the conductor to anneal, with a consequential increased risk of conductor breakage.
- **Poor condition of the structures (steel towers)**. An independent assessment[98], in 2004, of the line structures found 32 of the 70 structures on this line to have structural or damage related issues.
- **Sub-standard clearance.** The original design temperature of the line was 70 degrees. The independent assessment (noted above) found 19 spans to have substandard clearances to 70 degrees and 15 spans to have substandard clearances to 49 degrees. In 2008, work was undertaken on a number of spans to enable the line to be compliant at 49 degrees. 5 spans remain strictly non-compliant at 49 degrees – although it is understood that due to the inaccessible nature of these spans, this is acceptable, at least as a temporary measure. The line was de-rated to 49 degrees in March 2008.
- **Environmental noise**. Transend considers there to be excessive noise due to the corona discharge of this line. Transend states in its IES that this noise has resulted in a number of complaints.

The augmentation of the existing capacity is required to ensure Transend can comply with its network performance requirements for the forecast load in that area i.e. a statutory reliability standard under the regulatory test. On this matter, the IES states:

[96] Stated during a meeting with Transend staff 11-13 August 2008.
[97] Stated in section 1.3 of the project definition form, provided in the email dated 9 September 2008 – Request for Information Log numbers 188 and 220.
[98] Hydro Tasmania – Field Investigation Report, provided in email dated 18 August 2008- Request for Information Log number 168

> *"The current arrangements will not comply with clause 5.(1)(a)(i) of the Electricity Supply Industry (Network Performance Requirements) Regulations 2007 in that 'no more than 25 MW of load is capable of being interrupted by a credible contingency event' at Knights Road Substation. In the event of the loss of the Chapel Street–Kingston–Knights Road 110 kV transmission line, the combined load at Huon River, Kermandie and Knights Road substations would result in the interruption of more than 25 MW of load. This 25 MW load was exceeded on 25 July 2008 ..."*

The IES examines a number of options, all involving the replacement of the line. These options are as follows:

- Option 1 - Reconductor and augment the existing line, which will require works to strengthen the existing towers to allow for the larger conductor, but will not address the issues related to the condition of the towers;
- Option 2 - New pole line, with the steel poles in the same location as the existing towers;
- Option 3 - New tower line, with the new towers in the same location as the existing towers; and
- Option 4 - New pole line with optimised pole locations.

Economic analysis of the options was presented in the IES, this considered the planning, capital[99], operating and maintenance costs of the 4 options:

Option	Capital cost ($millions)	NPV ($millions)
Option 1	$8.6	$9.9
Option 2	$9.8	$10.5
Option 3	$14.9	$15.6
Option 4	$8.9	$9.6

Option 4, the new pole lines with optimised pole locations, is Transend's preferred option, as it addresses all issues and is considered to be the least cost solution.

Two independent reports have been supplied to support this project[100]:

- The independent "field" assessment of the towers (noted above) was conducted in 2004. This assessment determined the number of towers in poor condition and the number of spans that had substandard clearances to 70 and 49 degrees.
- An independent "desk-top" assessment of the replacement options was conducted in 2008. This assessment considered the scope and capital costs of the above four options and a "do nothing" option, and the advantages and disadvantages of the options. The preferred option in this assessment was Option 2, the new pole line with steel poles in the same location as the existing towers. In preferring this option

[99] It is noted that the capital costs in the NVP analysis does not include the contingency and escalation that is included in the project cost that provided in the Transend proposal.
[100] Provided in the emails, dated 4 September and 18 August 2008 – Request for Information number 183, 168.

to the lower cost option, which has been selected by Transend, the report stated the following[101]:

"[Option 2] *is preferred over* [Option 4*] because although the latter involves about 10 – 20 fewer poles and has lower costs, it will be a new line and subject to DA approval. There will probably be objections from landowners who will be required to have structures on their land for the first time, but now have nothing on their property. This could cause protracted discussion and justification.*"

It then went on to say:

"*It is recognised that some reduction in the number of poles required for* [Option 2] *may be achievable which will result in a reduction in the line cost. This reduction will be possible if pole positions can be rationalised on the properties that already have poles and where lengthy development application processes are not involved in reducing the number of poles. This will result in a solution that sits between* [Option 2] *and* [Option 4]. *It is suggested that this be explored further when a more detailed investigation is carried out in relation to the development application requirements and the community consultation process is progressed further.*"

[101] Section 4, page 9, of the Maunsell options analysis report – Request for Information number 183