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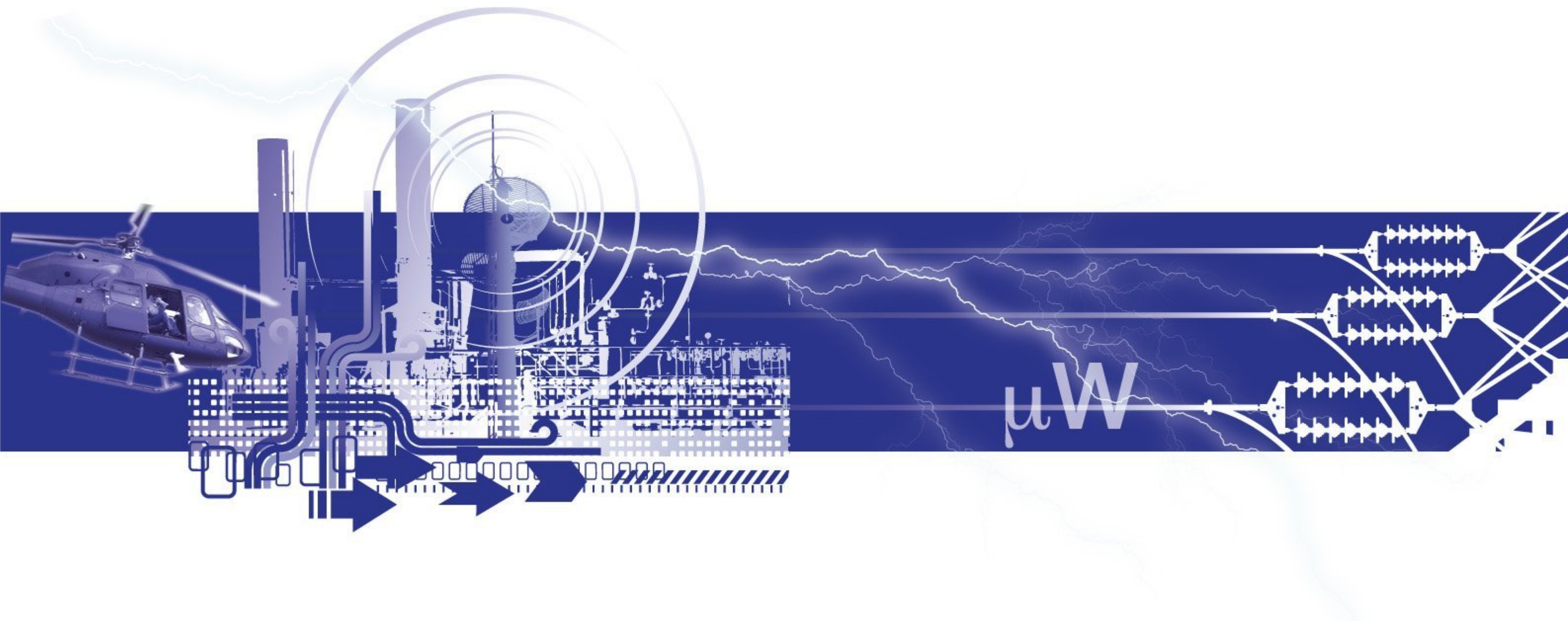

Commentary on Victorian Electricity Distribution Network Service Providers Distribution Determination 2011-2015 (Draft Decision) June 2010

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by
Paul Barnfather & Andrew Birch

Summary

This report provides a commentary on the findings contained in the Victorian Electricity Distribution Network Service Providers Distribution Determination 2011-2015 (Draft Decision) June 2010.

Nuttall Consulting was engaged by the AER to provide technical advice on the Victorian Distribution Network Service Providers' (DNSPs) proposals, including the development of a replacement capital expenditure forecasting model.

This report comments on the findings contained in the Nuttall Consulting report "Victorian Electricity Distribution Revenue Review", dated 4th June 2010. Specifically this report reviews the observations relating to zone substation plant replacement contained in section 6.3 of that report.

CitiPower's proposed investment plan in this area was developed through a trial project using EA Technology's CBRM process and models. The use of CBRM methodology to forecast required asset replacement was analysed in detail by Nuttall Consulting. They stated that they *"see no reason to consider [CBRM] is not appropriate for this purpose"*. Nevertheless, the consultants make a number of observations relating to the CBRM model in terms of:

1) Challenges to the input data and assumptions
2) Questioning the outputs produced by the CBRM model, on the basis that the consultants' own model produces a different result

This report aims to address the above concerns and concludes that the input data and assumptions used by CitiPower are reasonable and justified, based on the available information. Furthermore, this report discusses why it is not unexpected that the two models would produce a different result.

Contents

1 Background

The Victorian Distribution Draft Determination was published by the Australian Energy Regulator (AER) on 10th June 2010. The draft determination applies to CitiPower and four other Victorian electricity distributors.

EA Technology Limited completed a trial CBRM project with CitiPower in February 2009 for the purpose of supporting CitiPower's submission to the AER. The project scope included power transformers and high voltage switchgear.

Subsequent to this trial, Powercor independently applied the CBRM methodology to its power transformer and high voltage switchgear assets.

The AER engaged Nuttall Consulting to review CitiPower and Powercor's proposals and to develop a replacement capital expenditure forecasting model *"similar to those applied by OFGEM"*. The resulting model is referred to as the Repex model and is documented in the Nuttall Consulting report "Victorian Electricity Distribution Revenue Review", dated 4th June 2010. This model appears to be similar in operation to models used by Parsons Brinckerhoff in the UK as part of recent UK Distribution Price Control Reviews. This is the first Australian determination that has used this particular model.

2 CBRM observations

The operation of the CBRM model is documented in the EA Technology report number 6345 "Trial Application of Condition Based Risk Management with CitiPower - Application to Primary Transformers & 11/6.6kV Switchgear". It is not intended to subject the CBRM methodology to further analysis here.

However, Nuttall Consulting made a number of specific observations relating to the implementation of CBRM by CitiPower in their report. These observations will be addressed in this section.

2.1 Validity of failure rates used in the model

Nuttall Consulting challenged the equipment failure rates used in the model. One of the strengths of the CBRM methodology is that it makes underlying assumptions and factors explicit. This enables any assumptions to be openly challenged, and we believe that it is right and proper that Nuttall Consulting should do so as part of the evaluation of CitiPower's regulatory submission.

In reference to the calibration of the model, on page 112 Nuttall Consulting challenge the failure rate used in the model, stating *"The issue in our opinion is why [EA Technology] did not determine that a rate below the general international rate was more appropriate, given the recent 5-year history."*

The failure rate used for high voltage switchgear was 0.13% per annum. We are not aware of any internationally published failure rates against which to compare this figure. However, in EA Technology's experience the average failure rate for comparable assets in recent CBRM studies is 0.49%. The rate used by CitiPower is less than a third of this average rate.

For power transformers, the CIGRE International Survey on Failures in Large Power Transformers in Service concluded that the overall failure rate for power transformers with tapchangers not less than 20 years old was 1.5-2%. The higher figure is in line with EA Technology's experience of rates observed in previous CBRM studies for similar assets. The failure rate used in the CitiPower transformer model is 0.5%, i.e. between one quarter and one third of the published general international rate.

We note that the same low failure rate has been used by Powercor in the preparation of their CBRM models for their transformer population.

The above rates represent the expected likelihood of the *permanent unavailability of an asset i.e. a situation which would necessitate its replacement*. This includes catastrophic failures. The rates used in the CitiPower model are considerably lower than comparable international rates. We accept that information on CitiPower's actual historic failure rate is sparse, although this is also a reflection of CitiPower's hitherto reliable asset base. Nevertheless, the models make use of rates many times below the average.

Therefore the basis on which Nuttall Consulting suggest the failure rates used in the model should be "more appropriate" is unclear.

2.2 Combination of age and condition Health Indices to give a final Health Index

On page 110, the Nuttall Consulting report gives an example to illustrate the perceived deficiencies of combining of Health Indexes (HIs).

It is believed that the transformer discussed is a 10MVA 22/6.6kV transformer in an urban location. The final HI for the transformer given through CBRM is 7.2, and the transformer is recommended for replacement in the next 5 years. The final HI is calculated by combining the Age HI, Dissolved Gas Analysis (DGA) HI and Oil Condition (OC) HI and applying a transformer condition factor to give a final HI. In this particular example the HIs were:

Age	5.5	This is the maximum Age HI allowed by the model, This reflects the assumption in the model that age alone does not indicate end of life. The transformer was installed in 1938 and is 72 years old.
DGA	4.3	DGA results show increasing gas levels consistent with an ageing transformer.
OC	3.2	This result shows the presence of moisture and acidity as well as breakdown strength. It also includes a factor to correct the HI due to oil reconditioning that took place in 2002.

These three HIs were combined to give combined HI of 6.3. Finally, a transformer condition factor based on observed condition was applied to give a final HI of 7.2. EA Technology maintain that, based on the available information, this final HI is representative of the condition of the transformer and that it has indeed reached the end of its useful service life.

The above example serves to illustrate the effectiveness of combining multiple measures of condition into a single HI; by any individual measure, the transformer might appear to have some service life remaining. It is only by considering all relevant factors (age, observed condition, measured condition, expected service life, ageing rate, manufacturer type history, etc) that an accurate indication of remaining life can be obtained.

2.3 The use of factors in addition to measured condition to modify remaining asset life

Nuttall Consulting comment on the use of factors in the CBRM process on page 110 stating *“it is not clear why these factors have a significant influence on the predicted remaining life over the actual condition information obtained through testing”*.

Condition measurement through testing will generally identify that a specific problem has occurred, or is about to occur. It can therefore be an excellent indicator of remaining life where the degradation and subsequent failure mode is well understood. Nevertheless, condition information alone does not necessarily provide the most accurate long-term forecast of remaining life.

For example, consider an asset that is known to be prone to corrosion damage. If such an asset is placed in a corrosive or hostile environment, it is prudent for an asset manager to plan from the outset that the asset will have a reduced service life. Such a prediction can be made well in advance of corrosion problems being detected via condition information.

CBRM models use multiple sources of information to forecast remaining service life as reliably as possible. In addition to direct measurements to objectively measure asset condition, it benefits from subjective observations made by asset managers and field staff.

These observations are expressed as factors within the model to quantify subjective observations and apply them across large numbers of assets. In some cases, such as the example described above, these factors may well exert considerable influence over the predicted remaining life. In other cases, measured condition information will dominate. As with all CBRM factors, these are shown explicitly in the *Calibration* section of the model and can be inspected, challenged and modified if required.

3 Comparison of replacement models

3.1 Repex methodology

The Repex model used by Nuttall Consulting is probabilistic and uses "*age as a proxy for the many factors that drive individual asset replacement".* The model is similar to the standard age-based asset survivor model that has been used extensively by Ofgem and its consultants in a number of previous UK distribution price reviews. Both models are used to forecast the volume of asset replacement for each network operator.

The Repex model uses a coarser granularity than the Ofgem model; distribution assets are broken down into 11 categories, compared with the 68 asset classes used by Ofgem. The Ofgem model also includes benchmark data from all UK network operators. As this is the first time the AER has used the model, it is unclear if the results produced in this determination have been benchmarked against other comparable utilities. The relative simplicity of the Repex model appears to be intentional and reflects the limited availability of data, as Nuttall Consulting state *"This approach allows a common framework to be applied without the need to be overly intrusive in data collection and detailed analysis of the asset management plans"*.

The inputs to the Repex model are: asset age profile, expected asset life and previous replacement expenditure. The model then calculates an implied asset life for the previous regulatory period and an implied life for the forecast period. The model does not include any reference to asset condition, and makes the implicit assumption that the replacement programme in the previous period was appropriate and efficient.

3.2 Comparison of the outputs from Repex and CBRM

On page 112, Nuttall Consulting state that, "*given the significant increase in replacement needs forecast through these models, we do not consider that CitiPower has adequately demonstrated that they are fit for purpose".* In addition, the Repex model found an *"apparent pre-mature timing for asset replacement"* in the CBRM output.

It could be inferred from the above that the forecast increase in replacement activity produced by the CBRM model is problematic and creates an apparent conflict with the replacement programme determined by the Repex model. It is important to recognise that, given the differences in the way the models operate, such a discrepancy should not be unexpected.

The Repex model attempts to determine the appropriate level of investment for the next regulatory period based on what was invested in the preceding period, taking into account the expected changes in asset age from one period to another. The determined level of investment will therefore be correct if and only if the level of investment in the previous period was also correct. Indeed, Ofgem themselves state that their similar model is designed to answer the question "*Are volumes of replacement being forecast by the [network operator] consistent with what has been done in the past or with what industry as a whole is planning to do in the future?"*

By contrast, the CBRM model uses future asset condition as the primary driver for asset replacement. The risk and present-value analysis then determines whether and when replacement investment is justified in financial terms. This enables the least-cost investment programme to be determined for a particular asset class.

The result is that where the risk carried by a group of assets is found to be excessive (typically in a high opex environment), the CBRM model will recommend increased capital investment in order to bring the overall cost down. Where the risk is too low (such as might be found in a high capex environment), network investment will be constrained. The power of this approach is that under- or over-investment will be recognised and addressed in a timely manner, enabling network operators to deliver their service obligations at the minimum overall cost.

In the UK, Ofgem recognise that the age-based asset survivor model does not necessarily identify the most cost-effective investment plan; rather, it *"provides a robust starting point for discussions on appropriate levels of asset replacement*". In recognition that asset condition information may influence the final outcome, Ofgem state that, where the identified level of investment is higher than that produced by their model, *"[network operators] must provide a high standard of information based on robust condition based assessment or other network drivers"*. We believe that CBRM is fit for purpose in this respect.

CitiPower are tasked with responsibly managing an ageing asset base and have done so with historically low levels of asset replacement activity. In Nuttall Consulting's words, *"We do accept however that the aging of the network is imposing greater needs on the business, above those faced in the current period."*

We believe that the output from CitiPower's CBRM models supports this view and correctly identifies the necessary investment to effectively address this matter during the next regulatory period.

4 Summary

CBRM uses current and future asset condition as the primary driver for asset replacement. While an age-based model undoubtedly provides a robust starting point, there is a considerable risk in relying solely on this approach: the need for increased asset replacement may not be identified until assets actually begin to fail, resulting in significant increases in costs and customer disruption.

We believe that it is incumbent on a network operator to responsibly plan for such eventualities and maximise the use of condition information in planning future asset replacement strategies. The CBRM models incorporate such information and have been effectively used by utilities around the world to identify the optimum investment plan to manage and plan for the replacement of assets.

CitiPower have implemented a comprehensive, detailed and robust CBRM process to provide the high standard of information necessary to determine the most appropriate level of required investment. We therefore believe that the levels of investment identified using this process, based on the available information, are both prudent and justified. In our view, the proposed programme represents the lowest-cost investment plan to adequately manage the replacement of assets over the next regulatory period.

Appendix 1 CVs of Key Team Members

Paul Pschierer-Barnfather

Paul Pschierer-Barnfather joined EA technology as a Principal Consultant in 2008. He was formerly Director of Electrical Services at the New and Renewable Energy Centre (NaREC) in North-East England, where he was responsible for their Ultra High Voltage Testing Facility (formerly the British Short Circuit Testing Station). Paul previously worked for VA Tech T&D in Austria as Technology Coordinator, being responsible for the portfolio of corporate research projects. He began his career in the electricity industry with Northern Electric, where he worked as a High Voltage Systems Planner and then as Distribution Strategy Manager.

Qualifications:

B Eng (Hons) 1st class in Mechanical Engineering with Electronic Systems from Brunel University

Experience and Skill base

- Management and business development of commercial high-voltage test facility in accordance with ISO17025
- High voltage testing and measurement techniques
- High voltage equipment failure investigation and reporting
- Representation at specialist CIGRE working groups (including substations, networks and transformers)
- Management of corporate R&D portfolio
- Due diligence, business spin-out and business acquisition
- Securing sources of research funding, including government grants and venture capital
- Development and application of new technologies for large electrical systems, including superconducting fault-current limiters, power electronics and active network control
- Development and deployment of computer-based systems for investment planning, project control and Distribution Price Control submission
- High voltage system design
- Electrical distribution field operations including maintenance, fault-finding, repair and construction

Language Skills

English, German

Other information

Associate member of the Institution of Engineering and Technology

Andrew Birch

Andrew joined EA Technology as a senior consultant in the Strategic Asset Management team in 2010. Prior to moving to the UK Andrew was a Transmission Planning Engineer at Energex, (Energex is an Australian DNO servicing South east Queensland), where he was responsible for undertaking power system studies, developing investment proposals to address network limitations and seeking business approval in a regulated environment. Andrew started his engineering career with Queensland Rail (QR) as a Power Systems Engineer where he was involved with HV transformer testing, acceptance testing of locomotives and substation earthing.

Qualifications:

B Eng (Hons) in Electrical and Electronic Engineering from James Cook University
Graduate Certificate in Electricity Supply Engineering from Queensland University of Technology

Experience and Skill base

- Power system analysis
- Economic options analysis
- Online partial discharge measurements
- Power Industry regulation
- Knowledge of distribution network assets and operation
- Application of Condition Based Risk Management
- HV transformer testing
- Impacts of PV generation on distribution networks