Draft Report to

The Independent Market Operator

Analysis of Procedures for Assessing the Capacity Value of Intermittent Generation in the Wholesale Electricity Market

2 August 2010

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1 INTRODUCTION

McLennan Magasanik Associates (MMA) has been engaged by the Independent Market Operator (IMO) to evaluate proposals for methods of valuing the capacity of intermittent generation in the Wholesale Electricity Market of Western Australia. This project will result in allocating capacity credits for intermittent generators which will determine their participation in the reserve capacity mechanism.

MMA has demonstrated that the current method of valuing capacity based on average power over the last three years is not necessarily consistent with the contribution that these resources make to system reliability with respect to expected unserved energy. In respect of wind farms the current method gives a good approximation in the current circumstances but it may not remain accurate if there is a much higher penetration of wind power or if other renewable energy resources are added such as those based on solar thermal or photovoltaic technologies.

In particular, the current method would not provide an accurate assessment for solar energy based resources. It may not give an accurate assessment for wind farms located away from the existing sites. It is therefore necessary to develop a more accurate method which could apply to any intermittent resource and which would provide a robust measure of the impact of such resources on system reliability.

Accordingly alternative methods have been proposed based on:

- System reliability analysis that determines an equivalent capacity by comparing the system reliability in two simulations; one with and one without the nominated resource;
- Estimating the trading interval loss of load probability as a function of system loading conditions and using this function to weight the output from intermittent generators based on historical output profiles corresponding to periods of high system demand and exposure to system unreliability; or
- Averaging the historical output of intermittent generators over selected time periods that may be based on high levels of system demand or high levels of the remaining load that must be supplied by scheduled generation.

A review of study results reported in two MMA reports[1] shows that methods based on selected time periods that represent periods of system stress would provide a simple yet effective measure until more data become available on the performance of the existing and prospective intermittent generators. Methods based on loss of load probability and reliability equalisation have the potential to provide a more accurate assessment but they are subject to material volatility in measurement due to the limited information available

[1] Valuing the Capacity of Intermittent Generation in the South-west Interconnected System of Western Australia, 19 May 2010
Supplementary Analysis of Capacity Valuation Metrics,12 April 2010

on power station performance at times of high system demand. At this stage it is necessary to make a trade-off between accuracy and measurement volatility because a volatile measure would result in significant commercial risk which is not desirable.

This report explores a number of proposals for how the time averaging over selected periods could be refined to obtain the best compromise between:

- Transparency
- Simplicity
- Continuity of valuation (reflecting the regulatory/cost risk to existing facilities)
- Volatility
- Practicality
- Robustness (addresses principle of capacity

It is concluded that the method based on averaging over 250 trading intervals based on selected historical years would best satisfy the criteria that have been considered throughout this study.

This conclusion is consistent with the earlier MMA work which indicated that period averaging over 250 to 750 trading intervals per year would reduce the volatility of the measure without undue inaccuracy. The longer period of averaging provides some additional conservatism when using the averaging method.

2 PROPOSED METHODS

2.1 Basis for methods

Three basic methods have been proposed with some variations as summarised in Table 2-1. The following sections describe the methods in more detail. In addition, these methods could also be based on system peak demand, rather than the load for scheduled generation[2]. However, it is a clear conclusion from previous analysis that basing trading interval averages on the highest load for scheduled generation is more accurate than system peak demand because it is the load imposed on scheduled generation which has the more direct impact on system reliability.

The methods are based around the following concepts:

1. A measure of fleet performance of the total set of intermittent generation resources based on historical periods, either taking the last three years or taking three selected years that represent high levels of system demand
2. A comparative measure of contribution within the fleet performance value which is based on selecting more trading intervals, either 250 or 750 trading intervals per year
3. Treating the committed projects as a fleet and treating prospective plants as mutually exclusive additions to the fleet, in the first instance.
4. Averaging the assessment over three years to obtain additional smoothing over time.

[2] "Load for Scheduled Generation" is calculated by subtracting the output of all the intermittent generators (wind, solar, tidal, wave power) from the system peak demand. The higher this value, the lower the system reliability as measured by the loss of laod probability.

Table 2-1 Methods Considered

Proposal ►	1	1A	2A	2B	3
Primary Fleet Measure	The annual average value over the selected trading intervals		Average over the selected years	Average over the selected years	The annual average value over the selected trading intervals
Period of measure	The highest 12 trading intervals since October 2001		Highest 750 trading intervals with a load shape scaled to the forecast demand based on three selected years at 50%, 30% and 10% probability of exceedance peak demand	Highest 750 trading intervals in each of the last three years	The highest 175 trading intervals in each year since October 2001
Fleet percentile measure	95% probability level of the annual values assuming normal distribution	90% probability level of the annual values assuming normal distribution	Average	Average	90% percentile of the 175 values over the historical period
Allocation within the fleet value	According to the value of the LSG during the top 250 trading intervals for each of the last three years		Average 750 trading interval value weighted according to the incidence peak the peak demand distribution for the selected profiles.	Average over the 750 trading intervals in the last three years.	Average over the 250 trading intervals in the last three years.
Multi-year Average	Average the values assessed for the last three capacity years.		Average the assessed value with the two previous assessments.		No additional averaging.

2.2 Proposal 1 - Fleet Apportioned; LSG 12 Intervals Average

The Key Focus of this proposal is to "Ensure system reliability is safeguarded by focusing on high confidence, average performance, over a small number of critical intervals to determine overall intermittent capacity value then allocate to individual plant on merit."

The principles are to:

- Assign a capacity value to the intermittent generator fleet based on the 95% confidence level of fleet output averaged annually over the top 12 intervals in all previous years selected on Load for Scheduled Generation (LSG).
- Differentiate each plant on merit and manage the volatility of individual plants by apportioning the fleet capacity value based on plant averages over a moderate number of critical demand intervals. The ranking is to use 250 trading intervals each year with the highest Load for Scheduled Generation.
- Thus the fleet capacity is to be apportioned according to the average plant output for the 750 intervals comprising the top 250 intervals (of LSG) in each of the 3 most recent capacity years. Since these periods would have occurred by the end of July each year, a value would be able to be assessed prior to the start of the next capacity year in October.

The Process for existing plants (all plants with Capacity Credits) would be:

- Determine the LSG and rank the highest intervals for each of the previous capacity years from Oct 2001. Where measured historical data are not available, the nearest equivalent day would be applied from the available data having regard to the nearest available wind and temperature data.
- The fleet capacity value would be calculated by determining the 95% confidence level of the average of 12 interval average fleet output values for each of the previous capacity years from Oct 2001. Since at most 8 values are currently available, the method would calculate the mean and standard deviation of the sampled values and calculate percentile value as

  Mean – Standard Deviation * 1.64485

- Determine the 3 year rolling average of the top 250 (LSG) interval performance for each plant using actual, calculated or default values.
- Assign capacity value to each plant such that the sum of assigned values weighted by 3 year rolling average performance measured in megawatts equals total fleet capacity.

The Process for proposed plants would assess each plant individually with the existing fleet:

- For each of previous 3 years: subtract the modelled plant output from LSG (for existing fleet) for each trading interval and rank the highest intervals. Determine modelled output for plant in each of 250 highest trading intervals.

- Determine 3 year average of modelled values of output over 750 intervals comprising the top 250 intervals in each of the three years.
- Assign capacity values such that the sum of the assigned value together with those of the existing plants weighted by the 3 year rolling average megawatt output equals fleet capacity value.

2.3 Proposal 1A

Proposal 1A is the same as Proposal 1 except that the percentile level is 90% instead of 95%.

2.4 Proposal 2A - Individual Assessment; LSG 750 Intervals Average with Specific PoE Years

The Key Focus is to "Ensure system reliability is safeguarded, differentiate plant on merit and manage volatility through a rolling average assessment of individual plant."

The principles are to:

- Assign capacity values based on a 3 year rolling average of plant's average performance over the most critical 750 trading intervals selected on LSG.
- The LSG profiles are based on taking three historical load profiles that represent 10%, 30% and 50% probability of exceedance peak demand and scaling the load profile to match the forecast demand in relevant capacity year.
- The relevant years would be varied or supplemented when peak conditions above 50% POE exceedance again occur in the WEM.

The Process for existing plants (all plants with Capacity Credits) would be:

- Select three representative historical load profiles based on capacity years. Initially these are 02/03, 03/04 and 04/05 which represent 50%, 10% and 30% POE summer peak years, respectively.
- Scale the historical load profile to reflect the forecast demand for the relevant capacity year for each of the historical load profiles for the corresponding level of peak demand.
- Determine the LSG by subtracting the sum of all existing intermittent generation from the scaled load profile. (The intermittent generation profiles must be those for the corresponding historical load profile year to ensure consistency between intermittent gen output and system demand).
- Determine the 750 intervals with highest LSG for each historical load profile.
- Calculate a weighted capacity value based on weighting the three historical profiles according to the incidence of the peak demand distribution.

- Assign capacity value to plant equal to the average of the weighted plant output and the value that applied for each of the 2 previous assessments. Initially the current method would apply until two years with the new method had been completed.

The Process for proposed plants would assess each plant individually with the existing fleet:

- Determine the LSG by subtracting the sum of all existing and the proposed intermittent generation from the scaled load profiles. (The intermittent generation profiles must be matched to the weather conditions for each).
- Determine the 750 intervals with highest LSG for each scaled historical load profile.
- Average the plant output for the 750 intervals for each of the 3 years.
- Weighted the average values by the weighting appropriate to the peak demand distribution.
- Assign capacity value to the plant equal to the weighted average. If there are available assessments for prior years as if the plant were committed, then the same averaging would apply as for existing plants.

2.5 Proposal 2B - Individual Assessment; LSG 750 Intervals Average; Past 3 Years

Proposal 2B is the same as for Proposal 2A except that the LSG is based on the previous three historical years of data without scaling to forecast conditions.

2.6 Proposal 3 - Fleet Apportioned; Peak Load 90 Percentile

The Key Focus is to "Ensure system reliability is safeguarded by focusing on high percentile performance over peak hours in peak season to determine overall intermittent capacity value then allocate to individual plant on merit."

The principles to be applied are:

- Assign capacity value to the intermittent generator fleet at the 90th percentile level of trading interval output during the top 1% of thirty minute intervals for the most recent three years. This period is represented by 175 trading intervals per year.
- Apportion the fleet capacity value based on individual plant average performance over a moderate number of critical demand intervals.
  - This is achieved by rating the individual plants within the fleet capacity value, according to individual plant output during the top 250 intervals (selected on Load for Scheduled Generation) in each of the most recent three years.

The Process for existing plants (all plants with Capacity Credits) is:

- Determine the output of the intermittent generator fleet based on actual data (or available modelled data where actual data is not available) at the 90th percentile level of trading interval output during the top 1% of thirty minute trading intervals for the most recent three capacity years.

- Assign capacity value to the intermittent generator fleet at the 90th percentile level of interval fleet output for the selected periods.
- For each of the previous 3 years including all plants with Capacity Credits determine the LSG and rank the highest intervals.
- Determine the 3-year rolling average of the top 250 interval (LSG) performance for each intermittent generation plant, using actual, calculated or default values as available.
- Assign a capacity value to each plant such that the sum of the assigned values, weighted by 3-year rolling average performance and plant size equals the fleet capacity value.

The Process for proposed plants would assess each plant individually with the existing fleet:

- For each of the previous three years: subtract the modelled plant output from the LSG (previously determined for the existing fleet) and rank the highest intervals, then determine the modelled output for the plant in each of the 250 highest intervals and the combined fleet over the 175 trading intervals as before.
- Determine the three-year average of modelled or assigned values of output over the top 250 intervals in each year for the plant.
- Assign a capacity value to the plant such that the sum of the assigned value of the intermittent generation plant, weighted by 3-year rolling averages, equals the fleet capacity value.

These methods were applied using data for Albany, Walkaway, Emu Downs and three generic solar proposals:

- GPV – photovoltaic plant near Geraldton
- GST - a solar thermal power plant near Geraldton
- IST - a solar plant at an inland location east of Geraldton

Where chronological data were not available, the nearest equivalent day was included according to the best match of minimum and maximum daily temperatures and AM and PM average wind speeds.

2.7 Other variations

Some further variations were examined:

- Using the system peak demand instead of load for scheduled generation. This approach is not recommended because it does not model penetration or resource diversity effects on system reliability.

- Applying the Proposal 1 but using a 90% percentile level instead of the 95 percentile level in using the annual values from the top 12 trading intervals.

3 RESULTS

Some of the methods would be based on historical analysis and therefore the results are shown in the year that they would apply if calculated based on historical data and then applied two years hence. For example, for Proposal 1, the method could not be applied until two years of annual date were available as at September 2003 and that value would then have been applied for the capacity year commencing September 2006. Hence the earliest year for Proposal 1 is 2006 in Table 3-1 which summarises the aggregate results in MW. The values relative to rated capacity are shown in Table 3-2. The Proposal 2A involves rescaling future years and we have not attempted to do that until the capacity year commencing 2012, so a more limited set is provided for that method. The values are quite stable because we have not represented a change in the reference years. A change in the reference years would add volatility to the measure that is not revealed in the two Tables.

3.1 Proposal 1

Figure 3-1 shows the assessed rated capacity ratios for the incumbent wind farms using Proposal 1. The values are shown in the capacity year in which they would have applied if the method had been used from September 2003 when two years of loading data were available. There is some stability in the measure as more years of trading interval data are

Table 3-1 Summary of aggregate results (MW)

Proposal	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total Wind													
P1		9.7	26.9	37.2	41.4	29.4	34.2	30.0					
P1A		24.6	37.5	46.8	49.7	39.0	43.3	39.2					
P2A							71.2	73.0	71.9	72.2	71.9	72.1	72.0
P2B	53.8	58.1	61.1	61.9	63.7	61.9	65.6	65.1					
P3	13.5	16.0	19.7	23.3	23.1	22.7	27.3	23.3					
P1P		19.1	33.4	43.1	47.9	32.4	37.3	35.7					
Wind + GPV													
P1		112.3	113.0	117.7	119.5	100.2	102.0	104.4					
P1A		118.1	118.1	118.1	118.1	118.1	118.1	118.1					
P2A								129.1	127.2	126.9			
P2B	90.0	98.0	100.7	100.5	99.4	98.4	107.4	111.6					
P3	25.8	29.1	33.0	32.4	36.2	42.2	57.4	73.2					
P1P		113.7	117.3	121.8	124.3	104.5	108.3	110.2					
Wind + GST													
P1		110.6	110.9	116.7	120.2	115.6	115.5	117.3					
P1A		117.5	117.5	117.5	117.5	117.5	117.5	117.5					
P2A								133.3	133.7	133.3			
P2B	91.3	100.0	102.5	101.5	99.2	97.9	108.7	114.7					
P3	24.4	25.0	28.5	26.3	29.7	34.8	40.8	50.0					
P1P		146.3	141.9	142.5	145.8	136.1	137.0	138.5					
Wind + IST													
P1		41.8	62.8	75.4	84.1	74.6	80.0	84.4					
P1A		59.9	59.9	59.9	59.9	59.9	59.9	59.9					
P2A								128.1	126.4	125.9			
P2B	82.6	92.7	95.1	94.8	93.1	92.8	102.2	108.9					
P3	16.6	24.1	27.5	26.3	26.8	30.4	42.4	66.0					
P1P		54.5	73.3	86.5	95.0	83.3	86.8	91.6					

Table 3-2 Summary of aggregate results (ratio of rated capacity)

Proposal	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total Wind													
P1		0.05	0.14	0.20	0.22	0.16	0.18	0.16					
P1A		0.13	0.20	0.25	0.26	0.21	0.23	0.21					
P2A							0.38	0.39	0.38	0.38	0.38	0.38	0.38
P2B	0.28	0.31	0.32	0.33	0.34	0.33	0.35	0.34					
P3	0.07	0.08	0.10	0.12	0.12	0.12	0.14	0.12					
P1P		0.10	0.18	0.23	0.25	0.17	0.20	0.19					
Wind + GPV													
P1		0.39	0.39	0.41	0.41	0.35	0.35	0.36					
P1A		0.41	0.41	0.41	0.41	0.41	0.41	0.41					
P2A								0.45	0.44	0.44			
P2B	0.31	0.34	0.35	0.35	0.34	0.34	0.37	0.39					
P3	0.09	0.10	0.11	0.11	0.13	0.15	0.20	0.25					
P1P		0.39	0.41	0.42	0.43	0.36	0.37	0.38					
Wind + GST													
P1		0.38	0.38	0.40	0.42	0.40	0.40	0.41					
P1A		0.41	0.41	0.41	0.41	0.41	0.41	0.41					
P2A								0.46	0.46	0.46			
P2B	0.32	0.35	0.35	0.35	0.34	0.34	0.38	0.40					
P3	0.08	0.09	0.10	0.09	0.10	0.12	0.14	0.17					
P1P		0.51	0.49	0.49	0.50	0.47	0.47	0.48					
Wind + IST													
P1		0.14	0.22	0.26	0.29	0.26	0.28	0.29					
P1A		0.21	0.21	0.21	0.21	0.21	0.21	0.21					
P2A								0.44	0.44	0.44			
P2B	0.29	0.32	0.33	0.33	0.32	0.32	0.35	0.38					
P3	0.06	0.08	0.10	0.09	0.09	0.10	0.15	0.23					
P1P		0.19	0.25	0.30	0.33	0.29	0.30	0.32					

included in the annual averages. The black line represents the 95th percentile value based on the annual values.

The corresponding results using a 90th percentile value is shown in Figure 3-2 (denoted case 1A). The values are typically about 5% of rated capacity higher and have very similar variability. If the assessment had been based on the system peak demand at the 95th percentile instead of Load for Scheduled Generation, the assessed capacities would have been much greater as shown in Figure 3-3 compared to Figure 3-1. These results are about 3% of rated capacity higher than the LSG model. However, we do not recommend using system peak demand because it does not recognise the impacts of supply diversity among the intermittent resources and it does not represent the effects that would occur to system reliability with higher levels of penetration.

Figure 3-4 shows the impact of adding the three types of solar projects to the wind portfolio with the results shown as a ratio of rated capacity. The following features are of importance:

- The diversity effects are significant especially in the early period when there was not much data

Figure 3-1 Proposal 1 – wind only - LSG

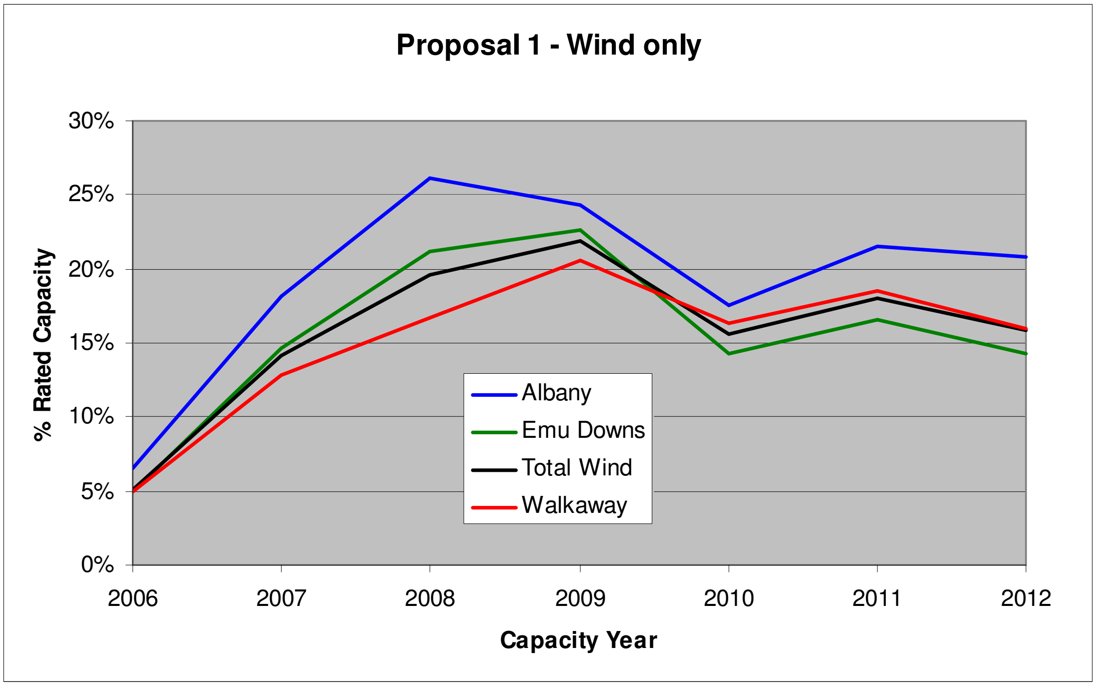
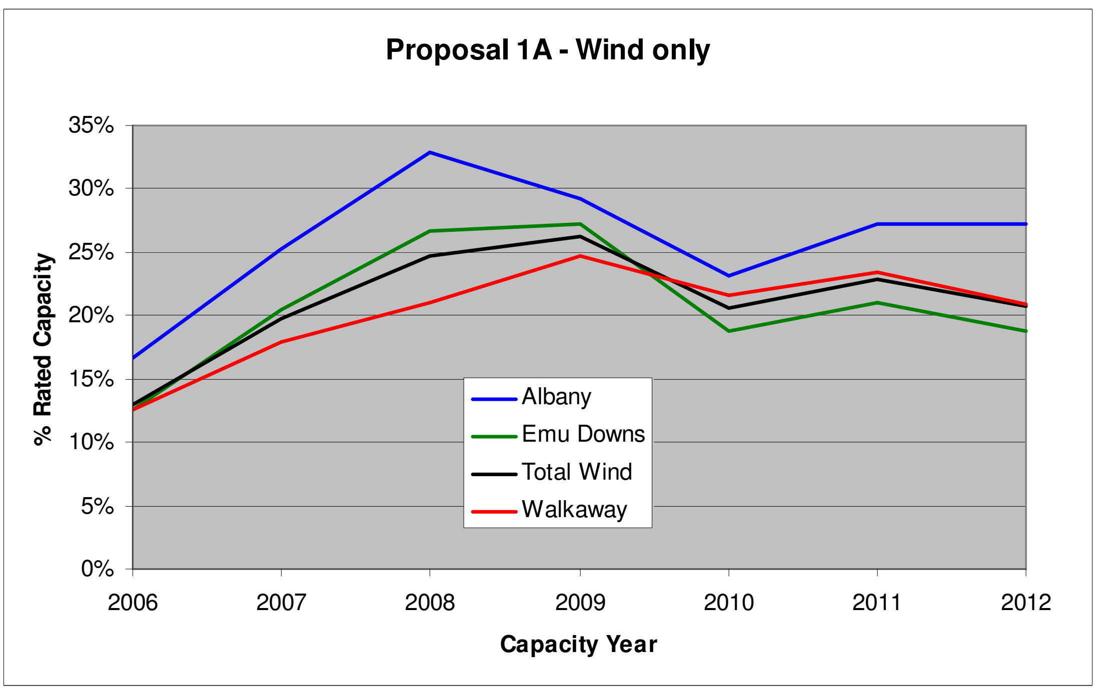
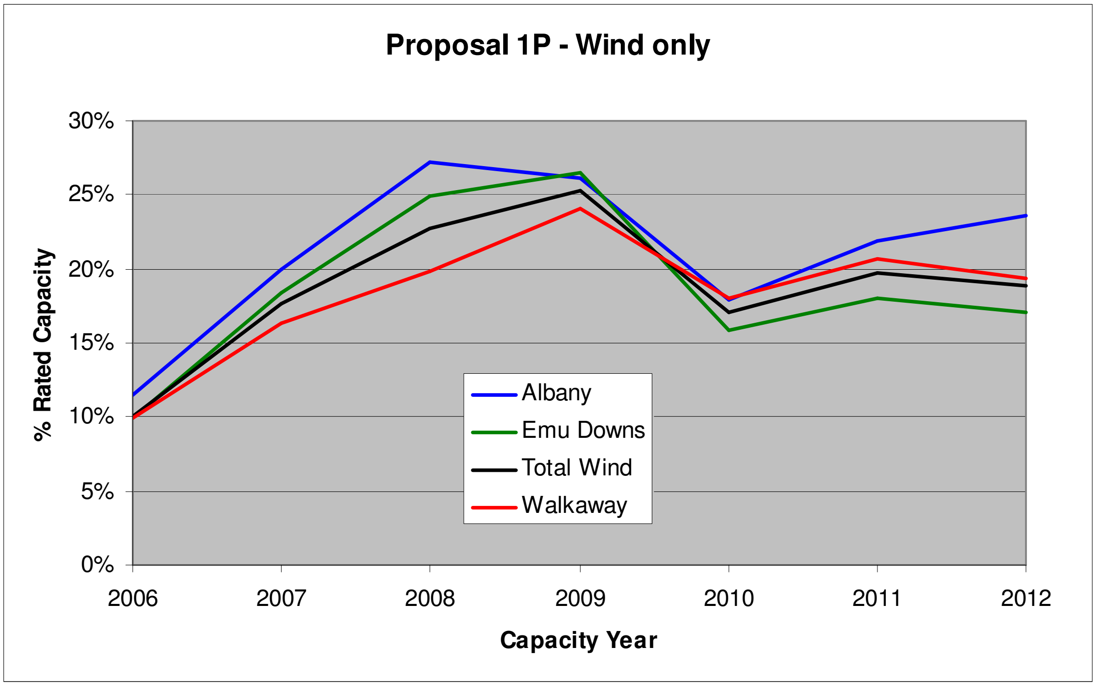


Figure 3-2 Proposal 1A – wind only - LSG



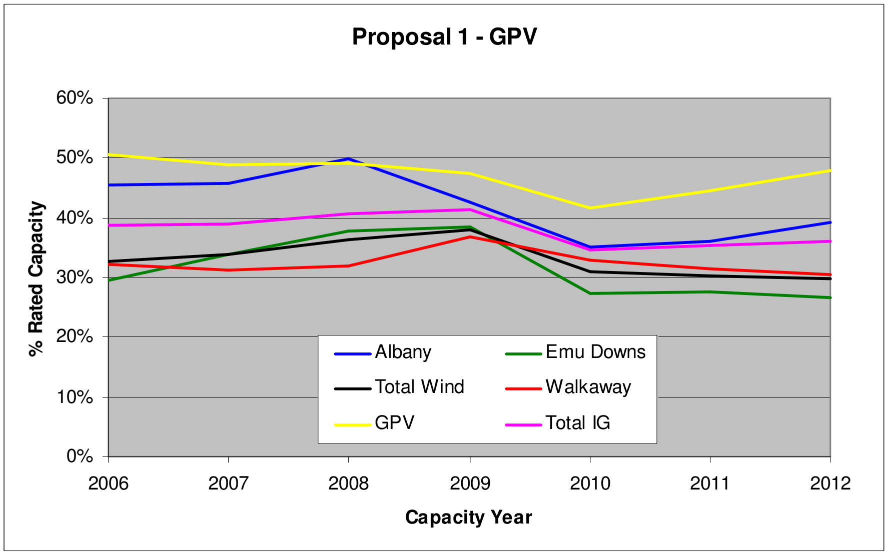
- The IST project has an unfavourable impact on the fleet as a whole due to some unfavourable patterns of generation which result in low levels of intermittent generation in the 12 trading intervals. This is an example of how the limited period for selection of the fleet performance has a direct influence in creating significant volatility in the measure. This is not a desirable outcome.

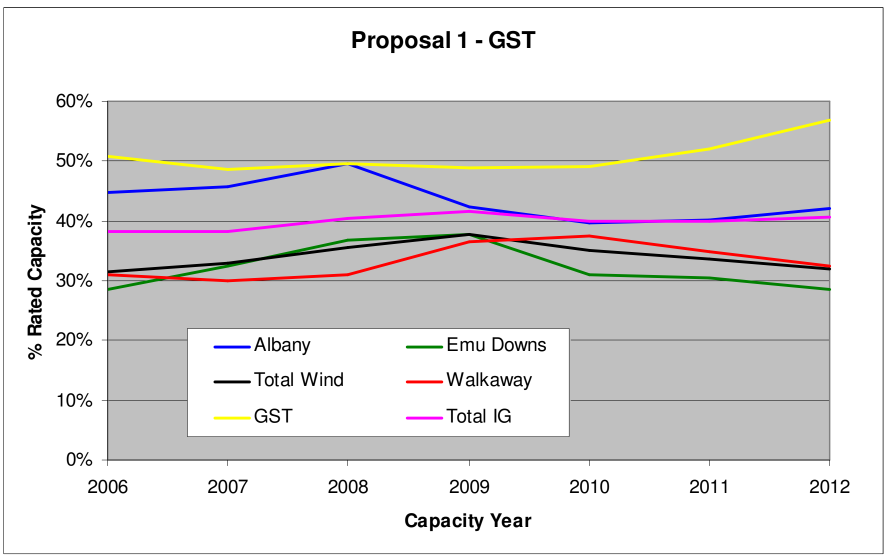
Figure 3-3 Proposal 1P – wind only - LSG



- The solar credits do seem to be enhanced in the later years. This may be due to drier and sunnier weather which enhances the output. The enhanced solar value does not pass through to the wind farm assessments, which is appropriate.
- The relative wind contributions are similar despite the varying effect of the different solar resources.
- The overall assessed capacity for wind is much less than what was obtained from the LOLP and reliability equalisation analysis previously reported, although comparable to the lower end of the range given the uncertainty in that assessment as shown in Figure 3-5. The previous work showed the 90th percentile capacity value for the wind farms at about 35% capacity ratio which is similar to the value shown in Figure 3-4 with the solar plants added (particularly GPV and GST). However the higher value for wind is then dependent on these other resources whereas the market modelling showed these higher values for wind capacity were not dependent on additional resources.
- We therefore conclude that this method would be too conservative and would create potential distortions among different resources due to the fleet based assessment depending on so few trading intervals even though they are averaged over at least 8 years.

Figure 3-4 Impact of additional of solar projects – Proposal 1





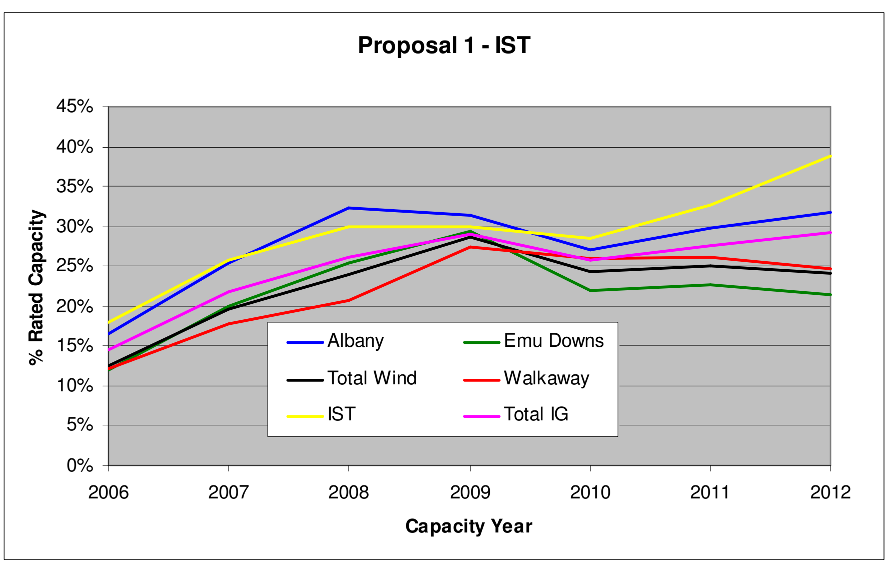
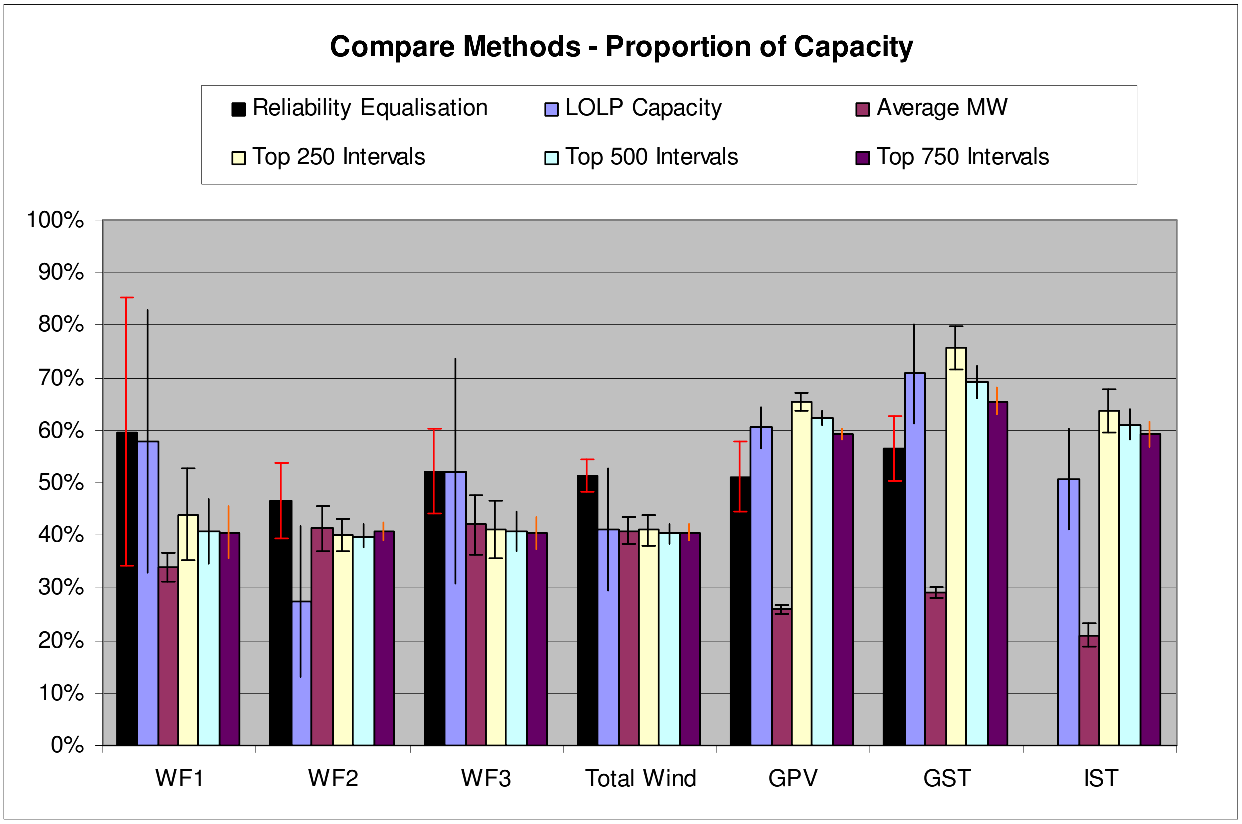


Figure 3-5 Comparison of Methods



Source: Figure 7-1 from previous MMA analysis

3.2 Proposal 2A

Proposal 2A results are shown in Figure 3-6. The values are only shown for future years as they rely on scaling load shapes. This analysis has been done for the existing wind portfolio to 2016/17 but no further. The combined solar profiles have not been assessed beyond 2013/14, however there is little change. The main source of change would occur when new representative years for 50%, 30% and 10% POE exceedance load profiles are adopted. That could potentially alter the assessment. Progressively the volatility would be expected to decline as more information becomes available about the coincidence of intermittent generation output and high system demand.

The assessed capacity value ratios are similar to that which was obtained from reliability analysis as shown in Figure 3-5. The volatility would be low in most periods because the representative years would only be updated once every 3-5 years on average.

3.3 Proposal 2B

Proposal 2B relies on averaging over the most recent three years and therefore there would be some year to year volatility in the result as new information is included and previous historical generation patterns discarded in the analysis. This method has been

Figure 3-6 Proposal 2A Capacity Value Ratios

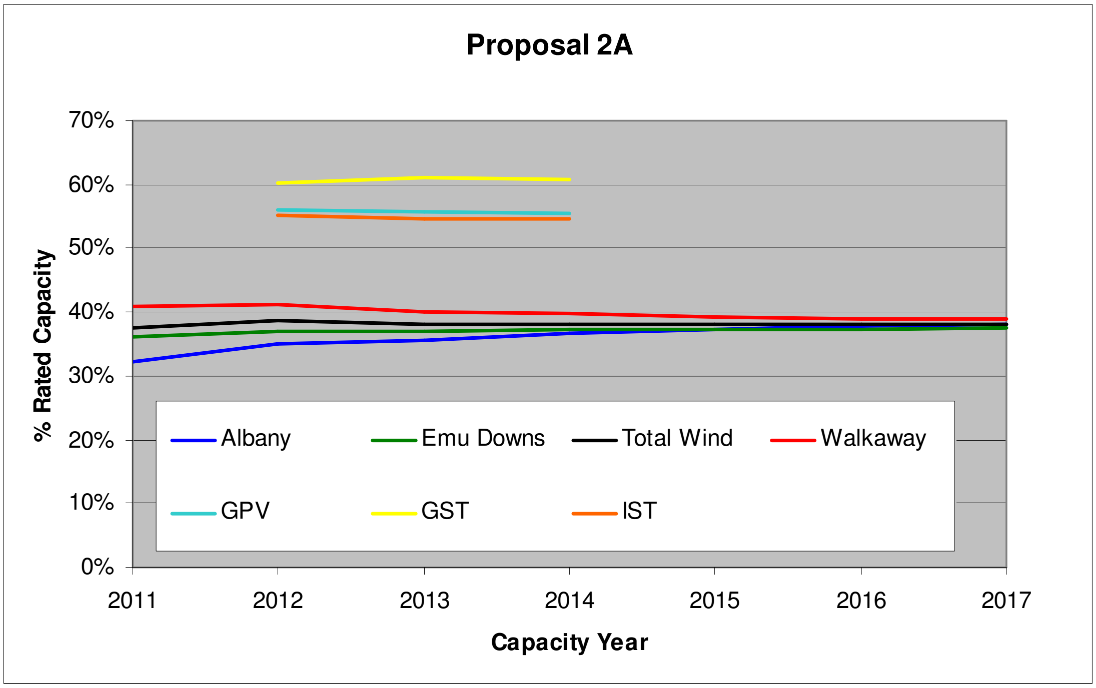
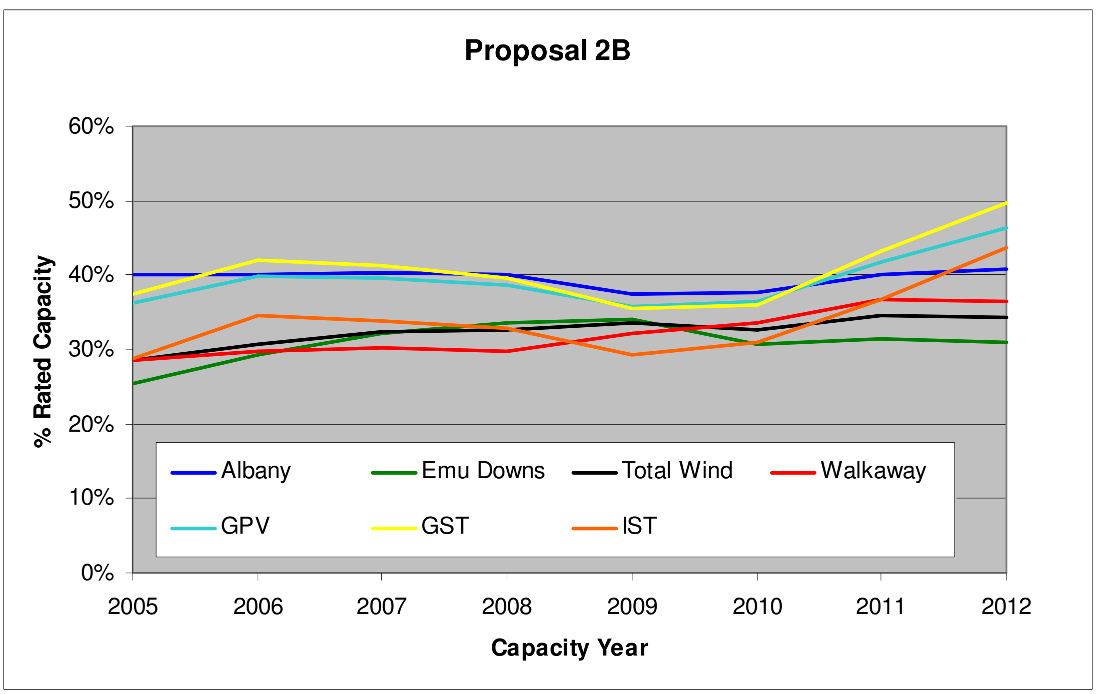


Figure 3-7 Proposal 2B Capacity Value Ratios

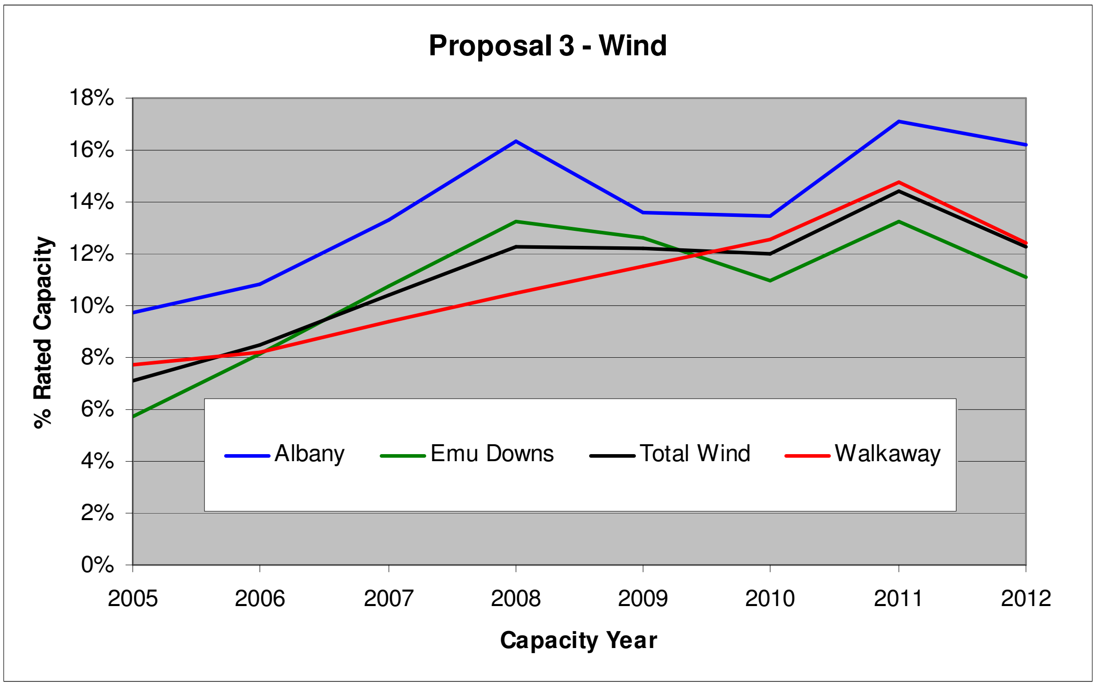


used to calculate the applicable capacity value ratios that would have applied from 2005/06 to 2012/13 capacity years as shown in Figure 3-7. The value of the solar resources increases toward the end of the period. The wind values show some variation with a slight increasing trend as the system demand increases. These values are lower than those for Proposal 2A as they are not based on a forward looking perspective.

3.4 Proposal 3

Proposal 3 also looks back using the last three years of data and applies a 90 percentile level based on the top 1% of trading intervals (175 per year). Figure 3-8 shows the resulting capacity value ratios for the existing wind farms as a fleet without additional intermittent generation resources. There is a moderate level of volatility from year to year which is primarily affected by the application of the 90 percentile over the limited number of trading intervals. The capacity value assessed is well below the range shown in Figure 3-5 from the reliability analysis.

Figure 3-8 Capacity value ratios for Proposal 3 for wind farms only

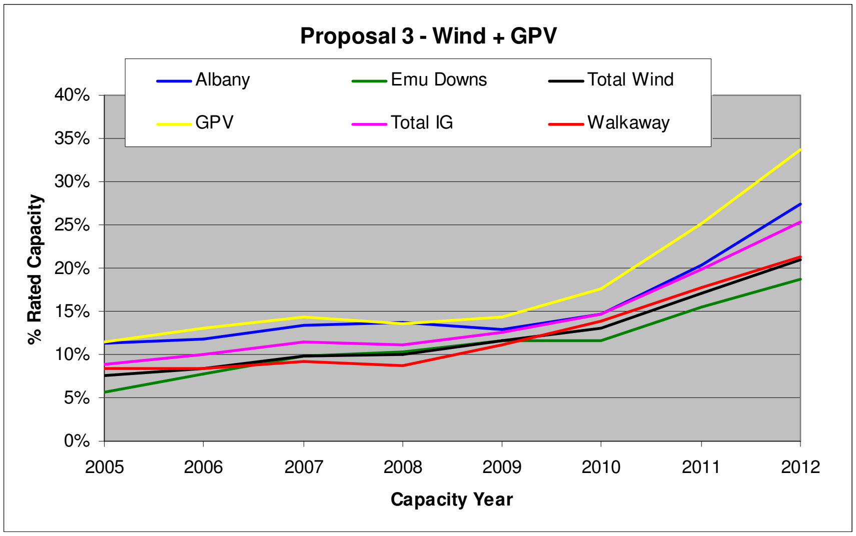


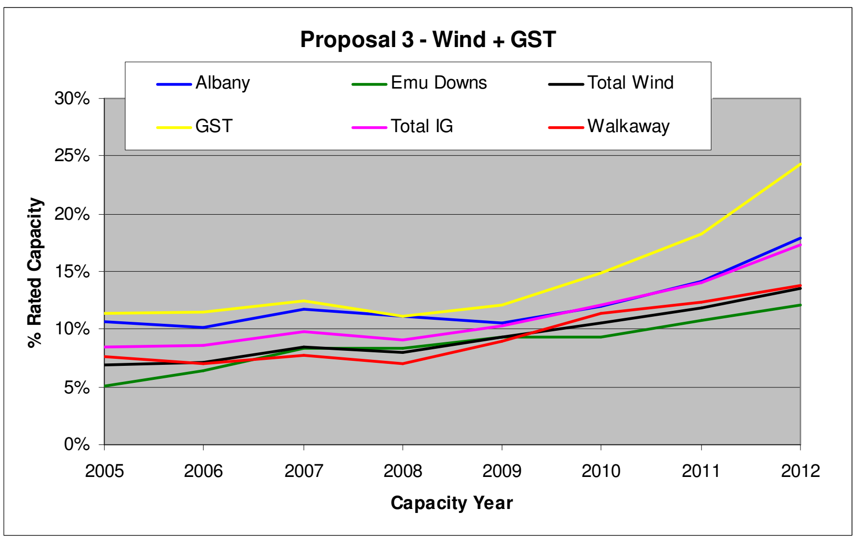
The impact of adding solar resources under Proposal 3 is shown in Figure 3-9. The assessed capacity increases over time as the system demand increases. The capacity allocated is quite sensitive to the mix of resources due to the way it influences the choice of the 175 trading intervals for the fleet capacity measure. Under this method a hotter and drier period that results in higher output for the solar resources would also increase the capacity assessed for the wind farms. Thus there would be some interactions among the assessed values that would be moderately volatile from year to year.

3.5 Total assessed capacity

Figure 3-10 shows the total assessed capacity for the existing wind farms and for the average of the three types of solar resources for the four proposals. The results show that Proposals 1 and 3 are unduly conservative for wind and that only Proposal 2B obtains a reasonable capacity value for solar resources. On this basis only Proposal 2 B would meet the objective that the assessed values should be consistent with reliability analysis.

Figure 3-9 Capacity value ratios for Proposal 3 with solar resources





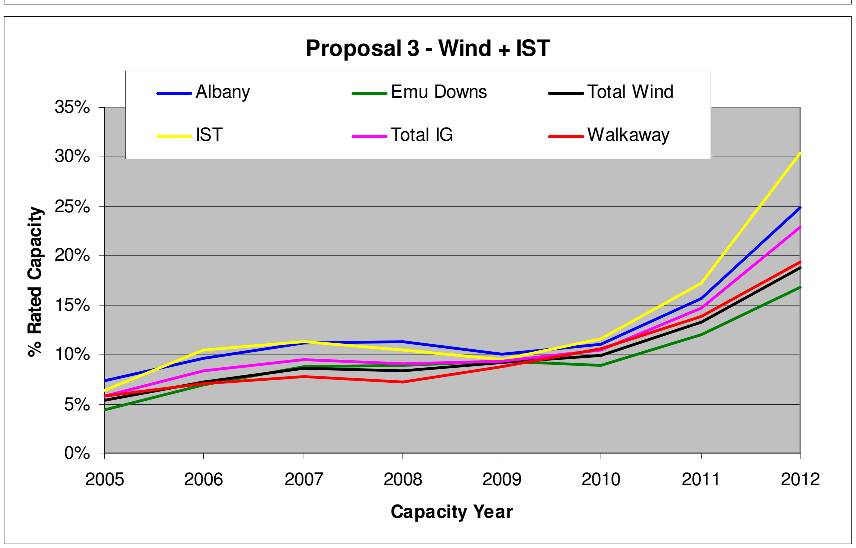
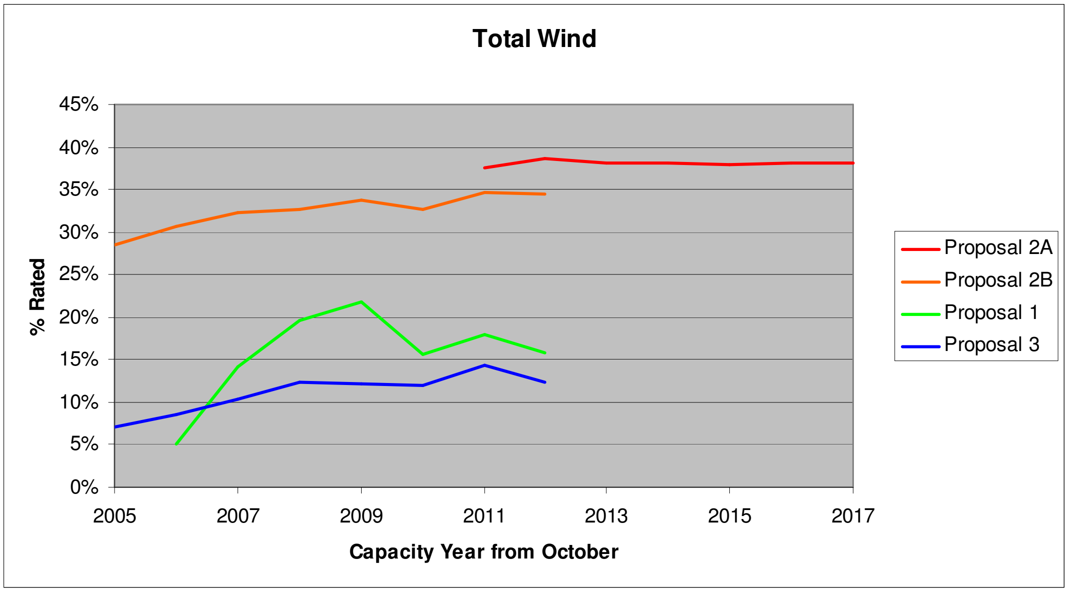
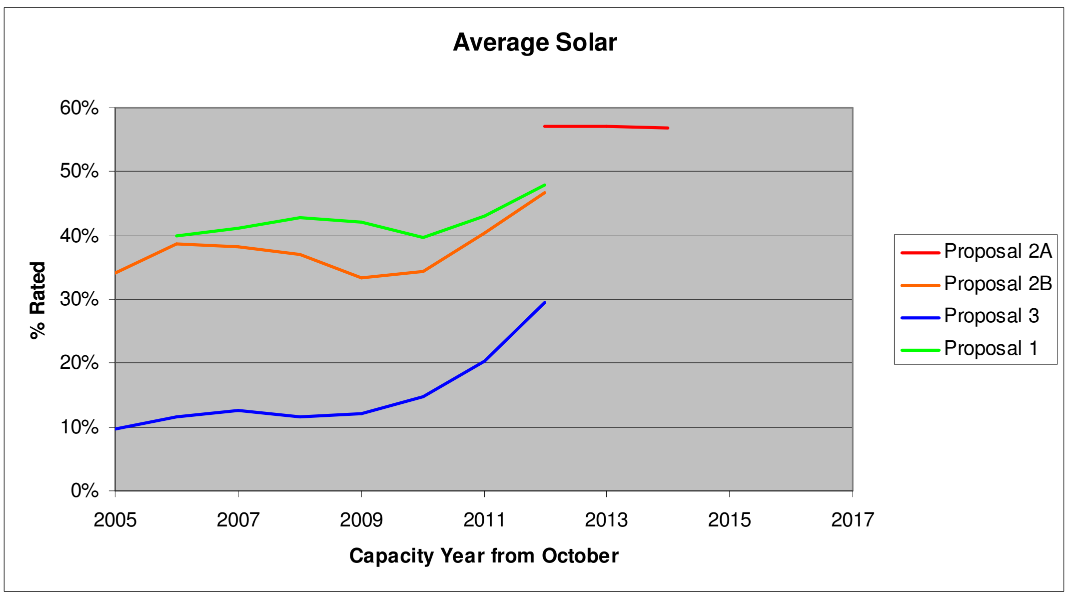


Figure 3-10 Total assessed capacity for the proposals





3.6 Comparison of methods

The various proposals have been compared with reference to the following criteria in Table 3-3:

- Basis – how are the capacity values assessed
- Transparency – it is easy to understand how the method works and how to replicate it?
- Simplicity – is the method simple to apply?

Table 3-3 Comparison of proposals

Proposal ► Criteria ▼	**1**	**2A**	**2B**	**3**
Basis	Fleet POE for 12 TI, shared on last three years 250 TI	750 TI for selected high demand years scaled to forecast	750 TI based on last three years	Fleet POE on 175 TI, shared on 250 TI over last three years
Transparency	Moderate – complex interactions but based on history	Moderate – some interactions and forecasting uncertainty	High – based on history	Moderate – some interactions
Simplicity	Moderate	Moderate	High	Moderate
Fleet POE	95%			90%
Accuracy and Robustness	Low (Conservative)	High – best represents reliability impact	Moderate (Conservative)	Low (Conservative)
Continuity of valuation	Low due to significant interactions among resources	High – changes infrequently, but then substantially	Moderate due to year to year variations	Moderate with significant interactions among resources
Overall assessment	Too conservative	Best fit to criteria	Very conservative for solar and inaccurate	Very conservative and inaccurate

- Fleet POE (probability of exceedance) - what level of conservatism is applied in selecting the measure of output which qualifies as the basis for measuring the effective capacity?
- Accuracy and robustness – how accurate and stable is the measure obtained?
- Continuity of valuation – will the measure change slowly over time or will it jump about from year to year?

The assessment shows that Proposal 2A is the best fit to the reliability assessment and that it is able to adapt to changing market scale and levels of penetration. The other methods are either too conservative or only backward looking and are unlikely to provide a robust and accurate assessment of reliability impacts.

The main disadvantage of Proposal 2A is that is may provide a sudden change in assessed value when new load shapes are selected to represent the 50%, 30% and 10% probability of exceedance peak demand profiles. This volatility could be well managed by using such approaches as:

- multi-year averaging as is used in the other methods to smooth the transition to the more accurate assessment
- increasing the number of historical years as they become available and developing methods for selecting suitable data when historical measurements are not available for the currently selected years
- limiting the rate of change of the capacity ratios.

3.7 Use of system peak demand

Each of the method was tested for the impact of using system peak demand instead of Load for Scheduled Generation. As expected the assessed capacity value was always higher when using system peak demand because doing so does not address the impact of higher levels of penetration. A summary of the effects of using system peak demand is provided in Table 3-4 for the last three years of assessments.

Table 3-4 Increase in assess capacity ratio by using system peak demand

Proposal ►	P1	P2A	2B	3
Total Wind	2% - 18%	4%	8%	25% - 35%
Average Solar	10% - 26%	5%	22%	35% - 52%
Total Intermittent	5% - 18%	5%	13%	25% - 43%

Generally use of system peak demand would result in a significantly higher capacity assessment, especially where the method is very conservative using Load for Scheduled Generation. MMA would not recommend using system peak demand to overcome the conservatism. It would be preferable to use Load for Scheduled Generation and select the time periods to best reflect the system reliability impact. Using the percentile methods to apply a conservative approach does not accurately represent the value of output well above the minimal levels with respect to long-term reliability.

4 CONCLUSIONS

An analysis of various methods of calculating and smoothing the assessment of capacity for intermittent generation has shown that Proposal 2A which relies on selected periods of high system demand can produce a robust estimate of capacity value. Volatility of the measure could occur when the base years of 2002/03 to 2003/05 are changed to reflect more recent examples of coincidence of peak system demand and intermittent generation output. However sudden changes could be avoided by smoothing the assessment over a number of periods or by limiting the rate of change of the assessed capacity value ratio.

The use of Load for Scheduled Generation as the measure of system stress is much preferred over using system peak demand because it is better matched to the conditions that reduce system reliability. It is the load to be supplied from the scheduled generation which better reflects the impact on system reliability. Previous analysis by MMA has shown a direct relationship between Load for Scheduled Generation and loss of load probability on a trading interval basis. By using LSG it is easier to represent the effects of higher penetration of intermittent generation and the effect of diversity of different resources and locations. This is important in providing new entrants with the incentive to locate new intermittent generation where it can provide a better contribution to system reliability without reducing its overall economic value in providing energy at non-peak times.