

PAPER NO. : **EMC/RCP/24/2006/CP11**

SUBJECT : **CONCEPT PAPER – GUIDELINES FOR COMPENSATION**

FOR : **DECISION**

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Executive Summary

The RCP previously considered a review of the compensation regime and asked EMC to investigate whether the regime could be enhanced by introducing decision-making guidelines and formulae. This paper presents recommended guidelines and a formula to determine the amount of compensation where the request for compensation relates to energy, reserve or regulation. In these cases, it is suggested that compensation be based on the generator's offer curve. Because there have been no claims for compensation since the start of the market, it is recommended that the guidelines and formula be introduced on a non-binding basis. Once sufficient experience has been gained in their application, they could then be introduced formally into the Market Rules.

1. Introduction

At its meeting on 11 January 2005, the RCP considered a review of the compensation regime and asked EMC to investigate whether the regime could be enhanced by introducing decision-making guidelines and formulae to assist the EMC or PSO in determining the quantum of compensation payable in respect of a claim. This paper outlines suggested decision-making guidelines and formulae to assist the EMC and PSO in considering requests for compensation submitted under Section 3.11 of Chapter 3 of the Market Rules.

2. Background

The current compensation regime is capable of delivering economically efficient outcomes and is consistent with the principle of natural justice. However, it does not provide decision-makers with any guidelines on how to assess requests for compensation made under Section 3.11 of Chapter 3 of the Market Rules. Similarly, the regime does not provide applicants with any certainty about the criteria that will be used to assess their request. This lack of certainty has the potential to undermine the efficiency of the compensation regime.

The RCP has asked the EMC to investigate whether the compensation regime could be enhanced by including decision-making guidelines and formulae to determine the amount of compensation payable. The decision-making guidelines and formulae would guide the EMC and PSO when assessing a request for compensation. The aim is to enhance the overall efficiency of the compensation regime.

This paper presents the results of the EMC's investigation, as well as a summary of the consultation carried out.

3. Objective

The objective is to design a suite of decision-making guidelines and formulae that assist decision-makers in making decisions on requests for compensation that are both economically and administratively efficient. These objectives can be achieved as follows:

- Administrative efficiency is increased by providing both the EMC/PSO and applicants with better information about how requests for compensation are assessed. The decision-making guidelines and formulae may also result in more timely decisions, further enhancing administrative efficiency.
- Robust formulae can help ensure that the amount of compensation paid in respect of a particular event is economically efficient.

At the same time, the decision-making guidelines and formulae must not create undesirable incentives. The decision-making guidelines or formulae must not encourage behaviour that increases the number of events where compensation is payable, nor should they encourage behaviour that increases the amount of compensation payable in respect of an event.

4. Framework

Decision-making guidelines are intended to help the EMC/PSO determine whether compensation is payable in respect of a particular event. *Formulae* are intended to help the EMC/PSO determine how much compensation is payable in respect of a particular event.

Decision-making guidelines are, at a basic level, an interpretation of the rules that describes in simple terms the precise pre-conditions that must exist before compensation can be payable in respect of a particular event.

Formulae describe the amount of compensation that is to be paid in respect of an event if the decision-making guideline indicates that compensation should be paid. Formulae can not be developed to cover all possible events in respect of which compensation may be payable. They are only suitable for situations where:

- The costs imposed by the event are similar across different Market Participants and different technologies; and
- The opportunity cost experienced by Market Participants can be quantified, either directly or using a proxy.

At a basic level, formulae can only be used where they are capable of reflecting opportunity costs across a range of different situations and different market participants without creating undesirable incentives or inefficient levels of compensation.

From this perspective, it is important to provide decision-making guidelines and formulae only where conditions exist that make a one-size-fits-all approach suitable. For other situations where the impact of an event can differ widely between technologies or market participants, the current approach of basing compensation on the market participant's submission should continue.

5. Recommended Guidelines and Formulae

In accordance with the framework set out in Section 4, this paper includes simple decision-making guideline in respect of every rule listed in Section 3.2.1.4 of Chapter 3 of the Market Rules.

Similarly, in respect of the amount of compensation that should be paid in respect of a particular event, the following principles have been applied:

1. The amount of compensation should generally be set by the EMC or PSO based upon its consideration of the applicant's submission unless specific guidance is provided in the form of a formula.
2. Where any physical damage has occurred, compensation will generally be set by the EMC or PSO based upon its consideration of the applicant's submission.

Consequently, a formula has only been provided where the request for compensation relates to an instruction by the PSO to produce more or less than the scheduled quantity of energy¹, reserve or regulation. This is because, for traded products, cleared prices or the generator's offer prices can be used to derive a good estimate of the opportunity cost of complying with the PSO's instruction.

¹ In the case of energy, the instruction must be to provide more than the sum of the scheduled quantity of energy and reserve before a claim for compensation can be put forward.

For other events where such information is not available, such as an instruction to defer or cancel maintenance, the amount of compensation that should be paid to the affected market participant will be assessed on a case-by-case basis.

Only one claim for compensation may be made in respect of a particular instruction from the PSO. For example, where a market participant has received an instruction to provide energy, it is only permissible to make a claim for compensation for the energy delivered. It is not permissible to lodge a claim for additional compensation for the provision of reserve.

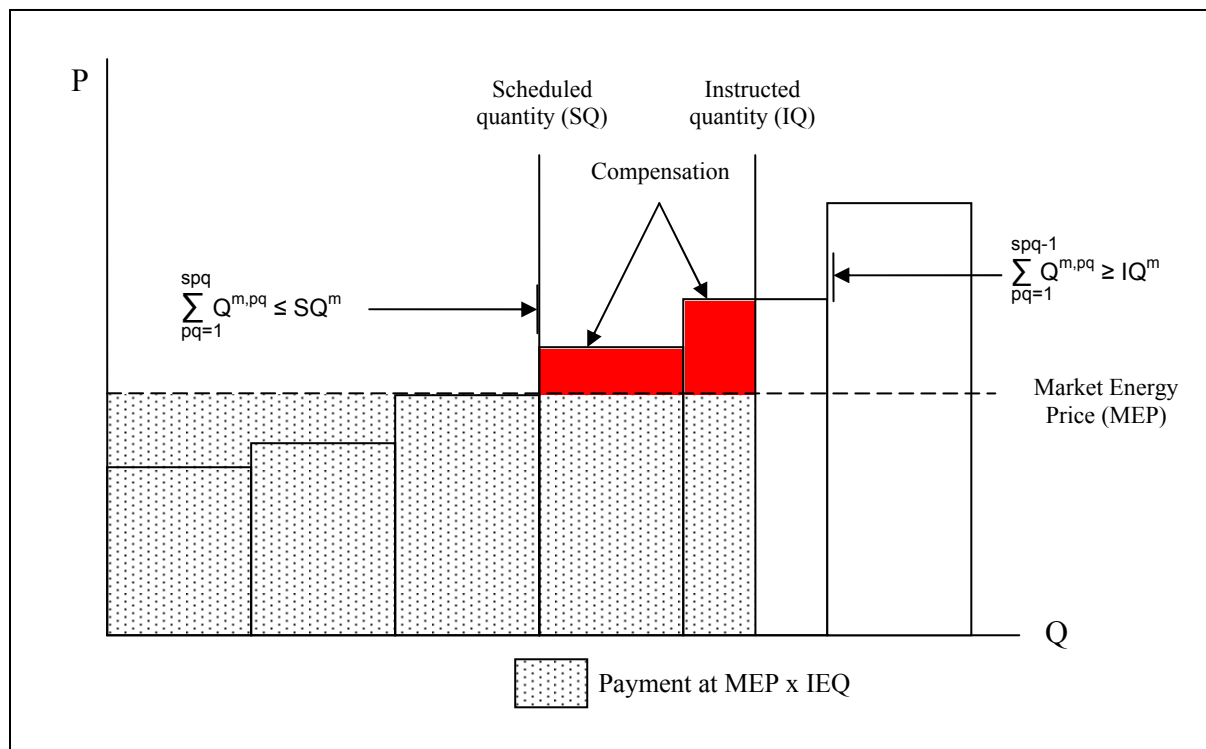
The recommended decision-making guidelines and formula are attached as Appendix 1. The decision-making guidelines outline conditions that must exist before a market participant is eligible for compensation, and suggest a basis for calculating compensation if the conditions exist. The formula then outlines how compensation should be calculated where the request for compensation relates to energy, reserve or regulation.

6. Formula Based Compensation – Basic Principles

The basic principle underlying the formula outlined in Appendix 1 is that the Market Participant should be compensated on the basis of its offer prices. The following examples show how offer prices would be used as a basis for compensation where the Market Participant is instructed to provide more or less than the scheduled quantity of energy.

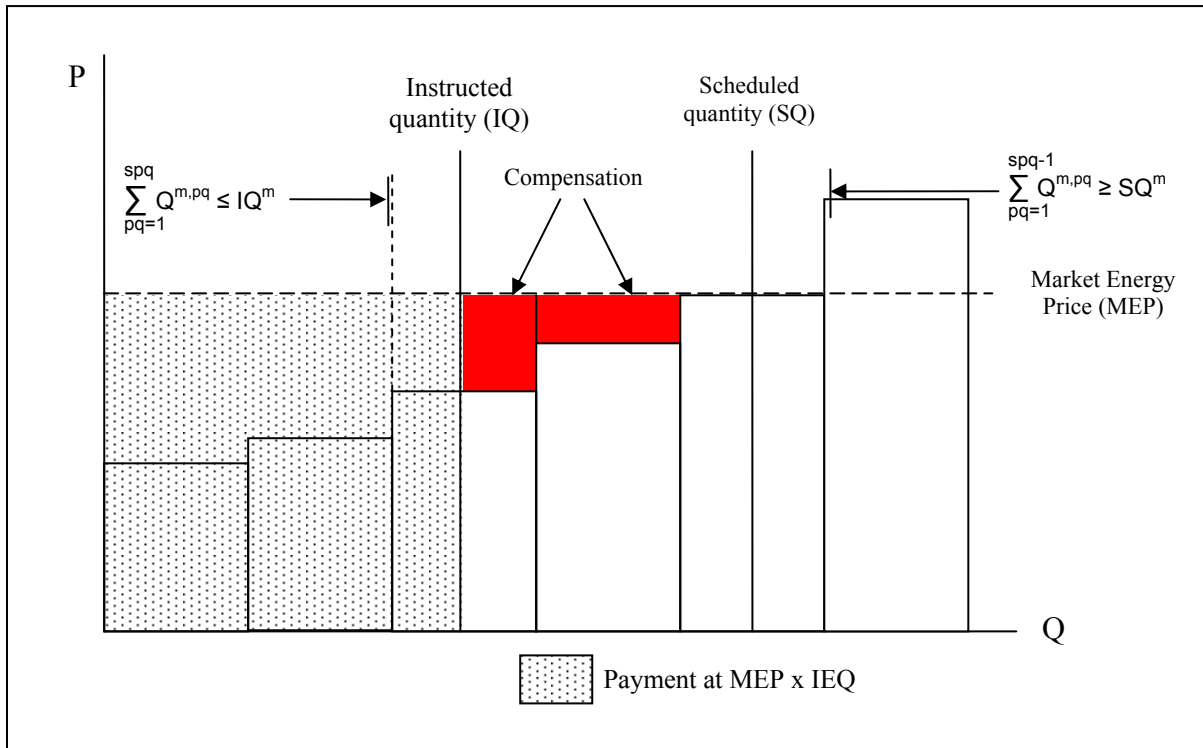
Where a Market Participant is instructed to produce more than the scheduled quantity, they will be paid at the market clearing price for the entire quantity of energy they produce. Where the offer price for the relevant quantity band is higher than the market clearing price, the Market Participant is compensated for the difference between the offer price and the market clearing price for the additional quantity of energy produced. This is illustrated by Figure 1 below.

Figure 1: Calculation of Compensation for Energy Where IQ>SQ



Where the instruction is to produce less than the scheduled quantity, the total revenue of the Market Participant will reduce by a sum equal to the reduced output in MWh multiplied by the market clearing price. Against this, the Market Participant avoids the cost of producing the output it is now not required to produce. Under the marginal pricing model, the Market Participant's offer price is a proxy for the marginal cost of production. Therefore, compensation is based on the difference between the market clearing price and the Market Participant's offer price. This is illustrated in Figure 2 Below.

Figure 2: Calculation of Compensation for Energy Where SQ>IQ



The worked examples in Appendix 2 show how the formula would be applied in practice.

7. Status of Formulae and Guidelines

Since the beginning of the market on 1 January 2003, no claims for compensation have been lodged. As a result, there are no historical cases against which the performance of the decision-making guidelines and formulae could be assessed.

The proposed decision-making guidelines and formulae can be expected to be robust, but it has not been possible to test them against known claims for compensation. To implement them through the rules would give rise to the risk that they are not suitable for all possible future events in respect of which claims for compensation may be put forward.

EMC recommends that the decision-making guidelines and formulae be introduced on a non-binding basis until sufficient experience has been gathered to judge whether they should be included in binding form in the Market Rules. If they are proven to be effective in practice, it will then be possible to formalise them in the rules.

The success of this arrangement will depend crucially on the commitment of the EMC/PSO to applying the decision-making guidelines and formulae as far as practicable in any decisions they make when assessing a request for compensation under Section 3.11 of Chapter 3. Some flexibility is also needed so that EMC/PSO can deviate if there is a good reason to do so. Introducing the decision-making guidelines and formulae on a non-binding basis provides this flexibility.

8. Incentives and Economic Efficiency

The proposed guidelines suggest that compensation for energy, reserve and regulation should, in some cases, be based on offer prices.

A key concern with such an approach is whether Market Participants may be incentivised to structure their offers to maximise the amount of compensation that is payable. On balance, EMC considers that this concern can be managed under the proposed regime for the following reasons:

- The circumstances under which compensation could be payable are infrequent and mostly unexpected. It would be difficult for a Market Participant to act strategically without knowledge of when these events are likely to occur.
- Instructions to vary the output of energy and reserves are likely to occur in situations where the market is under stress. In such situations, prices are already likely to be high (and may be at VoLL). The design of the market is based on the premise that high prices are required during periods of stress to encourage generators to make sufficient generation available. The compensation mechanism similarly is designed to ensure that generators do not suffer a financial loss as a result of responding to an instruction issued by the PSO.
- If the guidelines are implemented on a trial basis, and they are non-binding under the rules, then the EMC/PSO will still have the ability to consider Market Participant behaviour when determining how much compensation would be paid. If the outcome of compensation paid on the basis of the decision-making guidelines and formulae would be inefficient, the EMC/PSO still have the ability to adjust the actual compensation paid to an efficient level.
- The compensation mechanism under Section 10.2.9 of Chapter 6 already provides for compensation to be based on generator offer prices amongst a range of other factors. This means that the general approach of using generator offers to determine compensation is already established in the general design of the market.
- As all settlement prices are determined on the basis of generator offers. Any concerns surrounding the competitiveness of offer prices are an issue that arises independently of the methodology used to determine the amount of compensation.

Overall, EMC considers that sufficient safeguards exist to allow the guidelines to be introduced safely on a trial basis until some experience can be gained with their application in real situations.

9. Suggested Process

As outlined in Section 6 of this paper, it is proposed that the decision-making guidelines and formulae be introduced on a non-binding basis. This gives rise to the question of how this would best be achieved.

EMC suggests that the Chairman of the RCP, on behalf of the RCP, would write letters to the Chief Executives of the EMC and the PSO, asking them to consider the decision-making guidelines and formulae when considering requests for compensation. The letters would also ask the EMC and the PSO to inform the RCP of any experience gathered in applying the decision-making guidelines and formulae. The decision-making guidelines and formulae would also be published on the EMC website.

The EMC would review the decision-making guidelines and formulae once sufficient experience has been gathered in their application and would report its findings to the RCP.

10. Consultation

The EMC published a draft of this paper for consultation. PowerSeraya Ltd and Senoko Power Ltd provided a number of comments that have been addressed through editorial changes and through more detailed explanations.

PowerSeraya Ltd also raised the following comment:

“The compensation for dispatch at lower than scheduled energy level is paid at the difference between the market price and the offer price does not seem to be reasonable. In our opinion, the energy price should be paid at the full market price for the amount of schedule lost.”

EMC Response:

This paper proposes that a generator that is instructed to produce less than the scheduled quantity of energy be paid the difference between the market clearing price and the energy price for the reduced quantity of energy. This is illustrated in Figure 2 in Appendix 1, and the Worked Example 2 in Appendix 2. The reason for this is that the generator not only loses revenue by generating less than the scheduled quantity, but also avoids the cost of producing the energy it is now no longer required to produce.

If compensation were to be paid at the full market price, as suggested, this would significantly over-compensate the generator compared to the true lost profit. The aim of the compensation regime is to put the claimant into a position that is as close as possible to the position it was in before the event that is the subject of the claim for compensation occurred.

The marginal pricing model used in the Singapore wholesale electricity market provides incentives for generators to set offer prices at the marginal cost of generating. The difference between the market clearing price and the offer price (marginal cost) then provides a contribution towards fixed costs and profit for all but the marginal offer tranche.

The offer price must signal the point at which the Market Participant is indifferent as to whether their offer is cleared or not. Using an energy offer as an example, the offer price signals that the generator does not wish to generate if they receive less than the offer price.

However, if the price is equal to, or higher than the offer price, the generator wishes to generate.

Using the example of a generator who has offered 100MW at \$100/MWh in a particular trading period, the generator must be indifferent to receiving \$0 and incurring \$0 in additional costs and the alternative of receiving \$5000 in revenue and incurring the additional cost associated with producing 50MWh of energy. Where the market clearing price exceeds the offer price, the generator will no longer be indifferent whether it is cleared because the difference between the market clearing price and the offer price is pure profit.

For a generator that was cleared but later instructed to reduce output, it is this profit which the compensation mechanism should seek to replace.

11. Recommendations

EMC recommends that the Panel:

- a. **endorse** the proposed decision-making guidelines and formulae for the calculation of compensation outlined in Appendix 1;
- b. **agree** to write to the EMC and PSO, requesting that they use the decision-making guidelines and formulae in determining the amount of compensation payable for future requests for compensation;
- c. **agree** that the decision-making guidelines and formulae for the calculation of compensation outlined in Appendix 1 be published; and
- d. **request** that the EMC and PSO inform the RCP of the experience gained in applying the decision-making guidelines and formulae to requests for compensation submitted under Section 3.11 of Chapter 3 of the Market Rules.

APPENDIX 1: Guidelines and Formula for Compensation

Purpose

The purpose of these guidelines is to assist the EMC and the PSO in assessing requests for compensation submitted under Section 3.11 of Chapter 3 of the Market Rules.

These guidelines have no formal standing under the Market Rules and are intended to assist the EMC or the PSO, as the case may be, in determining whether compensation is payable in respect of a particular event, and if so, to calculate an amount of compensation that is fair and economically efficient.

It is intended that the EMC and PSO would use these guidelines as much as possible, and where appropriate, when considering requests for compensation.

Guidelines

Any claim for compensation that involves physical damage to plant, or any similar complicating factors should be based upon the Market Participant's submission in support of the request for compensation.

Only one claim for compensation may be made in respect of a particular instruction from the PSO. For example, where a Market Participant has received an instruction to increase its output by 10MW, it is only permissible to make a claim for compensation for the energy delivered. Assuming the generator provided an additional 5MWh in response to the PSO's instruction, then compensation would be paid for 5MWh of energy produced. It is not permissible to lodge a claim for additional compensation in respect of the same instruction, for example for the provision of reserve.

If a generator is scheduled for reserve, this is treated as a contract to sell the cleared quantity at the market clearing price, if called upon. Therefore, a generator that is scheduled to provide 150MW of energy and 10MW of reserve cannot lodge a claim for compensation if it is instructed by the PSO to ramp up to 160MW. However, if the same generator is instructed to ramp up to 170MW, and it complies with the instruction, then it could submit a claim for compensation for the output above 160MW.

A request for compensation should first be assessed against the criteria in Table 1 to assess whether compensation is prima-facie payable.

Table 2 then provides guidance on the basis on which compensation should be determined in respect of instructions to increase or decrease the provision of particular products. Table 3 provides eligibility criteria where the claimant has been scheduled to provide both energy and reserve.

The formula then assists the EMC and PSO to calculate the amount of compensation payable where the instruction relates to energy, reserve or regulation. Where there is no applicable offer, compensation will be assessed on the basis of the Market Participant's submission in support of the request for compensation. The price caps for energy, reserve and regulation will apply to any such request to limit the amount of compensation that may be sought as long as no physical damage to plant, or any similar complicating factors.

Basis for Compensation

The general principle applied to compensation for energy, reserve and regulation is that the amount of compensation is based on the offer price submitted by the Market Participant. Within this general principle, the following applies:

Where a claim relates to an instruction to provide more than the scheduled quantity of energy ($IQ > SQ$), then the compensation is paid as the difference between the offer price and the market clearing price over the additional quantity of energy provided. This is because the Market Participant is automatically paid the market clearing price for the injected quantity of energy. This is illustrated in Figure 1.

A similar principle applies where a Market Participant is instructed to provide less than the scheduled quantity of energy. In that situation, the compensation is also based on the difference between the market clearing price and the offer price submitted by the Market Participant over the additional quantity provided. This is illustrated in Figure 3.

Where a claim relates to an instruction to provide more than the scheduled quantity of reserve ($IQ > SQ$) or regulation, then the compensation is paid as the offer price multiplied by the quantity over and above the scheduled quantity that the Market Participant was instructed to provide. This is because the Market Participant will be automatically paid only for the scheduled quantity of reserve or regulation.

Table 1: Criteria to Determine Whether Compensation is Payable

Section	Provision for Compensation	Instruction applies to	Assessment criteria
4.7.3 of Chapter 5	Providers of reactive support or voltage control that are not providing services pursuant to an ancillary services contract that are directed by the PSO to take action. This is subject to Section 8.4.2 which states that there is no entitlement for compensation for any ancillary service that must be provided pursuant to any electricity licence or connection requirement or any registration requirement referred to in the Market Rules, the Transmission Code or any applicable connection agreement. Compensation therefore only applies to instructions outside the limits of Transmission Code requirements. See also Section 8.4.3 relating specifically to registered facilities/generation settlement facilities.	Reactive support and voltage control	<p>In principle, a Market Participant may make a request for compensation if:</p> <ul style="list-style-type: none"> • The market participant is not providing services pursuant to an ancillary services contract; and • the PSO gives an instruction to provide reactive support and voltage control; and • the instruction is to provide above levels required by electricity licence, connection requirement, the Transmission Code, or any registration requirement referred to in the Market Rules; and • the Market Participant complies with the instruction.
5.4.3 of Chapter 5	Market Participants directed by the PSO to take action in accordance with the Market Rules when market mechanisms fail to provide adequate security	Not specific	<p>In principle, a Market Participant may make a request for compensation if:</p> <ul style="list-style-type: none"> • market mechanisms fail to provide adequate security, and • The PSO gives direction to take action, and • the Market Participant complies with the instruction.

<p>5.6.2 of Chapter 5</p>	<p>Once an emergency operating state has been declared by the PSO - Market Participants who comply with a direction issued to it pursuant to Section 5.6.1. This may include cancelling all maintenance or other planned work affecting the security of the PSO controlled system, cancelling, denying requests for or deferring approved planned outages, directing that PSO controlled grid or generation facilities be returned to service and operating to security limits appropriate for any emergency operating state.</p>	<p>Maintenance, work affecting security of PSO controlled system, outages, directions to return to service, operating to security limits appropriate for an emergency operating state</p>	<p>In principle, a Market Participant may make a request for compensation if:</p> <ul style="list-style-type: none"> • The PSO declares an emergency operating state, and • The PSO gives direction pursuant to Section 5.6.1 of Chapter 5; and • the Market Participant complies with the direction.
<p>7.7.2 and 7.7.3 of Chapter 5</p>	<p>A Market Participant for a generation facility in respect of which an outage is cancelled, deferred or recalled by the PSO may apply for compensation for direct expenses incurred as a result if the conditions specified in Sections 7.7.2.1 to 7.7.2.4 of Chapter 5 are met.</p>	<p>Outages that have received planning approval or final approval by the PSO</p>	<p>In principle, a Market Participant for a generation facility may make a request for compensation only if:</p> <ul style="list-style-type: none"> • The PSO cancels, defers or recalls outage; and • if the conditions specified in Sections 7.7.2.1 to 7.7.2.4 of Chapter 5 are met.
<p>8.4.3 of Chapter 5</p>	<p>Market Participants directed by the PSO to provide any level of any ancillary service above the levels required by the electricity licence or any registration requirements referred to in the Market Rules, the transmission code or any applicable connection agreement, and if the facility is not otherwise subject to an ancillary service contract.</p>	<p>Primary reserve, secondary reserve, contingency reserve, regulation, reactive power and voltage support service, black start service, fast start service, reliability must-run service</p>	<p>In principle, a Market Participant may make a request for compensation if:</p> <ul style="list-style-type: none"> • The PSO has issued a direction for ancillary service, and • the quantity instructed is above that required otherwise, and • the Market Participant has complied with the direction.
<p>8.6.2 of Chapter 5</p>	<p>Market Participants directed by the PSO under an emergency operating state to provide any class of contracted ancillary service, even if the EMC does not have an ancillary service contract in respect of that registered facility.</p>	<p>Reactive support and voltage control service, black start capability, fast start service, reliability must-run service</p>	<p>In principle, a Market Participant may make a request for compensation if:</p> <ul style="list-style-type: none"> • The PSO has declared emergency operating state, and • The PSO issued a direction for contracted ancillary service, and • the Market Participant has complied with the direction.

<p>9.1.7, 9.1.8 and 9.1.3 of Chapter 5</p>	<p>Market Participants, with a valid energy, reserve or regulation offer, who comply with a dispatch instruction issued pursuant to Section 9.1.3 of Chapter 5 - where the PSO considers that any dispatch instructions issued in accordance with Section 9.1.2 of Chapter 5 could result in the PSO controlled system entering into a high-risk or emergency operating state. Under Section 9.1.8, compensation is not available for dispatch instructions for reactive support and voltage control.</p>	<p>Energy, primary reserve, secondary reserve, contingency reserve, regulation</p>	<p>In principle, a Market Participant may make a request for compensation if:</p> <ul style="list-style-type: none"> • The PSO has issued a dispatch instruction pursuant to Section 9.1.3 of Chapter 5; and • the Market Participant has complied with the instruction.
<p>9.7.3 of Chapter 5</p>	<p>When a dispatch error has occurred, a market participant who has sustained a loss or damage as a result may make a request for compensation to the PSO.</p>	<p>Not specific</p>	<p>In principle, a Market Participant may make a request for compensation if:</p> <ul style="list-style-type: none"> • A dispatch error has occurred, and • the Market Participant has sustained a loss or damage as a result.
<p>10.4.1 of Chapter 5</p>	<p>When a Market Participant for a generation facility has taken action in response to an abnormal frequency condition. Abnormal frequency conditions and actions to be taken identified in Section 9.5 of the System Operation Manual.</p>	<p>Not specific</p>	<p>In principle a Market Participant can claim compensation if:</p> <ul style="list-style-type: none"> • It has taken action in response to abnormal frequency condition in accordance with the System Operation Manual.

Table 2: Basis for Compensation

PSO direction relating to	Compensation paid where instruction is to produce/deliver more than scheduled or required quantity	Compensation paid where instruction is to produce or deliver less than scheduled or required quantity
Energy	As per formula. If scheduled for both energy and reserve, consult Table 3 below.	As per formula and table below. If scheduled for both energy and reserve, consult Table 3 below.
Primary Reserve	As per formula	None
Secondary Reserve	As per formula	None
Contingency Reserve	As per formula	None
Regulation	As per formula	None
Reactive support and voltage control	To be determined on the basis of the applicant's submission	None
Black start capability	To be determined on the basis of the applicant's submission	None
Fast start service	To be determined on the basis of the applicant's submission	None
Reliability must-run service	To be determined on the basis of the applicant's submission	None
Others	Eligibility for compensation and amount of compensation payable to be determined on the basis of the applicant's submission.	

Table 3: Criteria for Eligibility for Compensation Where Generator Scheduled for Both Energy and Reserve

Assessment Criterion	Compensation Payable
Quantity instructed by the PSO is less than the scheduled quantity of energy	Compensation payable in accordance with formula 3 below (if $IQ^m < SQ^m$)
Quantity instructed by the PSO is greater than or equal to the scheduled quantity of energy, but less than or equal to the sum of the scheduled quantity of energy and the scheduled quantity of reserve	No compensation payable
Quantity instructed by the PSO is greater than the sum of the scheduled quantity of energy and the scheduled quantity of reserve	Compensation payable in accordance with formula 2 below (if $IQ^m > SQ^m$)

Formula to Calculate Compensation in Respect of Energy, Reserve and Regulation

COMP^{m,pq} is calculated as follows:

1. If $IQ^m = SQ^m$, then $COMP^m = 0$
2. If $IQ^m > SQ^m$, then

$$COMP^m = \sum_{pq=1}^n COMP^{m,pq}$$

where

COMP^{m,pq} is the compensation paid in relation to the price-quantity pair pq of the energy, reserve or regulation offer from the generator m for the relevant dispatch period

The compensation due under each price-quantity pair spq (COMP^{m,spq}) is then calculated as follows:

$$\text{If } \sum_{pq=1}^{spq} Q^{m,pq} \leq SQ^m, \text{ then } COMP^{m,spq} = 0$$

[This is Expression 1 in Worked Example 1]

or

$$\text{If } \sum_{pq=1}^{spq-1} Q^{m,pq} \geq IQ^m, \text{ then } COMP^{m,spq} = 0$$

[This is Expression 2 in Worked Example 1]

Otherwise,

$$COMP^{m,spq} = \max[0, (P^{m,pq} - MCP^m)] * 0.5 * [\min(\sum_{pq=1}^{spq} Q^{m,pq}, IQ^m) - \max(\sum_{pq=1}^{spq-1} Q^{m,pq}, SQ^m)]$$

[This is Expression 3 in Worked Example 1]

3. If $IQ^m < SQ^m$, then

$$COMP^m = \sum_{pq=1}^n COMP^{m,pq}$$

where

$COMP^{m,pq}$ is the compensation paid in relation to the price-quantity pair pq of the energy, reserve or regulation offer from the generator m for the relevant dispatch period

The compensation due under each price-quantity pair spq ($COMP^{m,spq}$) is then calculated as follows:

$$\text{If } \sum_{pq=1}^{spq} Q^{m,pq} \leq IQ^m, \text{ then } COMP^{m,spq} = 0$$

[This is Expression 4 in Worked Example 2]

or

$$\text{If } \sum_{pq=1}^{spq-1} Q^{m,pq} \geq SQ^m, \text{ then } COMP^{m,spq} = 0$$

[This is Expression 5 in Worked Example 2]

Otherwise,

$$COMP^{m,spq} = \max[0, (MCP^m - P^{m,pq})] * 0.5 * [\min(\sum_{pq=1}^{spq} Q^{m,pq}, SQ^m) - \max(\sum_{pq=1}^{spq-1} Q^{m,pq}, IQ^m)]$$

[This is Expression 6 in Worked Example 2]

where

MCP^m for energy - is the market energy price (MEP) in \$/MWh at MNN m , as defined in Section 2.2.2 of Chapter 7 of the Market Rules
for reserve and regulation – \$0/MWh in all cases

SQ^m is the quantity (MW) of energy, reserve or regulation scheduled for GRF m in the original dispatch schedule. Where a claim relates to energy, and a unit is scheduled for both energy and contingency reserve, and the instruction is to provide more than the scheduled quantity of energy, then SQ^m is the sum of the quantities in MW scheduled for energy and contingency reserve for GRF m .

- IQ^m is the quantity of energy, reserve or regulation in MW that the PSO has instructed GRF m to provide in dispatch period m. This quantity may be amended to reflect any partial compliance with the PSO's instruction.
- spq is an index of a specific price-quantity pair in an energy, reserve or regulation offer
- pq is the index of the price-quantity pairs in an energy, reserve or regulation offer, ordered by increasing price
- $Q^{m,pq}$ is the quantity of the price-quantity pair pq for the energy, reserve or regulation offer from GRF m for the relevant dispatch period
- $P^{m,pq}$ is the price of the price-quantity pair pq for the energy reserve or regulation offer from GRF m for the relevant dispatch period. Where the offer is for reserve, the reserve price is adjusted by the applicable effectiveness multiplier (as defined in Section D.24.7 of Appendix 6D of Chapter 6 of the Market Rules)
- n is the maximum number of price-quantity pairs contained in the offer submitted by the market participant.

Where a claim for compensation relates to reserve provided by a Interruptible Load facility, the term GRF is deemed to refer to such an Interruptible Load facility.

The following figures illustrate the calculation of compensation for energy using the formulae outlined above:

Figure 1: Calculation of Compensation for Energy Where $IQ > SQ$

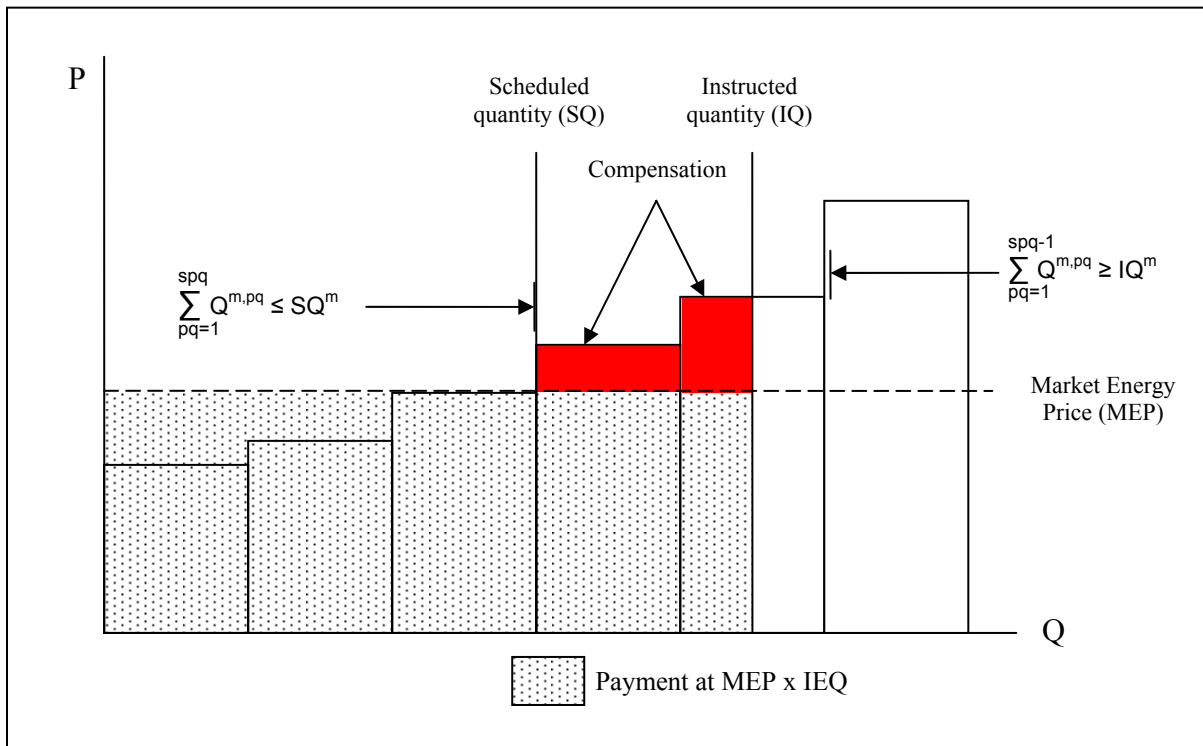


Figure 2: Calculation of Compensation for Energy Where $SQ > IQ$

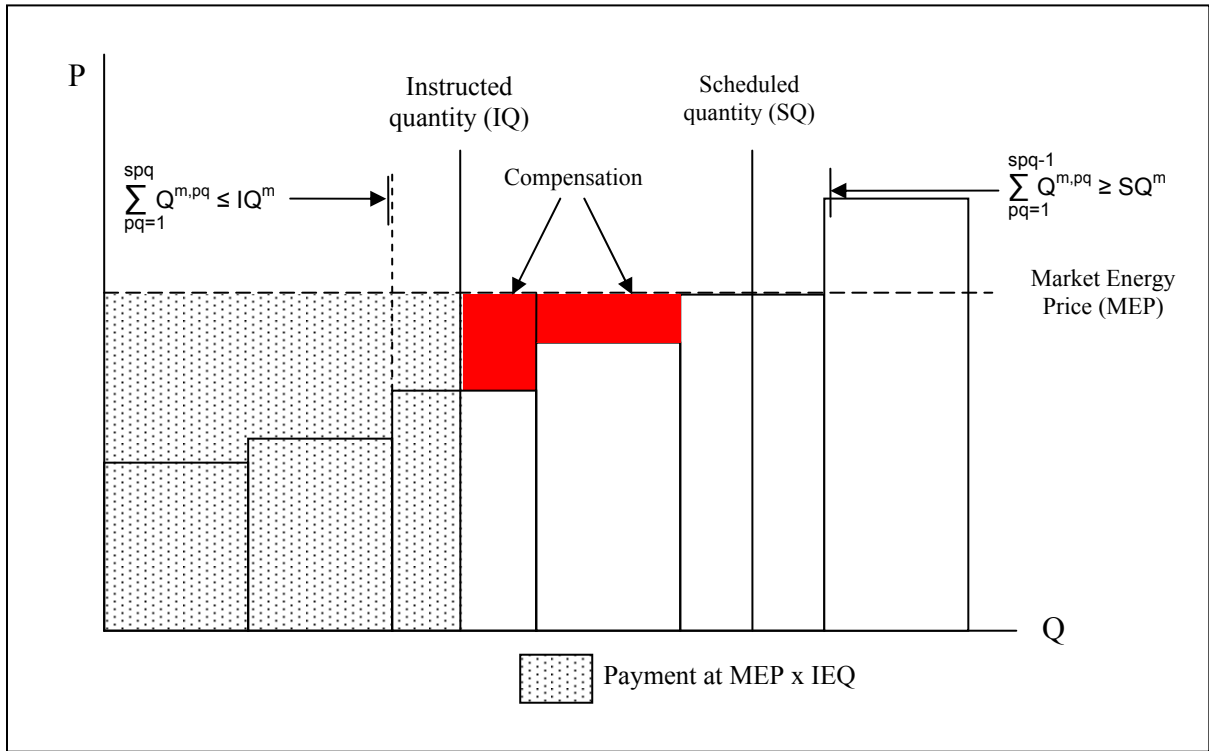
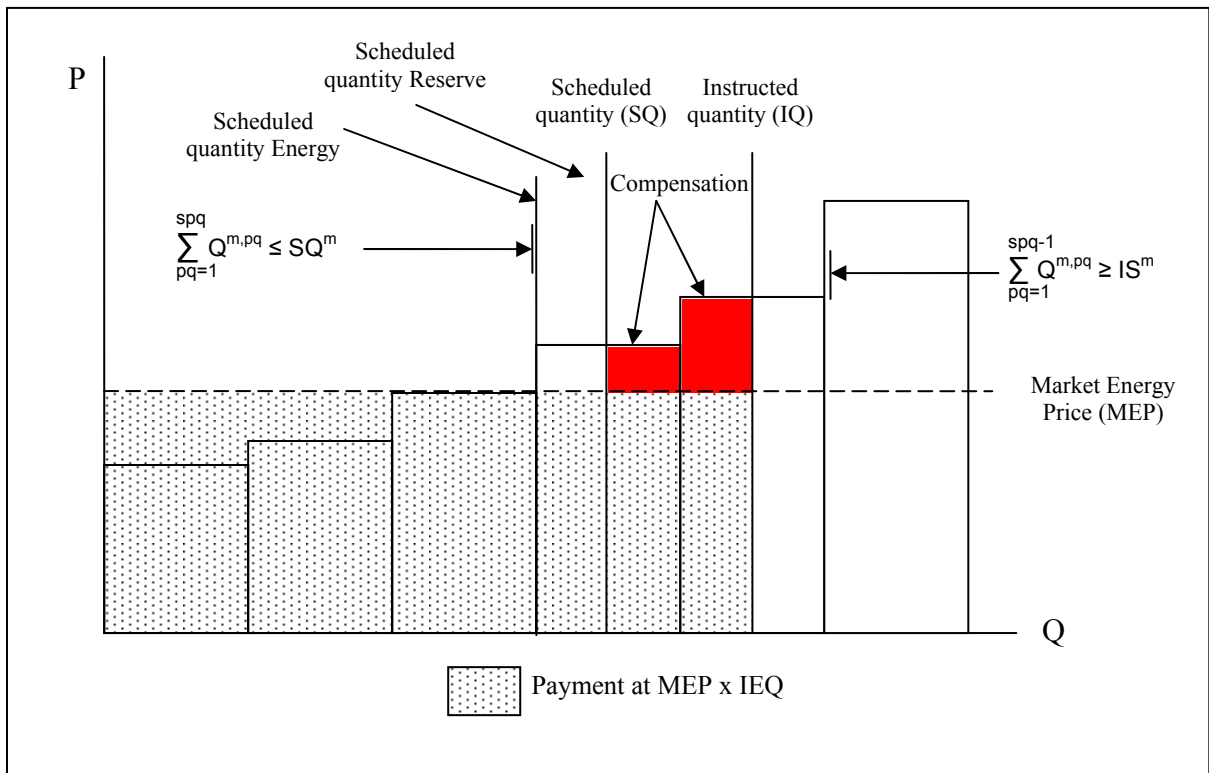


Figure 3: Calculation of Compensation for Energy Where GRF Scheduled for Both Energy and Reserve and where $IQ > SQ$



Worked Examples

Example 1: IQ>SQ

Scheduled Quantity 300MW/150MWh
 Instruction from the PSO 365MW/182.5MWh
 MEP \$110/MWh

Band	Offer Quantity MWh	Cumulative Quantity MWh	Offer Price \$/MWh	Sum of all quantities up to and including pq (Sum A)	Sum of all quantities up to and including pq-1 (Sum B)	Is Sum A less than or equal to SQ (Expression 1)	Is Sum B greater than or equal to IQ? (Expression 2)	Is compensation for offer band pq zero in accordance with Expression 1 or 2?	Expression 3		Amount of compensation payable for offer band pq in \$
									Maximum of 0 or (offer price in band pq less MEP)	Quantity [(minimum of Sum A or IQ) less (maximum of Sum B in MWh or SQ)]in MWh * 0.5	
1	100	100	0	100	0	YES	NO	YES			0
2	50	150	80	150	100	YES	NO	YES			0
3	50	200	100	200	150	YES	NO	YES			0
4	50	250	105	250	200	YES	NO	YES			0
5	50	300	110	300	250	YES	NO	YES			0
6	25	325	120	325	300	NO	NO	NO	10	12.5	125
7	25	350	150	350	325	NO	NO	NO	40	12.5	500
8	10	360	200	360	350	NO	NO	NO	90	5	450
9	10	370	280	370	360	NO	NO	NO	170	2.5	425
10	10	380	350	380	370	NO	YES	YES			0
Total compensation payable											1500

In Example 1, the Market Participant is scheduled at 300MW. It receives an instruction from the PSO to increase output to 365 MW. For the purpose of illustration, it is assumed that the instruction occurs at the beginning of the trading period and ramping is instantaneous. The above table shows the ten offer bands and how each offer band is assessed against Expression 1 and Expression 2. Where compensation is not zero under the conditions of Expression 1 or Expression 2, an amount of compensation is calculated for each offer band using Expression 3. Finally, the compensation for each offer band is summed to obtain the total amount of compensation payable for this trading period.

Example 2: SQ>IQ

Scheduled Quantity
Instruction from the PSO
MEP

350MW/175MWh
275MW/137.5MWh
MEP \$150/MWh

Band	Offer Quantity MWh	Cumulative Quantity MWh	Offer Price \$/MWh	Sum of all quantities up to and including pq (Sum A)	Sum of all quantities up to and including pq-1 (Sum B)	Is Sum A less than or equal to IQ (Expression 4)	Is Sum B greater than or equal to SQ? (Expression 5)	Is compensation for offer band pq zero in accordance with Expression 4 or 5?	Maximum of 0 or (MEP less offer price in band pq)		Quantity [(minimum of Sum A or SQ) less (maximum of Sum B in MWh or IQ)]in MWh * 0.5	Amount of compensation payable for offer band pq in \$
									Expression 6			
1	100	100	0	100	0	YES	NO	YES			0	
2	50	150	80	150	100	YES	NO	YES			0	
3	50	200	100	200	150	YES	NO	YES			0	
4	50	250	105	250	200	YES	NO	YES			0	
5	50	300	110	300	250	NO	NO	NO	40	12.5	500	
6	25	325	120	325	300	NO	NO	NO	30	12.5	375	
7	25	350	150	350	325	NO	NO	NO	0	12.5	0	
8	10	360	200	360	350	NO	YES	YES			0	
9	10	370	280	370	360	NO	YES	YES			0	
10	10	380	350	380	370	NO	YES	YES			0	
Total compensation payable											875	

In Example 2, the Market Participant is scheduled at 350MW. It receives an instruction from the PSO to decrease output to 275 MW. For the purpose of illustration, it is assumed that the instruction occurs at the beginning of the trading period and ramping is instantaneous. The above table shows the ten offer bands and how each offer band is assessed against Expression 4 and Expression 5. Where compensation is not zero under the conditions of Expression 4 or Expression 5, an amount of compensation is calculated for each offer band using Expression 6. Finally, the compensation for each offer band is summed to obtain the total amount of compensation payable for this trading period.