Assessment of the Value of Lost Load for the Electricity Commission

Consultation Discussion Paper

Centre for Advanced Engineering

Purpose of Document

The purpose of this document is to seek the views of interested parties on the economic cost of transmission outages to consumers otherwise referred to as the Value of Lost Load. It is intended that the VoLL derived by this process be applied to the Grid Investment Test to be implemented by the Electricity Commission under Part F of the Electricity Governance Rules.

This paper is an interim report and does not represent the final views or research outcomes of the study.

Introduction

A key role for the Electricity Commission, in the new industry governance structure, will be to approve new transmission investment and mandate Transpower's revenue recovery methodology for this investment. The process for decision making currently being proposed is as follows:

- Transpower will develop a Grid Upgrade Plan for addressing investment on an 'investor of last resort" basis.
- The Grid Upgrade Plan will require a set of Security Standards approved by the Electricity Commission. A shift from deterministic to probabilistic security standards is being investigated as a more dynamically efficient approach.
- As there may be a range of technical solutions available for addressing upgrade issues or lower cost non-lines solutions able to be provided by parties other than Transpower, the Electricity Commission is required to provide a Grid Investment Test to ensure the most advantageous solution for the economy is adopted.
- To enable economic evaluation of reliability investments using the Grid Investment Test an assessment of the Value of Lost Load, VoLL or the economic cost of lost productivity resulting from a loss of electricity supply is required.

``

Background

The Centre for Advanced Engineering, CAE, produced a report on the Reliability of Electricity Supply in December 1993. Part A of this report covered customer requirements and specifically made an assessment of the Value of Lost Load.

This assessment was based on a relatively extensive survey of consumers which was adequate to provide an indication of the New Zealand's consumer perception of VoLL. It remains the most comprehensive New Zealand specific body of work on this subject, however there has been period significant change in the industry over the past decade.

VENCorp, the transmission provider in Victoria, Australia, has more recently undertaken a similar survey based assessment of Value of Customer Reliability (VCR). This work was prepared by Charles River Associates and completed in 2003. VENCorp moved to a VCR measure to be explicit about what they were valuing (customer reliability) and to differentiate from the VoLL measure used in the wholesale market.

CAE has been engaged by the Electricity Commission to update its previous work as the basis for determining an initial assessment of the Value of Lost Load in New Zealand for consultation.

The study dovetails with other Electricity Commission investigations in progress. Familarisation with the following papers will provide an understanding of the demarcation between the document and the overall framework being developed by the Electricity Commission:

- Probabilistic Transmission Planning: Comparative Options and Demonstration, Parsons Brinkerhoff Associates.

- Alternatives to Transmission Investment, Saha International

This draft discussion document therefore presents CAE's initial findings for the purpose of seeking further public consultation.

Limitations of Analysis

This project does not make comment on Security Standards or the probability models that are applied as inputs to those standards. It therefore does not analyse reliability statistics and their trends.

This project is to provide the VoLL that will be applied to the Grid Investment Test but is not required to provide comment on the design of the GIT. The sensitivity of the GIT to the VoLL input will need to be investigated prior to finalizing the GIT design.

A balancing mechanism to ensure electricity price rises relating to the provision of enhanced security via grid investment do not have a greater economic impact than the risk being secured against, may need to considered in order to close the process loop.

``

Here a yardstick of implied impacts on overall GDP, rather than on individual consumer groups, may be appropriate.

The VoLL derived in this study may therefore change via an iterative process adjusting for fine tuning of the GIT and public consultation.

It is assumed that transmission constraints, probabilities and risks of reduced supply, the benefits of augmentation options, etc. will all be able to be quantified in terms of units of electricity, kWh, and therefore a VoLL expressed in $/kWh is appropriate.

There is clear evidence that costs vary with the duration of the outage. For example, there is a higher fixed cost component of short term disruptions and costs are therefore less sensitive in terms of electricity consumption. However this study is aiming to derive a national average cost as opposed to a figure that can be accurately applied to individual consumers.

Boundary Assumptions

The Value of Lost Load, VoLL, relates solely to transmission outage and in particular outages in the core grid.

Averaging and assumptions with regard to aggregation of different Load User Groups may not prove accurate at distribution network level or grid offtake nodes.

A single weighted average VoLL figure is justified on the fact that the core of the transmission grid is shared by all consumers. Reduced availability at a node through which power flows impacts on the service able to be delivered by the rest of the core grid.

The VoLL is different for planned and unplanned outage events. This project calculates the VoLL for unplanned outages only. It is assumed that planned outages only occur when affected parties have had the opportunity to minimize losses and agree to mitigation provisions for disrupted service.

This consideration may need to be addressed in the GIT design if the proposed investment is targeting other issues such as contingency provisions during planned outages. For example, consistent definitions of reliability are needed between VoLL and GIT assessments.

Dry years also present a different type of security issue. In this case supply is constrained rather than lost, the level of constraint depends on demand response, and has a relatively graceful ramp up.

The VoLL is only intended to be suitable for application to the GIT. It does not attempt to define how risk burden/economic cost should be shared among parties. It is also not designed as an indicator of potential liability exposures: it should be seen as a measure of marginal impacts rather than as a measure of average impacts.

``

Methodology

The project has primarily aimed to deliver a robust methodology with the objective of focusing public consultation on the accuracy of the input data to that model.

The model has been developed to permit participants in the consultation process for to test impact of their own input data with regard to costs and probabilities.

CAE believes that survey based assessment of VoLL is a more direct method of determining the lost economic value than attempting to derive a model of the relationship between electricity consumption and national production or wealth creation. However, it is acknowledged that aggregated consumer assessments or producer and consumer assessments may produce an overstated value.

In this regard it should be noted that the survey data assumes the worse case i.e. worst cost and worst timing for the individual respondent. Further no diversity in the impacts experienced by each consumer has been assumed. As a single national average the result is therefore very conservative and overstated. Public comment is sought on this issue.

The approach has been to build a bottom up model of load groups and their consumption, with an assessed VoLL for each. This matrix will be used to determine the weightings that will be applied in deriving an average figure for VoLL.

The model mimics the VENCorp method and then restructures the 1992 CAE study data into the same analysis format so that direct comparison between the two studies can be made. Provision for a third set of cost input variables has also been made to test sensitivities.

The following methodology has been applied:

1. A model was developed that applied the VENCorp costs, load groups, durations and probabilities to derive the VENCorp VoLL calculation of $29.60/kWh.

2. CAE survey data was restructured into the same load groups and inflated to present value.

3. The different breakdowns in statistics in each data source were addressed by aggregating or disaggregating each data source as required to achieve a common framework. Equivalent Australian statistics will be analysed to achieve normalization with New Zealand's statistics. Achieving total reconciliation would be a very time consuming exercise. Accuracy limits will be determined on the basis of significance to the overall analysis.

4. New Zealand consumption figures for each load group have been updated to the current Energy Data File published by the Ministry of Economic Development (year to March 2003). This provides a breakdown of consumption, number of connections, energy/line cost by ANZIC code in industrial, commercial and residential classes.

` `

5. Differences in load group definition between New Zealand and Australia, now and in 1992, were adjusted for. This is discussed in the section on model calibration.

6. In some instances in the CAE survey data it has been noted that a single response skews the data for a load group i.e. well outside the normal standard deviation. Investigation continues to determine how sensitive the result is to these extremes and whether of not they should be excluded by simply reducing the sample size.

7. In some cases sample sizes are very small and so it may be a more valid alternative to leave this data in, but increase the sample size.

8. The CAE data is not broken down into different event durations. The survey assumed an average duration of 3.2 hours. Data has been scaled accordingly to align with the VENCorp 2 and 4 hour datasets.

9. When/if additional surveys are undertaken to obtain up-to-date NZ data for the load groups that prove to dominate outcome and variance by time can be included. The Australian time distribution of costs for other load groups is considered to be a fair proxy.

10. If the impact of outage duration on costs is entered into the model then the event duration probabilities will also need to be updated to New Zealand figures. Transpower has been approached for this data.

11. The need for adjustments to reflect changes in consumer behavior is being assessed and is discussed later. For example, computing dependent consumers are more aware of how security issues impact their business and have modernized with installation design/equipment that is more tolerant.

12. Comparison with the VENCorp investigation of VoLL will be made in order to highlight where any significant deviation between the two studies. The VENCorp study is the most recent and relevant to New Zealand survey based assessment of VoLL. Where significant differences are discovered CAE will attempt to provide explanation and normalize the two bodies of work.

13. Where necessary explanations and assumptions will be checked via survey/discussion with actual consumers.

14. The sensitivity of the weighted average VoLL to changes in the assessment of VoLL for each load group will be assessed to determine the need for more detailed investigation for specific key load groups.

15. A survey the MEUG consumers to identify their impact on results is in progress.

Public consultation will provide a further opportunity for refining the VoLL assumptions for each load group.

``

Description of Model

The model is made available in its electronic form as it is developed to permit users to test their own input data and compare results with the VENCorp and CAE datasets.

The linked spreadsheets record the process aligning and grouping the VENCorp and CAE datasets into the same format.

Three cost, duration, and load group matrixes are presented for the VENCorp, CAE, and a Trial datasets.

Provision to apply different event duration probabilities is provided via an additional table.

Calculation of the weighted average VoLL's is achieved by selecting the input datasets in the results matrix.

Calibration of Model

Initial loading of the raw data gave very large differences between the VENCorp and CAE results with the CAE result being significantly higher. The following adjustments have been made:

- The aggregation of sub-load groups to a consistent basis. For example, Government, Education, and Transport being services are treated as services (the Business Group from the 1992 work is a total of commercial and manufacturing (industrial) so not relevant for the new categories).

- There is an argument for removing the IT group as there would no longer be the same 'Computing' cost as there was in 1992 - it is also arguable whether the Communication services included in the EDF classifications equates to CAE IT group . At this stage it has left in.

That gives a much more consistent result for the Commercial load group with other studies.

That left a major difference in industrial relative to other studies. The problem was pinpointed to the average load per customer (from the EDF data) being quite low in NZ where normally the Industrial Load Group has a high cost combined with high consumption resulting in a lower cost/kWh. This is because EDF counts each supply point as a customer so a single large industrial consumer can be counted as multiple customers.

``

This was resolved by calculating the average load per respondent for the manufacturing and MEUG groupings in the 1992 study (which together make up the Industrial Grouping). This gave an average load of nearly 3400kW per customer in comparison to 50 kW per customer from the EDF data. The cost per customer is normalized with this ratio to ensure a consistent cost per kW/load result with the original data.

This data can be further improved with updated cost and consumption data from MEUG members (a survey has been initiated). Initial survey results look fairly consistent with the updated number currently in the model.

Comparison with VENCorp Study

The updated model gives a VoLL result for New Zealand of $20.95 kWh. This is approximately 70% of the VENCorp study (excluding any exchange rate differences). CAE has the following expectations with regard differences between the VENCorp and CAE results:

- Australian residential consumers are likely to place a higher value on continuity due to their greater exposure to summer air conditioning load, more intensive urbanisation, etc.

- Australian agricultural consumers are likely to place a far higher value on continuity due to the critical role of irrigation there. Since the CAE survey New Zealand has increased its usage of irrigation so the actual differential with Australia is not expected to be as extreme now. A check on whether milk processing is categorised consistently is still needed. While the New Zealand number needs updating at only 3.6% of total demand it will not have a significant impact on the average result

- Currently there is only single time point data for New Zealand (although it is shown both at 2 hour and 4 hours). If the shorter time periods have a higher cost /KW load (quite likely if the Australian data is a guide) and a higher probably of occurrence (also likely based on the Australia data) then the New Zealand average cost will increase once this data is incorporated.

- New Zealand has a higher proportion of electricity use (41% versus 32%) in the relatively low VoLL Industrial Sector. This reduces the overall result in comparison to Australia.

- New Zealand has a small number of very large consumers (four largest consumers make up 25% of New Zealand's total demand). This has the impact of reducing the VoLL of the Industrial Sector because the average load divisor is so large (even though the cost is high). Australia is thought to have a more diverse industrial sector with less domination by a few large consumers. [Note: this is illustrated by separating the manufacturing and MEUG responses in the 1992 data – Manufacturing on its own has an average load of $84.60/kW of total load while

` `

MEUG members are $3/kW of total load (for a 3.2 hour stoppage). Combined in the Industrial category the result is $6/kW of total load]

At this time results do not appear be outside the bounds of these expectations.

Sensitivity

This work is still in progress.

We include a preliminary first assessment of the derived VC sensitivity to changes in the individual sector parameters.

Parameter selection;

- Varying by ±10% the VenCorp $ per event/kW total load data for each sector in turn. (Baseline VCR results are 28.40 complete, 24.53 partial)
- Probability of event duration - Trial 3
- Weightings by sector – EDF (NZ)

	Variation of $/event/kW	Sector Weighted VCR from Varied Input Data Residential	Agricultural	Commercial	Industrial
Complete Residential	+10%	28.93	28.64	29.80	29.07
	-10%	27.87	28.16	27.00	27.73
Partial Residential	+10%	24.67	24.77	25.93	25.20
	-10%	24.38	24.29	23.13	23.86

Parameter selection;

- Varying by ±10% the VenCorp $ per event/kW total load data for each sector in turn. (Baseline VCR results are 28.27 complete, 26.09 partial)
- Probability of event duration - VenCorp
- Weightings by sector – EDF (NZ)

	Variation of $/event/kW	Sector Weighted VCR from Varied Input Data Residential	Agricultural	Commercial	Industrial
Complete Residential	+10%	28.88	28.47	29.52	29.02
	-10%	27.65	28.07	27.01	27.51
Partial Residential	+10%	26.49	26.29	27.35	26.85
	-10%	25.69	25.89	24.84	25.30

Cursory examination of the above analysis suggests that the commercial sector is the most sensitive to changes to the current data set and thus this sector needs to be evaluated further to see if tighter control can be applied.

` `

Recommended Further Refinements

This work is still in progress.

Contact for Feedback

Comments or feedback on this interim report should be provided to :

Ken Mitchell
Programme Manager
Centre for Advanced Engineering
Phone/fax 03 434 3016
Mobile 021 377 804

Email knemitchell@ihug.co.nz