

RCP PAPER NO. : **EMC/RCP/73/2014/CP51**

SUBJECT : **INCREASING THE TRANSPARENCY OF ENERGY UPLIFT CHARGES**

FOR : **DECISION**

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DATE OF MEETING : **6 MAY 2014**

Executive Summary

The monthly and hourly energy uplift charges (MEUC and HEUC) are charges imposed on loads based on their actual consumption in each settlement interval.

It is proposed for EMC to publish quantitative and qualitative analyses of the MEUC and HEUC on a monthly basis. The intent of the proposal is to increase transparency on the energy uplift charges imposed on market participants (MPs) in the Singapore Wholesale Electricity Market (SWEM).

This paper examines the information currently published for the MEUC and for the verification of its individual components, and concludes that the MEUC is adequately transparent. In contrast, the information currently published for the HEUC is inadequate for transparency. As a result, to evaluate how the transparency of the HEUC can be increased, this paper identifies the key contributing factors of the HEUC through theoretical and empirical analyses. We then recommend a framework for identifying and analyzing the trading days with abnormal HEUC values. The analysis of abnormal HEUC values is proposed to be provided in the existing monthly trading reports.

We recommend that the RCP **support** the proposal to increase the transparency of the HEUC as described in **section 4.3** of this paper and its implementation cost as set out in **section 6** of this paper.

At the 73rd RCP meeting, the RCP by majority vote **supported** the proposal and its implementation cost, and **tasked** EMC to seek EMA's approval of the cost.

1. INTRODUCTION

This paper assesses the proposal for EMC to publish quantitative and qualitative analyses of the monthly and hourly energy uplift charges (MEUC and HEUC) on a monthly basis. The intent of the proposal is to increase transparency on the energy uplift charges imposed on market participants (MPs) in the Singapore Wholesale Electricity Market (SWEM).

2. BACKGROUND

Purpose of Energy Uplift Charges

The monthly and hourly energy uplift charges (MEUC and HEUC) are charges imposed on loads based on their actual consumption in each settlement interval, as measured by their withdrawal MEUC quantities (WMQ) and withdrawal energy quantities (WEQ) respectively¹. In general, loads pay the energy uplift charges, in addition to the Uniform Singapore Energy Price (USEP), Allocated Regulation Price (AFP), EMC fees and Power System Operator (PSO) fees for their energy consumption.

The MEUC, is computed², before the beginning of a calendar month for all settlement intervals in that upcoming calendar month, to account for and distribute estimated costs incurred and refunds received (Monthly Energy Uplift Amount (MEUA)) across the estimated monthly WMQ (MWMQ). Table 1 shows the estimated costs and refunds in each component of the MEUA.

Table 1: Estimated Costs and Refunds in MEUA

Components of MEUA ³	Estimated Costs and Refunds	
	Costs	Refunds
Monthly Amount for Compensation and other Payments (MACP)	<ul style="list-style-type: none"> the <u>compensation claims payable by EMC/PSO</u> under section 3.11 of Chapter 3 of the Market Rules the <u>compensation/costs awarded against EMC/ PSO</u> under Market Rules or <u>payable by EMC/PSO</u> to resolve disputes under the Market Rules the procurement costs for <u>contracted ancillary services</u> and related audit and testing costs incurred by EMC/PSO 	<ul style="list-style-type: none"> the <u>insurance monies received by EMC</u> for the compensation claims awarded against EMC under the Market Rules the <u>compensation/costs awarded in favour of EMC/ PSO</u> under the Market Rules or <u>received by EMC/PSO</u> to resolve disputes under the Market Rules the <u>financial penalties</u> imposed by the Market Surveillance and Compliance Panel (MSCP) under the Market Rules received by EMC
Monthly Energy Uplift Shortfall (MEUS)	<ul style="list-style-type: none"> the <u>under-recovery</u> of the MEUA in the previous calendar month due to over-estimation of MWMQ 	<ul style="list-style-type: none"> the <u>over- recovery</u> of the MEUA in the previous calendar month due to under-estimation of MWMQ

¹ The difference between WMQs and WEQs arises from the net treatment of non-reserve charges for embedded generators (EGs). For the associated loads of EGs, while the HEUC is imposed on their gross consumption as measured by their WEQs, the MEUC is imposed on only their net consumption as measured by their WMQs.

² Please refer to Annex 1 for the formulae for MEUC in the Market Rules.

³ The MEUA encompasses the Monthly Transitional Payment Amount (MTRA) approved by the Energy Market Authority (EMA) and the Monthly Miscellaneous Costs (MISC) determined by the EMC Board. However, they have never been incurred since market start and will be excluded from discussion in this paper.

The HEUC is computed⁴, after each half-hourly settlement interval, to account for and distribute settlement deficits and surpluses (Hourly Energy Uplift Amount (HEUA)) of that settlement interval across the total WEQ (\sum WEQ⁵) in that settlement interval. Table 2 shows the settlement deficits and surpluses in each component of the HEUA.

Table 2: Settlement Deficits and Surpluses in HEUA

Components of HEUA ⁶	Settlement Interval Surpluses and Deficits
Net Energy Settlement Credit (\sum NESC)	<ul style="list-style-type: none"> the differences between the total settlement amounts received from loads and that paid to generators for energy for that settlement interval
Net Metering Error Adjustment (\sum NMEA)	<ul style="list-style-type: none"> the differences between the total settlement adjustment amounts paid to generators/loads and that received from generators/loads for energy due to metering errors of the corresponding settlement interval⁷ from previous trading days

3. ANALYSIS OF MONTHLY ENERGY UPLIFT CHARGES

3.1 Required Publication of MEUC

As required under section 4.1.9 of Chapter 7 of the Market Rules, EMC currently publishes values of the MEUC, as well as the MWMQ and the individual components of the MEUA, for each calendar month on the first business day of that calendar month. The information on MEUC is published via the monthly MEUC statements⁸ available on EMC's website.

Within the MEUA, the MEUS is merely an adjustment component to recover or refund the deficit or surplus in MEUA collected in the previous calendar month. These deficits and surpluses arise mainly from discrepancies in the estimated⁹ and actual MWMQs in the previous calendar month. Therefore, the extent of transparency of the MEUC lies largely in the MACP.

3.2 Current Transparency of MEUC

From the **quantitative** perspective, it is worth noting that EMC currently also publishes the values of the estimated costs and refunds in the MACP. Moreover, the MPs can verify most of the values with the other relevant information (required to be published by the Market Rules) available on EMC's website. Table 3 summarizes the relevant information and their corresponding sections in the Market Rules, which facilitates verification of the estimated costs and refunds in the MACP.

⁴ Please refer to Annex 1 for the formulae for HEUC in the Market Rules.

⁵ For analysis from a broad market perspective, most of the terms used in this paper have the sigma sign (\sum) to sum the respective values across all settlement accounts for that settlement interval.

⁶ The HEUA encompasses a) the Net Reserve/Regulation Settlement Credits (NRSC and NFSC) which accounts for the differences between the total settlement amounts received from reserve and regulation users and that paid to reserve and regulation providers and b) the Net Transmission Right Settlement Credit (NTSC) which accounts for the differences between the transmission right settlement amounts received from generators and that paid to other generators. However, they will be excluded from discussion in this paper because a) the NRSC and NFSC should be zero unless due to rounding errors and b) the NTSC is not applicable since financial transmission rights have not been implemented in the SWEM.

⁷ There are 48 half-hourly settlement intervals in each trading day (24 hours).

⁸ Please refer to Annex 2 for a sample (March 2014) of the monthly MEUC statements which can be accessed via <https://www.emcsg.com/marketdata/priceinformation>.

⁹ The estimated MWMQ is derived from the annual system demand forecast by the EMA, prorated according to the number of days in the month of the MWMQ estimated.

Table 3: Relevant Information for Verification of MACP

Estimated Costs and Refunds in MACP	Verification of Values	Source of information	Market Rules
<ul style="list-style-type: none"> the <u>compensation claims payable by EMC/PSO</u> under section 3.11 of Chapter 3 of the Market Rules 	✓	<ul style="list-style-type: none"> Summary of the subject-matter of the dispute and the amount of money to be paid in compensation notices¹⁰ 	Chapter 3 section 3.14.1
<ul style="list-style-type: none"> the <u>compensation/costs awarded against EMC/PSO</u> under Market Rules or <u>payable by the EMC/PSO</u> to resolve disputes under the Market Rules 	✓	<ul style="list-style-type: none"> Annual summary of payments¹¹ 	Chapter 3 section 3.14.3
<ul style="list-style-type: none"> the procurement costs for <u>contracted ancillary services</u> and related audit and testing costs incurred by EMC/PSO 	✓	<ul style="list-style-type: none"> Annual cost of the contracted ancillary services (inclusive of GST)¹² 	Chapter 5 section 8.7.1.1
<ul style="list-style-type: none"> the <u>insurance monies received by the EMC</u> for the compensation claims awarded against EMC under the Market Rules 	N.A. ¹³	N.A.	N.A.
<ul style="list-style-type: none"> the <u>compensation/costs awarded in favour of EMC/PSO</u> under the Market Rules or <u>received by EMC/PSO</u> to resolve disputes under the Market Rules 			
<ul style="list-style-type: none"> the <u>financial penalties imposed by the MSCP</u> under the Market Rules received by EMC 	✓	<ul style="list-style-type: none"> Financial penalty amounts in MSCP determination reports¹⁴ 	Chapter 3 section 7.2.19

From the **qualitative** aspect, we noticed that the components of the MACP are recovered on an incurred basis. For the contracted ancillary services costs, the monthly recovery amount is derived from the annual ancillary services contracts signed with providers. As for the compensations and penalties, they are based on the actual amounts to be paid or already collected by EMC. The monthly recovery or distribution hence varies according to the frequency and severity of such incidents.

As a result, EMC is of the view that quantitative and qualitative analyses of the MEUC are not necessary.

¹⁰ When the PSO or the EMC is obliged to pay compensation or damages, the EMC is required to publish the compensation notices. These compensation notices can be accessed via <https://www.emcsg.com/n1051.37.html>.

¹¹ The EMC is required to publish a summary of all payments by the PSO or the EMC. These summaries can be accessed via <https://www.emcsg.com/aboutthemarket/summaryofpayments>.

¹² The EMC is required to publish annually the total costs of contracted ancillary services. This information can be accessed by MPs after log-in via Home > Secure Area > Publications > Settlement and Ancillary Services > Contracted Ancillary Services at <https://www.emcsg.com>.

¹³ There have been no refunds under these two provisions since market start.

¹⁴ The MSCP determination reports can be accessed via <https://www.emcsg.com/aboutthemarket/paneldeterminations>.

4. ANALYSIS OF HOURLY ENERGY UPLIFT CHARGES

4.1 Publication and Current Transparency of HEUC

As for the HEUC, EMC currently publishes the final half-hourly values of the HEUC for all settlement intervals of each trading day on the tenth business day from that trading day. The information on the HEUC is published via the daily Wholesale Electricity Prices (WEP) statements¹⁵ available on EMC's website.

In contrast with the MEUC, the HEUC only has its final values published, with no breakdown on the individual components of the HEUA i.e. $\sum\text{NESC}$ and $\sum\text{NMEA}$.

This section of the paper shall provide theoretical and empirical analyses of the individual components of the HEUA, to enhance understanding on the variations in the HEUA, and in turn the HEUC. Such analyses allow us to identify and understand the influential components of the HEUA, so as to better evaluate how transparency of the HEUC can be increased.

4.2 Factors Contributing to Variation in HEUA

To understand the variations in the HEUA, we shall examine in detail the individual components of the HEUA and the contributing factors for them being non-zero i.e. negative or positive. When an individual component of the HEUA is negative, the total settlement (adjustment) amount receivable exceeds the amount payable. When the component is positive, the total settlement (adjustment) amount receivable falls short of the amount payable instead. Table 4 shows a summary of the contributing factors to the non-zero components of the HEUA.

Table 4: Summary of Contributing Factors to Non-Zero Components of HEUA

Components of HEUA	Contributing Factors
$\sum\text{NESC}$	<ul style="list-style-type: none"> • Intertie imbalances • Transmission losses • Metering errors • Transmission constraints
$\sum\text{NMEA}$	<ul style="list-style-type: none"> • Different rates applicable to loads and generators • Inability to identify counterparties to metering errors

4.2.1 Net Energy Settlement Credit ($\sum\text{NESC}$)

EMC determines the $\sum\text{NESC}$ for each settlement interval as follows:

$$\begin{aligned}\sum\text{NESC} &= \sum\text{Generation Energy Settlement Credit } (\sum\text{GESC}) \\ &- \sum\text{Load Energy Settlement Debit } (\sum\text{LESD}) \\ &+ \sum\text{Bilateral Energy Settlement Credit } (\sum\text{BESC})\end{aligned}$$

As the $\sum\text{BESC}$ is always zero¹⁶, the non-zero $\sum\text{NESC}$ is contributed by differences between the total settlement amount for energy received from loads ($\sum\text{LESD}$) and that paid to generators ($\sum\text{GESC}$), arising from intertie imbalances, transmission losses, metering errors, transmission constraints and rounding errors. Due to the variety of contributing factors, the magnitude of the non-zero $\sum\text{NESC}$ is usually large and contributes significantly to the HEUA.

¹⁵ The daily WEP statements can be accessed via <https://www.emcsg.com/marketdata/priceinformation>.

¹⁶ Under the Market Rules, when there is a bilateral energy quantity to be settled between a selling party and a buying party, EMC will debit the selling party and credit the buying party by the same dollar amount ($\text{USEP} \times \text{Bilateral Energy Quantity}$). Thus, the net impact to $\sum\text{BESC}$ is always zero.

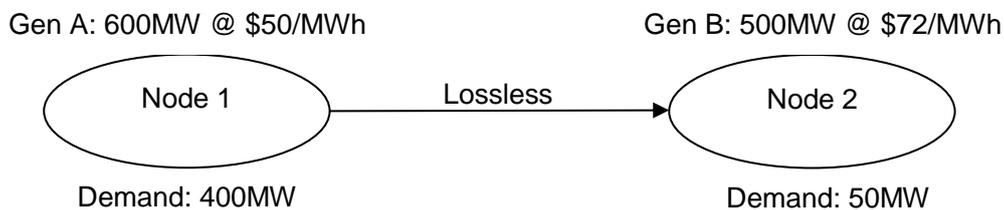
The following examples illustrate how the above-mentioned factors, specifically intertie imbalances, transmission losses, metering errors and transmission constraints, contribute to non-zero $\sum\text{NESC}$ s. In the simplified scenarios, the market consists of only 2 generators, Generators A and B, serving demand at 2 different nodes, Nodes 1 and 2. Generators are paid the nodal prices, which reflect the prices to consume one more unit of energy at the respective nodes due to locational marginal pricing. Loads pay the USEP, which is the volume weighted average of the nodal prices.

Intertie Imbalances

Intertie imbalances contribute to non-zero $\sum\text{NESC}$ s because intertie flows are not settled in the SWEM. When there is a net import of energy via the intertie, less generation is required. When there is a net export of energy via the intertie, more generation is required. Depending on the direction of the net intertie flow, the non-zero $\sum\text{NESC}$ s arising from intertie imbalances can be positive (for net intertie outflow) or negative (for net intertie inflow). Their magnitude depends on the extent of the intertie imbalances, influencing the HEUA accordingly.

Example 1: Intertie Imbalances

In this example, it is assumed that there are no metering errors, and lines are lossless and unconstrained to isolate the effect of intertie imbalances on $\sum\text{NESC}$. There is a net export of 10MW of energy via the intertie.



Nodal Price ₁ = \$50/MWh	Scheduled Load ₁ = WEQ ₁ = 400MW	IEQ _A = 460MW
Nodal Price ₂ = \$50/MWh	Scheduled Load ₂ = WEQ ₂ = 50MW	IEQ _B = 0MW
	IXQ = 10MW	IMQ = 0MW

$$\begin{aligned} \text{USEP} &= \frac{(\text{Nodal Price}_1 \times \text{Scheduled Load}_1) + (\text{Nodal Price}_2 \times \text{Scheduled Load}_2)}{\sum \text{Scheduled Load}} \\ &= \frac{(\$50 \times 400) + (\$50 \times 50)}{450} \\ &= \$50/\text{MWh} \end{aligned}$$

Total settlement amount made to generators:

$$\begin{aligned} \sum \text{GESC} &= (\text{Nodal Price}_1 \times \text{IEQ}_A) + (\text{Nodal Price}_2 \times \text{IEQ}_B) \\ &= (\$50 \times 460) + (\$50 \times 0) \\ &= \$23,000 \end{aligned}$$

Total settlement amount made to loads:

$$\begin{aligned} \sum \text{LESD} &= \text{USEP} \times (\text{WEQ}_1 + \text{WEQ}_2) \\ &= \$50 \times (400 + 50) \\ &= \$22,500 \end{aligned}$$

$$\begin{aligned} \sum \text{NESC} &= \sum \text{GESC} - \sum \text{LESD} \\ &= \$23,000 - \$22,500 \\ &= \mathbf{\$500} \end{aligned}$$

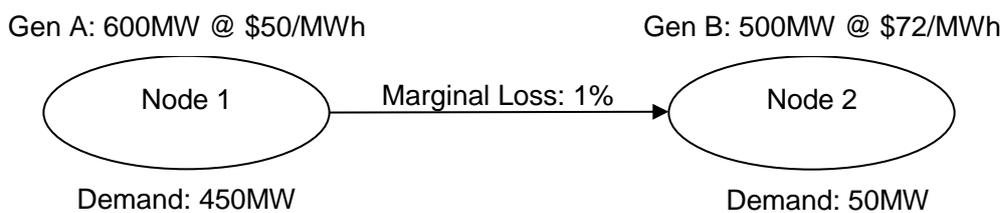
The positive $\sum\text{NESC}$ represents the additional payment to be borne by loads to pay Generator A for the additional 10MW of generation quantity to cover the net intertie export¹⁷.

Transmission Losses

Transmission losses contribute to non-zero $\sum\text{NESC}$ s due to the difference between modelled marginal loss and physical average loss. Theoretically, the average loss on a transmission line is only half of the marginal loss on the line. However, marginal losses, instead of average losses, are modelled in the Market Clearing Engine (MCE) for the derivation of nodal prices. As a result, the average losses in physical reality are smaller than the marginal losses reflected in the nodal prices and the USEP. The non-zero $\sum\text{NESC}$ s arising from transmission losses are thus always negative and their magnitude depends on the loss rate, affecting the HEUA accordingly.

Example 2: Transmission Losses

In this example, it is assumed that there are no intertie flows and metering errors, and lines are unconstrained to isolate the effect of transmission losses on $\sum\text{NESC}$. The lines have a marginal loss rate of 1%.



Actual Transmission Loss (calculated based on average loss) = $50 \times 0.5\% = 0.25\text{MW}$

Nodal Price ₁ = \$50/MWh	Scheduled Load ₁ = WEQ ₁ = 450MW	IEQ _A = 500 + 0.25 = 500.25MW
Nodal Price ₂ = \$50 × 1.01 = \$50.50/MWh	Scheduled Load ₂ = WEQ ₂ = 50MW	IEQ _B = 0MW

$$\text{USEP} = \frac{(\$50 \times 450) + (\$50.50 \times 50)}{500}$$

$$= \$50.05/\text{MWh}$$

Total settlement amount made to generators:

$$\sum\text{GESC} = (\$50 \times 500.25) + (\$50.50 \times 0)$$

$$= \$25,012.50$$

Total settlement amount made to loads:

$$\sum\text{LESD} = \$50.05 \times 500$$

$$= \$25,025$$

$$\sum\text{NESC} = \$25,012.50 - \$25,025$$

$$= \mathbf{-\$12.50}$$

While the nodal price at Node 2 prices in a marginal loss of 1%, in reality, the actual average transmission loss is only half of the marginal loss i.e. 0.5%. The negative $\sum\text{NESC}$ represents the excess payments made by loads because the price paid by loads is higher than that necessary to cover actual transmission losses, and is thus returned to loads.

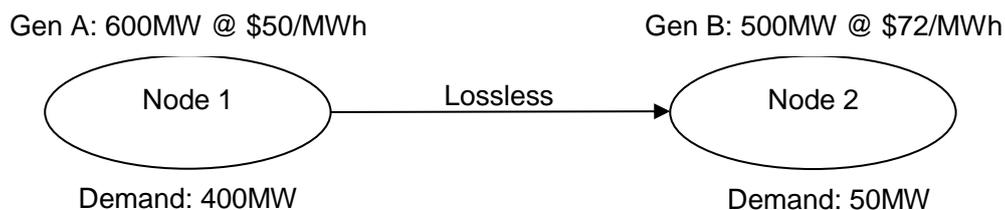
¹⁷ The intertie import and export are balanced to ensure that net intertie flow over time is close to zero.

Metering Errors

Metering errors occur when the metered quantities of energy differ from the actual quantities of energy withdrawn by loads and injected by generators. Aggregate metering errors arise when the sum of the quantities of energy metered to be withdrawn by loads and exported via intertie outflow exceeds or falls short of the sum of the quantities of energy metered to be injected by generators and imported via intertie inflow, after accounting for transmission losses. The non-zero $\sum\text{NESC}$ s arising from aggregate metering errors can be positive or negative depending on the direction of the aggregate metering errors, and their magnitude depends on the extent of the aggregate metering errors, influencing the HEUA accordingly.

Example 3: Metering Errors

In this example, it is assumed that there are no intertie flows, and lines are lossless and unconstrained to isolate the effect of metering errors on $\sum\text{NESC}$.



$$\begin{aligned} \text{Nodal Price}_1 &= \$50/\text{MWh} & \text{Scheduled Load}_1 &= \text{WEQ}_1 = 400\text{MW} & \text{IEQ}_A &= 455\text{MW} \\ \text{Nodal Price}_2 &= \$50/\text{MWh} & \text{Scheduled Load}_2 &= \text{WEQ}_2 = 50\text{MW} & \text{IEQ}_B &= 0\text{MW} \end{aligned}$$

$$\begin{aligned} \text{USEP} &= \frac{(\$50 \times 400) + (\$50 \times 50)}{450} \\ &= \$50/\text{MWh} \end{aligned}$$

With net metering error arising from the IEQ of Generator A being over-metered i.e. $\text{IEQ}_A = 455\text{MW} > 450\text{MW}$,

Total settlement amount made to generators:

$$\begin{aligned} \sum\text{GESC} &= (\$50 \times 455) + (\$50 \times 0) \\ &= \$22,750 \end{aligned}$$

Total settlement amount made to loads:

$$\begin{aligned} \sum\text{LESD} &= \$50 \times (400 + 50) \\ &= \$22,500 \end{aligned}$$

$$\begin{aligned} \sum\text{NESC} &= \$22,750 - \$22,500 \\ &= \mathbf{\$250} \end{aligned}$$

The positive $\sum\text{NESC}$ represents the additional payment to be borne by loads to pay generator A for the additional 5MW of generation quantity inaccurately metered. This additional payment by loads arising from metering errors will be refunded to loads via the $\sum\text{NMEA}$ of future settlement intervals if the metering errors are subsequently discovered (see Example 5).

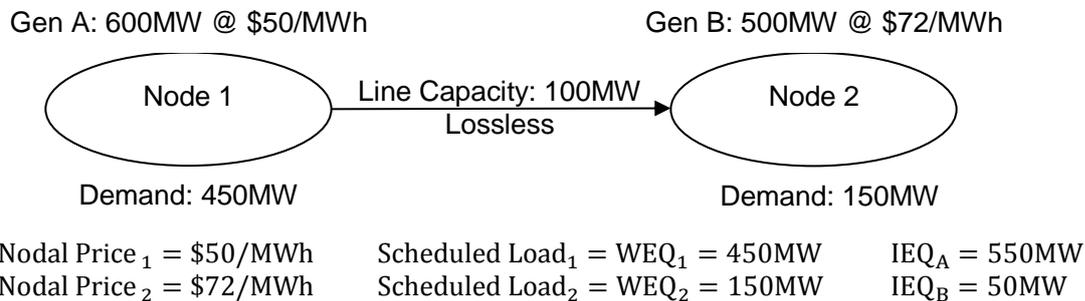
Transmission Constraints

Transmission constraints contribute to non-zero $\sum\text{NESC}$ s due to the price separation resulting from transmission congestion. Price separation leads to the price paid by loads for consumption being higher than the price paid to generators for generation for a specific quantity of energy. As a result, the non-zero $\sum\text{NESC}$ s arising from transmission constraints are always negative, and

their magnitude depends on the severity of the transmission congestion, influencing the HEUA accordingly.

Example 4: Transmission Constraints

In this example, lines are lossless and constrained at 100MW, and it is assumed that there are no metering discrepancies to isolate the effect of transmission constraints on $\sum\text{NESC}$.



$$\text{USEP} = \frac{(\$50 \times 450) + (\$72 \times 150)}{600} = \$55.50/\text{MWh}$$

Total settlement amount made to loads:

$$\sum\text{LESD} = \$55.50 \times 600 = \$33,300$$

Total settlement amount made to generators:

$$\sum\text{GESC} = (\$50 \times 550) + (\$72 \times 50) = \$31,100$$

$$\sum\text{NESC} = \$31,100 - \$33,300 = -\$2,200$$

While the USEP accounts for the purchase of 150MW at \$72 at Node 2, 100MW of the purchase is generated by Generator A at only \$50 at Node 1. Therefore, the negative $\sum\text{NESC}$ represents the excess payments made by loads because the price paid by loads to consume the energy is higher than that paid to generators to supply the energy due to the transmission constraint, and are thus returned to loads.

4.2.2 Net Metering Adjustment Error ($\sum\text{NMEA}$)

EMC determines the $\sum\text{NMEA}$ for each settlement interval as follows:

$$\begin{aligned} \sum\text{NMEA} &= [\sum\text{Generation Metering Error Adjustment for Energy} (\sum\text{GMEE}) \\ &- \sum\text{Generation Metering Error Adjustment for Fees} (\sum\text{GMEF})] \\ &- \sum\text{Load Metering Error Adjustment} (\sum\text{LMEA}) \end{aligned}$$

The non-zero $\sum\text{NMEA}$ is contributed by differences between the total settlement adjustment amount received from loads ($\sum\text{LMEA}$) and that paid to generators ($\sum\text{GMEE} - \sum\text{GMEF}$) for energy arising from settlement re-runs relating to metering errors for corresponding settlement intervals of previous trading dates. The differences result when the NMEA amount for an affected settlement account cannot be exactly offset by a corresponding NMEA amount for another affected settlement account. These financial imbalances arise because

- the rates applied to metering adjustment quantities of loads and generators are different¹⁸; and
- the counterparties to the metering errors cannot be identified or the metering adjustment quantities do not exactly offset.

The non-zero \sum NMEAs can be positive or negative depending on the direction of the adjustments and their magnitude depends on the magnitude of the adjustments as well, contributing to the HEUA correspondingly. When there is such an imbalance, it will be allocated to the HEUA of the respective settlement interval in the preliminary settlement statements issued on the business day immediately following the date of completion of the settlement adjustment.

Example 5: Metering Adjustment Errors

From Example 3, the metering error of $\Delta IEQ = IEQ_{corrected} - IEQ_{original} = 450 - 455 = -5$ MWh for trading day T period 1 is discovered and the settlement adjustment run is to be conducted on the T+48 business day. The following adjustment amount needs to be made:

$$\begin{aligned} GMEE &= MEP \times \Delta IEQ = 50 \times -5 = -\$250 \\ GMEF &= (PSOA + EMCA) \times \Delta IEQ = (0.2 + 0.3) \times -5 = -\$2.50 \end{aligned}$$

In this case, if no counterparty of the metering error is identified, LMEA = 0.

Therefore, an imbalance occurs:

$$NMEA = \sum GMEE - \sum GMEF - \sum LMEA = -\$247.50$$

The negative \sum NMEA represents the refund returned to loads because of the additional payment previously collected from them arising from the metering error. The \sum NMEA of -\$247.50 will contribute to the HEUA of period 1 in the preliminary settlement statement issued on the T+49 business day.

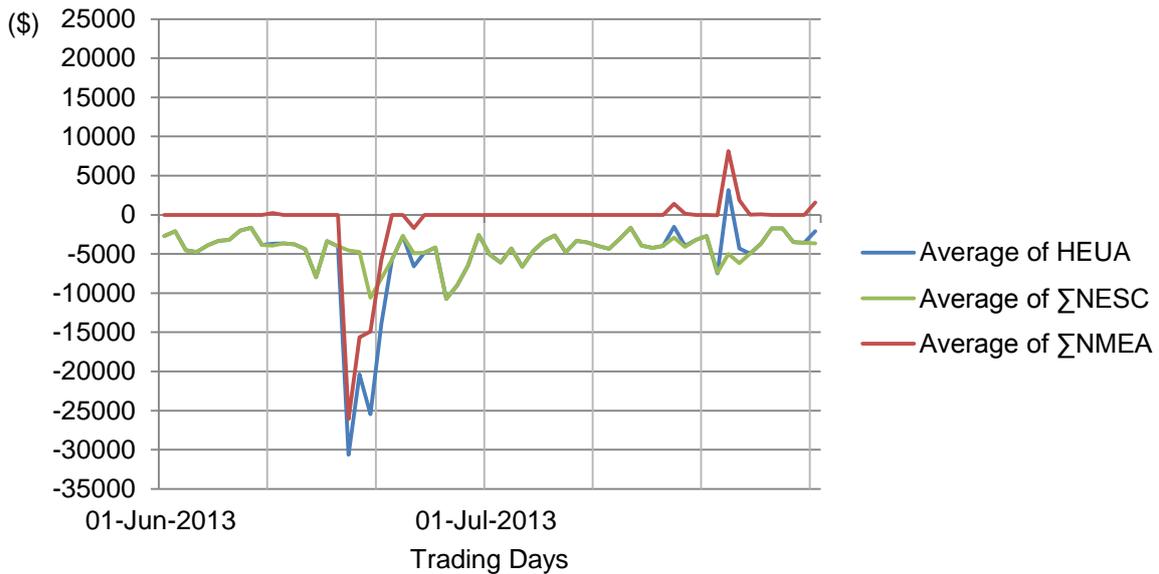
4.2.3 Empirical Analysis of HEUA

In order to verify the contribution of \sum NESC and \sum NMEA to HEUA, the historical daily values of HEUA, \sum NESC and \sum NMEA averaged across all settlement intervals from 1 January 2012 to 31 December 2013 were compiled and analysed in Annex 3.

Indeed, the empirical data concurs with our theoretical study of HEUA being mainly contributed by the \sum NESC and \sum NMEA. As illustrated in Figure 1 (extracted from Annex 3), the HEUA is significantly contributed by \sum NESC, with a high correlation coefficient of 0.89. In addition, any deviation of HEUA from \sum NESC (HEUA- \sum NESC) is significantly contributed by \sum NMEA, with a perfect correlation coefficient of 1.

¹⁸ The rate applicable to metering adjustment quantities of loads is (USEP + AFP + HEUC + MEUC + EMC fee + PSO fee) while the rate applicable to that of generators is (MEP – EMC fee – PSO fee).

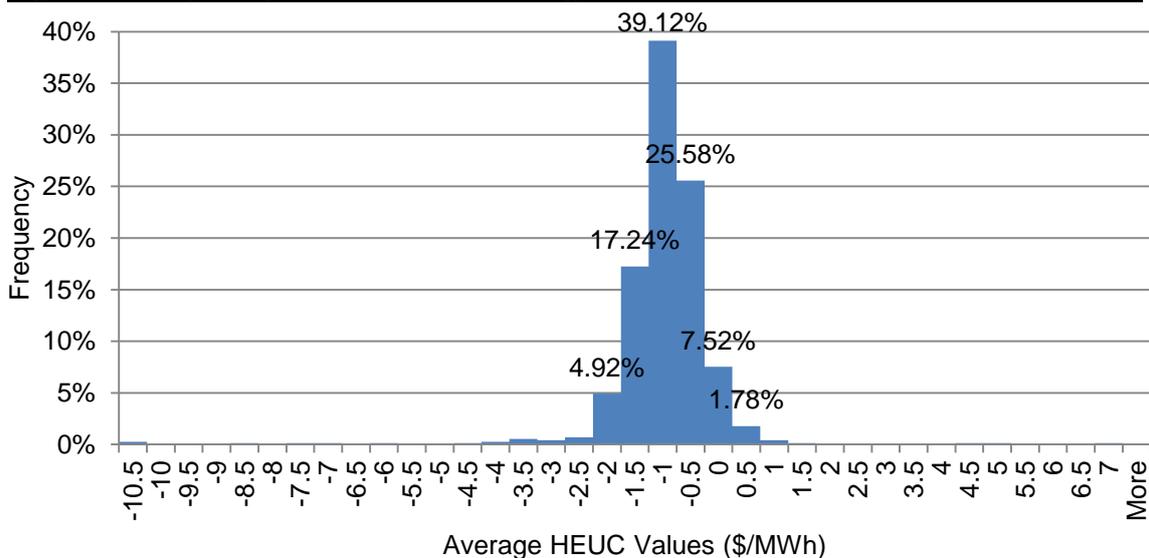
Figure 1: Daily Values of HEUA, Σ NESC and Σ NMEA Averaged across all Settlement Intervals from Jun 2013 to Jul 2013



4.3 Increasing the Transparency of HEUC

Before studying how transparency of the HEUC can be increased, we studied the volatility of the HEUC in recent years. For 1 January 2012 to 31 December 2013 (731 days), the average HEUC value for a settlement interval is computed for each day. As shown in Figure 2, the average HEUC value is relatively stable, ranging from -2.5 to 0.5 for 96.16% of the time (703 days). Therefore, EMC recommends providing information on the significant HEUC variations on a monthly basis.

Figure 2: Frequency Distribution of Average HEUC Values from Jan 2012 to Dec 2013



For the analysis of the HEUC, we propose that EMC first identify trading days with abnormal daily HEUC values averaged across all settlement intervals (“abnormal trading days”) in the month. Daily HEUC values averaged across all settlement intervals will be considered abnormal if they exceed a defined threshold range. The threshold range recommended is the 95% confidence interval using the latest 2-year historical data. Based on the 2-year historical data for 2012 and 2013, the threshold range is:

$$\text{mean} \pm (\text{standard deviation} \times 1.96) = -1.2193 \pm (1.01 \times 1.96) = -\$3.20 \text{ to } \$0.76$$

EMC will then provide more information on the abnormal trading days. For each abnormal trading day, EMC will identify the specific settlement intervals with abnormal HEUC values (“abnormal settlement intervals”) which can be explained by metering errors, transmission constraints or meter adjustments. EMC will provide information on the abnormal settlement intervals for the abnormal trading days in a month as part of the EMC monthly trading report. Table 5 summarizes the information we propose EMC provide to explain for the abnormal settlement intervals.

Table 5: Information for Possible Causes of Abnormal HEUC

Possible Causes	Impact on HEUC	Analysis of Cause	Information to be provided
Intertie Imbalances	Depends on magnitude of net intertie flow	N.A.	N.A. (due to confidentiality of $\sum IXQ$ and $\sum IMQ$ according to Rule Change Paper EMC/RCP/08/2003/201)
Transmission Losses	Depends on loading level, but relatively consistent	N.A.	N.A.
Metering Errors	Depends on magnitude of metering error	✓	Ratio of $(\sum WEQ + \sum IXQ)$ to $(\sum IEQ + \sum IMQ)$ of the abnormal settlement interval as an indicator ¹⁹
Transmission Constraints	Significant when price separation occurs	✓	Reference to price separation incidents in the abnormal settlement interval
Metering Adjustments	Usually insignificant, occasionally significant	✓	$\sum NMEA$ of the abnormal settlement interval

5. CONCLUSION

While the MEUC is adequately transparent, the HEUC is not. Its variations are driven by imbalances in the settlement amounts for energy and the settlement adjustment amounts for metering errors during settlement re-runs. However, EMC publishes only the values of the HEUC, without any other information explaining the imbalances.

As a result, the paper proposes a framework for EMC to identify settlement intervals with outlier HEUC values using a dynamic threshold and analyze them using publishable information. It is also proposed for such analyses to be published in the existing EMC monthly trading reports.

6. IMPLEMENTATION PROCESS

The implementation of this proposal is estimated to take 12 man-days, and incur a one-off cost of \$5,400 and a recurring cost of \$16,200 annually. This cost has not been budgeted and would require EMA’s approval before EMC can incur it and recover from market.

¹⁹ The ratio of $(\sum WEQ + \sum IXQ)$ to $(\sum IEQ + \sum IMQ)$ is expected to be 0.994 since the average transmission loss provided by the PSO is 0.6%. Hence, a significant variation from the expected ratio will be a good indicator for the presence of net metering errors.

7. CONSULTATION

The concept paper was published for consultation on 3 April 2014.

Comments were received from Keppel Merlimau Cogen (KMC). Their comments and our response are provided below:

Comments from KMC

- Keppel does not support the proposal to increase the transparency of the HEUC under section 4.3 because the information proposed to be provided will put market participants with transmission constraints in a less favourable position as compared to those without.
- Nonetheless, by not disclosing the individual components of the HEUC does not mask or hide price separation incidents, the release of information will quantify the impact of the price differences due to transmission constraints.
- Keppel would like to seek justification for the need to increase transparency of HEUC especially when out of the five possible causes of abnormal HEUC prices, only three will be published.

Our response

KMC's views are noted. Currently, the analysis in the existing monthly trading report already explains the causes as well as the impact of price separation events due to transmission constraints. Our proposal merely identifies the price separation events which have an impact on HEUC.

We did not propose EMC identifying transmission losses and intertie imbalances as possible causes for abnormal HEUC because firstly, the transmission loss rate is rather stable and changes gradually over time and secondly, the RCP had decided that intertie information should be kept confidential.

8. RECOMMENDATION

We recommend that the RCP

- a) **support** the proposal to increase the transparency of the HEUC by including an analysis of abnormal HEUC values in the monthly trading reports, as described in section 4.3 of this paper; and
- b) **support** the implementation cost in section 6 of this paper and task EMC to seek EMA's approval of the cost.

9. DECISION AT THE 73RD RCP MEETING

At the 73rd RCP meeting, the RCP by majority vote **supported** the proposal to increase the transparency of HEUC and its implementation cost, and **tasked** EMC to seek EMA's approval of the cost.

The details of the votes are as follows:

Those who voted to support the proposal:

- | | |
|----------------------|--|
| 1. Mr. Toh Seong Wah | Representative of the EMC |
| 2. Mr. Kng Meng Hwee | Representative of the Power System Operator |
| 3. Mr. Daniel Lee | Representative of Generation Licensee |
| 4. Mr. Luke Peacocke | Representative of Generation Licensee |
| 5. Mr. Phillip Tan | Person experienced in Financial Matters in Singapore |
| 6. Mr. Michael Wong | Representative of Retail Licensee |
| 7. Mr. Dallon Kay | Representative of Wholesale Electricity Trader |

Those who voted not to support the proposal:

- | | |
|------------------|---|
| 1. Mr. Sean Chan | Representative of Retail Electricity Licensee |
|------------------|---|

Those who abstained:

- | | |
|-----------------------|---|
| 1. Mr. Lawrence Lee | Representative of Market Support Services Licensee |
| 2. Mr. Chan Hung Kwan | Representative of Transmission Licensee |
| 3. Ms. Frances Chang | Representative of Consumers of Electricity in Singapore |

When new items are included in the computation of MEUC and HEUC in future, EMC should make them transparent as well. Where necessary, EMC would also seek the RCP's opinion on whether new information relating to the new items should be included in the analysis of abnormal HEUC values in monthly trading reports.

Annex 1: Background – Formulae for MEUC and HEUCFormulae for MEUC

According to the Market Rules Chapter 7 Sections 4.1.6 to 4.1.8,

$$\text{MEUA} = \text{MACP} + \text{MTRA} + \text{MISC} + \text{MEUS}$$

$$\text{MWMQ} = \text{projected } \sum_h \sum_a \text{WMQ}_h^a$$

where:

\sum_h = sum over all settlement intervals h in a calendar month

\sum_a = sum over all settlement accounts a

$$\text{MEUC} = \text{MEUA}/\text{MWMQ}$$

Formulae for HEUC

According to the Market Rules Chapter 7 Sections 3.5.1 to 3.5.2,

$$\text{HEUA}_h = \sum_a (\text{NESC}_h^a + \text{NRSC}_h^a + \text{NFSC}_h^a + \text{NTSC}_h^a + \text{NMEA}_h^a)$$

$$\text{HEUC}_h = \text{HEUA}_h / \sum_a \text{WEQ}_h^a$$

where:

h = a settlement interval

\sum_a = sum over all settlement accounts a

Annex 2: Analysis of MEUC – Sample MEUC Statement

Monthly Energy Uplift Charge for March 14

Month: March 14

No. of days: 31

MWMQ p. month: 3,833,808.219

Items	Annual Budget	Monthly Budget	Daily To Recover
Ancillary Services Cost	9,653,169.60	819,858.24	26,447.04
Ancillary Testing cost incurred by PSO	0.00	0.00	0.00
Compensation by EMC/PSO			
* Chapter 5, section 4.7.3 (reactive voltage)	0.00	0.00	0.00
* Chapter 5, section 5.4.3 (market mechanism failed)	0.00	1,071,271.75	34,557.15
* Chapter 5, section 5.6.2 (operation under emergency operating state)	0.00	0.00	0.00
* Chapter 5, section 7.7.3 (cancel defer recall outage)	0.00	0.00	0.00
* Chapter 5, section 8.3.4 (ancillary service contracts audit cost)	0.00	0.00	0.00
* Chapter 5, section 8.4.3 (ancillary service not contracted)	0.00	0.00	0.00
* Chapter 5, section 8.6.2 (class of ancillary not on contract)	0.00	0.00	0.00
* Chapter 5, section 9.1.7 (pvd more/limit provision)	0.00	0.00	0.00
* Chapter 5, section 9.7.3 (dispatch error)	0.00	0.00	0.00
* Chapter 5, section 10.4.1 abnormal frequencies)	0.00	0.00	0.00
Dispute Res. by EMC/PSO	0.00	0.00	0.00
Comp by EMC/PSO from dispute	0.00	0.00	0.00
Less			
Comp by EMC/PSO from dispute	(0.00)	0.00	0.00
Penalty received from MP	0.00	0.00	0.00
Insurance monies to EMC	(0.00)	(0.00)	(0.00)
Total MACP (\$)	9,653,169.60	1,891,129.99	61,004.19
MTRA (\$)	0.00	0.00	0.00
MISC (\$)	0.00	0.00	0.00
MEUS (\$)	0.00	73,089.40	2,357.72
MEUA (\$)	9,653,169.60	1,964,219.39	63,361.91
MWMQ (MWh)		3,833,808.219	123,671.23
MEUC (\$/MWh) = MEUA/MWMQ		0.51	0.51

Note : The figures shown are exclusive of GST.

Annex 3: Analysis of HEUC – Historical Values of HEUA, Σ NESC and Σ NMEA

