# Long Term Adequacy Metrics, Threshold and Threshold Actions Recommendation Paper

## February 7, 2008

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## Executive Summary

### Purpose of this Recommendation Paper

The purpose of this recommendation paper is to present AESO recommendations which meet the Department of Energy (DOE) electricity market policy requirements with respect to Long Term Adequacy (LTA). LTA refers to the ability of market participants to respond to market signals and build sufficient new electricity generation to meet forecast Alberta system load over the long term. The recommended LTA solution identifies Metrics, a Threshold and Threshold Actions which the AESO will utilize to monitor and approach long term supply adequacy in Alberta.

### Background

Following extensive stakeholder consultations regarding Alberta's competitive electricity market, the DOE, in its 2005 Policy Paper[1] and subsequent clarifications recommended that the AESO work with stakeholders to address LTA as follows:

- "develop key indicators to monitor LTA"[2] ("Metrics")

- "provide an early-warning system of adequacy issues in Alberta"[3] and "establish an appropriate metric"[4] to determine a forecast level of reliability ("Threshold") at which point the AESO would have the authority to intervene in the market to implement one or more actions ("Threshold Actions")

- "make recommendations to refine, amend or "enhance" market design ("Market Modifications") in a manner that will address any future capacity adequacy issue"[5]

Following extensive industry consultation, the AESO published an LTA recommendation paper[6] (LTA 2007) outlining its initial recommendations on the suite of Metrics, the Threshold and the Threshold Actions as well as a Market Modification recommendation on outage reporting.

To help implement LTA 2007 recommendations, the AESO formed the LTA Workgroup, a volunteer stakeholder group which was asked to work with the AESO to further discuss and refine the initiatives outlined in the paper. The LTA Workgroup has been fully briefed on all of the recommendations presented in this paper.

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[1] Alberta's Electricity Policy Framework: Competitive – Reliable – Sustainable June 6, 2005 Alberta Department of Energy the "Policy Paper"
[2] Policy Paper page 34
[3] Policy Paper page 34
[4] Policy Paper page 34
[5] ADOE Policy Clarification Letter to the LTA Committee April 25, 2006 page 5
[6] AESO Long Term Adequacy Recommendation February 22, 2007

The AESO also notes that the outage reporting Market Modification recommendation from the LTA 2007 paper was implemented on December 3, 2007 with the approval of OPP 606 Generator Outage Coordination and the implementation of the "Quick Hits" market rule changes. The outage reporting information from OPP 606 has been incorporated into the Metrics recommendations which are described below.

**LTA as a "Bridging Mechanism"**

In an energy only market design, the market determines the appropriate level of adequacy over the long term. The AESO recommendations address LTA indirectly by creating a "bridging mechanism" in the event that adequacy becomes an issue during a two year forecast period and action has to be taken to maintain adequacy until new capacity is built or load decreases.

**Metrics**

The AESO recommends that the following Metrics should be calculated by the AESO and publicly reported on a quarterly basis:

1. New Generation Status and Retirements
2. Reserve Margin
3. Supply Cushion
4. Two Year Probability of Supply Adequacy Shortfall (2YRPSAS)
5. Generation Investment Signposts; and,
6. Contribution to Costs of Notional Gas-Fired Peaking Unit

The New Generation Status and Retirements, Reserve Margin, Supply Cushion and 2YRPSAS Metrics are the core of the package of Metrics. The Reserve Margin looks out five years and focuses on the peak load day of each year. The Supply Cushion looks out two years and will show the ability of firm generation plus imports to meet the daily peak. The 2YRPSAS Metric is a probabilistic calculation of the ability for all generation sources to meet load in every hour over a two-year period. The LTA Workgroup has supported the publication of these four metrics.

The Generation Investment Signposts Metric will identify any inconsistencies in forecasts of electricity and natural gas prices, Reserve Margin and cost of new entry for coal and gas fired generation.

The "Contribution to Costs of Notional Gas-Fired Peaking Unit" Metric will track historical electricity and natural gas prices in a form that will provide insights into historical market trends relevant to the operation of peaking units.

Most members of the LTA Workgroup did not support the publication of these last two metrics because the Metrics on the basis that they are generation investment indicators which could be too easily misinterpreted, rather than supply adequacy indicators. The AESO acknowledges that the last two Metrics do not measure adequacy, however the information provided reflects important market conditions

and is relevant to the incentive to invest in generation. **The AESO is seeking further feedback on the usefulness and appropriateness of publishing these two Metrics.**

Further details, rationale and examples of the Metrics are provided in Appendix 1.

### Threshold

The recommended Threshold is based on the 2YRPSAS Metric, which has been designed to provide an assessment of the likelihood of involuntary load curtailments over a two year period. The AESO is recommending that the Threshold be measured in expected Total Energy Shortfall hours in the period and the appropriate Threshold level be set at 1600 MWh which is equivalent to the commonly used one in ten year outage rule of thumb for a system of Alberta's size. The AESO does not intend to have a Threshold measure or level associated with any of the other Metrics defined in this paper.

### Threshold Actions

The AESO recommends that if the Threshold is breached, the AESO may consider procuring the following Threshold Actions:

- Load Shed Service ("LSS") to reduce demand
- Back-up Generation to provide capacity ("Back-up Generation")
- Emergency Portable Generation to provide capacity

This combination of Threshold and Threshold Actions was chosen because it focuses on solving an issue that may arise over a two-year time frame. That will give generation developers every opportunity to respond to market signals and build new generation, resulting in the market providing adequacy for the system on its own, without additional market interventions. The Threshold Actions will have minimal market impact in that they will allow the price to go to the price cap before being called upon.

The Threshold Actions are complementary. Indeed, it is expected that they would be procured on a competitive basis with each other to provide the service level the AESO decides it needs.

The Threshold Actions are effective in preventing curtailment of firm load and can be implemented relatively quickly; especially if suppliers are pre-qualified well before the Threshold is breached. This speed of implementation is important because the Threshold calculation only looks forward two years.

### Market Modifications

The LTA 2007 paper identified potential market constraints that may be a cause for concern as well as other market enhancements that may improve the markets

ability to provide LTA. The improvements or changes will require further study, analysis and discussion all of which were beyond the scope of LTA. Since that time, the AESO has issued a Market Roadmap paper which outlines a work plan for future market initiatives and will be working with stakeholders to further define and prioritize elements of that work plan.

## 1. Introduction

Following extensive stakeholder consultations regarding Alberta's competitive electricity market, the Alberta Department of Energy ("DOE") released a June 2005 electricity market design paper entitled "Alberta's Electricity Policy Framework: Competitive-Reliable- Sustainable" (the "Policy Paper"). The Policy Paper determined that it is not desirable to modify in any fundamental manner the energy only market design but rather to focus on collateral policy refinements aimed at improving the current design.

The Policy Paper expressed confidence in the ability of market participants to respond to market signals and build sufficient new electricity generation to meet forecast Alberta system load over the long term (Long Term Adequacy or LTA). However, the Policy Paper did make recommendations regarding supply adequacy which is the ability of electricity supply to meet system load and specifically requested that the AESO work with stakeholders to address LTA as follows:

- "develop key indicators to monitor LTA"[7] ("Metrics")

- "provide an early-warning system of adequacy issues in Alberta"[8] and "establish an appropriate metric"[9] to determine a forecast level of reliability ("Threshold") at which point the AESO would have the authority to intervene in the market to implement one or more options ("Threshold Actions")

- "make recommendations to refine, amend or "enhance" market design ("Market Modifications") in a manner that will address any future capacity adequacy issue"[10]

In September of 2005, the AESO created the Long Term Adequacy Committee (LTA Committee). The purpose of the LTA Committee was to provide a forum for the AESO and stakeholders to work together to help the AESO meet its obligations with respect to Long Term Adequacy as set out in the Policy Paper.

In February of 2007, the AESO published the paper, "Long Term Adequacy Recommendation" (LTA 2007) outlining its initial recommendations on the suite of Metrics, the Threshold and the Threshold Actions as well as a Market Modification recommendation on outage reporting.

[7] Policy Paper page 34
[8] Policy Paper page 34
[9] Policy Paper page 34
[10] ADOE Policy Clarification Letter to the LTA Committee April 25, 2006 page 5

Following the publication of the LTA 2007 paper, the AESO formed the LTA Workgroup, a volunteer stakeholder committee which was asked to work with the AESO to further discuss and refine the initiatives outlined in the LTA 2007 paper. The LTA Workgroup has been fully briefed on all of the recommendations presented herein.

The AESO also notes that the outage reporting Market Modification recommendation from the LTA 2007 paper was implemented on December 3, 2007 with the approval of OPP 606 Generator Outage Coordination and the implementation of the "Quick Hits" rule changes. Given stakeholder feedback on the confidential nature of outage information, the AESO will not be creating and reporting historical outage information at this time as originally recommended. The outage reporting information from OPP 606 has been incorporated into the Metrics recommendations which are described below.

# 2. Background

## 2.1 Requirements of Policy Paper

This recommendation paper was created to meet the DOE's requirements as set out in the Policy Paper. The purpose of this section of the paper is to briefly review those requirements and to set out some standardized terms that will be used throughout the paper.

The Policy Paper indicated that the DOE would work with the ISO and stakeholders to implement a robust and effective monitoring system to ensure that all market participants understand the reserve margin and overall state of generation capacity adequacy in the province. It further recommended that the ISO develop key indicators to monitor long term adequacy and to provide an early-warning of adequacy issues in Alberta. The AESO was also to establish an appropriate metric to assess the adequacy of generation supply to meet system load and develop options which would be used to approach potential adequacy issues.

To facilitate LTA discussions, the AESO established the following terms:

**Metrics**: The entire suite of LTA related information items, including historical data, forecasts and leading and lagging indicators that the AESO will regularly capture, calculate and report upon.

**Threshold**: The specific points/quantum with respect to one or more Metrics, when if breached or forecast to be breached, the AESO may choose to implement one or more Threshold Actions.

**Threshold Actions**: The out-of-market[11] measures the AESO may choose to implement to remedy an actual or impending long term adequacy shortfall.

[11] Out-of market measures are actions that are taken outside of the normal scope of day to day energy market operations.

### 2.2 LTA as a "Bridging Mechanism"

In regulated markets, the appropriate level of "adequacy" is set or approved by regulators. Targets for standard industry metrics like reserve margin and "loss of load probability" led to required levels of generation capacity being built. However, under an energy-only market model, like Alberta, the market determines the appropriate reserve margin; it determines the appropriate level of adequacy in the long term. In an energy only market, LTA is intrinsically determined by the market design and the Policy Paper focused on collateral policy refinements aimed at improving the current design and not to make any fundamental changes to Alberta's energy only market.

Thus, the LTA recommendations are not directly addressing long term adequacy. Rather, the LTA recommendation address long term adequacy indirectly by creating a "bridging mechanism" in the event that adequacy becomes an issue during a two year forecast period and action has to be taken to maintain adequacy until new capacity is built or load decreases.

## 3. Metrics

After further review and discussion within the LTA Workgroup, the AESO recommends proceeding with the original LTA 2007 Metrics as proposed with one exception. The Loss of Load Probability or Expected Unserved Energy Metric has been dropped from consideration in the context of the LTA framework.

In selecting and designing the recommended Metrics, the AESO took into consideration the following principals. The Metrics, as a group, will:

- cover the key elements which directly or indirectly measure adequacy.
- be relatively simple to understand and promote understanding of the market.
- be based on publicly available information, be verifiable, and provide an outlook on adequacy.

The AESO will calculate and report on the following six Metrics on a quarterly basis or more frequently if required. The information will either be available on its website or in a published report.

1. New Generation Status and Retirements
2. Reserve Margin
3. Supply Cushion
4. Two Year Probability of Supply Adequacy Shortfall (2YRPSAS)
5. Generation Investment Signposts
6. Contribution to Costs of Notional Gas-Fired Peaking Unit

Further details, rationale and examples of the Metrics are provided in Appendix 1.

The New Generation Status and Retirements, Reserve Margin, Supply Cushion and 2YRPSAS Metrics are the core of the package of Metrics. The Reserve Margin looks out five years and focuses on the peak load day of each year. The Supply Cushion looks out two years and will show the ability for firm generation plus imports to meet the daily peak. The 2YRPSAS Metric is a probabilistic calculation of the ability for all generation sources to meet load in every hour over a two-year period. The LTA Workgroup has supported the publication of these four metrics.

The Generation Investment Signposts Metric will identify any inconsistencies in forecasts of electricity and natural prices, Reserve Margin and cost of new entry for coal and gas fired generation. The AESO expects this Metric to promote understanding of the market by revealing underlying trends in energy prices, electricity supply and load relative to generation supply costs.

The "Contribution to Costs of Notional Gas-Fired Peaking Unit" Metric will track historical electricity and natural gas prices in a form that will provide insights into historical market trends relevant to the operation of peaking units. The AESO expects this Metric to promote understanding of the market by providing a directional historical perspective regarding the attractiveness of generation investment in Alberta and whether any actual implemented market changes may be influencing generation investment decisions.

Most members of the LTA Workgroup did not support the publication of these last two metrics because the Metrics were not adequacy indicators but were generation investment indicators which could be too easily misinterpreted. The AESO acknowledges that the last two Metrics do not measure adequacy, however the information provided reflects important market conditions and is relevant to the incentive to invest in generation. The LTA Workgroup did acknowledge that the information provided by the last two Metrics may be useful to the AESO in evaluating the appropriate steps to take after a Threshold is breached in conjunction with other analysis. By publishing the Metrics, the AESO will be providing clarity and transparency regarding the information it is using to assess market conditions after the Threshold is breached. The AESO also notes that market participants should rely on their own judgment when assessing and interpreting any of the published Metrics. **The AESO is seeking further feedback on the usefulness and appropriateness of publishing these two Metrics either as part of its requirement to publish Metrics to meet government policy or as part of its role under the EUA**.

The LTA 2007 paper had recommended developing a longer term Loss of Load Probability or Expected Unserved Energy Metric; however, the AESO is no longer considering such a Metric for LTA purposes. Such modeling efforts would have required the preparation of public energy price forecasts and the creation of a near term view on specific new generation additions both of which were considered to be inappropriate activities for the AESO.

Taken together, the package of Metrics will provide a comprehensive view of adequacy over a five year forecast period and should help identify any underlying issues. To the extent that the Metrics point to potential underlying market structure issues, the AESO and stakeholders can work to isolate the issues and resolve them before they become adequacy problems.

# 4. Threshold

The AESO continues to recommend that the Threshold be based on the 2 year Probability of Supply Adequacy Shortfall (2YRPSAS) Metric. The AESO has undertaken extensive modeling work on the 2YRPSAS and held numerous LTA Workgroup sessions to better understand and interpret the 2YRPSAS Metric. Further details and examples of the model results are provided in Appendix 1.

The AESO has identified several potential 2YRPSAS model outputs which could be used to set a Threshold level, however, the AESO believes that the Total Energy Shortfall measure is the most appropriate measure to use. A discussion on the choice of Threshold measure and Threshold level is provided below.

## 4.1 Rationale Underlying Threshold and Threshold Actions

The Threshold calculation looks forward two years, which is shorter than the time period required to construct new generation. The two-year rolling time frame for AESO out of market action will provide the market every opportunity to provide for longer term adequacy on its own.

The Threshold Actions are also expected to be implemented within two years of identifying an adequacy issue. Given such a short timeframe and the nature of the out of market actions, the Threshold level should be set to reflect a relatively high standard of adequacy which would allow adequate preparation time to develop Threshold Actions.

## 4.2 Understanding the 2YRPASA Model Results

The 2YRPSAS is a probabilistic model and the model output reflects the likely or expected outcome of events given a very large number of potential trials. The model measures, among other things, the number of times a supply shortfall occurs where demand exceeds generation and there could be a need to shed load on the system.

In any electrical system, there is always a possibility that a supply shortfall could occur given a combination of events which could not have been reasonably foreseen or prevented. The model forecasts a relatively high number of supply shortfalls in part because the model was purposefully designed to be easy to understand and does not reflect the full dynamic nature of the market and the system in responding to a pending supply shortfall. Elements such as demand response and interruptible contracts were not expressly incorporated into the model. Therefore, although the model results are considered to present a reasonable representation of supply adequacy, the model results should be considered directional in nature and used within the context for which they were created.

The AESO has undertaken extensive analysis to understand the impact of model assumptions on the forecast of adequacy in Alberta and has performed a number of sensitivity analyses all of which were used in determining an acceptable and appropriate Threshold for the model.

### 4.3 Supply Shortfall Characteristics

The 2YRPSAS model is designed to track supply shortfalls measuring the hours when electricity demand exceeds supply in each two year period and storing the supply shortfall data from approximately one thousand two year period trial runs. The AESO has chosen to publish the supply shortfall data from the model in three formats as described below and illustrated in Appendix 1:

**Shortfall Count:** The total number of supply shortfall hours in each two year period. Shortfall Count measures the frequency of the problem.

**Worst Shortfall Hour:** The largest megawatt supply shortfall hour in each two year period. Worst Shortfall Hour measures the greatest magnitude of the problem.

**Total Energy Shortfall:** The cumulative megawatt hours of supply shortfall over the entire two year period. Total Energy Shortfall measures the cumulative magnitude of the problem incorporating the frequency, magnitude and duration of the problem.

While each of the data formats noted above measure different aspects of a supply shortfall, extensive examination of the model results indicate that the data formats are highly correlated and that any one of the three formats could be used for setting a Threshold level.

One additional data format which could be measured is supply shortfall duration, the number of consecutive hours of outage. At this time, the AESO does not intend to report information on supply shortfall duration primarily because the impact of prolonged outages is already reflected in Total Energy Shortfall data. Industry studies have also shown that the frequency of outages has a larger potential cost impact than the duration of each outage[12].

### 4.4 Supply Adequacy in Context

Supply adequacy is only one element of a reliable electricity service and measures to promote supply adequacy need to be taken in context. Most outages experienced by customers reflect distribution events rather than supply adequacy. The Canadian Electrical Association estimates that in Canada customers are interrupted on average 1.25 times a year in urban areas and 2.46 times per year in rural areas, however, over 90% of those interruptions are distribution related and a large percentage of the remaining outages are likely transmission rather than generation related.

[12] "Understanding the Cost of Power Interruptions to U.S. Electricity Consumers" Kristina H. LaCommare and Joseph H. Eto, Ernest Orlando Lawrence Berkeley National Laboratory, September 2004

The optimum level of electricity service depends on the transmission and distribution networks, on the level of supply adequacy and on customer efforts to provide incremental measures to optimize their specific needs. All of these elements should be considered when choosing an appropriate Threshold level.

### 4.5 Recommended Threshold Measure and Level

Resource adequacy criteria requires an understanding of demand growth, demand characteristics, demand-side management, sensitivity of demand to weather, availability of emergency assistance from others, the expected in-service dates of generating units, and fuel and generating unit availability. Because these factors vary from system to system, there are no standardized resource adequacy criteria methodologies to be applied in Alberta.

The most common resource adequacy criterion used in North America follows the historical-regulatory approach and applies a traditional “rule of thumb” that allows expected outages that accumulate to one day in ten years. Many jurisdictions will determine the probabilistic adequacy level implied by this “1 in 10” rule and translate the results into an equivalent measure such as reserve or capacity margin for their specific system.

Using a literal interpretation of the “1 in 10” rule and applying it to a system the size of Alberta (approximately 8000 MW), the equivalent resource adequacy criterion appropriate for the 2YRPSAS model would suggest a maximum expected Total Energy Shortfall level of 1600 MWh. This level is equivalent to a one hour supply shortfall for the entire 8000 MW system once every ten years (or a one hour 800 MW supply shortfall per year in each of the two model years).

The AESO recognizes that the “1 in 10” rule implies a level of resource adequacy which is likely higher than would be determined in the Alberta electricity market.[13] The AESO believes, however, that the 1600 MWh Total Energy Shortfall target reflects an appropriate adequacy standard for the purpose of considering the implementation of the specific Threshold Actions outlined in this paper. As noted in section 4.6 which follows, the 2YRPSAS forecast results for the October 2007 to September 2009 period indicate an expected Total Energy Shortfall of 937 MWh, which is below the proposed Threshold level and would indicate that no action is being signalled for that period at this time.

### 4.6 Historical Context for Threshold Level

To put the proposed Threshold level into historical perspective, the AESO performed an historical analysis applying the 2YRPSAS methodology to the actual generation fleet and the actual demand levels in consecutive two year historical periods. The historical model outputs, therefore, represent a probabilistic assessment of the level of resource adequacy that may have been available. To undertake this assessment, the model did not use actual outages in

[13]“ Resource Adequacy Final Report January 2005” A Joint Project of the Center for the Advancement of Energy Markets and the Distributed Energy Financial Group, LLC

the period; rather it predicted a level of forced outages based on historical outage information.

The historical analysis is summarized below in terms the Total Energy Shortfall for each period.

| | Total Energy Shortfall<br>MWh |
|---|---|
| Historical: | |
| Oct 2001/ Sep 2003 | -110 |
| Oct 2003/ Sep 2005 | -437 |
| Oct 2005/ Sep 07 | -205 |
| **Forecast:** Oct 2007/ Sep 2009 | -937 |

The historical model results appear to be consistent with the overall market conditions that existed in those time periods. The 2001/03 period had a relatively high degree of supply availability due to the addition of new generation following deregulation and the backup supply capability of the Cloverbar gas units. Demand growth began to catch up with supply during subsequent years until the addition of the large Genesee coal unit in 2005. Supply conditions became tighter with the retirement of the Cloverbar gas units in 2006 and are forecast to continue to narrow as demand growth overcomes anticipated new generation projects in 2008/09.

### 4.7 Other Market Comparisons

In North America, many NERC regions use a probabilistic analysis approach to resource adequacy. WECC is currently developing such an approach. Some NERC regions have established either a capacity margin or reserve margin requirement based on their respective probabilistic resource analysis.

NERC, itself, has never had generation reliability or resource adequacy criteria or standards (e.g., loss of load expectation (LOLE) = 0.1 day/year, “x” percent capacity or reserve margin, etc.). Rather, NERC has always depended on the Region’s or Regional member’s determination and calculation of an appropriate level of generation or resource adequacy for that Region or member system.

### 4.8 Application of the Threshold

When the 2YRPSAS model is run and the calculated Total Energy Shortfall breaches the 1600 MWh level, the AESO may take steps to implement the Threshold Actions within the 2 year time frame, for the time period when the Threshold is breached. Subsequently, if conditions change and the Threshold is no longer an issue, then the AESO can discontinue the acquisition of Threshold Action products.

Before preparing the requests for proposals and proceeding to procure the Threshold Actions, the AESO will:

- undertake further analysis using the 2YRPSAS model or other means in an effort to determine more precisely the likely cause of the breach; the other Metrics will be utilized as part of that analysis
- determine the most effective timing of the remedy
- use the Worst Shortfall Hour measure as a guide to determine the size of the procurement program required

The Total Energy Shortfall measure would be used both to determine when to begin examining Threshold Actions and when to consider discontinuing the Threshold Actions program. The AESO does not intend to have a Threshold measure or level associated with any of the other Metrics defined in this paper.

## 5. Threshold Actions

### **5.1 Threshold Action** Criterion and Recommendations

Threshold Actions are defined as the out-of-market measures the AESO may choose to implement to remedy an actual or impending long term adequacy shortfall. Threshold Actions are intended to be a balance of the following key elements:

**Effectiveness**: The Threshold Actions must directly address an impending adequacy issue.

**Market stability and certainty**: From a principle perspective, the Threshold Actions would promote increased stability and reduced uncertainty for the market.

**Cost**: Threshold Actions will have a cost, which will be recovered from load. The actual cost of the proposed Threshold Actions will be very hard to predict and must be assessed by the AESO at the time of implementation.

The following three Threshold Actions are recommended:

1. Load Shed Service (“LSS”)
2. Self Supply and Back-up Generation (“Back up Generation”)
3. Emergency Portable Generation

The proposed Threshold Actions are effective in that they are expected to provide significant capacity at the time required and the AESO should be able to obtain the capacity within a relatively short time period. The Threshold Actions will also contribute to market stability in that they should have a minimal impact on the market when they are procured and when they are dispatched. The cost on a $/MWh basis could be significant when the Threshold Actions are procured and/or dispatched but the overall cost should be much lower than most of the

other options considered. The Threshold Actions can work together yet, at the same time, they will compete with each other to lower the overall program costs.

The proposed Threshold Actions will provide an effective solution to bridge a temporary adequacy gap without impacting investor confidence in the market.

Each of the proposed Threshold Actions is discussed further below.

### 5.2 Load Shed Service

**Description:** If a Threshold is breached, the AESO would contract with load customers for the right to curtail load in certain circumstances and under specific terms and conditions. Load would only be curtailed under this service to avoid involuntary curtailments. It is expected that load participants may require a notification period, and may require a commitment over several hours in order to implement the curtailment.

Program elements for LSS and other Threshold Actions may include:

- evaluating MW amount needed

- contract tendering and administration

- dispatch priority considering different operational requirements within the offer

- dispatch response time

- submission of data to verify compliance, and

- settlement

Mass market retailers may be able to participate in the LSS program if they can find adequate and verifiable means to curtail their customers. This includes the use of any demand response tools that they find beneficial for use in the program.[14]

**Rationale:** LSS can be implemented relatively quickly and is expected to provide capacity when it is needed. To encourage generation investment in an energy only market, it is generally understood that there will be periods of high prices. The LSS program allows the price to reach the price cap due to insufficient supply, while reducing the risk of regulatory intervention through proactive monitoring and timely, targeted response.

LSS can be a great bridging mechanism, if generation capacity is being built but isn't complete, because the LSS program can be implemented and terminated relatively quickly. Also, LSS does not have to be purchased in large volumes and can be easily customized to accommodate smaller sized procurement programs. The LSS program is also effective in that the majority of costs are incurred only when needed during times of supply shortfall. In addition, loads have the opportunity to participate in and benefit financially from the LSS program.

[14] Additional Demand Response Programs will be considered in a process separate from the Threshold Actions.

### 5.3 Self-Supply and Back-Up Generation

**Description:** Under the Back-up Generation option, the AESO would contract with the owners of self-supply and back-up generation for the ability to call on generation that normally would generate either solely for its own use, or supplies its own back-up power when there is a system outage. (For example, back-up generators at hospitals or office buildings.)

Back-up Generation units were not built by the owner to directly profit from the generation output. The owners are not in the business of power generation. However, the owners may be willing to offer the service for a fee when the system is facing involuntary load curtailment.

The service would be intended for those generators that would not participate in the market under normal market conditions. The service is also intended to include generators that will exist within the system regardless of market conditions. And since the generators already exist, contracts may be entered into with the owner in a timeline relatively close to a potential supply shortfall situation. It is expected that these generators would supply electricity in excess of their onsite needs; otherwise they could offer their electricity as load shed service. It may be necessary to ensure that these generators have adequate metering facilities and meet the technical requirements of the wire owner to offer electricity volumes in excess of their load. The distribution companies within the province currently accommodate distribution connected generation that sells electricity into the power pool; therefore it is expected that the generators that could provide such service would need to comply with the existing connection requirements, similar to how they would sell that energy into the power pool if they wished to be a participant. Interconnection costs could be considered with their offers, but it is expected these offers would be evaluated and compared with other offers that may not include such costs.

Just like LSS, the AESO would not dispatch Back-up Generation units except to avoid involuntary curtailments. The AESO would create these contracts at the same time as the LSS contracts are being created to ensure that the contracts are consistent.

Generators entering this program will do so under the condition that they will be ineligible to offer energy into the energy market. Thus, the generator should initially decide if they wish to participate in the program, or evaluate the merits of offering energy into the energy market.

**Rationale:** A Back-up Generation service has very similar benefits to LSS. It can be implemented relatively quickly, especially if the AESO were to pre-qualify generators before an adequacy issue is identified. It can be suspended on very little notice and the costs will only be incurred during times of supply shortfall. The service has minimal market impact in that it allows the price to go to the price cap and is effective in preventing curtailment of firm load.

Actively pre-qualifying Back-up Generators and/or actively seeking potential Back-up Generators if a Threshold is breached may have the additional benefit of identifying possible LSS providers.

### 5.4 Emergency Portable Generation

**Description**: The AESO would enter into a contract with an owner of emergency portable generation. Experience in other jurisdictions indicates that portable generation can be made available to the system well within the 2 year time frame. Emergency Portable Generation will be permitted to offer on similar terms to LSS and Back-up Generation. That is, this generation would only be dispatched during supply shortfall situations. The owners of such generation would be expected to comply with the normal interconnection application process.

Emergency Portable Generation would be procured on similar terms to LSS and Back-up Generation. Competing on an equal basis, Emergency Portable Generation would not receive any additional consideration or special compensation (i.e. they would be responsible for securing a site, and transportation costs would only be recoverable through their offers). Furthermore, program participants will face certain restrictions. Portable generators participating in the program will be ineligible to also participate in the energy market. If program participants decide to no longer participate in the Emergency Portable Generation program, they will be restricted from participating in the energy market for a period or face financial penalties. (For example, the contract could state that the unit, by serial number, is ineligible to participate in energy market for a predefined period after participation or be subject to a refund of payments received).

**Rationale:** An Emergency Portable Generation service has very similar benefits to LSS and Back-up Generation. It can be implemented relatively quickly. It can be suspended on very little notice and the costs will only be incurred during times of supply shortfall. The service also has minimal market impact in that it allows the price to go to the price cap and is effective in preventing curtailment of firm load. Portable generation may offer energy in larger MW increments; however it is still expected that the increments will be small enough to be considered within smaller sized procurement programs.

The AESO recognizes that there is greater risk that these types of units may seek longer term arrangements in the marketplace than the other Threshold Actions and that the AESO may have to seek a balance between contract cost and contract term when comparing the Threshold Action contract offers.

### 5.5 Threshold Action Contract Elements

Some of the more important elements of the contract between the AESO and the Threshold Action providers would be:

- Minimum MW amount of load or supply

- Minimum and maximum length of curtailment or supply period

- Notice period before actual curtailment or dispatch

- Compensation: may include prepayments before actual contract services are provided and/or lump sum payments when actual services are provided

- Maximum price paid for curtailment or supply

- Penalties for not curtailing or supplying when directed by AESO

These and other contract elements would be reviewed and finalized under the normal AESO contracting procedure in a timely manner before the Threshold Action procurement proceeds.

### 5.6 Recovery of Threshold Action Costs

It is recommended that load pay for the cost to procure the Threshold Actions, since the alternative to procuring these services would be to curtail load. Presumably load that would have self curtailed below the price cap would have already responded, so the effect is to encourage load response from customers who require even higher prices before they will respond. The load that continues to receive service and avoids involuntary curtailment will pay the additional cost for the Threshold Actions.

Costs would be recovered through a charge allocated to hourly load through the Power Pool.

## 6. Congruence with Government Policy

The LTA recommendations proposed in this paper are in alignment with government policy as outlined in the Policy Paper[15] and subsequent DOE clarification letter[16].

The Metrics, Threshold and Threshold Action descriptions were deemed to be "directionally consistent with the first recommendation by the DOE to the ISO, as set out under section 4.3.4 of the Policy Paper."[17]

The AESO expects that the Metrics, as proposed, will meet the requirement to provide a "forward view of the expected state of capacity adequacy in the Alberta market."[18]

The AESO believes that the Threshold Actions proposed meet the DOE expectation that the actions are "transitory, quickly executable, effective, and sized to the location and timing of a supply shortfall but do not need to signify an unrecoverable problem with the energy only market design."[19]

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[15] Alberta's Electricity Policy Framework: Competitive – Reliable – Sustainable June 6, 2005 Alberta Department of Energy, the "Policy Paper"

[16] ADOE Policy Clarification Letter to the LTA Committee April 25, 2006

[17] ADOE Policy Clarification Letter to the LTA Committee April 25, 2006 page 4

[18] ADOE Policy Clarification Letter to the LTA Committee April 25, 2006 page 6

[19] ADOE Policy Clarification Letter to the LTA Committee April 25, 2006 page 6

The Policy Paper also directed the AESO to provide an indicator of the "status, timing and progress of current and future transmission lines."[20] Early in the stakeholder consultation process, the AESO made clear its intention to provide extensive transmission status information through a separate process and that the LTA Metrics would not include any specific transmission related reporting. To that end, the AESO posts regular updates on all major transmission projects on its website and holds public meetings to ensure all stakeholders are fully informed on the AESO's plans.

The AESO notes that while this paper does not include Thresholds and Threshold Actions for potential future transmission adequacy situations which may arise on a regional basis, similar tools to those proposed in this paper may be considered in addressing such transmission constraints.

## 7. Next Steps

The AESO welcomes feedback on the LTA recommendations put forward in this paper. A comment matrix has been prepared to make it easier for stakeholders submit their comments. After receiving feedback from stakeholders, the AESO will review the feedback, respond to comments, suggestions and concerns, and move towards implementation.

Implementation is expected to be in the form of ISO rules, and ultimately a series of ongoing reports on adequacy. ISO rules will proceed through the regular rule change process, and will provide an opportunity for additional consultation. Development of IT systems and programs will occur simultaneously to ensure that rules and systems align.

In terms of the Threshold Actions, ISO rules may define some contract terms in advance to ensure that if at some future date such Threshold Actions are ever necessary, the Threshold Actions will be implemented in a contractual form that the AESO recommendation intends.

Please use the comment matrix on the AESO website to submit your feedback to Gordon Nadeau at gordon.nadeau@aeso.ca by February 21, 2008.

[20] Policy Paper page 34

# Appendix 1: Metrics

## 1.1 New Generation Status and Retirements

**Description:** The New Generation Status and Retirements Metric would be a summary report on the outlook for generation capacity in Alberta in the following four categories:

1. **Active Construction** - includes generation projects that are under construction or otherwise viewed to be committed to completion.
2. **Approved** - includes announced generation projects that have secured regulatory or other approvals and permits required to proceed. In addition, the owner of the project will have made a public statement about moving ahead with the project.
3. **Announced** - would include projects which may only be in the study stage or have only contributed a limited level of investment to move the project forward. The Metric report may include commentary on factors that impact the timing and / or viability of new projects. Topics would include but not be limited to changes to regulatory or permitting processes, site availability issues, technology developments and fuel availability.
4. **Retirements** – would include units that are being demolished or otherwise committed to retirement for Reserve Margin and other Metric calculation purposes. Potential retirements such as the generation units with expiring PPA contracts may also be noted for information purposes.

Information provided for the four categories includes specifics on the project sponsor, the project name, the MW size, fuel type, and commercial operation date or retirement date as appropriate. Upgrades to existing generation units are also included. A “Status” field allows the AESO to provide additional clarifying information if available.

Confidential information will not be disclosed in this Metric; it draws upon many forms of publicly available information from a wide variety of sources.

**Rationale:** Information on prospective generation additions provides context to interpreting the Reserve Margin and other Metrics.

## Results:

The New Generation Status and Retirements information is summarized in the following tables:

| Project Sponsor(s) | Project Name | Fuel | AIL MW | In Service Date(s) | Status |
|---|---|---|---|---|---|
| **Active Construction** | | | | | |
| Suncor | Firebag Stage 3 Utilities | Gas | 170 | 2009 | Under construction |
| EPCOR | Cloverbar Peaker #2 | Gas | 101 | Nov-08 | AESO Application in process |
| ATCO | Valleyview Peaker | Gas | 47 | Jul-08 | AESO Loss Factor unit |
| Shell | Caroline | Gas | 20 | TBD | Under construction |
| CNRL | Horizon Phase 1 | Gas | 101 | 2008 | Under construction |
| MEG | Christina Lake | Gas | 85 | Jul-08 | Under construction |
| TransAlta | Keephills #3 | Coal | 450 | Apr-11 | Under construction |
| **Approved** | | | | | |
| Earth Renew Organics | | Biomass | 4 | 2007 | EUB Decision |
| EPCOR | Cloverbar Peaker #3 | Gas | 101 | 2010 | AESO Application in process |
| Suncor | Voyager #1 | Gas | 85 | 2011 | EUB Decision |
| Suncor | Voyager #2 | Gas | 85 | 2012 | |
| Imperial | Kearl #1 | Gas | 85 | 2011 | EUB Decision |
| Imperial | Kearl #2 | Gas | 85 | 2012 | EUB Decision |
| Shell | Muskeg River Expansion(Jack Pine) | Gas | 85 | 2011 | EUB Decision |
| Shell | Muskeg River Expansion(Jack Pine) | Gas | 85 | 2012 | |

| Project Sponsor(s) Announced | Project Name | Fuel | AIL MW | In Service Date(s) | Status |
|---|---|---|---|---|---|
| Confidential | Confidential #674 | Gas | 110 | May-08 | AESO Application in process |
| Enmax | 1200 MW | Gas | 1200 | 2011 | Corporate Announcement |
| Confidential | Confidential #672 | Gas | 99 | Sep-08 | AESO Application in process |
| Confidential | Confidential #656 | Coal | 53 | Sep-09 | AESO Application in process |
| EBC Envir North America | | Biomass | 3 | 2008 | EUB Application filed |
| Shell | Carmon Creek | Gas | 180 | 2010 | AESO Application in process |
| Opti/Nexen | Long Lake South | Gas | 85 | 2011 | EUB Application filed |
| Petrocanada/UTS | Fort Hills Mine | Gas | 170 | 2011 | EUB Application filed |
| Canadian Hydro Developers | Dunvegan | new Hydro | 100 | 2011 | EUB Application filed |
| CNRL | Horizon Phase 3 | Gas | 85 | 2012 | Corporate Announcement |
| Total | Surmount | Gas | 85 | 2012 | Corporate Announcement |
| Total | Deer Creek Joslyn Mine | Gas | 85 | 2013 | EUB Application filed |
| Sherritt | Bow City | Coal | 1050 | TBD | AESO Application in process |
| EPCOR | Dodds-Roundhill coal gasification project | Gas | 380 | 2013 | Corporate Announcement |
| MaximPower | Deerland Peaking Station | Gas | 180 | Sep-09 | AESO Application in process |
| Enmax | Nose Creek Creek Generator | Gas | 97 | Jan-09 | AESO Application in process |
| MaximPower | HR Milner Expansion | Coal | 500 | Dec-12 | AESO Application in process |
| Confidential | Confidential #739 | Gas | 82 | 01-08-2009 | AESO Application in process |
| Confidential | Confidential #741 | Gas | 85 | 01-03-2011 | AESO Application in process |
| Confidential | Confidential #744 | Gas | 350 | 01-09-2010 | AESO Application in process |
| Confidential | Confidential #745 | Gas | 200 | 01-07-2009 | AESO Application in process |
| Confidential | Confidential #749 | Gas | 90 | 01-09-2009 | AESO Application in process |

| Project Sponsor(s) | Project Name | Fuel | AIL MW | In Service Date(s) | Status |
|---|---|---|---|---|---|
| **Announced-deferred/cancelled** | | | | | |
| Synenco | Northern Lights Mine | Gas | 85 | TBD | EUB Application filed |
| Synenco | Northern Lights Upgrader | Gas | 40 | TBD | EUB Application filed |
| Husky | Sunrise | Gas | 85 | 2010 | Cogen unit cancelled |
| Petrocanada | Meadow Creek | Gas | 330 | 2013 | Deferred |
| Petrocanada | Hangingstone | Gas | 220 | 2013 | Deferred |
| CNRL | Primrose East | Gas | 85 | TBD | Cogen unit cancelled |
| EPCOR | Genesse 4 | Coal | 450 | TBD | |
| TransAlta | Keephills #4 | Coal | 450 | TBD | |
| Confidential | Confidential #660 | Gas | 80 | TBD | AESO Application in process |
| Shell | Muskeg River Expansion(Jack Pine) | Gas | 85 | TBD | Deferred |
| Shell | Muskeg River Expansion(Jack Pine) | Gas | 160 | TBD | Deferred |
| Petrocanada/UTS | Fort Hills Upgrader | Gas | 415 | TBD | Deferred |
| Petrocanada | MacKay River Expansion | Gas | 250 | TBD | Cancelled |
| **Retirements-Approved/Announced** | | | | | |
| ATCO | Rainbow #1 | Gas | 26 | 2011 | AESO TMR contract |
| | Rainbow #2 | Gas | 40 | 2011 | AESO TMR contract |
| | Rainbow #3 | Gas | 21 | 2011 | AESO TMR contract |
| ATCO | Battle River #3 | Coal | 148 | 2013 | PPA expires |
| | Battle River #4 | Coal | 148 | 2013 | PPA expires |
| TransAlta | Wabumun #4 | Coal | 279 | 2010 | Company Announcement |

### 1.2 Reserve Margin

**Description:** The Reserve Margin Metric is a forecast, expressed in percentage terms, of the amount of Alberta generation capacity (at time of system peak) that is in excess of the annual peak demand[21]. Several years of historical data and five years of forecast data will be reported and calculated as follows:

Reserve Margin (%) = {(Installed Generation Capacity – Peak Demand)/Peak Demand} *100

Installed Generation Capacity equals the Active Construction generation information from the New Generation Status and Retirements Metric plus the currently existing installed generation capacity less the expected generation retirements.

Peak demand will be the annual peak load forecast from the most current version of the AESO's "Future Demand and Energy Requirements" document.

The Reserve Margin Metric incorporates the following adjustments:

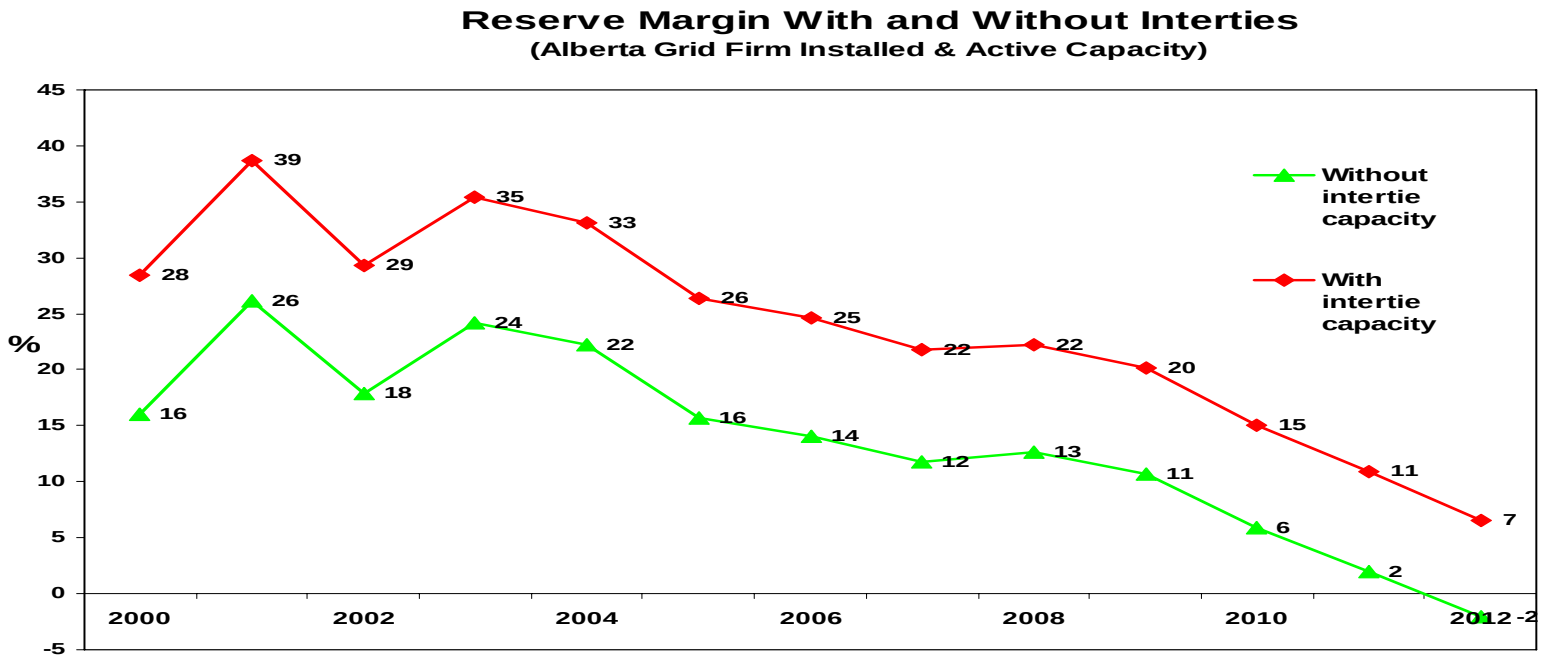
- Onsite "behind the fence" demand and the associated onsite generation capacity required to meet that demand at the time of system peak is excluded from the calculation of AIES Reserve Margin.
- Wind capacity is excluded and hydro capacity is derated to reflect the expected capacity available at the time of system peak. Irrigation hydro is assumed to be unavailable in the winter and large hydro has been derated by 25% at that time as well.
- Intertie capacity is incorporated into the calculation to reflect the likelihood that imports will be available during a supply shortfall situation within Alberta.

For future publications, the AESO will assess the benefits of providing multiple Reserve Margin scenarios in addition to the single scenario presented herein.

**Rationale:** The Reserve Margin Metric has the benefit of being easy to understand, is fact based and can reflect the important generation constraints. A five-year forecast time horizon will provide visibility far enough into the future so that impending adequacy issues can be tracked well before they become challenging to manage. At the same time, it must be recognized that a Reserve Margin calculation is deterministic and therefore does not address several key issues such as outages and derates that would reduce capacity during system peak load.

[21] The AESO peak load forecasting methodology is outlined in the AESO Load Forecasting document located on our website.

**Results:**
The Reserve Margin information for the AIES is summarized in the following graphic:




Lower Reserve Margin levels in later years of the assessment period are not forecasts of shortages. Rather, they are an indication that approved and announced new projects need to be brought along through regulatory approval to construction at the appropriate speed. At some point, the interpretation of the graphic shifts from an evaluation of supply margin to a determination of future needs and investment opportunities.

### 1.3 Supply Cushion

**Description:** The Supply Cushion Metric provides a two-year forecast of available daily generation capacity and peak demand.

Supply Cushion (MW) = (Total Daily Supply – Estimated forced outages and derates) - Daily peak demand

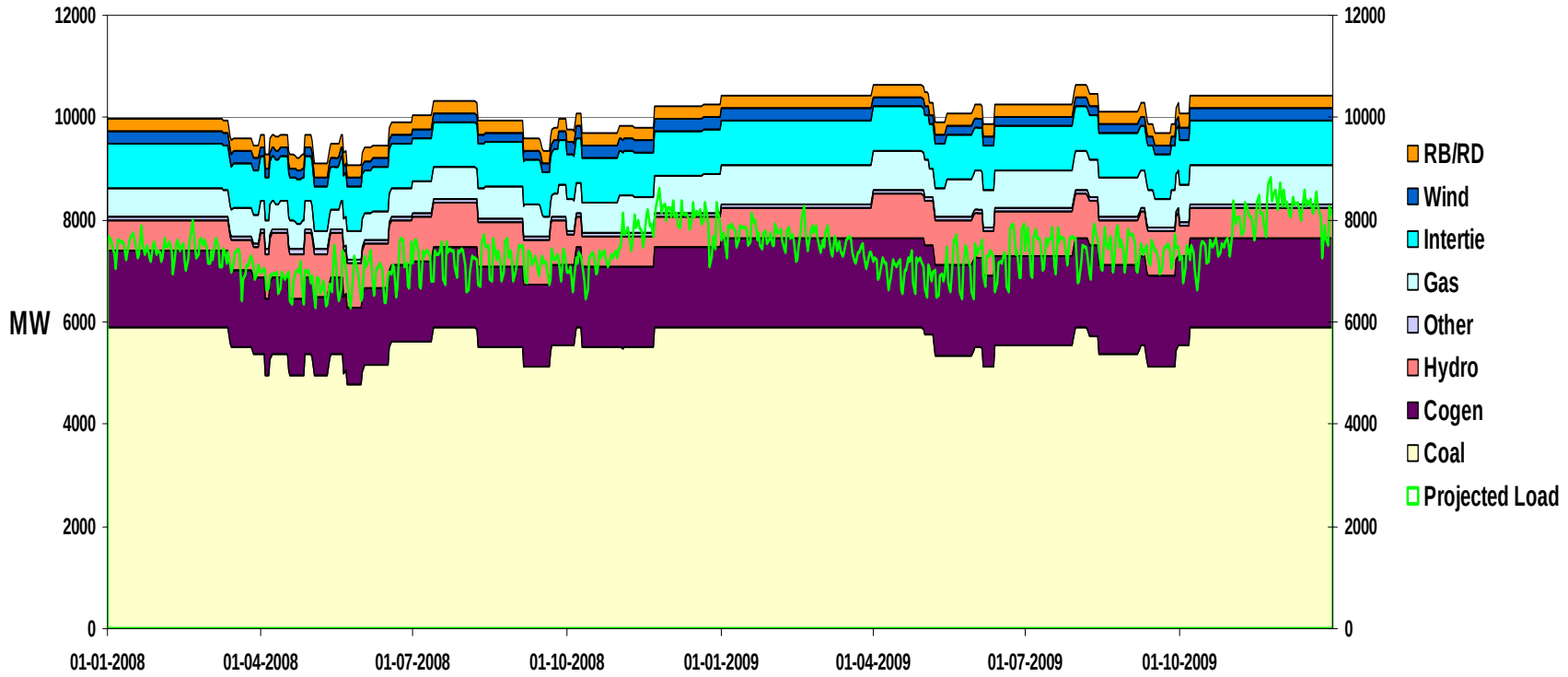
Total Daily Supply incorporates the maximum capability of the generating units less daily average planned outages and derates. Outages for the generating assets are incorporated as reported by participants in their outage scheduling submissions except for hydro units. Hydro capacity is adjusted for the winter period with irrigation hydro being reduced to zero and large hydro having a constant 75% capacity rating based on historical averages. Forced outages and derates are incorporated on an average basis using an estimated historical average value of 300 MW per day. Any confidential information used in the Metric is only shown in aggregate form.

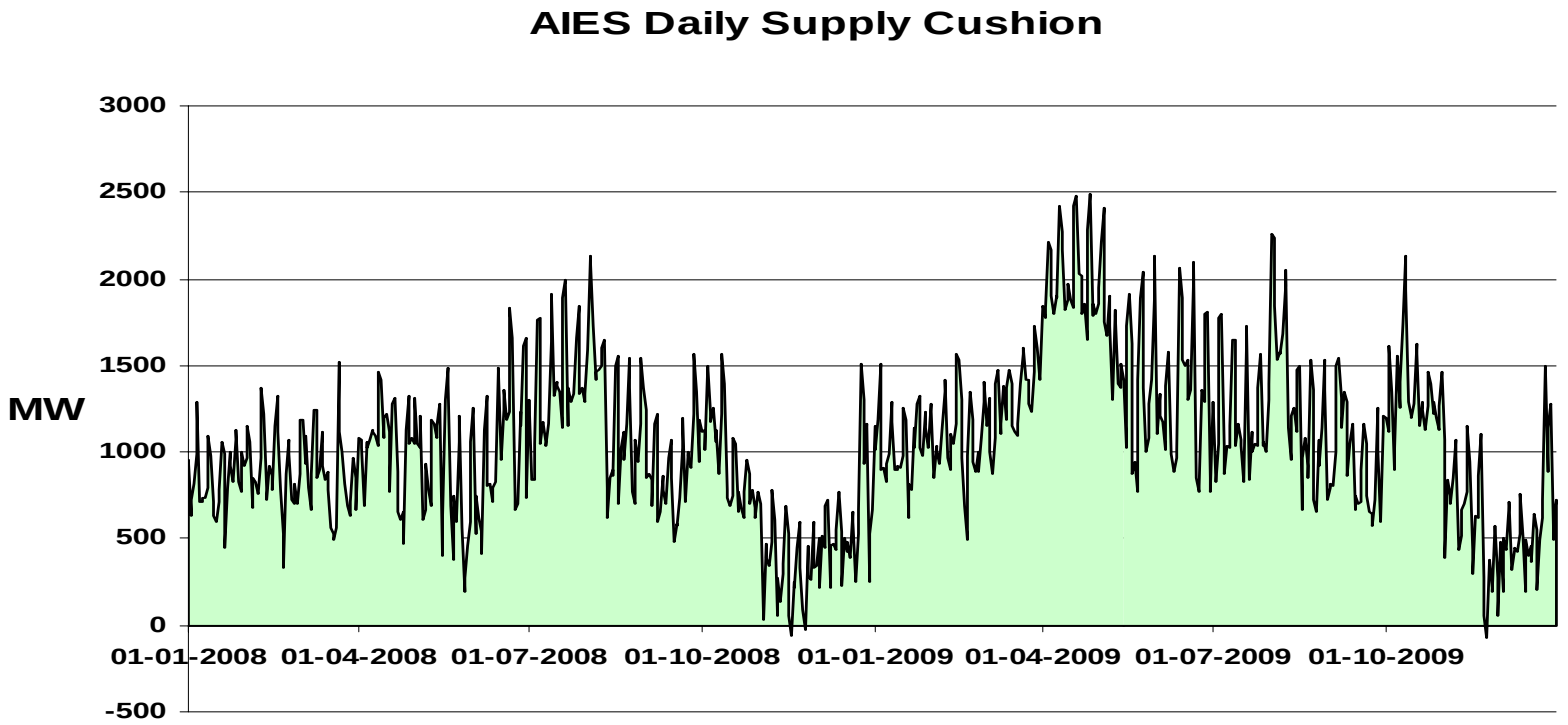
Wind capacity and interties are excluded from the Supply Cushion calculation although they are provided for reference purposes in the available supply graphic. Similarly, backup generation from the Rossdale and specific Rainbow gas fired generators are excluded from the calculation because they are not normally in the market but are available under contract as backup generation under certain system conditions.

A deficiency of supply to demand may indicate a reliance on imports to balance demand. The Metric illustrates the number, duration and magnitude of the forecast supply deficiencies.

**Rationale:** The Supply Cushion Metric provides visibility of the system's ability to meet the peak load on a daily basis. Although this Metric includes average forced outage rates and a single peak load estimate, it will be possible to envision, for example, the impact of one more forced outages and a higher than anticipated peak demand. This Metric will also show how much and how often Alberta load could be relying on imports. The Supply Cushion Metric expands upon the Reserve Margin Metric by including a "reserve margin" view on a daily basis, as opposed to an annual basis, while also accounting for expected outages. The Supply Cushion Metric identifies the specific days that may cause a concern, and it should be relatively easy and intuitive to understand.

## AIES Daily Peak Demand and Available Supply Including Interties






The Daily Peak Demand and Available Supply shown above is a companion graph shown with the Supply Cushion Metric as it provides a view of all capacity including wind and backup generation which are not in the Supply Cushion calculation. The companion graph enables participants to visually add or subtract supply or outage components to reflect their own supply assessments.

The Supply Cushion Metric graph illustrates that for most days there is adequate supply (500 MW or more) and there are tight periods in the winter of 2008 and 2009 where on some days a supply shortfall is calculated. During those tight periods, actual outage levels on high demand days will be important and may be less than the average 300 MW forced outage level used in the calculation.

## 1.4 Two Year Probability of Supply Adequacy Shortfall (2YRPSAS)

**Description:** The 2YRPSAS model is designed to track supply shortfalls measuring the hours when electricity demand exceeds supply in each two year period and storing the supply shortfall data from approximately one thousand two year period trial runs. The AESO has chosen to publish the supply shortfall data from the model in three formats as described below:

**Shortfall Count:** The total number of supply shortfall hours in each two year period. Shortfall Count measures the frequency of the problem.

**Worst Shortfall Hour:** The largest megawatt supply shortfall hour in each two year period. Worst Shortfall Hour measures the greatest magnitude of the problem.

**Total Energy Shortfall:** The cumulative megawatt hours of supply shortfall over the entire two year period. Total Energy Shortfall measures the cumulative magnitude of the problem incorporating the frequency, magnitude and duration of the problem.

The Metric is calculated using the following inputs on a deterministic basis:

- AIES hourly load forecast
- Forecast maximum capability of generation assets, including existing units, retirements, and Active Construction units expected in the two year period.
- Planned outages
- Intertie capacity

The Metric also uses a distribution of outcomes for the following inputs:

- Intermittent or energy limited resources (such as wind and hydro power)
- Cogeneration asset's net to grid production
- Forced coal outages

For simplicity and ease of interpretation, the Metric does not incorporate the potential impact of demand response or the potential demand reduction from the curtailment of DOS load.

The model that calculates this Metric looks two years forward on an hourly basis. The model outputs reflect conditions over the entire two year period; however, it is able to examine individual months, seasons or years if more detailed analysis is required or appropriate. In comparison to the Supply Cushion Metric, the 2YRPSAS provides the probability of a supply shortfall over a defined time frame. It is not intended to focus on individual days or hours.

**Rationale:** This Metric takes the Supply Cushion Metric one step further to include the dynamic impacts of changes in cogeneration output, forced coal outages, and the intermittent nature of wind power. This Metric will take into consideration instances when there are lower behind the fence loads at cogeneration sites, above average forced coal outages and/or the wind power is at maximum capacity. Such normal market occurrences are not easily reflected in the single point of time estimates used in the Reserve Margin and Supply Cushion Metrics.

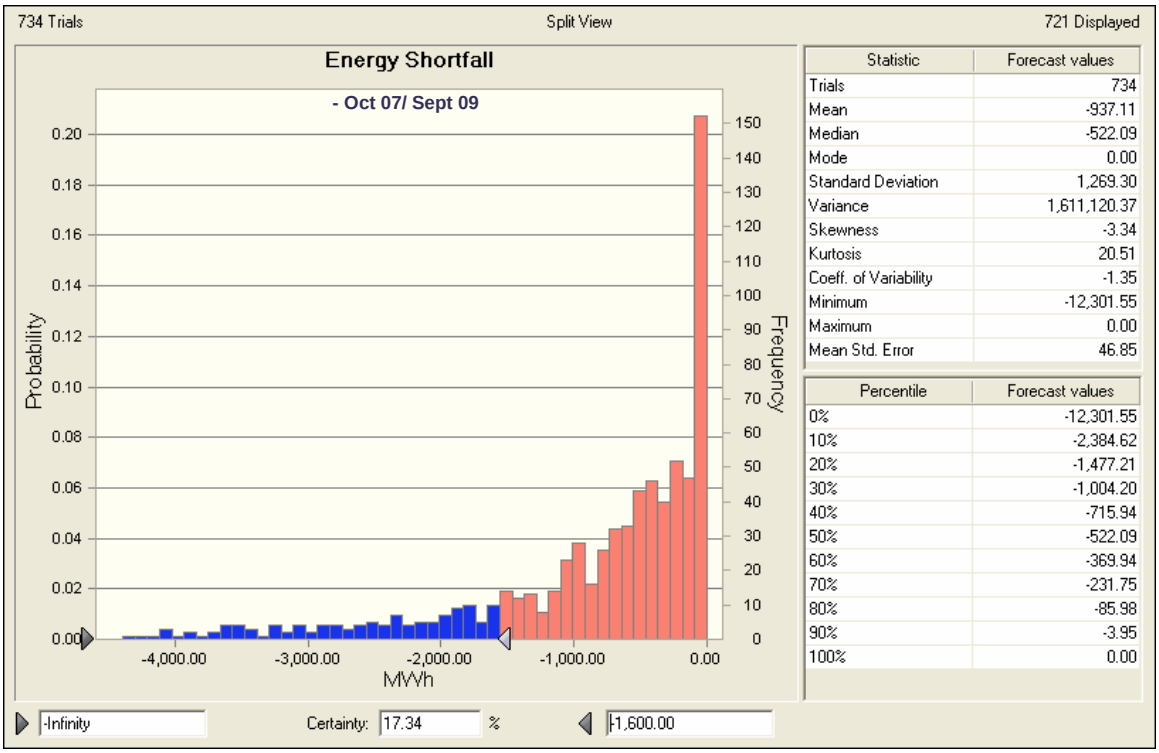
This Metric provides the most inclusive indicator of an impending supply shortfall over the subsequent two-year period and the AESO is proposing to define a threshold based on this specific Metric which, if breached, may result in the procurement of Threshold Actions.

Given the significance of the results coming from this Metric, the AESO has undertaken extensive consultation with a representative industry workgroup to review the model and input assumptions and verify the model results against other models and historical experience.

The model inputs are primarily derived from information generally available to the public. The AESO does expect to make ongoing improvements to the model as it gains experience with it and intends to implement a process for changing the model methodology or input assumptions that would involve stakeholder consultation.

**Results:**

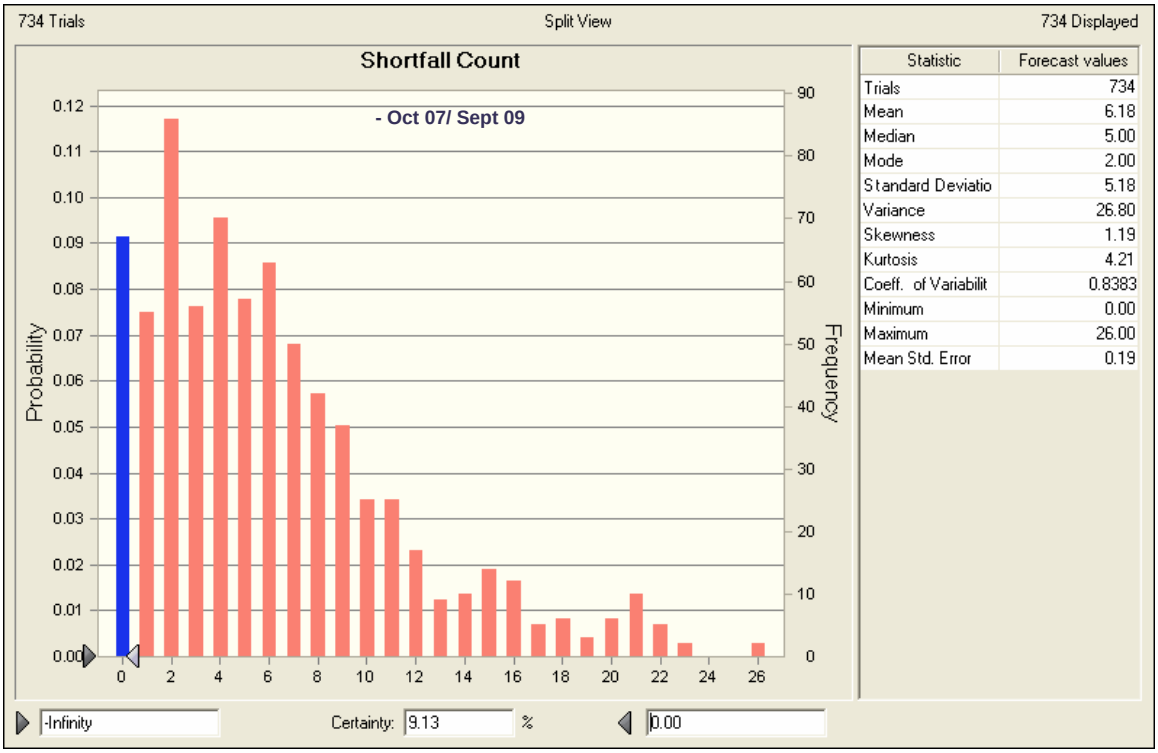
The 2YRPSAS Metric output is summarized in the following three graphics:



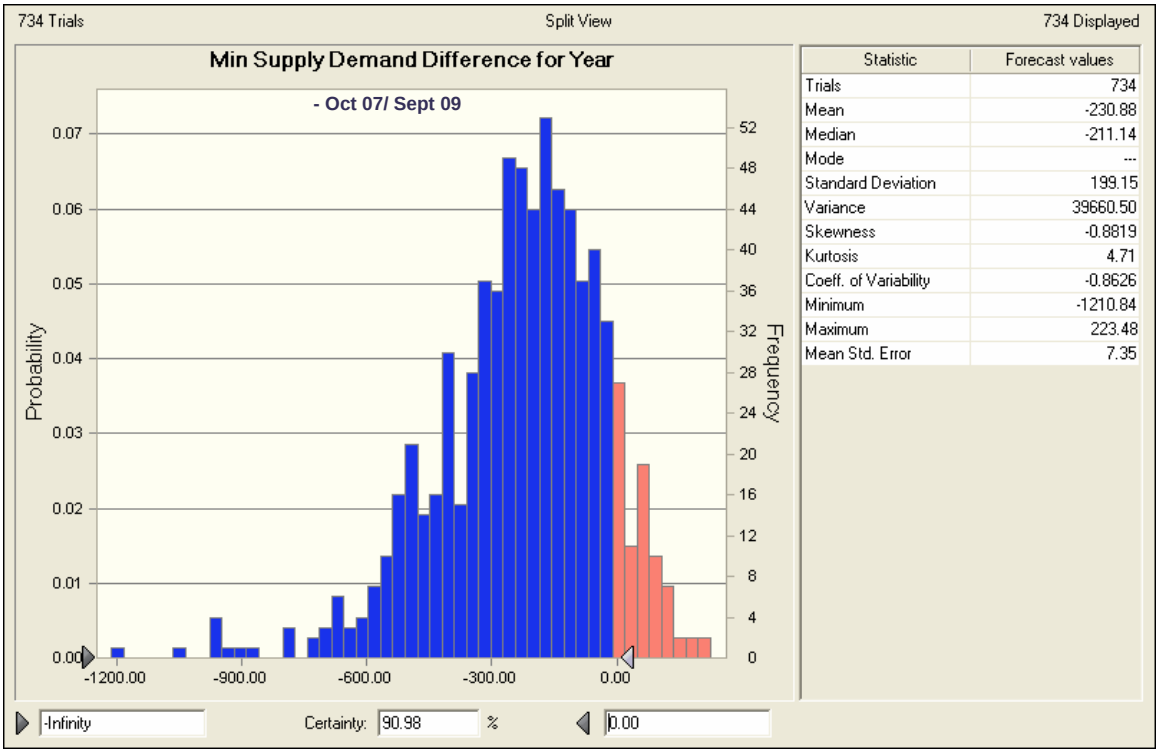

| Statistic | Forecast values |
|---|---|
| Trials | 734 |
| Mean | -937.11 |
| Median | -522.09 |
| Mode | 0.00 |
| Standard Deviation | 1,269.30 |
| Variance | 1,611,120.37 |
| Skewness | -3.34 |
| Kurtosis | 20.51 |
| Coeff. of Variability | -1.35 |
| Minimum | -12,301.55 |
| Maximum | 0.00 |
| Mean Std. Error | 46.85 |

| Percentile | Forecast values |
|---|---|
| 0% | -12,301.55 |
| 10% | -2,384.62 |
| 20% | -1,477.21 |
| 30% | -1,004.20 |
| 40% | -715.94 |
| 50% | -522.09 |
| 60% | -369.94 |
| 70% | -231.75 |
| 80% | -85.98 |
| 90% | -3.95 |
| 100% | 0.00 |

The Total Energy Shortfall Metric above indicates that of the 734 trials run over 82% had an Total Energy Shortfall less than 1600 MWh and that the expected value for the time period is 937 MWh which is below the 1600 MWh proposed Threshold level. Each bar on the graph depicts the frequency or probability of a specific Total Energy Shortfall level. For example, approximately 30 runs or 4% of the runs had a Total Energy Shortfall level of 1000 MWh.




The Shortfall Count Metric above indicates that in the 734 trial runs almost all runs had nine or less hours of supply shortfall and the expected value during the forecast period was six hours of supply shortfall. Each bar on the graph depicts the frequency or probability of a specific Shortfall Count level. For example, approximately 38 runs or 5% of the runs had a Shortfall Count of exactly nine hours.




| Statistic | Forecast values |
|---|---|
| Trials | 734 |
| Mean | -230.88 |
| Median | -211.14 |
| Mode | --- |
| Standard Deviation | 199.15 |
| Variance | 39660.50 |
| Skewness | -0.8819 |
| Kurtosis | 4.71 |
| Coeff. of Variability | -0.8626 |
| Minimum | -1210.84 |
| Maximum | 223.48 |
| Mean Std. Error | 7.35 |

The Worst Shortfall Hour Metric above indicates that while over 90% of the 734 trial runs had a supply shortfall hour, most supply shortfall hours were less than 500 MW in size and the expected value of the Worst Shortfall Hour during the period was 230 MW. The Metric is useful in that it provides an indication of the required MW size of Threshold Action procurement program that may be needed if conditions deteriorate beyond the Threshold level.

### 1.5 Generation Investment Signposts

**Description:** The Generation Investment Signpost Metric may be more appropriately termed a comparison. It shows, in a graph, the forecast trends of the following items:

- Reserve Margin
- Forward electricity prices (obtained from an independent broker)
- Forward natural gas prices (obtained from an independent exchange or broker)
- Levelized cost of new coal and gas-fired generation in $/MWh. (published by the AESO ) Levelized cost estimates reflect the future discounted average cost of generation over the life of the asset and include installed capital costs, load factors, fuel cost, operating life, non-fuel operating and maintenance costs, and financing assumptions

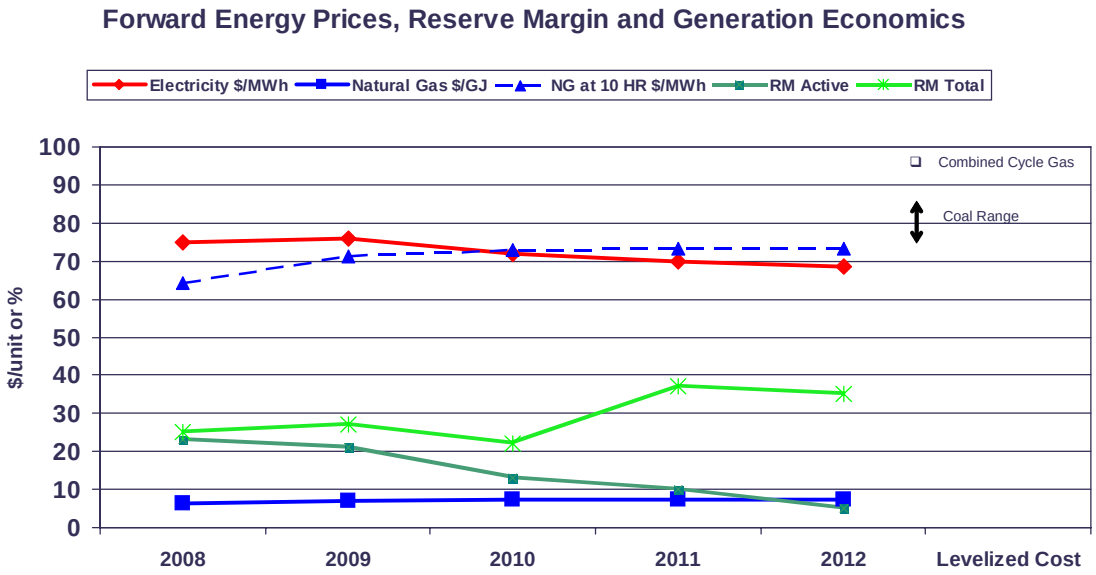
**Rationale:** The Generation Investment Signpost Metric is intended to identify any general inconsistencies between the need for new generation (Reserve Margin), forward electricity and natural gas prices relative to the cost to build new coal and gas fired generation (levelized cost of new generation plant). The Metric would be used as part of the suite of Metrics to create a view of the overall state of generation supply adequacy in Alberta. By publishing this Metric, the AESO will be providing clarity and transparency regarding the information it is using to assess market conditions after the Threshold is breached.

The Metric is intended to be a useful indicator of market trends and not a forecast of generation investment economics. Care must be taken when interpreting the results because the forecast time horizon is five years and investment decisions are typically based on 30 years or more. The first few years of a plant's life are important but represent only part of the overall investment decision for a potential generation owner. Furthermore, different generation units have different price requirements depending on the optimum time of operation and a simple comparison to annual electricity price can be misleading.

Even with the limitations noted above, the Metric will be useful in highlighting relative trends in the key investment indicators of future electricity price, fuel cost and construction cost. Issues that are identified and not fully explainable from an initial analysis may be highlighted for further independent analysis, if needed.

**Results:**

The Generation Investment Signposts Metric is summarized in the following graphic:




The Generation Signposts Metric above indicates that there is some consistency in the market signals between the need for new capacity (as illustrated by the decline in the reserve margin over time) and forward energy prices and generation costs (forward electricity and natural gas prices appear to be aligned and near the levelized cost level under which new generation may be incented to proceed). The Generation Signposts Metric is not meant predict generation economics but rather serve as a warning mechanism if there is misalignment in the market signals suggesting a need to investigate further.

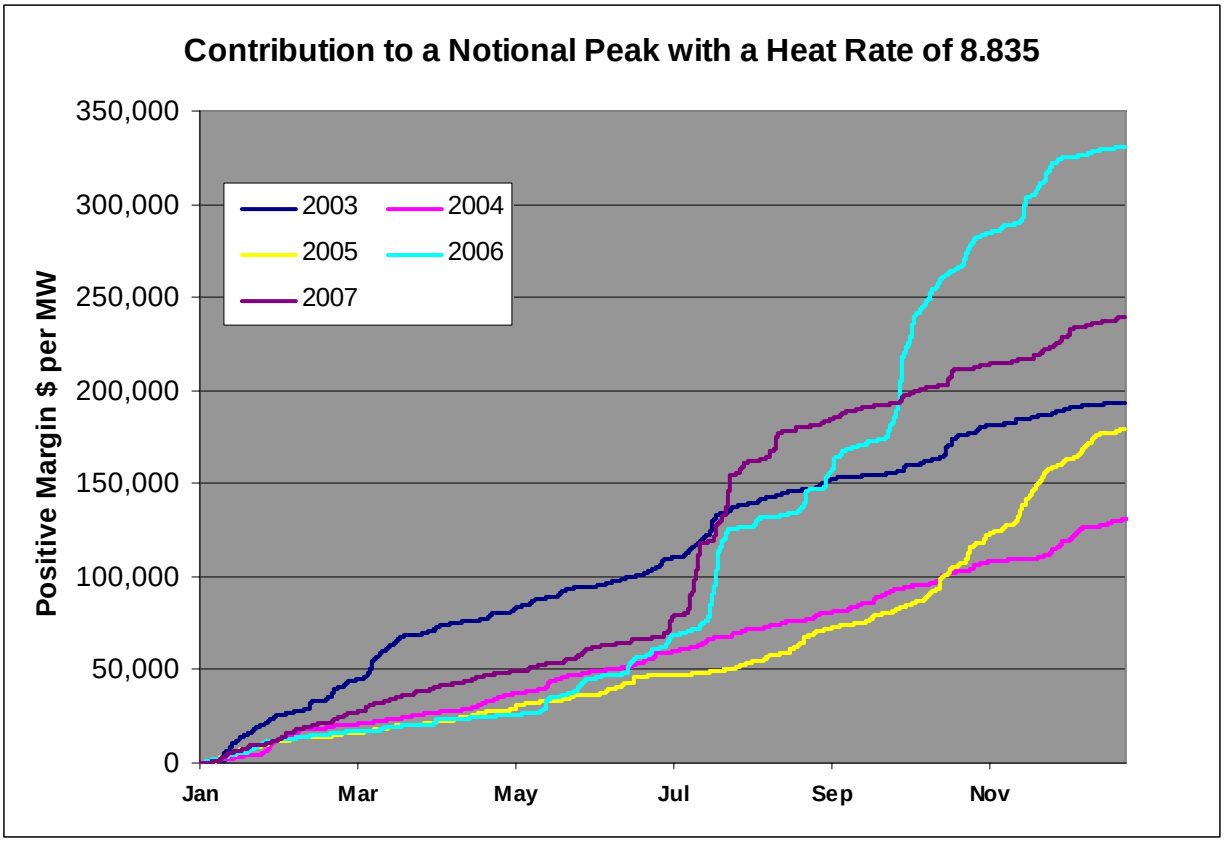
## 1.6 Contribution to Costs of Notional Gas-fired Peaking Unit

**Description:** The Contribution to Costs of Notional Gas-Fired Peaking Unit Metric utilizes historical electricity and natural gas prices together with an assumed peaking unit heat rate to estimate the positive contribution to the non-fuel costs that a new gas-fired peaking unit could theoretically have received over the past several years. The Metric measures the positive contribution on a per MW basis and displays the results on a cumulative annual historical basis. It is neither a forecast nor a depiction of actual peaking unit revenues. The Metric does, however, provide insights into historical market trends relevant to the operation of peaking units.

The Metric can also be considered a rough investment indicator, although there are some significant limitations in that regard. The most important limitation is that the Metric is historical and investment decisions are primarily based on anticipated future conditions. Nevertheless, understanding how a peaking unit may have competed in the past can provide insights into its participation in the future. Another limitation of the calculation stems from the fact the introduction of a new peaking unit into the market will, in and of itself, lower pool price realizations and therefore the Metric will tend to overestimate the potential contributions. Due to the complexity of the calculation, this second order impact has not been included in the Metric. Despite the limitations mentioned, the Metric does provide an opportunity to compare the capital and non-fuel operating costs of a new unit to the contribution to those costs that unit could have received in each of the last several years.

**Rationale:** This Metric can be used in conjunction with other Metrics and market signals to create a more complete and consistent interpretation of market fundamentals. Changes in the Metric over time may also help assess the impact of any actual market design changes on the fidelity of the pool price. The Metric would be used as part of the suite of Metrics to create a view of the overall state of generation supply adequacy in Alberta. By publishing this Metric, the AESO will be providing clarity and transparency regarding the information it is using to assess market conditions after the Threshold is breached.

**Results:**
The Contribution to Costs of Notional Gas-Fired Peaking Unit Metric is summarized in the following graphic:




The above Metric indicates that the positive margin calculation is higher in 2006 and 2007 than it has been in previous years. The trend toward higher positive margins is consistent with recent historical Reserve Margin trends and indicates that the market is receiving consistent signals in that regard.