Calculation of Unforced Capacity Ratings (UCAP)

Rationale

3.1 Calculation of UCAP

3.1.1 – 3.1.2

UCAP is intended to represent the reliability contribution of a capacity asset's physical reliability during tight supply market conditions. UCAP captures an asset's observed operational performance over a defined historical period, including its performance during system scarcity conditions. Adopting UCAP as the standard capacity product for the Alberta capacity market creates a consistent and measurable supply adequacy product that allows different technologies to compete on a level playing field (i.e., 1 MW of UCAP should deliver the same amount of reliability regardless of the underlying technology).

The AESO considers that it is the entity best suited to perform UCAP calculations, given that the AESO is an independent entity that does not own or operate any power facilities, does not have a financial stake in the electricity industry, and currently collects the data needed to perform UCAP calculations. Furthermore, given that the AESO is responsible for maintaining system reliability, the AESO is well positioned to ensure a common approach for assessing the reliability value of each asset.

The AESO will calculate an annual UCAP to align with the capacity obligation period. Feedback from stakeholders identified that a seasonal UCAP and seasonal obligation period could introduce the following complexities:

(a) reduced investor certainty due to the difficulty in forecasting capacity market revenues;

(b) difficulties associated with the need for a higher price cap in a seasonal auction, which is required for assets that might only clear one season but require a full year's worth of capacity revenue to remain in the market; and

(c) the estimation of a seasonal capacity volume and seasonal UCAP becoming increasingly difficult as the period of estimation becomes more granular given the data available to the AESO.

The intent of using a UCAP is to link the reliability of a capacity asset to the individual performance of that asset during tight supply conditions, creating an incentive for the capacity market participant to maintain high availability for the capacity asset when the system needs it the most. A capacity asset that performs, on average, better than or equal to its UCAP during periods of system stress may receive a higher UCAP for future auctions.

The AESO will calculate UCAP by averaging the available capability or the metered volumes (capacity factor) of assets during hours with tight supply cushion over the previous five years. The availability capability or metered volumes determination for assets is described below. This approach has the following benefits:

- Using historical performance of assets during times when capacity was required provides an expectation of what the assets can be relied on to provide in the future.
- This approach implicitly captures the correlation of each capacity asset's capacity value and the drivers of tight supply cushions, such as: seasonal load, seasonal derates, seasonal output levels and planned outages. These historical observations provide the AESO confidence on each asset's contribution to supply adequacy without having to establish complex assumptions and modelling relationships that would be required in

alternate approaches such as Effective Load Carrying Capability (ELCC) or Equivalent Forced Outage Rate (EFORd).

- This methodology is simple and replicable allowing an asset owner to have clear signals on how to increase its asset's UCAP.
- This approach is connected to supply cushion hours and is directly aligned to Alberta capacity needs. Further the alignment with the performance assessment approach sends the right incentives to asset owners to maintain and increase the UCAP rating of their assets.
- Given Alberta's high load factor, planned outages can drive supply shortfall situations. By leaving all the drivers of availability, including planned outages, in the calculation the approach ensures that capacity market participants are measured on a full suite of resource adequacy contributions or limitations.

The AESO recognizes that using historical data has limitations. For example, incentives were different in the past and history may not be a perfect indicator of the future. Tight supply periods may change in the future to be more heavily weighted in different periods than have occurred in the past. A UCAP determination approach that is based on five years of historical data will always have some amount of lag in reflecting changes to an asset's UCAP. The UCAP refinement process described in subsection 3.2 of CMD Final is intended to provide capacity market participants with an opportunity to request changes to the hours or data used to calculate an asset's UCAP due to specific circumstances listed in section 3.2, provided sufficient evidence is produced.

The AESO explored methodologies for measuring reliability in other capacity markets, including approaches based on installed capacity, effective load carrying capability and equivalent forced outage rate:

(a) **Installed capacity (ICAP).** ICAP reflects the "nameplate" capacity of an asset adjusted for temperature derates. Using the ICAP approach for determining the capacity value of assets may create an adverse selection problem for the AESO, where assets with lower performance and poorer reliability will clear the auction because they are able to bid at lower costs (by saving on plant maintenance) relative to the higher performing assets that are more expensive because they invest in their maintenance. ICAP may overstate an asset's ability to provide capacity during tight supply cushion hours since it does not account for forced or planned outages and other derates.

(b) **Effective Load Carrying Capability (ELCC).** ELCC measures the capacity of an asset by simulating the asset's contribution to system reliability. This is accomplished by calculating the unserved energy expectation of two different scenarios, one with and one without the asset. The AESO will not be using an ELCC approach for the initial implementation of the Alberta capacity market because this approach is less transparent and far more complex to implement than the chosen UCAP methodology. Due to the large number of modelling inputs required to complete this analysis, capacity market participants would likely not be able replicate the UCAP that the AESO calculated for its asset.

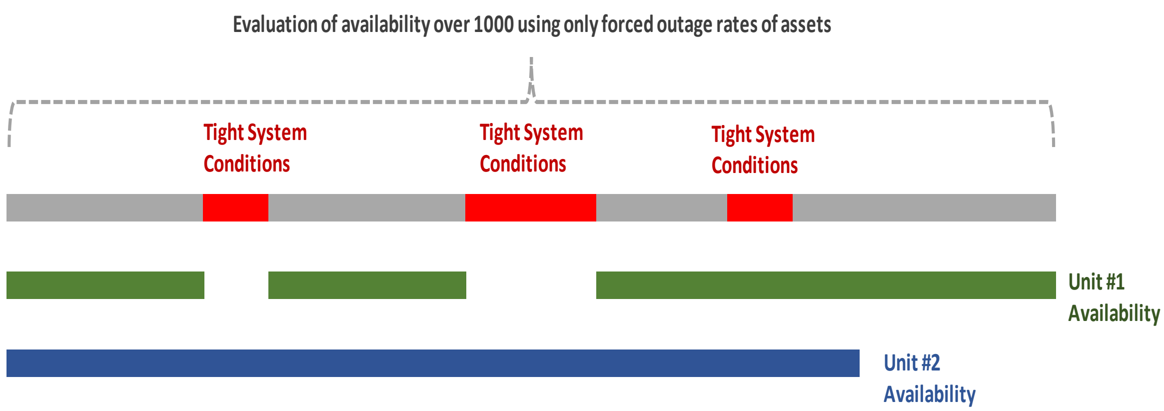
(c) **Equivalent Forced Outage Rate (EFORd).** EFORd measures the probability that an asset will not be available when required due to uncontrolled or unplanned outages or derates. The information market participants historically provided in an energy only market construct is not to the level of detail required for the AESO to accurately complete an EFORd statistic for all assets. The capacity factor and availability factor approaches, which use energy market data in their determination, will provide an equivalent measure of unit reliability during periods of tight supply conditions.[1]

Stakeholders that have advocated for the use of EFORd-based incentive schemes (and the use of 1,000+ hours) suggest that the AESO should assess performance in ways other than energy delivered during tight system conditions, such as rewarding an asset's long-run average availability. It is the AESO's view that this would not create the right signal for asset performance in the capacity market. An asset's UCAP that is based on the asset's long-run average availability over a significant number of hours (1,000 or more) will not reflect the likelihood that an asset will be available during shortage conditions.

For example:

Two assets run for 1,000 hours each. Many of these hours have adequate supply and reliability is not at risk. The system experiences 50 tight supply conditions during the year. Based on EFORd measures, an asset that delivered energy for every hour the system was in tight supply conditions and an asset that was offline for every hour of tight system conditions will receive substantially the same availability measure. Figure 1 below illustrates how EFORd and the use of 1,000 hours does not account for tight system conditions when evaluating the reliability potential of an asset.

Figure 1 – *Evaluation of availability over 1000 using only force outage rates of assets*



UCAP based on forced outage rate (EFORd)	
Unit #1 Availability	85%
Unit #2 Availability	85%

Contribution to system reliability during tight system conditions	
Unit #1 Availability	25%
Unit #2 Availability	100%

The AESO also received feedback from stakeholders recommending the creation of an EFORd-based UCAP methodology. In the AESO's view, such an approach would misalign incentives by compensating assets for availability during periods when the system is not deficient in reserves, and when no additional reliability is necessary.

[1] For clarity, the RAM described in subsection 4.2 of Section 3, *Calculation of Demand Curve Parameters,* makes assumptions regarding outage rates for thermal assets based on available capability data to determine conditions of tight supply in the Monte Carlo simulation, which assesses system reliability.

3.1.3 The AESO will not calculate UCAP for the asset types that will be ineligible for the capacity market. Please refer to subsection 2.1.2 of the rationale document for Section 2, *Supply Participation* for assets that are ineligible for participation in the initial capacity market.

3.1.4 – 3.1.5

The AESO recognizes that calculating UCAP based on historical performance may not capture all of the transitional issues that arise from moving from an energy only market to a market structure with both capacity and energy markets, as well as be fully indicative of future performance in the capacity market. The purpose of the UCAP range is to recognize this transitional issue and provide capacity market participants with the flexibility to select a UCAP within a predetermined range that may better reflect the asset's potential performance in the capacity market.

Each asset will be able to choose a UCAP by selecting the highest or lowest value determined from these three approaches:

- a UCAP range established in accordance with the elimination approach as in 3.1.6,
- a range of +/-2% multiplied by the asset's maximum capability. These values will be added and subtracted to the UCAP of the asset to calculate an alternate UCAP range.
- every capacity asset will receive a UCAP range of at least +/- 1 MW of UCAP

The AESO believes that allowing participants to select the UCAP of their assets with these ranges reasonably addresses the concerns of market participants that assets would perform differently under the incentive scheme of the capacity market than they performed under the energy market only incentives.

3.1.6 The elimination approach involves eliminating 5% of the hours in which an asset was the lowest performing, effectively raising average performance to determine an upper range, and to eliminate 5% of the hours in which the asset was the highest performing, effectively lowering average performance to determine a lower range. The elimination approach will result in asset-specific UCAP ranges, which will reflect that the reliability value of each asset may vary based on historical performance. Below is an illustration of the AESO's elimination approach:

Figure 2 – *Elimination approach for determining UCAP range*

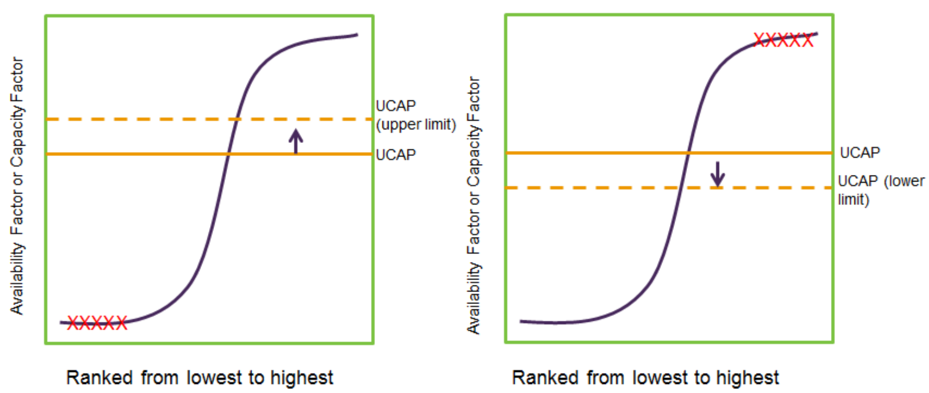


Table 1 below provides an example of each methodology for an asset that has a UCAP of 10 MW, and an MC of 12. The asset's availability factor is 83%.

Table 1 – *Example UCAP ranges*

	Elimination Approach*	+/- 2%	+/-1 MW	Final Range
UCAP (upper limit)	10.1 MW	(12MW*0.02) +10 10.24 MW	11 MW	11 MW
UCAP	10 MW	10 MW	10 MW	10 MW
UCAP (lower limit)	9.9 MW	(12MW * -0.02) +10 9.76 MW	9 MW	9 MW

*Based on historical performance, the elimination method established a UCAP range at +/-1% of availability factor

Stakeholders suggested using the minimum and maximum single-year UCAP values to establish the upper and lower bounds of the UCAP range (the "minimum/maximum method"). The AESO has performed analysis on this approach and compared it with the elimination approach and has determined that the minimum/maximum method establishes very wide UCAP ranges for certain assets, capturing near zero to full maximum capability of an asset in some instances. Consequently, the minimum/maximum method does not align with the intent of UCAP, which is to represent the reliability value of an asset during the tightest supply cushion hours. There are a number of negative consequences if UCAP ranges are too wide:

(a) Reliability concerns where market participants may use the ranges to overstate their UCAP because they assess the risk of performance events as low. This could introduce issues of adverse selection where less reliable assets select high upper values for their UCAP and potentially displace higher reliability assets

(b) Market distortion concerns where market participants may use ranges to lower the UCAP in order to withhold capacity from the auction.

(c) They may make the reliability value somewhat arbitrary and meaningless.

Stakeholders also suggested using a standard deviation approach to establish a UCAP range. This approach would compare all of the data points used in determining UCAP, to the final UCAP value to determine the standard error. However, due to the large range established through this approach, particularly for variable resources, this would again deviate from the intent of UCAP.

The UCAP range will not be applicable to demand response capacity assets or external capacity assets. The purpose of the UCAP range is primarily to handle transitional issues. Both of these asset types are considered new assets for the first capacity auction, and do not have any historical data to adjust to address transitional issues.

3.1.7 The minimum size requirement of 1 MW aligns with energy market minimum block size and the declaration of available capability. In order to perform an availability assessment, an available capability must be captured and maintained for the capacity asset.

3.1.8 Final asset level UCAPs will be shared publicly during the pre-auction period to support a fair, efficient and open market which involves minimizing information asymmetry. The data currently published on the AESO website may enable sophisticated market participants to estimate, with some accuracy, the UCAP values for most of the generating units in the market. If sophisticated market participants can derive information from public data with a good degree of accuracy, then this information should be made available to all market participants. Otherwise, the market would not offer a level playing field for small and large participants.

UCAP for capacity assets that meet the minimum threshold of hours for calculating UCAP per Section 3.1.11

3.1.9 Due to the different operating characteristics of variable and dispatchable assets, the AESO will use two UCAP methodologies to appropriately represent the reliability value of each type of asset.

Availability factor methodology

The availability factor methodology relies on historical declarations of a capacity asset's available capability. The AESO is using the availability factor methodology for an asset that can respond to a dispatch and/or have metered volumes that align with its dispatch. For this asset the available capability declaration represents its full generating capability or load reduction in that period. Data in the Energy Trading System is presumed to be accurate given the must-offer must-comply obligation in subsection 3 of Section 203.1 of the ISO rules, *Offers and Bids for Energy*. As a result, the available capability declared by dispatchable assets in the past provides a reasonable representation of a dispatchable asset's future ability to perform under similar conditions.

Capacity factor methodology

UCAP for all capacity assets whose generation capability is dependent on a fuel supply that is uncontrollable (i.e., wind, sunlight or water) and have no storage capability will be calculated using the capacity factor approach. While such an asset may be capable of producing energy, it may not be available to do so due to the variable nature of its fuel source. Therefore, the capacity contribution of these assets will be calculated using the capacity factor methodology.

CMD 1 considered using maximum metered volumes as the denominator in the hourly capacity factor calculations. However, maximum metered volumes may capture outlying values where load goes offline and the generation remains active (i.e., outside normal operating conditions), which requires the AESO to identify outliers. The AESO has determined maximum capability as the denominator in the hourly capacity factor calculation provides a more stable value that only changes when the capacity market participant changes an asset's capability.

Availability factor through linear regression

The AESO will use a linear regression UCAP determination approach for self-supply assets that chose to be dispatched at a gross generation meter. This approach has been developed in response to stakeholder comments that the previously recommended capacity factor approach did not provide recognition for available but not dispatched generation levels. This approach will recognize the undispatched generation availability and ancillary services volumes, when applicable, while determining a UCAP level that also recognizes how gross dispatch generator volumes compare to net to grid energy volumes.

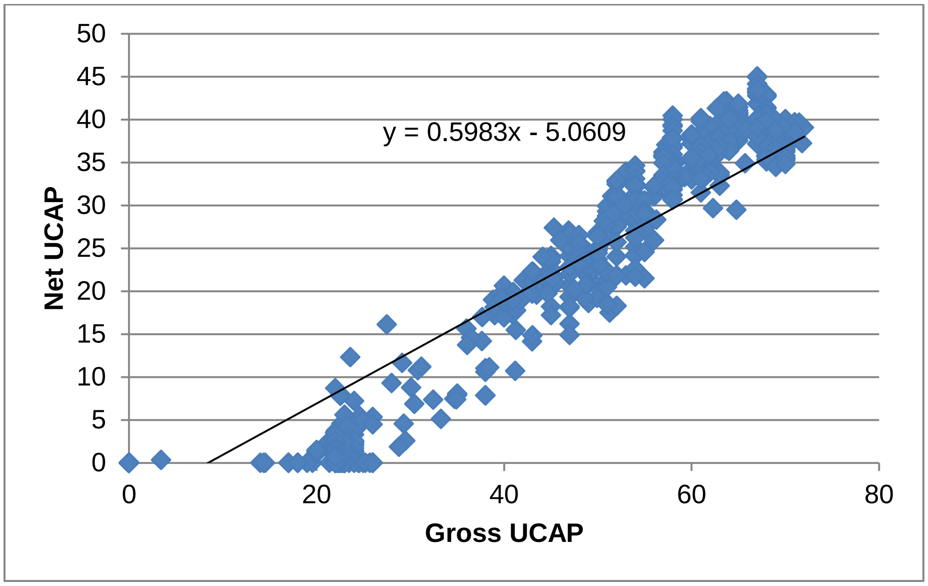
The AESO will perform a linear regression of the capacity asset's net to grid metered output against dispatch level over the historical tight supply cushion hours. The linear regression provides a historical review of how gross generation dispatches have translated into net to grid energy volumes. This linear regression will create a formulaic representation of this relationship in the form of a line: $Y = M(X)+B$.

This approach will rely on historical declarations of a capacity asset's available capability. The AESO will use these declarations to determine a "gross to grid" UCAP based on availability factor methodology described above and in section 3.1.9.a.

The AESO will use these "gross to grid" UCAP value as the (X) variable in the linear regression formula to calculate the self-supply site's UCAP for use in the capacity market.

For example, the linear regression determines the relationship between the site's gross generation dispatch (gross UCAP in the graphic below) to the site's net to grid energy volumes (net UCAP in the graphic below). This relationship can be expressed as a line formula.

Figure 3 – *Example linear regression for self-supply dispatched gross-to-grid*



The site's gross to grid UCAP is calculated using the capacity asset's available capability (AC) and maximum capability over the historical tight supply cushion hours:

$$UCAP_{AF\ gross} = (AC/MC) * MC = (36/69)*69 = 36\ MW$$

Using the line formula the final UCAP determination, the availability factor through linear regression, would be determined as:

$$UCAP_{AF\ net} = 0.5983\ (UCAP_{AF\ gross}) – 5.0609 = 0.5983\ (36) – 5.0609 = 16.46\ MW$$

This approach recognizes how gross asset dispatch translates into net to grid volumes as well as the capacity asset declared availability capabilities over the tight supply cushion hours. For this reason the AESO believes this is an improved approach to the previously suggested capacity factor approach for self-supply sites that choose to be dispatched on a gross basis.

Five-year history

Assessing an asset's capacity contribution over a 5-year period provides a reasonable estimate of future unit performance. This large sample over periods of low supply captures the variability in system conditions across different seasons.

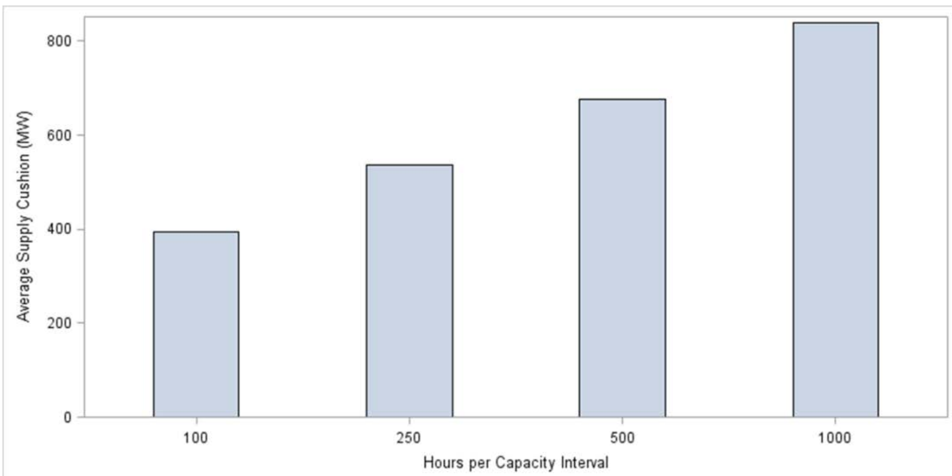
Tight supply cushion hours

Supply cushion is a measure of real-time system resource adequacy risk. A large supply cushion indicates less real-time system resource adequacy risk because more energy remains available to the AESO to respond to unplanned market events. A low supply cushion indicates that the system has fewer assets available to react to unexpected outages or load increases, therefore, indicating a high real-time system resource adequacy risk. Evaluating the historical performance of a capacity asset during a subset of tight supply cushion hours captures the correlation of the asset's availability and capability with all other system factors that drive the tight supply cushion hours. This is expected to provide an indication of how the asset will perform in the future under similar conditions when capacity is needed.

CMD 1 and 2 considered using 100 tight supply cushion hours per year to calculate UCAP. The AESO has determined that calculating UCAP using 250 tight supply cushion hours continues to measure asset performance during periods that matter most for system reliability; namely, whether the asset delivers energy or reserves during stressed system conditions.

The AESO has increased the tight supply cushion hours to 250 hours in response to stakeholder feedback indicating concern that UCAP calculations utilizing only 100 hours created excessive risk for market participants. Stakeholders requested the UCAP calculation to be based on 1,000 or more tight supply cushion hours. The AESO has determined increasing the number of hours used in the UCAP calculation beyond the 250 hours would not meet the intent of the UCAP methodology, as it would result in capacity value being measured under conditions with a supply cushion two or more assets away from a supply shortfall situation during a significant portion of hours.

Figure 4 – *Evaluation of number of tight supply cushion hours*



Hours per Capacity Interval	Average Supply Cushion (MW)					
	2012/13	2013/14	2014/15	2015/16	2016/17	All
100	47	516	666	476	268	395
250	173	670	811	633	402	538
500	313	792	942	798	532	675
1000	482	929	1,083	993	709	839

Planned and forced outages

Unlike other jurisdictions, the AESO does not restrict the timing, duration and frequency of planned maintenance outages scheduled by an asset owner, as long as notification of the planned outage is provided to the AESO 24 months in advance. Firms have the flexibility and independence to schedule the outages of its assets without the need for AESO approval. Further, given the high load factor in Alberta, planned outages are a driver of tight supply hours. As such, Alberta's capacity market needs to ensure that planned outages are scheduled in a manner consistent with the assumptions used in developing the capacity obligation. This may result in planned outages occurring in, or leading to supply shortfall conditions. By reflecting the duration and timing of planned outages in an asset's UCAP, the incentive is placed on the asset owner to optimize outage frequency and duration in order to minimize supply adequacy risk, thereby maintaining system reliability. The probability of asset unavailability due to planned outages should be reflected in an asset's UCAP values as they better reflect the realities of Alberta's outage planning framework.

UCAP for capacity assets that do not meet the minimum threshold for calculating UCAP per section 3.1.11

3.1.10 For an asset without 5 years of operating history in Alberta, the AESO will determine the UCAP using a class-average, a production or load estimate or through jurisdictional review.

The class-average will be used for capacity assets without operational history that are of a similar design or have similar operational characteristics to other capacity assets in Alberta. This approach allows the AESO to approximate the reliability contribution of a new asset based on how similarly configured assets have performed in the past during tight market conditions.

If a new asset does not have any similarly-designed or geographically located assets, the AESO will use production or load estimates based on engineering data provided by the new asset during prequalification. This will allow the AESO to approximate the reliability contribution of a new asset based on the best available information until historical data becomes available. In absence of class average or comparable class estimate the AESO will examine how similar assets or an asset class has performance in other capacity market jurisdictions during tight system conditions.

3.1.11 The AESO completed an analysis to determine a minimum number of hours that could be used to accurately reflect the UCAP of a new asset. This analysis used a discrete distribution to estimate the minimum number of hours required to estimate UCAPs for thermal and variable assets. A discrete distribution is characterized by a limited number of possible observations. The discrete probability distribution took different levels of asset performance into account; ranging from offline to full capacity. In theory, using the entire performance spectrum for units should lead to a minimum threshold that is aligned with the actual operational behaviour of the units. In order to determine the minimum number of hours required to accurately reflect the UCAP of an asset, the AESO applied the following methodology:

Define the discrete distribution

This step approximated the performance data for all 8760 hours in a year into the predefined number of bins listed in Figure 5. A five percent increment was used because it created a balance between a manageable number of categories and accurate indication of performance levels. For thermal assets performance levels were determined using availability factor data, and for variable assets performance levels were established using capacity factor data.

The analysis assigned a weighting to each bin using historical data. The analysis examined historical data for a five year period and calculated a frequency count using the performance thresholds listed Figure 5. The frequency count and the total number of observations were used to assign a weighting to each of the bins in the distribution.

Figure 5 - ***Bins used to define the discrete distribution***

Availabilty Factor		Discrete
From (> than)	To (<= than)	Value
0%		0%
0%	5%	5%
5%	10%	10%
10%	15%	15%
15%	20%	20%
20%	25%	25%
25%	30%	30%
30%	35%	35%
35%	40%	40%
40%	45%	45%
45%	50%	50%
50%	55%	55%
55%	60%	60%
60%	65%	65%
65%	70%	70%
70%	75%	75%
75%	80%	80%
80%	85%	85%
85%	90%	90%
90%	95%	95%
100%		0%

Calculate the Summary Statistics for the Distribution

This analysis calculated the expected value, variance, and standard deviation of the discrete distribution using the formulas outlined below.

A discrete random variable X follows the following probability distribution:

Value of X	x_1	x_2	$\cdots$	x_n
Probability	p_1	p_2	$\cdots$	p_n

The mean (expected value) of X is the sum of the products Xi* Pi:

$$\mu X = X1*P1 + X2*P2 + \cdots + Xn*Pn = \sum_{i=1}^{n} Xi*Pi$$

With mean μX , then the variance of X is:

$$\sigma^2 X = (x1-\mu X)^2 * p1 + (x2-\mu X)^2 * p2 + \cdots + (xn-\mu X)^2 * pn = \sum_{i=1}^{n} (Xi-\mu X)^2*Pi$$

The standard deviation σX is the square root of the variance.

Calculate the Sample Size

The sample size was calculated using a targeted standard error of two percent. The standard error of the sample mean depends on both the standard deviation and the sample size; the standard error decreases as the sample size increases. The standard error indicates the uncertainty around the estimate of the mean measurement. The standard error is an indicator of the level of uncertainty that the AESO is willing to take around the expected value for performance factor calculations. The formulas for the standard error and the sample size are illustrated below.

Standard Error (se) =σ/√n

Where σ is the standard deviation of the distribution and n is the sample size.

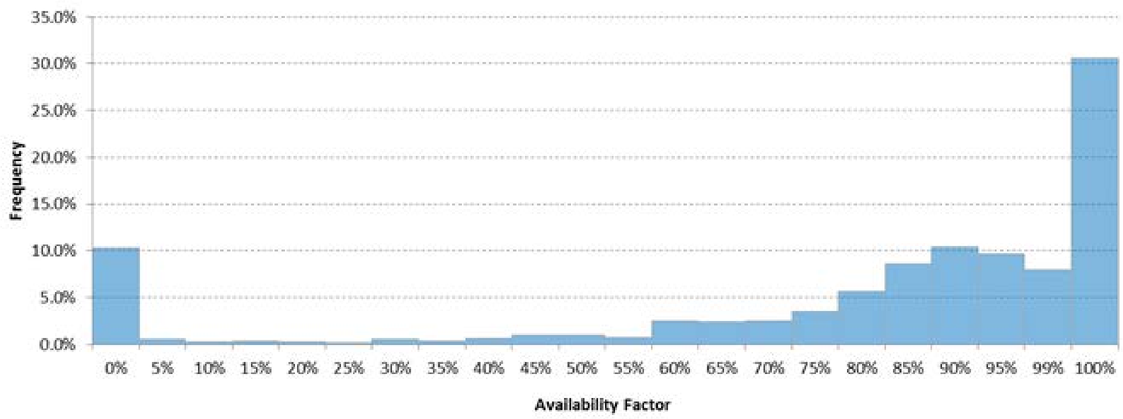
Sample size was calculated as follows

n= 〖σ/〖se〗^2 〗^2

Results for thermal assets

Figure 6 shows the shape of discrete distribution for thermal assets. This illustrates the different levels of availability and the corresponding weightings used to assess the minimum number of hours required to calculate UCAP for thermal assets.

Figure 6 – *Distribution of availability factor data for thermal units*



The summary statistics of the distribution are shown in Figure 7. The sample size calculated for the distribution is close to 250 observations. Having at least 250 hours of availability data for thermal assets should be sufficient to calculate a UCAP that is aligned with historical performance.

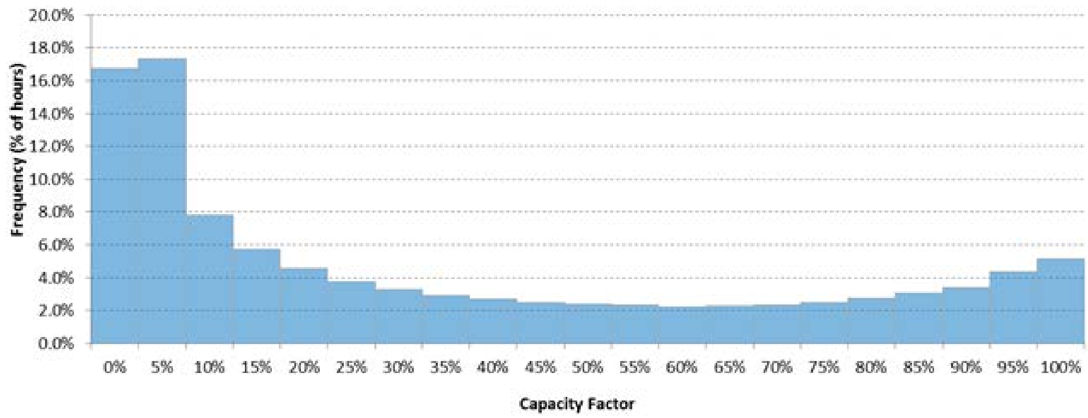
Figure 7 – *Summary statistics for thermal assets*

Summary Statistics	
Expected Value	78.4%
Variance	9.9%
Std Dev	31.5%
Std Error	2.0%
Sample Size	248

Results for variable assets

Figure 8 illustrates the shape of discrete distribution for wind assets. This shows the different capacity factor thresholds as well as the accompanying weightings that were used to assess the minimum number of hours required to calculate UCAP for variable assets.

Figure 8 – *Distribution of capacity factor data for variable units*



The summary statistics of the distribution are shown in Figure 9. The sample size calculated for the distribution is near to 300 observations. Having at least 300 hours of capacity factor data for variable assets should be sufficient to calculate a UCAP value that is aligned with historical performance.

Figure 9 – *Summary statistics for variable assets*

Summary Statistics	
Expected Value	34.5%
Variance	11.8%
Std Dev	34.3%
Std Error	2.0%
Sample Size	294

Asset-specific UCAP methodologies

3.1.12 The AESO's approach to the selection of a methodology to calculate asset-specific UCAPs is described in detail below:

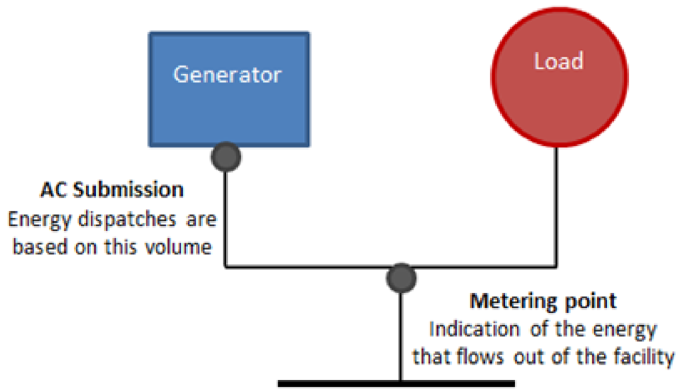
Wind & solar, & run of river hydro assets

The AESO is using the capacity factor methodology to determine the UCAP of wind, solar and run of river hydro assets. Due to the variability of their fuel source, which is determined through environmental changes, these assets have limited ability to change generation levels relative to energy dispatches.

Self-supply assets dispatched gross to grid

Some self-supply sites (with load served by onsite generation) currently offer their energy into the energy market on a gross basis, meaning that the available capability for the asset is submitted without discounting the portion of its generation that is used to serve onsite load:

Figure 10 – *Gross metering of self-supply site*



Such self-supply sites are often dispatched to a level beyond the energy that they can deliver to the grid. Therefore, using an availability factor to calculate UCAP would risk overestimating the site's capability to deliver capacity. The AESO recognizes that using a capacity factor approach suggested in earlier versions of the CMD may not capture some of the undispatched energy these assets would be able to supply to the grid. For these sites, the AESO will now perform a linear regression of the net to grid metered output of the self-supply site relative to the weighted average energy market dispatches issued to the generating asset(s) on the self-supply site as observed in each of the 250 tightest supply cushion hours per year for the past five years. This methodology is described above in subsection 3.1.9.

Demand Response

Demand Response (DR) assets can provide capacity by reducing energy consumption during system stress conditions. Comparable pre-qualification requirements for DR assets and generation assets will ensure all supply side capacity assets provide comparable reliability for consumers.

Load customers in Alberta have never been subject to a "must offer" obligation in the energy market. Therefore, no availability factor, capacity factor or class performance can be established. In the absence of Alberta specific information, the AESO will establish an initial performance measure, the derating factor, for all new demand response assets based on the average demand response performance in system stress events in other jurisdictions. The AESO will apply this factor to all new demand response assets until an Alberta specific performance can be established.

The AESO acknowledges that there is variation in how demand response resources are treated across other capacity markets. Treatment can vary significantly in how each of the markets take different approaches to calculating baselines, may or may not gross up demand response performance to account for transmission losses and reserve requirements and may have different procedures for notifying demand response resources of a performance event. Since no single market would provide an exactly analogous representation of general demand response performance during tight system conditions during the obligation period in Alberta, the AESO will average the historical performance of demand response assets in other capacity market jurisdictions where the assets had an obligation to provide capacity during a system stress event.

The AESO considers this to be a reasonable approach, as it reflects the following:

- Demand response may not always provide or achieve its full "nameplate" capacity during a performance event.
- No data exists on how Alberta based demand response assets will perform in a capacity market.

- The asset owner will still have a choice on the size of the reduction, the guaranteed load drop amount, or the firm consumption level.

To determine the derating factor, four jurisdictions were reviewed including PJM, NYISO, ISO-NE and the United Kingdom. The markets have been chosen as they represent capacity market jurisdictions where loads curtail consumption in response to system operators rather than in voluntary response to price. The demand response resources had either to be certified prior to offering into the auction, or to satisfy credit requirements, similar to the Alberta capacity market.

Event performance in PJM, the ISO-NE and ISO New York is measured as load reductions that were Y % of their capacity commitment.

Figure 11 – *PJM demand response performance*[2]

Delivery year	Event Performance
2009-2010	No Events
2010-2011	100%
2011-2012	91%
2012-2013	104%
2013-2014	94%
2014-2015	No Events
2015-2016	No Events
Average Event Performance	**97%**

Figure 12 – *ISO-NE demand response performance*[3]

Data Source	Date	Performance Hours	Type	Response
2011 Report	Jun-10	3	Event	91.8%
2012 Report	Jul-11	6	Event	94.8%
2012 Report	Dec-11	3	Event	87.7%
2013 Report	Jan-13	3	Event	86.3%
2014 Report	Jul-13	8	Event	115.5%
2014 Report	Dec-13	4	Event	81.2%
2017 Report	Aug-16	4	Event	102.2%
Average Event Performance				**94.2%**

[2] http://www.pjm.com/~/media/committees-groups/task-forces/scrstf/20160506/20160506-item-02a-dr-event-performance-mandatory-v-voluntary.ashx

[3] Compiled from the ISO-NE Monthly Market Reports for March of 2011-2018: https://www.iso-ne.com/markets-operations/market-performance/performance-reports/?document-type=Monthly%20Markets%20Reports&load.more=6

Figure 13 – *NYISO demand response performance*[4]

Data Source	Date	Season	Type	Response
2017 Report	2017-08-24	Summer 2017	Test	133.70%
2017 Report	2017-02-23	Winter 2016-17	Test	118.70%
2016 Report	2016-08-25	Summer 2016	Test	122.60%
2016 Report	2016-08-12	Summer 2016	Event	101.30%
2016 Report	2016-03-02	Winter 2015-16	Test	120.20%
2015 Report	2015-08-27	Summer 2015	Test	124.40%
2015 Report	2015-03-03	Winter 2014-15	Test	95.90%
2013 Report	2013-07-18	Summer 2013	Event	75.20%
2013 Report	2013-07-17	Summer 2013	Event	67%
2013 Report	2013-07-16	Summer 2013	Event	71.80%
2013 Report	2013-07-15	Summer 2013	Event	63.70%
2012 Report	2012-06-22	Summer 2012	Event	97.50%
2012 Report	2012-06-21	Summer 2012	Event	72.60%
2012 Report	2012-06-20	Summer 2012	Event	79.60%
2011 Report	2011-07-22	Summer 2011	Event	92.80%
2011 Report	2011-07-21	Summer 2011	Event	90.10%
Average Event Performance				**81.16%**

Notes:

The table reports New York-wide average performance data for New York's "ICAP/SCR" resource type, which is capacity market DR.

ICAP/SCR resources are occasionally activated for voluntary, rather than mandatory, events. Voluntary events are not included in the table. According to the 2014 Report, there were no mandatory events during Summer 2014 or Winter 2013-14.

The 2011, 2012, 2013 and 2014 Reports did not report Test performance.

The 2012 report listed an event that was mandatory in Zone J and voluntary elsewhere. This event was excluded from the above data.

The 2011 Report listed two events without indicating whether these were mandatory or voluntary. The AESO included these in the table.

UK De-rating methodology for demand side resources

The demand resource de-rating factor is based on a combination of test and performance data for Demand Response providing operating reserves. The demand resource de-rating factor was 89.7% for 2014 and 86.8% for 2015.[5]

The AESO will not use demand response factors from the UK market as they represent performance in the ancillary markets (Short Term Operating Reserves (STOR) availability) and are not representative of capacity performance events.

[4] Compiled from NYISO Annual Reports on Demand Response Programs: http://www.nyiso.com/public/markets_operations/market_data/demand_response/index.jsp

[5] https://www.emrdeliverybody.com/Capacity%20Markets%20Document%20Library/DSR%20De-rating%20Information.pdf

As a result of this analysis, the initial derating factor the AESO will use for demand response will be 91% based on the average of past performance of demand response assets in PJM, the ISONE and the NYSIO.

(97+94+81)/3= 91%

Firm Consumption Level (FCL)

This asset commits to reducing load consumption to a pre-defined level during an EEA event. The capacity contribution of an FCL asset is evaluated by comparing their consumption after a performance event to a pre-defined FCL.

For FCL assets the qualified baseline is intended to capture the top range that an FCL asset may qualify to sell into the capacity auction. The methodology to determine the qualified baseline establishes the average, typical consumption of the load and provides the upper bound to the amount of capacity the asset may provide. The AESO will remove days that had tight supply cushion hours or performance periods from the qualified baseline to recognize that price responsive loads have historically reduced consumption as pool prices increase. Since loads have not historically participated in the energy market the AESO will not be able to adjust the qualified baseline by energy dispatches or load outages.

Table 2 - *Determination of qualified baseline for an FCL asset*

Date/Day			1-2 p.m	2-3 p.m	3-4 p.m	4-5 p.m	5-6 p.m	6-7 p.m	7-8 p.m
03-Apr	Tuesday	Day 1	22.3	23.1	23.9	23.1	22.3	19.9	19.1
04-Apr	Wednesday	Day 1	22.3	23.1	23.9	23.1	22.3	19.9	19.1
05-Apr	Thursday	Day 2	24.6	25.4	24.6	24.6	23.9	20.7	20.7
06-Apr	Friday	Day 3	12	13	13.5	11.7	12	22	19
07-Apr	Saturday	Weekend	23.55	23.85	24.3	23.85	23.25	22.5	21.75
08-Apr	Sunday	Weekend	23.25	25.2	24.6	23.25	21	19.5	18
09-Apr	Tight Supply	Day 4	15.75	15	16.05	15.9	15.9	16.05	15.9
10-Apr	Tuesday	Day 5	15.6	15.9	15.75	15	15.15	15.75	15
11-Apr	Wednesday	Day 6	21	21.75	22.5	21.75	21	18.75	18
12-Apr	Thursday	Day 7	23.25	24	23.25	23.25	22.5	19.5	19.5
13-Apr	Friday	Day 8	12	11.25	12	11.7	12	21.75	21
14-Apr	Saturday	Weekend	23.55	23.85	24.3	23.85	23.25	22.5	21.75
15-Apr	Sunday	Weekend	23.25	25.2	24.6	23.25	21	19.5	18
16-Apr	Monday	Event Day	15	15.75	15	16.05	15.9	15.6	15
17-Apr	Tuesday	Day 9	15.75	16.2	15.6	15.9	15.75	15	15.15
18-Apr	Wednesday	Event Day	21.75	22.5	21.75	21.75	21	20.25	19.5
19-Apr	Thursday	Day 10	12	11.4	11.7	11.25	11.7	22.5	21.45
20-Apr	Friday	Day 11	25.2	23.85	25.2	24	23.7	23.25	21.75
21-Apr	Saturday	Weekend	24.6	24.3	24.6	23.85	23.25	20.7	20.25
22-Apr	Sunday	Weekend	24	23.85	23.25	23.25	21	20.25	18.75
23-Apr	Monday	Day 12	15.75	15	16.05	15.9	15.9	16.05	15.9
24-Apr	Tuesday	Day 13	15.6	15.9	15.75	15	15.15	15.75	15
25-Apr	Wednesday	Day 14	23.25	25.2	24.6	23.25	21	19.5	18
26-Apr	Thursday	Day 15	23.25	23.55	23.25	23.25	22.5	22.2	21.45
Qualified Baseline hour			**18.9**	**19.2**	**19.4**	**18.8**	**18.4**	**19.5**	**18.7**

An illustrative example of qualified baseline determination for tight supply cushion hour that occurred during 5-6p.m:

- A tight supply cushion hour occurred on April 27 between 5-6 p.m. of the previous year.
- To recognize that this load may have already reduced consumption as a response to high prices during the tight supply cushion hour the AESO will re-estimate the consumption by the following methodology:
  - o The load will be averaged during the previous 15 non-holiday weeks days prior to the day with the tight supply cushion hour, using the same hour (5-6 p.m.) as the tight

supply cushion hour. The tight supply cushion hours on April 9th and the event day hours on April 16 and 18 will not be used in the averaging calculation.

- o Using this approach, the qualified baseline value for April 27 between 5-6 p.m. will be determined to be 18 MW

- This methodology will be used to determine the qualified baseline hours for all 250 tight supply cushion hours of the previous year.

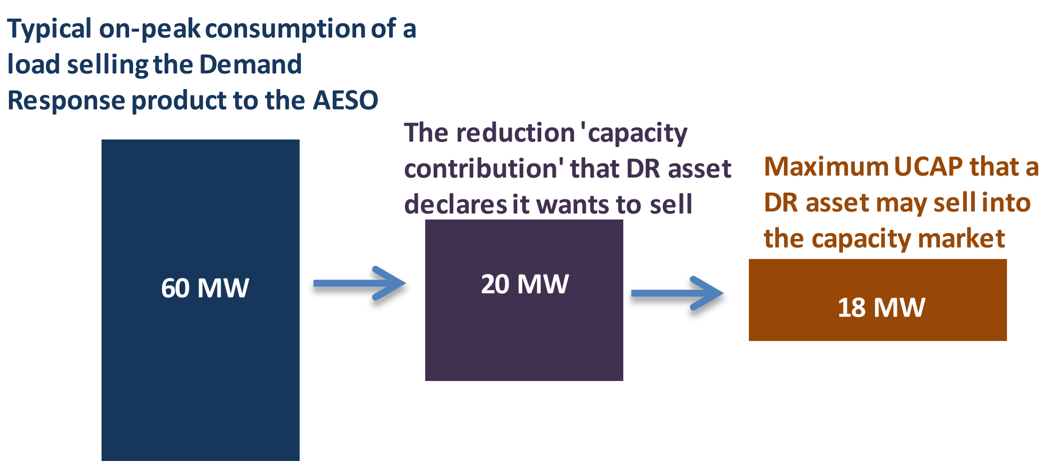
Once an FCL asset has capacity market performance history, the capacity contribution will be calculated as the historical qualified baseline calculation minus the firm consumption level. This will reflect the performance of FCL asset's ability to reduce to its firm consumption level during delivery events.

An FCL asset will be physically tested to ensure that the FCL, a pre-defined level claimed by the asset, can be realistically achieved by the asset during an EEA event. If the asset is unable to reduce to its FCL levels during a delivery event the UCAP of the asset will be reduced for the subsequent auctions to reflect that the asset is a less reliable resource.

Guaranteed Load Reduction asset (GLR):

A GLR asset will declare its capacity capability to the AESO. The capacity capability will represent the load the GLR asset will be able to reduce when required for capacity delivery purposes. The GLR value declared must be equal to or lesser than the maximum load the asset may be able to consume. All GLR assets will initially receive a 91% derating factor (see the discussion in the FCL asset, above) until an asset specific availability factors can be observed as the asset accumulates capacity market operational data

Figure 14 - *Illustrative example of GLR UCAP determination until operational data becomes available*



The availability factor will be applied to the capacity contribution declared by the GLR asset:

- 20 MW x 91%* = 18.2 MW of capacity is the maximum UCAP the GLR asset may sell into the capacity auction. Once GLR asset performance data becomes available an availability factor will be established. This asset specific availability factor will be used to create a UCAP for the asset.

Aggregated assets

The UCAP for aggregated assets will be based on the sum of the performance of each of the individual assets being aggregated. Performance will be measured using observed available capability declarations or metered volumes during the 250 tightest supply cushion hours of the previous 5 years. If the aggregated capacity asset contains both capacity factor and availability factor assets the capacity factor methodology will be used to determine UCAP. If the asset's UCAP is determined using an availability factor methodology the AESO would add the component available capabilities which would be zero and the aggregate asset would not meet the availability criteria described in Section 8 and would be subject to annual payment adjustments. Whereas, if the asset's UCAP is determined using a capacity factor methodology, the AESO will rely on meter data for determining availability.

Determination of capacity limit of each Alberta intertie

The capacity limit of each intertie limits the volume of capacity that can be provided from external assets and will be determined prior to each capacity auction. The capacity limit is intended to reflect the volume of capacity that could have flowed into Alberta during the 250 tightest supply cushion hours for each year during the previous 5 years.

For the BC, Montana Alberta Tie Line (MATL) and Saskatchewan interties, the capacity limit is determined on an hourly basis by taking the minimum of firm transmission and available transfer capability (ATC).

The BC/MATL combined path is additionally constrained due to the joint scheduling limit. The hourly capacity limit is determined using the minimum of firm transmission and ATC prior to load shed services for imports (LSSi) arming. LSSi is an ancillary service that is provided by loads that are armed and automatically trips following the loss of the intertie. The AESO has observed that the volume of load that is available to provide LSSi is lower when the Alberta system is in periods of tight supply. The AESO expects that these loads have reduced their consumption based on energy market price signals and also believes this practice may continue in the future. As a result, the AESO believes that determining the amount of capacity that could be delivered into Alberta over the intertie while including the LSSi volumes may overstate the intertie delivery ability during future tight supply cushion hours. As a result, the AESO will be determining intertie values without the increase flow volumes attributed with LSSi loads.

The hourly capacity limits are then averaged to arrive at final capacity limits for the BC intertie, Saskatchewan intertie, BC/MATL path and MATL intertie. During a capacity auction the capacity procured from external capacity assets will not exceed the capacity limits identified for each intertie.

External assets

For the first capacity auction, a new external asset must declare its UCAP to the AESO, demonstrate that the external asset has firm transmission in the amount of the UCAP declared and confirm that the UCAP is being supplied from a source that is non-recallable. For new external capacity assets, in the absence of asset specific operating history, the AESO will apply the intertie derating factor to all external assets. This approach will be an interim measure until enough history is obtained in the capacity market, an existing external asset's UCAP will be established in the same manner as an internal capacity asset, as the AESO will have the data to determine UCAP based on an availability factor or capacity factor approach, as applicable.

Mothballed or temporary delisted assets

Section 306.7 of the ISO rules, *Mothball Outage Reporting* (Section 306.7) enables market participants to exit the energy-only market by taking their generating units offline for a period of up to 24 months for non-operational reasons. Section 306.7 is intended to help market participants manage fixed costs associated with generator maintenance.

The available capability of a generating asset on a mothball outage is 0 MW. While this captures the real-time availability of a mothballed generator it may not accurately represent the unit's ability to deliver capacity in future tight supply hours. The available capability of a mothballed generator is reflective of an economic decision by the asset owner and not reflective of an asset's reliability. Therefore, using available capability declarations while the asset was mothballed will not being considered in the calculation of the asset's UCAP. The AESO intends to use the historical observations of the asset's performance prior to the mothball outage to determine its UCAP.

The methodology described in Section 3.1.11 establishes the minimum number of hours that could be used to accurately reflect the UCAP of an asset that has been on a mothball outage.

Long lead time assets, type 2

The AESO recognizes that per subsection 4.1 of Information Document # 2012-007 (R), *Long Lead Time Energy,* a long lead time asset is expected to restate its available capability in the Energy Trading System during economic shutdown to better reflect physical capability. As a result, observed available capability may not be an accurate representation of the asset's ability to deliver capacity in tight supply cushion hours and the use of availability factor may discount the true capacity contribution of the asset, especially if the tight supply cushion hour occurred in a relatively weaker economic period when the asset was offline. The expectation is that these assets would be able to return to service within a short amount of time if required for system reliability. The AESO has established the minimum number of tight supply cushion hours required to calculate a statistically significant UCAP for thermal units at 250 hours. Any hours where availability was reduced due to a long lead time configuration for economic purposes will be excluded from the sample set used to calculate a UCAP. If a long lead time asset has less than the 250 tight supply cushion hours the asset's availability will be supplemented with a class average for similarly designed assets.

To confirm that availability was reduced due to a long lead time claim for economic purposes, the AESO will review the following:

(a) The participant comment in ETS indicating that the unit was offline for a long lead time configuration.

(b) The cost assessment for the asset in comparison to pool price during that period. The AESO will determine an approximate marginal operating cost for the asset based on past operational history. This marginal operating cost assumption will be compared to pool prices during the period for which UCAP is being determined. When pool price is less than the marginal operating costs of the asset those hours will be excluded from the UCAP calculation of the asset.

3.2 UCAP refinement process

3.2.1 As part of the sequence of activities, leading up to a capacity auction, a capacity market participant will have the opportunity to submit a request a UCAP refinement based on a number of criteria

3.2.2 The enumerated list in subsection 3.2.2 of the proposal is intended to identify reasonable scenarios that would result in UCAP not being reflective of the reliability of the capacity asset. Acceptable refinement requests will be limited to the scenarios outlined in this section. The intent of this approach is to ensure that accurate asset reliability values are obtained for each asset while reducing the number cases taken to the formal appeal process.

Reductions to available capability that occur as a result of a transmission constraint will be considered an acceptable reason to initiate a UCAP refinement. However assets whose availability was reduced due to distribution system constraints or transmission outages, where the asset was electrically disconnected from the transmission system will not be able to request a UCAP refinement. The AESO is obligated to plan and make arrangements for the expansion or enhancement of the transmission system. Therefore, transmission constraints resulting in violations of limits on the transmission system are an acceptable exemption from the calculation of UCAP. Unavailability due to a distribution constraint should be reflected in the UCAP methodology, given it is a participant's choice of whether to connect to the distribution or transmission system.

3.2.3 If the AESO and the capacity market participant are unable to achieve resolution on a UCAP refinement issue, the capacity market participant has the ability to escalate by filing a formal dispute through the dispute resolution process.