Notice of Market Rules Modification

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This paper assesses the current publication of offer data and addresses two related proposals to (i) review the dimensions of the data format (level of aggregation, masking and timing of publication) in which offer information can be released and (ii) extend the publication of offer information for reserve and regulation.

The benefits of information transparency include reducing information asymmetries, increasing market participation, improving market monitoring, improving demand response, increasing liquidity and reducing risk premiums. However, the costs of greater transparency include potentially facilitating collusion among suppliers, to the detriment of consumers.

Based on the analysis in this paper, **EMC recommends to maintain the status quo in the dimensions of the data format for energy offer publication** (i.e. aggregated and masked with a 4-week lag) as the incremental benefits to be gained from publishing data in a non-aggregated and non-masked manner with shorter time lag are expected to be small, while the costs (i.e. potential to facilitate collusion among suppliers), are expected to be high, given the existence of pivotal suppliers in the energy market.

On the other hand, extending the publication of supply curves to reserve and regulation is unlikely to significantly increase the likelihood of collusion from the status quo because there has been no pivotal supplier in the regulation market and there is a very low probability (~1%) of having at least one pivotal supplier in the reserve market. Furthermore, reserve providers are unlikely to have the incentive or ability to accurately withhold reserve capacity.

Therefore, it is recommended that EMC publishes the reserve and regulation supply curves with similar data format dimensions as the energy supply curve. This aggregated reserve and regulation offer information will show, for each half-hourly period and based on all offers considered for the Real-Time Schedule (RTS), each distinct offer price (in $/MWh) and the total offer capacity (in MW) at that price. A proposed template of this information is appended as Annex 5.

At the 103rd RCP meeting, the Panel in-principle supported publishing the reserve and regulation supply curves.

At the 105th RCP meeting, the RCP by majority vote **supported** the proposed rule modifications set out in **Annex 7**.

Date considered by Rules Change Panel: 13 November 2018

Date considered by EMC Board: 15 January 2019

Date considered by Energy Market Authority: 31 January 2019

Proposed rule modification:

See attached paper.

Reasons for rejection/referral back to Rules Change Panel (if applicable):

PAPER NO.	:	**EMC/BD/01/2019/06**
RCP PAPER NO.	:	**EMC/RCP/105/2018/355**
SUBJECT	:	**PUBLICATION OF OFFER DATA**
FOR	:	**DECISION**
PREPARED BY	:	**YAP YUN BEN / LOH LUCIA** **ECONOMIST / SENIOR ECONOMIST**
REVIEWED BY	:	**VERONICA RODRIGUEZ** **SVP, MARKET ADMINISTRATION**
DATE OF MEETING	:	**15 JANUARY 2019**

Executive Summary

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On the other hand, extending the publication of supply curves to reserve and regulation is unlikely to significantly increase the likelihood of collusion from the status quo because there has been no pivotal supplier in the regulation market and there is a very low probability (~1%) of having at least one pivotal supplier in the reserve market. Furthermore, reserve providers are unlikely to have the incentive or ability to accurately withhold reserve capacity.

Therefore, it is recommended that **EMC publishes the reserve and regulation supply curves with similar data format dimensions as the energy supply curve**. This aggregated reserve and regulation offer information will show, for each half-hourly period and based on all offers considered for the Real-Time Schedule (RTS), each distinct offer price (in $/MWh) and the total

offer capacity (in MW) at that price. A proposed template of this information is appended as Annex 5.

At the 103rd RCP meeting, the Panel (i) by majority vote **in-principle supported** publishing the reserve and regulation supply curves and (ii) by majority vote supported maintaining the status quo in the publication of energy offers.

At the 105th RCP meeting, the RCP by majority vote **supported** the proposed rule modifications set out in **Annex 7**.

1. Introduction

This paper reviews the current publication of offer data and addresses two related proposals to (i) review the dimensions of the data format (level of aggregation, masking and timing of publication) in which offer information can be released and (ii) extend the publication of offer information to reserve and regulation.

2. Background

2.1 Publication of Lagged Aggregated Energy Offer Information

In July 2014, the Energy Market Authority (EMA) published a decision paper on the "Review of market information to facilitate efficient electricity spot and futures trading". In the paper, EMA assessed, among other information, whether the price-quantity energy offers of market participants (MPs) in the Singapore Wholesale Electricity Market (SWEM) (at that time not made available) should be disclosed.

The objective was to enhance data transparency in order to facilitate efficient trading and risk management for participants both in the spot market and electricity futures market. However, the key concern with releasing energy offer information was that it could lead to exercise of market power, especially during tight supply situations. EMA opined that such concern could be mitigated by aggregating the energy offer information and delaying the release of the data. On balance, EMA decided to make available each half-hourly period's aggregated energy offer information to all data subscribers and SWEM's MPs through EMC with a four-week time lag. Please refer to **Annex 1** for a template of this information.

2.2 Proposals Received

During the 2015/16 Rules Change Work Plan Prioritisation exercise, a proposer suggested that EMC publishes the supply curve for energy and reserve for each dispatch period in real-time, so as to assist the market in understanding the drivers of energy and reserve prices. However, the RCP noted that arising from EMA's aforementioned decision paper in 2014, the energy supply curve was already being published with a four-week lag. The RCP thus refined the scope of this issue to examine the publication of reserve and regulation supply curves with a four-week lag rather than in real-time (i.e. extending the current publication of delayed aggregated energy offer information to reserve and regulation).

Additionally, another proposal received during the 2017/18 Rules Change Work Plan Prioritisation exercise suggests for EMC to release the delayed energy offer data earlier and with higher level of granularity. Hence, this paper will address all the above issues.

3. Analysis

The decision to publish offer information for the different products – **Energy, Reserve and Regulation** – in the SWEM boils down to an analysis of the benefits and costs of publishing such information. The RCP had examined this topic various times previously[1]. EMC's general conclusion[2] in those papers was that the benefits of publishing offer information did not outweigh the costs of doing so at that time of analysis, and that the decision should be reviewed again in

[1] Specifically, Papers No. EMC/RCP/40/2008/CP16: Publishing generation offers and dispatch quantities (dated 4 November 2008) and EMC/RCP67/2013/316: Publication of total available offer capacity (dated 7 May 2013).

[2] Note that in RC316, the RCP by majority vote supported the proposal to publish Total Available Offer Capacity for all products across all schedules, contrary to EMC's recommendation for the RCP not to support the proposal.

the future when the level of market concentration is lower. Therefore, in the sections that follow, we analyse the costs and benefits of publishing offer data.

3.1 Benefits of Information Disclosure and Transparency

It is widely accepted in economic literature that information disclosure is important for the efficient operation of markets. In general, market data transparency provides the following benefits[3]:

- **Reduces Information Asymmetries and Increases Market Participation** – Information asymmetries can create a competitive disadvantage for less informed MPs, thereby discouraging participation in a market, reducing entry, and reducing new investment[4]. MPs with a significant share of supply or consumption have a natural information advantage over smaller MPs, simply by virtue of having visibility of their own production (or demand) and costs which comprise a larger proportion of the market. Market data transparency reduces, or even eliminates this information asymmetry and therefore encourages greater participation in the market and improves decision making by smaller entities.

- **Improves Market Monitoring** – Visibility of market data allows for monitoring of the market by regulators, academics and other analysts, and the general public. The release of offer information may prompt academics and others to assess the causes of and cures for market power[5]. Such actions, and even the threat thereof, can increase market efficiency and promote public understanding that market outcomes are monitored and remediated when this is needed. This increases the general public's confidence in the market. While the energy supply curve that is currently published with a four-week lag is not disseminated to the public at large, it is given to all MPs and data subscribers, and any member of the public can apply to EMC for data subscription at a nominal cost.

- **Improves Demand Response** – Releasing information on aggregated offer curves allows MPs to predict the shape and position of the offer curve, thus providing an opportunity for some MPs to adjust their loads to profitably curtail consumption. Increasing demand responsiveness to price signals makes demand more elastic, and as a result, policies that improve demand responses to price signals, such as those that promote transparency, can mitigate unilateral and coordinated exercises of market power. However, as will be discussed in section 3.2, it may also increase the likelihood of coordinated behaviour among suppliers.

- **Increases Liquidity in Related Financial Markets** – Limited access to market information would cause smaller financial (and physical) MPs to exit (or forego entering) the electricity futures market, resulting in a less liquid financial market. If there is asymmetry in access to data, because smaller MPs would have visibility to a smaller portion of the market compared to larger MPs (who view their own data), bid-ask spreads could increase, and this could have a negative impact on market liquidity. Asymmetric access to offer information appears to be one of the primary concerns for stakeholders overseas[6].

- **Reduces Risk Premiums** – The ability to accurately predict the slope of the offer curve reduces risk premiums and also increases liquidity in the futures market. MPs can use

[3] "Electricity Market Data Transparency", CRA report to Alberta Market Surveillance Administrator, 22 Nov 2011, http://albertamsa.ca/uploads/pdf/Archive/2011/Market%20Data%20Transparency/CRA%20Report%20for%20MSA%2011-22%202011.pdf

[4] "Information and Competition in the Electric Power Markets: Is Transparency the Holy Grail?", 18 Nov 2014, http://www.felj.org/sites/default/files/docs/elj352/20-375-413-Niefer-final-11.1.pdf?v=2

[5] Ibid.

[6] "Electricity Market Data Transparency", CRA report to Alberta Market Surveillance Administrator, 22 Nov 2011, http://albertamsa.ca/uploads/pdf/Archive/2011/Market%20Data%20Transparency/CRA%20Report%20for%20MSA%2011-22%202011.pdf

historical offer curves to predict offers level for future periods. This is useful because large offer price differential can lead to price volatility. It is not sufficient for traders to have knowledge of the current price, since it is the slope of the offer curve that is useful in predicting price changes. Impairing the ability of MPs to predict price jumps would then potentially increase risk, and the market would therefore increase the risk premium.

3.2 Costs of Information Disclosure and Transparency

Although disclosure of market information generally improves market outcomes, it may also increase the likelihood of coordinated behaviour among suppliers. Such behaviour can result in a variety of harm, including high prices to consumers, productive inefficiency and dynamic inefficiency.

Market transparency does not by itself increase the risk of coordinated behaviour. It is only in the presence of other market factors such as high seller concentration, product homogeneity, inelastic demand and stability of costs, that market transparency can increase the likelihood of coordinated behaviour. Given that electricity is a homogeneous product, and that costs[7] and demand[8] are relatively stable in Singapore, it is important to assess the seller concentration and demand elasticity in the SWEM.

3.2.1 Degree of Competitiveness in the SWEM

The degree of competitiveness in the SWEM is assessed below using the Herfindahl-Hirschman Index (HHI) and the Pivotal Supplier Test. The higher the market concentration and number of pivotal suppliers, the greater the likelihood of collusion will be.

A. Herfindahl-Hirschman Index (HHI)[9]

The HHI is a commonly accepted measure of market concentration. The HHI increases both as the number of firms in the market decreases and as the disparity in size between those firms increases. The United States Department of Justice and the Federal Trade Commission generally classifies markets into three types[10]:

1. Unconcentrated Markets: HHI below 1,000
2. Moderately Concentrated Markets: HHI between 1,000 and 1,800
3. Highly Concentrated Markets: HHI above 1,800

The HHI in SWEM (based on registered capacities[11] of generators for energy) is **1,681** as of November 2017, indicating that the electricity market in Singapore is **moderately concentrated**.

[7] More than 90% of Singapore's electricity is generated using imported natural gas, largely via pipelines from Malaysia and Indonesia.

[8] With Singapore's tropical climate, there is relatively little seasonal variation in electricity consumption, although there is substantial variation from weekdays to weekends.

[9] The HHI is calculated by summing the square of the market share (in decimal) of each firm competing in a market and multiplying by 10,000. The HHI can range from close to zero (indicating near perfect competition) to 10,000 (indicating a monopoly).

[10] See Section 5.3 of the US DOJ and FTC horizontal merger guidelines, <http://www.justice.gov/atr/horizontal-merger-guidelines-08192010>. See also <http://www.justice.gov/atr/herfindahl-hirschman-index>. The HHI thresholds used in this paper are based on the thresholds adopted by FERC using the US DOJ and FTC's 1992 guidelines, see https://www.ferc.gov/whats-new/comm-meet/2012/021612/E-2.pdf.

[11] This includes the generation capacities of Generation Settlement Facilities, but excludes those of Commissioning Generation Facilities.

Compared with the HHI assessment done in a previous RCP paper (RC316)[12], the HHI has fallen from 2,521 in November 2012, where the market was then considered highly concentrated. This is due to an increase of 2,713 MW of registered capacity since then, bringing the total registered capacity in the market to about 13,524 MW as of November 2017.

B. Pivotal Supplier Test (for Energy and Regulation)

In RC316, a Pivotal Supplier Test was used to identify the market power of generation companies (gencos) in SWEM. The test was applied to Energy and Regulation only; excluding Reserve.

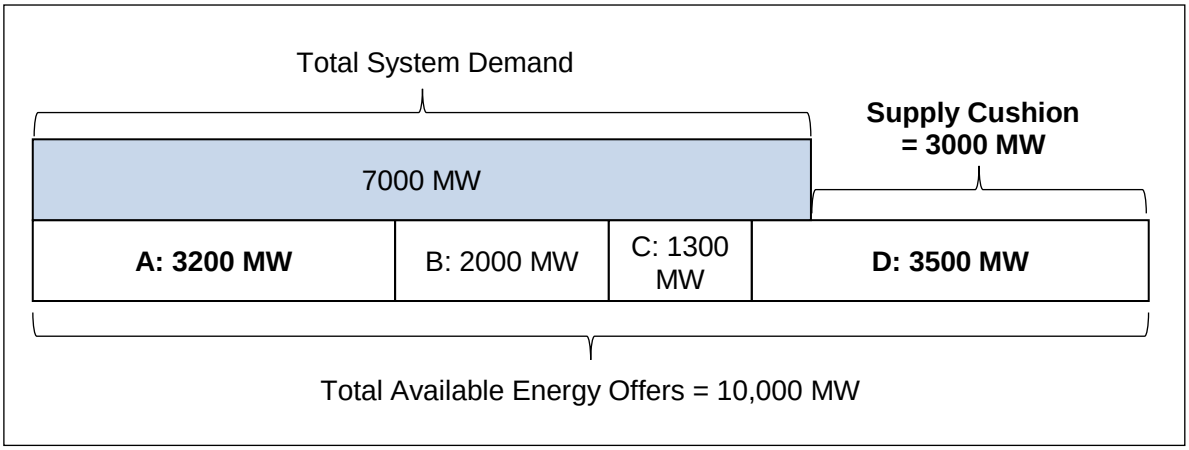
This section reassesses the market using the Pivotal Supplier Test, and compares it with the previous results in RC316 (based on 2012 data).

Background on Pivotal Supplier Test

The individual Pivotal Supplier Test measures the existence of and the extent to which each supplier's output must be individually scheduled to meet demand. With reference to Figure 1 below, suppose that the total system demand is 7,000 MW and the total offered capacity from 4 gencos (Gencos A to D) in a given dispatch period is 10,000 MW. The resulting supply cushion is 3,000 MW (i.e. 10,000 MW – 7,000 MW).

Applying an individual Pivotal Supplier Test, if either Genco A or D withdraws more than 3,000 MW of offered capacity, a supply shortfall will occur. This implies that two pivotal suppliers, Gencos A and D, exist in this given dispatch period.

Figure 1: Pivotal supplier(s) without contracts



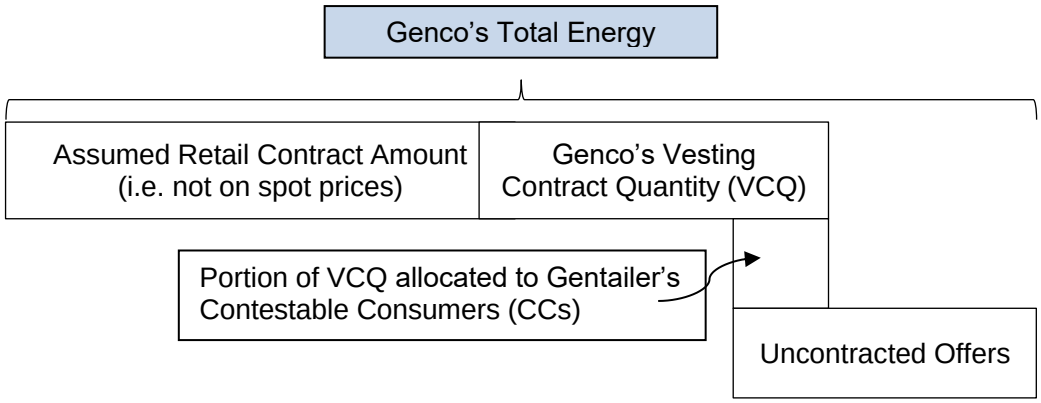
Steps used to Determine Existence of a Pivotal Supplier in the SWEM **(for Energy)**

The pivotal supplier test described in Figure 1 did not account for any contracted volumes which are not exposed to spot prices. However, in the SWEM, gencos have vesting contract and retail contract obligations (usually with its affiliated retailer). As such, there is a need to net off these contracted levels when determining the existence of a pivotal supplier for energy, as described in the steps below.

[12] See "RC316: Publication of total available offer capacity", dated 7 May 2013.

1. For each period, compute each Genco's Uncontracted Offers in the SWEM as reflected in Figure 2.

Figure 2: Computing a Genco's Uncontracted Offers (in MW)



- Uncontracted Offers = Genco's Total Energy Offers – Assumed Retail Contract amount – Genco's VCQ + Portion of VCQ allocated to Gentailer's CCs

Where:

Vesting Contract Quantity (VCQ)	=	Quarterly Vesting Quantity Allocated to Genco (period-weighted)
Portion of the total remaining VCQ for all CCs allocated to a Gentailer's CCs (after allocating VCQ to all non-CCs)	=	$\frac{\text{Total VCQ for all CCs}}{\text{Total WEQ of all CCs}} \times \text{WEQ}^{13}$ of Gentailer A
	=	$\frac{\text{Total VCQ} - \text{Total NCC load}}{\text{Total WDQ}} \times \text{WEQ of Gentailer A}$
Total NCC load	=	Total WEQ – Total WDQ
Assumed retail contract amount	=	X% of Gentailer's WEQ

The uncontracted offers in Figure 2 reflect the maximum energy offer quantity that a genco can withdraw once it has fulfilled its contract obligations. The portion of vesting contract quantity allocated to a gentailer's CCs will offset a portion of the genco's contracted position. Therefore, it forms part of the genco's uncontracted offers.

The analysis will evaluate non-spot price retail contract levels at 70%, 80%[14] and 90%.

For the Pivotal Supplier Test for Energy applied in 2012 (RC316), the NCC load used was 32% of Total Withdrawal Energy Quantity (WEQ). Due to an increase in retail contestability since then and the availability of metered total CC load data (i.e. Total WDQ), the analysis in this paper will be based on the actual NCC load calculated according to the formula shown above, which is lower than levels assumed in 2012.

[13] WEQ: Withdrawal Energy Quantity

[14] EMA assumed an 80% retail contract level in its review of the 2015/2016 Vesting Contract Levels.

2. For each period, compute Total System Demand.

   - Total System Demand = System-wide Energy Demand + Total Regulation Requirement + Total Contingency Reserve Requirement

Regulation requirement and reserve requirement are considered part of total system demand as the Total Energy Offer that a genco submits usually indicates the maximum quantity it is willing to generate at. This maximum quantity includes the facility's regulation offers and the maximum of its primary or contingency reserve offers. Contingency reserve requirement is used here as it is the largest of primary and contingency reserve requirements.

3. For each period, compute the Supply Cushion for Energy.

   - Supply Cushion for Energy = Total Available Energy Offers – Total System Demand

4. For each period, compare the supply cushion for energy with each genco's uncontracted offers. If a genco has uncontracted offers that exceed the supply cushion, that genco is considered to be a pivotal supplier for energy (for that given period).

Steps used to Determine Existence of a Pivotal Supplier in the SWEM (for Regulation)

1. For each period, compute the Supply Cushion for Regulation.

   - Supply Cushion for Regulation = Total Regulation Offers – Regulation Requirement

2. For each period, compare the supply cushion for regulation with each genco's total regulation offer. If a genco has a total regulation offer that exceeds the supply cushion, that genco is considered to be a pivotal supplier for regulation (for that given period).

Results of the Pivotal Supplier Test **(for Energy and Regulation)**

The Pivotal Supplier Test was applied to Energy and Regulation for all dispatch periods from **1 October 2017 to 31 December 2017 (4416 Periods) (referred to as "current test")**. These results are compared against those of the Pivotal Supplier Test applied for the period **1 June 2012 to 31 August 2012 (4416 Periods) in RC316 (referred to as "past test")**, and are shown in Tables 1 - 3 below.

Table 1: Results for the current test (1st October 2017 - 31 December 2017)

Product	Assumed Retail Contract Level	Total No. of Periods									
		At least 1 Pivotal Supplier		1 Pivotal Supplier		2 Pivotal Suppliers		3 Pivotal Suppliers		4 Pivotal Suppliers	
		No.	%	No.	%	No.	%	No.	%	No.	%
Energy	70%	364	8.24%	356	8.06%	8	0.18%	0	0.00%	0	0.00%
	80%	213	4.82%	210	4.76%	3	0.07%	0	0.00%	0	0.00%
	90%	139	3.15%	139	3.15%	0	0.00%	0	0.00%	0	0.00%
Reg	NA	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%

Table 2: Results for the past test (1st June 2012 - 31 August 2012)[15]

Product	Assumed Retail Contract Level	Total No. of Periods									
		At least 1 Pivotal Supplier		1 Pivotal Supplier		2 Pivotal Suppliers		3 Pivotal Suppliers		4 Pivotal Suppliers	
		No.	%	No.	%	No.	%	No.	%	No.	%
Energy	70%	809	18.32%	547	12.39%	251	5.68%	4	0.09%	7	0.16%
	80%	530	12.00%	384	8.70%	136	3.08%	8	0.18%	2	0.05%
	90%	301	6.82%	264	5.98%	29	0.66%	8	0.18%	0	0.00%
Reg	NA	585	13.25%	585	13.25%	0	0.00	0	0.00%	0	0.00%

Table 3: Comparison of results (Current test – Past test)

	% Retail Level	Total No. of Periods									
		At least 1 Pivotal Supplier		1 Pivotal Supplier		2 Pivotal Suppliers		3 Pivotal Suppliers		4 Pivotal Suppliers	
		No.	%	No.	%	No.	%	No.	%	No.	%
E	70%	-445	-10.08%	-191	-4.33%	-243	-5.50%	-4	0.09%	-7	-0.16%
	80%	-317	-7.18%	-174	-3.94%	-133	-3.01%	-8	-0.18%	-2	-0.05%
	90%	-162	-3.67%	-125	-2.83%	-29	-0.66%	-8	-0.18%	0	0.00%
R	NA	-585	-13.25%	-585	-13.25%	0	0.00%	0	0.00%	0	0.00%

Table 3 shows that the **number of periods with pivotal supplier for energy and regulation has decreased significantly**. Specifically, for regulation, while there were some periods with one pivotal supplier in the past test, **none of the periods had any pivotal supplier for regulation** in the current test.

Overall, the results suggest that **both the markets for Energy and Regulation have become more competitive over the past years**, and that market power of suppliers is less of a concern now.

C. Pivotal Supplier Test (for Reserve)

The Pivotal Supplier Test was not applied to Reserve in RC316, for two reasons:

a. Reserve costs are allocated to gencos

Reserve costs are currently allocated to gencos as a function of their scheduled energy level and standing probability of failure. To avoid paying high reserve charges and to hedge their reserve exposure, gencos will usually offer a certain proportion of their facility's capacity into the reserve market. They thus have less incentive to withhold reserve capacity in this market.

[15] The results for the past test shown in this paper are different from the one published in RC316 due to some inaccuracies and errors in the results published in RC316.

b. Reserve requirements are endogenously determined

To withhold reserve capacity, a genco must be aware of the actual reserve requirement and its own reserve capability (which varies with its scheduled energy level). However, these are not known ex-ante because:

i. System-wide reserve requirement depends on largest scheduled generator

Currently, reserve requirements are based on the largest generator scheduled in a given dispatch period. However, the reserve requirements will only be determined in the real-time dispatch schedule (RTDS), which is published just slightly prior to the start of the dispatch period. Gencos are thus unable to accurately predict the reserve requirement until then and resultantly, unable to reduce reserve capacity ahead of the dispatch period.

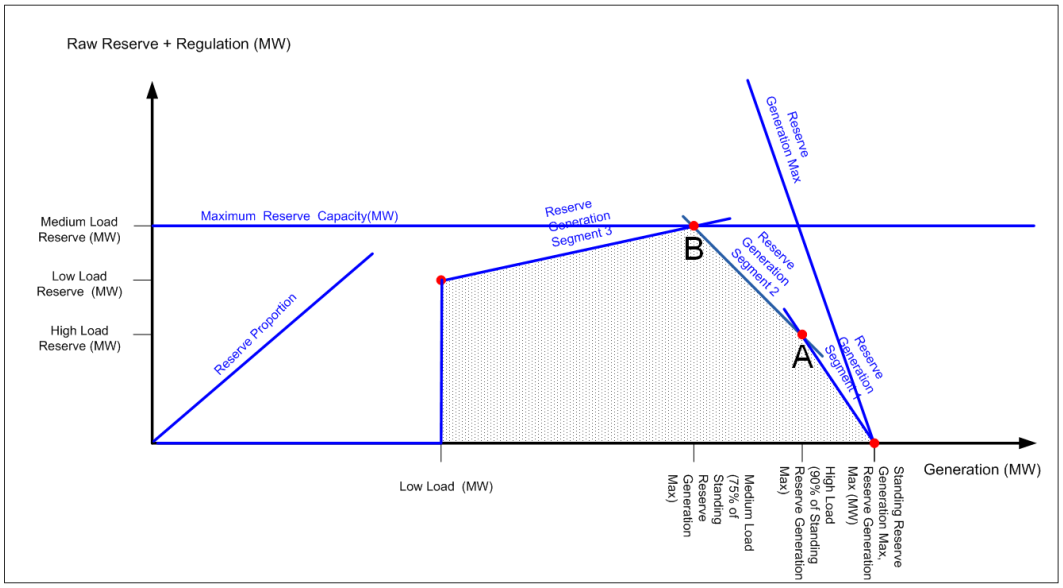
Even if forecast schedules give gencos an insight of the largest generator that may potentially be scheduled, offers are subject to changes before gate closure. After gate closure, gencos that try to withhold capacity cannot do so without reasonable justification. Thus, there remains an element of uncertainty.

ii. A generator's scheduled reserve depends on its scheduled energy level

The Market Clearing Engine (MCE) currently models each generator's ability to provide reserve using their respective reserve capability envelope, for which an example for primary reserve is shown in Figure 3. This envelope shows a generator's scheduled energy level (x-axis) and its corresponding reserve capability at that generation level (y-axis). For example, referring to Point A in Figure 3, if the MCE chooses to schedule a generator at High Load, the generator can only provide a maximum level of primary reserve equal to its High Load Reserve. This level is much lower than if the generator had been scheduled at its Medium Load, in which case it can provide a maximum level of primary reserve equal to its Medium Load Reserve (see Point B).

Thus, for a genco to be certain of its scheduled reserve and resultantly, excess reserve capacity that it may withhold, it must have certainty over its scheduled energy level. However, as stated, a genco will not know its actual scheduled energy until the publication of the RTDS. As such, it is hard for a genco to accurately withhold reserve capacity to drive up prices or create a reserve shortfall.

Figure 3: Reserve Capability Envelope



Notwithstanding the above reasons, in this paper, a Pivotal Supplier Test was applied on an ex-post basis to Reserve[16]. This means that using data from actual historical periods' reserve requirements and scheduled energy levels, the Pivotal Supplier Test was applied to reserve providers to gauge whether (assuming that the system-wide reserve requirements and gencos' scheduled energy levels could be known in advance) there were any pivotal suppliers for reserve.

The results would provide an indication of the extent of potential detriment if reserve supply curves, that could indirectly provide some kind of "ex-ante" information for future periods (especially if offer patterns for energy, reserve and regulation do not change much over time), are published. The potential detriment would be lower if there are no or few pivotal suppliers for reserve.

Steps used to Determine Existence of a Pivotal Supplier in the SWEM **(for Reserve)**

The steps described below are applied to **each class of reserve** (Primary Reserve and Contingency Reserve) **separately**.

1. For each period, compute the Total Reserve Requirement for a given reserve class.

   - Total reserve requirement for a given reserve class = Ex-post system-wide reserve requirement for that reserve class

2. For each historical period, compute each Genco's Actual Total Reserve Capability based on the actual scheduled energy level for each of its generators, adjusted for each generator's reserve effectiveness. Please refer to **Annex 2** for details on reserve effectiveness and the scaling factors corresponding to the different reserve provider groups.

   - Actual reserve capability for each facility = Reserve Effectiveness Scaling Factor × Minimum (Reserve offer for that genco's facility, maximum reserve capability at that facility's ex-post scheduled energy level)
   - Genco's actual total reserve capability = Sum of actual reserve capability of each facility across all of the genco's facilities

3. For each period, compute the system-wide Total Reserve Capability (i.e. Total reserve offers subject to actual reserve capabilities).

   - Total Reserve Capability = Sum of (each genco's actual total reserve capability) across all gencos with reserve offers + Sum of all Interruptible Loads' offers[17]

4. For each period, compute the Supply Cushion for Reserve.

   - Supply Cushion for Reserve = Total Reserve Capability – Total Reserve Requirement

5. For each period, compare the supply cushion for reserve with each genco's actual total reserve capability. If a genco has an actual total reserve capability that exceeds the supply cushion, that genco is considered to be a pivotal supplier for **reserve** (for that given period).

[16] Note that in calculating the Total System Demand (= System-wide Energy Demand + Total Regulation Requirement + Total Contingency Reserve Requirement) for the Pivotal Supplier Test for Energy, the Total Contingency Reserve Requirement is also endogenously determined and hence used on an ex-post basis.

[17] Interruptible Loads' reserve capabilities are taken as equal to their reserve offers because they are not subject to the Reserve Capability Envelope in Figure 3, and their Reserve Effectiveness Scaling Factor is 1.

Results of the Pivotal Supplier Test **(for Reserve)**

The Pivotal Supplier Test was applied to Reserve on an ex-post basis for all dispatch periods from **1 October 2017 to 31 December 2017 (4416 Periods).**

The results of the Pivotal Supplier Test for Reserve are shown in Table 4 below.

Table 4: Results of the Pivotal Supplier Test for Reserve

Class of Reserve	Total No. of Periods									
	At least 1 Pivotal Supplier		1 Pivotal Supplier		2 Pivotal Suppliers		3 Pivotal Suppliers		4 or More Pivotal Suppliers	
	No.	%	No.	%	No.	%	No.	%	No.	%
Primary	47	1.06%	2	0.05%	2	0.05%	2	0.05%	41	0.91%
Contingency	54	1.22%	43	0.97%	4	0.09%	2	0.05%	5	0.11%

As shown in Table 4, there is at least one pivotal supplier about 1% of the time for both reserve classes. In general, the probability of having a pivotal supplier in any period for each of the two classes of reserve is low. Coupled with the fact that reserve costs are allocated to gencos (which reduces their incentive to withhold reserve capacity), and that reserve requirements are endogenously determined (which makes it hard for a genco to accurately withhold reserve capacity to drive up prices or create a reserve shortfall)[18], we assess that there are no **market power concerns in the Reserve market** at present.

3.2.2 Price Elasticity of Demand in the SWEM

Price inelastic demand makes the exercise of market power – either unilaterally or through coordinated behaviour – more profitable and hence more likely. Greater demand response would curb suppliers' ability to exercise market power as consumers would be able to respond to high prices by curtailing their load.

In SWEM, the demand forecast provided by the PSO, which is used for scheduling, is assigned a very high bid price of $50,000/MWh in the MCE. Although consumers are now able to submit bids into the energy market (as part of the EMA's Demand Response Scheme since 28 April 2016), such participation is still in its nascent stages. The corollary is that demand remains largely perfectly price inelastic in the SWEM, with the system demand being completely served (perfectly inelastic) as long as there are sufficient energy offers, even if such offers are priced at the price cap of $4,500/MWh.

3.3 Dimensions of Data Format

There are various possible formats in which offer information can be released. These data format dimensions include[19]:

- **Level of aggregation** – For example, full disclosure at the aggregate level across all suppliers
- **Masking** – For example, concealing the identity of the market participant (MP)

[18] As discussed earlier in Section 3.2.1C (a) and (b) of this paper.

[19] "Transparency and Confidentiality in Competitive Electricity Markets", US Agency for International Development and the National Association of Regulatory Utility Commissioners, Jun 2009, source: http://www.naruc.org/international/Documents/EnergyDataTransparencyRpt0609.pdf

- **Timing of publication** – For example, delaying the publication of information for days, weeks or months

The risk of coordinated behaviour can be mitigated by changing the manner in which offer information is disclosed, for example by aggregating offers across all suppliers, masking the identity of each individual supplier, and delaying the publication of information.

While the publication of information may facilitate collusion, such behaviour should be addressed by other means in the long term, most effectively by increasing competition (for example, by facilitating entry, requiring divestiture, or expanding the market by increased interconnection capacity). In the shorter term, tacit or actual collusion is better handled by competition law.[20]

Further, in the Energy Sector Inquiry by the European Commission[21], it was concluded that "the risk of collusion does not outweigh the advantages of more transparency" and that "in any case, the risk of facilitating collusion could be reduced by only publishing figures on an aggregated rather than individual basis". Also, if data were published so promptly that it could be useful for suppliers to confirm whether colluders are sticking to an implicit or explicit price fixing agreement, having a sufficient lag would make it less of a concern.[22]

3.4 Assessment of Proposals

3.4.1 Recommended Dimensions of Data Format

Level of Aggregation

As discussed in Section 3.1, there are benefits to be gained from market data transparency in general. However, most of the benefits listed in Section 3.1 can already be realised by publishing the data in an aggregated manner. While the increase in competition could justify the publication of non-aggregated offer data, the incremental benefits to be gained by publishing non-aggregated data are expected to be small. Specifically, in our view, the only incremental benefit from publishing non-aggregated data is the ability to further improve market monitoring by the public.

Moreover, the costs of greater transparency are expected to be high as publishing data in a non-aggregated manner could potentially facilitate collusion among suppliers, to the detriment of consumers. For these reasons, **EMC recommends that the offer data continues to be published in an aggregated manner**.

Masking

Apart from the reasons stated above, the disclosure of the identity of the MP does not necessarily bring about incremental benefits. In fact, the disclosure of the identity could potentially facilitate collusive behaviour as it gives MPs the opportunity to monitor the behaviour of one another and the ability to enforce collusion. Hence, **EMC recommends that the identity of MPs continues to be masked**.

[20] "EFET updated position, May 2006, Transparency of information about the availability and use of infrastructure and the promotion of competition in European wholesale power markets", http://www.ceer.eu/portal/page/portal/EER_HOME/EER_CONSULT/CLOSED%20PUBLIC%20CONSULTATIONS/ELECTRICITY/GGP%20Transparency/RR/E06-PC-08-21_EFET_EMIT_updated_position_final.pdf

[21] "Energy, Basic Industries, Chemicals and Pharmaceuticals", EC DG Competition, 10 Jan 2007, source: http://ec.europa.eu/competition/sectors/energy/2005_inquiry/full_report_part2.pdf

[22] "Transparency and Confidentiality in Competitive Electricity Markets", US Agency for International Development and the National Association of Regulatory Utility Commissioners, Jun 2009, source: http://www.naruc.org/international/Documents/EnergyDataTransparencyRpt0609.pdf

Timing of Publication

EMC recommends that the energy offer data continues to be published with a 4-week lag for the following reasons:

- While the concentration in the SWEM has indeed reduced over the past few years as measured by both the Pivotal Supplier Test and the HHI, SWEM is still considered **moderately concentrated** (as measured by HHI). Additionally, the HHI should be interpreted carefully as it tends to underestimate concentration since it is calculated based on registered capacity instead of effective capacity[23].

- If data were published too promptly, it could be easier and faster for suppliers to confirm whether colluders are sticking to an implicit or explicit price fixing agreement. Hence, having a sufficient lag would make the issue of tacit collusion less of a concern.

- The incremental benefits to be gained from earlier release of offer data are expected to be small as we do not foresee how offer information will assist MPs in making spot and futures trading decisions since these decisions are normally made based on system-wide information such as load forecast, outages, prices and etc.

- Most other jurisdictions adopt an even longer time lag despite having relatively less concentrated markets compared to SWEM, as illustrated in Table 5 below (refer to **Annex 4** for indicative HHI for some of the jurisdictions).

Table 5: Posting Time Lag in Other Jurisdictions[24]

Posting Time Lag	Wholesale Electricity Market Operator(s)
At the end of each trading hour	NYISO (day-ahead bid data)
1-day lag	AEMO, NZEM
2-day lag	ERCOT
2-month lag	AESO
3-month lag	MISO, ISO-NE, NYISO (all bid data), CAISO
4-month lag	PJM

3.4.2 Publishing Offer Data for Reserve and Regulation

EMC recommends publishing reserve and regulation supply curves for the following reasons:

- **Increasing market data transparency provides benefits** such as reducing information asymmetries, increasing market participation, improving market monitoring and improving provision of ancillary services from demand side (as discussed in Section 3.1).

- **Likelihood of increasing collusion is low**. The energy supply curve is already published. Extending the publication of supply curves to reserve and regulation is unlikely to significantly increase (if at all) the likelihood of collusion from the status quo because:
  a) In the current Pivotal Supplier Test, there were **no pivotal suppliers in the regulation market and low probability (~1%) of having at least one pivotal supplier in the reserve market**.
  b) **Competition in the regulation market is expected to increase** in the future when batteries enter the market.
  c) **Reserve costs are allocated to gencos** (which reduces their incentive to withhold reserve capacity), and **reserve requirements are endogenously determined** (which

[23] Effective capacity excludes generators which do not normally generate (for example due to them being uneconomic or inefficient), but which have yet to be decommissioned, deregistered or retired.

[24] For more details on offer data disclosure practices in other jurisdictions, refer to **Annex 3**.

makes it hard for a genco to accurately withhold reserve capacity to drive up prices or create a reserve shortfall).

Among the three different products – **Energy, Reserve and Regulation** – in the SWEM, the Energy market appears to be the one with the greatest market power concern, with 3.15% - 8.24% of the periods in the study period having at least one pivotal supplier (as compared to close to zero probability for reserve and regulation). To this end, the EMA's decision to publish aggregated (as opposed to unit-specific) energy offer information with a four-week lag (as opposed to real-time) would help mitigate concerns that the release of energy offer information could lead to the exercise of market power, as discussed in Section 3.3.

In comparison, given that market power is less of a concern in the reserve and regulation markets, the proposed publication of reserve and regulation supply curves could potentially be done with a shorter lag than the four weeks that is currently used for energy.

Nevertheless, for a start, and for consistency with the publication of the energy supply curve, it is **recommended that EMC publish the reserve and regulation supply curves with similar data format dimensions as the energy supply curve** too. The aggregated reserve and regulation offer information will show, for each half-hourly period and based on all offers considered for the RTS, each distinct offer price (in $/MWh) and the total offer capacity (in MW) at that price. A proposed template of this information is appended as Annex 5.

3.4.3 Implementation Cost

The breakdown of the estimated implementation time and costs are set out in Table 6 below.

Table 6: Estimated Implementation Time and Costs

Time Estimates	Effort Estimates (Man weeks)	Lapse Time (Calendar weeks)
0. Vendor Selection	N.A.	8
1. Change Requirement Scoping and Analysis	3	2
2. System Development/Testing/Documentation/Project Management	8.2	6
3. User Acceptance Testing (UAT)	2.5	4
4. Audit	N.A.	N.A.
Total Effort Required	**13.7**	**20**
Cost Estimates		
1. EMC Manpower (Within EMC's budget)	$29,200	
2. External Resource to Support (Vendor)	$31,084	
3. Audit	N.A.	
4. Operation Cost	N.A.	
Total Additional Cost Required	**$31,084**	

In addition, as there will be a code freeze period from March 2018 to January 2019 for EMC's server technology refresh, implementation of Items 2 – 4 (namely, System Development/Testing, UAT and Audit) is preferred to only begin **from February 2019**. Otherwise, **additional costs estimated at $9,216** to merge the code would be incurred.

4. Consultation

The concept paper was published for consultation on 12 March 2018, and comments were received from 4 stakeholders, namely PacificLight Power, Senoko, Tuaspring and Keppel Merlimau Cogen.

Comments from PacificLight Power

1) *Timeliness of information is important. PacificLight Power (PLP) therefore advocates a shorter lag time of 2 weeks for the energy offer data to be released to the market. The existing lag of 4-weeks is too long and reduces the benefit and usefulness of making the data available to market participants. The benefits would extend to the market maker for pricing of the future contracts, in particular the prompt quarter/month's contracts, and market participants who purchase electricity from the spot market.*

2) *PLP supports the early implementation of publishing offer data for reserve and regulation so long as it does not entail significant additional costs to the market.*

EMC's Response

1) We note PLP's preference to publish the energy offer data with a shorter time lag of 2 weeks. We agree in general that information timeliness correlates directly with usefulness for the user. However, for reasons explained in section 3.4.1, we do not recommend shortening the time lag. Specifically to facilitate MPs in making spot and futures trading or pricing decisions, there are currently useful information that are already being promptly published (such as prices, load forecast, AGOP, etc).

2) We note PLP's preference for early implementation of the publication of offer data for reserve and regulation. As mentioned in section 3.4.3 of this paper, additional costs estimated at $9,216 would be incurred if this proposal is to be implemented during EMC's server technology refresh period from March 2018 to January 2019.

Comments from Senoko

1) *We are supportive of publishing offer data for reserve and regulation, which helps to increase the transparency and efficiency of the market. However, we think that improvements can be made to remove the aggregation, masking and time lag of the offer data.*

2) *The paper has stated that the incremental benefits are expected to be small, while the costs are expected to be high. It is not clear why the incremental benefits are expected to be small, hence we would request EMC to evaluate further on the benefits of improving offer data on helping to increase market participation, demand response participation and liquidity in the electricity futures market.*

3) *We question the assessment that the potential to facilitate collusion is high, as it is demonstrated in the pivotal supplier test in the paper, that the SWEM have become significantly more competitive, while Frontier Economics stated in their final report for EMA in the Vesting Contract Regime Review that there is limited evidence for likely exercise of market power in SWEM and assessed to reduce VCL to the minimum level by end of 2018. EMA is also vigilantly monitoring the market for collusive behaviour. For the HHI calculation, the US Department of Justice website[25] states that moderately concentrated markets are in the HHI range of 1500–2500.*

4) *On top of that, the generation market share of the companies should be used, as there is a significant amount of registered capacity that is idle due to the high level of supply cushion, which is concurred by EMA CE's presentation slide 3[26] which shows the SWEM is in the 'Competitive' state.*

[25] https://www.justice.gov/atr/herfindahl-hirschman-index

[26] https://www.emcsg.com/f1671,123943/1_-_Ng_Wai_Choong_Energy_Market_Authority.pdf

EMC's Response

1) We note Senoko's support for the publication of reserve and regulation offer data.

2) The incremental benefits to be gained from publishing energy offer data in a non-aggregated and non-masked manner with shorter time lag are expected to be small because currently there are already other useful information that are being published such as prices, load forecast, AGOP, etc.

   While offer data could indeed facilitate demand response participation, we expect that assessment of the potential to participate, for example, would depend on data over a longer term and in a system-wide manner. There is thus no compelling reason for offer data to be published earlier (which in any case would always be published ex-post) or in a more granular manner, from the perspective of facilitating demand response participation.

   Similarly, we are unable to establish how earlier publication of energy offer data would increase market participation and liquidity in the electricity futures market given the suite of data currently available (e.g. prices, load forecast, outages).

3) While the measures of HHI and Pivotal Supplier Test have shown improvements in the state of competition in SWEM, we assessed that the market is still moderately concentrated.

   As for the HHI thresholds, while the DOJ states that moderately concentrated markets are defined as those with HHI in the range of 1500–2500, the FERC (regulator of the electricity industry) has decided to retain and adopt the previous HHI threshold (where moderately concentrated markets are defined as those with HHI in the range of 1000–1800) because based on FERC's experience in the electricity markets, they believe that more stringent thresholds are appropriate, especially given the distinctive characteristics of electricity markets[27]. As such, in this paper, we have adopted HHI thresholds aligned to FERC's for consistency.

Comments from Tuaspring

In response to EMC's consultation for publishing the offer data for reserves and regulations, Tuaspring feels uncomfortable about releasing this sensitive information. Unlike energy where market participants dynamically adjust the pricing from month to month depending on the cost of supply and demand-supply conditions, the reserve and regulation market tend to be more static. While there may be no significant concerns for market concentration, given the nature of these markets, releasing the offer stack can facilitate tacit collusion through signalling much more than the energy market. As such, Tuaspring believes releasing the offer data for reserve and regulation will be more detrimental than helping to improve market transparency.

EMC's Response

The ability to tacitly collude is dependent on, among others, the level of competition in the market. The results of the pivotal supplier test in this paper shows that there are few instances where pivotal suppliers are present.

Further, as the scheduling outcomes for reserve and regulation from generation registered facilities are subject to other modelling constraints (such as their respective energy schedules and reserve/regulation capability envelopes), EMC's view is that the availability of system-wide aggregated offer data alone should not be able to provide sufficient data to facilitate tacit collusion.

[27] Refer to Paragraph 39 of the FERC's "Analysis of Horizontal Market Power under the Federal Power Act", issued 16 February 2012: https://www.ferc.gov/whats-new/comm-meet/2012/021612/E-2.pdf

Comments from Keppel Merlimau Cogen

1) *We support EMC's recommendation to publish the reserve and regulation supply curves with similar data format dimensions as the energy supply curve.*

2) *With regards to the template of lagged aggregated reserve offer information, please clarify if the total offer capacity at specified offer price is adjusted for each generator's reserve effectiveness.*

EMC's Response

1) We note Keppel Merlimau Cogen's support for the publication of reserve and regulation supply curves with similar data format dimensions as the energy supply curve.

2) The total reserve offer capacity at the specified offer price is proposed to be adjusted for each reserve provider's reserve effectiveness as this information will be more reflective of the actual reserve capacity offered in the market. Note, though, that in settlement, reserve providers are paid based on their raw scheduled quantity at their respective adjusted reserve price.

5. Conclusion

This paper examined the current publication of offer data and addressed two related proposals to (i) review the dimensions of the data format (level of aggregation, masking and timing of publication) in which offer information are released and, (ii) extend the publication of offer information to reserve and regulation to increase data transparency relating to offer information.

Having assessed the benefits and costs of greater information transparency, EMC recommends retaining the current data format dimensions pertaining to the publication of energy supply curve. Further, EMC recommends publishing the reserve and regulation supply curves with similar data format dimensions as the energy supply curve, which is currently published in an aggregated manner with a four-week lag.

6. Deliberations at the 102nd RCP Meeting and Decisions at the 103rd RCP Meeting

The concept paper was first presented at the 102nd RCP meeting, where EMC recommended that the RCP support (a) publishing reserve and regulation supply curves with similar data format dimensions as the energy supply curve, and (b) maintaining status quo for the publication of the energy supply surve.

With reference to Senoko's comments (in section 4 above) on the calculation basis for HHI, the RCP requested for EMC to survey the practices in other jurisdictions. Additionally, the RCP also tasked EMC to consult the EMA on whether they would have any concerns with shortening the time lag, increasing the level of granularity and/or removing masking of identities with which energy offers are currently published.

At the 103rd RCP meeting, EMC presented the following updates to the Panel:

6.1 Calculation Basis for HHI

Markets surveyed generally use market shares based on either capacity or output to calculate the HHI (refer to Annex 6 for details). However, notwithstanding the use of HHI in our preceding

analysis, note that the HHI also has limitations[28] in its use as a structural indicator of the competitiveness of a market. It is therefore not a definitive measure of a market's competitiveness and should be interpreted together with other metrics (such as number of pivotal suppliers, price-cost mark-up), as has been done in section 3.2.1 of this paper, in order to provide a fuller picture of the state of the market.

6.2 EMA's concerns on changing the data format dimensions for the publication of energy offers

EMA expressed that they would be concerned if the publication lag time for energy offers is reduced. EMA's views can be summarised as follows:

- EMA in general agrees with EMC's assessment that the incremental benefits to be gained for increased disclosure are expected to be small;
- The status quo, with respect to the publication of energy offers, remains beneficial to mitigate the potential for coordinated exercise of market power that may arise from increased information transparency; and
- The current 4-week delay is useful for short-term market conditions to normalise, and to mitigate informational feedback that would allow for strategic bidding which facilitates exercise of market power.

6.3 RCP's decisions at the 103rd RCP Meeting

Having considered the concept paper and the above updates at the 103rd RCP meeting, the RCP by **majority vote in-principle supported** (i) publishing reserve and regulation supply curves with similar data format dimensions as the current energy supply curve, and (ii) maintaining status quo for the publication of the energy supply curve. In relation to (i), the RCP **by majority vote supported** implementing the changes **from March 2019**.

The details of the voting outcomes are as follows:

Table 7: Summary of Voting Outcomes at 103rd RCP Meeting

RCP Member		(i) Publishing Reserve and Regulation Offers	(ii) Maintain Status Quo for Energy Offers	Start to Implement from March 2019
Representative of EMC	Mr. Henry Gan	Support	Support	Abstained
Representative of PSO	Mr. Soh Yap Choon	Abstained	Support	Abstained
Representative of Generation Licensee	Mr. Tan Jun Jie	Support	Do not support	Support
	Mr. Tony Tan	Support	Do not support	Support
	Mr. Teo Chin Hau	Support	Do not support	Support
Representative of Retail Electricity Licensee	Mr. Sean Chan	Support	Support	Support
	Mr. Daniel Lee	Support	Do not support	Support
Representative of Wholesale Electricity Trader	Mr. Matthew Yeo	Support	Abstained	Support
Representative of market support services licensee	Ms. Ho Yin Shan	Support	Support	Support
Person experienced in Financial Matters in Singapore	Mr. Tan Chian Khong	Support	Support	Support
Representative of Consumers of Electricity in Singapore	Dr. Toh Mun Heng	Support	Support	Support
	Mr. YK Fong	Support	Support	Support
Decision		**By majority vote support**	**By majority vote support**	**By majority vote support**

[28] For example, (i) HHI does not consider market demand - In the extreme case where all or most generation capacities are required to meet demand, even the smallest of generators has market power, and (ii) HHI does not consider the fact that firms may not have the incentive to exercise market power, even if they possess the ability to do so, when they are over-contracted, for example.

7. Proposed Rule Modifications

To give effect to the RCP's decision in section 6.3, EMC has drafted the proposed rule modifications set out in Annex 7 and summarised in Table 8 below.

Table 8: Summary of Proposed Modifications

Chapter/ Section of Market Rules	Proposed Changes	Reasons for Change
Chapter 5 section 4.6	Replaced "2.1.4" with "2.1.5.4".	To correct erroneous reference.
Chapter 6 section 11.2 (new)	Added new sections to: ▪ require EMC to publish aggregated energy, reserve and regulation offer quantities on the 28th day after each trading day; ▪ stipulate that the published offers are accepted valid offers required to be used by the EMC in the production of the real-time schedule; ▪ stipulate that for aggregated reserve offer data, the quantity in each price-quantity pair is multiplied by the reserve effectiveness applicable to the offer; and ▪ specify that the identities of the offers are not published.	To reflect the current publication of aggregated energy offers. To give effect to the proposal to publish reserve and regulation offers.
Appendix 6D section D.3	Replaced "D.10" with "D.11". Redrafted description.	To correct erroneous reference. To clarify that the EstReserveEffectiveness parameter for a GRF is used to calculate the effective risk due to failure of that GRF.

8. Legal Sign-Off

The text of the proposed modifications in Annex 7 has been vetted by EMC's external legal counsel, whose opinion is that the proposed rule modifications reflect the intent of the rule modification proposal as expressed in the third column of the table in Annex 7.

9. Limitations of Offer Data in Corroborating Real-Time Outcomes

Given co-optimisation and various constraints which sets out the dependencies between energy and reserve/regulation capabilities, the use of offer data alone to corroborate real-time scheduling and/or price outcomes may be insufficient and possibly be misleading.

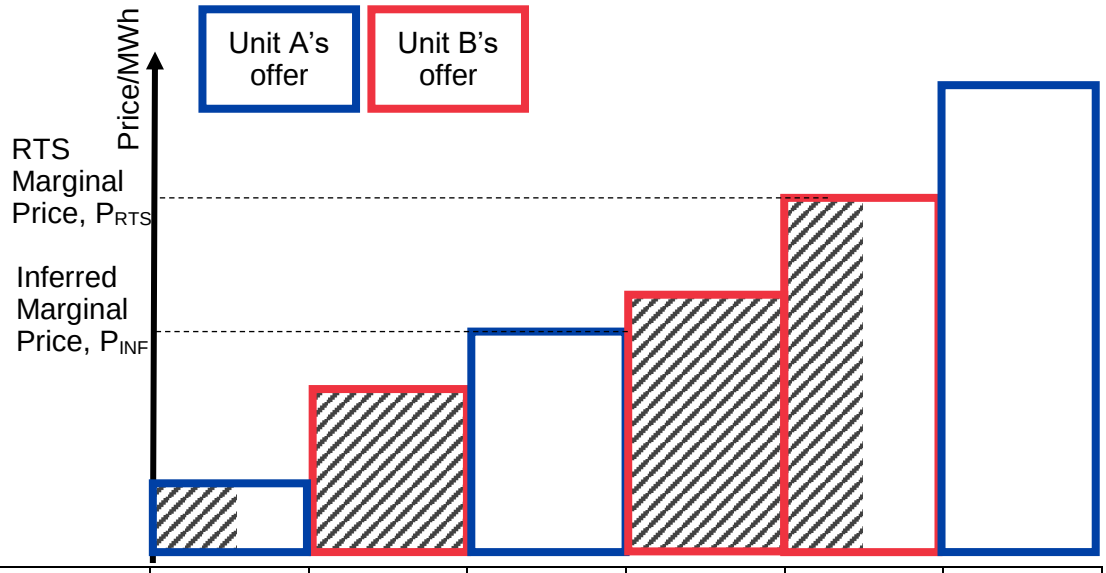
To illustrate the extent of this issue, we conducted further study on the difference between:

- the real-time schedule, and
- an inferred schedule assuming each individual market was scheduled purely based on merit-order alone and ignores any energy/reserve dependencies. This is intended to represent what one could infer solely from the published offer curve and system-wide data.

Box 1 below illustrates the methodology of this study, which is applied for each product (i.e. energy, regulation, primary reserve and contingency reserve) in each dispatch period.

Box 1: Illustration of Methodology[29]

Assume there are two units with the corresponding offers reflected below. Each price-quantity tranche is 10MW. The system-wide requirement is 30MW and the schedules for Unit A and Unit B are 5MW and 25MW respectively.



Real-time Schedule Quantity (1)	5	10	0	10	5	0
Inferred Merit-based Schedule Quantity* (2)	10	10	10	0	0	0
Difference = (1) – (2)	-5	0	-10	10	5	0

* The Inferred Merit-based Schedule Quantity refers to the scheduled quantity inferred solely using the published offer curve and system-wide requirement data, on a merit-order (i.e. lowest offer price) basis.

For quantities:

- **Total MW difference** (in MW)
  = Sum positive differences across all tranches
  = 15 (Note that the positive and negative differences in a given period would sum to zero.)

- **Percentage MW difference** (in %)
  = Total difference as percentage of system-wide requirement
  = 15 / 30 × 100% = 50%

[29] Note that for primary and contingency reserve, the offered quantities are adjusted by reserve effectiveness in alignment with the format proposed to be published.

For prices:

- **Price difference** (in $/MWh)
  = Real-time price[30] – Offer price of marginal offer based on inferred merit-based schedule
  = $P_{RTS} – P_{INF}$
- **Percentage price difference**
  = Price difference / Real-time price × 100%

The study was conducted for all dispatch periods in July 2018. The results of the study are summarised in Table 9 below. Annex 8 presents the graphs for the results across the entire study period.

Table 9: Summary Statistics of Study

	Average Total MW Difference (MW)	Average Percentage MW Difference (%)	Average Price Difference (in $/MWh)	Average Percentage Price Difference (%)
Energy	40.10	0.65%	5.31	4.28%
Regulation	35.79	30.40%	14.56	99.50%
Primary Reserve	46.76	26.23%	0.13	36.50%
Contingency Reserve	128.69	21.22%	10.81	98.49%

The results of the study in Table 9 (and in Annex 8) illuminate that there are substantial differences between the actual scheduled outcomes of the MCE and outcomes inferred solely based on offers, especially for regulation and reserves.

GRFs' regulation and reserve capabilities (and therefore schedules) are dependent on the corresponding scheduled energy levels. While MPs can offer reserve/regulation for quantities up to their standing data capabilities, in scheduling, the reserve/regulation quantities available may be limited by the reserve envelope constraints, regulation minimum and maximum constraints and the maximum capacity of a GRF, for example. This may lead to cheaper reserve/regulation offers not being able to be scheduled.

Marginal prices inferred solely based on offers therefore substantially underestimate the actual real-time price. Hence, while offer data could be useful in helping MPs better understand price outcomes, note that its usefulness could be limited in practice.

10. Consultation (Proposed Rule Modifications)

The proposed modifications were published for consultation on 08 October 2018, and comments were received from YTL PowerSeraya (YTLPS).

Comments from YTLPS

- *Proposed modification to Chapter 5 section 4.6.3 - We support the change.*
- *Proposed modification to Chapter 6 section 11.2 - We support the extended publication of aggregated reserve and regulation offer data, as it underpins a transparent and efficient market. In addition, we concur with the same publication format as that for the energy supply*

[30] For energy, the real-time price uses USEP as a proxy.

curve. We agree with the 28-day lag given the marginal benefits derived from a shorter lag period

- *Proposed modification to Appendix 6D section D.3 "$EstReserveEffectiveness_r$" - We support the change.*

EMC's response
YTLPS's comments are noted.

11. Decision at the 105th RCP Meeting

At the 105th RCP meeting, the Panel **by majority vote supported** the proposed rule modifications set out in Annex 7. The details of the voting outcomes are as follows:

The following Panel members supported the proposed rule modifications:

1.	Mr. Henry Gan	Representative of EMC
2.	Mr. Teo Chin Hau	Representative of Generation Licensee
3.	Mr. Tan Jun Jie	Representative of Generation Licensee
4.	Ms. Carol Tan	Representative of Transmission Licensee
5.	Mr. Sean Chan	Representative of Retail Electricity Licensee
6.	Mr. Vijay Sirse	Representative of Retail Electricity Licensee
7.	Mr. Matthew Yeo	Representative of Wholesale Electricity Trader
8.	Ms. Ho Yin Shan	Representative of the market support services licensee
9.	Mr. Tan Chian Khong	Person experienced in Financial Matters in Singapore
10.	Dr. Toh Mun Heng	Representative of Consumers of Electricity in Singapore
11.	Mr. Fong Yeng Keong	Representative of Consumers of Electricity in Singapore

The following Panel member abstained from voting:

1.	Mr. Soh Yap Choon	Representative of the PSO

12. Recommendations

The RCP **by majority vote** recommends that the EMC Board:

a) **adopts** the proposed rule modifications as set out in **Annex 7**;

b) **seeks** the EMA's approval of the proposed rule modifications as set out in **Annex 7**; and

c) **recommends** that the proposed rule modifications as set out in **Annex 7** come into force **20 calendar weeks** after (i) the date on which the approval of the Authority is published by the EMC or (ii) March 2019, whichever is later.

Annex 1: Template of lagged aggregated energy offer information

Date	Period	Lowest to Highest Offer Price ($/MWh)	Total Offer Capacity at Specified Offer Price (MW)
D	1		
D	1		
D	…		
D	1		
D	1		
D	…		
D	2		
D	2		
D	2		
D	…		
D	…		
D	…		
D	…		
D	…		
D	…		
D	…		
D	…		
D	48		
D	48		
D	…		
D	…		

Annex 2: Reserve Provider Group, Reserve Effectiveness and Scaling Factor

The PSO is required by the market rules to establish reserve provider groups. These reserve provider groups reflect how effective the different groups of generation and load registered facilities are at providing the reserve that they are scheduled to provide.

Reserve effectiveness (RE) is the actual response, i.e., the quantity of reserve provided as measured during a system disturbance or verification test, as a proportion of the expected response, i.e., scheduled reserve with respect to actual system frequency recorded by the PSO.

Generation and load registered facilities with similar RE (based on historical performance) will be classified in the same reserve provider group, and assigned a scaling factor corresponding to its reserve provider group, as shown below.

Reserve Provider Group	Reserve Effectiveness (RE)	Scaling Factor
A	RE ≥ 0.9	1.00
B	0.8 ≤ RE < 0.9	0.85
C	0.7 ≤ RE < 0.8	0.75
D	0.5 ≤ RE < 0.7	0.60
E	RE < 0.5	0.25

Annex 3: Offer Data Disclosure Practices In Other Electricity Markets

Posting Time Lag	Form of Disclosure		
	Unit-Specific Offers with IDs	Unit-Specific Offers with Masked IDs	Offers Aggregated by Zone
At the end of each trading hour			NYISO (day-ahead bid data)
1-day lag	AEMO, NZEM		
2-day lag	AESO		ERCOT
3-month lag	MISO	ISO-NE, NYISO (all bid data), CAISO	
4-month lag		PJM	

Note: This table is adapted from EMA's decision paper on the "Review of market information to facilitate efficient electricity spot and futures trading" published on the 22 July 2014 and have been updated accordingly to reflect any changes in their practices (if any).

Annex 4: HHI of other Jurisdictions

Jurisdiction	HHI
ISO-NE	Overall HHI in 2016 = 490, with the highest HHI of 993 in Connecticut[31]
MISO	Overall HHI in 2016 = 595, but up to 3749 in some areas [32]
PJM	Average HHI (Jan – Sept 2017) = 929[33]

[31] https://www.potomaceconomics.com/wp-content/uploads/2017/07/ISO-NE-2016-SOM-Report_Full-Report_Final.pdf

[32] https://www.potomaceconomics.com/wp-content/uploads/2017/06/2016-SOM_Report_Final_Rev.pdf

[33] http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2017/2017q3-som-pjm-sec3.pdf

Annex 5

- Template of lagged aggregated effective reserve offer information
- Template of lagged aggregated regulation offer information

Date	Period	Lowest to Highest Offer Price ($/MWh)	Total Offer Capacity at Specified Offer Price (MW)
D	1		
D	1		
D	…		
D	1		
D	1		
D	…		
D	2		
D	2		
D	2		
D	…		
D	…		
D	…		
D	…		
D	…		
D	…		
D	…		
D	…		
D	48		
D	48		
D	…		
D	…		

Annex 6: Survey of the Calculation basis for HHI in Different Jurisdictions

No.	Market	Context within which HHI was used	HHI Calculation Basis	Source
1	Australia National Electricity Market	One of the structural indicators of competitiveness	Capacity	Australia Energy Regulator, State of the Energy Market - May 2017 (Figure 1.21, page 48) https://www.aer.gov.au/system/files/AER%20State%20of%20the%20energy%20market%202017%20-%20A4.pdf
2A	Singapore	As a part of the analysis of the impact of using a concentration cap under the "improved vesting regime" option	Capacity	Frontier Economics, Review of Vesting Contract Regime - August 2016 (Figure 26, page 151) https://www.ema.gov.sg/cmsmedia/Consultations/Electricity/review%20of%20vesting%20contract%20regime%20(2016)/Frontier%20Economics%20-%20Review%20of%20Vesting%20Contract%20Regime%20-%20Revised%20Report%20-%20STC.pdf
2B	Singapore	Provide an overview of the wholesale electricity market	Scheduled Generation	EMA, Developing Efficient and Competitive Energy Markets in Singapore 2017 (Slide 3) https://www.emcsg.com/f1671,123943/1_-_Ng_Wai_Choong_Energy_Market_Authority.pdf
3	Alberta	As a simple market concentration metric	Capacity	Market Surveillance Administrator, Measuring Generator Market Power October 31, 2012 (Section 3.3.3) https://albertamsa.ca/uploads/pdf/Archive/2012/SOTM%20Market%20Power%20103112.pdf
4	Midwest ISO	Part of structural market power analyses for competitive assessment	Capacity	Potomac Economics, 2017 State of the Market Report for the MISO Electricity Market – Analytic Appendix (Figure A142, Page 141) https://www.potomaceconomics.com/wp-content/uploads/2018/07/2017-SOM-Appendix_Final_7-6.pdf
5	ISO New England	As one of the structural market power indicators	Capacity[34]	Potomac Economics, 2017 Assessment of the ISO New England electricity markets (Figure 1 page 3) https://www.potomaceconomics.com/wp-content/uploads/2018/06/ISO-NE-2017-EMM-SOM-Report_6-17-2018_Final.pdf
6	Great Britain	As an indication of market concentration	Metered volumes	Ofgem, State of the energy market 2017 report (Page 46 - 47) https://www.ofgem.gov.uk/system/files/docs/2017/10/state_of_the_market_report_2017_web_1.pdf
7	PJM	To evaluate the competitiveness of the market structure	Energy output (Hourly Energy Market HHI)	Monitoring Analytics, Quarterly State of the Market Report for PJM: January through September 2017, section 3 (Page 101) http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2017/2017q3-som-pjm-sec3.pdf
8	New Zealand	Illustration of the generation market concentration trend	Actual Generation	Electricity Authority, 2016/17 Annual Report, (Figure 9, Page 94) https://www.ea.govt.nz/dmsdocument/22577

[34] Uses Seasonal Claimed Capability - a generator asset's capability to perform under specified summer and/or winter conditions for a specified duration

Annex 7: Proposed Rule Modifications

Existing Market Rules (1 Oct 2018)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Reasons for Rule Changes
Chapter 5	**Chapter 5**	
4.6 RESERVE PROVIDER GROUPS 4.6.3 The *PSO* shall determine piece-wise linear effectiveness functions for each *reserve provider group* to satisfy the requirements of section 2.1.4 of Chapter 6.	**4.6 RESERVE PROVIDER GROUPS** 4.6.3 The *PSO* shall determine piece-wise linear effectiveness functions for each *reserve provider group* to satisfy the requirements of section ~~2.1.4~~2.1.5.4 of Chapter 6.	To correct erroneous cross-reference.
Chapter 6	**Chapter 6**	
11 EMC RESPONSIBILITIES AFTER TRADING DAY	**11 EMC RESPONSIBILITIES AFTER TRADING DAY**	
[New section]	**11.2 PUBLISHING OFFER DATA** 11.2.1 The *EMC* shall *publish* the information specified in section 11.2.2 contained in *offers* accepted as valid and required to be used by the *EMC* in the production of the *real-time schedule* in accordance with section 5.8. 11.2.2 The *EMC* shall, on the twenty-eighth day after each *trading day*, *publish* for each *dispatch period* in that *trading day*: 11.2.2.1 each price *offered* in *price-quantity pairs* of all *energy offers* and the total of the quantities	To specify that the data required to be published by the EMC under section 11.2.2 refers to information contained in the offers which are accepted as valid and required to be used in determining the real-time schedule. To require EMC to publish aggregated

Existing Market Rules (1 Oct 2018)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Reasons for Rule Changes
	in all the *price-quantity pairs* of all *energy offers offered* at such price; 11.2.2.2 each price *offered* in *price-quantity pairs* of all *reserve offers* for each *reserve class* and the total of effective quantities in all the *price-quantity pairs* of all *reserve offers* for each *reserve class offered* at such price, where the effective quantity in each such *price-quantity pair* in a *reserve offer* is determined by multiplying the quantity in each such *price-quantity pair* with the parameter $EstReserveEffectiveness_r$ applicable to such *offer*; and 11.2.2.3 each price *offered* in *price-quantity pairs* of all *regulation offers* and the total of the quantities in all the *price-quantity pairs* of all *regulation offers offered* at such price. 11.2.3 The information specified in section 11.2.2 will not contain any express reference to any *market participant* or *registered facility*.	energy offer data for each dispatch period with a 28-day lag. To require EMC to publish aggregated reserve and regulation offer data for each dispatch period with a 28-day lag. Specifically, in determining the aggregated reserve offer data, the quantity for each reserve offer shall be multiplied by the parameter $EstReserveEffectiveness_r$ applicable to such offer. To make clear that the identity of the market participants and the registered facilities will not be revealed from the information specified in section 11.2.2.

<table>
<tr><th>Existing Market Rules
(1 Oct 2018)</th><th>Proposed Rules Changes
(Deletions represented by strikethrough text and additions represented by double underlined text)</th><th>Reasons for Rule Changes</th></tr>
<tr><td><u>APPENDIX 6D</u></td><td><u>APPENDIX 6D</u></td><td></td></tr>
<tr><td>D.3 <u>PARAMETERS</u>

<table><tr><td>$EstReserveEffectiveness_r$</td><td>The estimated reserve effectiveness of reserve from reserve offer r, used when calculating the effective risk due to a failure of the associated generation registered facility. Calculated in accordance with section D.10.</td></tr></table></td><td>D.3 <u>PARAMETERS</u>

<table><tr><td>$EstReserveEffectiveness_r$</td><td>The estimated reserve effectiveness of reserve from reserve offer r, <u>calculated in accordance with section D.11. In the case of a generation registered facility, it is</u> used when calculating the effective risk due to a failure of the ~~associated~~ generation registered facility. ~~Calculated in accordance with section D.10.~~</td></tr></table></td><td>To correct erroneous cross-reference.

To clarify that this parameter is used to calculate the effective risk due to a failure of the generation registered facility.</td></tr>
</table>

Annex 8: Illustration of Results of Study in Section 9 of the paper

Figure A1: Total Difference (in MW) for Each Product by Period

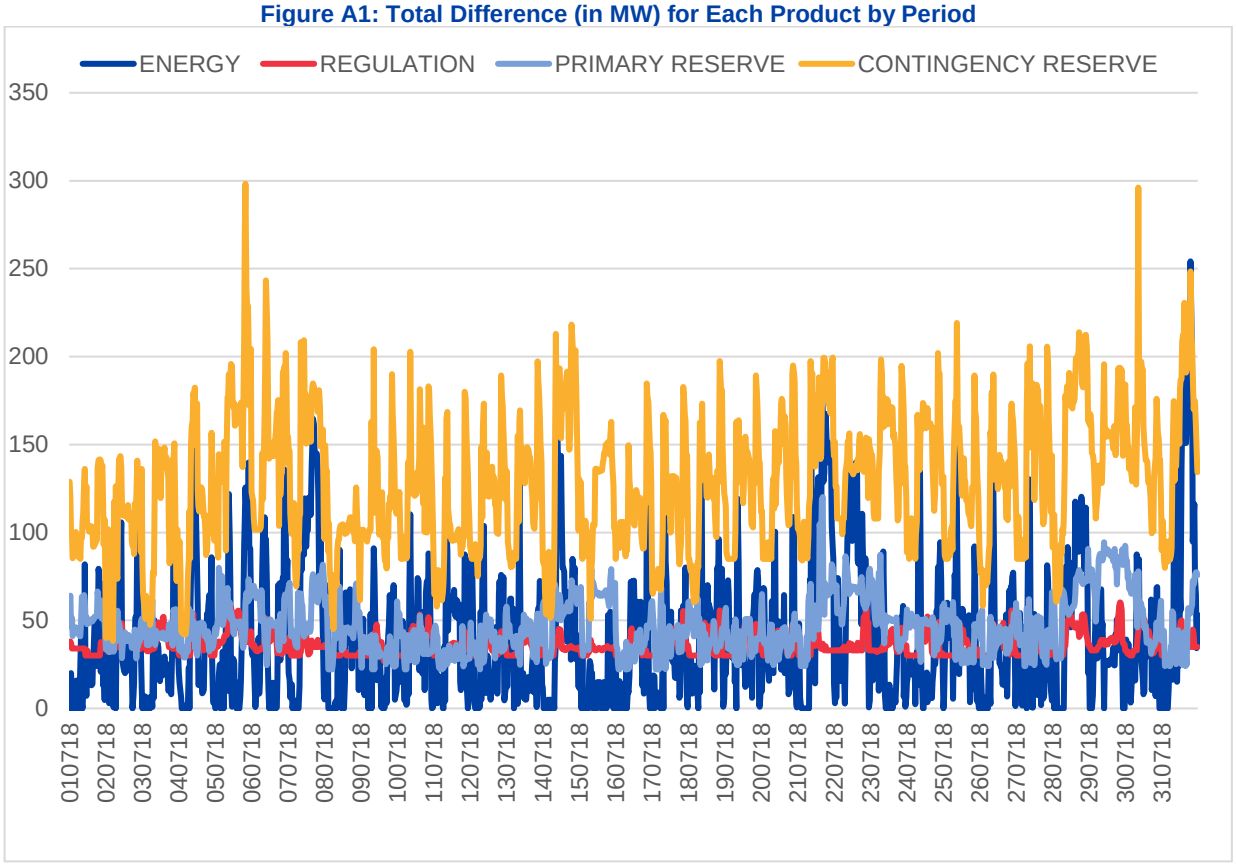


Figure A2: Percentage MW Difference (in %) for Each Product by Period

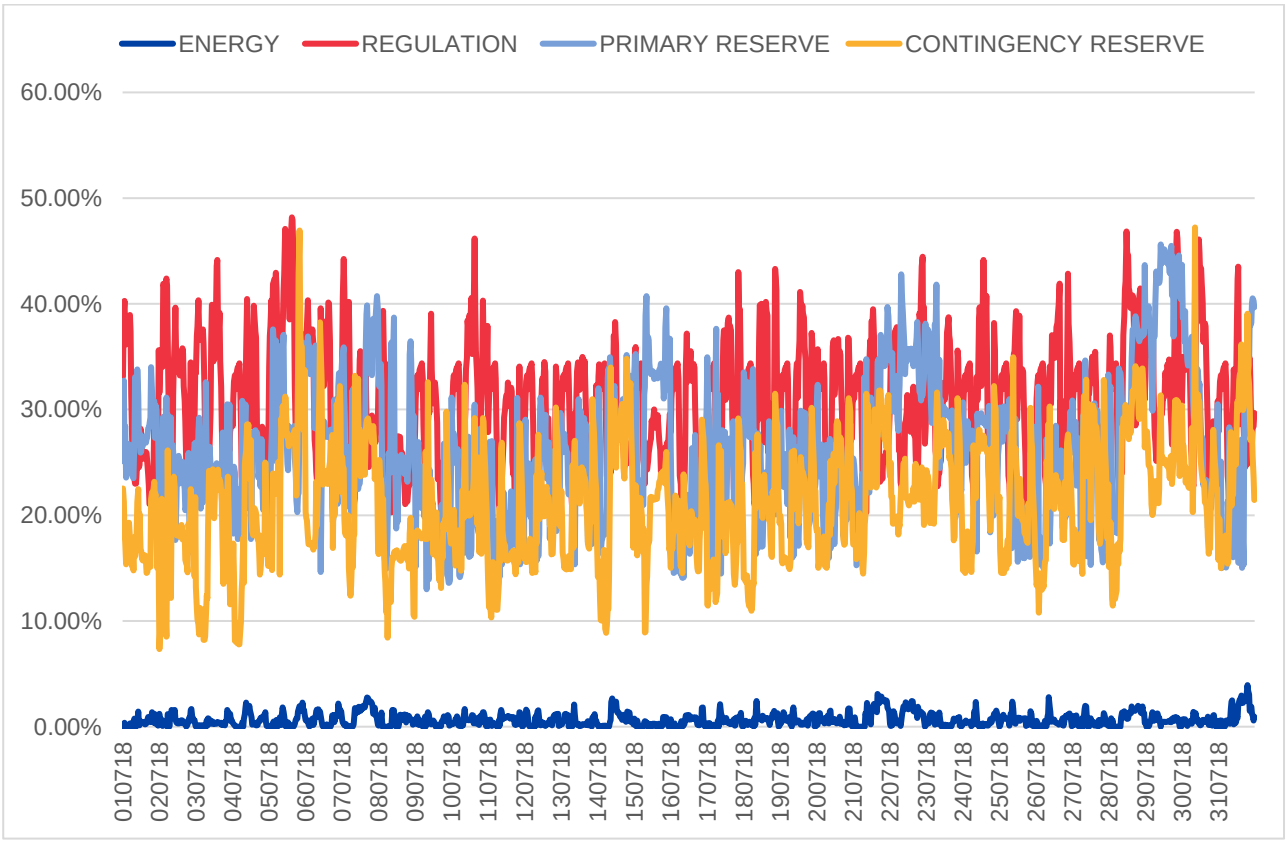


Figure A3: Price Difference (in $/MWh) for Each Product by Period

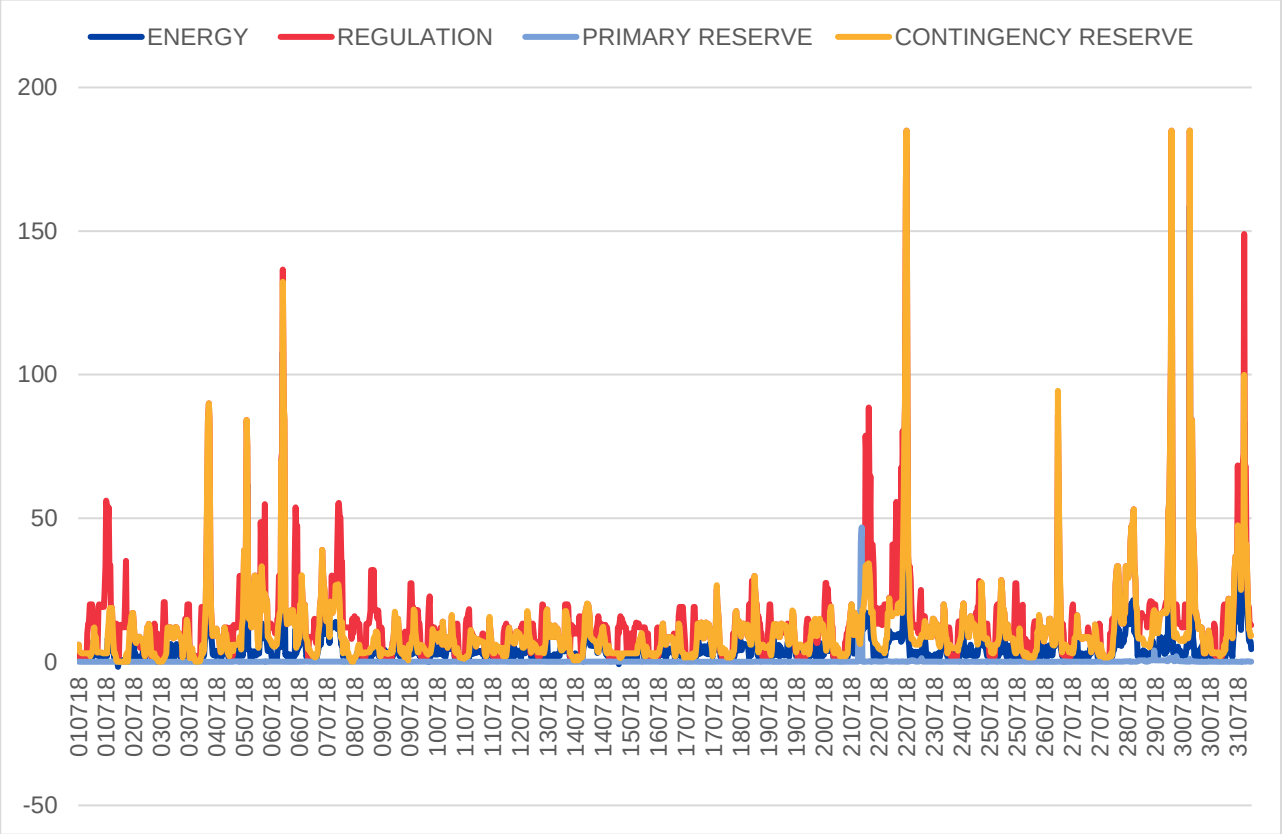


Figure A4: Precentage Price Difference (in $/MWh) for Each Product by Period