

RCP PAPER NO. : **EMC/RCP/149/2025/377**

SUBJECT : **REGULATION COST ALLOCATION TO GENERATION SETTLEMENT FACILITIES ABOVE 10MW**

FOR : **DECISION**

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Executive Summary

In the Singapore Wholesale Electricity Market (SWEM), regulation costs are allocated based on the causer-pays principle, capping each generation settlement facility's (GSF) share to the first 5MWh per trading period.

The recent influx of larger GSFs, driven by increased solar deployment, necessitates a review of regulation cost allocation. EMC proposes removing the 5MWh cap on AFP for GSFs such that all generation facilities pay a fair share.

EMC seeks the RCP's endorsement of this proposal on a conceptual level. For cost effectiveness, we nevertheless propose to implement the changes only in the next material market system update.

At the 149th RCP meeting, the RCP by majority vote endorsed this proposal on a conceptual level. EMC plans to implement the changes only in the next material market system update. EMC will also report to the RCP before embarking on this accordingly.

1. Introduction

Regulation costs in the Singapore Wholesale Electricity Market (SWEM) are allocated based on the causer-pays principle. The influx of generation settlement facilities (GSFs) over 10MW, driven largely by increased solar power, necessitates a review of this allocation to ensure these larger GSFs pay their fair share of the system's regulation cost.

This paper seeks to modify the allocation of regulation costs for generation settlement facilities with registered capacities of above 10MW.

2. Background

2.1 Reserve and regulation cost allocation methodology in SWEM

In the SWEM, reserves and regulation are ancillary services procured in the real-time markets. Reserves are provided by generation facilities (or Interruptible Loads) on standby to generate (or be interrupted) to arrest a fall in system frequency during generation contingencies. Regulation corrects second-to-second imbalances caused by small variations in generation and consumption.

It is considered that forced outages of small generators (with registered capacity of less than 10MW) would not result in the activation of reserves, and regulation is sufficient to cover the resulting energy loss from said outages. Therefore, reserve costs are only allocated to generators that are *scheduled* above 10MW per trading period. Regulation costs are currently charged to the first 10MW (or 5MWh in a trading period) of generation for each generator and all loads instead.

2.2 Reserve and regulation cost allocation across different facility registration schemes

The reserve and regulation cost allocation methodology above represents an overarching principle that applies generally. However, there are differences across various registration schemes in SWEM, especially for intermittent generation facilities (IGFs), i.e. solar facilities.

Currently, all IGFs are registered as non-dispatchable facilities in the SWEM regardless of their installed capacities¹ under the following schemes:

a. Individual generation settlement facility (GSF)

IGFs (and non IGFs with capacity below 10MW) can choose to register as a GSF individually. For such GSFs, regulation costs are allocated to their first 5MWh of metered generation in each trading period.

b. Pseudo GSF

Multiple IGFs with individual capacities of less than 10MW each may be aggregated and registered as one single Pseudo GSF. For Pseudo GSFs, the entire metered generation will be allocated of regulation cost.

c. Non-exporting Embedded Intermittent Generation Facility (NEIGF)

For embedded IGFs of less than 10MW that do not export to the grid, they can choose to be registered as NEIGFs. A NEIGF pays for its regulation cost based on its estimated generation half-yearly.

It is noteworthy that IGFs with individual installed capacities greater than 10MW are still required to be registered as individual GSFs, instead of as generation registered facilities (GRFs)². This is because the output of IGFs is not controllable and hence is unable to be subject to being

¹ For the avoidance of doubt, all references to name-plate ratings in this paper for IGFs are in MWac.

² For non-intermittent generation facilities with name-plate ratings of 10MW or more, they are required to be registered as generation registered facilities (GRFs) and be subject to dispatch.

scheduled and dispatched. Reserve costs are only allocated to generators scheduled above 10MW per trading period, thus IGF GSFs do not incur reserve costs. Regulation costs for each GSF are capped at the first 5MWh, regardless of the generator’s installed capacity.

3. Analysis

3.1 Regulation cost allocation to GSFs >10MW

Recently, GSFs with larger installed capacities have entered the market. As of July 2025, there are nine standalone GSFs with installed capacity above 10MW registered in the SWEM.

Currently, such GSFs only pay regulation costs up to the first 5MWh of their metered generation in each trading period. They are not allocated reserve cost. For example, a 40MW GSF and four 10MW GSFs incur different regulation costs. Assuming these GSFs are IGFs whose generation follows the latest solar generation profile by EMA, Table 1 shows the annual regulation cost differences, highlighting how the larger 40MW GSF is under-allocated regulation costs.

Table 1: Differences in Annual Regulation Costs

	A 40MWac IGF GSF	Four 10MWac IGF GSF
Daily IEQ ³	121.0MWh	121.0MWh
Daily FEQ ⁴ (quantity that is subject to regulation cost)	90.0MWh	121.0MWh
Estimated annual regulation cost ⁵	\$14,124	\$18,981

Considering that the magnitude of disturbances caused to the system by a 40MW GSF should be similar to that of a group of four GSFs of 10MW each, the current regulation cost allocation appears to unduly favour bigger GSFs.

3.2 Proposed solution

To ensure that GSFs, regardless of their capacities, pay their fair share of regulation costs, the regulation cost allocation methodology should be modified such that the full amount of generation from GSFs is subject to regulation cost, instead of only the first 5MWh.

3.3 Implementation

Implementing this proposal requires changing how EMC’s systems allocate regulation costs to all current and future GSFs. This is an extensive change and is expected to incur significant costs and time. While justified and in line with the causer-pays principle, its current impact is limited⁶. Hence, we propose implementing this change alongside another major system update in the future

³ IEQ is the metered generation quantity of a generation facility in a trading period. In this table it is estimated using the latest solar generation profile (version 1.19) published by EMA.

⁴ FEQ is the energy quantity that a generator/load is subject to regulation cost in a trading period. For a GSF, its FEQ takes the minimum of its IEQ and 5MWh in each period.

⁵ Estimated using the average AFP (\$0.43/MWh) in 2024.

⁶ As of July 2025, there are only two GSFs that are projected to be undercollected AFP charges. The projected annual undercollection of AFP charges from these two units currently stands at \$5,736.15.

4. Proposed Modifications to the Market Rules

To effect the proposal in section 3.2 of this paper, modifications to Chapter 7, sections 3.2.2.1 and 3.2.2.2 of the market rules are proposed. Please refer to Annex 1 for the proposed modifications.

5. Consultation

The proposed modifications were published for consultation on 25 July 2025. EMC received comments from Sembcorp Cogen, Keppel Merlimau Cogen, and PacificLight Power. The comments and EMC’s responses are provided below in Table 2.

Table 2: Summary of Industry Comments

S/N	Comment	EMC Response
Comments received from: Sembcorp Cogen		
1	<p>Incomplete Regulation Requirement Calculation The current methodology for determining regulation requirements only considers load facilities, excluding the variability introduced by solar GSFs. This results in an underestimation of the actual regulation needed and misallocates costs.</p> <p>Recommendation: Update the System Operation Manual to incorporate variability if IGS in the regulation requirement calculation. Incorporating forecast error or output variability from solar IGFs would better reflect their impact on system stability.</p>	<p>EMC shares Sembcorp’s desire to allocate regulation costs accordingly, which is the intent of this paper for GSFs with capacities above 10MW.</p> <p>EMC is also of the view that this proposal is independent of the setting of regulation requirements, which is beyond the scope of this paper. The issue the proposal addresses is an increase in GSFs >10MW, which is not necessarily solely borne out of an increase in solar deployment.</p> <p>Having said that, should the methodology to derive these requirements be revised, EMC would be open to revisit the regulation cost methodology.</p>
2	<p>No Consideration for Storage or Hybrid Systems The proposal does not differentiate between IGFs with and without energy storage or hybrid capabilities. Facilities that actively mitigate their variability should be recognized and incentivized.</p> <p>Recommendation: Consider a differentiated regulation cost model that accounts for grid supportive technologies such as batteries or hybrid systems.</p>	<p>EMC agrees with Sembcorp for the need for the right incentives for facilities that are able to manage their own intermittency.</p> <p>EMC’s proposal is in the context of available registration schemes today (GRF, GSF, PGSF, NEIGF, etc). EMC would also clarify that within said current framework, there is some consideration for hybrid models. As clarified in RC383⁷, a typically intermittent generation facility integrated with ESS</p>

⁷ EMC/RCP/139/2024/RC383 – Modelling of Energy Storage Systems

S/N	Comment	EMC Response
		<p>that render the output of said generation facility dispatchable shall not be considered an intermittent generation facility. This allows the facility to be registered as a GRF, where AFP will continue to be allocated only to the first 5MWh of its generation per period; in contrast pure IGFs can only be registered as GSFs and under this proposal will be charged AFP for its entire generation.</p>
<p>Comments received from: Keppel Merlimau Cogen</p>		
3	<p>Keppel objects the proposed allocation of regulation costs to generation settlement facilities as it does not fully address the underlying market issues. Any review of market cost allocation involving generation settlement facilities (including intermittent generation facilities) should be more comprehensive and include an assessment of the actual system regulation requirement that accounts for the grid impact of renewable energy sources and addresses the current mismatch between regulation supply, price signals, and grid reliability.</p>	<p>EMC notes Keppel’s comments on the impact of solar power and the call for a more comprehensive review of regulation requirements. EMC is however of the view that this proposal is independent of the setting of regulation requirements, which is beyond the scope of this paper. The issue the proposal addresses is an increase in GSFs >10MW, which is not necessarily solely borne out of an increase in solar deployment.</p> <p>Having said that, should the methodology to derive the regulation requirements be revised, EMC would be open to revisit the regulation cost methodology.</p>
<p>Comments received from: PacificLight Power</p>		
4	<p>The existing market design, as highlighted in the paper, addresses supply disruptions as follows:</p> <ul style="list-style-type: none"> a) For small generators (with capacity less than 10 MW), shortfalls are managed through regulation, and b) For large generators, contingency reserves are activated to cover the shortfall. However, this applies only to GRFs, as IGFs regardless of size, are exempt from bidding into the wholesale market due to the intermittent nature of their generation sources and are therefore registered as GSFs. <p>The proposal to amend cost allocation, so that large GSFs (essentially the large IGFs) contribute their fair</p>	<p>EMC appreciates and notes PacificLight’s comments.</p> <p>EMC recognises the impact of solar power on the grid and other GRFs. As noted by PacificLight, the operational realities and concerns brought by solar generation is discussed in EMA’s Intermittency Pricing Mechanism (IPM) paper. A final determination on the IPM would afford EMC the clarity to revisit regulation and potentially reserve costs allocation more holistically, if required.</p> <p>In the meantime, EMC would clarify that the current proposal is independent of</p>

S/N	Comment	EMC Response
	<p>share of regulation costs based on IEQ, aims to address the unequal treatment among the GSFs. While this addresses the inequity, there are potential issues as follows:</p> <ul style="list-style-type: none"> a) First, it overlooks the operational reality that when there is a sudden dip in solar output, GRFs are typically activated under contingency, not regulation, to meet the shortfall. b) Second, it deviates from the current market principle, whereby only fluctuations from small generators are managed through regulation. <p>These concerns highlight the need for a more holistic review of the treatment of large IGFs. Specifically:</p> <ul style="list-style-type: none"> a) There is a need to determine whether the provision for intermittency should be met through reserves or regulation, and to scale the requirements of the respective products accordingly. This requirement should reflect scenarios in which IGFs collectively experience maximum output reduction due to weather, aligning with concepts discussed in the Intermittency Pricing Mechanism (IPM) paper; and b) Only after establishing a clear and consistent operational approach can a fair cost allocation mechanism be implemented. Notably, IGFs currently do not pay for the reserves provided by GRFs, despite benefitting from system support during intermittency events. <p>Our concern with supporting the current proposal lies in the potential implication that:</p> <ul style="list-style-type: none"> i. There will be no further review to enhance the requirements for addressing intermittency, and ii. As a result, large IGFs may no longer be expected to contribute to other system costs beyond the proposed increase in regulation charges. 	<p>the determination on the provisions for intermittency, as it addresses the increase in GSFs>10MW, which may not be solely borne out of an increase in solar deployment.</p>

6. Legal Sign-off

The text of the proposed rule modifications as set out in Annex 1 has been vetted by EMC's internal legal counsel, whose opinion is that the modifications of the market rules reflect the intent of the proposed modifications as expressed in the third column of the table in Annex 1.

7. Conclusion

The current regulation cost allocation caps the share of a GSF to the first 5MWh of its generation in each trading period. This may result in GSFs with larger installed capacities being under-charged regulation costs. To ensure that all generation facilities pay a fair share of their regulation cost, EMC has proposed to remove the 5MWh cap in allocating regulation cost to GSFs.

Comments from industry consultation highlight the impact of increased solar deployment to the grid and they call for a more holistic review of regulation or even reserve cost/requirement setting methodology, citing the need for alignment with workstreams such as the Intermittency Pricing Mechanism (IPM) proposed by EMA. Given our current understanding of the IPM, we do not see that having any bearing on EMC's proposal in this paper. The proposal in this paper addresses the allocation of regulation costs to GSFs with capacities above 10MW, which are not necessarily only solar facilities. Having said that, should workstreams such as the IPM result in significant changes to the methodology to allocate reserve and regulation costs, EMC is open to revisit this proposal as necessary. There would be ample opportunity to do this given EMC is not proposing to implement this proposal immediately.

EMC therefore seeks the RCP's endorsement of this proposal on a conceptual level. For cost effectiveness, we nevertheless propose to implement the changes only in the next material market system update. EMC will report to the RCP accordingly on this.

8. Decision at the 149th RCP Meeting

At its 149th RCP meeting, the RCP by majority vote endorsed this proposal on a conceptual level.

The following RCP members supported this proposal on a conceptual level:

1. Mr. Teo Chin Hau (Representative of Generation Licensee)
2. Mr. Sherman Toh (Representative of Transmission Licensee)
3. Mr. Andrew Tan (Representative of Retail Electricity Licensee)
4. Dr Toh Mun Heng (Representative of Consumers of Electricity in Singapore)
5. Mr. Fong Yeng Keong (Representative of Consumers of Electricity in Singapore)
6. Mr. Wong Yew Chung (Person experienced in Financial Matters in Singapore)

The following RCP members did not support this proposal on a conceptual level:

1. Mr. Dallon Kay (Representative of Retail Electricity Licensee)
2. Mr. Cheong Zhen Siong (Representative of Wholesale Electricity Licensee)

As mentioned above, EMC plans to implement the changes only in the next material market system update. EMC will also report to the RCP before embarking on this accordingly.

ANNEX 1: Proposed Changes to the Market Rules

Existing Market Rules (1 January 2025)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Reasons for Modification
Chapter 7	Chapter 7	
3 NET SETTLEMENT INTERVAL CREDITS	3 NET SETTLEMENT INTERVAL CREDITS	
3.2 <u>NET REGULATION SETTLEMENT CREDITS</u>	3.2 <u>NET REGULATION SETTLEMENT CREDITS</u>	
<p>3.2.2.1 For a <i>settlement account</i> which is not associated with any <i>pseudo generation settlement facility</i>:</p> $FEQ_h^a = WEQ_h^a + \sum_{m(a)} \text{MIN} [IEQ_h^{m(a)}, CSZ] $ <p>where:</p> <p style="padding-left: 40px;">a = a <i>settlement account</i> which is not associated with any <i>pseudo generation settlement facility</i></p> <p style="padding-left: 40px;">h = a <i>settlement interval</i></p> <p style="padding-left: 40px;">$\sum_{m(a)}$ = sum over all <i>MNNs</i> m(a) of <i>GRFs</i> and <i>GSFs</i> associated with <i>settlement account</i> a</p>	<p>3.2.2.1 For a <i>settlement account</i> which is not associated with any <i>pseudo generation settlement facility</i> <u>where <i>net AFP treatment</i> has been granted under section 5.5A.4 of Chapter 2 to the <i>EGF group</i> to which such <i>pseudo generation settlement facility</i> is assigned:</u></p> $FEQ_h^a = WEQ_h^a + \sum_{m(a)} \text{MIN} [IEQ_h^{m(a)}, CSZ] + \sum_{n(a)} \text{IEQ}_h^{n(a)} $ <p>where:</p> <p style="padding-left: 40px;">a = a <i>settlement account</i> which is not associated with any <i>pseudo generation settlement facility</i> <u>where <i>net AFP treatment</i> has been granted under section 5.5A.4 of Chapter 2 to the <i>EGF group</i> to which such <i>pseudo generation settlement facility</i> is assigned</u></p>	<p>To amend the formula for FEQ such that the quantity of energy subject to regulation costs for GSFs and pseudo-GSFs whose EGF group is not granted net AFP treatment will be their entire generation quantity (and not be subject to the cut-off size), as represented by $\sum_{n(a)} \text{IEQ}_h^{n(a)}$ in the revised formula.</p> <p>To amend the component $\sum_{m(a)} \text{MIN} [IEQ_h^{m(a)}, CSZ]$ in the FEQ calculation such</p>

Existing Market Rules (1 January 2025)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Reasons for Modification
<p>MIN[X,Y] = Minimum of X or Y</p> <p> X = positive value for a real number, disregarding the sign</p> <p>CSZ = the cut-off size (in MWh) described in Appendix 7A</p>	<p>$h =$ a <i>settlement interval</i></p> <p>$\sum_{m(a)}$ = sum over all <i>MNNs</i> $m(a)$ of <i>GRFs</i> and <i>GSFs</i> associated with <i>settlement account a</i></p> <p><u>$\sum_{n(a)}$ = sum over all <i>MNNs</i> $n(a)$ of <i>GSFs</i>, including <i>pseudo generation settlement facilities</i> where <i>net AFP treatment</i> is not granted to the <i>EGF group</i> to which such <i>pseudo generation settlement facility</i> is assigned, associated with <i>settlement account a</i></u></p> <p>MIN[X,Y] = Minimum of X or Y</p> <p> X = positive value for a real number, disregarding the sign</p> <p>CSZ = the cut-off size (in MWh) described in Appendix 7A</p>	<p>that this component, which caps the quantity of energy subject to regulation costs at the cut-off size, will only apply to GRFs.</p>
<p>3.2.2.2 For a <i>settlement account</i> which is associated with a <i>pseudo generation settlement facility</i> and <i>net AFP treatment</i> is not granted to the <i>EGF group</i> to which such <i>pseudo generation settlement facility</i> is assigned:</p> $FEQ_h^a = WEQ_h^a + \sum_{n(a)} IEQ_h^{n(a)} $	<p>3.2.2.2 For a <i>settlement account</i> which is associated with a <i>pseudo generation settlement facility</i> and <i>net AFP treatment</i> is not granted to the <i>EGF group</i> to which such <i>pseudo generation settlement facility</i> is assigned:</p> $FEQ_h^a = WEQ_h^a + \sum_{n(a)} IEQ_h^{n(a)} $	<p>Consequential change as the revisions to section 3.2.2.1 above will already address the existing scenario under section 3.2.2.2.</p>

Existing Market Rules (1 January 2025)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Reasons for Modification
<p>where:</p> <p>a = a <i>settlement account</i> which is associated with a <i>pseudo generation settlement facility</i> and <i>net AFP treatment</i> is not granted to the <i>EGF group</i> to which such <i>pseudo generation settlement facility</i> is assigned</p> <p>h = a <i>settlement interval</i></p> <p>$\sum_{n(a)}$ = sum over all <i>MNNs</i> n(a) of <i>pseudo generation settlement facilities</i> associated with <i>settlement account</i> a</p> <p> X = positive value for a real number, disregarding the sign</p>	<p>where:</p> <p>a = a <i>settlement account</i> which is associated with a <i>pseudo generation settlement facility</i> and <i>net AFP treatment</i> is not granted to the <i>EGF group</i> to which such <i>pseudo generation settlement facility</i> is assigned</p> <p>h = a <i>settlement interval</i></p> <p>$\sum_{n(a)}$ = sum over all <i>MNNs</i> n(a) of <i>pseudo generation settlement facilities</i> associated with <i>settlement account</i> a</p> <p> X = positive value for a real number, disregarding the sign</p> <p><u>[Deleted and Intentionally Left Blank]</u></p>	