Mountain Associates

An assessment of the prudency of TransGrid's investment in the MetroGrid project

A report to the ACCC

14 April 2004

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1. Executive summary

This is an independent report to the ACCC on the prudency of TransGrid's investment in a 330 kV cable from Picnic Point to Haymarket and the development of the Haymarket substation ("the MetroGrid project"). TransGrid and EnergyAustralia jointly promoted the MetroGrid project and jointly applied the Regulatory Test, but this report focuses mainly on TransGrid's involvement in this project.

Mountain Associates has had unfettered access to all information TransGrid made available to the ACCC on this project. We would like to acknowledge the contribution of PB Associates and ACCC staff in the compilation and analysis of information presented in this report.

The MetroGrid project that has actually been developed bears little resemblance to the project that was specified, costed and compared to possible alternatives in the Regulatory Test. The initial cost estimate established at the time of the Regulatory Test was $142.5m (in 1999 dollars). TransGrid's latest estimate is $276m (nominal dollars) excluding various claims from various contractors and suppliers of around $40m. The original project was due to be commissioned by November 2003. At the time of writing (April 2004) the project is nearing completion but is yet to be commissioned. We understand that the project is scheduled for completion by July 2004.

We have reviewed TransGrid's application of the Regulatory Test to this project. In summary, while some aspects of the analysis were done well, the rigour and robustness of the design and costing of network options in particular, was inadequate. TransGrid knew that this was going to be a tremendously challenging project and they have claimed a number of "world firsts" in the development of the project. For example the 2002 annual report claims that "*the new 330kV cable ... will be one of the longest of its type in the world*" and "*the substation will be one of the most highly monitored and automated substations in the world*" and "*the scale of the project sees the design and installation of the world's most advanced gas insulated transformers and the first ever substation to have an integrated gas management system*".

We would have expected that for an investment of the size and complexity of the MetroGrid project, a more sophisticated and refined analysis should have been undertaken at the time of the Regulatory Test when fundamental investment decisions were being made. A more refined analysis, while inevitably requiring greater resources and time, in our view could have been conducted before the finalisation of the Regulatory Test.

In our review of the progress of the development of the project after the completion of the Regulatory Test, we noted a key milestone was reached around 18 months after the completion of the Regulatory Test. At this point it was clear that the project was expected to cost around 60% more than had been expected at the time of the Regulatory Test. TransGrid explained that by this time there was a pressing need to develop the project in order to ensure that the modified n-2 standard was implemented by the summer of 2004.

However, on the basis of information compiled at the time of the Regulatory Test, if TransGrid had implemented the identified demand management projects, there would have been potential to reduce demand by at least 130 MW. While this would not achieve the modified n-2 standard, it would ensure that the network serving the CBD and Inner Suburbs would remain compliant with the existing n-1 standard for several more years. This would have created a window of opportunity for TransGrid to reassess its options.

TransGrid's consultants had described the implementation of demand management programs as a "no-regrets" strategy. In our view, is was imprudent for TransGrid to have knowingly proceeded with a project that it knew was significantly more expensive than planned, when other less expensive alternatives that would have been able to maintain and possibly improve the reliability of the network, were available.

We note that there may be a number of ways to determine a prudency adjustment for the MetroGrid project. The prudency adjustment proposed in this report is based on a sequence of logical steps and computational assumptions. Underlying the analysis is a number of weighty assumptions on available technologies and their cost and assumptions on the ability of TransGrid and EnergyAustralia to implement those technologies. We have done this in lieu of a more objective and comprehensive assessment that could be achieved by completely re-running the entire Regulatory Test. But this would be far beyond the scope of this report.

However, we would caution that even if the entire regulatory test was re-run, the level of "inefficient" investment (and hence size of prudency adjustment) would still not be knowable with absolute certainty. It will always be affected by a number of subjective judgements no matter how precisely alternative projects are specified and costs estimated. We therefore suggest that any decision by the ACCC on a prudency adjustment should be informed by the facts of the case, but that the ACCC may more appropriately take a broader view including consideration of the impact of any prudency adjustment on investment incentives in the long term.

Finally, we would like to note an issue that arose shortly before this report was due to be delivered to the ACCC. In explaining their decision to substantially increase the capacity of the MetroGrid project, TransGrid produced an analysis that concluded that it knew in January 2001 that the project specified in the Regulatory Test and the substantially larger project that they designed after the Regulatory Test, did not achieve the modified n-2 reliability standard. In other words, it appears that TransGrid knew before it developed the MetroGrid project that it would fail to meet the reliability standard on which the investment had been justified in the first place. This is a startling conclusion but we have not had sufficient time to rigorously analyse or critique the underlying analysis and therefore do not think it is appropriate to draw conclusions on this at this stage.

2. Introduction

This is an independent report to the ACCC on the prudency of TransGrid's investment in a 330 kV cable from Picnic Point to Haymarket and the development of the Haymarket substation ("the MetroGrid project"). In the development of this report, Mountain Associates has had unfettered access to all information TransGrid made available to the ACCC on this project. We would like to acknowledge the contribution of PB Associates and ACCC staff in the compilation and analysis of information presented in this report.

TransGrid and EnergyAustralia jointly promoted the MetroGrid project and jointly applied the Regulatory Test. The main investment in the MetroGrid project is the 330 kV cable and substation by TransGrid, but the project also involved a significant 132 kV cable and substation development by EnergyAustralia.

The MetroGrid project that has actually been developed bears little resemblance to the project that was specified, costed and compared to possible alternatives in the Regulatory Test. The initial cost estimate established at the time of the Regulatory Test (in 2000) was $142.5m. TransGrid's latest estimate of the cost it has incurred in developing this project over the last four years is estimated to be $276m excluding various claims against TransGrid from various contractors and suppliers that may exceed $40m. The original project was due to be commissioned by November 2003. At the time of writing (April 2004) the project is nearing completion but is yet to be commissioned. We understand that the project is scheduled for completion by July 2004.

This report is set out as follows:

- Chapter 3 sets out our understanding of the ACCC's obligations in assessing the prudency of the MetroGrid project;
- Chapter 4 reviews TransGrid's assessment of the need for the project;
- Chapter 5 reviews TransGrid and EnergyAustralia's Regulatory Test assessment of the MetroGrid project;
- Chapter 6 assesses TransGrid's delivery of the chosen project;
- Chapter 7 is our assessment of the prudency of TransGrid's investment in the MetroGrid project, and consideration of possible prudency adjustments.

3. The ACCC's obligations in assessing the prudency of the MetroGrid project

3.1 Introduction

This chapter considers the details of the regulatory regime applying to TransGrid over the duration of the revenue cap from 1999 to 2004. This establishes the basis upon which the ACCC is required to assess TransGrid's investment in the MetroGrid project. The chapter covers in turn: the ACCC's Code obligations; the elaboration of these obligations in the Draft Regulatory Principles; and the role of the Regulatory Test in assessing prudency. Finally, we suggest how the ACCC could apply the prudency test in the assessment of the MetroGrid project.

3.2 The ACCC's Code obligations

The core obligation of the ACCC in relation to the regulation of capital investment by TNSPs is set out in Clause 6.2.3(d) of the Code. This holds that the regulatory regime to be administered by the ACCC must have regard to the need to (inter alia) "*provide a fair and reasonable risk-adjusted cash flow rate of return to … Transmission Network Service Providers on efficient investment given efficient operating and maintenance practices on the part of the … Transmission Network Service Providers*." In addition, the Code requires the ACCC to consider the investment necessary to ensure that TNSPs *"act efficiently to achieve the lowest sustainable cost of services"*.

3.3 The provisions of the Draft Regulatory Principles

The May 1999 (Draft) Statement of Regulatory Principles (DRP) elaborated on how the ACCC interprets its Code obligations to regulate capital investment. The basic design of this arrangement is that:

- The Commission would determine an allowance for capital expenditure based on a forecast at the start of the regulatory period;

- At the end of the period (after the investment had been made) the Commission would assess the prudency of capital expenditure on those projects whose actual cost exceeded the forecast cost.

In the DRP, prudent investment was defined to be "…the amount that would be invested by a prudent TNSP acting efficiently in accordance with good industry practice …"[1]

3.4 The role of the Regulatory Test

The Regulatory Test was promulgated in December 1999 under clause 5.6.5(q) of the Code (as it then was). The relevant provisions dealing with the Regulatory Test are established in Clause 5.6.5A of the Code.

The role of the Regulatory Test and the ACCC's determination of prudent investment has changed over time. Before the "Network and Distributed Resources" Code changes in March 2002, the Commission was required to automatically roll-in to a TNSP's Regulated Asset Base (RAB) any investment that had passed the Regulatory Test as applied by NEMMCo under clause 5.6.5. Since the NDR Code changes, this provision was removed. Therefore there is no explicit link between the outcome of the Regulatory Test and the amount of the investment to be "rolled-in" to the Regulatory Asset Base (RAB) – the Commission is not bound to accept the outcome of the Regulatory Test as the definitive statement on the amount to be rolled-in to the RAB. By corollary, that a project is deemed to have "passed" the Regulatory Test, is no proof of its prudency.

In the context of the prudency assessment of the investment in the MetroGrid project, TransGrid's Regulatory Test analysis of this project provides the engineering-economic evaluation of the possible investment choices and hence the justification for the option that was developed. The assessment of TransGrid's application of the Regulatory Test for this project is therefore a key starting point in the analysis of the prudency of this project.

3.5 Application of the prudency test

The TransGrid and EnergyAustralia revenue resets are the first of the "second-round" revenue resets. For the first time the ACCC is required to examine specifically how it would apply the prudency test. A key issue in the efficiency assessment is the definition of "good industry practice". In our view, "good industry practice" is not uniquely and objectively definable. An assessment of whether a TNSP developed a project in accordance with "good industry practice" necessarily requires the exercise of judgement taking account of the detailed facts and circumstances of the investment.

[1] This is taken from proposed statement 5.1 on page 63 of the Statement of Principles for the Regulation of Transmission Revenues", May 1999. The full text of this statement also required that one of three other conditions be satisfied for investment to be deemed to be prudent. The first condition was that incremental revenue generated by the capital expenditure exceeds the investment cost. This condition is obviously circular – as long as the Commission determines that the investment is prudent the present value of revenues (discounted at the allowed return) will be greater than the investment cost.

In addition to an assessment of the engineering and economic facts of an investment, the ACCC needs to weigh the political, organisational, environmental, strategic and administrative constraints facing TNSPs in deciding whether an investment was prudently made, and then in subsequently developing the project. In our view, a simplistic and doctrinaire interpretation of "good industry practice" that fails to take account of the real world constraints faced by TNSPs is contrary to the spirit and letter of the ACCC's Code obligations.

The assessment of "good industry practice" should take account of the information and analysis available to the TNSP (or that could reasonably be expected to be available to the TNSP) *at the time the TNSP decided to invest*. For example, if the investment was justified on the basis of demand forecasts that subsequently proved over-optimistic, it seems sensible that the TNSP should not be penalised if that demand forecast reflected the available information (and a reasonable analysis of that information) consistent with what would be expected of a TNSP applying "good practice". We suggest that, in general, TNSPs should be encouraged to take account of the most accurate information available to maximise the economic efficiency of that investment, even if the project eventually developed is different to the project that was first envisaged.

However it is much less clear what should be done if a TNSP conducts a poor investment analysis and makes economically inefficient investment decisions (on the basis of the information available at the time of the investment) but as events turn out the investment is justified because of an unforeseen change in events such as demand increases being much greater than forecast. In this case, should the ACCC penalise a TNSP for poor decision-making even if the investment turns out to have been efficient? This is a genuine quandary which fortunately does not arise in the case of the MetroGrid project.

In undertaking the ex-post assessment of investment, the essence of the ACCC's task is to 'step into the TNSP's shoes' at the time the investment was made and assess whether, according to the benchmark of "good industry practice", a prudent TNSP would have made the same decisions. If the ACCC determines that different decisions would have been made by a prudent operator than were actually made by the TNSP, then the task is to quantify the difference in investment under each set of decisions. This difference represents the cost of "inefficiency" to be excluded from the RAB. In this way, the ACCC will realise its Code obligation to ensure a "fair and reasonable risk-adjusted rate of return on efficient investment given efficient operation and maintenance practices".

There may be a number of ways to implement such prudency assessments. We suggest a systematic, chronological examination of the critical decisions to establish whether the TNSP made decisions consistent with good industry practice. The three sequential stages of this examination are as follows:

- First, assess whether there is a justifiable need for investment. This stage examines whether TransGrid correctly assessed the need for investment against its statutory and Code obligations. At this stage, the assessment focuses on the need for investment, without specifically focussing on what that investment may be. An affirmation of the need for investment does not imply acceptance of the specific project that was proposed or developed.

- Second, assuming the need for investment is recognised, assess whether TransGrid proposed the most efficient investment to meet that need. The content of the assessment here is whether TransGrid objectively and competently analysed the investment to a standard that is consistent with "good industry practice."
- Third, assess whether the project that was analysed to be the most efficient was indeed developed, and if not whether the difference reflects decisions that are consistent with "good industry practice". The analysis in this third step necessarily requires the ACCC to examine in detail the factors that caused changes in the project design and/or delivery and assess how TransGrid responded to those factors in comparison to what could be expected of a prudent operator.

A structured examination of the project through each of these stages provides the content and rationale for the prudency assessment and any possible reduction in the amount of the total cost of the project to be rolled-in to the RAB.

Finally, it bears specific mention that the discussion in this chapter on the application of the ex-post prudency assessment of investment by TNSPs is germane to the regulatory framework that applied to TransGrid (and other TNSPs) over the current regulatory control period. We note that the ACCC has recently issued a discussion paper on changes to the regulatory framework to place far greater reliance on a firm ex-ante assessment and therefore to minimise the scope for ex-post prudency assessments. We understand that if these changes are accepted this arrangement will apply to the regulation of investment in the coming regulatory period.

4. Review of TransGrid and EnergyAustralia's assessment of the need for the MetroGrid project

4.1 Overview of the bulk supply networks serving the CBD and Inner City

The Sydney CBD and Inner City are supplied by several 132kV cables owned and operated by EnergyAustralia, which link to TransGrid's 330/132kV substations at Beaconsfield West, Sydney North at Dural, and Sydney South at Picnic Point. The Sydney CBD and inner suburbs are also supplied by a 330kV cable (Cable 41) that runs from Sydney South to Beaconsfield West substations. This is currently (until the MetroGrid project is commissioned) the only 330kV line supplying the Sydney CBD. It was commissioned in 1979.

There are presently nine 132kV cables supplying the CBD itself. Three of these cables run independently, while the remaining cables share a common trench with at least one other CBD supply circuit. The four largest cables associated with the supply to the CBD emanate from Beaconsfield West, two of these cables share a common trench but all four cables run through the one segregated ductline to the CBD.

Recently EnergyAustralia has undertaken a number of augmentation works to support supply into the Sydney CBD and inner suburbs, especially to support Cable 41. These works include:

- Uprating of feeders 910 and 911, which increased the capacity to Chullora.[2]
- Installation of reactors at Peakhurst to improve load sharing.
- Establishment of a second Roselle-White Bay-Pyrmont 132kV cable which reduces the loading on the four Chullora-Beaconsfield cables (91A, 91B, 91X and 91Y) when cable 41 is out of service.

[2] The ACCC was advised that its impact varies with system conditions but typically results in about 100MW increase with Cable 41 in service, and up to 160MW (2*80MW) with Cable 41 out of service. This work was critical as it enabled better utilisation of the capacity of #3 and #4 transformers at Sydney South, effectively increasing the 330/132kV capacity to the inner metropolitan area.

- Connection from Bankstown to Greenacre Park. This enables the transfer of about 120MVA from Chullora to Sydney South, which reduces the loading on cable 41 and Sydney North at the expense of increased loading on Sydney South.
- Replacement and upgrade of two transformers at Sydney South substation

Since the electricity transmission and distribution businesses in New South Wales were separated EnergyAustralia has become responsible for the 132kV cables supplying the CBD (and their development) while TransGrid is responsible for the 330 kV Cable 41, and for the development of subsequent 330 kV cables. TransGrid and EnergyAustralia engage in joint planning for the networks supporting the Sydney area and the Regulatory Test for the MetroGrid project represented a joint effort by both organisations.

The MetroGrid project (it was originally known as the Sydney Central project) was first discussed in the early 1990s. However the scope of the project has changed since that time, largely in response to demand growth rates which were revised downwards.[3]

4.2 Proposed new planning standard for the CBD and Inner City

The choice of the planning standard to apply in TransGrid and EnergyAustralia's networks is a matter to be regulated by the government of New South Wales, not the ACCC. In our view it is therefore inappropriate for the Commission to take a view on the planning standard adopted by TransGrid.

However, the choice of planning standard and the timing of its implementation has a very significant impact on the level of investment. Therefore we think it is helpful to understand what these planning standards mean and the implications for the necessary investment if different standards are adopted.

In verbal discussion with ACCC staff, TransGrid suggested that the "modified n-2" standard – upon which the need for the MetroGrid project was justified - was not new, but was simply a return to the standards that the networks serving in the CBD had initially been developed to.

TransGrid explained that as demand increased in relation to the capacity of the network over time, the planning standard had effectively "degraded" to the standard (generally n-1) currently pertaining. We have not attempted to verify this statement, but it seems quite plausible considering that Cable 41 and much of the 132 kV cable network have been operational for at least 25 years and that the relativity between the size of the network and the demand it serves would have been quite different 25 years ago.

An important contextual feature at the time that the implementation of the modified n-2 was being considered was the failure of cables serving Auckland. In February 1998, a series of failures in four 110kV transmission cables left the Auckland CBD virtually without power

[3] Worley in association with PriceWaterhouseCoopers , October 1998. "Report to IPART on capital expenditure review in NSW electricity transmission – supplementary report on TransGrid final report."

for five weeks. Prior to the cable failures, there were four 110kV cables supplying electricity to the Auckland CBD.[4] A number of factors contributed to the cable failures including the environmental conditions at the time, cable ageing and ratings, and cable condition and load monitoring. Following this failure, letters were exchanged between the CEOs of TransGrid and Energy Australia calling for joint planning of augmentations to the network serving the Sydney CBD.

This led to a proposed revised planning standard which became known as the "modified n-2" standard. A conventional "n-2" standard means that the network is developed so that at least 2 critical network elements could fail simultaneously, and the network would still be able to supply the expected peak demand. Critical network elements could typically include busbars, overhead lines, underground cables and transformers.

The modified n-2 standard that TransGrid defined is a less onerous standard in that it only provides for the simultaneous failure of the existing 330kV cable (and any subsequent 330 kV cables) and one of the critical 132 kV network elements serving the CBD (which includes cables, transformers, and any section of busbar).

While the conceptual principle of deterministic standards is intuitively clear, in its practical implementation there are many degrees of freedom in assessing and applying the standard and calculating the size of the investment necessary to ensure compliance with the standard. For example:

- The assumptions on future peak demand (and its distribution across the network) will affect the determination of whether the network is able to meet that demand. For example future demand forecasts could be based on the expected value or a 1 in 10 year value or a 1 in 100 year value;
- The assumptions on network impedance will affect power flows and hence the impact of the failure of specific network elements on the redistribution of energy flows on the remaining elements. In practice the impedance of many network elements is not fixed and power flows through network elements can be varied through the use of fixed capacity reactive devices and through variable power electronics devices such as variable capacitors (Static Var Compensators) and quadrature boosters;
- The definition of credible contingencies affects whether compliance with a planning standard is achieved. For example, a credible contingency could be defined to include the failure of a busbar. In the change to the modified n-2 standard, TransGrid and EnergyAustralia argued that busbar failures should also be included as credible contingencies;
- The calculation of the expected demand could include or exclude the impact of interruptible contracts and/or network support agreements with distributed generators;

[4] These formed the main supply, but there is also a 22kV feeder, between the Kingsland and Liverpool Street substations, which continued supplying about 20MVA throughout the outage.

- The duration of the failure to meet demand (i.e. non-compliance with demand) could be defined to be an instant, or a longer period such as the length of time the remaining network elements could be operated at their emergency ratings.
- The disposition of generation at different points on the network affects load flows which in turn affect the impact of the failure of specific network elements on the ability of the remaining network to meet the expected demand.

In its application of the Regulatory Test for the MetroGrid project and in their communication with ACCC staff, TransGrid argued that its decision to adopt the modified n-2 standard was compliant with international standards in other major cities. As explained earlier, we don't think the ACCC should opine on the planning standards adopted by TNSPs. For completeness however, we note that general statements that "the proposed standard is compliant with international standards for major cities" can be misleading unless the comparison of planning standards reflects the full complexity of the calculation and application of those standards in each case. In essence we think the issue is more subtle and subjective than TransGrid and EnergyAustralia have portrayed it.

Finally, it bears specific mention that in considering the adoption of a planning standard for a transmission network, it is helpful to be mindful of the capacity of the distribution network that operates below it. TransGrid's Regulatory Test final report states that "*in the event of such a (major transmission) failure, restoration of load to the CBD would require extensive 11kV load transfers, which can take several hours to implement.*" [5] This statement suggests that an economic consideration of the cost of transmission reliability in the inner metropolitan area needs to weigh the cost of that reliability with the likely extent and duration of any outages taking account of the ability to mitigate the extent and duration of those outages through redispatch of the distribution network.

4.3 Impact of planning standards on the need for investment

It is important to understand the impact of different planning standards on the extent of investment needed to meet those standards. In the rest of this sub-section we have tried to elucidate this through a simplified heuristic analysis. A load flow model would deliver a more precise analysis and hence more accurate conclusions, but the fundamental principles and argument remains the same.

If the conventional "n-2" standard were to apply in the planning of the MetroGrid project, then TransGrid and EnergyAustralia would have needed to develop a network that had sufficient spare capacity so that if both the existing 330 kV cable (Cable 41) as well as the new cable (Cable 42) were to fail the remaining network would need to be able to carry the full load.

The cyclic rating of Cable 41 is 660 MW and the cyclic rating of Cable 42 is at least 750 MW. Therefore the simultaneous failure of Cable 41 and Cable 42 would mean that up to 660 MW plus 750 MW = 1410 MW of spare capacity would be needed to supply the demand if

[5] TransGrid and EnergyAustralia, 2000 op. cit., p. 15.

both of these cables failed at the same time (assuming both cables were loaded to their full capacity at the time they failed). This amount of spare capacity compares to the 2004 summer load in the CBD and Inner City area which is around 1500 MVA. In other words, the network would need to be designed and built to cover effectively twice the existing demand. The capital cost of this spare capacity – based on current experience - would be around $564m[6]. To recover the return and depreciation of this investment – leaving aside any increased operating expenditure - would require TransGrid's revenues (and prices) to rise by around 18%[7] from their 2003/4 level.

It is quite understandable therefore that TransGrid/EnergyAustralia proposed a less onerous "modified" n-2 standard. Under this standard, the required amount of spare capacity needs to be large enough to cater for the simultaneous failure of a 330 kV cable and any 132 kV feeder or 330/132kV transformer or any section of 132kV busbar.[8]

Assuming the two elements that failed were loaded to their full capacity at the time they failed, this would therefore mean that the network would be required to have sufficient capacity to replace the simultaneous failure of both elements. This would mean a spare capacity of around 750MW[9] + 220[10] MW = 970 MW. This is clearly less than the 1410 MW of spare capacity that would be required to ensure compliance with a "conventional" n-2 standard.

It is important to note that the planning standard adopted by TransGrid/EnergyAustralia is a *deterministic* standard – it does not consider the likelihood of the failure of network elements. Instead it takes as given that the network could fail at the time of peak demand and therefore determines the level of capacity needed to meet that peak demand assuming that one (n-1) or two (n-2) network elements fail simultaneously. Therefore knowledge of the probability of failure of network elements is not pertinent. Nevertheless, as with any risk assessment, it can be useful to at least attempt to understand the likelihood that certain critical network elements would fail simultaneously.

In this regard, ACCC staff asked TransGrid to provide a history of forced (unplanned) and planned outages of Cable 41 and the other critical 132 kV network elements. From this information we know that in the 12 years between 13 March 1992 and 13 March 2004, Cable 41 failed 6 times for a duration ranging between 3 minutes and 1 hour 47 minutes. From the data provided by TransGrid it is unclear if there has ever been a co-incident outage of Cable 41 and any of the critical 132 kV network elements since Cable 41 was commissioned in 1979.

In the Regulatory Test application, TransGrid recognised that the probability of the simultaneous failure of Cable 41 and any one of the critical 132 kV elements was low, but suggested that "*the possibility of a critical double outage is substantially increased by the*

[6] 1410MW*$400/kW
[7] $70m/$393m
[8] TransGrid and EnergyAustralia, 2000 op. cit., p. 5.
[9] The cyclic capacity of the new cable 42.
[10] The cyclic capacity of one of the Rozelle to Pyrmont cables according to information provided by TransGrid in a simplified schematic.

number of elements which are critical to the operation of the system with Cable 41 out of service."[11]

While this may be true, the key issue is not the simultaneous failure of two network elements (double contingencies) per se, but double contingencies at the time of system peak demand, or when other critical networks are on planned outages. Furthermore the failure of key network elements and the time of peak demand are likely to be independent of each other; and planned outages and the time of peak demands are likely to be negatively correlated (planned outages are typically taken when demand is relatively low - in autumn and spring).

The implementation of the modified n-2 standard has a bearing not just on TransGrid's initial investment in Cable 42 - which is required to bring the system up from an n-1 to modified n-2 standard, but also on the subsequent investment needed to maintain that standard. An examination of the options presented in the Regulatory Test shows that for the chosen option, over the 10 year period from 2003 to 2013 around 1300 MW of capacity would need to be developed.[12] This equates to more than 100 MW of additional capacity per year. At an average cost of around $400/kW, this equates to additional investment of around $40m per year.

By comparison, we understand that the last significant investment in the MetroGrid area was the commissioning in 1979 of Cable 41. While the apparent need for considerable new investment over the next ten years may in part reflect "catch-up" for relative under-investment over the last 25 years, it also appears that a significant reason for much higher investment relates to the implementation of a much more demanding reliability standard.

The implementation of the modified n-2 standard would clearly require a step-change in investment in transmission capacity in the CBD. For this reason TransGrid proposed a phased introduction of the standard so that the investment would be planned and completed only when the system was found to be no-longer compliant with the existing planning standards. TransGrid's load flow modelling in 1999 showed this to be by October 2003, and accordingly the investment was proposed for commissioning by this date. The idea of a phased implementation of the revised planning standard was commended in the Ewbank Preece report[13] to the ACCC and referred to in NERA's report to TransGrid.[14]

Finally, it should be noted that in addition to affecting the absolute level of investment, the use of a modified n-2 planning standard also affects the order in which investments need to be made, thus impacting the present value (in financial terms) of different investment decisions. For the investment option that TransGrid demonstrated to be least cost, the use of a modified n-2 planning standard dictates that a significant network investment was needed *before* demand-side management was implemented – even though, in present value terms, deferring the investment through implementation of demand management would have been more economic. By comparison, the use of an n-1 standard in the same circumstance would have pointed to the implementation of demand side management to defer the significant network investment. We expand on this below and again in Chapter 7.

[11] TransGrid and EnergyAustralia, 2000 op. cit., p. 16.
[12] The chosen option envisaged two separate 600 MW cables from Sydney South to Haymarket and 100 MW of demand side management (i.e. demand shifting or demand reduction).
[13] Ewbank Preece 1999 op. cit., p 8.
[14] NERA 2000 op. cit., p. 24.

4.4 Assessment of the need for investment

It is important to be clear what our assessment in this sub-section means. Specifically, our assessment relates to the need for a significant investment that would improve the margin between the demand and transmission supply capacity to the CBD and Inner City. This assessment has no implication for which of the several investment options were the most appropriate. Also, any assessment of the need for investment must also relate to the timing of that investment.

We have not attempted to replicate the load flow analyses underlying the options reviewed in the Regulatory Test. However, we have reviewed load flows covering the Sydney area that TransGrid specifically constructed for us, using the information available in 1999 at the time that the Regulatory Test was conducted[15]. These load flows demonstrate that the network was expected no longer to be n-1 compliant by the summer of 2004 assuming the Kurnell-Bunnerong Cable had not been built; or by the summer of 2005 assuming this cable had been built.[16]

These load flows also demonstrate that the network was not compliant with the modified n-2 standard in 1999, and the level of non-compliance only increased thereafter despite the projects that were undertaken. On the basis of this information, there is no doubt that a significant investment – whether it be a new cable and/or generator and/or large load decrease/shift – was needed as soon as possible to ensure compliance with the revised standard.

Therefore we can accept TransGrid's analysis of the need for significant investment[17] in the CBD by October 2003 (or even earlier for that matter) on condition of the implementation of the modified n-2 criteria. Furthermore the principle adopted by TransGrid to implement the investment only once the network was expected to be no longer compliant with the existing planning standard, we consider to be consistent with good industry practice.

[15] ACCC staff asked TransGrid to supply the original planning standards but TransGrid explained that this was not available in a "single document".

[16] Both of these dates take account of a number of other network augmentations/refurbishment actions that were undertaken by EnergyAustralia and TransGrid including the replacement and upgrading of two Sydney South transformers; the closing 910 and 911 to Chullora; installing a second cable from Roselle to Pyrmont; uprating Sydney South Transformers; uprating cables 910 and 911.

[17] In its cost-effectiveness analysis, NERA concluded that "if the enhanced supply capacity (or demand reduction) required in 2003/4 is centred in the Sydney CBD area, the load flow model indicates that it needs to be of a magnitude of around 200MW" (NERA 2000, pg 24). As discussed we have not reviewed the load flow analyses underlying the Regulatory Test application, but on the basis of NERA's analysis and load flows prepared for the Commission by TransGrid, an augmentation of at least 200 MW by 2003/4 appears to be realistic.

5. Review of TransGrid and EnergyAustralia's Regulatory Test assessment of the MetroGrid project

5.1 Introduction

This chapter examines the way that TransGrid and EnergyAustralia determined the most efficient project to meet the need for investment in capacity to the CBD and Inner City. The chapter covers the second step of the three step analytical framework described in Chapter 3. As such it focuses specifically on the analysis underlying the selection, costing and comparison of the various options included in the Regulatory Test analysis.

The chapter begins by briefly reviewing the process for the application of the Regulatory Test to the MetroGrid project and explains the role of TransGrid, EnergyAustralia, consultants and other interested parties. It then reviews three key elements of the application of the Regulatory Test to the MetroGrid project:

- how possible options were developed and specified;
- how options were costed; and
- how options were compared.

5.2 Overview of the process of the application of the Regulatory Test

The MetroGrid Regulatory Test application was the first application of this test to an intra-regional network augmentation. The regulatory process commenced in October 1998, with a final report released in February 2000.

The initial "cost effectiveness analysis" was conducted by NERA on behalf of TransGrid and EnergyAustralia and was completed in December 1998. It accompanied a consultation paper dated January 1999, released by TransGrid and EnergyAustralia notifying interested parties of supply needs into the Sydney CBD and inner suburbs. Interested parties were initially given two weeks to comment on this paper, although the period of consultation was subsequently extended to a month. TransGrid and EnergyAustralia also held a public forum on the project in February 1999.

At the time that TransGrid and EnergyAustralia were conducting the Regulatory Test for the MetroGrid project, NERA's initial cost effectiveness analysis was developed on the basis of a general cost-benefit assessment but also included an analysis of "customer benefits" for information.

In view of the delay in changes to the Regulatory Test, the Minister for Energy in the government of New South Wales applied to the Commission for a Code derogation to the provisions of the Regulatory Test. This was rejected and the Regulatory Test was formally promulgated in December 1999 and TransGrid completed and published the outcome of the application of the Regulatory Test to the MetroGrid project in February 2000. There was no consultation with interested parties on the application of the revised Regulatory Test to the MetroGrid project.

TransGrid sought assistance from a number of specialist consultants in the development of the Regulatory Test analysis. In particular:

- SKM was commissioned to verify the capital costs of the network options defined by TransGrid and EnergyAustralia;
- The National Institute of Economic and Industrial Research (NIEIR) was commissioned to develop an independent demand forecast for the inner metropolitan area; and
- NERA was commissioned to conduct the cost effectiveness analysis and to develop the costs and technical and environmental parameters for the generation options, and cost and scope for Demand Side Management (DSM). NERA played a critical role in the application of the Regulatory Test and TransGrid and EnergyAustralia accepted verbatim NERA's "Final Cost Effectiveness Analysis Report" in their Regulatory Test report "Electricity Supply to Sydney's CBD and Inner Suburbs: Final Report".

5.3 Review of the development and specification of options in the Regulatory Test

TransGrid developed and assessed 13 options, consisting of five network options, four options involving a combination of generation and network investments, one option involving a combination of DSM and network investment and three options involving a combination of network investment, generation/co-generation and DSM. A 14th option consisting of a combination of DSM and network investment was shown to be by far the cheapest alternative but was rejected by NERA, because it believed that the option was not technically feasible.

The five network options were developed by TransGrid and EnergyAustralia. The options involving co-generation and in one case cogeneration plus an open cycle gas turbine plant appear to have been developed by NERA. Sithe Energies Australia and Alise EnergyAustralia proposed cogeneration capacity and Kurnell and Botany respectively. NERA was responsible for developing the costs and technical and environmental parameters

of these generators. NERA also developed the input on DSM including the costs and potential for this in the Sydney CBD and Inner City area.

Other than the five network options which were developed by TransGrid and EnergyAustralia, it appears that NERA has developed all other options. It then sequenced the combinations of generation, network investment and demand management according to the investment requirements needed to meet the modified n-2 planning standard, on the basis of EnergyAustralia's load flow model incorporating demand forecasts from EnergyAustralia and NIEIR.

A key issue in assessing the chosen option from amongst the available alternatives is that the chosen option and its peers, are bona fide options. Similarly it is important to understand whether some obvious options had been excluded from the comparison.

Dealing first with the latter point (whether alternatives have been excluded), it is clear that there could be a great number of possible options whether pure network options or combinations of network/DSM/generation/co-generation projects that could be developed to meet the modified n-2 reliability standard. We note that in the course of developing the Regulatory Test application, alternatives were proposed by interested parties, although some[18] were subsequently rejected by TransGrid's consultant NERA as technically infeasible.

However, we also note that a number of interested parties including the Environment Protection Agency, Sustainable Energy Development Authority, the Total Environment Centre and Delta Electricity criticised the way that some options had been developed and evaluated. It may be possible to come up with very many more options than the 13 chosen for evaluation by NERA. Whether or not this would deliver a more favourable project is another matter. On balance we have no reason to believe that favourable alternatives were deliberately excluded from the evaluation, and since we are not in a position to attempt to reconstruct the development and analysis of alternative options, we do not consider this issue further.

Turning to the issue of the bona fides of the chosen alternatives, we examine in turn the scope for DSM, generation investment opportunities and the network projects included in the 13 options examined in the Regulatory Test.

5.3.1 Specification of scope for Demand Side Management

NERA, TransGrid's economic consultant, was responsible for developing the assessment of the scope for DSM.

Resource and time constraints have meant that we have been unable to independently assess the scope for demand side management in the CBD or Inner City areas. However we believe that on the whole NERA produced a helpful analysis, fit for the purpose of assessing the possible scope of DSM as an alternative to network augmentation or generation solutions. Its analysis systematically analysed the possible sources of demand management and drew on anecdotal and empirical evidence of the nature and cost of load reductions or shifts.

[18] NERA argued that 250 MW of demand side management in the inner metropolitan area was unachievable.

However an oversight in NERA's analysis is that it apparently took no account of the scope of interruptible contracts in load management because it claimed that it "(does) not have access to further (EnergyAustralia) marketing information and so cannot provide further analysis".[19] This is despite their own observation that a demand management strategy undertaken by VPX in Melbourne in 1998 was able to elicit 100 MW of demand management for the 1997/8 summer period, primarily from offers by stand-by generation and interruptible loads.

Like NERA, we do not have sufficient information to assess the true scope for demand management through interruptible contracts. However, there are a number of significant point loads in the CBD area, including significant commercial air-conditioning demand. Through greater take-up of thermal storage air-conditioning, much of this demand may be particularly amenable to interruptible contracts.

Finally NERA had taken account of power factor correction in some of their DSM assumptions (such as more efficient fluorescent lighting). But we note that improving the power factor in the CBD from its current level of 0.89 to 0.95 would effectively add around 100MW[20] of capacity to the network. While we have not examined the electrical engineering of this issue in further detail, it would appear that there is scope to improve the effective load carry capacity of the network through such power factor correction – whether this is done at the point of demand or directly on the network through reactive devices or a combination of the two.

For these reasons we consider NERA's conclusion on the scope for demand side reduction in 1999 of around 130 MW, as a plausible minimum and that the true scope for DSM may in fact be considerably higher than this.

5.3.2 Specification of generation/co-generation projects

Moving to the assessment of the generation and cogeneration projects included in the Regulatory Test assessment, we note that NERA effectively undertook the evaluation necessary to include possible generation projects as part of various Regulatory Test options. The three generation/cogeneration projects included two possible cogeneration projects at Kurnell and Botany, and a prospective open cycle generator to be located in the CBD. According to NERA's report the co-generators had already obtained environmental approval and proponents (Sithe Energies Australia for the Kurnell co-generator and Alise EnergyAustralia for a co-generator and possibly also OCGT at Botany). Information on the capability and technical parameters of these generators was obtained directly from the proponents and since these generators (other than the OCGT at Kurnell) had environmental approval, we are satisfied to rely on the information and analysis of these generators presented by NERA.

There is a subsidiary network issue that arises specifically if additional generation capacity is located south of Botany Bay i.e. that transmission capacity needs to be developed to transfer

[19] NERA 2000 op. cit., p. 34.

[20] This based on TransGrid information of existing (base case) summer load in 2004 of 1650 MVA and 1470 MW in the inner metropolitan area.

power to the CBD. The route to get such capacity is via a cable between Kurnell and Bunnerong on either side of Botany Bay. In the Regulatory Test assessment, this cable is shown as having a capital cost of $35m. However, in response to a February 2004 question from ACCC staff on this cable, TransGrid suggested that a cable between Kurnell and Bunnerong would "almost certainly" involve tunnelling under Botany Bay due to environmental and other factors.[21] Tunnelling can be expected to drastically increase the cost of the project compared to laying the cable in a shallow trench as had been assumed.

The remaining significant generator option is a 250 MW OCGT to be located within the CBD at Haymarket, which was included in Option 6. There is nothing unusual about locating generating plant within or close to a major CBD and examples of this exist in major cities throughout the world. We understand that NERA contacted the EPA to discuss environmental constraints on the location of a generator within the CBD and we understand that the EPA expressed concern over CO_2 and NOx emissions within the Sydney basin, but did not formally state that consent would not be granted to the project.

In verbal discussions with TransGrid and EnergyAustralia during the revenue reset process, ACCC staff were led to believe that there may still be doubts about establishing an OCGT within or close to the CBD. In subsequent correspondence with the ACCC, TransGrid stated that *"due to environmental concerns with the emissions from a generator in the Sydney basin, EIS approval for any significant embedded generation within the Sydney basin was highly unlikely and remains so"*[22]. Taken at face value[23], this suggests that the inclusion of an OCGT within the CBD is not in fact a bona fide investment option – as had been assumed in the Regulatory Test analysis.

This is a critical issue. If environmental limitations would have precluded the development of an OCGT in the CBD then it should not have been included as an option in the Regulatory Test assessment. We have used NERA's cost effectiveness model to evaluate the relative ranking of Option 6 (the project that entailed the development of an OCGT in the CBD followed by cables from Sydney South to Haymarket) compared to the chosen option, Option 10. Using actual cost information on the MetroGrid project suggests that, with hindsight, Option 6 would in fact have been a more economical solution than Option 10.

If it subsequently turns out that building an OCGT in the CBD is not in fact a plausible option, or that it would have cost substantially more or less than expected, or taken substantially longer to build than envisaged, then why was this option included in the Regulatory Test assessment? Our view is that TransGrid and EnergyAustralia should have investigated the option of locating a generator in the CBD in greater depth to obtain greater certainty on this option.

5.3.3 Specification of network projects

With respect to the network alternatives, these appear to have been developed on the basis of a desk-top conceptual design conducted by TransGrid for the 330 kV network and substation

[21] ACCC-040225-50f, 18 February 2004.
[22] ACCC-040203-40p, 3 February 2004.
[23] This statement may be contradicted by the fact that the cogeneration plant already had EPA approval.

options, and by EnergyAustralia for the consequent 132 kV investments. The actual MetroGrid project that has been developed is very different to the project that was envisaged. For example:

- The actual cable is 28 kilometres long with a 3.5km cable tunnel; compared to 27 kilometres and a 1 kilometre tunnel;
- The sub-station is situated indoors rather than outdoors;
- The transformers are gas-insulated rather than oil-insulated;
- The transformers are dry-cooled rather than water-cooled;
- The substation is buried underground rather than sitting on the surface;
- There is basement-level cable entry rather than ground level entry.

In a report addressed to the ACCC, TransGrid suggested that "*The MetroGrid project highlights the more general point that a significant amount of work remains to be done in order to finalise the detailed design of any project after the Regulatory Test process has been completed. It would not be practical for these detailed processes to be carried out before the Regulatory Test was applied, given that they would then either need to be conducted in relation to each of the alternative options being considered, or, if only applied to one option, would raise the perception that TransGrid was seeking to pre-empt the outcome of the regulatory process".*[24]

There is a substantive issue here: how far should a prudent operator be expected to go in producing a rigorous assessment of investments options during the Regulatory Test? Obviously producing rigorous assessments of a large number of possible options has implications for the cost of the Regulatory Test process, as well as for the time required to conduct such assessments, which in turn may have implications for the ability of the TNSP to meet its statutory and Code reliability obligations.

Furthermore, in many cases establishing a more accurate specification of the different network projects would have required not just desk-top research by TransGrid's engineers, but also the active involvement of third parties including equipment suppliers, planning authorities, environmental regulators and in some cases land owners.

As with so many aspects of the assessment of TransGrid decisions on the MetroGrid project, there is no uniquely right answer to the question of how rigorous the comparative evaluation of options should be at the Regulatory Test stage. Judgement is required to find the correct trade-off between the quality of the investment assessment, and the time and resource implications of higher quality assessments necessary to ensure efficient investment decisions.

TransGrid's categorical position on this issue is that *"it would not be practical for these detailed processes to be carried out before the Regulatory Test was applied"*[25]. We disagree with this. The rigour of the so-called "detailed processes" is not absolute and the decision is not between undertaking "detailed processes" or not. Rather the issue is judging how much

[24] TransGrid 2003 op. cit,. p. 24.
[25] Ibid, p. 24.

rigour would be appropriate to ensure that an adequately informed investment decision can be made.

In our view, time was not a factor constraining the development of an accurate specification of the network options before the completion of the Regulatory Test. The idea of a major network investment to expand capacity to the CBD was first seriously discussed in 1997 – although it had been debated from the early 1990s. The first Regulatory Test assessment of options was then completed by December 1998, and the final Regulatory Test was published in February 2000. More than three years passed between the initial conception and the final completion of the Regulatory Test for TransGrid and EnergyAustralia. We can't see why, with this time available, TransGrid and EnergyAustralia were not able to have undertaken a better quality assessment and definition of the proposed network options.

Furthermore, it could be expected that laying a major cable into Sydney and terminating it at a substation in a key commercial and tourist district would present substantial technical, environmental and social challenges. But TransGrid showed little attempt to take account of any of these complications at the time the project was designed and specified as part of the Regulatory Test assessment. It did not attempt to obtain an independent opinion on the network options it developed. SKM (consulting engineers) was commissioned to review TransGrid's network costing, but this did not extend to a review of the conceptual design.

During the course of the Regulatory Test, interested parties had an opportunity to nominate additional projects or variations of the projects proposed at that time. A fifth network option was included in the comparison on the recommendation of an interested party. While some interested parties may well have sophisticated knowledge of some aspects of the decisions underlying network investment, in general it would be inappropriate to rely on interested parties – who are after all not in the business of transmission planning - to provide a meaningful review or assessment of TransGrid and EnergyAustralia's network propositions.

For these reasons, inter alia, we think it would have been prudent to conduct a more comprehensive assessment of the network possibilities and their risks at the time of the Regulatory Test than TransGrid and EnergyAustralia conducted. This could have been expected to produce an appropriately informed assessment at the time that fundamental and potentially irrevocable decisions between those choices were being made. Had such information been available at the time of the Regulatory Test, it may well have led to the selection of an alternative project, or the redesign of options to take account of the development risks, or a review of non-network alternatives to possibly defer the implementation of the modified n-2 standard while ensuring that the network was operated in accordance with existing n-1 standard.

5.4 Costing of options

TransGrid and EnergyAustralia estimated the costs of all the network options while NERA appears to have been primarily responsible for costing the generation and demand-side management options. We review the costing in each of these areas in turn.

5.4.1 Costing of Demand Side Management

NERA costed the DSM potential concluding that the average cost per kW of response would be $1100/kW, for a total response of 130 MW. This compares to SEDA's assessment of an average cost of $500/kW for a demand side response of 250 MW. We have reviewed NERA's analysis and while the we are not in a position to verify NERA's information, we consider the costing it produced for the individual demand management programs it examined to be plausible.

However in order to arrive at their calculation of the weighted average cost of demand side response, NERA calculated the average cost per kW of reduction across five different demand reduction programs, assuming the cost applying to the *maximum* reduction in each program. But the aggregate demand reduction that NERA assumed (130MW) was not equal to the sum of the individual DSM programs since some programs are mutually exclusive. This arithmetic error distorts the weighted average cost of demand reduction from the figures that would be produced on the basis of NERA's own analysis of the cost of individual programs. We have corrected this calculation to take the mid-point of the weighted average cost of demand reduction assuming the minimum demand reduction is achieved and the weighted average cost assuming the maximum demand reduction is achieved. This produces a weighted average cost of demand reduction of $888/kW, compared to NERA's calculation of $1100/kW. We have used this figure in our analysis in Chapter 7.

5.4.2 Costing of generation projects

NERA costed the Kurnell and Sithe co-generation plants and the Botany OCGT based on publicly available information and confirmed these costs with the project proponents in some cases. The OCGT at Haymarket was costed on the basis of estimates provided in submissions to NEMMCO as part of the SANI Riverlink inquiry. We have no reason to doubt the costing of possible generation projects by NERA.

5.4.3 Costing of network projects

TransGrid and EnergyAustralia costed the five network options and the network augmentation associated with the generation and bundled options. They produced an initial costing of four network options by November 1998 in time for the completion of the initial cost effectiveness study by NERA in December 1998. As mentioned an additional network option was added on the basis of comments by Sithe, and additional network cost estimation was completed in relation to network projects associated with generation options and bundled options included the final cost effectiveness analysis conducted by NERA.

In all cases, the projects were only specified to a "conceptual design" stage. This is an engineering term to describe the first stage, high level examination of possible options. Some "conceptual designs" can in fact be quite detailed and take account of sophisticated cost estimates and careful analyses of possible development risks.

TransGrid appear to have developed conceptual designs only to a very high level at the Regulatory Test stage. There appears to have been no attempt to take account of specific development risks or to tailor the conceptual design to the specific circumstances it was facing. For example, for the network option that was finally chosen for development, TransGrid based the conceptual design for this on the existing Cable 41 and the Beaconsfield substation at which it terminates, which were commissioned in 1979. In so doing no account of was taken of local circumstances. In explaining the reasons for the cost-overrun, these local factors played a significant role. For example:

- TransGrid suggested that storing millions of litres of oil on a site adjacent to Darling Harbour would present an unacceptable safety and environmental risk. Therefore it was necessary to install gas-insulated transformers and a gas-insulated reactor (rather than oil insulated transformers and reactors) which increased the relevant substation costs from an initial estimate of $8.4m to $28.2m.
- The substation is situated adjacent to a large pedestrian walkway leading from Central Station to Darling Harbour and the Powerhouse Museum and the safety and environmental risk posed by an outdoor substation in this location are substantial. But the Regulatory Test had assumed an outdoor substation based on Beaconsfield, and was estimated to cost $25m. The estimated final cost for the indoor substation is $68.3m excluding provision for unresolved contract claims.
- TransGrid explained that Sydney's narrow congested streets meant that it would be necessary to considerably extend the amount of the cable that was laid in a cable tunnel. The cost of the cable tunnel itself increased from the estimate of $5.8m to $28.7m, attributable to the need for a 3.5 km tunnel compared to a 1km tunnel, as had been assumed in the Regulatory Test. TransGrid indicated that the need for a longer tunnel was known in mid-2000 – just three months after the Regulatory Test was complete[26]. The cost of the cable and its installation is now estimated to be $36.5m more than TransGrid's estimate of $97.3m[27]. At the time of the Regulatory Test, TransGrid had been warned by Ewbank Preece that their installed cable estimates may be around 40% higher than TransGrid had assumed.[28]

From this we conclude that TransGrid appear to have made little attempt to consider the actual conditions of a cable from the Sydney South substation to Haymarket at the time it conducted the Regulatory Test. In fact it almost appears as if TransGrid had intentionally sought to cost a "notional"[29] project expressly ignoring what it would later claim to be obvious features.

TransGrid and EnergyAustralia put to ACCC staff that their costing had been independently verified by consulting engineers Sinclair Knight Merz (SKM) in a report to TransGrid in 1998 and subsequently by Ewbank Preece in a report to the ACCC in 1999. We have

[26] MetroGrid Supplementary Report to the ACCC, 18 March 2004. p.37.
[27] This excludes around $6m attributable to TransGrid's decision to install a higher capacity cable.
[28] Ewbank Preece, 1999 op. cit., p. 13.
[29] This is the term that NERA used to describe the network projects included in the Regulatory Test specification.

reviewed these reports and find no reason to conclude that they provide a meaningful verification of the costs of developing a 330 kV cable and substation in the CBD.

The SKM report was completed around two weeks after it was started and ran to just seven pages. SKM pointed out that "*it was not possible to make a direct comparison of total estimates as neither TransGrid nor EnergyAustralia provided an estimate for the full scope of work required"*[30] and that the installed cable is the most significant cost item but that "*time did not permit investigating the feasibility of the proposed routes or the length".*[31]

The Ewbank Preece report was commissioned by the ACCC to review TransGrid and EnergyAustralia's proposals to augment supply to the Sydney CBD and surrounding suburbs. The review took the form of a "*high level audit*" of the initial cost-effectiveness analysis report produced for TransGrid and EnergyAustralia by NERA. Ewbank Preece explained that it did not attempt "*to replicate the cost estimating process for the transmission options undertaken by TransGrid and EnergyAustralia".*[32]

Instead it commented only on the "*generic costs*" (for cable, switchgear, transformers etc.) used by TransGrid in developing their network cost estimates. It is notable in this regard that while Ewbank Preece agreed with TransGrid's substation costs estimates – based on the type of substation TransGrid proposed - it cautioned that international experience suggested that TransGrid may have underestimated the cost of the installed cable by around 40%. As it has turned out, TransGrid underestimated the installed cost of the cable by even more than this.

Important drivers for the increased cost of the project have been changes in the conceptual design of the project (underground, indoor substation vs surface, open substation; longer tunnels and cable, gas insulated transformers etc.). This change in the conceptual design of the project would not have been picked up in either the SKM or Ewbank Preece reports as these reports took the "conceptual design" of the project as given and then simply costed the works necessary to deliver that conceptual design. The Ewbank Preece report was even a further step removed since it did not even consider the costs of the various projects but only assessed the "generic" costs of the main constituent parts of the various network project. As such, we think that it may be possible to attach some weight to both reports but only as a verification of TransGrid and EnergyAustralia's assessment of the costs of the notional projects they had defined, but not more than this.

The detailed and accurate costing of each of the network projects is a significant and complex undertaking that would involve extensive discussion with prospective manufacturers and careful environmental and planning assessments. In addition, some of the factors affecting the actual cost of a project would only be ultimately confirmed long after such detailed investigation i.e. when the project is under construction.

It would inappropriate to expect TransGrid to have perfect foresight or to have undertaken a perfectly detailed and accurate costing of all the various network augmentation possibilities. Rather, as with the earlier discussion on the appropriate specification of possible options, the issue to be assessed here is what standard of costing accuracy and rigour is consistent with

[30] Sinclair Knight Merz, 1998. p. 1.
[31] Ibid, p. 1
[32] Ewbank Preece 1999 op. cit., p. 13

"good industry practice" at the Regulatory Test stage when fundamental investment choices are being made.

The MetroGrid project was expected to be one of the biggest single network projects (and almost certainly the most complex) ever undertaken by TransGrid. It presented a number of very complex engineering and environmental challenges that could have been expected. In this context, what standard of cost assessment should reasonably be expected of a prudent operator? Costing the projects more accurately would have required a more detailed analysis to be undertaken before conducting the present value analysis of the various options in the Regulatory Test than TransGrid and EnergyAustralia undertook. However it would be inappropriate to suggest that TransGrid should have been able to develop more accurate cost assessments without first examining the resource and time implications of this.

Dealing first with the resource implications, we know that around 18 months after completing the Regulatory Test, TransGrid increased the estimated cost of their element of the MetroGrid project from $142.5m to $227.5m[33]. This followed the development of a detailed conceptual design of the project; discussions with suppliers of cable, transformers, switchgear and civil works (some contracts had even been let by this time) and detailed route assessments and discussions with planning authorities and environmental regulators. The development of this work no doubt consumed significant amounts of TransGrid's professional and administrative resources partly in developing the conceptual design and partly in evaluating and negotiating contracts with suppliers and service providers.

Developing all five possible network options to the same level of accuracy would have been a significant undertaking. But it certainly would not have meant five times the amount of work since there are scope economies in such analyses. A more robust cost assessment of all five network options at the stage of the Regulatory Test could have been expected to be well within TransGrid and EnergyAustralia's capabilities. We understand that this point is generally accepted in TransGrid – during interviews it explained to ACCC staff that its investment appraisal process has been substantially improved in the recent past by placing greater rigour at the beginning of the process (the Regulatory Test stage).

With respect to the implication of bringing assessment work forward to the time of the Regulatory Test, we note that more than three years passed from the time that a major investment in capacity in the CBD was first formally discussed and the finalisation of the Regulatory Test process in 2000. In fact, consideration at various levels had occurred on the need for a second cable to the CBD more than 10 years before the Regulatory Test. TransGrid was able to develop a much more accurate costing of the MetroGrid project just 18 months after completion of the Regulatory Test. On this measure, TransGrid had time to develop more accurate cost estimates *before* running the Regulatory Test.

It is clear however, that TransGrid faced some significant uncertainties during the Regulatory Test period. Most of this uncertainty related to changes in the basic principles of the Regulatory Test from a "customer benefit" test to a "net benefit" test. Dealing with changes in the Regulatory Test could have diverted management attention during this period, and this

[33] As discussed later, this was ultimately reported to the Board of TransGrid in February 2002, but TransGrid would have been able to obtain an accurate estimate of the revised cost of the project by Mid 2001 since all but one of the major contracts had already been let by this time.

could account, in part, for why a more thorough costing of the various options was not performed.

On the other hand, it could be argued that the accuracy of the costing of the options should have been largely independent of the specific details of any Regulatory Test that TransGrid may have been required to apply. This argument holds that a prudent operator would undertake careful investment assessment as a matter of course, whether or not there was a Regulatory Test process to be conducted. We incline to this view and therefore think that uncertainty about the form and content of the Regulatory Test can not be held up as an impediment to the development of more robust cost estimates at the time of the Regulatory Test.

A final issue to be covered within this sub-section is whether more accurate information on the cost of the network options would have led to a different decision on which network project to build or the order in which the projects should be built. If the decision to build the chosen project was largely insensitive to the cost of the various network options then demanding greater accuracy in the initial cost estimates of those projects, possibly would not have resulted in different investment decisions. TransGrid claims that *"had the Regulatory Test assessment been conducted on the basis of the March 2003 capital cost estimate ... of $235.8m, then the options which rank most highly under the Regulatory Test would still have been those where there was an augmentation to the network first, ahead of cogeneration and/or DSM options".* [34]

We have reviewed the evidence supporting this claim and conclude that the claim, while valid, is misleading. For example, by virtue of the modified n-2 standard and the date that TransGrid decided this standard was to be achieved by (summer 2004), some options such as investing in demand management before a network option, could automatically be excluded from consideration because it would fail to deliver the modified n-2 standard in time.[35]

With respect to TransGrid's second argument that using the March 2003 capital cost estimate of $235.5m, a network option would still have been developed before a cogeneration option, we have recast the numbers used in the model developed by NERA for the Regulatory Test assessment and agree with this conclusion. However, the difference between the most economical network option and the generation options is small. The latest information from TransGrid and EnergyAustralia on the actual cost of the MetroGrid project suggests that it would have been more economic to build a generator *before* the network alternative.

This conclusion is of course subject to the assumption that the costs of all the other network options and generation projects would have been as TransGrid and EnergyAustralia had forecast them to be. As we have set out in this section, there is strong reason to suggest that this would not have been the case. However, the general point stands: the choice of investment project is sensitive to the assumed capital costs and had these costs been more accurately forecast at the time of the Regulatory Test, a different investment decision may well have been made. This conclusion is particularly apposite if more accurate information on the cost needed to bring the network to the modified n-2 standard would have affected the

[34] TransGrid 2003, op. cit., p. 49.

[35] NERA had assumed that only 130 MW would have been available from DSM and since an increment in capacity of 200 MW in the CBD would have been needed, DSM could not be relied upon to achieve compliance with the modified n-2 standard.

decision on how to ensure compliance with the modified n-2 standard by the summer of 2004. This is a key issue and we return to it again in the next chapter.

5.5 Comparison of options

NERA developed the comparative cost effectiveness analysis of the various options. This was done by calculating the present value of the various options discounted at a real discount rate of 12%. Four different scenarios were simulated with different assumptions on the development of generation in the Sydney area. Sensitivities to key assumptions such as capital costs, the cost of capital and demand forecasts were incorporated.

We consider that the cost effectiveness modelling by NERA generally was helpful and that on the basis of the information and assumptions provided in the model, it could be expected to deliver an objective result. However, it would have been possible to obtain a more comprehensive understanding of the relative rankings of the various options with a more sophisticated sensitivity analysis. In particular, more could have been done to take account of different combinations and permutations of sensitivities (e.g. increases in the capital cost of one project compared to decreases in the cost of others, using different discount factors and different demand assumptions).

Furthermore, we consider that the central estimate of the cost of capital used (12%, real) is much too high when compared to the actual Weighted Average Cost of Capital approved by the Commission in the 2000 Revenue control determination – 6.85% real (pre-tax). The effect of using this cost of capital has been to relatively advantage options that involved higher capital expenditure in the earlier years of the evaluation period. However, we have verified that - all other assumptions remaining the same – this would not have altered the ranking of the various options in the Regulatory Test comparison.

6. Assessment of TransGrid's delivery of the chosen project

6.1 Introduction

TransGrid claim a number of "world firsts" in the development of the MetroGrid project. For example the 2002 annual report reports that "*the new 330kV cable ... will be one of the longest of its type in the world*" and "*the substation will be one of the most highly monitored and automated substations in the world*" and "*the scale of the project sees the design and installation of the world's most advanced gas insulated transformers and the first ever substation to have an integrated gas management system*". [36]

Leaving aside whether TransGrid fairly evaluated the economics of such an advanced installation compared to its alternatives - which we covered in the previous chapter - the ACCC will also be concerned to understand whether TransGrid efficiently delivered the project. This chapter sets out the final stage of the three stage prudency assessment described in Chapter 3. The objective of this stage of the analysis is to assess whether the project that was analysed to be the most efficient was indeed developed, and if not whether changes to the initial specification reflect the application of "good industry practice". The analysis in this third step necessarily requires an examination of the factors that caused changes in the project design and/or delivery and assesses TransGrid's response to those factors in comparison to what could be expected of a prudent operator.

The chapter begins with a brief summary of the differences between the project as defined in the Regulatory Test and the actual project that was developed. It then briefly analyses the reasons for the differences. Finally the chapter focuses on describing and assessing how TransGrid responded to the higher cost of the project when this information became known.

6.2 Summary of the differences between the Regulatory Test project and actual project

The project defined in the Regulatory Test bears little resemblance to the project that was actually developed. The initial cost estimate established at the time of the Regulatory Test was $142.5 in 1999 dollars. The Regulatory Test project was due to be commissioned by October 2003. The final cost (also in 1999 dollars) of the actual project is estimated to be $276m excluding variation claims by TransGrid's various contractors and suppliers of $40m. At the time of writing (April 2004) it has not yet been commissioned.

[36] TransGrid Annual Report 2002, pages 25 and 27.

The reason for the differences in the total cost of the project can be attributed to an augmentation in the capacity of the project (bigger cables, bigger and more transformers); and differences in the conceptual design of the project (not related to an increase in capacity) and increased costs of delivering the project. The delay in the development of the project appears to be attributable to a number of factors, some of which appear to have been outside TransGrid's control.

6.3 Description and analysis of differences in the design and cost of the project

There are a number of reasons for differences in the specification and cost of the project between that which was actually developed and the project as specified and costed in the Regulatory Test. We have classified these into two categories: cost increases attributable to increases in the capacity of the project; and cost increases that reflected changes in the design and specification of the project. We have included in the latter category any cost increases attributable to events that occurred in the course of development, such as delays in the approval processes leading to extra costs to speed-up subsequent project delivery. In practice, splitting the increased costs between these two categories is problematic and the analysis and summary presented in Table 6.1 and Table 6.2 represents the best available estimates from analysis and data provided by TransGrid.

6.3.1 Capacity-based cost increases

A description and cost estimate of the different capacity-based increases are set out in Table 6.1 below

Table 6.1: Capacity-based cost increases.

Augmentation	Incremental Cost $m nominal
Transformer rating increase: The original design included two transformers rated at 375MVA. The MetroGrid project now contains three 400MVA transformers (the third transformer is discussed later). TransGrid has estimated that the additional cost to increase the transformer ratings from 375 MVA to 400 MVA relates primarily to a 25% increase in the cooling capacity due to the higher heat load. The reasoning for the increased size of the transformers is that actual demand was greater than projected by EnergyAustralia.	1.0
Haymarket substation third transformer auxiliary power requirements: TransGrid has advised that the inclusion of the third power transformer has resulted in an increase in the size of both the auxiliary power and air-conditioning systems and required additional cabling.	0.5
Haymarket substation additional 330kV switchbays: TransGrid has advised that the decision to order and install two additional 330kV switchbays was based on future load growth and that these additional bays may be required in about 10 years time.	4.0

Increased cable size from 600MVA to 750MVA: The initial cable size was based on a single 600MVA cable. TransGrid claims that due to an increase in demand, this led to the decision to install larger cables in order to ensure that the MetroGrid project has a reasonable life and defers the need for further work in the future.	5.0
Third transformer cost: The original design included two 375MVA transformers. The MetroGrid project now contains three 400MVA transformers. TransGrid has advised that it made provisions for a third 400MVA third transformer because planning studies and projections of load growth indicated that further augmentation would be required in the distant future. This does not include the installation cost of a third transformer. Other costs associated with the third transformer include: ▪ *Additional Plant and Design modifications* - the full cost for these works was $2.2 million, with $0.7 million relating to the third transformer. ▪ *GIS Storage* - the full cost for these works is $06 million, with $0.2 million relating to the third transformer. ▪ *Delays, Disruption and Acceleration* - the full cost is $4 million, with $1.2 million relating to the third transformer.	12.1
TOTAL	22.6

We have attempted to understand precisely why TransGrid decided to substantially increase the size of the MetroGrid project compared to the project defined in the Regulatory Test. In its report "Review of MetroGrid Project – Initial Review November 2003", there was an explanation to the effect that an increase in actual summer maximum demand in the inner metropolitan area compared to the projections in the Regulatory Test analysis "*led to a decision to install a larger capacity cable, in order to ensure that the MetroGrid project has a reasonable life and defers the need for further works in the future*".[37]

We have examined the diversified demand at the time the decision was made to augment the project (between February 2000 and July 2001 when the cable contracts were let). This evidence suggests that for the summer of 1999/2000 the Inner Metropolitan Area Diversified Summer Maximum Demand was above both the EnergyAustralia and NIEIR demand forecasts. However, for the summer of 2000/2001 the demand was in line with the lower EnergyAustralia forecasts. A simple trend analysis on the basis of these two data points and knowledge of the historic demand suggests a trend growth in demand consistent with the NIEIR demand forecast.

The Regulatory Test assessment used the lower EnergyAustralia demand forecast in its base case assessment, but the higher NIEIR forecast was used in a sensitivity analysis. The outcome of this analysis was that for the chosen option, Option 10, there would be no change to the design and specification of Cable 42, but rather that the subsequent investment in the third cable to the CBD would be brought forward by a few years. TransGrid's claim that demand was higher than forecast at the time of the Regulatory Test is correct for 1999/2000 only, and at any rate the trend rate of growth at the time the investment decision was made is entirely consistent with the Regulatory Test forecasts.[38] Furthermore, the Regulatory Test

[37] TransGrid 2003, op. cit., p. 31

[38] As an aside, we note that the evidence of actual demand to-date remains within the range used in the Regulatory Test.

assessment had already taken account of sensitivities in demand forecasts and had not recommended changes to the design of the chosen project in light of higher demand forecasts.

On the basis of this analysis, ACCC staff subsequently requested TransGrid to supply the detailed economic justification for their decision to augment the capacity of the project in 2001. In response TransGrid explained that *"the planning studies that fully confirmed the advantages of a higher cable rating under revised forecast load conditions were completed by January 2001"*.[39]

However, these studies have not been made available to the ACCC. Instead TransGrid provided a report produced on 17 March 2004 which is ostensibly based on the data and model used in January 2001. An analysis of the results presented in the 17 March 2004 report does indeed confirm that it would have been necessary to expand the capacity of the project and to increase the number of transformers in order to ensure that the MetroGrid had a better chance of meeting the modified n-2 reliability standard.

In fact the results presented in this report go further than this and demonstrate that even after the expansion of the capacity of the project, it was still not compliant with the modified n-2 standard that TransGrid had used to justify the investment in the first place. This is a startling conclusion: in effect it says that TransGrid knew before it developed the MetroGrid project, that it would fail to meet the reliability standard on which the investment had been justified in the first place.

ACCC staff put it to TransGrid that its modelling indicated that the MetroGrid project failed to meet the modified n-2 standard. TransGrid did not disagree with this conclusion, but rather suggested that *"the commissioning of the No. 42 works (the MetroGrid project) is consistent with the strategy of moving towards the 'modified n-2' criterion"*.[40] But TransGrid's Regulatory Test assessment was quite clear that the development of the MetroGrid project was about achieving the modified n-2 reliability standard as it had been explicitly defined. If the criterion was simply that the investment should "move towards" the modified n-2 standard then a completely different analysis should have been done.

For example, as discussed earlier, TransGrid rejected a number of investment choices, such as the implementation of 130 MW of DSM before the construction of a new cable, because this would fail to achieve the modified n-2 standard. If the criterion was simply to "move towards" the modified n-2 standard then this investment option – or others like it - should have been chosen first since NERA's analysis showed that implementing DSM before a major network project would have been much cheaper.

In addition, if they knew that the project was going to fail to meet the modified n–2 standard why did TransGrid incur considerable additional expenditure in "fast tracking" the MetroGrid project? It appears that this "fast tracking" was responsible for a large proportion of outstanding contract claims.

[39] TransGrid's reply to ACCC-040317-57-1, ACCC-040107-39-2c, ACCC-040107-39-2d, ACCC-040219-49a, ACCC-040219-49b, 19 March 2004.

[40] TransGrid's reply to ACCC-040326-58-2, 8 April 2004.

TransGrid's explanation of the justification to resize the MetroGrid project was only produced shortly before this report was due to be delivered to the ACCC. The data provided by TransGrid raises fundamental issues about the nature of any prudency adjustment that would be appropriate. But we have not had sufficient opportunity to rigorously analyse or critique their analysis and therefore do not think it is appropriate to draw conclusions on this at this stage.

6.3.2 Design and delivery-based cost increases

Table 6.2 provides a summary of the design and specification-based cost variations of the actual project that have been developed compared to the cost and specification of the project identified in the Regulatory Test.

Table 6.2 Design and delivery-based changes

Design and specification variations	Incremental Cost $m (nominal)
Gas insulated transformers: the original design of the project assumed oiled cooled transformers (costed at $8.4 million). TransGrid claims that obtaining approval for the installation of transformers containing 400,000 litres of oil, with the associated explosion, fire and environmental risks in close proximity to a public walkway and nearby Darling harbour. This also includes other additional plant and design modifications.	6.1
Gas insulated reactors: similar reasoning to that explained above. The estimated cost at the time of the Regulatory Test was $1.2 million.	1.0
Cooling system: the original design was for a outdoor substation, however the Haymarket substation is indoors. TransGrid notes that an indoor substation requires a cooling system to transfer heat generated in the electrical equipment to the outside. Further, TransGrid has decided to install a dry cooling system.	7.0
Additional Plant and Design modification, GIS storage and Delays, disruption and acceleration costs: these costs relate to the two transformers.	4.7
Haymarket substation underground development: the original design assumed that the substation would be constructed above ground, and the 330kV cable would enter the site via an inclined tunnel. TransGrid has advised that the space and project timing would not allow the construction of a vertical access shaft to the tunnel on the Haymarket site, and therefore the solution was to construct a cable basement.	4.5
Haymarket Architectural design: A condition of approval on the DA required a design competition involving independent architects to design the exterior of the substation.	0.5
Other Haymarket work including: Secondary system requirements and changes, increased communication facilities, initial site work for the Haymarket substation, Haymarket substation work and auxiliary power, GIS storage.	11.7
External contracts and consultants: Haymarket substation tender price increases for contracts, TransGrid increased labour costs relating to site inspection design review and final commissioning and testing, engagement of external specialist for design purposes, Siemens and Toshiba additional costs	20.5

due to design variations, compression of work, legal costs.	
Tunnel project work including: increase tunnel length, TransGrid labour and material expenses, contracts and consultants, rebate from EA, tunnel contract and ancillary works, Wattle shift shaft changes.	22.9
Cable project works including: increased route length, cable management system, optical fibre cable, EIS conditions of approval, cable bridge, spares, increased TG labour costs, M5 cycleway, other agency costs, road restoration, program compression, delays and disruptions.	32.5
Cost of Haymarket site (which was allocated in the miscellaneous line item).	9.85
Total	112.3

We have not yet attempted to analyse these cost and design variations in detail to assess the prudency of the unforecast costs.

6.4 TransGrid's response to the increased cost of the chosen project

A core issue in assessing the prudency of TransGrid's expenditure on the MetroGrid project is to assess when TransGrid knew with certainty that the actual cost of the project would be much higher than established in the Regulatory Test and what TransGrid did about it when it found out. One way to assess the prudency of TransGrid's actions is to compare what TransGrid did in response to the cost increases, and what a prudent operator would have done in the same circumstances.

We will first establish the facts on the cost increases and when these became known. The facts as we understand them are as follows:

- In February 2000 the Regulatory Test was complete. For the chosen option, (Option 10) the capital cost to develop the cable from Sydney South to Haymarket and then Haymarket substation was assumed to be $142.5m in 1999 dollars.
- From February 2000 the conceptual design for the project was developed in greater detail and by February 2002 a memo[41] was presented to the Board of TransGrid explaining that the cost estimate for the project was now expected to be $227.5m plus an amount for contingencies. As described earlier part of the reason for the increase was that TransGrid decided to build a higher capacity cable and bigger and more transformers, and part of the increase is due to a miscalculation of the costs of the main elements of the project.
- By the end of February 2002 all the main contracts for the project had been let. On the basis of the dates that the contracts were let (from July 2001) and

[41] TransGrid, 2002 "Supply to the Sydney CBD and Inner Suburbs Project, Revised Project Cost Estimate". File TP/6094. Note to the Board of TransGrid from the General Manager/Engineering, 21 February 2002.

TransGrid's explanation that it realised that it needed a 4 kilometre tunnel rather than a 1 kilometre tunnel just a few months after the Regulatory Test was complete[42] (work on this tunnel was the last major construction contract to be let) it would appear reasonable to assume that TransGrid knew with a high degree of certainty that the project would cost much more than envisaged, within 18 months of the completion of the Regulatory Test.

- From February 2002 to the present there have been numerous cost increases and a few decreases across the full range of activities for the development of the project. The project had not yet (April 2004) been commissioned and we understand that there are some substantial claims against TransGrid (exceeding $40m in total) from contractors and suppliers. At the time of writing, the expected total cost of the project is $276m excluding these claims.

From this account it appears that there was a critical point, around a year to 18 months after the Regulatory Test was complete i.e. from February to August 2001 when TransGrid knew that the project that it had assessed in the Regulatory Test to be the most economic, was now going to cost at least $227.5m or 60% more than originally expected. The obvious question that leads from this is: how did TransGrid respond to this information, and was this response consistent with "good industry practice"?

We know that TransGrid responded to the information by continuing to develop the project without change. In February 2002, a memorandum was sent to the Board of TransGrid informing them of the increased cost, but no decision was sought on whether TransGrid should change course or consider alternative options.[43] To assess whether this response was prudent it is necessary to consider what options were open to TransGrid at this time.

TransGrid put to the ACCC that it had no option but to proceed at this point because it had agreed with EnergyAustralia that the modified n-2 standard would be implemented by October 2003 and therefore the project needed to be developed by this time to deliver that level of reliability. As discussed earlier, we accept that to provide a level of reliability consistent with the modified n-2 standard it would be necessary to augment capacity to the CBD and Inner City by around 200 MW. We have reviewed the alternative investments included in the Regulatory Test assessment and it appears from this that the only possible alternative to the chosen network solution would be to develop a 250 MW OCGT at Haymarket. This was assumed to have a capital cost of $95m (clearly substantially less than the cost of the cable to Haymarket) and in the Regulatory Test analysis it had been assumed to have a total development time of three years – two years for planning and one for construction.[44] So, on the basis of this argument, one possible alternative would be for TransGrid to have canned their proposed project and in its place developed an OCGT at Haymarket.

But there are a number of arguments against this. Firstly, it is not clear that TransGrid could necessarily have developed an OCGT at Haymarket in three years, if at all. Complex

[42] TransGrid, 2004 "MetroGrid Supplementary Report to the ACCC", 18 March 2004, p.37.

[43] TransGrid, 2002 "Supply to the Sydney CBD and Inner Suburbs Project, Revised Project Cost Estimate". File TP/6094. Note to the Board of TransGrid from the General Manager/Engineering.

[44] NERA 2000 op. cit., p. 71.

environmental consents would need be obtained and it is not clear that consent would have been given at all. Secondly a site would need to be found that is large enough to accommodate such plant and gas supplies may need to be reinforced to be able to supply such a large demand. Thirdly, TransGrid has no experience in electricity generation and additional time would be needed for it to develop the capability necessary to deliver such a large and complex investment. Finally, even if an OCGT were to have been built it is not clear that this would necessarily have been the most economical alternative. The economics is assessed not by comparing the capital costs of alternatives at one point in time, but rather on the basis of the present value of that investment and subsequent investments over a significant period of time. To assess this, TransGrid would need to have to re-run the Regulatory Test and re-estimate the capital cost not just of the one project for which it now had much better information, but also for the other five network options. We conclude from this that it would be unreasonable to expect TransGrid to have pursued generation alternatives at this point.

The other possible option open to TransGrid would have been to consider DSM solutions to defer the construction of the cable or a different network project. But as discussed the plausible potential for DSM could be as low as 130MW. This falls well short of the 200MW required to ensure modified n-2 compliance and so we can discount this alternative immediately.

The only remaining option would be for TransGrid to develop one of the other possible network options. On balance we don't think it would have been practical to expect TransGrid to do this at this point. Based on the experience with the project that was developed, producing a detailed design, obtaining the necessary environmental and planning consents and then developing the project could be expected to take more than three years. Besides, it is not clear that developing other network options would *necessarily* have been economically advantageous – this would only have become clear after re-running the Regulatory Test.

This bring us to the conclusion that if TransGrid and EnergyAustralia had no discretion in the decision to implement the modified n-2 standard by October 2003, then they did indeed have no alternative but to go ahead with the project that they had planned to develop, even though they knew that it would be much more expensive than had been assumed in the Regulatory Test.

But TransGrid did have discretion in deciding the timing of the implementation of the modified n-2 standard. TransGrid explicitly told ACCC staff that the date for the implementation of the modified n-2 standard was a management decision. Furthermore, this fits with TransGrid's own logical explanation of the timing of the implementation of the modified n-2 standard i.e. when the network no longer complies with the existing n-1 standard. Therefore the question is whether it was prudent for TransGrid to proceed with a project that it knew would be much more expensive than first planned?

To answer this question we need to know what alternatives were available to TransGrid and what implementing these alternatives would mean for TransGrid's ability to deliver on its statutory reliability obligations. In this regard, TransGrid presented to us load flow modelling that confirmed that if a number of relatively small investments were made, the network would continue to conform to the n-1 standard to, until the summer of 2005. As discussed in Chapter 4, these actions included:

- Uprating of feeders 910 and 911, which increased the capacity to Chullora.[45]
- Installation of reactors at Peakhurst to improve load sharing.
- Establishment of a second Roselle-White Bay-Pyrmont 132kV cable which reduces the loading on the four Chullora-Beaconsfield cables (91A, 91B, 91X and 91Y) when cable 41 is out of service.
- Connection from Bankstown to Greenacre Park. This enables the transfer of two zone substations amounting to about 120MVA from Chullora to Sydney South, which reduces the loading on cable 41 and Sydney North at the expense of increased loading on Sydney South.
- Replacement and upgrade of two transformers at Sydney South substation.
- The development of 200 MVA cables between Kurnell and Bunnerong.

TransGrid and EnergyAustralia have undertaken all of these projects with the exception of the development of the Kurnell-Bunnerong cable. This cable project was included in some options in the Regulatory Test at a cost of around $35m. In its 2004 revenue application, EnergyAustralia indicated that it now proposes to develop this project at a forecast cost of $36.4m. However, as discussed earlier, in response to questions from ACCC staff, TransGrid has suggested that the actual cost of this project is likely to be much higher than estimated in the Regulatory Test since it is likely to require a cable tunnel under Botany Bay rather than simply direct-buried cable on the floor of the bay.

TransGrid also told us that construction of this cable is only likely to defer the need for a major augmentation to the CBD for 1 to 2 years. On the basis of this information, it may therefore have been uneconomic for TransGrid/EnergyAustralia to have developed the Kurnell-Bunnerong cable in order to defer the MetroGrid project by only 1 to 2 years. This suggests that there was little that TransGrid could do to defer the development of the MetroGrid project beyond the summer of 2004, and that it would be needed by this time not just to meet the modified n-2 standard, but also the existing n-1 standard.

However, this conclusion necessarily assumes that there is no potential to implement DSM measures. As discussed, the Regulatory Test had assumed 130 MW of DSM. Indeed, the option that TransGrid has pursued involves 100 MW of DSM to be implemented from 2008 to 2012 before the commissioning of a second cable to the city in 2014.[46] TransGrid and EnergyAustralia obviously accepted this argument since this was the option they proposed in the Regulatory Test and have since pursued.

So, what if the 130 MW of DSM projects were brought forward – from after the MetroGrid project (as had been assumed in the Regulatory Test) to before the MetroGrid project? Would the networks serving the CBD and Inner City still be n-1 compliant? To answer this question with certainty it is necessary to make assumptions on precisely where in the network this

[45] The ACCC has been advised that its impact varies with system conditions but typically results in about 100MW increase with cable 41 in service up to 160MW (2*80MW) with cable 41 out of service. This work was critical as it enabled better utilisation of the capacity of #3 and 4 transformers at Sydney South, effectively increasing the 330/132kV capacity to the inner metropolitan area.

[46] NERA had assumed 100 MW rather than 130 MW of DSM because it argued that the last 30 MW would not in fact defer the second cable and so it would be pointless implementing it.

reduction in demand is likely to occur and then to run load flow simulations to calculate the impact on the ability of the network to deliver power at the time of peak demand under various contingencies.

We have not done this, but have instead used the information provided to us by TransGrid on the effective capacity of the networks serving the CBD and Inner City assuming the outage of the largest single supply – i.e. Cable 41 (1700MVA) and the expected diversified peak demand in the CBD and Inner City network (1650 MVA). This shows that in 2004 the network was able to meet the n-1 criterion with 50 MVA to spare (1700 MVA – 1650 MVA). If we now assume that demand is growing at 3% (this is the higher forecast growth rate produced by NIEIR for the Regulatory Test), then (roughly) an additional 3% of 1470 equals 44 MW needs to be added to the capacity of the networks serving the CBD and Inner City every year to ensure that the network remains compliant with the n-1 criterion.

On the basis of this calculation, reducing/shifting peak demand by 130 MW in the inner metropolitan area through DSM measures should ensure that the network remains compliant with the existing planning standards until 2008[47]. It is important to note that this amount of load shifting excludes any reduction attributable to power factor correction through network investment in reactive devices by TransGrid and EnergyAustralia and excludes any interruptible supply contracts or distributed generation contracts. However, to err even further on the side of caution, for argument's sake we will reduce the deferment from 2008 to 2006. This analysis, suggests that TransGrid did in fact have the ability to defer the implementation of the MetroGrid project by a significant period and still maintain the existing reliability standard of the network.

However, this argument hinges critically on the assumption that the 130 MW of DSM is indeed realistic and that TransGrid could have been expected to bring this level of DSM about. On the first issue, we have explained why we accept NERA's arguments on this. As discussed, TransGrid evidently did as well since this assumption underlies the option it chose to develop. But it is important to consider the factors that may in fact constrain the implementation of DSM and the extent to which TransGrid can be held accountable for its implementation. In this regard we note the following:

- TransGrid's main customer within the inner metropolitan area is EnergyAustralia. Other than a few large industrial customers, TransGrid has no direct relationship with the customers who would need to implement the DSM measures. This means that if it wanted to bring about many (but not all) DSM options it would need to encourage the distribution network operator in Sydney i.e. EnergyAustralia to take action on its behalf;
- DSM has been studied in the electricity industry in Australia and internationally over many years. It is now clear that the implementation of such measures requires initiative and co-ordination by network service providers and usually requires financial incentives. The combination of retail tariffs which generally reflect average costs rather than marginal costs and the (generally) very low

[47] 180 MW of available reserve (50 MW existing reserve plus 130 MW DSM) divided by 44 MW required additional reserve per year, and rounded down to the nearest whole number is 4 years. Four years on from 2004 is 2008.

elasticity of electricity demand means that it is necessary for network companies to provide direct financial incentives in order to ensure the take-up of DSM.[48]

- The development of DSM by TransGrid and EnergyAustralia would have required the development of capabilities and resources that TransGrid and EnergyAustralia did not have in 1999. This would have taken time to achieve.
- Under the current regulatory incentive structure for capital investment, TransGrid and EnergyAustralia have very weak incentives to implement DSM – by comparison network assets earn the regulated rate of return. This issue has long been recognised.

In view of these factors we have considered whether it could reasonably be expected that TransGrid and EnergyAustralia could have deferred the development of the MetroGrid project through the implementation of the DSM measures. On balance, we consider that this would have been a reasonable expectation. In particular we note:

- TransGrid and EnergyAustralia had assumed it was possible to achieve 130 MW of DSM in view of their acceptance of NERA's analysis and their choice of Option 10 – which incorporates DSM – as the chosen option;
- TransGrid and EnergyAustralia have a common shareholder. This, combined with the long tradition of joint planning provides a strong relationship between both organisations and leads us to conclude that it would be reasonable to expect TransGrid to be able to deliver the DSM program in concert with EnergyAustralia; and
- TransGrid and EnergyAustralia operate large businesses and need to manage many complex interactions with interested parties and customers. Both organisations possess sophisticated administrative and commercial capabilities. We see no reason that these could not be readily applied to the implementation of significant demand management programs.

This leads us to conclude that, had they chosen to, TransGrid and EnergyAustralia could have deferred the implementation of the modified n-2 criterion from the October 2003 implementation date specified at the time of the Regulatory Test, while still ensuring compliance with their existing planning standard. This action would have been consistent with TransGrid's own logical consideration in assessing the timing of the implementation of the MetroGrid project during its Regulatory Test assessment.

[48] As discussed NERA costed 130 MW of demand reduction at an average price of management at $888/kW.

7. Assessment of the prudency of TransGrid's investment in the MetroGrid project

7.1 Introduction

Chapters four and five reviewed TransGrid's assessment of the need for investment and how it evaluated and then chose the project that it argued was best suited to meet the investment need. Chapter six assessed the actual expenditure on the actual project compared to the expected expenditure on the project defined in the Regulatory Test.

This three-part review provides the factual and contextual base for consideration of whether any part of the investment is inefficient and hence should be excluded from the Regulatory Asset Base. The chapter starts with a brief revision of the key conclusions of the three stage assessment. It then discusses possible ways to make a prudency adjustment.

7.2 Conclusions from the three stage assessment

7.2.1 Need for investment

The key conclusions of this stage of the assessment are as follows:

- TransGrid and EnergyAustralia's analysis that a significant investment of around 200 MW or more was needed to bring the networks in the CBD and Inner City to the proposed modified n-2 standard seems reasonable.
- TransGrid and EnergyAustralia's justification for the timing of the implementation of the revised standard, i.e. when the network no longer satisfied the existing standard, seems logical and consistent with good industry practice.

7.2.2 Assessment of preferred project

- It may be possible to develop many more than the 13 options assessed in the Regulatory Test. But there is no reason to believe obviously plausible alternatives were excluded.

- The assessment of the scope for DSM by NERA appears appropriate, although we consider that NERA's estimate of the potential for demand side reduction may be considered to be a plausible minimum.
- The evaluation of generation alternatives to network investment appears to be objective and robust. However we understand that there is now significant doubt about the potential for an OCGT within the CBD. TransGrid and EnergyAustralia should have investigated the option of locating a generator in the CBD in greater detail in order to obtain greater certainty on this option at the time of the Regulatory Test assessment.
- The quality of the analysis of possible network options by TransGrid was not fit for purpose. The actual project that was developed bears very little resemblance to the conceptual design that was specified and costed in the Regulatory Test.
- We disagree with TransGrid's view that it would not have been possible to develop a far better specification of the project before the Regulatory Test was complete. TransGrid has recognised the need for a more refined analysis and costing of projects at the time that fundamental investment decisions are being made.
- We believe that the accuracy and rigour of TransGrid's costing of the network projects – at the Regulatory Test stage - was below the standard of "good industry practice". In developing the detailed conceptual design of the chosen project after the Regulatory Test, a very significant number of alterations were made to the project, particularly the route length and specification of the cable trench and tunnel; the design of the Haymarket substation and the insulation of transformers. TransGrid explained to ACCC staff that the need for these changes was self-evident "particularly in terms of finding a cable route and accommodating a major substation in one of the busiest and most heavily utilised precincts in Sydney". We can find no convincing reason why TransGrid was not able to take account of these issues before the Regulatory Test comparison was performed.
- The cost-effectiveness analysis conducted by NERA appears to be objective.

7.2.3 Development of actual project

The key conclusions from this stage of the assessment are as follows:

- TransGrid knew with a high degree of certainty that the project would cost much more than envisaged (around $227m compared to $142m) around a year to 18 months after the Regulatory Test was complete.
- TransGrid could have deferred the implementation of the modified n-2 criterion from the October 2003 implementation date specified at the time of the Regulatory Test, while still ensuring compliance with their existing planning standard.

- By bringing forward investment in the DSM program specified in the Regulatory Test assessment of the chosen option, TransGrid would have been able to defer investment in the MetroGrid project to ensure the continued compliance of the network with the existing n-1 standard until 2006 and potentially much later than this. This action would have been consistent with TransGrid's own logic for assessing the timing of the implementation of MetroGrid.
- Extending the compliance of the network with the existing planning standard would have provided an opportunity to revisit the Regulatory Test analysis to develop a more accurate specification of the network options and their costs in light of the revealed information. We think that when it became known to TransGrid that the Regulatory Test decision was based on fundamentally flawed data, it would not be unreasonable to expect that TransGrid should have done this.
- TransGrid's explanation of the justification to resize the MetroGrid project was only produced shortly before this report was due to be delivered to the ACCC. The data provided by TransGrid raises fundamental issues about the nature of any prudency adjustment that would be appropriate. But we have not had sufficient opportunity to rigorously analyse or critique their analysis and therefore do not think it is appropriate to draw conclusions on this at this stage.

7.3 Consideration of a prudency adjustment for the MetroGrid project

The summary above has established our concern with the rigour and robustness of the analysis of the network options included in the Regulatory Test, and how TransGrid responded to the flaws in its earlier conceptual design and cost assessments when they became known. The issue is whether this is likely to have led to inefficient investment decisions, and if so, the value of the inefficient investment that should be excluded from the Regulatory Asset Base. This sub-section covers this.

Before exploring this further, it could be argued that it is unnecessary even to consider the efficiency of the expenditure that was made, and rather that simply any positive difference between the capital amount determined in the Regulatory Test and the amount actually spent should be excluded from the RAB. The basis of this argument is the Commission's 2000 TransGrid revenue cap decision, in which the Commission stated that it would "*roll into the asset base those costs that were identified in the Regulatory Test assessment but not any cost over-runs incurred during construction.*" On this basis of this argument, the amount that the ACCC should allow would be $142.5m. This would mean excluding from the RAB an amount of between approximately $133m and $274m (before adjustment for inflation), based on an estimate of the total (nominal) cost of the project of between $276m and $316m.[49]

[49] The difference reflects the provision for unsettled claims from TransGrid's contractors and suppliers.

However, the ACCC is required to ensure that such an approach is consistent with its Code obligations (to ensure a fair and reasonable risk adjusted return on efficient investment). This approach necessarily assumes that the difference between the total cost of the project and the amount specified in the Regulatory Test is attributable to TransGrid's inefficiency in the development of the chosen project i.e. it necessarily assumes that the assessment of the efficient project (and its cost) in the Regulatory Test was the "right" answer.

However, throughout this report we have pointed to weaknesses in the analysis of the chosen project in the Regulatory Test. Therefore we have no reason to believe that the Regulatory Test estimate of the cost of this project (or indeed even the choice of project) represents efficient investment. Therefore there is no reason to attribute all of the difference between the Regulatory Test cost estimate, and the actual cost, to inefficiency on TransGrid's part and therefore we have not pursued this approach further.

We therefore need to return to the central problem of determining whether TransGrid's decisions were imprudent and if so, the amount of the cost of the investment to be excluded from the RAB. In our view, the problem boils down to assessing what TransGrid did, around 18 months after the completion of the Regulatory Test, when it knew that the actual cost of the project was likely to be at least $227.5m plus contingencies compared to the amount determined in the Regulatory Test of $142.5m plus contingencies.

This first issue to consider is whether TransGrid in fact had any choice as to how it should respond to this information. TransGrid justified the initial date for the implementation of the MetroGrid project on its calculation of when the network would no longer be compliant with the existing planning standards. We also know that on the basis of a number of actions that TransGrid and EnergyAustralia undertook, as well as the implementation of demand management measures which it did not undertake, it would have been possible to maintain the existing n-1 planning standard until at least the summer of 2005/6 and possibly considerably later than this.

By bringing the DSM program forward, TransGrid would have been able to extend the compliance of the network with the existing n-1 standard thus deferring the need to comply with the modified n-2 standard by at least two years. Using TransGrid's logic for the timing of the implementation of the modified n-2 standard, it would therefore not have been necessary to implement the modified n-2 standard until two years later. This would have created a window of opportunity to reassess the possible investment options to take account of the new information. We consider that in the circumstances, this is the action that a prudent operator could have been expected to follow.

In light of this critical conclusion and having regard to the approach outlined in Chapter 3, we need to assess the difference in the hypothetical investment that would have resulted if the analysis was re-done, compared to the investment that TransGrid and EnergyAustralia actually undertook. This would amount to re-running the Regulatory Test using up-to-date information and re-constructing the existing investment options and possibly creating others as well. It would also mean re-considering the conceptual design of each of the projects in each investment option and finally costing each project and performing the cost minimisation analysis. This would be a mammoth undertaking. Completion of this task in the context of the current revenue cap decision is completely beyond the scope of this report.

We have sought a short-cut through this by adopting the simplifying assumption that after the hypothetical re-examination of options that a prudent operator would have pursued, that Option 10 (the chosen option in the Regulatory Test) would have remained the preferred option.

On this assumption, the determination of the amount of TransGrid's total investment in the MetroGrid project to be excluded from the RAB is therefore given by the difference between the present cost of Option 10 as initially envisaged, compared to the present cost of Option 10 with the investment in DSM brought forward, before the investment in Cable 42 and Haymarket. This difference represents the value of "inefficient" investment.

It should be noted that the re-ordering of investment choices does not affect the magnitude of the investment: exactly the same total MVA capacity is added and exactly the same total expenditure is made. But, by re-ordering the timing of the investments, the net present cost of both options, discounted at the cost of capital, is different.

The re-ordering of the DSM and investment in Cable 42 and Haymarket substation is consistent with our view set out in greater detail earlier that the implementation of DSM would have been able to defer the development of the second cable to the CBD for at least 2 years while ensuring that the existing n-1 standard was maintained.

In conducting this analysis we have been careful to ensure that the information used in this calculation reflects the information available at the time that the analysis and decisions would have been made (approximately July 2001). This reflects the view that prudency assessments should take account of information that was known when decisions were made rather than back-calculation using current data. We have set out below precisely the assumptions on the key inputs:

- **Discount rate:** NERA had used a real discount rate of 12% real as its central estimate. This is considerably higher than the rate that TransGrid appear to have used in its own internal investigations (for example the analysis of the Kempsey-Coffs Harbour project used a discount rate of 7%). We have used a rate of 6.85%. This is consistent with the pre-tax real WACC determined by the Commission in the 2000 network revenue cap for TransGrid. This information would have been available in mid-2001.
- **Cost of DSM:** We have used an average cost of $888/kW. This is based on the analysis undertaken by NERA and included in the Regulatory Test assessment. However it differs from the average cost of $1100/kW assumed by NERA, as we believes this average cost was incorrectly calculated. This is discussed in greater detail in Chapter 5.
- **Scope for DSM:** We have assumed that 100 MW of DSM is implemented. This is somewhat less than the available DSM of 130 MW assumed by NERA, but is consistent with the assumed inclusion of DSM in Option 10. An additional justification for the use of 100 MW is based on the amount of capacity needed to defer the implementation of the network solution by a full year. Assuming a growth rate of around 3% (roughly the same as the 2.9 assumed by NIEIR) an additional amount of 50 MW is needed every year to defer the need for a second cable to the CBD by one year, based on the 2004 summer peak load of 1650

MVA. Therefore 30 MW of DSM capacity would not defer the investment by a full year, and so we have not included it in the calculation.

- **Timing of investment in DSM and network projects:** For the revised Option 10, we have assumed that the investment in DSM would begin when TransGrid knew that the project would cost much more than envisaged (i.e. the year beginning June 2001). The investment then follows each year after this as originally envisaged. For the investment in Cable 42 and Haymarket this is simply deferred by two years so that the investment starts in the year beginning June 2001 rather than the year beginning June 1999.
- **Capital cost of network projects:** For the capital cost of the first network investment (in Cable 42 and Haymarket) we have used the estimate of $227.5m. As discussed, this number was reported to the Board of TransGrid in February 2002, but it is clear that this number or close to it would have been known by around the middle of 2001. We have assumed that the profile of annual expenditure is unchanged so we have simply augmented the annual expenditures pro-rata in each year so that the total expenditure over the period of the project equates to $227.5m. We have made a similar adjustment to the investment by EnergyAustralia. Revised cost information was not available from EnergyAustralia in the same way as it was for TransGrid. So, for want of a better assumption, we have assumed that a closer examination of the network investment by EnergyAustralia would have revealed roughly the same mis-calculation as was the case for TransGrid. Using this assumption gives a capital cost for the EnergyAustralia investment of $68m.[50]
- **Demand forecasts:** We have used the same base case assumptions used by NERA in the Regulatory Test – i.e. demand forecasts based on EnergyAustralia estimates. However, to be conservative our assumptions on the scope for deferring network investment used the higher NIEIR forecasts. As discussed earlier, the use of the EnergyAustralia assumptions here would have resulted in an even longer deferral of investment in Cable 42 and Haymarket than we had assumed.

We have recorded these assumptions in a copy of the spreadsheet models NERA developed for the Regulatory Test. The calculation in this model delivers a net present cost of the original Option 10 of $218m, and a net present cost for the re-ordered Option 10 of $182m, giving a difference of $36m in 1999 dollars. Accordingly, if the prudency adjustment is to be made on this basis, the amount that TransGrid and EnergyAustralia should record in their RAB at the end of the current regulatory period would be in total $42.7m (in 2004 dollars) less than the amount that would be calculated if no prudency adjustment was to be made.

It should be noted that this calculation of the prudency adjustment rests on the view that TransGrid could and should have deferred the implementation of the MetroGrid project when it knew that it would cost much more than first expected. This does not challenge the

[50] The actual cost of EnergyAustralia's MetroGrid investment is, we understand, currently estimated at $92m.

planning standard that TransGrid chose to adopt, but does challenge the date that it chose to implement it by.

However, it could be argued that this is inconsistent. Specifically if could be argued that if the ACCC should not judge the appropriate planning standard to be adopted, so it should also not judge the timing for the adoption of any change to the standard. On the other hand, the argument that TransGrid should have exploited the window of opportunity to defer the change to the new standard, is consistent with the logic on the timing of the MetroGrid project that TransGrid had produced to justify the development of this project by October 2003. On balance, we incline to this argument and therefore suggest that a prudency adjustment of $42.7m as described above is plausible.

Finally, we note that there may be a number of ways to determine a prudency adjustment for the MetroGrid project. The prudency adjustment proposed in this report is based on a sequence of logical steps and computational assumptions. Underlying the analysis is a number of weighty assumptions on available technologies and their cost and assumptions on the ability of TransGrid and EnergyAustralia to implement those technologies. We have done this in lieu of a more objective and comprehensive assessment that could be achieved by completely re-running the entire Regulatory Test. But this would be far beyond the scope of this report.

However, we would caution that even if the entire regulatory test was re-run, the the level of "inefficient" investment (and hence size of prudency adjustment) would still not be knowable with absolute certainty. It will always be affected by a number of subjective judgements no matter how precisely alternative projects are specified and costs estimated. We therefore suggest that any decision by the ACCC on a prudency adjustment should be informed by the facts of the case, but that the ACCC may more appropriately take a broader view including consideration of the impact of any prudency adjustment on investment incentives in the long term.

8. Reports, memos and notes cited in this report

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