THEORETICAL ENERGY SCHEDULE

Version 1.2

June 2020

Important notice

PURPOSE

AEMO has prepared this document to describe the process to determine the Theoretical Energy Schedule as it applied in the Western Australia Wholesale Electricity Market, and to address frequently asked questions.

This document is not a substitute for, and should not be read in lieu of, the relevant Wholesale Electricity Market (WEM) Rules.

This document is not a substitute for legal or technical advice. No person or organisation should act on the basis of any information contained in this document without obtaining appropriate professional advice.

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VERSION CONTROL

Version	Release date	Changes
1.2	June 2020	Updated to current AEMO branding and general review for consistency between sections.

Contents

Tables

Figures

Abbreviations

Abbreviations	Meaning
Alt Max Price	The Alternative Maximum STEM Price which represents the maximum price that can be submitted into Balancing. Also known as the liquid price
BMO	Balancing Merit Order
EOI	EOI Quantity or the MW quantity at the end of the interval
Facility	Any reference to a 'Facility' within this document means a Balancing Facility under the Wholesale Electricity Market Rules (clause of the WEM Rules 7A.1.6) and includes Stand-Alone Facilities but excludes the Balancing Portfolio
FAQs	Frequently Asked Questions
LFAS	Load Following Ancillary Service or Load Following Service
Max TES	Maximum Theoretical Energy Schedule
Min TES	Minimum Theoretical Energy Schedule
MPI	The Market Participant Interface for the WEMS
MWh	Megawatt hour(s)
NSG	Non-Scheduled Generator
P-Q Pair	Balancing Price-Quantity Pair
SOI	SOI Quantity or the MW quantity at the start of the interval
SSAF	Synergy Standalone Facility
TES	Theoretical Energy Schedule
WEMS	Wholesale Electricity Market Systems
WSDL	Web Service Definition Language, used to automate exchange of information with the WEMS

Please note that any capitalised terms not referenced in the table above are defined terms in the WEM Rules. The WEM Rules are available at: https://www.erawa.com.au/rule-change-panel/wholesale-electricity-market-rules

1. Introduction

This document explains the Theoretical Energy Schedule (TES) and its use in the Western Australian Wholesale Electricity Market (WEM) in the form of a series of frequently asked questions (FAQs). These questions describe TES, from high level concepts and context to detailed implementation.

The document is targeted at those who have a basic understanding of the Balancing Market as well as the gross dispatch model.

2. TES Fundamentals

2.1 What is TES?

TES is an acronym which stands for Theoretical Energy Schedule, which is calculated by AEMO to determine a Balancing Facility's Out of Merit quantities. TES represents the amount of energy, in megawatt hours (MWh), which should have been produced in an interval, by a Facility or the Balancing Portfolio.

The TES calculation is performed after the event (ex-post) using the Balancing Price to determine the 'theoretically optimal' generation schedule which would have produced the most cost efficient outcome for the Trading Interval, considering the starting position of each generator and their individual Ramp Rate Limits.

2.2 What is TES used for?

TES is used as part of the settlement process, such that for each Trading Interval:

a) Market Participants are paid the Balancing Price for their TES quantities. These are classed as 'In Merit' quantities.

b) TES quantities are compared against what was actually generated (using sent out meter schedules), with any differences between these two values (outside of certain tolerances known as Settlement Tolerances) being designated as Out of Merit.

Out of Merit quantities are eligible for compensation payments under certain circumstances.

Related Questions:

- Section 4.6 - *What are Settlement Tolerances?*
- Section 5.1 - *What does it mean to be Out Of Merit?*
- Section 5.2 - *What Out Of Merit quantities are eligible for compensation payments?*

2.3 When is TES published?

Provisional TES values are calculated by AEMO on business days only and made available to Market Participants up to three business days after the completion of the Trading Day.

Final TES values are calculated by AEMO and made available to Market Participants sixteen business days after the completion of the Trading Day, following receipt of the outage schedule and non-compliance information from System Management.

2.4 Where can TES values be viewed?

Provisional TES and Final TES values are available to Market Participants through the MPI and via web services.

Specifically, they can be found on the Balancing Schedule page, located under the Balancing menu of the MPI. For those who prefer to use web services, the `getTheoreticalEnergySchedule` report is described by the WSDL file https://wems.aemo.com.au/mpi/ws/balancing/v2.4?wsdl.

Final TES values are also included within the Settlements Participant Information Report (PIR), which is accessible via the Settlements menu on the MPI.

2.5 What TES values can be viewed publicly?

All TES information is Rule Participant Market Restricted (clause of the WEM Rules 10.2.3(a)), in that information that relates to an individual Market Participant can only be accessed by that Market Participant. TES values are not available to the public.

2.6 Why do we have Min and Max TES values?

TES is used by AEMO to calculate Constrained payments to generators. The TES is compared with the sent out meter schedule (or sum of sent out meter schedules in the case of the Balancing Portfolio) to determine the amount of Out of Merit generation.

In practise, AEMO actually calculates two types of TES:

- Min TES, which is used in Downwards Out of Merit Generation calculations; and
- Max TES, which is used in Upwards Out of Merit Generation calculations

This prevents overstating Out of Merit quantities in the event that a P-Q Pair has a loss factor adjusted price equal to the Balancing Price. This scenario is shown within the examples of the following question.

Related Questions: P-Q

- Section 2.2 – What is TES used for?

2.7 What is the difference between Min TES and Max TES?

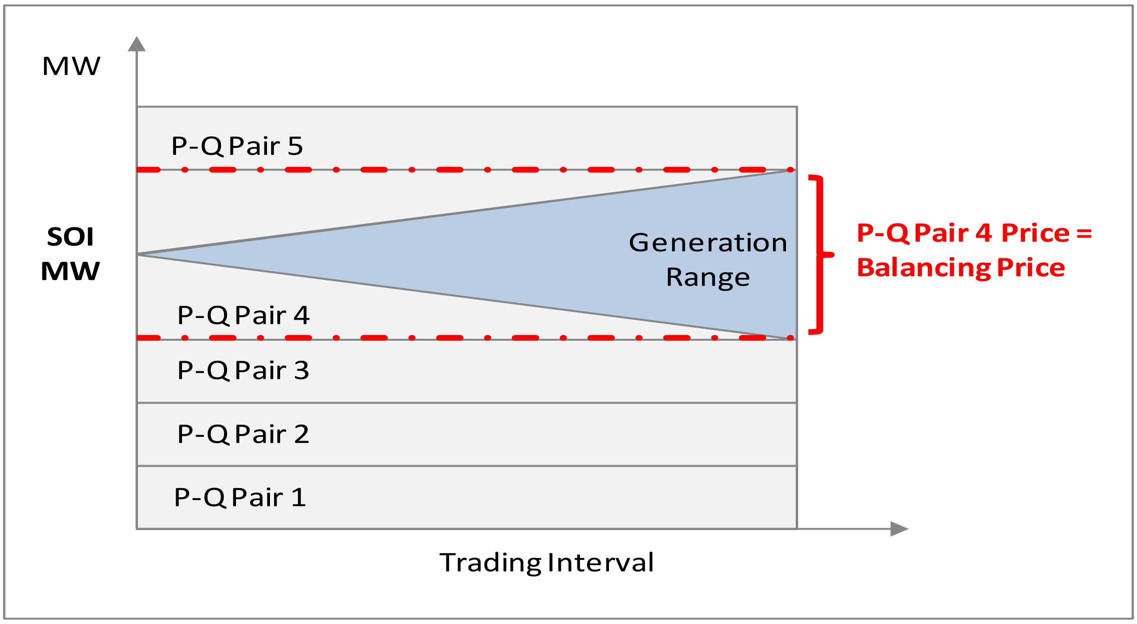
To understand the difference between Min TES and Max TES we must compare their definitions:

- Max TES - the maximum energy that could have been dispatched from P-Q Pairs with a price less than or equal to the Balancing Price taking the SOI and Ramp Rate Limit into account.
- Min TES - the maximum energy that could have been dispatched from P-Q Pairs given its Available Capacity with a price less than the Balancing Price taking the SOI and Ramp Rate Limit into account.

In most cases Min TES will be equal to Max TES, however they will differ if one of the P-Q Pairs has a loss factor adjusted price equal to the Balancing Price, or in the event of an outage which affects the available capacity of a Facility or the Balancing Portfolio.

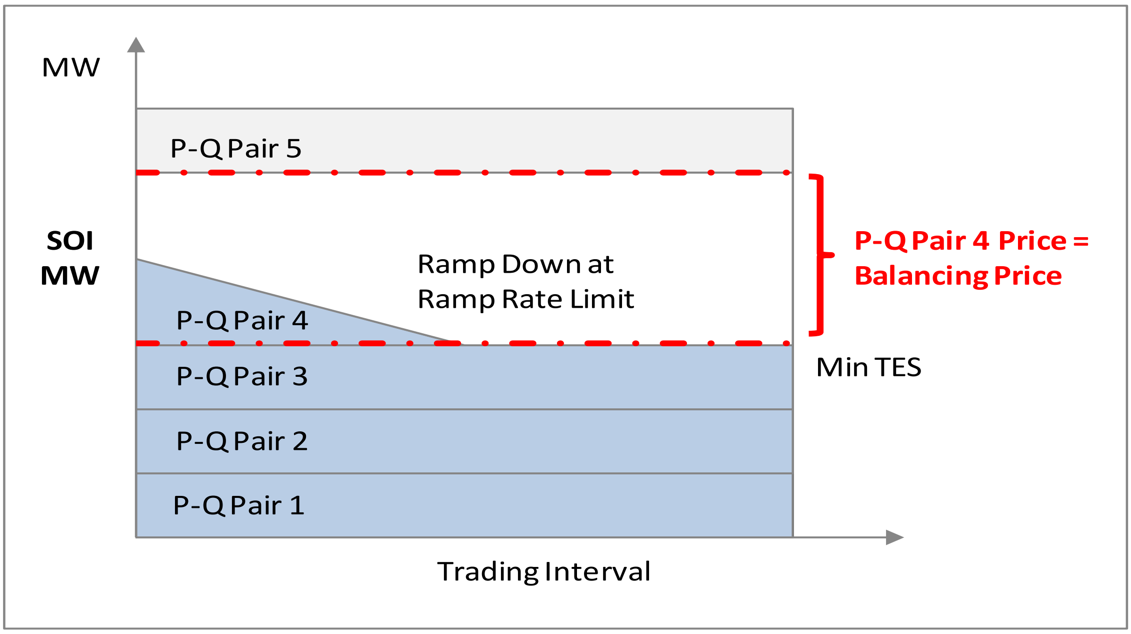
In cases where one of the Balancing Facility's P-Q Pairs has a loss factor adjusted price equal to the Balancing Price, the Balancing Facility is the marginal generator (i.e. they are the price setter). In these circumstances, generation will fall somewhere within that P-Q Pair (see Figure 1):

Figure 1 Generation range for marginal generator



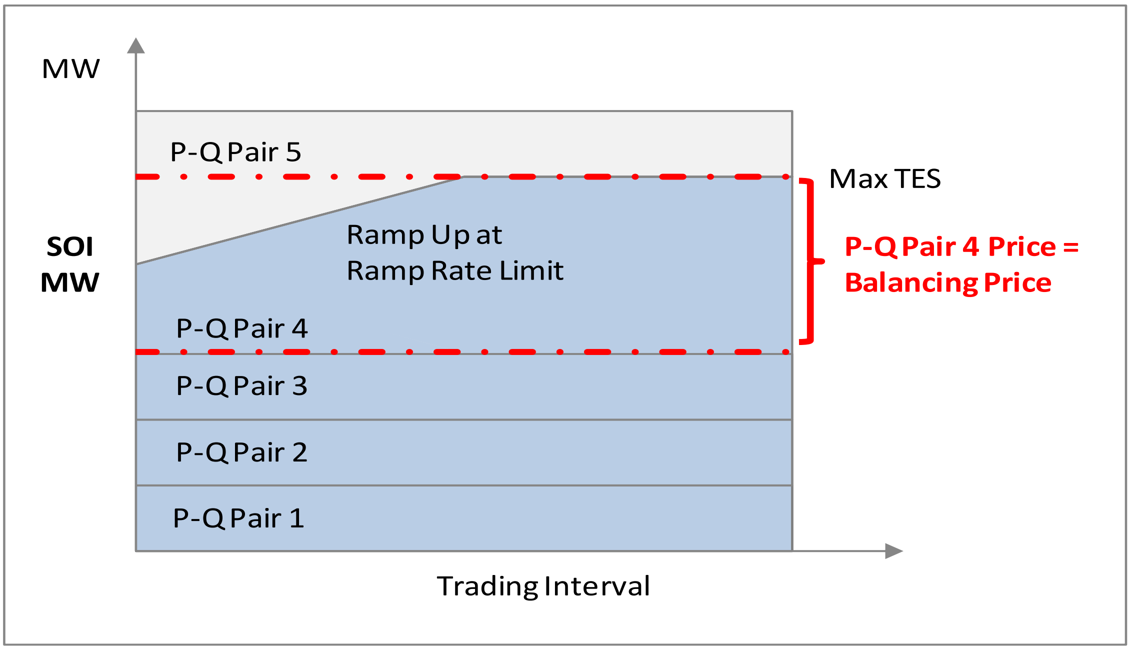
In the event that *a Facility was constrained off (generated less than what was expected by the BMO)*, the calculation of *Downwards Out of Merit Generation* quantities uses a TES equal to the minimum generation range (see below, area in blue) given the available capacity – i.e. the maximum energy that could have been dispatched in the P-Q Pairs with a price less than the Balancing Price. This is known as Min TES.

Figure 2 Minimum generation range for marginal generator



In the event that *a Facility was constrained on (generated more than what was expected by the BMO)* occurred, the calculation of *Upwards Out of Merit Generation* quantities uses a TES equal to the maximum generation range (next page, area in blue) – i.e. the maximum energy that could have been dispatched in the P-Q Pairs with a price less than or equal to the Balancing Price. This is known as Max TES.

Figure 3 Maximum generation range for marginal generator



Related Questions:

- Section 5.4 – *How to determine Upwards Out Of Merit Generation for a Facility?*
- Section 5.5 – *How to determine Downwards Out Of Merit Generation for a Facility?*
- Section 5.6 – *How to determine Upwards Out Of Merit Generation for the Balancing Portfolio?*
- Section 5.7 – *How to determine Downwards Out Of Merit Generation for the Balancing Portfolio?*

2.8 Why use loss factor adjusted prices?

As part of the creation of the Balancing Merit Order (BMO), all P-Q Pairs must be ranked in order of cost. While this appears simple, it is important to note that:

- Prices within Balancing Submissions for Facilities are priced 'as at' the Facility.
- Prices within Balancing Portfolio Balancing Submissions are priced 'as at' the Muja reference point.

To ensure that the prices are compared on an equal playing field, the Facility prices are loss adjusted to the Muja reference point. This adjustment is performed during BMO processing, with prices in each Facility P-Q Pair adjusted by (divided by) their marginal loss factors to derive a BMO Price. The BMO represents an ordered list of loss adjusted submissions priced 'as at' the Muja reference point.

To provide transparency, original submitted prices (submitted_price), loss adjusted prices (bmo_price) and the loss factor multiplier (marginal_loss_factor) are available within the Balancing Submissions report and through web services. This report is available to Market Participants via the Balancing Submissions page, located under the Balancing menu of the MPI. For those who prefer to use web services, the `getBalancingSubmissions` report is described by the WSDL file *https://wems.aemo.com.au/mpi/ws/balancing/v2.4?wsdl.*

As of WEMS 3.10, the MPI and web service reports round marginal loss factors to 3 decimal places, however the precision of the marginal loss factors used to create the bmo_price is far greater. A system improvement request has been raised to address this in a future WEMS release.

2.9 Are TES values in MWh?

Yes, TES values are in MWh. While Market Participants make Balancing Submissions and receive Dispatch Instructions which are based on Target MW values with associated Ramp Rate Limits, the TES calculation converts these into energy equivalent values in megawatt hours (MWh).

One MWh is the amount of energy that could be produced in an hour by a 1 MW generator. As an analogy, when driving a car the MW value is the speed it is travelling at, whilst MWh can be likened to the distance travelled in an hour.

2.10 Does TES apply to Non-Scheduled Generation (NSG) Facilities?

Yes. However, as NSG Facilities can't guarantee to be running at their dispatched level, their TES calculations are different.

Related Questions

- Section 4.2.4 – *Calculate Max TES for Non-Scheduled Generators*
- Section 4.2.5 – *Calculate Min TES for Non-Scheduled Generators*

2.11 Are outages considered in the TES calculation?

Yes, outages are considered in Min TES calculations. Outages reduce the Available Capacity of the Facility or the Balancing Portfolio, which used as a ceiling value in the calculation of Min TES.

Related Questions

- Section 4.2.3 – *Calculate Min TES for Scheduled Generators and the Balancing Portfolio*
- Section 4.4 – *What is the difference between Sent Out Capacity and Available Capacity?*

3. Provisional and Final TES

3.1 Why do we have a Provisional TES?

Provisional TES values are provided to Market Participants as soon as possible after the Trading Day using the latest available information at the time of publication. The calculation uses SCADA data and output estimates from System Management.

The purpose of the Provisional TES is to provide indicative TES values for each Market Participant to review prior to the publication of Final TES.

3.2 Why can Provisional TES publication delayed for up to 3 business days?

The calculation of Provisional TES is highly dependent on input information being received from System Management, such as SCADA End of Interval quantities and Dispatch Instructions. Under the WEM Rules (clause of the WEM Rules 7.13.1) System Management are required to provide this information to AEMO by noon on the first Business Day following the day on which the Trading Day ends. In most cases, information is received by this time and Provisional TES values are made available to Market Participants the same day.

However, if System Management advises AEMO that it has been prevented from providing this data, AEMO may extend the timeline of Provisional TES publication by up to a further two business days to allow System Management to resolve any issues.

3.3 Why is Final TES publication delayed for 16 business days?

The delay in publication of Final TES is due to the dependency on receiving the schedule of all Planned Outages, Forced Outages and Consequential Outages from System Management, as well as any Synergy non-compliance information.

Under the WEM Rules (clause of the WEM Rules 7.13.1A), System Management is required to provide all outage information and Synergy non-compliance information by noon on the fifteenth Business Day following the day on which the Trading Day ends. AEMO calculates Final TES and publishes to Market Participants once this information is received.

3.4 Why are there differences between Provisional and Final TES?

As not all information is available or complete at the time of calculation and publication of Provisional TES, it will inherently contain inaccuracies such as values based on estimates. For example, the full schedule of outages referred to in clause of the WEM Rules 7.13.1A is not available to AEMO until Final TES is calculated, therefore differences in values between Provisional and Final TES should be expected.

Related Question:

- See 3.3 - *Why is Final TES publication delayed for 16 business days?*

3.5 I think my Provisional TES is incorrect, what do I do next?

Contact AEMO Market Operations (WA) immediately to work through any concerns. They can be reached on 1300 989 797, or by emailing wa.operations@aemo.com.au.

Due to the timing of the Provisional TES calculations, inaccuracies in TES values will be present until final information is made available to AEMO.

It is important for Market Participants to discuss any TES queries and/or disputes with AEMO before Final TES values are published to allow time to investigate and confirm data with System Management, if required. Once Final TES values are published they cannot be altered.

Related Question:

- See 3.3 - *Why is Final TES publication delayed for up to 16 business days?*

3.6 Can I dispute the results of a TES calculation?

The results of Provisional TES can be disputed with the AEMO Market Operations (WA) team, however, once Final TES has been published, the WEM Rules prevent altering Final TES values under disagreement or dispute (clause of the WEM Rules 6.15.4).

4. Calculating TES

4.1 How do you convert Target MW values to energy equivalent MWh values?

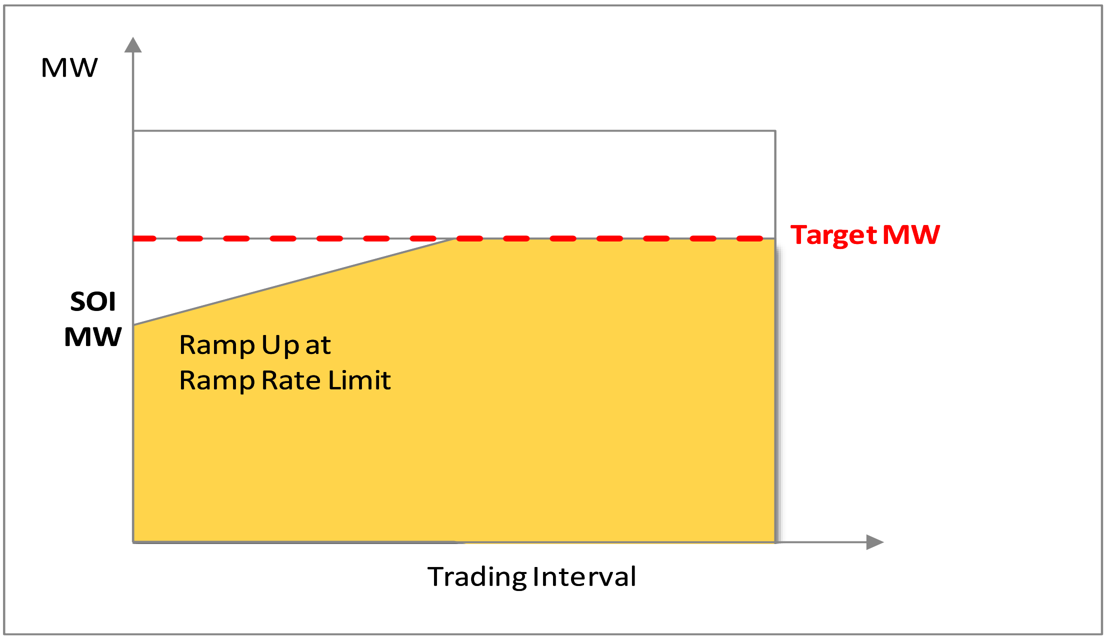
The conversion from Target MW to MWh requires working out the average MW output over a half hour Trading Interval and dividing this by two to get the MWh value.

Example 1: A Facility starts the Trading Interval (SOI) at 100MW and continues to generate at 100MW until the end of the Trading Interval (EOI). The average MW output over the Trading Interval is therefore 100MW; so over the interval, 50MWh was generated.

Example 2: A Facility starts the Trading Interval (SOI) at 0MW and increases generation (ramps up) at a constant ramp rate until reaching 100MW output at the end of the Trading Interval (EOI). The average MW output over the Trading Interval is 50MW; so over the interval, 25MWh was generated.

Calculations of average MW values are generally slightly more complicated as a result of ramping (up or down) from the SOI set point to a Target MW value and remaining at this set point until the end of the Trading Interval (Figure 4 depicts this situation).

Figure 4 SOI ramp up to Target MW

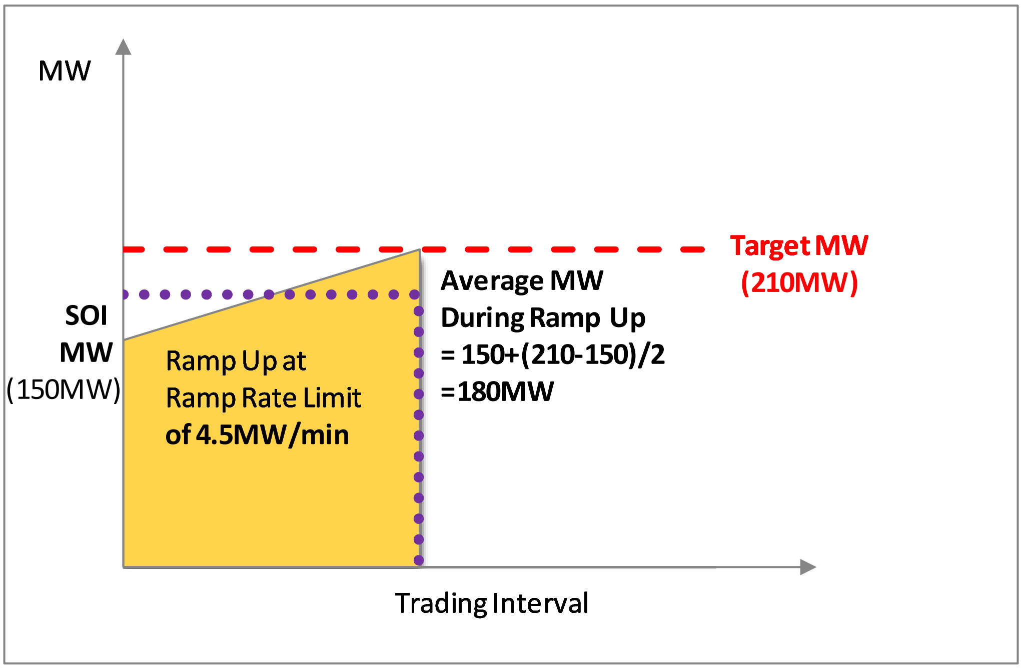


The simplest way to calculate the MWh value in these cases is to split the Trading Interval into two parts:

Part 1: Calculate the MWh Value for Ramp Up (or Down) Component

Part 1A Calculate the average MW during ramp up (or down)

Figure 5 Example generator average MW during ramp up from SOI to Target MW

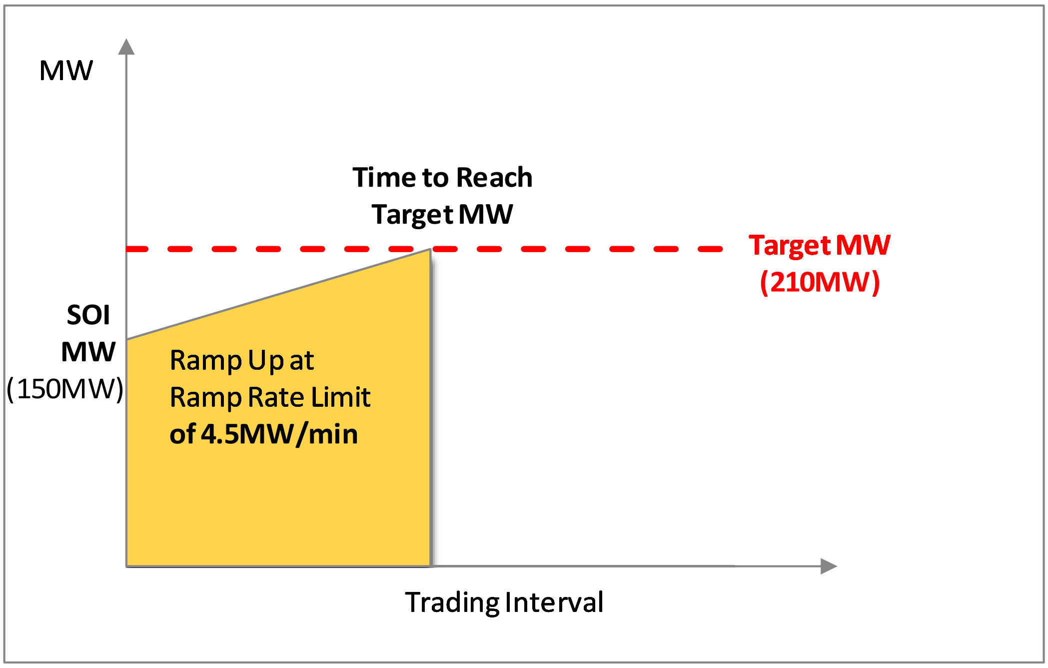


In the example above,

$$AverageMW = \left(SOI\ MW + \frac{(TargetMW - SOI\ MW)}{2} \right)$$
$$= 150 + \left(\frac{210 - 150}{2} \right) MW$$
$$= 180\text{MW}$$

Part 1B Calculate the time spent to ramp up (or down) to the Target MW

Figure 6 Example time to reach Target MW from SOI



In the example above,

$$RampDurationInHours = \frac{(Target\ MW - SOI\ MW)}{Ramp\ Rate\ Limit \times 60}$$

$$= \left(\frac{210 - 150}{4.5 \times 60}\right)$$

$$= \frac{60}{270}$$

$$= 0.2222\ Hours$$

Part 1C Multiply the Average MW during ramp up (or down) by the ramp duration to find the MWh value

$$MWh\ During\ Ramp\ Up\ (or\ Down) = AverageMW \times RampDurationInHours$$

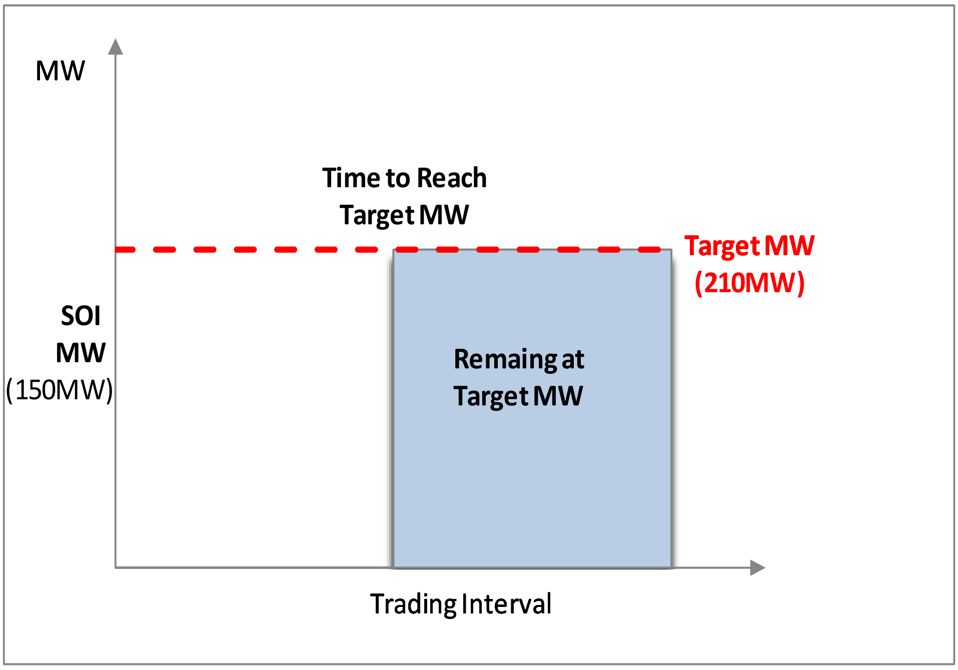
$$= 180MW \times 0.2222\ hours$$

$$= 40MWh$$

Part 2: Calculate the MWh Value for the Rest of Interval (ROI)

Multiply the $TargetMW$ by the remaining time in the interval to find the MWh value

Figure 7 Example remain at Target MW for the Rest of Interval



In the example above,

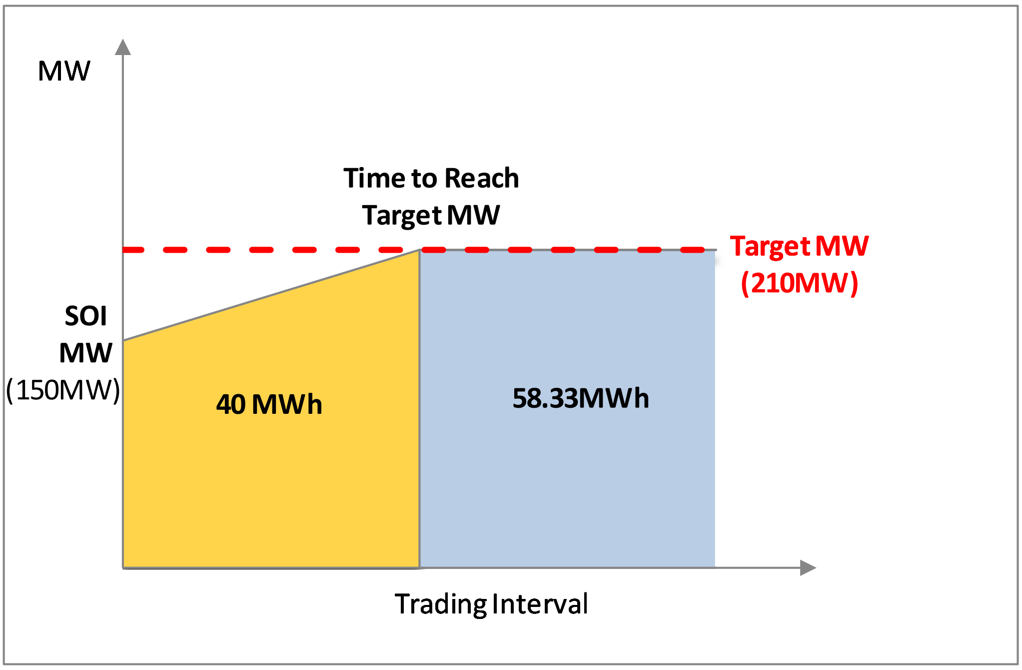
$$MWh\ for\ ROI = TargetMW \times (0.5 - RampDurationInHours)$$

$$= 210MW \times (0.5 - 0.2222)$$

$$= 58.33MWh$$

Part 3: Calculate the MWh Value for the whole of the interval

Figure 8 Example MWh for the whole interval



In the example on the above,

$$\begin{aligned} MWh\ Value\ for\ Whole\ Interval &= MWh\ During\ Ramp\ Up + MWh\ for\ ROI \\ &= 40 + 58.33 \\ &= 98.33MWh \end{aligned}$$

4.2 How does AEMO calculate TES?

AEMO uses the following process to calculate TES for all Balancing Facilities (clause of the WEM Rules 6.15):

1) Create a Pricing Balancing Merit Order (BMO)
2) Calculate Max TES for Scheduled Generators and the Balancing Portfolio
3) Calculate Min TES for Scheduled Generators and the Balancing Portfolio
4) Calculate Max TES for Non-Scheduled Generators
5) Calculate Min TES for Non-Scheduled Generators

4.2.1 Create a Pricing Balancing Merit Order (BMO)

BMOs are created by AEMO and are used by System Management to dispatch facilities. When it comes to determining a Balancing Price, the BMO used to determine facility dispatch is not suitable as it does not take into account the facility's SOI and its achievable generation profile given its ramp rate constraints and actual NSG EOI values. Consequently, to calculate the Balancing Price, AEMO creates a *Pricing BMO* which takes these factors into account.

AEMO publishes two different Pricing BMOs, a Provisional Pricing BMO published on the calendar day following the Trading Day, and the (Final) Pricing BMO which is published on the 3rd Business Day after the Trading Day.

During the creation of a Pricing BMO, quantities from P-Q Pairs within the BMO that cannot be achieved (due to Facility SOI generation levels and ramp rate constraints) are moved to either the minimum price or the Alt Max Price (liquid price). The effect of this amendment is to adjust the BMO to have these quantities in a position within the BMO which reflects their 'must run' or 'must not run' status. The resulting Pricing BMO is therefore a reflection of the physically achievable amount and order of generation during a Trading Interval.

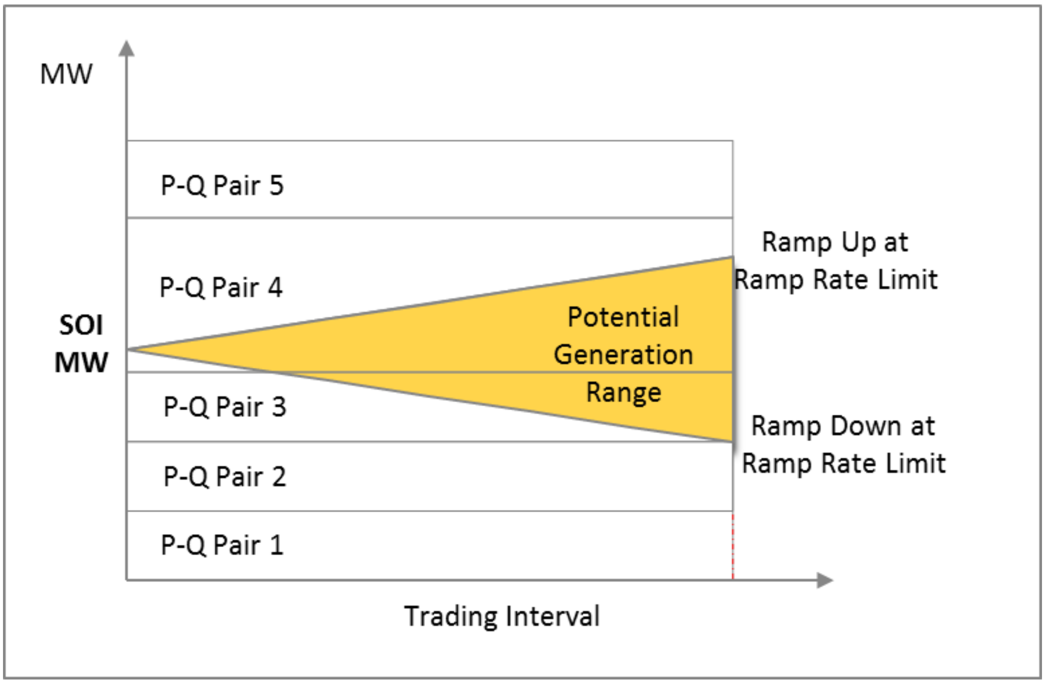
The Pricing BMO is used as an input and starting point for the TES calculations, and is made available to Market Participants via both the MPI reports display, and via web services. The Provisional Pricing BMO (Provisional BMO) and Final Pricing BMO (Final BMO) reports can be found on the Balancing Merit Order page, located under the Balancing menu of the MPI or alternatively via web services, which is described by the WSDL file *https://wems.aemo.com.au/mpi/ws/balancing/v2.4?wsdl.*

In the event that AEMO is unable to determine a Pricing BMO for any reason, including because it has not received the required information from System Management, AEMO will attempt to use the most recent Provisional Pricing BMO. If this is not available, AEMO will use the last BMO or Forecast BMO as the basis for TES calculations.

Step 1: Calculate the Potential Generation Range

Figure 9 below depicts the first stage of the Pricing BMO calculation, where the maximum potential generation range of a Facility, or the Balancing Portfolio, in a Trading Interval is determined by using the SOI MW as the starting point and extrapolating to the end of interval using Ramp Rate Limits.

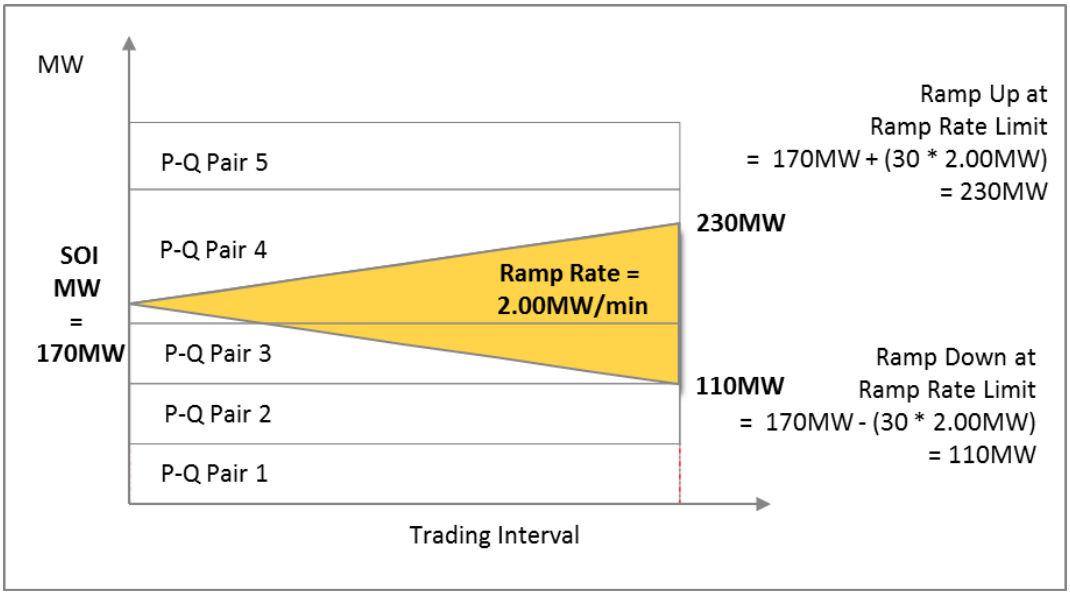
Figure 9 Potential generation range from SOI to EOI



Example

For a Facility with a SOI MW of 170MW and a Ramp Rate Limit of 2MW/min, we derive a maximum potential generation range of between 110MW and 230MW. This is show in Figure 10:

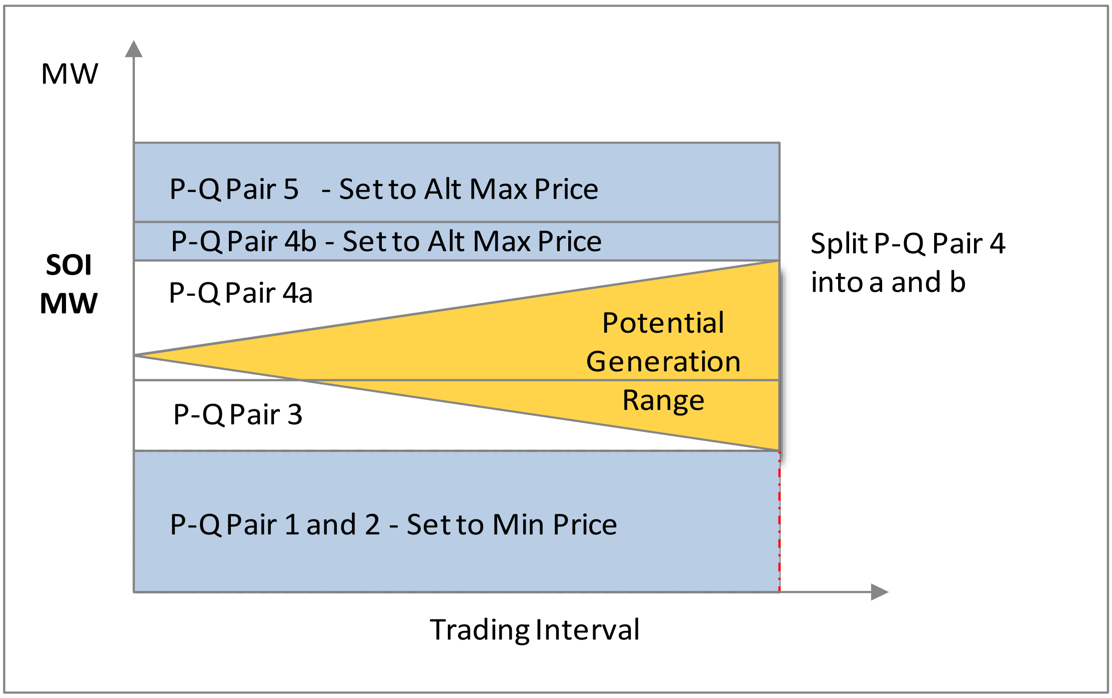
Figure 10 Example extrapolation of potential generation range from SOI to EOI



Step 2: Set Unachievable Quantities to Minimum Price or Alt Max Price

Figure 11 depicts the second stage of the Pricing BMO calculation, where quantities that could not have been achieved are set to the minimum or Alt Max Price based upon their location in the BMO.

Figure 11 Unachievable quantities set to Minimum Price or Alt Max Price



Example

Continuing the same example, assuming the following P-Q Pairs, set P-Q Pair 1 and P-Q Pair 2 to minimum price as the Min EOI MW value is 110MW.

i.e. For first 110MW of lowest priced P-Q Pairs (red), set Prices to Minimum Price (green) as below:

Table 1 Example unachievable P-Q Pairs set to Minimum Price

Submission	Price ($/MW)	Quantity (MW)	Cumulative Quantity (MW)	BMO Price ($/MW)	Comments
P-Q PAIR 5	323	55	330	323	
P-Q PAIR 4	150	110	275	150	
P-Q PAIR 3	60	55	165	60	
P-Q PAIR 2	35	55	110	-1000	Set P-Q Pair to Minimum Price
P-Q PAIR 1	-300	55	55	-1000	Set P-Q Pair to Minimum Price

As the Max EOI MW is 230MW and this falls within P-Q Pair 4 (see Cumulative Quantity column), we need to split P-Q Pair 4 into two parts (red in example), with the unachievable 45MW set to Alt Max Price and the remaining achievable 65MW of P-Q Pair 4 kept at the original price.

P-Q Pair 5 is also unachievable (orange in the table below), so this is set to Alt Max Price.

i.e. For last 100MW of highest priced P-Q Pairs, set Prices to Alt Max Price (green), as below:

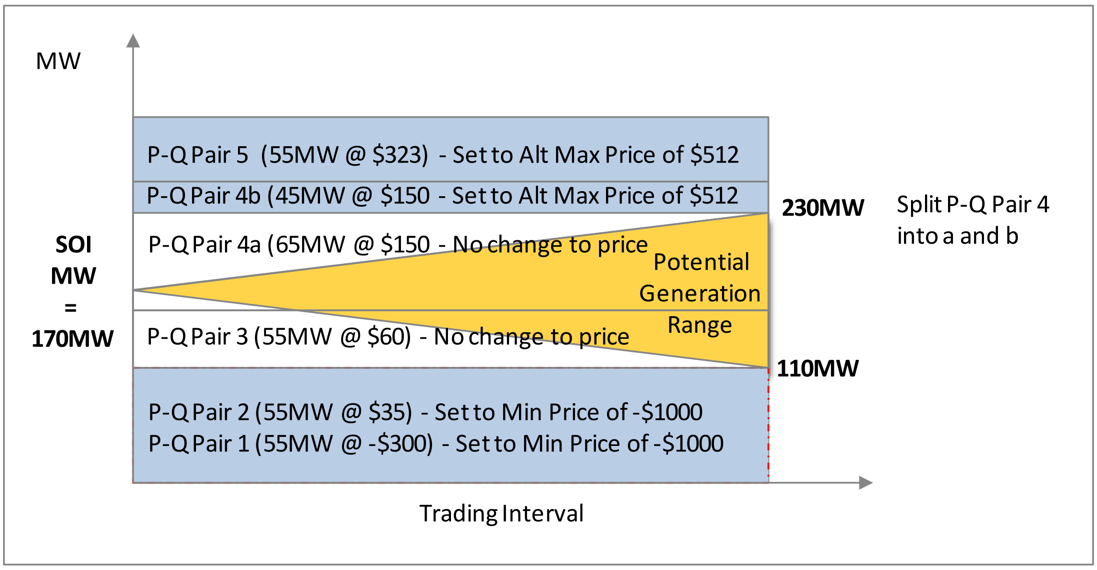
Table 2 Example unachievable P-Q Pairs set to Alt Max Price

Submission	Price ($/MW)	Quantity (MW)	Cumulative Quantity (MW)	BMO Price ($/MW)	Comments
P-Q PAIR 5	323	55	330	512	MW unachievable – therefore set to Alt Max Price
P-Q PAIR 4 – Part B	150	45	275	512	P-Q Pair 4 split, unachievable MW price set to Alt Max Price
P-Q PAIR 4 – Part A	150	65	230	150	P-Q Pair 4 split, achievable MW price remains unchanged
P-Q PAIR 3	60	55	165	60	
P-Q PAIR 2	35	55	110	-1000	
P-Q PAIR 1	-300	55	55	-1000	

The quantities in Balancing Price Quantity Pairs which are able to be reached have not been set to either the minimum or Alt Max Price.

This is depicted in Figure 12:

Figure 12 Example achievable P-Q Pairs are not set to Minimum Price or Alt Max Price



4.2.2 Calculate Max TES for Scheduled Generators and the Balancing Portfolio

For each Facility and the Balancing Portfolio, for a Trading Interval:

Step 1: Calculate Maximum Generation at or below the Balancing Price ($Max\ Gen$) value:

$Max\ Gen$ = Sum of all BMO Quantity (MW) values from P-Q Pairs where the BMO Price is less than or equal to the Balancing Price.

$$Max\ Gen = \sum BMO\ Quantities, where\ BMO\ Price\ \leq Balancing\ Price$$

Example

If we assume that the Balancing Price is $150 and use the Balancing Submissions from the Pricing BMO created in Section 4.2.1 (see below), we can calculate $Max\ Gen$ at or below the $Balancing\ Price$ as the sum of $BMO\ Quantities$ less than or equal to a $BMO\ Price$ of $150/MW. This is shown in green on the below table, where the $Max\ Gen$ = 230MW.

Table 3 Example maximum generation quantity at or below the Balancing Price

Submission	Price ($/MW)	Quantity (MW)	Cumulative Quantity (MW)	BMO Price ($/MW)	Comments
P-Q PAIR 5	323	55	330	512	$> Balancing\ Price$
P-Q PAIR 4 – Part B	150	45	275	512	$> Balancing\ Price$
P-Q PAIR 4 – Part A	150	65	230	150	$\leq \mathbf{Balancing\ Price}$
P-Q PAIR 3	60	55	165	60	$\leq \mathbf{Balancing\ Price}$
P-Q PAIR 2	35	55	110	-1000	$\leq \mathbf{Balancing\ Price}$
P-Q PAIR 1	-300	55	55	-1000	$\leq \mathbf{Balancing\ Price}$

Step 2: Calculate Maximum End of Interval ($Max\ EOI$) MW value

a) If $Max\ Gen$ is less than Start of Interval MW, $Max\ EOI$ is the greater of:

   i. Start of Interval (MW) – Max Ramp Down in 30 mins (MW); or

   ii. Maximum Generation Below or Equal to Balancing Price

This is either the maximum generation below or equal to the Balancing Price using the Pricing BMO, or where this is not achievable, the maximum generation that can be achieved by ramping down from the SOI set point at the maximum Ramp Rate Limit.

else

b) If $Max\ Gen$ is more than Start of Interval MW, $Max\ EOI$ is the lesser of:

   i. Start of Interval (MW) + Max Ramp Up in 30 mins (MW); or

   ii. Maximum Generation Below or Equal to Balancing Price

This is either the maximum generation below or equal to the Balancing Price using the Pricing BMO, or where this is not achievable, the maximum generation that can be achieved by ramping up from the SOI set point at the maximum Ramp Rate Limit.

else

c) If $Max\ Gen$ is equal to Start of Interval MW, $Max\ EOI = SOI$

Regardless of the situation (a, b or c above) one calculation can be used to calculate $Max\ EOI$:

$$Max\ EOI = \max\left(SOI - (Ramp\ Rate \times 30), \min(SOI + (Ramp\ Rate\ \times 30), Max\ Gen)\right)$$

Where:

- SOI – Facility or Balancing Portfolio Start of Interval MW Quantity (EOI MW from previous Trading Interval)
- $Ramp\ Rate$ – Facility or Balancing Portfolio Ramp Rate Limit expressed in MW per minute
- $Max\ Gen$ – Calculated at Step 1 (see Section 4.2.2).

Example

Following on from the earlier example, as $Max\ Gen$ (230MW) is greater than SOI (170MW), we calculate $Max\ EOI$ as the lesser of:

1. $200MW + (2 \times 30) = 230MW$; (max achievable by ramping up at the Ramp Rate Limit) and
2. $55MW + 55MW + 55MW + 65MW = 230MW$, (max submitted below or equal to Balancing Price)

Therefore, in our example $Max\ EOI$ is 230MW.

Using the full calculation for the same example:

$$\begin{aligned}
Max\ EOI &= \max\left(SOI - (Ramp\ Rate \times 30), \min(SOI + (Ramp\ Rate\ \times 30), Max\ Gen)\right) \\
&= \max\left(170 - (2 \times 30), \min(170 + (2\ \times 30), 230)\right) \\
&= \max\left(170 - 60, \min(170 + 60{,}230)\right) \\
&= \max\left(110, \min(230{,}230)\right) \\
&= \max(110{,}230) \\
&= 230MW
\end{aligned}$$

Step 3: Calculate Maximum TES value

$$Max\ TES = (Max\ EOI \times Interval\ Duration) - \left((Max\ EOI - SOI) \times \frac{Ramp\ Rate\ Duration}{2}\right)$$

Where:

- $Max\ EOI$ – Calculated at Step 2
- SOI – Facility or Balancing Portfolio Start of Interval MW Quantity (EOI MW from previous Trading Interval)
- $Interval\ Duration = 0.5$
- $Ramp\ Rate\ Duration = \frac{|Max\ EOI - SOI|}{Ramp\ Rate} \div 60$
- $Ramp\ Rate$ – Facility or Balancing Portfolio Ramp Rate Limit expressed in MW per minute

Note that $Interval\ Duration$ and $Ramp\ Rate\ Duration$ are expressed in hours.

Example

Following on from the earlier example,

$$Max\ EOI = 230MW$$
$$SOI = 170MW$$
$$Interval\ Duration = 0.5$$

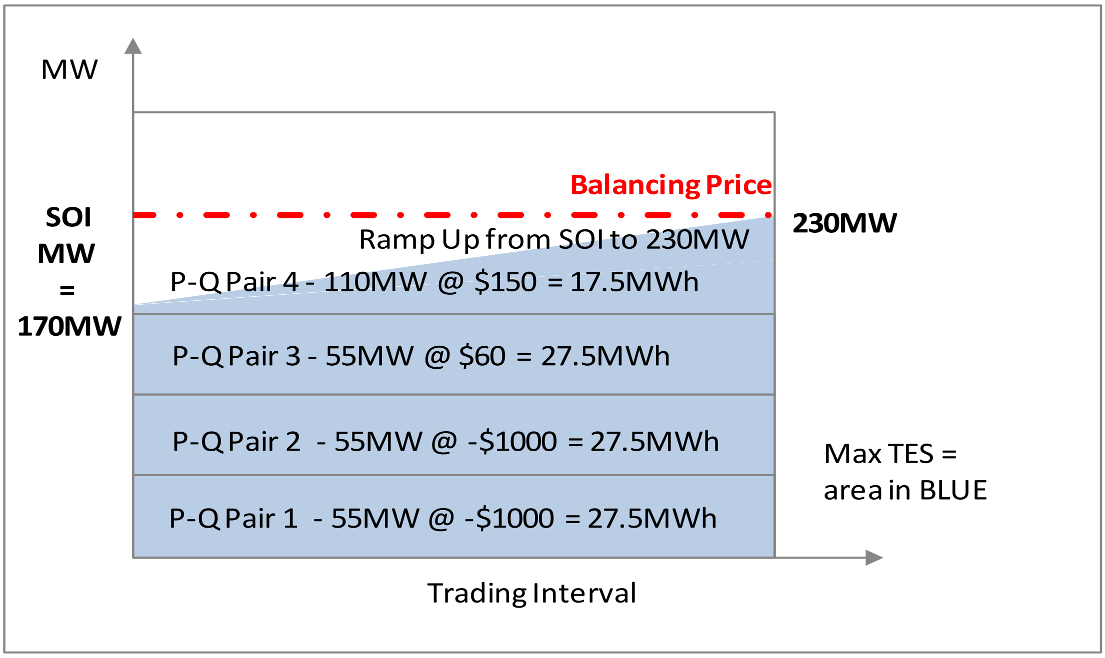
$$\begin{aligned} Ramp\ Rate\ Duration &= \frac{|Max\ EOI - SOI|}{Ramp\ Rate} \div 60 \\ &= \frac{|230 - 170|}{2} \div 60 \\ &= \frac{60}{2} \div 60 \\ &= 0.5 \end{aligned}$$

Therefore:

$$\begin{aligned} Max\ TES &= (Max\ EOI \times Interval\ Duration) - \left((Max\ EOI - SOI) \times \frac{Ramp\ Rate\ Duration}{2}\right) \\ &= (230 \times 0.5) - \left((230 - 170) \times \frac{0.5}{2}\right) \\ &= 115 - (60 \times 0.25) \\ &= 115 - 15 \\ &= 100MWh \end{aligned}$$

This example is shown in the diagram below:

Figure 13 Example maximum TES in a Trading Interval



4.2.3 Calculate Min TES for Scheduled Generators and the Balancing Portfolio

For each Facility and the Balancing Portfolio, for a Trading Interval:

Step 1: Calculate Maximum Generation Below Balancing Price ($Max\ Gen\ Below$) value:

$Max\ Gen\ Below$ = Sum of all BMO Quantity (MW) values from P-Q Pairs where the BMO Price is less than the Balancing Price.

$$Max\ Gen\ Below = \sum BMO\ Quantities, where\ BMO\ Price\ < Balancing\ Price$$

Example

Continuing on from earlier examples, if we assume that the Balancing Price is $150 and use the Balancing Submissions from the Pricing BMO created in 4.2.1 (see below), we can calculate $Max\ Gen\ Below$ *Balancing Price* as the sum of $BMO\ Quantities$ less than a $BMO\ Price$ of $150/MW. This is shown in green on the below table, where the $Max\ Gen\ Below$ = 165MW.

Table 4 Example maximum generation quantity below the Balancing Price

Submission	Price ($/MW)	Quantity (MW)	Cumulative Quantity (MW)	BMO Price ($/MW)	Comments
P-Q PAIR 5	323	55	330	512	$\geq Balancing\ Price$
P-Q PAIR 4 – Part B	150	45	275	512	$\geq Balancing\ Price$
P-Q PAIR 4 – Part A	150	65	230	150	$\geq Balancing\ Price$
P-Q PAIR 3	60	55	165	60	$< Balancing\ Price$
P-Q PAIR 2	35	55	110	-1000	$< Balancing\ Price$
P-Q PAIR 1	-300	55	55	-1000	$< Balancing\ Price$

Step 2: Calculate Maximum End of Interval ($Max\ EOI$) MW value

a) If $Max\ Gen\ Below$ is less than Start of Interval MW, $Max\ EOI$ is the greater of:

i. Start of Interval (MW) – Max Ramp Down in 30 mins (MW); or

ii. Maximum Generation Below Balancing Price (calculated at Step 1)

This is either the maximum generation below the Balancing Price using the Pricing BMO, or where this is not achievable, the maximum generation that can be achieved by ramping down from the SOI set point at the maximum Ramp Rate Limit.

else

b) If $Max\ Gen\ Below$ is more than Start of Interval MW, $Max\ EOI$ is the lesser of:

i. Start of Interval (MW) + Max Ramp Up in 30 mins (MW); or

ii. Maximum Generation Below Balancing Price (calculated at Step 1)

This is either the maximum generation below the Balancing Price using the Pricing BMO, or where this is not achievable, the maximum generation that can be achieved by ramping up from the SOI set point at the maximum Ramp Rate Limit.

else

c) If $Max\ Gen\ Below$ is equal to Start of Interval MW, $Max\ EOI = SOI$

Regardless of the situation (a, b and c above) one calculation can be used to calculate $Max\ EOI$:

$$Max\ EOI = \max\left(SOI - (Ramp\ Rate\ \times 30), \min(SOI + (Ramp\ Rate \times 30), Max\ Gen\ Below)\right)$$

Where:

- SOI – Facility or Balancing Portfolio Start of Interval MW Quantity (EOI MW from previous Trading Interval)
- $Ramp\ Rate$ – Facility or Balancing Portfolio Ramp Rate Limit expressed in MW per minute
- $Max\ Gen\ Below$ – Calculated at Step 1

Example

Following on from earlier examples, as $Max\ Gen\ Below$ (165MW) is less than SOI (170MW), we calculate $Max\ EOI$ as the greater of:

1. $170MW - (2 \times 30) = 110MW$ (max achievable by ramping down at the Ramp Rate Limit) or
2. $55MW + 55MW + 55MW = 165MW$ (max submitted below Balancing Price)

Therefore, in our example $Max\ EOI$ is 165MW

Using the full calculation for the same example:

$$\begin{aligned} Max\ EOI &= \max\left(SOI - (Ramp\ Rate \times 30), \min(SOI + (Ramp\ Rate\ \times 30), Max\ Gen)\right) \\ &= \max\left(170 - (2 \times 30), \min(170 + (2\ \times 30), 165)\right) \\ &= \max\left(170 - 60, \min(170 + 60,165)\right) \\ &= \max\left(110, \min(230,165)\right) \\ &= \max(110,165) \\ &= 165MW \end{aligned}$$

Step 3: Calculate Minimum TES value (Before Adjusting for Outages)

$$Min\ TES_{Pre\ Outages} = (Max\ EOI \times Interval\ Duration) - \left((Max\ EOI - SOI) \times \frac{Ramp\ Rate\ Duration}{2}\right)$$

Where:

- $Max\ EOI$ – Calculated at Step 2
- SOI – Facility or Balancing Portfolio Start of Interval MW Quantity (EOI MW from previous Trading Interval)
- $Interval\ Duration$ = 0.5
- $Ramp\ Rate\ Duration = \frac{|Max\ EOI - SOI|}{Ramp\ Rate} \div 60$
- $Ramp\ Rate$ – Facility or Balancing Portfolio Ramp Rate Limit expressed in MW per minute

Note that $Interval\ Duration$ and $Ramp\ Rate\ Duration$ are expressed in hours.

Example

Following on from the earlier example,

$$Max\ EOI = 165MW$$
$$SOI = 170MW$$
$$Interval\ Duration = 0.5$$

$$Ramp\ Rate\ Duration = \frac{|Max\ EOI - SOI|}{Ramp\ Rate} \div 60$$

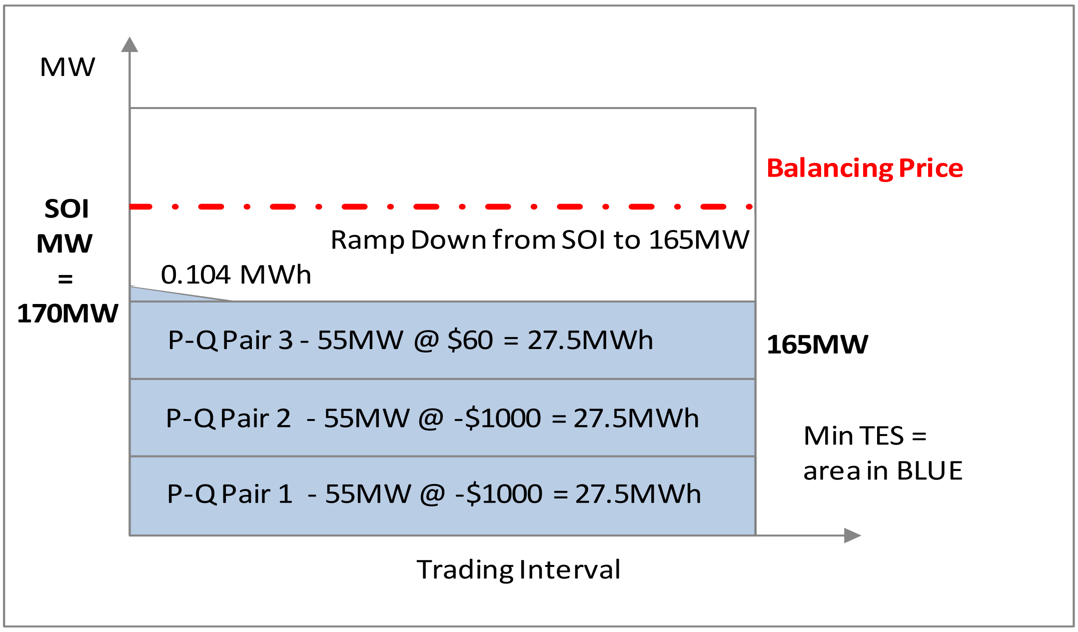
$$
\begin{aligned}
&= \frac{|165 - 170|}{2} \div 60 \\
&= \frac{5}{2} \div 60 \\
&= 0.0417
\end{aligned}
$$

Therefore:

$$
\begin{aligned}
&Min\ TES_{Pre\ Outages} \\
&= (Max\ EOI \times Interval\ Duration) - \left((Max\ EOI - SOI) \times \frac{Ramp\ Rate\ Duration}{2}\right) \\
&= (165 \times 0.5) - \left((165 - 170) \times \frac{0.0417}{2}\right) \\
&= 82.5 - \left(-5 \times \frac{0.0417}{2}\right) \\
&= 82.604 MWh
\end{aligned}
$$

This example is shown in the diagram below:

Figure 14 Example minimum TES value before adjusting for outages



Step 4: Calculate Maximum Sent Out Energy in Event of an Outage

Where a Balancing Facility or Balancing Portfolio is subject to an Outage, calculate the maximum amount of sent out energy, in MWh, which could have been dispatched given the Available Capacity for that Trading Interval.

$$Available\ Capacity = \max(0, SOC - Outage\ MW)$$

$$Max\ Sent\ Out\ Energy\ MWh = Available\ Capacity \times 0.5$$

Where:

- SOC – Sent Out Capacity for the Facility or the Balancing Portfolio (in MW), as defined in Standing Data.
- $Outage\ MW$ – Quantity of Outages for the Facility or the Balancing Portfolio (sum of outages), submitted to System Management (in MW).

Example

If we assume an $Outage\ MW$ of 60MW occurred within the Trading Interval for our example Facility, which has a $Max\ Sent\ Out\ Capacity$ of 330MW, the calculation of $Max\ Sent\ Out\ Energy$ is as follows:

$$Available\ Capacity = \max(0, SOC - Outage\ MW)$$
$$= \max(0,330 - 60)$$
$$= 270MW$$

$$Max\ Sent\ Out\ Energy\ MWh = Available\ Capacity \times 0.5$$
$$= 270 \times 0.5$$
$$= 135MWh$$

Step 5: Adjust Min TES for outages

Min TES is the lesser of Min TES (Before Adjustment for Outages) and Max Sent Out Energy

$$Min\ TES = \min\left(Max\ Sent\ Out\ Energy\ MWh, Min\ TES_{Pre\ Outages}\right)$$

Where:

- $Min\ TES_{Pre\ Outages}$, as calculated at Step 3
- $Max\ Sent\ Out\ Energy\ MWh$, as calculated at Step 4

Example

By using the values calculated in Steps 3 and 4:

$$Min\ TES = \min\left(Max\ Sent\ Out\ Energy\ MWh, Min\ TES_{Pre\ Outages}\right)$$
$$= \min(135,82.604)$$
$$= 82.604MWh$$

4.2.4 Calculate Max TES for Non-Scheduled Generators

For each Non-Scheduled Generation (NSG) Facility for a Trading Interval, compare the price from its single P-Q Pair with the Balancing Price. If the P-Q Pair price is lower than or equal to the Balancing Price, it will be dispatched and TES is equal to the Sent Out Metered Schedule. If the P-Q Pair price is higher than the Balancing Price, the NSG will be dispatched down at its maximum ramp rate.

Step 1: Compare BMO Price with Balancing Price and Calculate Max TES

a) If $BMO\ Price\ \leq Balancing\ Price$

$$Max\ TES = Sent\ Out\ Metered\ Schedule$$

Otherwise,

b) $$Max\ TES = (Max\ EOI \times Interval\ Duration) - \left((Max\ EOI - SOI) \times \frac{Ramp\ Rate\ Duration}{2}\right)$$

Where:

- $Sent\ Out\ Metered\ Schedule$ (SOMS) – Sent out SCADA quantities provided by System Management
- SOI – Facility Start of Interval MW Quantity (EOI MW from previous Trading Interval)
- $Interval\ Duration$ = 0.5
- $Ramp\ Rate\ Duration = \frac{|Max\ EOI - SOI|}{Ramp\ Rate} \div 60$
- $Max\ EOI = \max\left(0, SOI - (Ramp\ Rate \times 30)\right)$
- $Ramp\ Rate$ – Facility Ramp Rate Limit expressed in MW per minute

Note that $Interval\ Duration$ and $Ramp\ Rate\ Duration$ are expressed in hours.

Example

Assume a Balancing Price of $50 and the following P-Q Pair for an NSG:

Table 5 Example P-Q Pair

Submission	Ramp Rate (MW/min)	SOI MW	BMO Price ($/MW)	Quantity (MW)	SOMS
P-Q PAIR 1	0.5	20	73	30	10

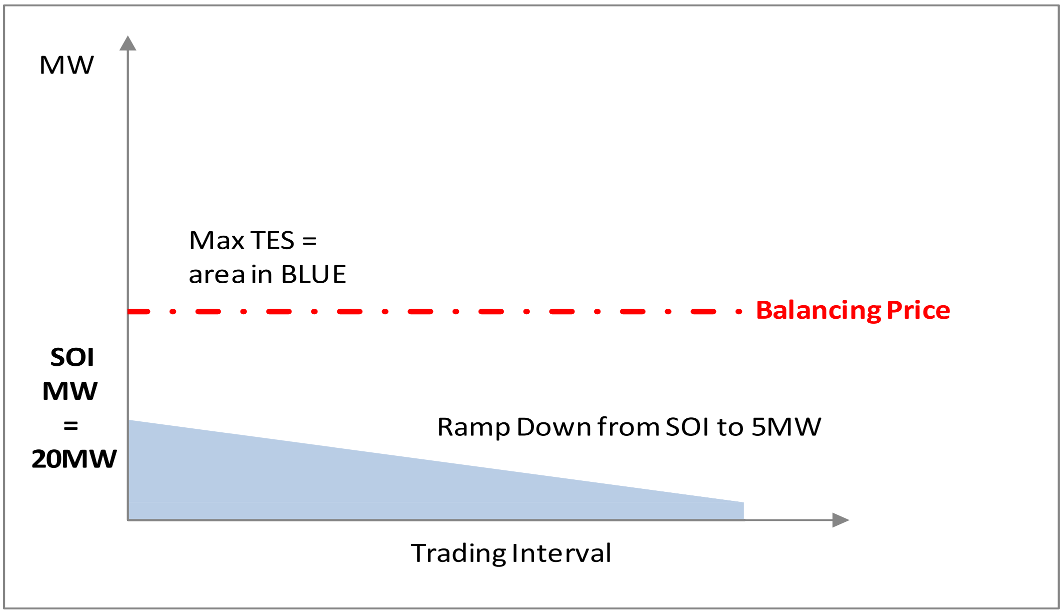
$$
\begin{aligned}
Max\ EOI &= \max\big(0, SOI - (Ramp\ Rate \times 30)\big) \\
&= \max\big(0{,}20 - (0.5 \times 30)\big) \\
&= \max(0{,}20 - 15) \\
&= 5MW
\end{aligned}
$$

$$
\begin{aligned}
Ramp\ Rate\ Duration &= \frac{|Max\ EOI - SOI|}{Ramp\ Rate} \div 60 \\
&= \frac{|5 - 20|}{0.5} \div 60 \\
&= \frac{15}{0.5} \div 60 \\
&= 0.5
\end{aligned}
$$

$$
\begin{aligned}
Max\ TES &= (Max\ EOI \times Interval\ Duration) - \left((Max\ EOI - SOI) \times \frac{Ramp\ Rate\ Duration}{2}\right) \\
&= (5 \times 0.5) - \left((5 - 20) \times \frac{0.5}{2}\right) \\
&= 2.5 - (-15 \times 0.25) \\
&= 2.5 - (-3.75) \\
&= 6.25MWh
\end{aligned}
$$

This example is shown graphically below:

Figure 15 Example Maximum TES



Had the Balancing Price been greater than the Submission Price, then Max TES would equal 10MWh (Sent Out Meter Schedule).

4.2.5 Calculate Min TES for Non-Scheduled Generators

For each Non-Scheduled Generation (NSG) Facility for a Trading Interval, the Min TES is equal to the Sent Out Metered Schedule unless a Dispatch Instruction was issued to the Facility to limit its output. In these cases, Min TES is equal to System Management's estimate of maximum amount of sent out energy, in MWh, which the Facility would have supplied in the Trading Interval had the Dispatch Instruction not been issued.

Step 1: Check for a Dispatch Instruction and Compare BMO Price with Balancing Price

Assuming a Dispatch Instruction was issued to limit output within the Trading Interval:

a) If $BMO\ Price < Balancing\ Price$

$Max\ TES = Sent\ Out\ Estimate\ from\ System\ Management$

Otherwise,

a) $Max\ TES = Sent\ Out\ Metered\ Schedule$

Where:

- $Sent\ Out\ Estimate\ from\ System\ Management$ – Estimate of sent out energy which would have been provided in Trading Interval had the Dispatch Instruction not been sent
- $Sent\ Out\ Metered\ Schedule$ (SOMS) – Sent out SCADA quantities provided by System Management

Example

Assuming a Dispatch Instruction was issued to limit output, either the $Sent\ Out\ Estimate\ from\ System\ Management$ or the $Sent\ Out\ Metered\ Schedule$ are used to determine Max TES.

4.3 Is there a limit on the number of P-Q Pairs that TES will use in the calculation?

No. All P-Q Pairs are considered in the TES calculations.

4.4 What is the difference between Sent Out Capacity and Available Capacity?

Sent Out Capacity refers to the capacity of a generator as defined at the Facility (not loss adjusted) and is defined within Standing Data.

Available Capacity in the TES calculation refers to generator capacity at the Facility or Balancing Portfolio, taking outages into account. It is the Sent Out Capacity less any outages within the Trading Interval.

4.5 Is there a mathematical formulation of the TES calculation?

Maximum TES value for a Scheduled Generator and the Balancing Portfolio

$$Max\ TES = (Max\ EOI \times 0.5) - \left((Max\ EOI - SOI) \times \frac{Ramp\ Rate\ Duration}{2}\right)$$

Where:

- $Max\ EOI = \max\left(SOI - (Ramp\ Rate \times 30), \min(SOI + (Ramp\ Rate\ \times 30), Max\ Gen)\right)$
- $Max\ Gen = \sum BMO\ Quantities, where\ BMO\ Price\ \leq Balancing\ Price$
- $Ramp\ Rate\ Duration = \frac{|Max\ EOI - SOI|}{Ramp\ Rate} \div 60$, Note that $Ramp\ Rate\ Duration$ is expressed in hours.
- $Ramp\ Rate$ – Facility or Balancing Portfolio Ramp Rate Limit expressed in MW per minute
- SOI – Facility or Balancing Portfolio Start of Interval MW Quantity (EOI MW from previous Trading Interval)

Minimum TES value for a Scheduled Generator and the Balancing Portfolio

$$Min\ TES = \min\left(Max\ Sent\ Out\ Energy, Min\ TES_{Pre\ Outages}\right)$$

$$= \min\left(\left(\frac{\max(0, SOC - Outage\ MW)}{2}\right), Max\ EOI \times 0.5 - \left((Max\ EOI - SOI) \times \frac{Ramp\ Rate\ Duration}{2}\right)\right)$$

Where:

- $Max\ EOI = \max\left(SOI - (Ramp\ Rate \times 30), \min(SOI + (Ramp\ Rate\ \times 30), Max\ Gen\ Below)\right)$
- $Max\ Gen\ Below = \sum BMO\ Quantities, where\ BMO\ Price\ < Balancing\ Price$
- $Outage\ MW$ – Quantity of Outages for the Facility or the Balancing Portfolio (sum of outages), as received from System Management (in MW).
- $Ramp\ Rate\ Duration = \frac{|Max\ EOI - SOI|}{Ramp\ Rate} \div 60$, Note that $Ramp\ Rate\ Duration$ is expressed in hours.
- $Ramp\ Rate$ – Facility or Balancing Portfolio Ramp Rate Limit expressed in MW per minute
- SOC – Sent Out Capacity for the Facility or the Balancing Portfolio (in MW), as defined in Standing Data.
- SOI – Facility or Balancing Portfolio Start of Interval MW Quantity (EOI MW from previous Trading Interval)

Maximum TES value for a Non-Scheduled Generator

a) If $BMO\ Price\ \leq Balancing\ Price$

$Max\ TES = Sent\ Out\ Metered\ Schedule$

Otherwise,

b) $Max\ TES = (Max\ EOI \times 0.5) - \left((Max\ EOI - SOI) \times \frac{Ramp\ Rate\ Duration}{2}\right)$

Where:

- $Sent\ Out\ Metered\ Schedule$ (SOMS) – Sent out SCADA quantities provided by System Management
- SOI – Facility Start of Interval MW Quantity (EOI MW from previous Trading Interval)
- $Max\ EOI = \max\left(0, SOI - (Ramp\ Rate \times 30)\right)$
- $Ramp\ Rate\ Duration = \frac{|Max\ EOI - SOI|}{Ramp\ Rate} \div 60$, Note that $Ramp\ Rate\ Duration$ is expressed in hours.
- $Ramp\ Rate$ – Facility Ramp Rate Limit expressed in MW per minute

Minimum TES value for a Non-Scheduled Generator

a) If $BMO\ Price\ < Balancing\ Price$ and Dispatch Instruction has been issued to limit output

$Max\ TES = Sent\ Out\ Estimate\ from\ System\ Management$

Otherwise,

b) $Max\ TES = Sent\ Out\ Metered\ Schedule$

Where:

- $Sent\ Out\ Estimate\ from\ System\ Management$ – Estimate of sent out energy which would have been provided in Trading Interval had the Dispatch Instruction not been sent
- $Sent\ Out\ Metered\ Schedule$ (SOMS) – Sent out SCADA quantities provided by System Management

Related Question:

- Section 4.2 - How does AEMO calculate TES?

4.6 What are Settlement Tolerances?

Settlement Tolerances is the permissible range (excluding Ancillary Services) by which a Facility or Balancing Portfolio can vary from its Theoretical Energy Schedule before the variation is considered to be Out of Merit.

4.6.1 Facility Settlement Tolerance

AEMO determines the Settlement Tolerance for each Facility (clause of the WEM Rules 6.17.9) as:

a) The Tolerance Range or Facility Tolerance Range which has been determined by System Management and provided to AEMO, divided by 2;

otherwise,

b) $\min\left(3MWh, \max(0.5MWh, 3\% \times CapCon)\right)$

Where $CapCon$ equals either,

- Sent Out Capacity in the case of a Non-Scheduled Generator and a Scheduled Generator; or

- Nominated maximum consumption quantity in the case of a Dispatchable Load, as set out in Standing Data (expressed in MWh)

4.6.2 Tolerance Range or Facility Tolerance Range

System Management may determine the Tolerance Range to apply to all Facilities (clause of the WEM Rules 2.13.6D), or determine a Facility Tolerance Range to apply to a specific generation Facility.

A Facility Tolerance Range will apply for a specific generation Facility in place of the Tolerance Range determined under clause of the WEM Rules 2.13.6D.

The Tolerance Range is required to be reviewed at least annually by System Management (clause of the WEM Rules 2.13.6G).

Tolerance Ranges to apply to Facilities from 1 July 2014 are calculated by System Management using the following formula:

$$Tolerance\ Range = \pm \max\left(6, \min(5\% \times NPC, 4 \times ROC)\right)$$

Where:

- NPC: Name Plate Capacity of the generator, expressed in MW (clause of the WEM Rules Appendix 1(b)(ii))
- ROC: Rate of Change or Ramp Rate of a Unit per minute (clause of the WEM Rules Appendix 1(b)(v))

For more information, see http://www.aemo.com.au/Electricity/Wholesale-Electricity-Market-WEM/Data/Tolerance-ranges

4.6.3 Balancing Portfolio Settlement Tolerance

The Portfolio Settlement Tolerance equals the lesser of:

- 3 MWh; and
- 3% of the Sent Out Capacity of the Balancing Portfolio (expressed as MWh).

5. Out of Merit

5.1 What does it mean to be Out Of Merit?

Out of Merit generation occurs when a Facility or Balancing Portfolio is not dispatched in accordance with its position in the Balancing Merit Order (BMO). There are two possible cases:

- The Facility or Balancing Portfolio generated *more* than their Max TES. In this case, they are classed as having been dispatched Upwards Out of Merit. This is also referred to as 'Dispatched On' or 'Constrained On'; or
- The Facility or Balancing Portfolio generated *less* than their Min TES. In this case, they are classed as having been dispatched Downwards Out of Merit. This is also referred to as 'Dispatched Off' or 'Constrained Off'.

Related Question:

- Section 5.2 – *What Out Of Merit quantities are eligible for compensation payments?*
- Section 5.3 – *What Out Of Merit quantities are not eligible for compensation payments?*

5.2 What Out Of Merit quantities are eligible for compensation payments?

5.2.1 Facilities

Provided Dispatch Instructions were adequately or appropriately complied with, all Facility Out of Merit quantities should be eligible for compensation payments where:

Upwards Out of Merit / Constrained On:

- The sum of the Upwards Out of Merit Quantities is greater than or equal to:
  - The Facility's Settlement Tolerance; plus
  - Any *upwards* LFAS enablement instructed by System Management (in MWh); plus
  - For Synergy Standalone Facilities, any *upwards Backup* LFAS enablement instructed by System Management (in MWh).

Downwards Out of Merit / Constrained Off:

- the sum of the Downwards Out of Merit Quantities is greater than or equal to:
  - The Facility's Settlement Tolerance; plus
  - Any *downwards* LFAS enablement instructed by System Management (in MWh); plus
  - For Synergy Standalone Facilities, any *downwards Backup* LFAS enablement instructed by System Management (in MWh).

5.2.2 Balancing Portfolio

Provided Dispatch Orders were adequately or appropriately complied with, Balancing Portfolio Out of Merit quantities should be eligible for compensation payments where:

Upwards Out of Merit / Constrained On:

- the sum of the Upwards Out of Merit Quantities for all facilities in the Balancing Portfolio is greater than or equal to:
  - The Portfolio Settlement Tolerance; plus
  - The sum of *upwards* LFAS enablement and *upwards* backup LFAS enablement instructed by System Management (in MWh); plus
  - Any *increase* in sent out energy due to a Network Control Service Contract which System Management instructed a Facility within the Balancing Portfolio to provide; plus
  - If a Spinning Reserve Event has occurred, any Spinning Reserve Response Quantity.

Downwards Out of Merit / Constrained Off:

- the sum of the Downwards Out of Merit Quantities for all facilities in the Balancing Portfolio is greater than or equal to:
  - The Portfolio Settlement Tolerance; plus
  - The sum of *downwards* LFAS enablement and *downwards* backup LFAS enablement instructed by System Management (in MWh); plus
  - Any *reduction* in sent out energy due to a Network Control Service Contract which System Management instructed a Facility within the Balancing Portfolio to provide; plus
  - If a Load Rejection Reserve Event has occurred, any Load Rejection Reserve Response Quantity.

- If AEMO determines that a Dispatch Instruction or Dispatch Order was not followed to a reasonable standard or there is evidence of behaviour intended to manipulate Constrained On/Off payments, these will be dealt with by AEMO under the market surveillance and compliance regime.

Related Questions:

- Section 4.6 – What are Settlement Tolerances?
- Section 5.3 – What Out Of Merit quantities are not eligible for compensation payments?

5.3 What Out Of Merit quantities are not eligible for compensation payments?

5.3.1 Facilities

Facility Out of Merit quantities are not eligible for compensation payments when any of the below circumstances were applicable for the Trading Interval:

- AEMO determines that Dispatch Instructions were not adequately or appropriately complied with.
- The Facility was undergoing a Test or complying with an Operating Instruction. A test could be a commissioning test, a Reserve Capacity test or an equipment test. Tests are identified within Operating Instructions sent by System Management to AEMO.
- The Balancing Facility was a Non-Scheduled Generator and System Management has not provided AEMO with an estimate of the Facility's MWh quantity for the Trading Interval had the Dispatch Instruction not been issued.

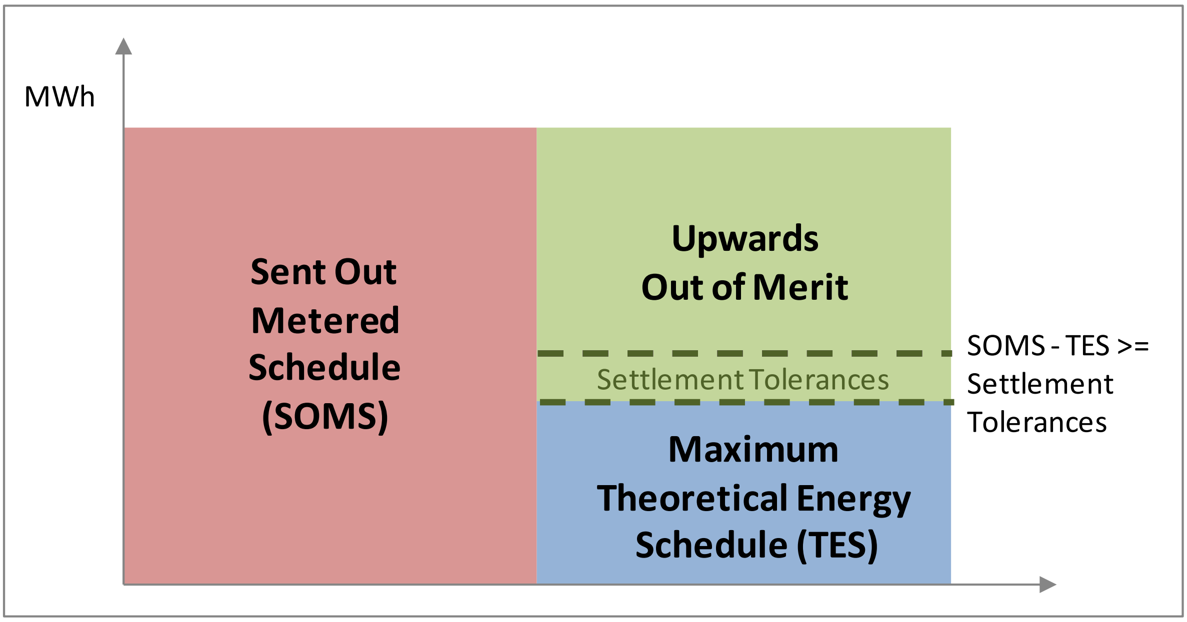
5.3.2 Balancing Portfolio

The only circumstance when Balancing Portfolio Out of Merit quantities are not eligible for compensation payments is when AEMO determines that Dispatch Orders were not adequately or appropriately complied with.

5.4 How to determine Upwards Out Of Merit Generation for a Facility?

If the Sent Out Metered Schedule for a Facility exceeds the Maximum Theoretical Energy Schedule, then provided the difference between these values is greater than or equal to the relevant Settlement Tolerance, the amount of difference (minus any LFAS enablement and SSAF Backup LFAS Enablement) is the Upwards Out of Merit Generation Quantity, or Constrained On Quantity.

Figure 16 Upwards Out of Merit generation



Sent Out Metered Schedules are based on 'Sent Out' values, i.e. the value at the generator and not loss adjusted to the Muja reference point.

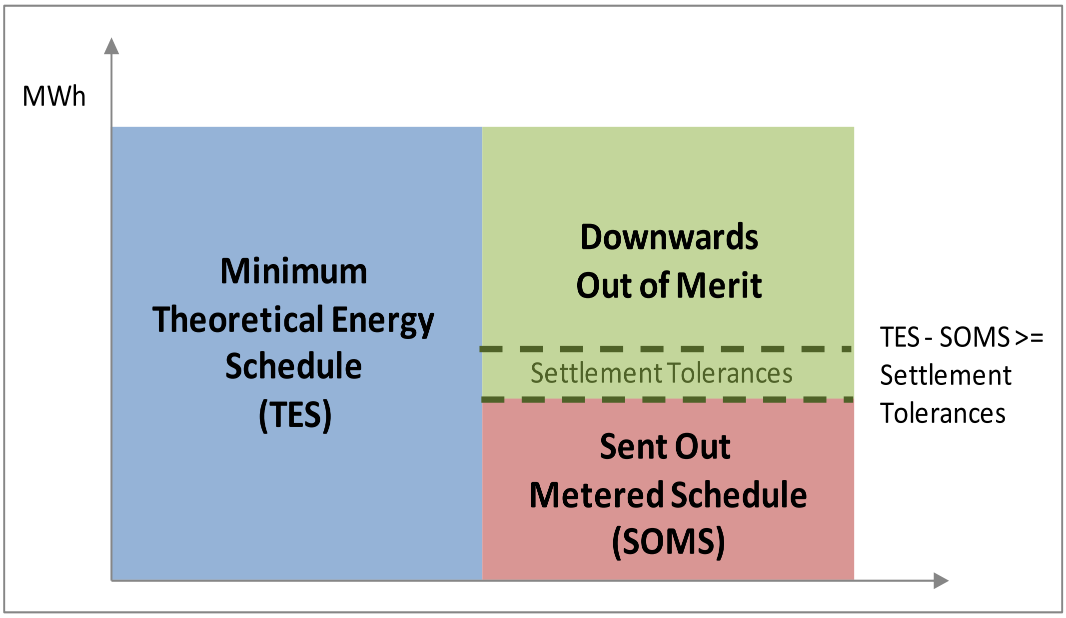
Related Question:

- Section 4.6 - *What are Settlement Tolerances?*

5.5 How to determine Downwards Out Of Merit Generation for a Facility?

If the Minimum Theoretical Energy Schedule for a Facility exceeds the Sent Out Metered Schedule, then provided the difference between these values is greater than or equal to the relevant Settlement Tolerance, the amount of difference (minus any LFAS enablement and SSAF Backup LFAS Enablement) is the Downwards Out of Merit Generation Quantity, or Constrained Off Quantity.

Figure 17 Downwards Out of Merit Generation



Sent Out Metered Schedules are based on 'Sent Out' values, i.e. the value at the generator and not loss adjusted to the Muja reference point.

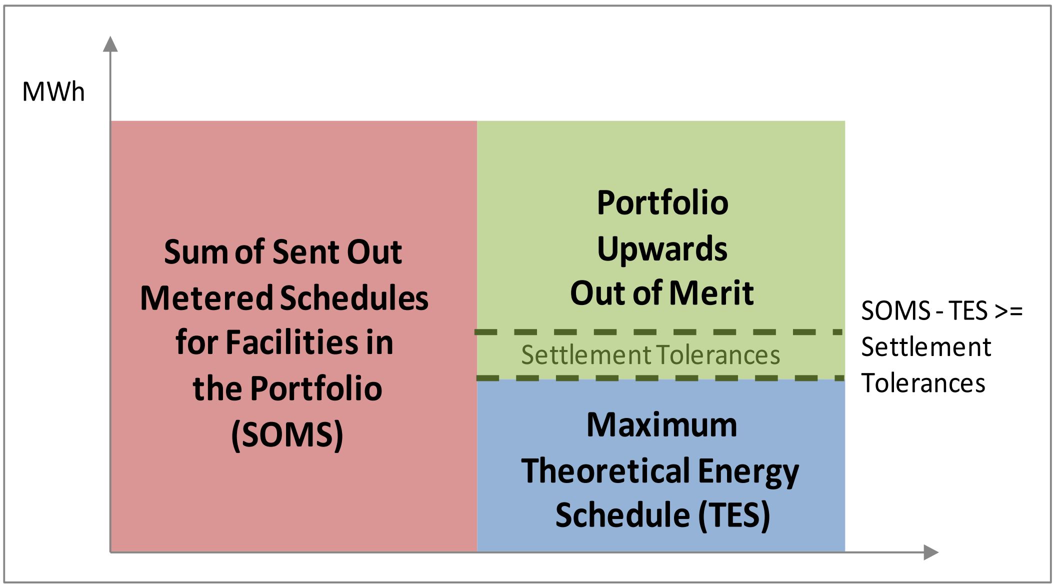
Related Question:

- Section 4.6 - *What are Settlement Tolerances?*

5.6 How to determine Upwards Out Of Merit Generation for the Balancing Portfolio?

If the sum of Sent Out Metered Schedules for all Facilities in the Balancing Portfolio exceeds the Maximum Theoretical Energy Schedule for the Balancing Portfolio, then provided the difference between these values is greater than or equal to the relevant Portfolio Settlement Tolerance, the amount of difference (minus any LFAS enablement, Backup LFAS Enablement, Spinning Reserve Response Quantity and Network Control Service Contract Quantities) is the Upwards Out of Merit Generation Quantity, or Constrained On Quantity for the Balancing Portfolio.

Figure 18 Portfolio Upwards Out of Merit generation



Sent Out Metered Schedules are based on 'Sent Out' values, i.e. the value at the generator and not loss adjusted to the Muja reference point.

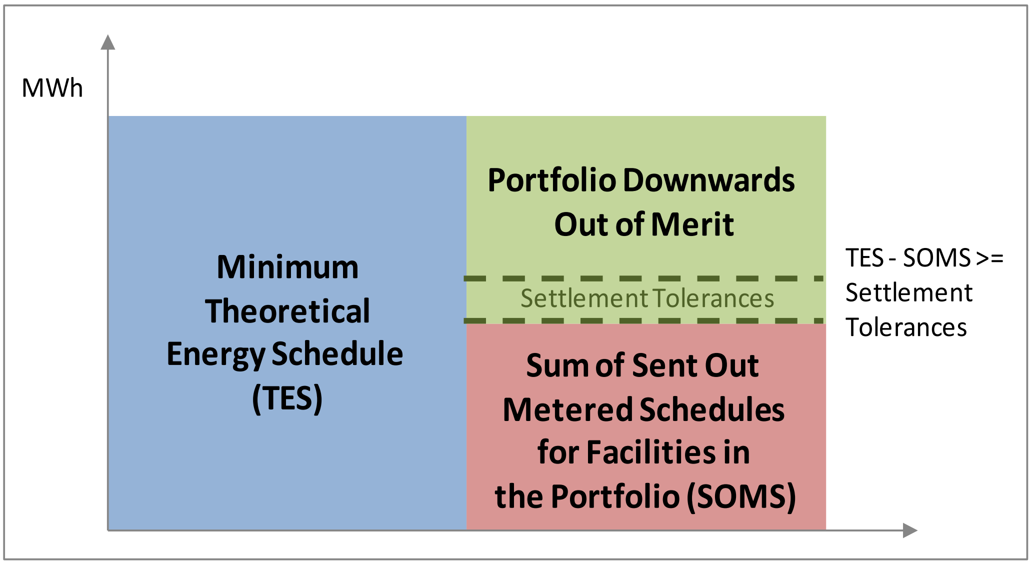
Related Question:

- Section 4.6 - *What are Settlement Tolerances?*

5.7 How to determine Downwards Out Of Merit Generation for the Balancing Portfolio?

If the Minimum Theoretical Energy Schedule for the Balancing Portfolio exceeds the sum of Sent Out Metered Schedules for all Facilities in the Balancing Portfolio, then provided the difference between these values is greater than or equal to the relevant Portfolio Settlement Tolerance, the amount of difference (minus any LFAS enablement, Backup LFAS Enablement, Load Rejection Reserve Response Quantity and Network Control Service Contract Quantities) is the Downwards Out of Merit Generation Quantity, or Constrained Off Quantity for the Balancing Portfolio.

Figure 19 Portfolio Downwards Out of Merit generation



Sent Out Metered Schedules are based on 'Sent Out' values, i.e. the value at the generator and not loss adjusted to the Muja reference point.

Related Question:

- Section 4.6 - *What are Settlement Tolerances?*