Philippine Electricity Market Corporation

STUDY ON DISPATCH TOLERANCE LIMIT

by the Technical Committee

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LIST OF ACRONYMS

ASPP	Ancillary Services Procurement Plan
MAG	Market Assessment Group
MDOM	Market Dispatch Optimization Model
MMAR	Monthly Market Assessment Report
MO	Market Operator
MSC	Market Surveillance Committee
PEM Board	Philippine Electricity Market Board
RTD	Real Time Dispatch
SO	System Operator
TC	Technical Committee
TCMM	Technical Committee Market Manual
TP	Trading Participant
WESM	Wholesale Electricity Spot Market
PGC	Philippine Grid Code

1. INTRODUCTION

Dispatch tolerance is a limit on the extent to which trading participants may deviate from dispatch targets as determined by the System Operator (SO) in accordance with Clause 3.8.7 of the WESM Rules.[1] Dispatch targets are the ex-ante dispatch schedules produced by the Market Dispatch Optimization Model for each scheduled generating unit, scheduled loads and reserve facilities for the end of a trading interval.[2]

The dispatch tolerance, as provided in the WESM Rules, was set in recognition that participants may not always be able to meet dispatch targets due to various legitimate reasons (e.g. control and monitoring problems, frequency regulation functions, etc.).

Under the WESM Rules, dispatch tolerances shall be set for every trading participant. The rules on registration provide that upon registration of a scheduled generation unit, the Intending WESM member may seek a ruling from the SO on its dispatch tolerance.[3] However,

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[1] **3.8.7 Dispatch Tolerances**

3.8.7.1 *Dispatch tolerances* shall be set to allow limits on the extent to which Trading Participants may deviate from *dispatch* targets issued by the *System operator*.

3.8.7.2 The *Market Operator* shall maintain and *publish dispatch tolerances* standards developed by the *System operator* for each type of plant, and location, in accordance with the *Grid Code and Distribution Code.*

[2] Excerpts of Minutes of the 12th PEM Board Meeting, 17 August 2005

[3] 2.3.1.7 A *Scheduled Generation Company* is required to operate any *scheduled generating unit* in accordance with the scheduling and dispatch procedures described in chapter 3, within the *dispatch tolerances* specified in accordance with clause 2.3.3.5.

2.3.3.5 Prior to registration of a *Trading Participant* in respect of a *scheduled generation unit* or *scheduled load facility*, an Intending *WESM member* may seek a ruling from the *System operator* with respect to the *dispatch tolerances* to be applied.

2.3.3.6 If no prior ruling is sought under clause 2.3.3.5, the *System operator* shall make a ruling with respect to *dispatch tolerances* upon registration of that *Trading Participant*.

2.3.3.7 The *System operator* may, at any time, review any ruling made under clause 2.3.3.5 or 2.3.3.6 in the light of further information or experience

2.3.3.8 A *Scheduled Generation Company* may appeal to the *PEM Board* in respect of a ruling provided under this section that is relevant to that person or entity.

based on records, no Intending WESM member has sought a ruling from the SO with respect to the dispatch tolerance to be applied.

During the 12th Philippine Electricity Market (PEM) Board meeting on 17 August 2005, the PEM Board resolved to approve the adoption of ±3% as the initial dispatch tolerance limit for the WESM through PEM Board Resolution No. 2005-15.

Per calculations made by the MO as presented to the PEM Board, a dispatch tolerance of ±3% deviation from dispatch target is suitable for the Wholesale Electricity Spot Market (WESM). This tolerance limit is twice the maximum allowed energy imbalance of ±1.5% within the trading interval under the open access transmission provision. Additionally, the ±3% dispatch tolerance is within the range of the regulating reserve capacity of 4% of the hourly demand set in the Ancillary Services Procurement Plan (ASPP). [4]

The same initial dispatch tolerance of ±3% deviation from the dispatch target has been used by the WESM since its approval in 2005.

1.1. BACKGROUND

The Market Surveillance Committee (MSC) requested the Technical Committee (TC) to "*conduct a simulation and further review the reasonability of the ±3% dispatch tolerance limit*." In the course of its monitoring, *"the MSC observed that a large percentage of deviations from the ±3% dispatch tolerance limit were below ten MW and noted that said deviations were not monitored by the SO".* [5,6]

Based on the monthly monitoring of the MSC, data covering the billing period from 26 September 2013 to 25 October 2013 showed that deviations of ten MW and below constituted

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[4] Excerpts of Minutes of the 12th PEM Board Meeting, 17 August 2005.

[5] TC-RSTR-2013-02 *Request for Simulation and Further Review of the Reasonability of ±3% Deviation in RTD*, 14 November 2013.

[6] Subsequent clarification with NGCP revealed that Luzon System Operator and Visayas System Operator have separate criteria in monitoring deviations for the Luzon and Visayas grids. Criteria for Luzon: ±3% or ±10 MW, whichever is higher; and for Visayas: ±3% or ±1 MW, whichever is higher.

79% (3-5 MW) and 16% (5-10 MW) for Luzon while in Visayas, the same constituted 25% (3-5 MW) and 13% (5-10 MW). See Figure 1[7].

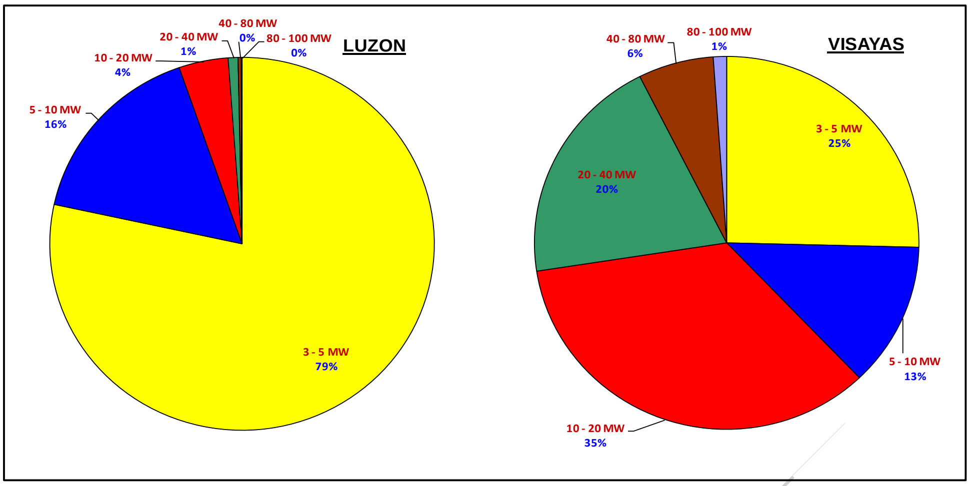

Figure 1. Generator-Trading Intervals with RTD Deviation exceeding ±3% by MW Deviation, Oct. 2013

In its correspondence to the TC, the MSC noted that the current guidelines as approved by the PEM Board specify a ±3% dispatch tolerance limit for the generating plants.

In 2011, a similar request was made by the MSC to the TC to review the applicability of the ±3% dispatch tolerance limit "*taking into consideration its impact to the grid and to the power system reliability and security".* [8] After careful deliberation, the TC responded to the MSC's request and recommended as follows: a) to maintain the application of the PEM Board-approved ±3% dispatch tolerance limit regardless of the plant size and type; and b) to shorten the trading interval to thirty (30) minutes or even shorter. [9]

The TC based its recommendation then on the historical information provided by the SO. Based on the TC's analysis, the dispatch tolerance limit is still within manageable limits and is still applicable for all WESM generator trading participants.

[7] Figure taken from MSC letter request.

[8] TC-RSTR-2013-02 *Request for Simulation and Further Review of the Reasonability of ±3% Deviation in RTD*, 14 November 2013, Annex B.

[9] TC-RSTR-2013-02 *Request for Simulation and Further Review of the Reasonability of ±3% Deviation in RTD*, 14 November 2013, Annex C.

Nonetheless, the MSC deemed that there is a need to have a further technical study in terms of capacity, resources, and sizes of plants on the reasonability of the ±3% dispatch tolerance limit. As such, the MSC once again requested the TC to conduct further study on the matter, include the Real Time Dispatch (RTD) deviations below ten MW in said study, and conduct simulations as necessary with a view to amend the current dispatch tolerance limit as may be applicable.

1.2. OBJECTIVE

The objective of this study is to assess the reasonability of the ±3% dispatch tolerance limit in terms of capacity, resources, plant size, and plant types, among others. Calculations for possible dispatch tolerance limits for the WESM, i.e. ±1%, ±2%, ±4% and ±5%, including the current dispatch tolerance limit of ±3% deviation are also presented and discussed. This report also incorporates the recommendations of the TC in addressing the issue on the high incidence of deviations of plants to the current ±3% dispatch tolerance limit.

1.3. SCOPE OF THE STUDY AND DATA LIMITATION

The study covered all plants being traded by WESM-registered trading participants for the Luzon and Visayas grids, which were observed to have frequent deviations to the ±3% dispatch tolerance limit.

To assess the reasonability of the dispatch tolerance limit, the study covered a one month billing period from 26 September 2013 to 25 October 2013. This was the billing period prior to the Malampaya shutdown scheduled in 11 November to 10 December 2013. The summary of reasons or justifications for plant deviations, both generator-related and SO-initiated, were derived from the SO Dispatch Discrepancy Monitoring Report provided to the Market Assessment Group (MAG) and the responses and explanations of trading participants to the MSC with regard to its deviations to the ±3% dispatch tolerance limit, if available.

The summary of reasons was, however, not provided for trading intervals with MW deviations below ten MW as the reasons for the deviations for the same were not available since the Luzon SO only monitors deviations ten MW and above. For purposes of illustration, graphs and tables presented in Section 2 were taken from the data for the Luzon grid only. All deviations of plants that were attributable to the SO instructions were excluded from the total number of trading intervals with deviations, for each plant type considered for this study.

2. REVIEW OF GENERATOR TRADING INTERVALS WITH RTD DEVIATIONS

Power plants in the Luzon and Visayas grids vary with respect to resource type and quantity. Table 1 shows the list of the total number of plants per resource type in the Luzon and Visayas grids. In terms of the number of plants, the Visayas grid has fewer plants compared to Luzon. Notably, there are no biofuel, natural gas (Natgas) and hydroelectric (hydro) power plants in the Visayas grid.

Table 1. Total Number of Plants per Resource Type

Plant Resource Type	Visayas	Luzon
Hydro	0	13
Coal	6	8
Oil	11	7
Geothermal	4	3
Natural Gas	0	3
Biofuel	0	1
Total	21	35

Based on the Monthly Market Assessment Report (MMAR) of MAG for the billing period 26 September to 25 October 2013:

> *About 11% and 13% of the total generator-trading intervals in Luzon and Visayas, respectively, had observed deviations between the RTD schedule and actual dispatch, exceeding the ±3% tolerance limit. Consistent with previous billing months, hydro plants in Luzon and coal plants in Visayas had the highest number of occurrences, with actual dispatch exceeding the tolerance limit in 50.1% and 66.1% of the total generator trading intervals, respectively.* [10]

[10] MAG-MMAR-2013-10 *Monthly Market Assessment Report for October 2013.*

As mentioned in Section 1.3, for purposes of illustration, graphs and tables presented in the succeeding subsections are based on data for the Luzon grid only.

2.1. Deviations to Various Dispatch Tolerance Limits according to Plant Type

Based on the number of trading intervals with deviations exceeding the ±3% dispatch tolerance limit reviewed by the TC, the TC requested the MAG to run a set of data for various dispatch tolerance limits during peak and off-peak periods, for each plant type and plant size in the Luzon and Visayas grids.

The TC reviewed and evaluated the data showing the total number of trading intervals with deviations to the dispatch tolerance limits of ±1%, ±2%, ±3%, ±4%, ±5% including those less than ±1% and greater than or equal to ±6% for all hours, for all plant types.[11]

In the course of the study, the TC noted that there are plants with no RTD schedules or instructions that were dispatched, and were eventually recorded as with "100% deviation" from the schedule[12]. The TC observed that most of these plants are ancillary service providers. It was however noted that the data used in the study already excluded all trading intervals with deviations which were attributable to instructions of the SO.

Noting the unavailability of information from the generators or the SO that would explain deviations, it would be assumed that one of the factors for these deviations could be due to plant start-up. Most of the plants that deviated but with no RTD schedules or instructions were fast-start generators thus the TC deemed that the SO must have instructed these plants to start-up if needed. The TC then excluded these deviations from the data set.

Table 2 below shows the summary of deviations to the sample dispatch tolerance limits for all trading intervals, for all plant types in Luzon during the billing period. The graphical representation of the data is shown in Figure 2.

[11] Note: Range of deviations to sample dispatch tolerance limits are as follows: < 1% = less than 1%; 1% = from 1% to less than 2%; 2% = from 2% to less than 3%; 3% = from 3% to less than 4%; 4% = from 4% to less than 5% ; 5% = from 5% to less than 6%; and ≥ 6% = from 6% and above 6%.

[12] Note: Deviation of plants with no RTD schedules are counted as 100% deviation.

Table 2. Number of Deviations to Dispatch Tolerance Limits, All Hours, Luzon Grid

Plant Type	Dispatch Tolerance						
	< 1%	[1%,2%)	[2%,3%)	[3%,4%)	[4%,5%)	[5%,6%)	≥ 6%
HYDRO	1594	825	708	408	324	190	974
COAL	2815	1463	734	293	114	88	380
OIL	154	227	175	91	57	31	322
GEO	802	1122	232	206	92	146	192
NATGAS	3051	1384	310	65	10	4	16

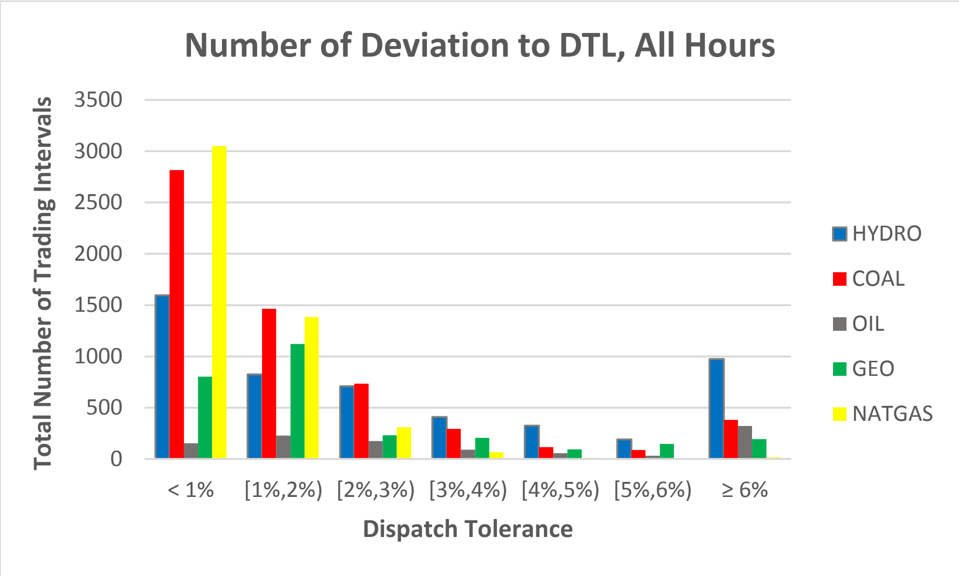

Figure 2. Number of Trading Intervals in Luzon Grid with Deviation from Dispatch Schedule

Figure 2 shows that during the billing period, Natgas plants have the most number of deviations that are less than 1%. The number of deviations however, dramatically decreased for higher than 3% deviation. This behavior is consistent with power plants' intention to adhere to the dispatch tolerance limit. It is worth noting though that there are only three Natgas units in Luzon.

On the other hand, among all plant types, hydro plants always have the most number of deviations to dispatch tolerance limits 3% and above. This large number of deviations might be attributable to the number of hydro units relative to the number of other plant types. In Luzon, there are a total of 13 hydro units as shown in Table 1 accounting for 37.14% of the total population in Luzon grid.

The number of trading intervals with deviations from the dispatch tolerance limit at ≥ 6% level for hydro plants abruptly shot up compared to 3%, 4% and 5% levels. Further, for dispatch tolerance ≥ 6%, hydro plants were noted to have the highest number of trading intervals with deviations compared with the other plant types. One of the reasons for this higher incidence of dispatch deviation could be due to the hydro plants' arrangements with the contracted party, such that when the water is available, the plants are required to generate at a certain level irrespective of the dispatch schedule to prevent wastage of water.

Data in Table 2 was computed to normalized the values with respect to the number of plants. That is, the total number of deviations was divided by the number of plants that deviated the dispatch tolerance limit for each plant type[13]. This is done to see if the number of deviations per plant of hydro plants is comparable with those of other plant types. Another way to observe the normalized values is to count the number of deviations per individual power plant and then collect these information per resource type. However, this second method is deemed time-consuming but will most likely present a similar picture with this simplified analysis.

Table 3 below shows the normalized values while the graphical representation of the data is shown in Figure 3.

Table 3. Number of Deviations to Dispatch Tolerance Limits, All Hours, Normalized

Plant Type	Dispatch Tolerance						
	< 1%	[1%,2%)	[2%,3%)	[3%,4%)	[4%,5%)	[5%,6%)	≥ 6%
HYDRO	144.91	75	64.36	37.09	29.45	17.27	88.545
COAL	351.88	182.88	91.75	36.63	14.25	11	47.5
OIL	22	32.429	25	13	8.143	4.429	46
GEO	267.33	374	77.33	68.67	30.67	48.67	64
NATGAS	1017	461.33	103.3	21.67	3.333	1.333	5.3333

[13] The number of plants for each plant type with deviations that are included in the data set are as follows: 11 hydro, 8 coal, 7 oil, 3 geothermal and 3 Natgas plants.

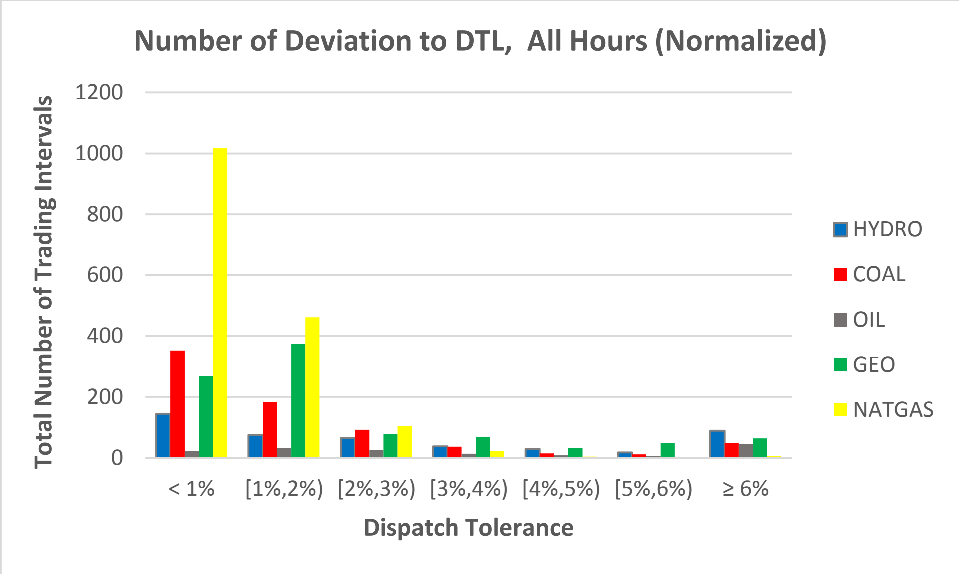

Figure 3. Number of Deviations to Dispatch Tolerance Limits per Plant, Normalized Values

Disregarding deviations below 3% produces a better scale as shown in Figure 4.

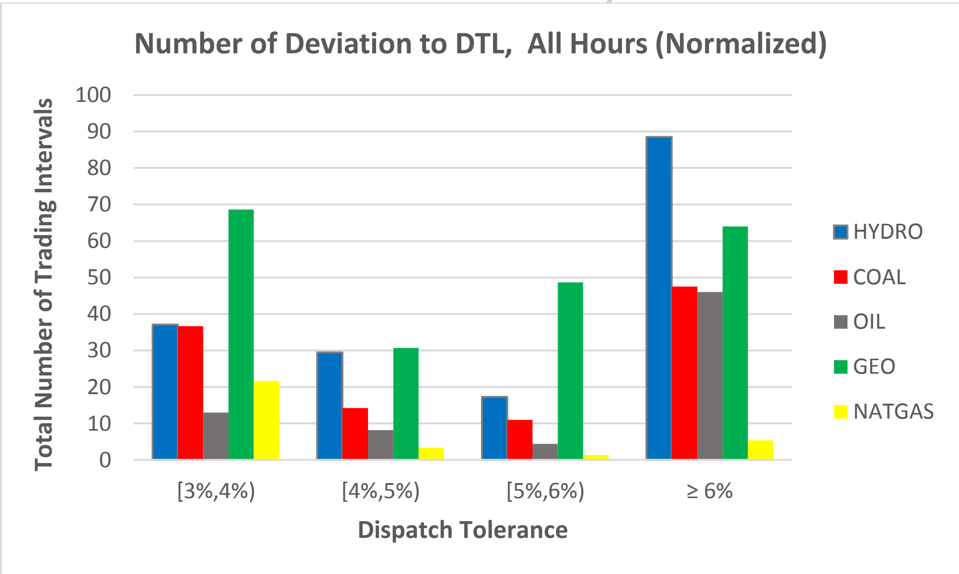

Figure 4. Number of Deviations to Dispatch Tolerance Limits per Plant, ≥ 3% DTL

Table 4. Number of Deviations to Dispatch Tolerance Limits, ≥ 3% DTL, Per Plant

Plant Type	Dispatch Tolerance [3%,4%)	[4%,5%)	[5%,6%)	≥ 6%	Total
HYDRO	37.091	29.455	17.27	88.55	172.36
COAL	36.625	14.25	11	47.5	109.38
OIL	13	8.1429	4.429	46	71.571
GEO	68.667	30.667	48.67	64	212
NATGAS	21.667	3.3333	1.333	5.333	31.667

Among the five plant types, Natgas has the least number of deviations at approximately 32 with oil following next at 72. Lastly, coal, hydro and geothermal plants have large deviations at 109, 172, and 212, respectively. Again, these deviation values are normalized with respect to plant types.

Chi-square test was conducted to determine if there was a significant difference among the five types of power plants with regard the number of deviations beyond the allowed dispatch tolerance limit (3%). The test showed that there was a significant difference. Upon further analysis, three power plant types, i.e. Natgas, oil and coal, have residuals below the average, while the other two have residuals above the average. Residual means the difference between the observed occurrence and the expected occurrence, which in this case is the average of the observed occurrences for the five groups. From this, it is deduced that further analysis on hydro and geothermal power plants can be conducted.

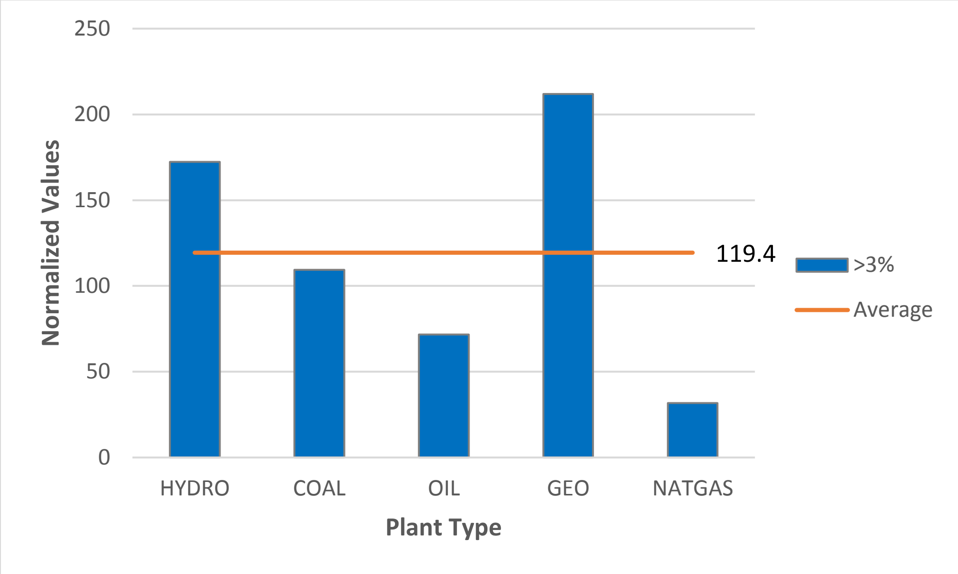

Figure 5. Normalized Values, > 3% DTL vs. Average

2.2. Deviations by Range of Percent and MW Deviation

Noting the frequent deviations of coal, hydro and geothermal plants, further evaluation was conducted with the data for these plant types categorized by range of percent deviation and by MW deviation.

Table 5a. Number of Deviations to DTL for Coal Plants, MW Deviation

MW Deviation	COAL						
	< 1%	[1%,2%)	[2%,3%)	[3%,4%)	[4%,5%)	[5%,6%)	≥ 6%
< 1 MW	1334	213	97	25		3	4
1 - 3 MW	1330	302	40	32	17	3	5
3 - 5 MW	136	597	79	13	8	9	17
5 - 10 MW	15	328	424	117	21	8	28
10 - 20 MW		23	94	82	50	34	58
20 - 40 MW				24	18	31	97
40 - 80 MW							126
> 80 MW							45
Total	*2,815*	*1,463*	*734*	*293*	*114*	*88*	*380*

Table 5b. Number of Deviations to DTL for Hydro Plants, MW Deviation

MW Deviation	HYD						
	< 1%	[1%,2%)	[2%,3%)	[3%,4%)	[4%,5%)	[5%,6%)	≥ 6%
< 1 MW	1500	691	352	135	92	69	91
1 - 3 MW	93	108	328	229	189	94	304
3 - 5 MW	1	22	15	23	33	10	124
5 - 10 MW		4	13	17	4	15	112
10 - 20 MW				4	6	2	69
20 - 40 MW							100
40 - 80 MW							121
> 80 MW							53
Total	***1,594***	***825***	***708***	***408***	***324***	***190***	***974***

Table 5c. Number of Deviations to DTL for Geothermal Plants, MW Deviation

MW Deviation	GEO						
	< 1%	[1%,2%)	[2%,3%)	[3%,4%)	[4%,5%)	[5%,6%)	≥ 6%
< 1 MW	594	800	32	15	2		
1 - 3 MW	208	322	195	150	33	133	76
3 - 5 MW			5	41	24	9	55
5 - 10 MW					33	4	46
10 - 20 MW							8
20 - 40 MW							4
40 - 80 MW							2
> 80 MW							1
Total	***802***	***1,122***	***232***	***206***	***92***	***146***	***192***

Currently, the Luzon SO does not report dispatch deviations that are less than ten MW. Table 5 above indicates that the percentage of deviations below ten MW from among coal, hydro and geothermal plants are as follows: coal plants, 88.42%; for hydro plants, 92.93%; and geothermal plants, 99.46%. However, even with this large number of incidents not reported, as long as each individual deviation is less than 10 MW, there is no expected significant effect to the grid.

2.3. Deviations during Peak and Off-peak Periods

The TC also considered the possibility that a number of these deviations occur during periods when these deviations would have a more significant impact on electricity prices. That is, the

TC tried to find out, if most of these deviations occurred during peak periods when electricity prices were higher. In addition, dispatch deviations were further classified into either over-delivery (i.e. plant output is greater than the dispatch schedule) or under-delivery (i.e. plant output is less than the dispatch schedule). In particular, the TC reviewed whether these plants over delivered during peak periods.[14]

Table 6 shows the summary of deviations during peak and off-peak periods. The graphical representation of the data is shown in Figures 6 and 7.

Table 6. Summary of Deviations to Dispatch Tolerance Limits, Off-peak & Peak Periods, Luzon

	Dispatch Tolerance (Off-peak)													
	Under							Over						
	≥ 6%	[5%,6%)	[4%,5%)	[3%,4%)	[2%,3%)	[1%,2%)	< 1%	< 1%	[1%,2%)	[2%,3%)	[3%,4%)	[4%,5%)	[5%,6%)	≥ 6%
HYDRO	96	24	41	61	103	157	200	444	251	302	148	129	60	385
COAL	155	24	38	99	259	405	626	786	408	157	67	24	16	34
OIL	16			3	2	3	8	1	6	8	7	2		6
GEO	73	64	37	61	55	213	210	190	414	69	47	19	12	44
NATGAS	11	3	8	21	112	542	901	857	135	7	1	1		1

	Dispatch Tolerance (Peak)													
	Under							Over						
	≥ 6%	[5%,6%)	[4%,5%)	[3%,4%)	[2%,3%)	[1%,2%)	< 1%	< 1%	[1%,2%)	[2%,3%)	[3%,4%)	[4%,5%)	[5%,6%)	≥ 6%
HYDRO	61	32	36	56	91	143	309	641	274	212	143	118	74	432
COAL	166	44	42	107	240	378	706	697	272	78	20	10	4	25
OIL	231	15	25	37	32	129	56	89	89	133	44	30	16	69
GEO	53	63	19	59	50	220	232	170	275	58	39	17	7	22
NATGAS	4	1	1	43	191	651	903	390	56					

[14] Peak period: Monday to Saturday 0800H – 2000H; Sunday/Holiday 1800 – 2100H
Off-peak period: Monday to Saturday 2100H – 0700H; Sunday/Holiday 0000H – 1700H, 2200H – 0000H

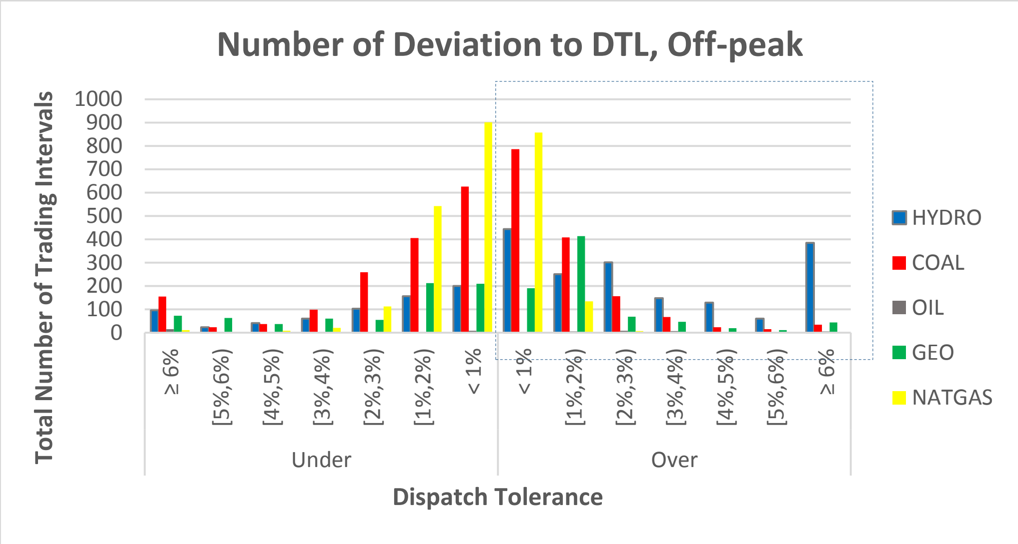

Figure 6. Number of Deviations to Dispatch Tolerance Limits, Off-peak Period, Luzon

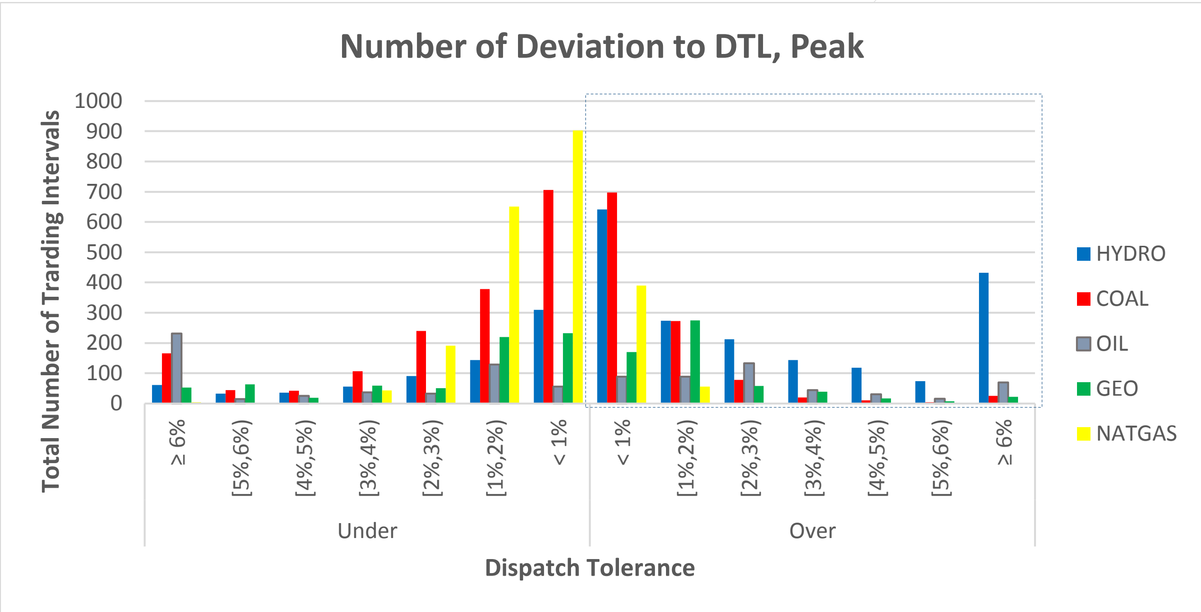

Figure 7. Number of Deviation to Dispatch Tolerance Limit, Peak Period, Luzon

Based on Figures 6 and 7, hydro plants tend to over-deliver both during off-peak and peak periods. In particular, 432 instances of dispatch deviations ≥ 6% during peak period have been monitored.

Dispatch deviations during peak and off-peak periods can be viewed relative to frequency control and market price. Among the possible reasons for a plant's deviations to the dispatch tolerance limit is related to frequency, considering that frequency is more difficult to manage during off-peak hours. It is assumed that the price during peak hours is higher compared to the price during off-peak. As such, plants are more likely to over-deliver during peak hours for higher commercial gain.

2.4. Deviations of Hydro Plants According to Plant Types

The TC also evaluated the data for hydro plants according to plant types. The MAG provided a set of data showing the trading intervals with deviations in MW for each hydro plant type. Currently, hydro plants in Luzon are categorized as impounding or multi-purpose, run-of-river or pumped storage type[15]. For the period covered, there are eight impounding or multipurpose, three run-of-river and one pumped storage hydro plant type.

Table 7a below shows the summary of deviations in MW for over-delivery and under-delivery of hydro plants during off-peak and peak periods.

Table 7a. Summary of Deviations in MW of Hydro Plants, Over-/ Under-delivery

		Impounding/ Multi-purpose		Run-of River		Pumped Storage	
Period	MW Deviation	under	over	under	over	under	over
OFF-PEAK	< 1 MW	390	742	68	180	5	7
	1 - 3 MW	64	270	76	230	7	29
	3 - 5 MW	13	21	14	54	2	5
	5 - 10 MW	6	21	14	15	2	14
	10 - 20 MW	4	11	2	3		18
	20 - 40 MW	5	20	1	2		26
	40 - 80 MW	2	16	2			22
	>80 MW	5	6				7
	Total	*489*	*1,107*	*177*	*484*	*16*	*128*
PEAK	< 1 MW	403	864	68	152	23	28
	1 - 3 MW	54	243	62	245	25	40
	3 - 5 MW	17	24	4	29	24	21
	5 - 10 MW	13	27	4	9	13	27
	10 - 20 MW	6	15		2	2	18
	20 - 40 MW	5	33			1	7
	40 - 80 MW	3	44				32
	>80 MW	1	29				5
	Total	*502*	*1,279*	*138*	*437*	*88*	*178*

[15] Section 2.2 *Power Plant Type*. TC Study on Luzon Hydroelectric Power Plants. December 2013. p. 6.

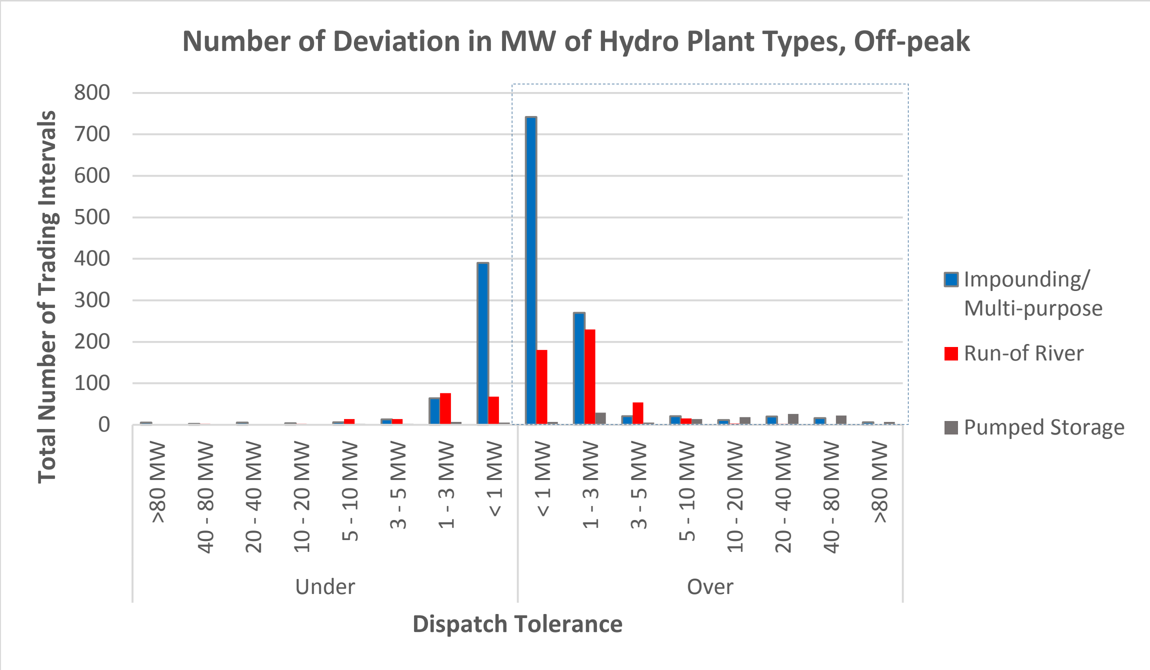

Figure 8. Number of Deviations in MW of Hydro Plants, Off-peak Period

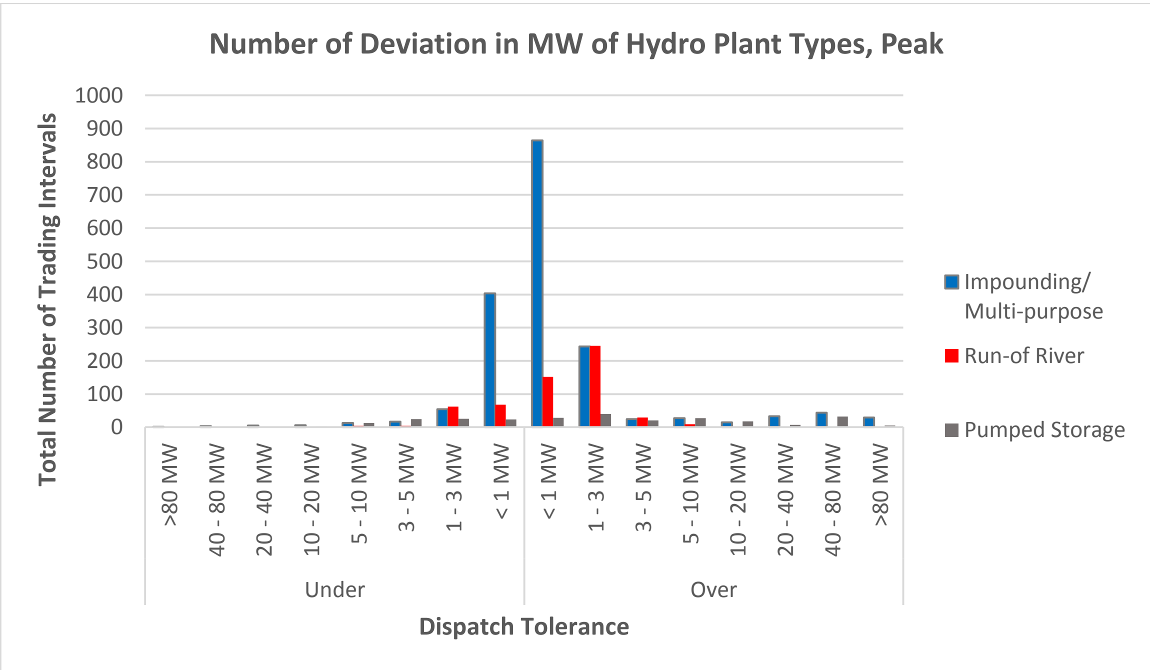

Figure 9. Number of Deviations in MW of Hydro Plants, Peak Period

As shown in Figures 8 and 9, impounding/multi-purpose hydro plants have the most frequent deviations, both for over-delivery and under-delivery, during both periods particularly for deviations less than one MW. It may be noted that most of the hydro plants in Luzon are impounding or multi-purpose which is likely the reason for the number of deviations. Data in Table 7b show the normalized values of deviations with respect to the number of plants per type.

Table 8b. Summary of Deviations in MW of Hydro Plants

		Impounding/ Multi-purpose	Run-of River	Pumped Storage
Period	MW Deviation	8	3	1
OFF-PEAK	< 1 MW	1132	248	12
	1 - 3 MW	334	306	36
	3 - 5 MW	34	68	7
	5 - 10 MW	27	29	16
	10 - 20 MW	15	5	18
	20 - 40 MW	25	3	26
	40 - 80 MW	18	2	22
	>80 MW	11		7
	Total	**1,596**	**661**	**144**
	Normalized Value	**199.50**	**220**	**144**
PEAK	< 1 MW	1267	220	51
	1 - 3 MW	297	307	65
	3 - 5 MW	41	33	45
	5 - 10 MW	40	13	40
	10 - 20 MW	21	2	20
	20 - 40 MW	38		8
	40 - 80 MW	47		32
	>80 MW	30		5
	Total	**1,781**	**575**	**266**
	Normalized Value	**222.63**	**191.67**	**266.00**

Data in Table 7b contains normalized values with respect to the number of hydro plants according to its type. Similar to Section 2.1, the total number of deviations was divided by the number of hydro plants per type, i.e. whether impounding/multi-purpose (8), run-of-river (3) or pumped storage (1).

Among the three hydro plants types, run-of-river has the most deviations during off-peak. During peak periods, pumped storage has the most number of deviations since this plant is providing ancillary services.

3. SYSTEM STABILITY AND FREQUENCY BIAS

The stability of a power system is ensured by maintaining the system frequency. In the Philippines, the SO maintains the system frequency at 60 Hz. Any power imbalance between generation and demand results in deviation from this nominal system frequency.

The Philippine Grid Code (PGC) requires the SO to maintain the system frequency between 59.7 Hz and 60.3 Hz.[16] The amount of power imbalance in MW which will result to a 0.1 Hz deviation in the frequency is specified as frequency bias. According to the SO, the frequency bias for Luzon Grid is 22 MW/0.1 Hz. In general, an uncontrolled deviation with as much as 66 MW may result to a 0.3 Hz deviation from the nominal frequency. For the Visayas grid, the frequency bias is about 5 MW/0.1 Hz.

In terms of dispatch tolerance, deviations from the dispatch schedule from multiple generators shall put the system stability at risk, if the aggregate deviations reach beyond 60 MW in Luzon. Much smaller deviations will have no significant effect on the grid. As such, the Luzon SO does not report deviations less than 10 MW. For both small and large deviations from dispatch schedules, Regulating Reserves are available in the grid. In the case of larger dispatch deviations, whether intentional or not, Regulating Reserves are available to keep the balance and maintain system frequency within the limits.

The TC is of the opinion that the ±3% dispatch deviation, which is within the 4% range of the regulating reserve capacity as set in the ASPP, will not primarily cause system instability.

4. LOAD FORECASTING

A fundamental principle in power system network operation is power balance between generation and loads including losses. As stated in Sec. 3, maintaining the stability of the Grid is a balancing act between energy sources and energy sinks. If we expect accuracy and precision in the supply side, the same criteria should be applied in the demand side as well. If needed to be particular about this, dispatch accuracy should be analyzed with load forecast accuracy.

[16] PGC Sec. 3.2.2.2
The control of system frequency shall be responsibility of the System Operator. The System Operator shall maintain the fundamental frequency within the limits of 59.4 Hz and 60.6 Hz during normal conditions. However, the System Operator shall intervene when the frequency limits of 59.7 Hz and 60.3 Hz are breached.

5. TRADING INTERVAL

The TC believes that significant deviations from dispatch schedule occur due to the lengthy one hour trading interval. With a one-hour trading interval, actual output of every power plant is monitored and controlled only once every hour. However, the market will achieve better gains by shortening the trading interval. Shortening the trading interval will minimize deviations between dispatch schedule and actual generation. A shorter trading interval will facilitate more frequent monitoring and control of actual power plant output. We note however that such shortening of trading interval will only be achieved with the new Market Management System (MMS) which is expected to be in operation not earlier than 2017.

Related to the issue on shorter trading interval, the TC emphasizes that transactions in the electricity market is based on energy units (MW-hr) instead of power units (MW). Analysis should not be limited to power deviations but should include energy deviations as well. Both magnitude and duration of deviations should be analyzed. This is important for both financial and technical considerations.

5.1. Intra-hour Variation in Demand

There are operational concerns regarding deviations both in supply and demand during intra-hour. At the end of the trading interval, the plant may meet its dispatch schedule but within the hour, plants are able to deviate.

The TC recommends that dispatch tolerance may be reviewed again after the trading interval is shortened.

6. REVIEW OF RELEVANT RULES

6.1. WESM Rules

According to the WESM Rules, the SO has the responsibility to develop the dispatch tolerance standard which includes updating the ±3% limit, to wit:

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Section 3.8.7 *Dispatch Tolerances*

3.8.7.1 *Dispatch tolerances* shall be set to allow limits on the extent to which *TRADING PARTICIPANTs* may deviate from *dispatch* targets issued by the *System operator*.

3.8.7.2 The *Market Operator* shall maintain and *publish* ***dispatch tolerances* standards developed by the *System operator* for each type of plant, and location**, in accordance with the *Grid Code and Distribution Code.*

Section 10.4.12 *Dispatch Tolerances*

Prior to the *spot market commencement date,* the *Market Operator* shall, subject to *PEM Board* approval, develop guidelines on *dispatch tolerances* for each type of *plant,* and location, taking into account *plant* characteristics, local *network* conditions and any other matter considered relevant for purposes of scheduling and dispatch, and in accordance with the *Grid Code and Distribution Code.*

6.2. Dispatch Protocol Manual

Section 4.3 Compliance with Dispatch Instructions

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Trading Participants shall see to it that their facilities operate within the dispatch tolerance limits and standards prescribed by the System Operator.

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6.3. PEM Board Resolution[17]

Resolved, to approve the adoption of ±3% of the dispatch target as the initial dispatch tolerance limits for the WESM.

7. SUMMARY AND RECOMMENDATIONS

Based on the above discussions the Technical Committee draws the following summaries and recommendations:

1. According to Fig. 5, only hydro and geothermal have significantly more dispatch deviations.
2. In general, this is no noticeable difference in the number of deviations between peak and off-peak periods.
3. During the period of study, hydro plants have a total of432 instances of over-delivery that is ≥ 6% of the dispatch schedule which occurred during peak hours.
4. Among hydro plants, impounding or multipurpose types have the most number of deviations for deviations <1MW.
5. Stability of the grid is about maintaining the nominal system frequency of 60 Hz with ± 0.3 Hz (0.5% tolerance). Based on the present analysis of the System Operator, Luzon Grid has a frequency bias of 20-25 MW per 0.1 Hz while Visayas Grid has a frequency bias of 5 MW per 0.1 Hz. This translates to 60-75 MW per 0.3 Hz for Luzon and 15 MW per 0.3 Hz for Visayas. This is a cumulative effect of all generators connected to the Grid.
6. The TC recommends that further investigation may be conducted if the deviation in MW exceeds the frequency bias (in MW/0.1 Hz) for each grid as declared by the System Operator.
7. The current 3% dispatch tolerance need not be revised but should only be qualified in consideration of frequency bias in the Luzon and Visayas Grids.
8. Maintaining the system frequency is based on the balance between supply and demand including losses. The TC is of the opinion that dispatch accuracy should be analyzed together with demand forecast accuracy.

[17] Excerpts of Minutes of the 12th PEM Board Meeting, 17 August 2005

9. Finally, the TC recommends that the trading interval be reduced from the current one-hour trading interval. Shorter trading interval shall minimize both end-of-interval dispatch deviations and intra-interval variations. Since energy units are traded in the Market, a shorter trading interval shall result to more accurate technical and commercial transactions.

ABOUT THE TECHNICAL COMMITTEE

The Technical Committee (TC) is mandated under Clause 1.7.2 of the WESM Rules to (a) monitor technical matters relating to the operation of the spot market; and (b) provide a report to the PEM Board on any matter of a technical nature relating to any WESM member which in the reasonable opinion of the TC, causes (i) the WESM Participant to be unable to comply with the WESM Rules; or (ii) unintended or distortionary effect to the operation of the WESM.

Further, Section 4 of the Technical Committee Market Manual (TCMM) provides that the TC shall conduct technical reviews and studies in relation to (a) power plant technical parameters; and (e) matters of technical nature that led to non-compliance of any WESM participant, and/ or distortionary effects to the WESM operation.

The TC is currently composed of four (4) members, namely, Prof. Jordan Rel C. Orillaza and Engr. William C. Alcantara as Independent Members; Engr. Jaime V. Mendoza, Distribution Management Committee (DMC) Representative; and Engr. Fidel D. Dagsaan, Jr., Systems Operator (SO) Representative. [18]

This report is prepared by the TC with the assistance of the MAG of the Philippine Electricity Market Corporation. [19]

[18] Engr. Fidel D. Dagsaan Jr. was appointed as SO representative to the TC on 01 May 2015 in place of Engr. Santiago A. Dimaliwat IV who was with the TC until 30 April 2015 and was part of the initial stages of this study.
[19] The MAG acts as the Technical and Administrative Secretariat of the TC

REFERENCES

Monthly Market Assessment Report (MAG-MMAR-2013-10), October 2013.
WESM Rules (Unofficial Copy), June 2015.