RCP PAPER NO.	:	**EMC/RCP/155/2026/CP105**
SUBJECT	:	**REVIEW OF THE UNKNOWN EXPOSURE ESTIMATION METHOD IN THE ESTIMATED NET EXPOSURE CALCULATION**
FOR	:	**CONSULTATION**
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DATE OF MEETING	:	**17 SEPTEMBER 2026**

Executive Summary

This paper proposes a new method to estimate a Market Participant's (MP) exposure during the days for which meter data is not yet available (the "unknown exposure" period). The objective is to improve the accuracy and responsiveness of the daily Risk Exposure mechanism in the National Electricity Market of Singapore (NEMS).

The current Estimated Net Exposure (ENE) method calculates unknown exposure using a rolling 90-day Average Daily Exposure (ADE). Analysis of historical NEMS data from 2020 to May 2026 showed that this approach understated some MPs' ENE during volatile market conditions, delaying margin calls at the moment they matter most.

EMC proposes a USEP-based ENE method for retail electricity licensees and the MSSL. This method estimates unknown exposure using the latest available daily USEP during the unknown period. Our analysis concludes that this significantly improves the timeliness and accuracy of net exposure monitoring and margin call triggers for retail electricity licensees and the MSSL.

The USEP-based method is not suitable for other classes of MPs (including generators and wholesale traders), whose withdrawal and negative injection quantities are not predictable.

EMC recommends that the RCP **support** the proposal to:

a) adopt the USEP-based ENE method for retail electricity licensees and the MSSL;

b) retain the current ADE-based ENE method for the rest of the MPs; and

c) task EMC to review the adequacy of the Credit Support Value mechanism, taking into account the improved accuracy and responsiveness of the Risk Exposure mechanism.

EMC seeks industry views on this subject and appreciates receiving comments by **4 September 2026**.

1. Introduction

At the 137th RCP Meeting, the panel unanimously supported the proposed approach for a holistic review of the current prudential requirements. This included a proposal (Proposal 2) to enhance the credit support framework by reviewing the Average Daily Exposure (ADE) calculation, the core component determining a market participant's (MP) Estimated Net Exposure (ENE) and overall Risk Exposure (RE).

This paper examines how the "unknown exposure" component of a Market Participant's (MP) Estimated Net Exposure (ENE) is calculated, with the aim of improving the accuracy and responsiveness of the Risk Exposure (RE) mechanism. The RE mechanism functions as an early warning system, triggering a margin call in a timely manner when an MP's risk exposure exceeds the prescribed threshold. The primary source of error in estimating an MP's RE lies in how unknown exposure is calculated within its ENE. Without an accurate and timely RE mechanism, an MP's net exposure may not be sufficiently covered by the credit support it has provided, especially when the market is volatile.

2. Background

2.1 Estimated Average Daily Exposure (ADE) and its Role in Credit Support Value (CSV) and Risk Exposure (RE) Mechanisms

In the National Electricity Market of Singapore (NEMS), the estimated ADE represents the typical daily trading liability of an MP. The ADE is the simple average of the MP's net settlement amounts from the 90 most recently available Preliminary Settlement Statements (PSS) or corresponding Final Settlement Statements (FSS).

The ADE serves two functions in the prudential framework:

1. Calculating the CSV: The CSV is calculated by multiplying the MP's Estimated ADE by 38 days for MPs and 33 days for the Market Support Services Licensee (MSSL). This requirement is designed to ensure that the MP provides sufficient baseline credit support to cover its average trading exposure, taking into account a 20-day payment cycle and a 18-day default remediation and suspension process.

$$Credit\ Support\ Value\ (CSV) = 38\ days\ \times ADE$$

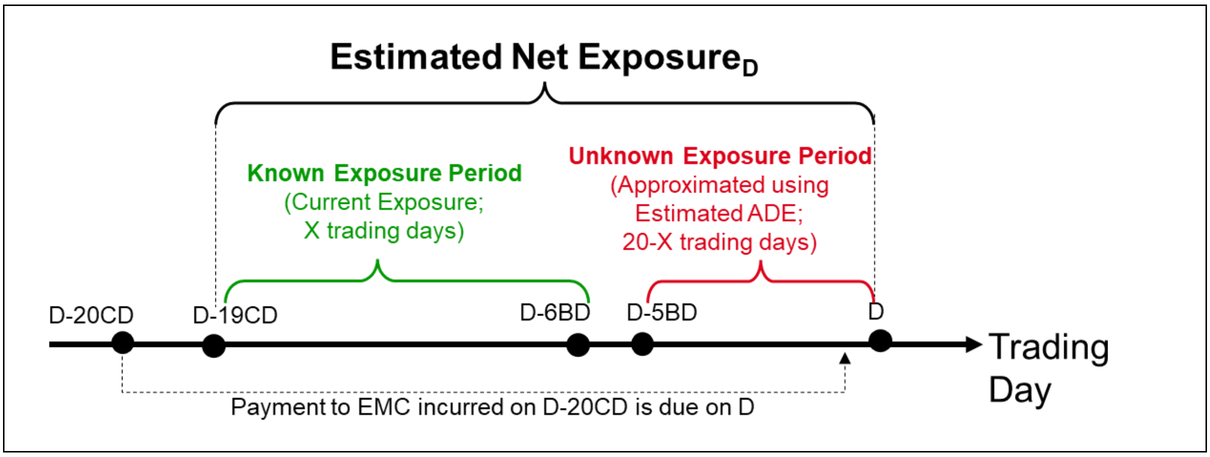
2. Approximating Unknown Exposure in RE: As metering and settlement data becomes available only after several days, EMC uses the historical 90-day ADE to approximate the MP's "unknown" unpaid trading exposure when calculating its daily RE (as detailed in Section 2.2), which is used for monitoring continuous adequacy of credit support.

The CSV and RE mechanisms together form a two-tiered safeguard against credit defaults. The CSV provides a baseline, while the RE mechanism acts as a dynamic daily monitor of the adequacy of credit support held in respect of each MP based on actual market conditions.

2.2 Estimated Net Exposure and its Role in Risk Exposure Mechanism

Settlement in the NEMS takes place 20 days in arrears. Estimated Net Exposure (ENE) is a daily metric calculated by EMC to estimate an MP's trading liability over this 20-day payment cycle. As metering data is only available to EMC 5 business days (BDs) after a trading day, EMC determines the net settlement amount for a given trading day only 6 BDs after that trading day. To bridge this gap, EMC uses the ENE formula to approximate an MP's net exposure on any given day by combining both known and estimated unknown exposures (Refer to Box 1).

Box 1: Breakdown of ENE into known and unknown exposures over a 20-day payment cycle



The ENE[1] is calculated using the following formula:

> *Estimated Net Exposure = Current Exposure + [(20-X) x Estimated ADE] – Prepayment Amount + Unpaid Amount*
>
> Where:

- *Current Exposure*: The MP's known exposure. It is calculated as -1 multiplied by the aggregated net settlement amounts from available preliminary or final settlement statements for all trading days where the invoices are not yet due for payment.
- *X*: This is the number of trading days to which the "Current Exposure" relates.
- *(20-X) x Estimated ADE*: This is the unknown exposure. As the payment cycle is 20 days, the remaining days *(20 – X)* lacking settlement data are estimated by multiplying them by the MP's estimated ADE.
- *Estimated ADE* (established MPs): Once an MP has sufficient trading history, their estimated ADE is calculated as -1 multiplied by the simple average of the net settlement amounts from their 90 most recently available PSS or FSS. [2]
- *Forecast ADE* (new MPs): Until a new MP accumulates 90 days of settlement statements, their estimated ADE is determined by a forecast ADE. [3]
- *Prepayment Amount*: Any advance payments the MP makes to EMC to proactively reduce their exposure.
- *Unpaid Amount*: Due and unpaid invoice amounts (less any credit support already recovered by EMC).

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[1] By convention, a positive ENE indicates that the MP has a payment liability to EMC (e.g. they owe money to the market). A negative ENE indicates that EMC owe money to the MP.

[2] In the NEMS settlement system, a negative net settlement amount means the MP owes money to EMC. Multiplying this by -1 converts their typical daily debt into a positive exposure value. If a negative estimated ADE is calculated (meaning the MP generally receives more money from the market than they pay), the rules treat the ADE as a zero value for the purpose of calculating credit support.

[3] If a new MP does not yet have 90 days of trading history, the initial ADE is based on the MP's own projections of the gross energy quantities they will inject or withdraw, multiplied by historical average prices. Once they begin trading, their ADE is dynamically calculated using a formula that takes the greater of their forecasted quantities or their actual maximum daily withdrawal/injection quantities, which is then multiplied by average historical prices. This prevents a new MP from underestimating their forecast to avoid putting up sufficient credit support. Once 90 days of actual settlement statements are available, they transition to the standard calculation.

The purpose of calculating the ENE is to monitor the adequacy of credit support through the Risk Exposure mechanism (RE). Each business day, EMC calculates an MP's RE:

$$Risk\ Exposure\ =\ Estimated\ Net\ Exposure/Credit\ Support\ Held$$

The resulting RE percentage determines when the margin call mechanism is triggered:

1. Notification: EMC notifies a MP when their ENE reaches 45% (or 50% for the MSSL) of their provided credit support.
2. Margin call: If the ENE reaches or exceeds 55% (or 60% for the MSSL) of their credit support, EMC issues a margin call.[4]
3. Remedy: The MP must satisfy the margin call within two BDs by providing additional credit support or making a prepayment to bring its RE down to 35% (or 40% for the MSSL) or lower.

2.3 Where does default risk in the NEMS originate?

In this paper, net creditors refer to MPs to whom EMC owes money (typically generators and demand response providers). Net debtors refer to MPs who owe EMC money (typically retailers). While net position reversals can occur, due to prolonged negative energy prices or generators scheduled below their bilateral contract levels, payment default risk historically originates from retailers.

Table 1[5] shows that margin calls in the NEMS have been issued mostly to retailers (refer to Appendix A for MP classification). From 2020 to 2025, no generator or the MSSL was issued a margin call or default notice.

Table 1 Total number of margin call issued from 1 January 2020 to 31 December 2025

	2020	2021	2022	2023	2024	2025
Retailers	8	11	0	0	0	0
Generators	0	0	0	0	0	0
MSSL	0	0	0	0	0	0
Wholesale Market Traders	0	1	0	0	0	0

Liberalisation of the retail market (Open Electricity Market) in 2019 contributed to increased margin call issuance in 2020, after a number of new retailers entered the market.

The high number of margin calls in 2021 was driven by price volatility from the global energy crisis that disrupted natural gas supplies from Indonesia. During this period, the actual trade exposures of many retailers significantly exceeded their actual credit support provided to EMC. A retailer failed to satisfy its margin calls and this resulted in an unprecedented default levy of $506,061.55 imposed upon non-defaulting MPs.[6] The absence of margin calls in more recent years reflected relatively stable USEP conditions since 2023. But as the 2021 crisis demonstrated, the shortcoming of current ENE method surfaces only during periods of high price volatility, which is exactly when prudential safeguard matters most.

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[4] If an MP believes there is a manifest error in their ENE calculation, such as a metering or system calculation error, they can submit a formal request for EMC to reassess the ENE and potentially revoke or revise the margin call.

[5] To align to EMC's current practice, the count of margin calls reported in Table 1 is based on Run Date. The figures differ from the 2021 NEMS report which was based on Trading Date.

[6] The EMA introduced the Performance Bond (PB) Regime in February 2024 for retail electricity licensees. While both credit support and PBs safeguard against default, EMA has clarified they serve different purposes. The PB regime is enforced directly by the EMA and is therefore not reviewed in this study.

3. Analysis

3.1 Are the current RE and ENE methods adequate?

Since a retailer's RE is calculated using its estimated ADE, it may fail to accurately reflect its actual settlement amounts during the unknown exposure period (refer to Box 1). To assess the accuracy and responsiveness of the current RE and ENE methods, they are benchmarked against the "Actual Risk Exposure (ARE)" and "Actual Net Exposure (ANE)". For clarity, both ARE and ANE are not defined in the NEMS Market Rules, they are only used for the purpose of this study. ARE is calculated retrospectively using actual settlement amounts for the 20-day payment cycle:

$$Actual\ Risk\ Exposure\ =\ Actual\ Net\ Exposure/Credit\ Support\ Held$$

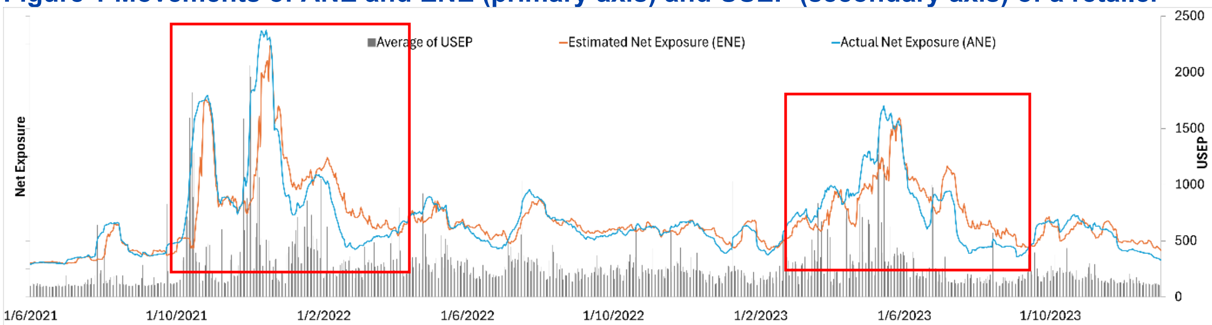
Where

- Actual Net Exposure (ANE): It is calculated as -1 multiplied by the aggregated net settlement amounts of an MP for all trading days on day D and the days immediately preceding it, but which are not yet payable on day D.

The key difference between ANE and ENE is data availability. For daily real-time monitoring, EMC currently can only rely on the 90-day ADE to bridge the data gap. Using NEMS data from 2020 to May 2026, EMC calculated the ANE and ENE for several retailers. Prepayments were excluded from ANE and ENE calculations to remove the impact of retailer's voluntary actions on their exposure calculations. It also better reflects reality where a defaulting retailer is unlikely to make prepayments during an actual event of default. Refer to Appendix B for an illustration of how the ENE and ANE are calculated for a retailer.

Figure 1 shows the ANE and ENE of a typical retailer. During periods of high USEP volatility, (especially in Q4 2021 and mid 2023), the ENE line (orange) consistently lagged the surging ANE line (blue). The ENE understates exposure while USEP is rising and overstates it when USEP falls, because the inflated data points persist in the 90-day rolling window into the following quarter. The core concern is that the current ENE method underestimates retailers' ANE during sudden USEP spikes, masking potential credit support insufficiency and leaving the market exposed to uncovered default risk. The 90-day historical average is inherently too slow to react to real-time price fluctuations.

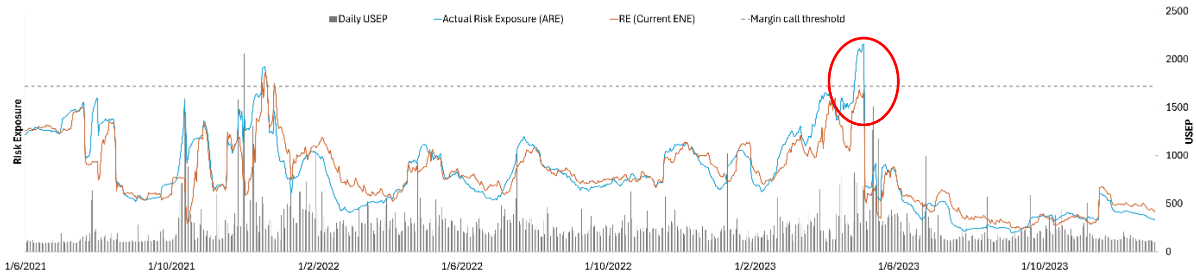
Figure 1 Movements of ANE and ENE (primary axis) and USEP (secondary axis) of a retailer[7]



The daily RE monitored by EMC is therefore inaccurate, creating a blind spot in which a retailer's calculated RE might appear safely below the 55% margin call threshold, while their Actual Risk Exposure (ARE) has already breached it. For example, in Figure 2 (circled in red), a retailer's ARE exceeded the margin call threshold on 25 April 2023 while its RE remained below it. EMC was therefore unable to issue a margin call to the retailer.

[7] Similar ANE and ENE movements are observed in other retailers.

Figure 2 Movements of ARE and RE (primary axis) and USEP (secondary axis) of a retailer



In practice, retailers tend to make prepayments when their RE approach the margin call threshold. Margin calls actually issued are therefore fewer than the examples used in this study. The analysis here reflects the worst-case scenarios, in which retailers make no prepayment. [8]

3.2 *Key drivers of retailer's and the MSSL's unknown exposure*

The "unknown exposure" period (5BDs immediately following a trading day) exists primarily because the metering data required to calculate an MP's exact settlement amount is not yet available to EMC. To improve the estimate, EMC examined the data availability of the components that drive retailers' settlement amounts.

Table 2 breaks down the settlement amount into its components to identify the key drivers of a retailer's settlement amount. The key components that have the most material impact on retailers' and the MSSL's settlement amounts are Energy Services (USEP multiplied by Withdrawal Energy Quantity) and financial hedge instruments (bilateral/vesting contracts).

Table 2 Breakdown of retailers' and the MSSL's settlement amounts[9]

		Weightage (% absolute amount)[10]		
Categories	Detailed Items	Retailer without BESC	Retailer with BESC	MSSL
Energy Service	Load Energy Settlement Debit (LESD)	98%	52%	84%
Reserve Service	Reserve Settlement Credit (RSC)	<1%	<1%	<1%
Regulation Service	Regulation Settlement Debit (FSD)	<1%	<1%	<1%
Financial Hedge Instruments	Bilateral Energy Settlement Credit (BESC) Vesting Contract Settlement Credit (VCSC)	0%	-47%[11]	15%
Uplift Charges	Monthly Energy Uplift (MEUC) Hourly Energy Uplift (HEUC) Net Energy Adjustment Debit (NEAD)	<2%	<1%	<2%
Financial Adjustments	Net Metering Adjustment Amount (NMEA)	<1%	<1%	<1%
Administrative Charges	EMC Admin Fee PSO Admin Fee	<1%	<1%	<1%

[8] In this study, the retailer's actual risk exposure (ARE) and risk exposure (RE) are calculated using the actual historical credit support held by EMC with respect to the retailer. Prepayment and unpaid dues are excluded in the calculation of ANE and ENE, and corresponding ARE and RE.
[9] Refer to EMC website for definition of the cost components (https://www.home.emcsg.com/glossary)
[10] Weightage is derived from total settlement amount data from 2020 to 2025 for retailers and the MSSL.
[11] The BESC of retailers are represented by negative percentage because it offset the LESD in Energy Service.

Since a retailer's settlement amount is primarily driven by Energy Service and Financial Hedge Instruments, it could be calculated exactly during the Unknown Exposure Period if USEP, Withdrawal Energy Quantity (WEQ) and bilateral/vesting contracts were all known.

However, not all data is available to EMC at the time when a retailer's ENE is calculated. The data availability of the components during the 20-day settlement cycle is summarised as follows:

- **Available in advance or real-time**: USEP[12], MEUC[13], Administrative Fees, Bilateral Contracts[14] and Vesting Contracts[15].
- **Delayed or after the Unknown Exposure Period**: Actual WEQ[16], HEUC[17], FSD[18], NEAD[19] and NMEA[20].

At the time that EMC calculates a retailer's ENE, the retailer's USEP and hedge contracts are known while WEQ is not. However, EMC assesses that the unavailable WEQ can be reliably estimated based on two empirically supported observations:

1. **WEQ is stable**. Appendix C.1 shows that retailers' WEQ remains predictable and constant, even when the USEP is volatile. Therefore, historical average WEQ is a reliable proxy for unknown WEQ.
2. **Settlement amounts correlate with USEP**. Appendix C.2 demonstrates strong negative correlation between settlement amounts and the USEP for most retailers from 2020 up to May 2026. However, there are instances where the correlations between settlement amounts and USEP weakens. Such instances could be attributed to the effects of bilateral or vesting contracts, which decouple settlement amounts from USEP. This observation is in line with the findings in Table 2 where financial hedge instruments (e.g. bilateral and vesting contracts) have substantial impact on settlement amounts for retailers and the MSSL.

3.3 *USEP-based method to estimate unknown exposure*

Therefore, EMC proposes to replace the 90-day ADE with a USEP-based method for retail electricity licensees and the MSSL. The method derives a "proxy WEQ" by removing the effect of financial hedges from the known exposure period (thereby isolating the underlying physical energy demand) averaging that quantity and applying the average to the latest available USEP to estimate exposure across the unknown period.

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[12] The USEP is calculated and published ex-ante every half-hour.

[13] The MEUC is estimated prior to the beginning of the calendar month, and its value is published on the first business day of that month

[14] The contract quantities for bilateral energy, reserve or regulation contracts must be submitted to EMC at least 10 days before the dispatch day to which they apply.

[15] The MSSL must submit the electronic data containing all relevant vesting quantities and prices at least 10 calendar days before the vesting period commences.

[16] The exact WEQ of a retailer is not known in real-time. The MSSL requires time to read and validate meters and only submits this actual metering data to EMC 5 business days after the trading day.

[17] The HEUC acts as a balancing item that captures the financial differences between the total amounts payable to generators and receivable from loads. These imbalances arise from transmission losses, intertie flows, and metering errors. As the HEUC calculation strictly relies on the final metered quantities, it is not published during the unknown period and is only made available after the actual metering data is processed.

[18] FSD is a debit calculated as the interval's Allocated Regulation Price (AFP) multiplied by the retailer's WEQ.

[19] NEAD is a debit applied to market participants who withdraw energy to recover the net adjustments caused by embedded generation facilities. The formula to calculate an MP's daily NEAD relies entirely on actualised physical quantities of an MP – Withdrawal Energy Quantity, Injection Energy Quantity and Withdrawal Price Quantity of Embedded Generators.

[20] NMEA captures the financial imbalances in the settlement system that arise when metering errors are discovered and corrected.

Table 3 outlines the exposure calculation by dividing the 20-day settlement cycle into three distinct periods based on data availability:

1. Known Exposure Period: Days where actual settlement amount and the USEP are known. Bilateral and Vesting Contract Settlement Credit are known.
2. Unknown Exposure Period: More recent days where only the USEP is known, but settlement amount is not known yet. Bilateral and Vesting Contract Settlement Credit are known.
3. Current Day: Today where settlement amounts and the USEP are unknown. Vesting Contract Settlement Credit is unknown. Bilateral contracts are known.

Table 3 General approach to estimate ENE (including current and unknown exposures) using USEP-based method

Period	Step	Description
Known Exposure Period	1) Calculate Current Exposure	Sum the actual settlement amounts of all the days in this period.
	2) Calculate daily proxy WEQ (with adjustment for hedges if applicable)	Divide daily settlement amount (with adjustments for hedges if applicable) by the USEP to obtain a daily proxy WEQ.
	3) Average proxy WEQ	Average the daily proxy WEQs over the known exposure period.
Unknown Exposure Period	4) Apply average proxy WEQ	Multiply the average proxy WEQ by the latest available daily USEP to estimate settlement amounts.
	5) Re-apply hedges	For retailers and the MSSL, specific hedges are reapplied to the estimated settlement amount in Step 4.
Current Day	6) Estimate Current Day	Average the exposures from the unknown exposure period to represent today.
Finally, sum the current exposure (Step 1), estimated unknown exposure (Step 4/5) and current day exposure (Step 6) to obtain the total ENE for current day.		

Step 6 estimates the current day by averaging the exposures derived for the unknown exposure period. EMC notes that this step reintroduces a small element of smoothing, since the current day is an average of the preceding days in the unknown exposure period, rather than from the latest available USEP. Nevertheless, the effect is limited because it applies to one day of a 20-day cycle, and the preceding days are estimated from the latest available USEP rather than from a 90-day average.

Tables 4, 5 and 6[21] provide detailed examples of this method applied across unhedged retailer, hedged retailer and the MSSL.

- Retailer without bilateral contract (Table 4) is the most straightforward case, with no bilateral contracts to adjust for, so the proxy WEQ is just settlement amount divided directly by the USEP.

[21] Figures in Tables 4, 5 and 6 have been scaled and do not represent actual settlement amounts of any MP. They are provided to demonstrate the calculation approach.

- Retailer with bilateral contract (Table 5) introduces a Bilateral Withdrawal Fraction (BWF) and tax adjustment into the denominator, because part of the retailer's Energy Service is offset through bilateral contracts so this portion must be stripped out to isolate WEQ. Where a retailer fully covers its withdrawal with injection energy quantities, the net difference between Energy Service and bilateral contract is largely the prevailing Goods and Services Tax (GST) imposed on Energy Service, which the bilateral contract does not net off. Retailers may alternatively provide bilateral quantities as Bilateral Absolute Quantity (BAQ), refer to Appendix D for an example with BAQ input.

- The MSSL with vesting contracts (Table 6) introduces an estimated Vesting Contract Settlement Credit (VCSC), calculated from the difference between a hedge price (HP) and the USEP multiplied by hedge quantity (HQ) for each period, aggregated across the 48 periods of the day. Where USEP exceeds the vesting price, the MSSL receives a positive VCSC and the gencos must pay vesting debits to the MSSL. Where USEP is below the vesting price, the VCSC is negative, and the MSSL pays vesting debits to the gencos. The MSSL's settlement amounts therefore move in either direction depending on the vesting position. The VCSC is subtracted from the settlement amount before division by USEP, removing the hedging effect to reveal the MSSL's unhedged market exposure, as with the retailer case.

Table 4 Calculation of ENE for a retailer without bilateral contract using the USEP-based method

<table>
<tr><th>Date</th><th>Period</th><th>Settlement Amount (A)</th><th>USEP (B)</th><th>Proxy WEQ</th><th>Average proxy WEQ</th><th>Current Exposure</th><th>Unknown Exposure</th><th>Current Day Exposure</th><th>ENE on 20/1/2022</th></tr>
<tr><td>-</td><td>-</td><td>(A)</td><td>(B)</td><td>(C) = (A)/(B)</td><td>(D) = Average of (C)</td><td>(E) = -1*sum(A)</td><td>(F) = (D) * (B)</td><td>(G) = Average of (F)</td><td>(E) + (F) + (G)</td></tr>
<tr><td>1/1/2022</td><td rowspan="12">Known Exposure Period</td><td>-34,793,064.12</td><td>381.90</td><td>91,104.62</td><td rowspan="12">108,036.71</td><td rowspan="12">558,214,099.23</td><td rowspan="12"></td><td rowspan="19"></td><td rowspan="20">983,425,598.37</td></tr>
<tr><td>2/1/2022</td><td>-34,535,376.66</td><td>393.04</td><td>87,866.63</td></tr>
<tr><td>3/1/2022</td><td>-50,184,799.50</td><td>446.95</td><td>112,284.01</td></tr>
<tr><td>4/1/2022</td><td>-28,722,043.65</td><td>250.40</td><td>114,703.41</td></tr>
<tr><td>5/1/2022</td><td>-32,931,101.19</td><td>297.79</td><td>110,585.60</td></tr>
<tr><td>6/1/2022</td><td>-57,033,267.30</td><td>497.06</td><td>114,741.60</td></tr>
<tr><td>7/1/2022</td><td>-55,346,624.88</td><td>451.24</td><td>122,653.95</td></tr>
<tr><td>8/1/2022</td><td>-45,813,479.13</td><td>475.34</td><td>96,379.81</td></tr>
<tr><td>9/1/2022</td><td>-54,016,886.64</td><td>596.78</td><td>90,513.46</td></tr>
<tr><td>10/1/2022</td><td>-85,556,108.76</td><td>712.19</td><td>120,130.91</td></tr>
<tr><td>11/1/2022</td><td>-40,690,578.33</td><td>352.32</td><td>115,492.42</td></tr>
<tr><td>12/1/2022</td><td>-38,590,769.07</td><td>321.64</td><td>119,982.18</td></tr>
<tr><td>13/1/2022</td><td rowspan="7">Unknown Exposure Period</td><td rowspan="8">Unknown</td><td>297.11</td><td rowspan="8"></td><td rowspan="8"></td><td rowspan="8"></td><td>32,098,786.80</td></tr>
<tr><td>14/1/2022</td><td>303.27</td><td>32,764,292.93</td></tr>
<tr><td>15/1/2022</td><td>287.33</td><td>31,042,187.78</td></tr>
<tr><td>16/1/2022</td><td>629.98</td><td>68,060,966.34</td></tr>
<tr><td>17/1/2022</td><td>624.75</td><td>67,495,934.34</td></tr>
<tr><td>18/1/2022</td><td>856.58</td><td>92,542,084.74</td></tr>
<tr><td>19/1/2022</td><td>444.81</td><td>48,055,808.81</td></tr>
<tr><td>20/1/2022</td><td>Current day</td><td>Unknown</td><td>Unknown</td><td>53,151,437.39</td></tr>
</table>

Table 5 Calculation of ENE for a retailer with bilateral contract (in terms of BWF) using the USEP-based method

Date	Period	Settlement Amount	USEP	BWF	Proxy WEQ	Average proxy WEQ	Current Exposure	Unknown Exposure	Current Day Exposure	ENE on 18/1/2020
-	-	(A)	(B)	(C)	(D)=(A)/ (B)/ (1+GST-C)	(E) = Average of (D)	(F) = -1*sum(A)	(G) = (E)*(B)* (1+GST-C)	(H) = Average of (G)	(F) + (G) + (H)
30/12/2019	Known Exposure Period	-10,427.75	83.15	1	1,791.56	1,781.44	240,322.43			334,906.77
31/12/2019		-8,343.09	74.34	1	1,603.27					
1/1/2020		-135,334.21	82.93	0	1,525.15					
2/1/2020		-17,715.15	129.69	1	1,951.37					
3/1/2020		-20,056.68	137.51	1	2,083.66					
4/1/2020		-11,135.54	86.81	1	1,832.50					
5/1/2020		-8,665.51	74.38	1	1,664.33					
6/1/2020		-9,182.75	76.72	1	1,709.88					
7/1/2020		-9,011.69	73.79	1	1,744.66					
8/1/2020		-10,450.05	78.24	1	1,908.06					
9/1/2020	Unknown Exposure Period	Unknown	74.52	1				9,292.72		
10/1/2020			75.34	1				9,394.98		
11/1/2020			75.83	1				9,456.08		
12/1/2020			75.25	1				9,383.75		
13/1/2020			85.16	1				10,619.54		
14/1/2020			74.55	1				9,296.46		
15/1/2020			72.55	1				9,047.06		
16/1/2020			75.37	1				9,398.72		
17/1/2020			74.07	1				9,236.61		
18/1/2020	Current day		Unknown	1				Unknown	9,458.44	

Table 6 Calculation of ENE for the MSSL with vesting contract using the USEP-based method

Date	Period	Settlement Amount	USEP	Estimated VCSC	Proxy WEQ	Average proxy WEQ	Current Exposure	Unknown Exposure	Current Day Exposure	ENE on 30/7/2021
		(A)	(B)	(C) = (HP-USEP)*HQ @ Periodic level	(D) = [-1*(A) – (C)] /(B)	(E) = Average of (D)	(F) = -1*sum(A)	(G) = (E)*(B)-(C)	(H) = Average of (G)	(F) + (G) + (H)
11/7/2021	Known Exposure Period	-589,108.82	98.95	181,885.39	4,115.45	4,314.30	5,677,157.73			13,718,842.26
12/7/2021		-598,703.25	100.34	177,730.89	4,195.46					
13/7/2021		-567,086.74	96.44	189,368.83	3,916.61					
14/7/2021		-567,254.95	96.19	190,101.83	3,920.92					
15/7/2021		-598,592.17	104.59	165,071.10	4,144.96					
16/7/2021		-641,102.52	113.03	139,910.55	4,434.15					
17/7/2021		-693,351.46	127.16	97,774.82	4,683.68					
18/7/2021		-680,090.23	115.1	133,743.40	4,746.71					
19/7/2021		-741,867.60	156.85	9,255.68	4,670.78					
20/7/2021	Unknown Exposure Period	Unknown	109.01	151,874.61				318,427.42		
21/7/2021			115.94	131,228.22				368,971.92		
22/7/2021			170.78	32,298.61				704,497.83		
23/7/2021			160.08	396.94				690,236.48		
24/7/2021			114.87	134,418.01				361,165.83		
25/7/2021			192.02	95,617.44				732,814.77		
26/7/2021			533.11	1,112,650.10				1,187,347.28		
27/7/2021			640.18	1,431,893.58				1,330,036.08		
28/7/2021			286.38	376,972.86				858,556.86		
29/7/2021			211.35	153,259.85				758,567.81		
30/7/2021	Current day		Unknown	Unknown				Unknown	731,062.23	

3.4 *Impact Assessment of ENE methods*

To assess accuracy, EMC compared the deviations of the current ADE-based ENE and the USEP-based ENE methods from the Actual Net Exposure (ANE) using average % absolute error in this study:

$$Average\ \%\ absolute\ error = \frac{1}{N}\sum_{i=1}^{N}\frac{|ANE_i - ENE_i|}{ANE_i} \times 100\%, for\ ANE_i > 0$$

Where:

- ANE_i= Actual Net Exposure on day i
- ENE_i= Estimated Net Exposure on day i (either Current ENE or USEP-based ENE)
- N = number of days in the year (e.g., 365, or 366 for a leap year, or fewer if data is incomplete for that year)
- i = index running over each day in the year[22]

Table 7 summarises the average percentage absolute error for eight retailers and three generators. A lower percentage indicates an ENE closer to the ANE. The "improvement" row shows the reduction in error achieved by the USEP-based method. Following are the key findings:

- **Accuracy**: Across all eight retailers and every single year recorded, the USEP-based ENE consistently yields a much lower average percentage of absolute error.

- **Consistency**: The current ENE errors are volatile, with percentage error frequently spiking sharply and fluctuating unpredictably from year to year. For example, Retailers 2 and 7 saw their error jump to 32% in 2024 and 60% in 2022 respectively. In comparison, the USEP-based ENE errors stay low and stable throughout. For most retailers, the error rate remains consistently low, generally hovering between 1% and 5%. The exception is Retailer 7. At very low withdrawal volumes in 2024 and 2025, small daily variations in Retailer 7's WEQ still produce material estimation error under the USEP-based method, albeit the consistent improvement from current method.

- **Sensitivity to hedge contracts**: For retailers with bilateral or vesting contracts, changes in bilateral quantities, hedge price and quantities can affect the accuracy of ENE calculation. If a retailer changes their bilateral quantity frequently, the current ENE method will exhibit higher error rate. In contrast, since the USEP-based ENE method takes into account the changes in bilateral or vesting contracts, it remains accurate despite those changes.

- **Adaptability**: Data is not available for some retailers in certain years, marked by '-', likely reflecting when a retailer started operating or winding down their activities. Despite different operating modes (e.g. starting up, winding down, very low WEQ), the USEP-based method proves to be more robust for these retailers.

- **Limitation:** The generators are net creditors, with negative ANE, for most of the time, so the data for average % absolute error is marked by '-' for those years. Both methods record errors of several hundred per cent, and the year-to-year swing in either

[22] Days on which an MP was a net creditor ($ANE_i \leq 0$) are excluded.

direction, reflecting the instability of the USEP-based method. This is because the USEP-based method corrects for USEP volatility but not for WEQ uncertainty. The USEP-based method assumes constant withdrawal or negative injection quantity across the 20-day settlement cycle. However, this assumption does not hold for generators and wholesale market traders, whose positions can reverse rapidly on operational need or forced outage.

Table 7 Comparison of percentage absolute error between current ENE and USEP-based ENE against ANE on an annual basis from 2020 through May 2026

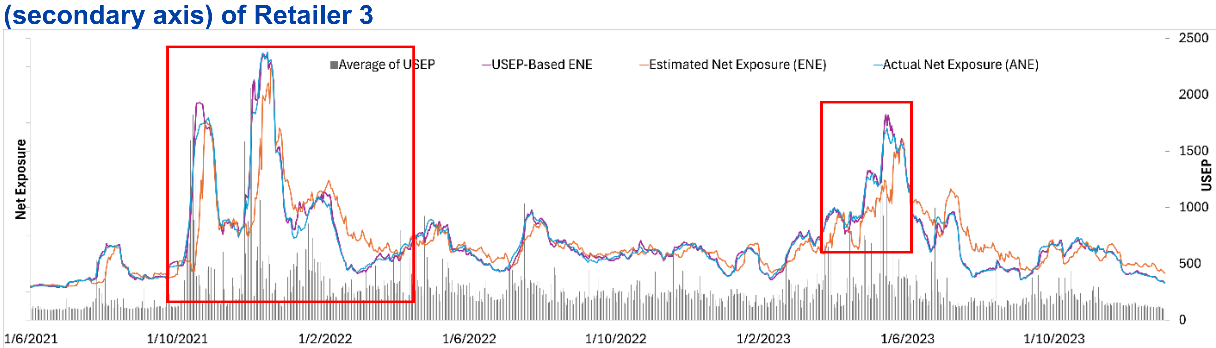
	Average % absolute error							
MP	Method	2020	2021	2022	2023	2024	2025	2026 (May)
Retailer 1	Current ENE	9%	9%	10%	22%	13%	8%	7%
	USEP-based ENE	2%	3%	4%	4%	2%	2%	3%
	Improvement	7%	6%	6%	18%	11%	6%	4%
Retailer 2	Current ENE	24%	16%	10%	15%	32%	12%	18%
	USEP-based ENE	1%	2%	2%	3%	2%	2%	2%
	Improvement	23%	14%	8%	12%	30%	11%	16%
Retailer 3	Current ENE	8%	9%	14%	19%	15%	8%	7%
	USEP-based ENE	2%	3%	4%	3%	3%	3%	2%
	Improvement	7%	7%	10%	16%	11%	5%	5%
Retailer 4	Current ENE	8%	10%	10%	17%	16%	8%	7%
	USEP-based ENE	2%	3%	3%	3%	3%	2%	3%
	Improvement	6%	7%	7%	14%	14%	6%	5%
Retailer 5	Current ENE	3%	7%	7%	14%	7%	4%	4%
	USEP-based ENE	1%	2%	2%	2%	2%	1%	1%
	Improvement	2%	5%	5%	12%	6%	3%	3%
Retailer 6	Current ENE	10%	11%	18%	31%	16%	10%	-
	USEP-based ENE	2%	2%	3%	4%	2%	2%	-
	Improvement	8%	8%	15%	28%	13%	8%	-
Retailer 7	Current ENE	8%	12%	60%	32%	44%	44%	14%
	USEP-based ENE	2%	3%	5%	4%	25%	37%	5%
	Improvement	6%	9%	55%	28%	19%	7%	9%
Retailer 8	Current ENE	-	-	11%	19%	13%	9%	9%
	USEP-based ENE	-	-	4%	3%	3%	2%	3%
	Improvement	-	-	7%	16%	11%	7%	6%
Generator 9[23]	Current ENE	46%	82%	1,992%	56%	110%	56%	49%
	USEP-based ENE	45%	88%	1,396%	58%	115%	72%	57%
	Improvement	1%	-6%	597%	-2%	-6%	-17%	-9%

[23] Generator 9 is an embedded generator (EG). The extreme deviations observed in 2022 were caused by highly volatile net positions, as the EG switches between being a net creditor and debtor frequently throughout that year.

Generator 10[24]	Current ENE	-	10%	0%	532%	8%	11%	189%
	USEP-based ENE	-	103%	3%	451%	59%	9%	33%
	Improvement	-	-93%	-3%	81%	-51%	3%	156%
Generator 11[25]	Current ENE	-	-	4%	79%	-	-	-
	USEP-based ENE	-	-	2%	29%	-	-	-
	Improvement	-	-	2%	50%	-	-	-

To visualise how the current ENE and the USEP-based ENE move against the USEP, Retailer 3 is used as an example for the visual illustration of what Table 7 is quantifying for (see Figure 3). The blue line represents the Actual Net Exposure (ANE), orange line represents the current ENE, purple line represents the USEP-based ENE and grey bars represent the daily USEP. As observed in Figure 3, the purple line (USEP-based ENE) tracks the blue line (ANE) far more closely than the orange line does, throughout the whole period. The orange line diverges most sharply from blue exactly at the USEP spikes. For example, around early 2022, and again in mid-2023 where the USEP (grey bars) surges. This mirrors the result in Table 7 where Retailer 3's current ENE errors are particularly high in 2022 and 2023 because current ENE overshoots or undershoots when USEP move sharply. The current ENE is not adjusting its ENE based on the latest available USEP the way the USEP-based method does. Between the USEP spikes, both orange and purple lines hug the blue line reasonably well. This is consistent with the results in Table 7 showing that even current ENE performs better in years with calmer USEP.

Figure 3 Movements of current ENE, USEP-based ENE and ANE (primary axis) and USEP (secondary axis) of Retailer 3



3.5 Impact on Retailers (including the MSSL)

Improved accuracy matters only if it translates into a more consequential measure. The risk exposure mechanism is an early warning system. Therefore, what matters is whether the method can correctly and in a timely fashion trigger margin calls when a retailer's actual risk exposure breaches the threshold.

In this study, risk exposure is calculated by dividing ENE by retailer's actual credit support posted with EMC. When this ratio crosses the margin call threshold, it signals the retailer's

[24] Generator 10 is an Embedded Generator. The large deviation observed in 2023 was mainly caused by a single event, where the EG switched unexpectedly from being a net creditor to a net debtor, with relatively significant positive exposure over a short period of time.
[25] Generator 11 displays empty values ('-') across multiple years because it typically operates as a net creditor. In this study, the average percentage absolute error is not calculated for net creditors (negative net exposure). Table 7 omits the remaining generators for the same reason; their frequent net creditor status results in empty values from 2020 to 2025.

risk is no longer adequately covered by its credit support, and a margin call should be issued to request the retailer to top-up its credit support or make prepayments to lower its ENE.

Table 8 shows that across almost every retailer, the current ENE method misses more margin calls than the USEP-based ENE. When it does catch them, it also triggers them substantially later. The USEP-based ENE reduces missed margin calls to zero or near-zero for most retailers. When the actual risk exposure exceeds the threshold, the lag in margin call trigger using the USEP-based method is typically 1-2 days, compared to 6-9 days with the current ENE. Or worse, the latter fails to trigger a margin call at all ("missed margin call" observed for Retailers 2, 3 and 4). Missed margin calls are more serious because the retailer's exposure risk went uncovered for an extended period.

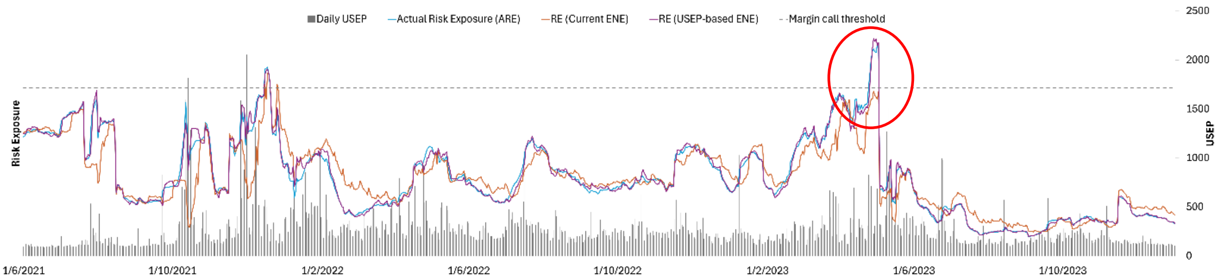
Table 8 Comparison of number of missed margin calls and average lag time in triggering margin call between current and USEP-based ENE from 2020 to 2026 (up to May 2026).[26]

	Current ADE-based method		USEP-based method	
Retailer	**Missed Margin Call**	**Average lag in margin call trigger**	**Missed Margin Call**	**Average lag in margin call trigger**
Retailer 1	5	6.5 days	1	1 day
Retailer 2	4	Missed margin call	0	1 day
Retailer 3	1	Missed margin call	0	1 day
Retailer 4	2	Missed margin call	0	1 day
Retailer 5	6	9 days	1	2 days
Retailer 6	0	9 days	0	1 day
Retailer 7	0	8 days	0	1 day
Retailer 8	14	6 days	1	1 day

Figure 4 reflects the same observations for Retailer 3 in RE terms. The current ENE line (orange) can be seen lagging behind the Actual Risk Exposure line (Blue) and staying below the dashed margin call threshold even while actual exposure has already crossed it (on 25 April 2023). As such, no margin call was issued, and the market was completely exposed to Retailer 3's default risk. In contrast, the RE for USEP-based ENE line (purple) tracks much closer to the blue ARE line, crossing the margin call threshold at nearly the same time as ARE does. As the USEP-based ENE is responsive enough to the underlying USEP price movement, it can detect the breach of threshold almost as soon as it occurs. This is why Retailer 3's USEP-based method triggers the margin call within 1 day.

[26] Generators are excluded from Table 8 because Table 7 showed that it is not meaningful to extend the USEP-based ENE method to generators.

Figure 4 Movements of RE (current ENE), RE (USEP-based ENE) and ARE (primary axis) and margin call threshold at 55% (primary axis), USEP (secondary axis) of Retailer 3



4. *Proposed Solution*

EMC therefore proposes to apply the USEP-based method to retailers and the MSSL. As shown in Table 7, the USEP-based method reduced estimation error for every tested retailer, including the MSSL, in every year recorded. For most retailers, the error rate remains consistently low and stable even during volatile USEP conditions. The method also proves to be more robust for retailers with different operating modes (e.g. new retailers starting up, winding down and running at low WEQ), as well as for those that frequently change their bilateral or vesting position, which the USEP-based method accounts for.

This improvement in accuracy is important because the risk exposure mechanism is an early warning system and what ultimately matters is whether a margin call is triggered correctly and promptly when a retailer's actual risk exposure breaches the threshold. Table 8 shows that the USEP-based ENE reduces missed margin calls to zero or near-zero for most retailers, and that where the threshold is breached, the trigger typically lags by 1–2 days compared with 6–9 days under the current method. A retailer's exposure would therefore be far better covered under the USEP-based method, particularly during periods of volatile USEP.

The same does not hold for other classes of MP, such as generators and wholesale market traders. As shown in Table 7, the USEP-based method did not consistently perform better than the current ADE-based ENE method and in several years performed worse. This is because the USEP-based method corrects for USEP volatility but not for WEQ uncertainty: it assumes a constant withdrawal or negative injection quantity across the 20-day settlement cycle, an assumption that holds for retailers but not for MPs whose settlement positions can reverse rapidly on operational need or forced outage. EMC therefore proposes to retain the current ADE-based method for all other MPs. Table 9 summarises the proposed ENE methods for different types of MP.

Table 9: Proposed ENE methods

	Retailers and the MSSL	Other MPs
Estimated Net Exposure	ENE = Current Exposure + Unknown Exposure – Prepayment + Unpaid Amount	
Current Exposure (X)	-1 x aggregate net settlement amounts set on all MP's PSS or FSS if available that are not yet due for payment on a given day.	
Unknown Exposure (20-X)	**USEP-based method** Unknown exposure = Proxy WEQ x daily USEP (account for bilateral and vesting quantities)	**ADE-based method** (current ENE) Unknown exposure =(20-X) x Estimated ADE

New MPs	MP with < 20 days of trade: GST x Rolling 20-day average WEP x Maximum (ForecastedDailyWithdrawal or ActualDailyWithdrawal)	MP with < 90 days of trade: GST x Rolling 90-day average WEP x Maximum (ForecastedDailyWithdrawal or ActualDailyWithdrawal)

Other Considerations

The USEP-based method draws on daily USEP, settlement amounts and bilateral and vesting contract quantities, all of which EMC already maintains for settlement purposes. No new data, nor additional submission and reporting obligation is required from MPs. The incremental burden is a one-time change to EMC's risk exposure mechanism. Nevertheless, EMC anticipates that operational complexity may increase to maintain and run two ENE methods in parallel for different types of MPs. If this concept is supported, EMC will perform a detailed assessment of operational system change and resource required to assess the feasibility of implementing the proposal.

Other considerations include the emergence of new classes of MPs or licensees in the future that may have very different business models and risk profiles (e.g. large energy storage operators) that may entail frequent switching of net settlement positions. In such cases, EMC could consider applying the ENE methods on a case-by-case basis, with defined criteria.

5 *Summary and Recommendation*

The current ENE method relies on a rolling 90-day ADE to estimate settlement data for the days on which metered data are unavailable for all MPs. Analysis of historical NEMS data from 2020 to May 2026 showed that this approach understated some MPs' ENE during volatile market conditions, delaying margin calls at the moment they matter most.

EMC proposes a USEP-based ENE method for retail electricity licensees and the MSSL. This method estimates unknown exposure using the latest available daily USEP during the unknown period. Our analysis concludes that this significantly improves the timeliness and accuracy of net exposure monitoring and margin call triggers for retail electricity licensees and the MSSL.

The USEP-based method is not suitable for the rest of the MPs (including generators and wholesale traders), whose withdrawal and negative injection quantities are not predictable.

Therefore, EMC recommends that the RCP **support** the proposal to

a) adopt the USEP-based ENE method for retail electricity licensees and the MSSL;
b) retain the current ADE-based ENE method for the rest of the MPs; and
c) task EMC to review the adequacy of the CSV mechanism, taking into account the improved accuracy and responsiveness of the Risk Exposure mechanism.

6. *Consultation*

EMC seeks industry feedback on the above recommendations. We appreciate receiving comments by **4 September 2026**.

Appendix A: List of Participants in NEMS (as of 31 December 2025) and their classification in this paper

No.	Category in this paper	Participant / Service Provider	EMA Licence
1	Retailer	Bioenergy	Retail Electricity Licensee
2	Retailer	Cleantech Solar Singapore Assets	Retail Electricity Licensee
3	Retailer	Diamond Electric	Retail Electricity Licensee
4	Retailer	Engie South East Asia	Retail Electricity Licensee
5	Retailer	Flo Energy Singapore	Retail Electricity Licensee
6	Retailer	Just Electric	Retail Electricity Licensee
7	Retailer	Keppel Electric	Retail Electricity Licensee
8	Retailer	MyElectricity*	Retail Electricity Licensee
9	Retailer	Sunseap Energy	Retail Electricity Licensee
10	Retailer	Union Power	Retail Electricity Licensee
11	Retailer	PacificLight Energy	Retail Electricity Licensee
12	Retailer	Sembcorp Power	Retail Electricity Licensee
13	Retailer	Senoko Energy Supply	Retail Electricity Licensee
14	Retailer	Seraya Energy	Retail Electricity Licensee
15	Retailer	Tuas Power Supply	Retail Electricity Licensee
16	Retailer	SP Services	Market Support Services Licensee
17	Generators	Aster Chemicals and Energy*	Generation Licensee
18	Generators	ExxonMobil Asia Pacific	Generation Licensee
19	Generators	Keppel Merlimau Cogen	Generation Licensee
20	Generators	Keppel Sakra Cogen*	Generation Licensee
21	Generators	Keppel Seghers Tuas Waste-to-Energy Plant (Tuas DBOO Trust)	Generation Licensee
22	Generators	Linde Gas Singapore	Generation Licensee
23	Generators	Meranti Power*	Generation Licensee
24	Generators	National Environment Agency	Generation Licensee
25	Generators	PacificLight Power	Generation Licensee
26	Generators	Sembcorp Cogen	Generation Licensee
27	Generators	Sembcorp Floating Solar Singapore	Generation Licensee
28	Generators	Sembcorp Solar Singapore	Generation Licensee
29	Generators	Senoko Energy	Generation Licensee
30	Generators	Senoko Waste-to-Energy	Generation Licensee
31	Generators	Singapore Refining Company	Generation Licensee
32	Generators	Taser Power	Generation Licensee
33	Generators	TP Utilities	Generation Licensee
34	Generators	Tuas Power Generation	Generation Licensee
35	Generators	TuasOne	Generation Licensee
36	Generators	YTL PowerSeraya	Generation Licensee
37	Wholesale Market Traders	Air Liquide Singapore	Electricity Wholesaler Licencee
38	Wholesale Market Traders	BEWGI-UE NEWater	Electricity Wholesaler Licencee
39	Wholesale Market Traders	Blue Whale Energy*	Electricity Wholesaler Licencee
40	Wholesale Market Traders	Crystal Clear Environmental	Electricity Wholesaler Licencee
41	Wholesale Market Traders	Green Power Asia	Electricity Wholesaler Licencee
42	Wholesale Market Traders	HSBC Institutional Trust Services (Singapore)	Electricity Wholesaler Licencee

43	Wholesale Market Traders	JE Green Solutions	Electricity Wholesaler Licencee
44	Wholesale Market Traders	Keppel DHCS*	Electricity Wholesaler Licencee
45	Wholesale Market Traders	Keppel EaaS*	Electricity Wholesaler Licencee
46	Wholesale Market Traders	LYS Genco Beta	Electricity Wholesaler Licencee
47	Wholesale Market Traders	PSA Corporation	Electricity Wholesaler Licencee
48	Wholesale Market Traders	Public Utilities Board	Electricity Wholesaler Licencee
49	Wholesale Market Traders	Seatrium ACE*	Electricity Wholesaler Licencee
50	Wholesale Market Traders	Singapore District Cooling	Electricity Wholesaler Licencee
51	Wholesale Market Traders	Singapore LNG Corporation	Electricity Wholesaler Licencee
52	Wholesale Market Traders	SolarLand Alpha Assets	Electricity Wholesaler Licencee
53	Wholesale Market Traders	Sungreen Energy*	Electricity Wholesaler Licencee
54	Wholesale Market Traders	Sunseap Commercial Assets	Electricity Wholesaler Licencee
55	Wholesale Market Traders	Sunseap Leasing	Electricity Wholesaler Licencee
56	Wholesale Market Traders	SP Energy Services*	Electricity Wholesaler Licencee
57	Wholesale Market Traders	Terrenus Energy SL1X	Electricity Wholesaler Licencee
58	Wholesale Market Traders	Terrenus Energy SL2	Electricity Wholesaler Licencee
59	Wholesale Market Traders	Terrenus Energy SR3	Electricity Wholesaler Licencee
60	Wholesale Market Traders	Yang Solar*	Electricity Wholesaler Licencee
61	Wholesale Market Traders	9 Solar Fintech*	Electricity Wholesaler Licencee

* The following market participant changes took place in 2025: - Aster Chemicals and Energy, Seatrium ACE, Keppel Sakra Cogen, Sungreen Energy, Blue Whale Energy, Yang Solar, MyElectricity, Keppel EaaS, 9 Solar Fintech, Keppel DHCS and SP Energy Services joined the market in January, February, February, April, July, July, August, August, September, September and December respectively. - Shell Singapore withdrew from the market in April.

Appendix B – Illustration of Estimated Net Exposure (ENE) and Actual Net Exposure (ANE) calculations

<table>
<tr><th>Trading Day</th><th>Daily USEP</th><th>Settlement Amount</th><th>Period</th><th>ENE on 30/7/2021</th><th>ANE on 30/7/2021</th></tr>
<tr><td>11/7/2021</td><td>98.95</td><td>- 2,980.55</td><td rowspan="9">Known Exposure</td><td rowspan="9">Current Exposure
= -1 x sum of net settlement amounts known on 30/7/2021 but not due (e.g. from 11 to 19 July 2021)
= 37,853.62</td><td rowspan="20">Sum of Actual Net Exposure (ANE) from 11 to 30 July 2021
= 153,844.60</td></tr>
<tr><td>12/7/2021</td><td>100.34</td><td>- 3,793.39</td></tr>
<tr><td>13/7/2021</td><td>96.44</td><td>- 3,365.00</td></tr>
<tr><td>14/7/2021</td><td>96.19</td><td>- 3,521.17</td></tr>
<tr><td>15/7/2021</td><td>104.59</td><td>- 3,972.83</td></tr>
<tr><td>16/7/2021</td><td>113.03</td><td>- 4,642.23</td></tr>
<tr><td>17/7/2021</td><td>127.16</td><td>- 4,847.57</td></tr>
<tr><td>18/7/2021</td><td>115.10</td><td>- 3,944.88</td></tr>
<tr><td>19/7/2021</td><td>156.85</td><td>- 6,786.00</td></tr>
<tr><td>20/7/2021</td><td>109.01</td><td>- 3,599.08</td><td rowspan="11">Unknown Exposure</td><td rowspan="11">Unknown Exposure=(20-X) x Estimated ADE
= (20-9) x 3,417.84
= 37,596.24</td></tr>
<tr><td>21/7/2021</td><td>115.94</td><td>- 4,837.77</td></tr>
<tr><td>22/7/2021</td><td>170.78</td><td>- 7,085.14</td></tr>
<tr><td>23/7/2021</td><td>160.08</td><td>- 6,710.89</td></tr>
<tr><td>24/7/2021</td><td>114.87</td><td>- 3,721.03</td></tr>
<tr><td>25/7/2021</td><td>192.02</td><td>- 5,920.42</td></tr>
<tr><td>26/7/2021</td><td>533.11</td><td>- 25,067.65</td></tr>
<tr><td>27/7/2021</td><td>640.18</td><td>- 28,880.61</td></tr>
<tr><td>28/7/2021</td><td>286.38</td><td>- 12,694.85</td></tr>
<tr><td>29/7/2021</td><td>211.35</td><td>- 7,960.27</td></tr>
<tr><td>30/7/2021</td><td>240.27</td><td>- 9,513.27</td></tr>
<tr><td colspan="4">Calculated Exposure (Prepayment and Unpaid Amount are not considered in this study)</td><td>$75,449.90</td><td>$153,844.60</td></tr>
<tr><td colspan="4">Assume the MP provides $158,400 of actual credit support</td><td>RE = 75,449.90/158,400 = 48% (no margin call)</td><td>ARE = 153,844.60/158,400 = 97% (should have issued margin call)</td></tr>
</table>

Appendix C.1 – Coefficient of variation (CV) of retailers for WEQ and USEP

The Coefficient of Variation (CV) is a statistical measure used to quantify the relative dispersion or volatility of data points around their mean. It is calculated using the formula:

$$CV = \frac{Standard\ Deviation}{Mean}$$

In this analysis, the CV is used to provide a comparable comparison of volatility between two entirely different metrics: the Uniform Singapore Energy Price (USEP) measured in dollars, and the Withdrawal Energy Quantity (WEQ) measured in MWh. By standardizing the measurement of volatility, the CV data supports the assumption of the proposed USEP-based ENE method.

As the table below demonstrates, the CV for retailers' WEQ is materially lower than the CV for the USEP for most retailers in most years. This indicates that a retailer's WEQ remains stable, even when spot prices experience extreme fluctuations. Because the WEQ is stable, it is reasonable to derive a "Proxy WEQ" from the known period and apply it to the unknown period to estimate an MP's exposure.

Retailers	2020		2021		2022		2023		2024		2025		2026	
	WEQ	USEP	WEQ	USEP	WEQ	USEP	WEQ	USEP	WEQ	USEP	WEQ	USEP	WEQ	USEP
Retailer 1	0.06	0.37	0.05	1.35	0.09	0.46	0.07	0.74	0.11	0.65	0.06	0.36	0.05	0.23
Retailer 2	0.08	0.37	0.08	1.35	0.06	0.46	0.09	0.74	0.10	0.65	0.05	0.36	0.04	0.23
Retailer 3	0.08	0.37	0.04	1.35	0.06	0.46	0.25	0.74	0.05	0.65	0.06	0.36	0.02	0.23
Retailer 4	0.08	0.37	0.05	1.35	0.09	0.46	0.13	0.74	0.08	0.65	0.06	0.36	0.05	0.23
Retailer 5	0.23	0.37	0.29	1.35	-	0.46	-	0.74	-	0.65	-	0.36	-	0.23
Retailer 6	-	0.37	1.16	1.35	0.21	0.46	0.13	0.74	0.17	0.65	0.09	0.36	0.10	0.23
Retailer 7	0.21	0.37	0.10	1.35	0.40	0.46	0.49	0.74	0.11	0.65	0.11	0.36	-	0.23

Note: CVs of WEQ of generators and wholesale traders are not calculated because their withdrawal or negative injection energy quantities are highly infrequent.

Appendix C.2 – Average annual correlation between retailers' settlement dues and the USEP

In the NEMS, a retailer's settlement due primarily consists of the Load Energy Settlement Debit (LESD), representing their financial liability for purchasing electricity from the spot market. In this study, LESD are recorded as negative values in the settlement system, a strong negative correlation (approaching -1.0) indicates that as the USEP increases, the retailer's settlement due proportionally increases (becomes more negative).

Selected retailers	Correlation between retailer's settlement amount and USEP						
	2020	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Retailer 1	-0.98	-0.99	-0.93	-0.98	-0.94	-0.83	-0.96
Retailer 2	-0.96	-0.98	-0.94	-0.98	-0.98	-0.94	-0.96
Retailer 3	-0.68	-1.00	-0.92	-0.69	-0.79	-0.51	-0.75
Retailer 4	-0.47	-0.99	-0.96	-0.98	-0.98	-0.90	-0.90
Retailer 5	-0.92	-0.99	-	-	-	-	-
Retailer 6	-	-0.95	-0.81	-0.98	-0.97	-0.97	-0.97
Retailer 7	-0.92	-1.00	-0.86	-0.93	-0.99	-0.97	-

Note: Correlations between generator's and wholesale trader's settlement amount and USEP are not analysed because their negative dues (withdrawal or negative injection energy quantities) are highly infrequent.

Appendix D – Illustration of USEP-based ENE calculation with Bilateral Absolute Quantity (BAQ) input

Note: If a MP has no BAQ, the MP can input '0' in column C

Date	Period	Settlement Amount	USEP	BAQ	Proxy WEQ	Average proxy WEQ	Current Exposure	Unknown Exposure	Current Day Exposure	ENE on 18/1/2020
-	-	(A)	(B)	(C)	(D) = -1*(A)/(B) + (C)	(E) = Average of (D)	(F) = -1*sum(A)	(G) = (B)* [(E)-(C)]	(H) = Average of (G)	(F) + (G) + (H)
30/12/2019	Known Exposure Period	-203,341.19	83.15	1,500	3,945.47	3,968.68	2,250,611.51			4,123,080.83
31/12/2019		-162,690.29	74.34	1,500	3,688.46					
1/1/2020		-203,341.19	82.93	1,500	3,951.96					
2/1/2020		-345,445.52	129.69	1,500	4,163.62					
3/1/2020		-391,105.35	137.51	1,500	4,344.20					
4/1/2020		-217,143.00	86.81	1,500	4,001.36					
5/1/2020		-168,977.36	74.38	1,500	3,771.81					
6/1/2020		-179,063.61	76.72	1,500	3,833.99					
7/1/2020		-175,728.00	73.79	1,500	3,881.46					
8/1/2020		-203,776.02	78.24	1,500	4,104.50					
9/1/2020	Unknown Exposure Period	Unknown	74.52	1,500				183,966.32		
10/1/2020			75.34	1,500				185,990.64		
11/1/2020			75.83	1,500				187,200.30		
12/1/2020			75.25	1,500				185,768.46		
13/1/2020			85.16	1,500				210,233.12		
14/1/2020			74.55	1,500				184,040.38		
15/1/2020			72.55	1,500				179,103.01		
16/1/2020			75.37	1,500				186,064.70		
17/1/2020			74.07	1,500				182,855.42		
18/1/2020	Current day		Unknown	1,500				Unknown	187,246.93	