SAHA

TransGrid

Service Target Performance Incentive Scheme: targets, caps and collars relating to the loss of supply event frequency parameter

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Final version

SAHA

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1 Background

1.1 The scheme

The Ministerial Council of Energy (MCE) articulated a number of principles for the roles of transmission networks in its December 2003 Report to the Council of Australian Governments.[1] This included:

- *Providing a transportation service from generators to loads*

- *Ensuring secure and reliable bulk electricity supply*

- *Facilitating competition between generators (even when located in different regions)*

In addition, the MCE also proposed a number of reforms, including that:

> *"...there would be valuable customer and investor benefits in more closely aligning transmission performance measures with their market impact. The MCE supports the current consideration by the ACCC of incentives for availability. Incentive arrangements should analyse the actual cost of constraints, set targets for circuit availability, and reward or penalise transmission companies for diversion from those target levels."*

In response to the MCE report, the electricity industry in Australia continues to evolve and as part of this evolution, market governance arrangements continue to change, especially for the transmission networks and in particular with respect to performance incentive arrangements.

The Australian Energy Regulator's (AER) November 2007 Service Target Performance Incentive Scheme (STPIS) sets out details of the performance incentive scheme for Transmission Network Service Providers (TNSPs). Under the AER's STPIS, TransGrid's revenue cap will incorporate a performance incentive scheme that would allow TransGrid to gain up to an additional 1% of revenue each year for above target performance, or lose up to 1% of revenue each year for below target performance.

The application of the scheme must be consistent with requirements of the National Electricity Rules (NER) clause 6A.7.4 and clause 1.4 of the scheme which provides an overview of the objectives. The operational aspects of the scheme are contained in clause 3.3 which relate to three key performance parameters for all of the TNSPs and identifies the items that each of the individual TNSPs need to provide as part of the determination process.

1.2 Parameter setting process

1.2.1 TransGrid's submission to the AER

TransGrid wrote to the AER in September 2007 advising that it did not wish to propose amendments, to add, remove or vary a parameter or the revenue at risk under the service component of the STPIS. However, TransGrid did recommend changes to the definitions in Appendix B to ensure that it comprehensively defines the parameters that apply to it under the scheme. In particular TransGrid recommended:

[1] http://www.mce.gov.au/assets/documents/mceinternet/MCE%5FDec03%5FRpttoCOAG20031211171443200411241640 56%2Epdf

- Additional detail on exclusions;
- 14 day cap for transmission circuit availability outages where an underground cable was damaged by an external party who failed to enquire with “dial before you dig”; and
- 7 day cap on outages for the average outage duration parameter.

In addition, it is highly likely that the AER will implement the Market Impact Transmission Congestion (MITC) parameter in the next regulatory period so TransGrid will not have to include transmission line availability (peak critical circuits) as an additional performance incentive parameter.

1.2.2 The AER’s explanatory statement

Following TransGrid’s submission, the AER released its consideration and decision in the scheme’s explanatory statement in November 2007. The AER considered that the parameters applying to TranGrid under the current determination are generally suitable for application in the next regulatory control period. In particular:

- Exclusions for circuit availability parameter definition;
- 14 day cap for transmission circuit availability outages where an underground cable was damaged;
- Additional loss of supply frequency clarification amendments that will assist reporting; and
- 7 day cap on outages for the average outage duration parameter definitions is appropriate.

However, the AER noted that some of the parameter definitions could be defined more clearly. The AER has adopted TransGrid’s proposed amendments to the parameter definitions, subject to some minor edits to ensure that it is clear which exclusions are relevant for each sub parameter.

1.2.3 SAHA submission on loss of supply event frequency parameter setting

TransGrid engaged SAHA International to assist them with the reviewing the methodology and setting of loss of supply event frequency parameter thresholds x and y. Key points raised in the report[2] include:

- TransGrid outage data has both lognormal and bimodal properties. Outage events are either resolved quickly and are brief in duration, and as a consequence impact a small number of customers, or are more complex and require greater resources and time to correct and impact either a large number of customers or a small number of customers for an extended period of time. These characteristics are particularly relevant when setting parameter targets as the basis for having two performance targets x and y is to measure both types of events. If the target parameters are too close, then one of the target parameters will be less relevant as they are effectively measuring similar performance.

[2] SAHA International Report to TransGrid on Service Standards Incentive Scheme: Review of data, methodology and parameters

- A sufficient sample size is needed to obtain a statistically reliable estimate. This can be achieved by using a longer time horizon and individual connection point data that is consistent with the establishment of the parameter. The SAHA analysis showed that TransGrid's data was consistent over a longer timeframe (11 years).

- SAHA also raised concerns with using fewer data points for simplicity including: plotting a straight line and developing a distribution based on 5 observations; the statistical confidence is limited by the extremely small data set; it does not take into account potential outliers very well, due to its small sample size; and there is a greater likelihood that the performance target is not reflective of the average performance history and limit parameters (cap and collar).

- Analysis of TransGrid's data showed that outliers must be included as there were 3 events in the last 15 years or at least one event each regulatory period.

- Proposed that the x parameter threshold remain the same at 0.05 system minutes, while the y parameter threshold is decreased from 0.40 to 0.25 system minutes.

1.3 Scope of this consultancy

TransGrid have asked SAHA International to provide analytical advice in relation to setting proposed performance targets, caps and collars that apply to the loss of supply event frequency parameter under the STPIS administered by the AER. In particular, SAHA has been asked to further examine the merits of using a longer time horizon, increased sample size and the inclusion of statistical outliers for developing targets, caps and collars. SAHA will also undertake statistical analysis to develop targets, caps and collars for TransGrid that will apply in the next regulatory period.

2 Framework

2.1 High level principles

The application of the scheme must be consistent with requirements of the National Electricity Rules NER clause 6A.7.4 and clause 1.4 of the scheme which provides an overview of the objectives. As the focus of the STPIS is on reliability, it compliments the regulated revenue determination process by developing incentives for the TNSPs to maintain a level of service subject to the approved capital and operating expenses.

The scheme provides a framework that enables the AER to adopt a consistent and comparable approach among the TNSPs. However, the AER has acknowledged that transmission networks, asset management plans, customers and climatic conditions vary between TNSPs and therefore so will their performance. Accordingly, the scheme has been designed to accommodate for these differences through clause 3.3 that enables flexibility when developing incentives under the scheme.

2.1.1 Strength of the incentive and constraints

From an operational perspective, this process is very similar to a budget setting or challenge process. As such, the strength of the incentive is important and needs to take into consideration the potential to make improvements as per clause 3.3(j)(3) of the scheme. That is, the targets must be fair, reasonable and achievable.

In addition, the TNSP's ability to meet these targets is subject to constraints. Some of these are not controllable by the TNSP such as force majeure events while other constraints may be due to legislation, rules or other obligations. Examples include:

- Ensuring the safety of staff, contractors, and the general public;
- Maintaining the security and reliability of the power system under the control of TransGrid;
- Ensuring all activities are undertaken in a manner that ensures compliance with all environmental obligations; and
- Minimizing the impact the transmission system has on the outcomes in the national electricity market.

Finally, the incentives are developed taking into consideration the capital and operating expenditure and revenue allowance.

2.1.2 Signal to noise or error

The strength of the incentive is also dependant on a clear signal being sent relative to the potential noise or error. Development of targets, caps and collars must be first based on a robust statistical approach and then followed by a pragmatic case assessment. The later approach being reserved when there is insufficient confidence in statistical techniques or where an apparent conflict exists between different measures. A simple solution that compromises statistical accuracy is more likely to lead to the development of targets that have noise or error and are therefore not fair, reasonable and achievable.

SAHA has previously argued that this can be remedied by analysing the data for each TNSP rather than having a prescriptive approach that applies to all TNSPs. This is consistent with clause 3.3 of the scheme which allows for variation / flexibility when setting parameter targets as it recognises that their will be differences in network planning, customer load and climatic conditions between regions. From a statistical perspective, the performance target is more likely to be accurate, or less prone to error, if the analysis is based on a longer time horizon, increased sample size and a non prescriptive approach to assessing the inclusion of statistical outliers.

3 Analysis and review

The first report prepared by SAHA focused on understanding the underlying data in order to develop the x and y thresholds for the loss of supply event frequency parameter. SAHA undertook this analysis using simple statistical analysis including data plots, frequency histograms and statistical distributions and confidence intervals (percentiles).

This report focuses on establishing the targets, caps and collars that will apply to the x and y parameter thresholds. That is, the average number of events above the threshold parameter and the extreme values (cap and collar) based on a statistical confidence interval. In addition, SAHA has also undertaken additional statistical analysis to determine if a longer timeframe will provide a better estimate.

3.1 Statistical tests to compare mean and variance

The analysis of variance (ANOVA) test is used to test differences in means (for groups or variables) for statistical significance by analysing the variances of the groups of data.

To understand the importance of the size of the data analysed, we performed the 'one-way ANOVA' test on the most recent 5, 10 and 15 year time sets of data (2003-2007, 1998-2007 and 1993-2007 respectively) to study the behaviour of the differences in means of the data for x parameter set at 0.05 and y at 0.25 for loss of supply event frequency.

The ANOVA test is performed by generating an initial null hypothesis against which we compare the actual performance of the data. The null hypothesis assumes the best case scenario. In this case, we assume the null hypothesis to be:

> H_O: *The size of the data set used for the projection is not statistically significant*

To test this hypothesis, we calculated the F-values and the corresponding significance factors (p-values) for the two parameters x and y and obtained the results set out in Table 3.1.1.

Table 3.1.1 ANOVA test results

Output	x=0.05	y>=0.25
p	0.6896	0.6965
F	0.3768	0.3665

The F-value is the ratio that compares between mean squares. The values of p indicate the existence of variation in the actual performance of data across the two parameters against the assumed null hypothesis.

Based on the observed results we can reject the null hypothesis that the size of the data set used for the projection is not statistically significant. Hence we can infer that the size of the data set used for statistical analysis is of significance.

It must be noted that the ANOVA test assumes normality of the data. The available data has been used as is, i.e. assumed to be normal.

From the results of the ANOVA test we can infer that the size of the data used is statistically significant and using a larger data set for developing performance targets will provide a more reliable estimate.

4 Setting the target, caps and collars

The previous section demonstrated that using more data (data over a greater time period) will provide a more accurate estimate. This section will use actual data and statistical distributions over a 5, 10 and 15 year time horizon to propose targets, caps and collars that will apply to the x and y parameters during the next regulatory period. SAHA recommends that at least a 10 year horizon is adopted for developing the incentive targets. However, the report also provides the analysis for other periods for completeness and transparency.

4.1 x parameter

The x parameter measures small loss of supply event frequency; events that are resolved quickly and are brief in duration. Table 4.1.1 below provides statistical analysis using actual data for a combination of time horizons. It shows a simple mean or average and standard deviation (assuming a normal distribution and therefore symmetrical distribution). The standard deviation is shown for illustrative purposes and is not recommended for cap and collar setting as the outage distribution is not symmetrical. The cap and collar setting is covered in the distribution analysis section.

4.1.1 Actual data

The table 4.1.1 below shows that the mean number of events above the threshold is declining over time. The most recent five years (2003-2007) had 3.8 events compared to 4.8 in the previous five years (1998-2002). While using the last ten years (1998-2007) had 4.3 events. This suggests that a target of 4 events for the x parameter is reasonable based on actual data.

However, table 4.1.1 shows that the variation in events or standard deviation has no trend. The most recent five years (2003-2007) had 3.3 events, the previous five years (1998-2002) were lower at 1.6 events while the five years prior again (1993-1997) had 2.9 events which was also lower than the most recent five years (2003-2007). Extending the timeframe to ten and fifteen years provides more consistent results with a standard deviation between 2.5 and 2.7 events. This analysis suggests that caps and collars should be based on the longest time horizon possible which is fifteen years in this case. The analysis also shows that outliers must be included as they occur in two out of the three five year comparison periods. The cap and collar setting process is covered in the next section.

Table 4.1.1 Statistical analysis of actual data for x>=0.05 loss of supply event frequency threshold over 5, 10 and 15 year time horizons

Period	Duration	Max	Mean	Min	Std Dev (one)*	Std Dev (two)*
years	Years	events	events	Events	events	events
1993-1997	5	11.0	6.2	3.0	2.9	5.0
1998-2002	5	6.0	4.8	3.0	1.6	2.8
2003-2007	5	9.0	3.8	1.0	3.3	5.5
1993-2002	10	11.0	5.5	3.0	2.4	4.0
1998-2007	10	9.0	4.3	1.0	2.5	4.2
1993-2007	15	11.0	4.9	1.0	2.7	4.6

Note: * This is a simple standard deviation that assumes normal distribution. It is useful for comparative purposes only rather than target, cap and collar setting which is discussed in the distribution analysis section.

4.1.2 Distribution analysis

The following analysis provides percentiles and the mean using a distribution function that best fits the actual data. That is, provides the best estimate of the actual data. Similar to the actual data shown above, the table 4.1.2 below shows that the mean number of events above the threshold is declining over time.

The distribution analysis is more appropriate for setting caps and collars as the percentiles are not symmetrical. The results from our ANOVA analysis and actual data showed that using more data is better for developing estimates of variance. To set the cap and collars SAHA recommends using a 10 or 15 year timeframe based on the 10th and 90th percentile. The longer timeframe provides a better estimate of the extreme values and the use of these percentiles is consistent with the preferred approach of the AER and its consultants. For transparency and completeness, SAHA has also provided 5 years data and the 5th and 95th percentiles. Based on the results in the table 4.1.2 below, SAHA recommends that the cap value for the x parameter is set at 2 events and the collar is set at 7 events. By way of comparison, this is an improvement on the previous regulatory period incentives that had a target of 5 events and a cap and collar of 3 and 8 events respectively.

Table 4.1.2 Statistical analysis of distribution for x>=0.05 loss of supply event frequency threshold over 5, 10 and 15 year time horizons

Period	Duration	95%(a)	90%(a)	Mean(b)	50%	10%(c)	5%(c)
years	Years	Events	events	events	events	events	events
2003-2007	5	8.83	6.68	3.24	2.38	0.72	0.58
1998-2007	10	8.97	7.47	4.29	3.88	1.52	1.03
1993-2007	15	10.10	8.50	4.94	3.51	1.87	1.34

Note:

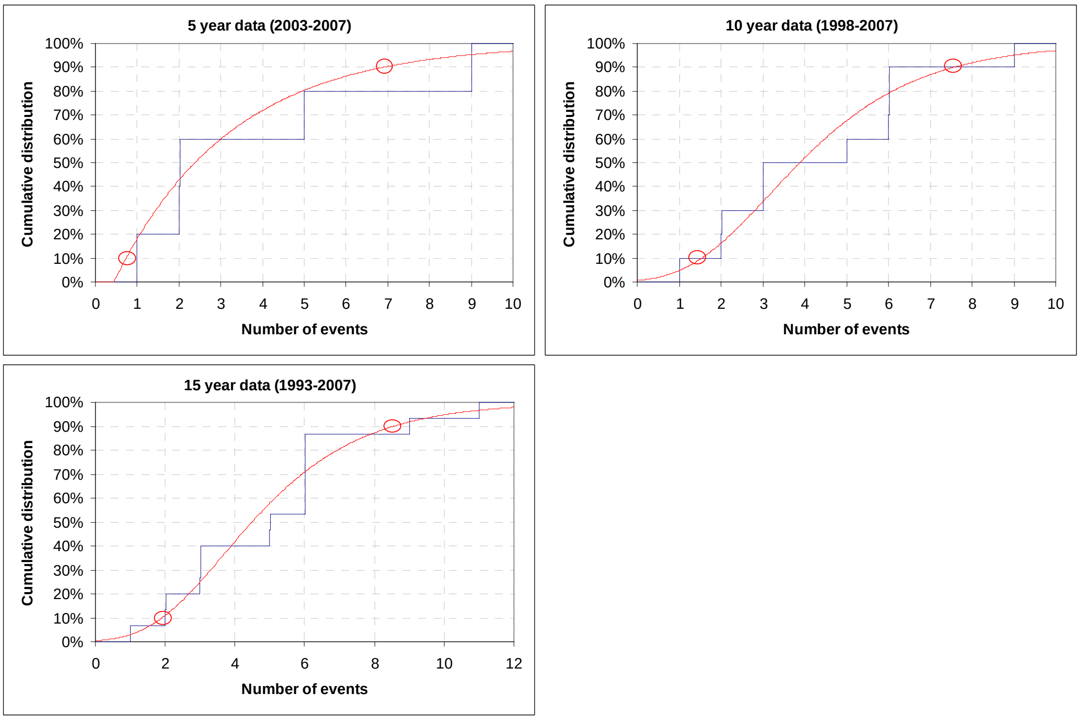
(a) The 95 and 90 percentiles provide an indication of the collar value.

(b) The mean provides an indication of the target value.

(c) The 5 and 10 percentiles provide an indication of the cap value.

The following charts 4.1.1 illustrate the tabled information shown above. They show the cumulative distribution of a distribution function that best fits the actual data.

Chart 4.1.1 Statistical analysis of distribution for x>=0.05 loss of supply event frequency threshold over 5, 10 and 15 year time horizons



4.2 y parameter

The y parameter measures large loss of supply event frequency events that are more complex and require greater resources and time to correct and impact either a large number of customers or a small number of customers for an extended period of time. Table 4.2.1 below provides statistical analysis using actual data for a combination of time horizons. It shows a simple mean or average and standard deviation (assuming a normal distribution and therefore symmetrical distribution). The standard deviation is shown for illustrative purposes and is not recommended for cap and collar setting as the outage distribution is not symmetrical.

It is also worth noting that SAHA's previous submission proposed a material improvement in the threshold incentive for the 2009-2014 regulatory period; decreasing the threshold from 0.40 to 0.25 system minutes. This will require TransGrid to rapidly resolve incidents resulting in loss of supply for a large number of customers.

4.2.1 Actual data

Table 4.2.1 below shows that the mean number of events above the threshold is declining over time, an outcome similar to that for the x parameter. The most recent five years (2003-2007) had 0.6 events compared to 1.2 in the previous five years (1998-2002). While using the last ten years (1998-2007) data showed 0.9 events. This suggests that a target of one event for the y parameter is reasonable based on actual data.

The standard deviation shows that the most recent five years (2003-2007) had 0.5 events, the previous ten years (1998-2007) was slightly higher at 0.7 events. The data supports using either a 5 or 10 year time horizon to determine the cap and collar values as they are broadly similar. Given our earlier analysis suggested that using a longer time period gives more reliable estimates, SAHA has used the 10 year data to estimate caps and collars. The cap and collar setting process is covered in the next section.

Table 4.2.1 Statistical analysis of actual data for y>=0.25 loss of supply event frequency threshold over 5, 10 and 15 year time horizons

Period	Duration	Max	Mean	Min	Std Dev (one)*	Std Dev (two)*
Years	years	events	events	events	events	events
1993-1997	5	4.0	1.2	0.0	1.6	2.8
1998-2002	5	2.0	1.2	0.0	0.8	1.4
2003-2007	5	1.0	0.6	0.0	0.5	0.9
1993-2002	10	4.0	1.2	0.0	1.2	2.1
1998-2007	10	2.0	0.9	0.0	0.7	1.2
1993-2007	15	4.0	1.0	0.0	1.1	1.8

Note: * This is a simple standard deviation that assumes normal distribution. It is useful for comparative purposes only rather than target, cap and collar setting which is discussed in the distribution analysis section.

4.2.2 Distribution analysis

Using the approach described in setting the x parameter cap and collars above which takes into account the 10 year timeframe and the 10^{th} and 90^{th} percentile distributions, table 4.2.2 below indicates that the cap and collar values (based on the distribution analysis) are reasonable at 0 and 2 respectively. As observed with the x parameter, the y parameter incentives have also been tightened, with the threshold being reduced from 0.40 to 0.25 system minutes and the target, cap and collar have remained constant at 1, 0 and 2 respectively.

Table 4.2.2 Statistical analysis of distribution for y>=0.25 loss of supply event frequency threshold over 5, 10 and 15 year time horizons

Period	Duration	95%(a)	90%(a)	Mean(b)	50%	10%(c)	5%(c)
years	Years	events	events	events	events	events	Events
2003-2007	5	1.56	1.32	0.64	0.64	-0.05	-0.27
1998-2007	10	2.11	1.79	0.89	0.89	-0.06	-0.32
1993-2007	15	2.93	2.23	0.93	0.63	0.04	-0.02

Note:

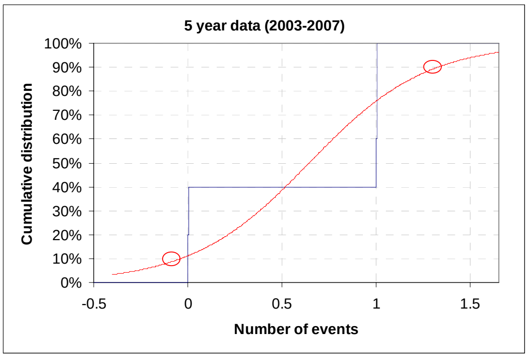
(a) The 95 and 90 percentiles provide an indication of the collar value.

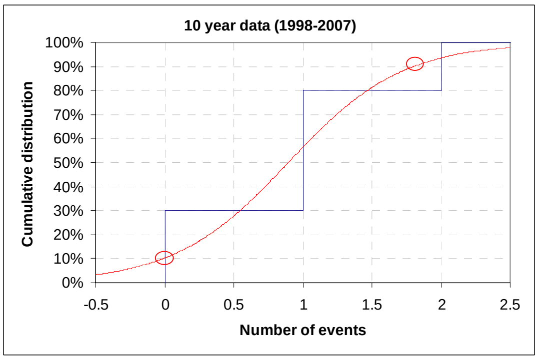
(b) The mean provides an indication of the target value.

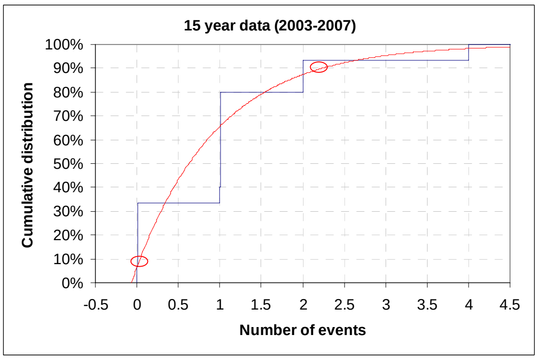
(c) The 5 and 10 percentiles provide an indication of the cap value.

The following charts 4.2.1 illustrate the tabled information shown above. They show the cumulative distribution of a distribution function that best fits the actual data.

Chart 4.2.1 Statistical analysis of distribution for y>=0.25 loss of supply event frequency threshold over 5, 10 and 15 year time horizons







5 Recommendations

SAHA recommends that the target for the x>=0.05 threshold parameter is set at 4 events (rounded) based on the average of the last five years of actual data. While the cap and collar values are set at 2 and 7 events respectively based on distribution analysis taking into consideration both 10 and 15 year horizons and 10^{th} and 90^{th} percentiles.

SAHA recommends that the target for the y>=0.25 threshold parameter is set at 1 event (rounded) based on the average of the last five years of actual data. The setting of the cap value is straight forward at 0 and the collar is at 2 based on the same methodology used to set the x threshold parameter.

In addition, the report raised some high level principles that will assist in developing effective performance incentives that allow for incremental improvements. A stronger signal will provide a stronger incentive. This can be in the form of the magnitude and or duration that the incentive is retained by the TNSP. The incentive must be fair, reasonable and achievable, that is material improvements can be made and must take into consideration constraints that may impact a TNSP performance. This is consistent with the scheme objectives.

A clear signal relative to noise (error) will provide a stronger incentive. More data each year or a longer time series will provide a better estimate (less error). The target (which is determined by the average) and the cap and collar (which are determined by the distribution or variability of the events) can be analysed using different time periods. SAHA advocates using a longer timeframe for developing caps and collars based on the randomness of available data which can be assessed on a case by case basis.

With regards to the scheme, SAHA supports that the use of a consistent framework to develop incentives for TNSPs to improve the reliability of their networks. SAHA also supports provisions of the scheme that allow flexibility as provided for by clause 3.3. This clause acknowledges that network performance will vary due to design, asset management, local climate conditions, customer load and geography. Consistent with this flexible approach, SAHA also supports a less prescriptive approach to the treatment of statistical outliers. The first position, is that they should be included unless case analysis suggests otherwise. Analysis of TransGrid data suggests that outliers occur once in every five years.

Finally, SAHA supports the use of asymmetrical targets, particularly if a parameter approaches zero. SAHA considers this to be consistent with Clause 3.3(f).of the scheme.