Energy Market Company

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SUBJECT : **PROPOSED EXTENSION OF TYPE 4 PRICE RE-RUNS**

FOR : **DECISION**

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Executive Summary

This paper assesses the proposal to extend Type 4 price re-runs to price separation incidents, whereby a transmission line is modelled to have reached its maximum capacity in the MCE, but did not actually do so in reality. This involves a review of the principle of ex-ante pricing in SWEM to ensure a consistent application of sound market principles.

The paper analysed both ex-ante and ex-post pricing methodologies under the following dimensions:

- **Short-term Efficiency** - Both ex-ante and ex-post pricing can provide generators with the certainty to adopt expensive generation options in times of supply shortage, so long as ex-post pricing is supplemented with a compensation arrangement to generators for which the market clearing price is inadequate to cover its costs of production. However, ex-post pricing has the advantage in that it compels consumers to respond more optimally to high prices by reducing their consumption to an efficient level.
- **Long-term Efficiency** - Instead of ex-ante pricing whereby investment decisions are guided by the MCE model rather than what happens in reality, in an ex-post regime both investment decisions and the model (through ex-post runs) will be more aligned to what happens in reality.
- **Equity** – Ex-post is likely more equitable, since prices will be based on actual decisions (e.g. level of consumption) and outcomes (e.g. transmission congestion) in the market, rather than upon a model whose input is a set of expectations on the like.

Notwithstanding, given Singapore's low demand volatility and the likely costs of implementing an ex-post pricing regime, EMC proposes to retain the current ex-ante pricing arrangement. In this case, it would not be consistent with market design principles to extend Type 4 price reruns, as proposed, to cases whereby transmission lines have reached their limit in the MCE model but did not do so in reality as proposed.

Alternatively, EMC could look into reducing the market trading periods from the current 30 minutes to 5 minutes, which will lead to the convergence between ex-ante and ex-post pricing. Any price discrepancy will also have a smaller financial impact since it is now applied onto a smaller energy quantity.

The RCP considered this proposal at the 48th RCP meeting and decided by majority vote **not to** extend Type 4 price reruns to cases whereby transmission lines have reached their limit in the MCE model but did not do so in reality.

1. INTRODUCTION

This paper assesses the proposal to extend Type 4 price re-runs to price separation incidents, whereby a transmission line is modelled to have reached its maximum capacity in the MCE, but did not actually do so in reality.

2. BACKGROUND

2.1 Market Design Principles of the SWEM

The Singapore Wholesale Electricity Market (SWEM) adopts the following market design principles, with associated impact on pricing and schedules:

- **Ex-Ante Pricing** – The schedules and prices for energy, regulation and reserve are co-optimised by the market clearing engine (MCE) prior to the start of each half-hour dispatch period, based on the most recently available inputs (e.g. offer bids, network status). This has the advantage of giving market participants certainty about prices ahead of dispatch, and is appropriate for Singapore where the actual dispatch does not differ significantly from expectations due to low demand volatility.
- **Locational Pricing** – SWEM adopts a sophisticated nodal pricing system where prices are spatially determined at each of the 690 injection and withdrawal nodes, taking into account localised demand/supply, power flows, losses and constraints. These locational price signals serve as economic inventives to sellers in the electricity market to reflect their relative geographical situation, thereby driving free decisions of trade and/or the new establishment of facilites to contribute to the efficient operation and expansion of the overall electricity market[1].

The implications of ex-ante pricing are that if the inputs used in the MCE co-optimisation process do not accurately reflect the physical reality for the period, then the pricing and scheduling computed would be sub-optimal.

2.2 Market Rules on Price Revision

Provision for Price Revision

In the design of SWEM, the PHB consultants provided for price revision when:

(a) there is a re-dispatch as a result of a significant contingency, or

(b) the market operator errs in calculating the original ex-ante prices.

Specifically, price revision takes place under the following scenarios

Type 1 - Cases where the MCE fails to produce a real-time schedule (RTS) for a dispatch period for any reason other than a real-time market suspension.

Type 2 - Cases in which the MCE has used input data that are not what should have been supplied to it, at the time the RTS for a dispatch period was produced.

[1] Page 5, *Implementation of Short and Long Term Locational Signals in the Internal Electricity Market*, CESI, Dec 2003.

Type 3 - Cases in which the MCE has used the adjusted nodal load forecasts which take into account the energy shortfall specified by the Power System Operator (PSO) for a dispatch period.

Type 4 - Cases in which the MCE has applied the constraint violation penalty (CVP) for line constraint for a dispatch period, and the PSO has subsequently confirmed that there was no load shed in that period[2].

Type 5 - Cases in which the MCE has produced prices which do not reflect their respective locational system marginal price(s) (LSMP).

Please refer to the **Annex** for details on how the various price revision cases are handled in the SWEM.

Zooming in to Type 4 price rerun, which pertains to this proposal, current rules provide for price revision where the MCE has applied CVP for line constraints, yet there is no load shed in real-time.

CVPs are costs applied by the MCE to ensure that certain constraints may be violated but only at an associated cost, which is established to discourage such violations from occuring and control its extent of occurence. The CVPs for line flow manages the overloading of power lines from their power carrying capacity; since line flow and node violations trade-off against each other (i.e. instead of violating line flow limits, load could be shed at receiving node), the CVP for line flow is derived from energy violation penalities.

As it is preferable for load to be shed rather than for the line to exceed its limits, the CVP for line flow violation is set as the maximum difference between energy prices at each end of the line (+VoLL and –VoLL) plus an adder, at 2.2xVoLL.

Based on the above derivation, the incurrence of CVPs for line constraint by the MCE should occur only in conjunction with nodal violation/load shed. However, since the line constraint CVP was determined ex-ante, it is possible that there is no nodal load shed during the actual dispatch period (e.g. if actual load is lower than forecast load, or due to load shifting by PSO). In such cases where line constraint CVP was invoked without a corresponding load shed during the period, which stems from the divergence between the ex-ante model and ex-post reality, the application of CVP is considered unjustified.

In this case, EMC will conduct Type 4 price revision and re-run the MCE by using the maximum actual line flow values supplied by the PSO or, if the EMC does not receive such values from PSO, EMC shall re-run the MCE by relaxing the line constraints in accordance with D.16.4, Appendix 6D of Chapter 6. The usage of maximum actual line flow values for such reruns is the only instance whereby an ex-post input is used in SWEM's ex-ante market.

2.3 Rule Change Proposals on Type 4 Price Rerun

Proposal 1: To Remove Type 4 Price Reruns

In 2008, EMC proposed to remove Type 4 Price Reruns with the support of the RCP and EMC Board. The proposal was based on the principle that there will inevitably be a divergence between the ex-ante estimates (e.g. load forecast) and actual values during

[2] Type 4 rerun was not included in the original market design. It was added in 2003 arising from RC215: *Removing the Effect of Constraint Violation Penalties on Energy Settlement when Load is not Shed*.

the period. Certain constraints in the MCE, calculated using ex-ante estimates, are precautionary in nature and just because ex-post no untoward circumstance has actually occurred, it does not mean that the cost of complying with them was not justified.

EMC was of the view that ex-ante provisions for such contingencies are necessary, regardless of the actual outcome. It is thus inconsistent and inefficient to charge ex-ante prices only if the constraints were necessary in a period (e.g. where an untoward circumstance has actually occurred), while “relaxing” the constraints and re-run the MCE using ex-post inputs (i.e. maximum actual line flow values) when these constraints were not necessary.

However, the EMA did not approve the proposal, on the following grounds:

> *Type 4 re-run does not compromise the ex-ante pricing philosophy of the market, as it is meant to address a problem caused by modeling imperfections, not energy shortfall. Useful price signals should be differentiated from “noise”, and Type 4 re-run was intended to remove the “noise”. In other words, if price separation is due to real constraints resulting in load shedding, we should not use Type 4 re-run to mute the price signal. However, if price separation is due to modeling imperfection, we should then be prepared to use Type 4 re-runs.*
>
> *The 19 Jan 08 price separation incident resulted in consumers having to bear a higher weighted average USEP of $590/MWh before Type 4 re-run. After Type 4 re-runs, price separation was reduced and the average USEP fell to $401/MWh for the day. The outcome of paying a higher weighted average USEP is not justifiable and would undermine the interests of consumers.*

Proposal 2: To Extend Type 4 Price Reruns

When EMA was considering EMC’s proposal to remove Type 4 price reruns, a proposal was received to the opposite effect – not to remove but to extend the conditions under which Type 4 re-runs will be conducted. The new proposal suggested extending Type 4 price reruns to cases where transmission lines had reached their maximum capacity in the MCE model, but did not in physical reality.

Figure 1: Line Loading Effects beyond Maximum Line Rating in the MCE

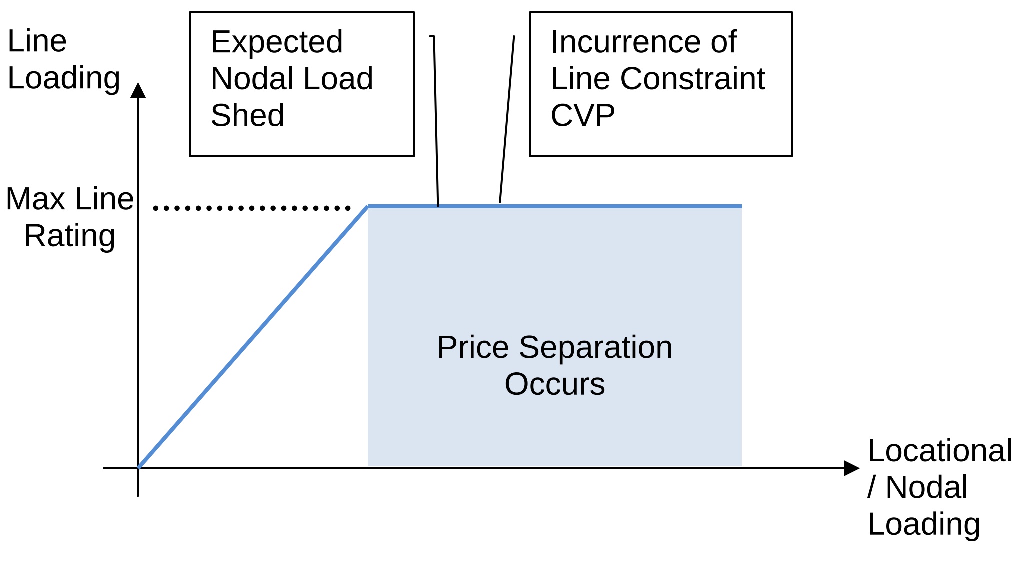


Figure 1 shows the line loading (blue line) as locational/nodal loading increases. Beyond the max line rating, the line loading maxes out and price separation occurs between the nodes at different ends of the line. If the locational/nodal loading increases further beyond what generation at the receiving node can serve, the MCE will determine firstly for load to be shed at the receiving node (penalty of 1.0x VoLL) and only beyond that will the MCE invoke the line constraint CVP (penalty of 2.2x VoLL).

The above loadings and penalties are co-optimised ex-ante by the MCE, based on estimated inputs. Depending on the actual conditions during the period, the effective loading of the line may differ. It is thus possible for i) the transmission line to reach capacity, ii) expected load shed at node, and/or iii) incurrence of line constraint CVP based on ex-ante modelling, while the actual line loading during the period is found ex-post to be below the maximum line rating (e.g. lower-than-expected demand).

To recap, the current rules provide for price reruns where line constraints CVP were imposed by the MCE, even though there was no load shed in real time. The new proposal involves an extension of the conditions for price rerun, so long as the line limits during the period are not reached.

3. ANALYSIS

The proposal to extend Type 4 price revision to cases whereby transmission lines have reached their limits in the MCE but did not do so in physical reality challenges SWEM's fundamental principle of determining prices based on ex-ante, rather than ex-post inputs. It is thus necessary to review this principle as holistically applied to all ex-ante inputs (e.g. pricing based on ex-ante load forecast versus ex-post actual load), rather than study the proposal on a piecemeal basis. This ensures a consistent application of sound market principles, without any overt biasness in influencing prices and/or favouring a group of stakeholders over another.

3.1 Economics of Ex-Ante and Ex-Post Pricing

SWEM operates on the principle of Ex-Ante Pricing (pricing determined ex-ante, using ex-ante estimates/inputs fed into the MCE) and Ex-Post Quantities for energy[3] (actual quantity of energy injection and withdrawal, which can only be determined based on metered quantities after the period). The latter is obvious, since an entity should pay/be paid for the actual energy consumed/produced, rather than charged based on an ex-ante forecast/schedule. Rather, it is the former principle of ex-ante pricing that bears closer scrutiny.

At first glance, ex-ante pricing appears reasonable. For example, an individual having a meal in a restaurant knows for certain the prices for his entrees, and does not get a nasty surprise when the bill comes. However, this is a case of static pricing where prices are determined through a simple ex-ante process (e.g. price of raw materials, cost of rent) and do not fluctuate. There are however instances in real life where prices are determined only ex-post, after all actual inputs (rather than estimates) become known. One such example is COE bidding, whereby COE prices are determined ex-post based on the actual bids (both number of bids and bid prices) received by the LTA, as opposed to estimates.

[3] For Reserve and Regulation, settlement is based on ex-ante scheduled quantities.

Figure 2: Effects of Ex-Ante and Ex-Post Pricing (Demand Divergence)

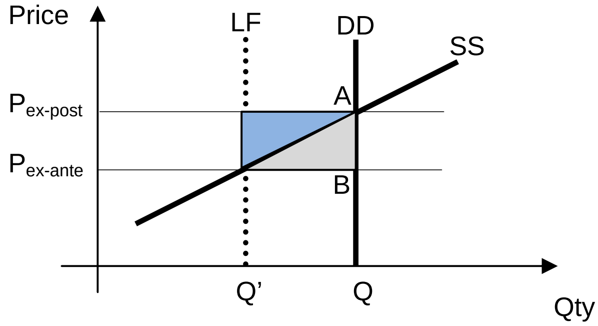


Figure 2 above shows the economic analysis of ex-ante versus ex-post pricing arising from the divergence between the ex-ante load forecast and the ex-post actual demand. SS represents the generator offer curve, LF the ex-ante load forecast, and DD the ex-post demand based on actual energy withdrawals.

Simple economic analysis concludes that the efficient outcome lies at "A", where DD meets SS, and prices settle at $P_{ex\text{-}post}$. However, with the current SWEM combination of ex-ante pricing with ex-post quantity, the equilibrium level lies at "B", where prices are $P_{ex\text{-}ante}$ (intersection of LF and SS), and quantity is "Q" (based on ex-post actual energy withdrawals). Relative to the efficient outcome at "A", generators suffer losses (gray triangle) and foregone profits (blue triangle). The reverse is also possible whereby if the load forecast over-estimates actual demand, consumers will end up having to pay the higher ex-ante prices and incur losses in consumer surplus.

Figure 3: Effects of Ex-Ante and Ex-Post Pricing (Supply Divergence)

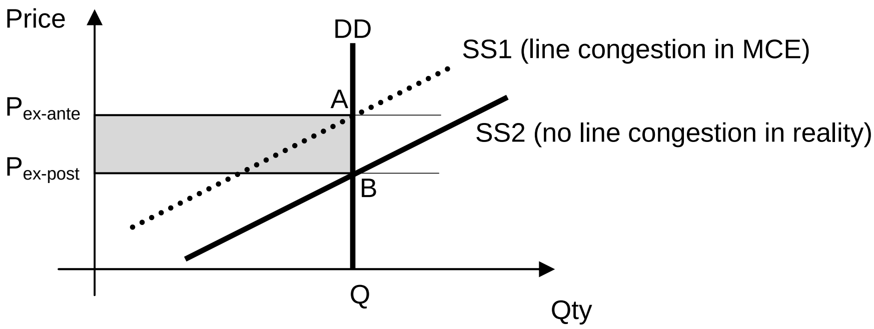


Figure 3 above shows the economic analysis of ex-ante versus ex-post pricing arising from supply divergence (e.g. at a given node, if the MCE expects transmission line congestion which does not exist in reality, then the modelled supply SS1 will be higher than actual supply SS2).

In this case, the efficient outcome lies at "B", where DD meets SS, and prices settle again at $P_{ex\text{-}post}$ rather than "A" where prices settle at $P_{ex\text{-}ante}$. Using ex-ante pricing, not only would consumers suffer higher prices and loss in consumer surplus, pricing signals suggest line congestion when none exists.

Although ex-ante pricing with ex-post quantities appear to be an incompatible match, its application in SWEM is justified from the fact that there is low demand volatility (Q' approximates Q well in Figure 2) and minimal congestion. In settling for this approximation of ex-ante pricing, it provides generators price certainty so that they can have the confidence to run up their expensive sources in times of supply shortage.

However, the key takeaway is the ex-post pricing leads to a more efficient outcome, and ex-ante pricing is reasonable only insofar as it is a good estimate of the actual ex-post pricing.

3.2 Inevitable Variance between MCE and Real Life

If the MCE perfectly models the power system, and the ex-ante forecasts perfectly estimates system conditions during the dispatch period, then the MCE's dispatch and pricing would be the most economically efficient outcome. Even if CVPs were invoked leading to high energy prices, they play an important signalling role in incentivising the appropriate investments.

The need for Type 4 price rerun stems from the fact that the above ideal scenario does not happen. Any divergence between the MCE's model/inputs with reality leads to a non-optimal dispatch and inaccurate price signals. Some possible sources for this divergence include:

- MCE models the power system using DC instead of AC flow
- Load forecast could differ from actual load for the period
- Other MCE inputs such as network status could change due to contingencies during the period (e.g. transmission line outage)
- Load Shifting by the PSO

The obvious solution is to improve and narrow this divergence between the MCE model and real life. However, there is a functional limit to how far the MCE model fully model the complexities of the power system and in any case, it is practically impossible to predict the load for a future dispatch period. Hence, the divergence between ex-ante pricing and ex-post pricing remains inevitable, with the only issue being the frequency and magnitude of such divergence.

3.3 Should Prices Follow MCE or Real Life?

Given the inevitable divergence between the MCE and reality, the next question would be which one of the two outcomes that pricing should take alignment from. If we deem that pricing outcomes should follow:

A) **MCE Model -** Ex-ante prices should be allowed to stay, regardless of ex-post outcomes

B) **Physical Reality -** After each period, prices should be rerun ex-post based on actual physical conditions during the dispatch period.

C) **Combination of Both -** The Phillipines market has a hybrid ex-ante/ex-post pricing determination methodology, whereby both ex-ante and ex-post prices are calculated. Ex-ante prices apply to ex-ante quantities, while ex-post prices are applied only to the differential quantity between ex-ante and ex-post quantities.

Given Singapore's low demand volatility, option (C) is unnecessarily complicated and resource intensive. It thus boils down to a decision between options (A) and (B). A comparison of the ex-ante/post approaches of the New Zealand and Philippines markets is shown in Table 1:

<u>Table 1: Comparison of Ex-Ante/Post Inputs used for Price Determination in the New Zealand, Philippines and Singapore Electricity Markets</u>

Categories	New Zealand	Philippines		Singapore
		Ex-Ante	**Ex-Post**	
Description	Real Time Market with ex-post pricing.	Real Time Market with ex-ante pricing applied to ex-ante quantities, and ex-post pricing applied to differential between ex-post and ex-ante quantities.		Real Time Market with ex-ante pricing
Demand	Actual demand over period based on metered data (ex-post)	Load forecast (ex-ante)	Actual demand over period based on metered data (ex-post)	Load forecast (ex-ante)
Supply	Generator offers (ex-ante)	Generator offers (ex-ante)	Generator offers (ex-ante)	Generator offers (ex-ante)
System Status	Based on system data from system operator before start of period (ex-ante)	Based on system data from system operator before start of period (ex-ante)	Determined by Market Operator, in consultation with the System Operator, which in its reasonable opinion best represent network conditions pertaining for the duration of the trading interval (ex-post)	Based on system data from system operator before start of period (ex-ante)
Price Rerun	Spring Washer After identifying the binding transmission security constraint(s), the high spring washer relaxation factor is applied to the maximum flow limit of the transmission security constraint(s).	N.A.	N.A.	Type 4 Rerun To rerun the MCE using the maximum actual line flow values provided by the PSO or if not available, to relax line constraint. (ex-post) All other inputs are what were originally provided for the real-time dispatch schedule. (ex-ante)

As shown above, different markets adopt a variety of either ex-ante/post inputs, depending on the respective principles that they subscribe to. The merits of both are assessed subsequently along the lines of short-term efficiency, long-term efficiency and equity.

3.3.1 Assessment of Short Term Efficiency

In the short term, price signals are efficient if they can direct both gencos and consumers to behave in such a way as to enhance system security. Hence, when electricity prices spike, i) generators should be incentivised to run up expensive generation options, while ii) consumers should be incentivised to reduce their consumption to an efficient level. Prices should also be determined in such a way to iii) reduce market gaming opportunities.

Price Certainty for Generators

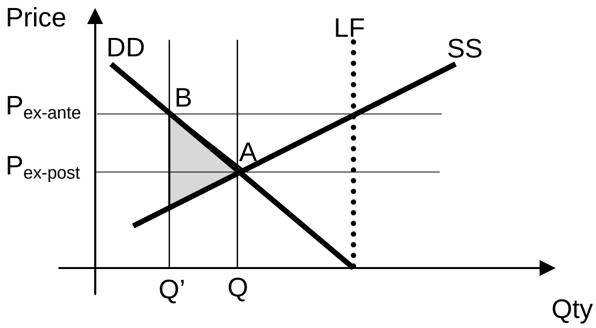
Ex-ante pricing is able to incentivise generators to adopt expensive generation options, because it provides generators with certainty of high payments to compensate them for their expensive generation options. However, this is not to suggest that ex-post pricing is incapable of achieving the same. For example, in the NYISO, generators are provided with Bid Production Cost Guarantees, which promises the certainty of “make whole” payments/compensation, in the event that the market clearing prices are unable to cover their production costs, as proxied by their electricity offers (including their marginal offers and start-up costs). Similarly, in an earlier review on price revision, EMC proposed a compensation arrangement for generators negatively affected by price revision by compensating them for the difference between their offers and the market clearing price, for energy quantities where the former exceeds the latter.

As such, both <u>ex-ante and ex-post pricing can provide generators with the certainty to adopt expensive generation options in times of supply shortage</u>, so long as ex-post pricing is supplemented with a compensation arrangement to generators for which the market clearing price is inadequate to cover its costs of production.

Demand Response from Consumers

Ex-post pricing leads to a more efficient outcome than Ex-ante pricing when consumers respond to high prices, as illustrated in the figure below:

<u>Figure 4: Effects of Ex-Ante and Ex-Post Pricing (Demand Response)</u>



In the figure above, LF is the load forecast, while DD is the true demand incorporating its response to high prices through its demand elasticity. In an ex-post regime, when demand reduces in response to high prices (move along DD), the equilibrium settles at

"A" where DD meets SS[4], and prices settles at $P_{ex\text{-}post}$. However, in an ex-ante regime, pricing is fixed at $P_{ex\text{-}ante}$ based on the intersection of LF and SS, regardless of the effect of demand response. As load reduces in response to the higher $P_{ex\text{-}ante}$, energy consumption falls to Q', which is below the efficient level of Q. This arises because prices were fixed at the higher $P_{ex\text{-}ante}$, which led to consumers over-curtailing their consumption beyond the efficient level of Q, to a lower Q' level. This results in a loss of welfare (sum of producer and consumer surplus) as shown in the shaded area.

From the consumer's perspective, <u>ex-post pricing incentivizes them to respond more optimally to high prices by reducing their consumption to an efficient level (Q), compared to ex-ante pricing whereby they over-reduce it to Q'</u>.

Market Gaming Opportunities

Literature suggests that in an ex-ante pricing regime, consumers have incentives to falsely declare their actual demand so as to influence ex-ante prices in their favour. Specifically, loads have the incentive to under-declare demand in the demand bidding process so as to drive prices down. During the period, they will then consume what they had originally intended, taking advantage of the lower energy prices that had been decided ex-ante. In additional to the obvious economic/financial impact, system security could also be compromised.

In contrast, under an ex-post pricing regime, consumers should act consistently with their bids since they have no incentivise to engage in such gaming opportunities.

The impact of market gaming in the context of SWEM's ex-ante pricing regime is limited though since there is no demand bidding, nor retailers estimating demand.

3.3.2 Assessment of Long Term Efficiency

In the long run, pricing signals from the market are important in guiding investment decisions to reap efficiency gains for society. Obvious as this may sound, these efficiency gains arising from productive efficiency (i.e. meeting load using the lowest cost of resources) accrues based on what happens in real life, rather than what happens in the MCE model. In other words, the MCE is useful, not from the efficiency gains captured in the model (e.g. through the objective function), but through its ability to guide real life outcomes towards the most efficient one, resulting in efficiency gains.

To illustrate, assume that the MCE model does not perfectly model reality (e.g. there is a consistent bias for power flows to be modelled to reach a particular transmission line's capacity even though they do not in real life), and there are two possible planting locations for a new generator: Location A which is efficient based on the model (e.g. planting a new generator at this site would relieve this imaginary congestion) but not so in reality, and Location B which is the reverse.

[4] In reality, consumers do not know the exact $P_{ex\text{-}post}$ that the market will settle at when determining the amount of energy to consume or curtail for the period, since $P_{ex\text{-}post}$ is available only after the period. However, it is reasonable to expect that over repeated games (periods), they can form a reasonable estimation of the extent to which prices will reduce from $P_{ex\text{-}ante}$ to $P_{ex\text{-}post}$, and hence adjust their consumption level accordingly (i.e. not reduce their consumption by so much, since they know actual price will likely be lower than $P_{ex\text{-}ante}$).

Under an ex-ante pricing regime, prices will be based on the ex-ante model rather than actual system conditions during the period, and the investor will be guided to build the plant in Location A. While this may result in gains to the model's objective function, these gains are purely a notional outcome that does not result in any real efficiency gains.

Conversely, under an ex-post pricing regime, the price signals will reflect the actual system conditions rather than what was modelled (e.g. that there was no effective congestion in a particular line) and lead the investor to build the plant in Location B that results in real efficiency gains.

In an earlier review[5], there was the argument that reruning the MCE with binding constraint relaxed if nothing bad happened ex-post is like buying insurance and then asking for a premium refund if nothing untoward happened. However, another way of looking at this is that the insurance premium had already been incurred by the market, when out-of-merit generators were scheduled, taking into account the binding constraint that did not exist in reality.

It thus boil down to whether this non-existent constraint should be used to set prices and if not (i.e. prices are rerun), which party should bear the costs of the out-of-merit schedule. If generators using expensive generation are not compensated, then they are bearing the costs; if they are compensated, then the market is bearing the cost.

In conclusion, prices should mirror reality as close as possible by addressing the variance due to load changes and modelling deficiencies, so as to ensure that final prices reflect the correct economic or grid conditions. <u>Instead of ex-ante pricing whereby investment decisions are guided by the model rather than what happens in reality, in an ex-post regime both investment decisions and the model (through ex-post runs) will be more aligned to what actually happens in reality</u>.

3.3.3 Assessment of Equity

The issue of equity in assessing the ex-ante versus ex-post argument is important, even if it is subjugated to economic considerations. The proposition thus far is that prices should be based on actual decisions (e.g. level of consumption) and outcomes (e.g. transmission congestion) in the market, rather than upon a model whose input is a set of expectations on the like. From this light, ex-post pricing should be considered equitable.

The main argument against the equity of ex-post pricing is that prices determined ex-ante between buyers and sellers should bind both parties after electricity has been produced and consumed. This argument would be valid if there were a day-ahead market with two-sided active bidding from both generators and loads, in which case the cleared quantities and prices determined ex-ante should be binding since both parties went into the trade "with their eyes wide open". However, SWEM only has a one-sided bidding mechanism from generators, with electricity demand decided based on the load forecast. Given the asymmetric extent of responses from generators and load, it is not entirely fair to assert that sellers had actively participated in the price determination process, since they were but passive parties in the transaction.

[5] RC272: Changes Arising from the Review of Price Revision in the Singapore Wholesale Electricity Market

3.4 Ex-Ante vs. Ex-Post/Price Revision

The earlier sections assessed that there are benefits in adopting ex-post pricing from the perspectives of short/long-term efficiency and equity, although these benefits could be limited given the relatively low demand volatility in Singapore's context. This section analyses the practical feasibility of doing so, balancing the benefits with the additional resources incurred.

Essentially, there are the following possible models to balance ex-ante with ex-post pricing:

Table 2: Comparison of Various Pricing Models

Model	Description	Advantages	Disadvantages
A) Pure Ex-Ante	Current model, where pricing is determined purely based on ex-ante inputs.	No system/rule changes required. Consistent application of ex-ante principles.	Leads to potential short/long term inefficiencies and inequity, although likely limited given relatively low demand volatility
B) Pure Ex-Post	Ex-ante prices are provisional, and settlement prices are determined by running MCE ex-post based on certain ex-post inputs (e.g. network status, actual demand).	Consistent application of ex-post principles. Potential gains to short/long term efficiencies and equity.	Requires the most amount of resources, which may or may not be justified Singapore's low demand/supply volatility
C) Ex-Ante, with Price Revision when Ex-Post Results differ significantly from Ex-Ante	Ex-ante pricing is retained, with price reruns under conditions which may have significant pricing corrections and financial impact to generators and loads This could include, but not limited to the following triggers: • Where actual load varies from the load forecast by more than a certain threshold • Where a transmission line has reached its maximum capacity in the MCE model, but found not to be so ex-post • Where a transmission line is within a certain threshold (say 70%) from its maximum capacity in the MCE model, since it is possible that it would have reached its maximum capacity during the period	Less resources required than a total move over to ex-post pricing, by retaining the existing ex-ante pricing framework	Could be construed as being inconsistent with principles of either ex-ante/ex-post pricing Difficult to set the comprehensive set of conditions under which to conduct price reruns, and basis for setting associated trigger levels Resources required to implement this change from current ex-ante model

Based on the above assessment, EMC is of the view that for the consistent application of pricing principles, we should consider either Model A (pure ex-ante pricing, which is our current model) or Model B (pure ex-post pricing). For Model C, it will be tenuous and contentious to ascribe all the conditions/scenarios under which price revision should take place, and the move towards a pure ex-post pricing regime will be more clean-cut.

Given the low demand volatility in Singapore and the likely costs of implementing an ex-post pricing regime, EMC proposes to retain the current ex-ante pricing arrangement. In this case, it would not be consistent with market design principles to extend Type 4 price reruns, as proposed, to cases whereby transmission lines have reached their limit in the MCE model but did not do so in reality as proposed. In any case, from the implementation of other ex-post markets shown in Table 1, the ex-post inputs used are demand (based on metered quantities) and system status, rather than load flow (i.e. actual load flow is not fed as an input into the model ex-post).

Alternatively, to minimise the discrepancy between ex-ante and ex-post pricing, EMC could also look into reducing the market trading periods from the current 30 minutes to, for example, 5 minutes (this is done in other markets such as the NYISO). As the period narrows, ex-ante and ex-post prices converge since the former will now be determined more regularly based on more updated data (e.g. network status). In addition, any price discrepancy will have a smaller financial impact since it is now applied onto a smaller energy quantity (for the same output/consumption level, a smaller time period will result in a smaller injection/withdrawal quantity).

4. CONCLUSION

Before assessing the proposal to extend Type 4 price re-runs, this paper reviewed the principle of ex-ante pricing in SWEM to ensure a consistent application of sound market principles.

The paper concluded that ex-post pricing leads to a more efficient outcome, and ex-ante pricing is reasonable only insofar as it is a good estimate of the actual ex-post pricing. Notwithstanding, the paper recognises that the divergence between ex-ante pricing and ex-post pricing remains inevitable, with the only issue being the frequency and magnitude of such divergence.

The paper analysed both pricing methodologies under the following dimensions:

- **Short-term Efficiency** - Both ex-ante and ex-post pricing can provide generators with the certainty to adopt expensive generation options in times of supply shortage, so long as ex-post pricing is supplemented with a compensation arrangement to generators for which the market clearing price is inadequate to cover its costs of production. However, ex-post pricing has the advantage in that it compels consumers to respond more optimally to high prices by reducing their consumption to an efficient level.
- **Long-term Efficiency** - Instead of ex-ante pricing whereby investment decisions are guided by the MCE model rather than what happens in reality, in an ex-post regime both investment decisions and the model (through ex-post runs) will be more aligned to what happens in reality.

- **Equity** – Ex-post is likely more equitable, since prices will be based on actual decisions (e.g. level of consumption) and outcomes (e.g. transmission congestion) in the market, rather than upon a model whose input is a set of expectations on the like.

Notwithstanding, given Singapore's low demand volatility and the likely costs of implementing an ex-post pricing regime, EMC proposes to retain the current ex-ante pricing arrangement. In this case, it would not be consistent with market principles to extend Type 4 price reruns, as proposed, to cases whereby transmission lines have reached their limit in the MCE model but did not do so in reality as proposed.

Alternatively, EMC could look into reducing the market trading periods from the current 30 minutes to 5 minutes, which will lead to the convergence between ex-ante and ex-post pricing. Any price discrepancy will also have a smaller financial impact since it is now applied onto a smaller energy quantity.

5. INDUSTRY CONSULTATION

This concept paper was published for industry comments on 05 February 2010, and the following comments were received:

<u>Comments from Keppel Energy</u>

KMC supports the proposal for extension of Type 4 price re-runs based on the premise that this proposal would serve as an improvement towards the current modelling method, i.e. reduce divergence between MCE's model/inputs and actual conditions, and thus eliminate unwarranted price separation which only burden consumers unjustifiably. However, we would suggest that EMC conduct and provide a cost-benefit analysis, taking into considerations amongst others, the re-run cost against the social loss due to the price separation, so that market participants are better poised to evaluate this proposal further.

<u>EMC's Response</u>

The divergence between the MCE's model/inputs and actual conditions is not solely a modeling issue, but also because the model uses ex-ante inputs (e.g. load forecast, system conditions), which may differ from the actual conditions over the period. As discussed in the paper, there should be a consistent basis in determining which inputs to use, either ex-ante or ex-post; short of moving to a pure ex-post market, we should stick to ex-ante inputs and hence, not extend Type 4 price re-runs.

<u>Comments from Sembcorp Cogen</u>

SembCogen is of the view that type 4 rerun itself is already a post event. As EMA had retained type 4 rerun to correct imperfect modeling, for the same reason, we are of the view that type 4 rerun should be extended to take care of network constraint issue as well. The discussion on whether Singapore electricity market should adopt ex-ante or ex-post pricing in this case is not so relevant as the purpose of the rerun is to rectify erroneous modeling itself.

As such, for the interest of consumers, the market rule should have a provision for price correction due to artificial network constraint. We support this proposed rule change CP 24.

EMC's Response

It is true that the current Type 4 rerun is an example of ex-post input. However, EMC had earlier argued that it is inconsistent in our current ex-ante regime and sought for its removal, which received the support of the RCP and EMC Board before being rejected by the EMA. EMC is of the view that the current Type 4 price re-run is already inappropriate and hence, does not recommend its extension to even more cases.

Also, as discussed earlier, the divergence between the model and actual output is not due to "erroneous modeling", but also the fact that the MCE uses ex-ante inputs (e.g. load forecast, system conditions). This therefore raises the issue of ex-ante versus ex-post, and EMC's recommendation that since the SWEM is an ex-ante market, we should stick to using inputs that reflect ex-ante conditions. We should therefore not extend Type 4 re-runs that seek to use inputs reflecting ex-post conditions.

Comments from Senoko Energy

Singapore's Wholesale Electricity Market was designed and established with an ex-ante pricing methodology. Senoko Energy endorses the Concept Paper's proposal not to extend type 4 price re-reuns because of the certainty that ex ante pricing provides to market participants.

Senoko Energy considers that price re-runs should not be widened beyond their current scope because of the potential that re-runs can result in a final settlement price that is below a dispatched generator's offer price.

EMC's Response

We note Senoko's concurrence with EMC's view not to support the proposal to extend Type 4 re-runs.

6. RECOMMENDATIONS

EMC recommends that the RCP **not support** the proposal to extend Type 4 price reruns to cases whereby transmission lines have reached their limit in the MCE model but did not do so in reality, as it would not be consistent with the current ex-ante pricing principles.

7. DELIBERATION AT THE 48th RCP MEETING

The RCP considered the proposal at the 48th RCP meeting, and voted in the following manner:

Those who voted to extend Type 4 price reruns:

1.	Ms. Annie Tan	Representative of Retail Electricity Licensee
2.	Mr. Sim Meng Khuan	Representative of Generation Licensee
3.	Mr. Philip Tan	Representative of Generation Licensee

Those who voted not to extend Type 4 price reruns:

1. Mr. Kenneth Lim — Representative of EMC
2. Mr. Luke Peacocke — Representative of Generation Licensee
3. Mr. Lawrence Lee — Representative of Market Support Services Licensee
4. Mr. Chan Hung Kwan — Representative of Transmission Licensee
5. Mr. Michael Lim — Representative of Consumers of Electricity in Singapore

Those who abstained:

1. Mr. Robin Langdale — Person experienced in Financial Matters in Singapore
2. Mr. Yeo Lai Hin — Representative of the PSO

Thus, the RCP by majority vote decided **not to** extend Type 4 price reruns to cases whereby transmission lines have reached their limit in the MCE model but did not do so in reality.

ANNEX

Type of Price Revision/MCE Re-Run Cases	What EMC does	Intention
Type 1 Cases where the MCE has failed[6] to produce a real-time schedule (RTS) for a dispatch period for any reason other than a real-time market suspension.	Re-run the MCE to produce the real-time pricing schedule (Section 9.2.6, Chapter 6)	To determine prices for settlement.
Type 2 Cases where the MCE has used input data that are not entirely what should have been supplied to it at the time the RTS for a dispatch period would normally have been produced.	Re-run the MCE by using all correct input data that should have been used by the MCE at the time when the MCE runs. (Section 10.2.5, Chapter 6)	To ensure that prices for settlement are based on correct and timely input data to the MCE.
Type 3 Cases where the MCE has used the adjusted nodal load forecasts which take into account the energy shortfall specified by the PSO for a dispatch period.	Re-run the MCE by using the ‘unadjusted’ nodal load forecasts to (i) determine the prices for settlement, and (ii) to determine compensation for affected generators under Appendix 6I of Chapter 6. (Section 10.2.8, Chapter 6)	To ensure that prices for settlement reflect the energy shortfall in the dispatch period.
Type 4 Cases where the MCE has applied constraint violation penalty (CVP) for line constraint for a dispatch period and the PSO has subsequently confirmed that there was no load shed in that period.	Re-run the MCE by using the maximum actual line flow values supplied by the PSO; if no such values is received from the PSO, EMC will re-run the MCE by relaxing the line constraints in accordance with D.16.4, Appendix 6D of Chapter 6. (Section 10.2.3A, Chapter 6)	To ensure that prices for settlement reflect the prevailing line conditions for the dispatch period.

[6] This would include ‘failed/missing/late’ RTS. The word ‘failed’ means the MCE did not issue a RTS to market participants and PSO prior to “T-30 seconds” (i.e., in accordance with the market operations timetable in Appendix 6A of the Market Rules). Strictly speaking, ‘failed’ or ‘missing’ RTS should not be considered as price revision, since no prices had been produced by the MCE initially.

Type of Price Revision/MCE Re-Run Cases	What EMC does	Intention
Type 5 Cases where the MCE has produced prices which do not reflect their respective locational system marginal price(s) (LSMP).	Re-run the MCE by using all correct input data that should have been used by the MCE at the time when the MCE runs. (Section 10.2.5, Chapter 6)	To ensure that all prices used for settlement reflect their respective LSMP(s). In absence of transmission congestion, all nodal prices should reflect one SMP, after adjusting for losses. However, when congestion occurs, there would be price separation where there will be two or more SMPs established, and the nodes within different systems should reflect their respective LSMPs.