Philippine Electricity Market Corporation

# Initial Loss Percentage for WESM Load Forecasting

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## 1. Introduction

The Initial Loss Percentage is the percentage of the demand forecast that is initially assumed to be the loss. It shall be netted out of the demand forecast in order to achieve the *Total Unrestrained Net Load Forecast.*[1]

The initial loss percentage is used to derive the load off-take from the input demand (generation) forecast.

Each *Forecast Area* shall have its own Initial Loss Percentage, and that it shall be reviewed on an annual basis.[2]

In compliance to Clause 6.3.2 of the WESM Manual on the Load Forecasting Methodology, this paper is being published by the Market Operator to indicate the Initial Loss Percentage for each Forecast Area, including the rationale and basis for the use of such values.

Previously, a single variable was applied to all forecast areas (or regions) in the WESM (Luzon, Visayas, and Mindanao). At the start of the commercial operations of WESM in 2006, it was set at 1.5%.

However, based on the WESM annual audit reports, it was noted that the final losses in Luzon average at a much different rate and varies depending on the level of demand. Also, it may not be appropriate that one initial loss percentage be set for all regions since they vary given their own network characteristics.

The setting of 1.5% for both regions of Luzon and Visayas may undermine the accuracy of forecasts in each region.

The Philippine Electricity Market Corporation (PEMC), which acts as the Market Operator that is tasked with the responsibility of forecasting load in the regions where it is operating in, recognizes such an issue in load forecasting, and therefore establishes the values for the different initial loss percentages for each forecast area in this paper.

[1] Clause 6.3.1 of the WESM Manual on the Load Forecasting Methodology
[2] Clause 6.3.2 of the WESM Manual on the Load Forecasting Methodology

## 2. Current Nodal Forecasting in the WESM

### 2.1. Overview of the Current Methodology

The current methodology of obtaining forecasts in WESM makes use of a "top-to-bottom" approach, in which the Market Operator performs forecasts for a certain region to eventually obtain load forecasts for each customer node.

There are two forecasting modules in the MMS: the Similar Day Load Forecast (SDLF) for the day-ahead and week-ahead projections (DAP and WAP), and the Load Predictor (LDP) for the hour-ahead forecasts (for RTD). However, since these modules merely employ a time-series function, they are unable to consider dynamic conditions in the grid. As such, their forecasts are replaced by values obtained from PEMC's in-house application, the Multivariate Forecasting System (MVFS).

Once the regional forecasts are obtained, the Market Management System (MMS) shall use the initial loss percentage to net out the total load that shall be pro-rated to each customer node based on the latest snapshot (for LDP) or the load pattern (for SDLF).

For example, if the "input demand forecast" for a certain region is 1,000 MW, given that the initial loss is set at 1.5%, then the total load shall be 985.22 MW (1000/1.015). The total forecasted load (net of loss) will then be pro-rated to each customer node. Let us assume in the following example that there are three (3) customer nodes in the sample region. The total load shall then be pro-rated to each customer node for an hour as shown below.

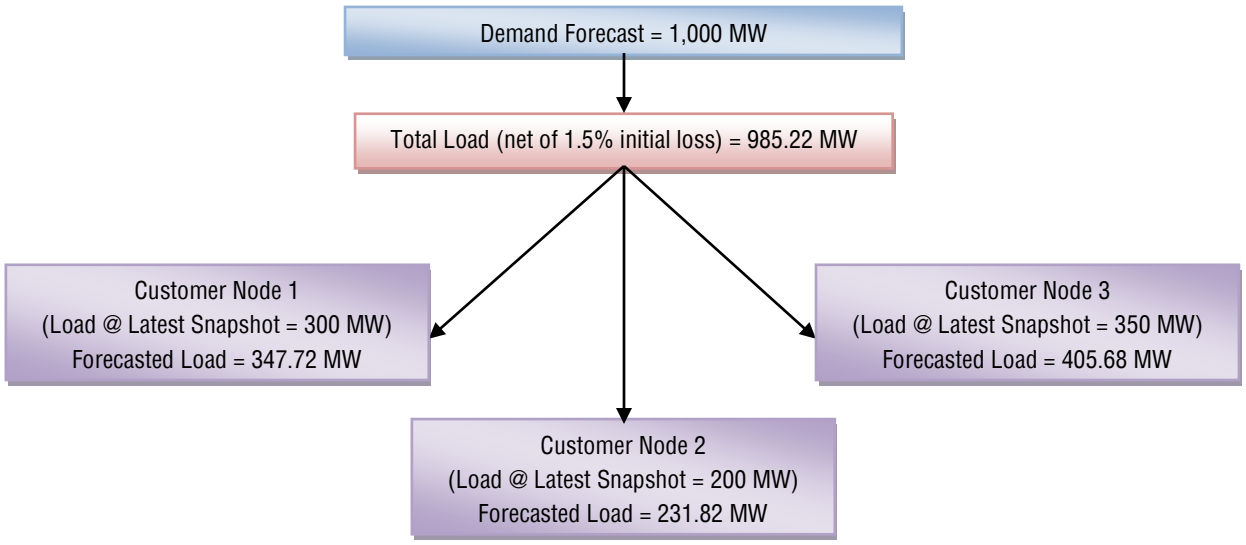


Figure 1. Sample Illustration of Current WESM Nodal Forecasting in a certain Forecast Area

The 1.5% initial loss is just an assumption used to obtain the total load, and eventually the forecasted load for each customer node. The final loss value in a region shall still depend on the power flow computed once the generation schedules are achieved during the optimization process of the workflow. Assuming that the customer nodes are in a 3-bus network diagram as shown below, the losses will be computed as power flow is achieved during the optimization process of the workflow.

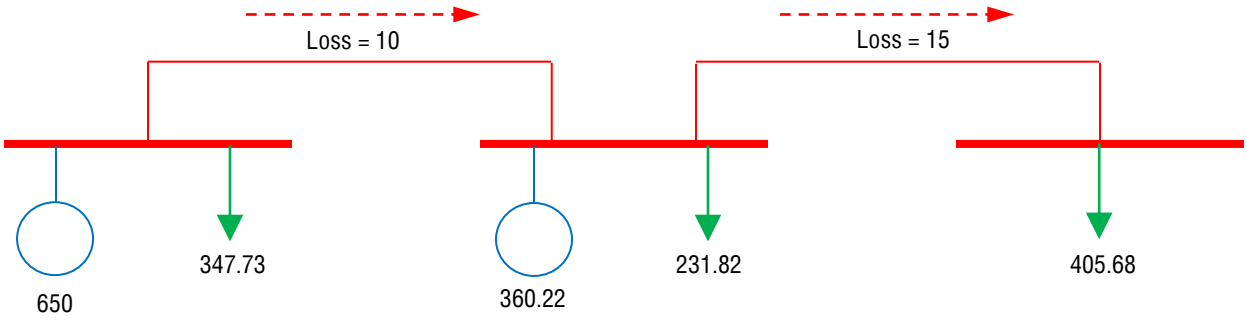


Figure 2. Nodal Forecasts for Sample 3-bus network

Hence, the "final demand forecast" (RTD Demand) for the trading interval shall be 1,010 MW instead of the "input demand forecast" of 1,000 MW.

The Market Operator, which has the ability to run the optimization engine in an "offline mode" is implementing an iterative process to achieve his intended forecast. In the example, the first iteration showed that an input demand forecast of 1,000 MW resulted to a final demand forecast of 1,010 MW. If the Market Operator deems it necessary that the final demand forecast should reflect 1,000 MW, he will adjust his input demand forecast at a lower rate at the next iteration to achieve his intended "final demand forecast".

## 2.2. Assessment of the Initial Loss Percentage

The 1.5% initial loss is observed to be critical, particularly if the final loss is not close to the initially assumed percentage. Using the previous example as illustrated in Figure 1, if the final loss obtained is 25 MW, then the demand that will be used as a reference for the scheduling of generators shall be 1,010 MW instead of the intended input of 1,000 MW.

This is the main reason why the Market Operator uses the "OFFLINE" system to compensate for the difference in their forecast and the final demand that could be determined for the RTD.

Even if the Market Operator achieves a reasonable accuracy on a regional level due to the iterative process being employed by the Market Operator, there are still issues with how nodal forecasts are obtained.

## 3. Options for Setting of Initial Loss Percentages

### 3.1. Setting of the Initial Loss Percentage based on Historical Information

The following alternatives shall use the data coming from the RTD workflow.

#### One Initial Loss Percentage

Currently, the initial loss percentage is a configurable variable for each workflow. Previously, each workflow has only one initial loss percentage value (1.5%) used for all regions (Luzon, Visayas, and Mindanao) even if forecasts are actually achieved separately.

This section intends to show if the historical information will be able to justify the applicability of the 1.5% initial loss percentage, or if another percentage is more viable but may be set for all regions. Since we are still assuming a single loss percentage here, and with Luzon and Visayas being interconnected through the 350 kV HVDC Link, the load and loss information collected shall be combined from both grids.

If we look closely on the distribution of the loss percentages (loss/load) for the covered period in RTD, we can observe that the average of loss percentage in the system (Luzon-Visayas) is 1.89% with a standard deviation of 0.24%. The standard deviation shows that the loss percentages lie within a narrow range, in which 95% of the population is within the range of 1.41% to 2.37%. The next figure shows the normal distribution curve of the loss percentages in the system at RTD during the study period.

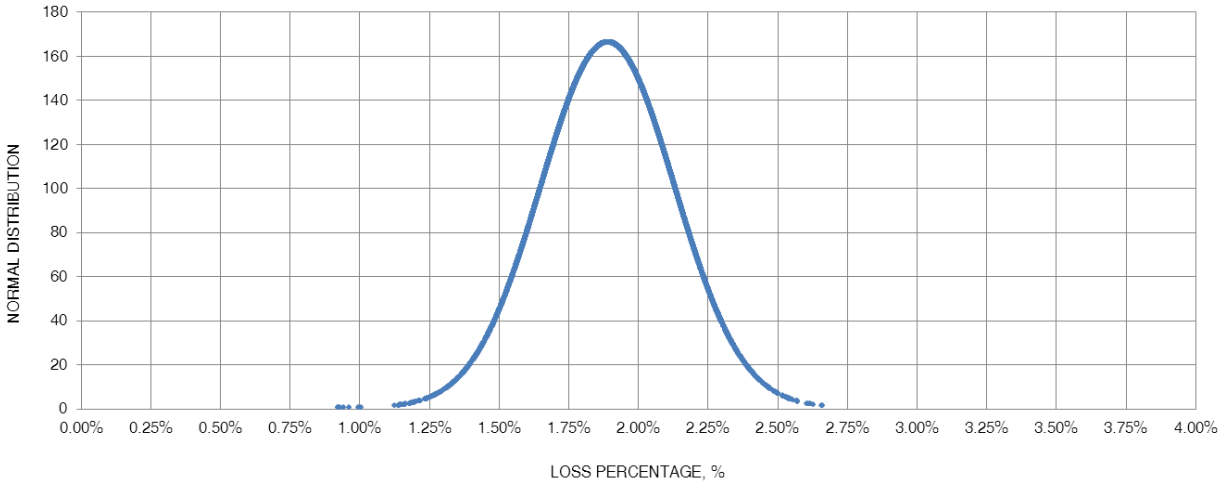


Figure 3. Distribution of Loss Percentages in System (Luzon-Visayas)

If there is only one initial loss percentage to be configured, it is advisable to use the 1.89% initial loss instead of the 1.5% currently configured in the MMS.

However, this lone setting brings up some issues, particularly since Luzon and Visayas are two separate grids with entirely different characteristics. Since Luzon has a higher quantity of load, and consequently a higher loss quantity, the average loss percentage was driven mostly by Luzon. Hence, it may be advisable to consider separate initial loss percentages for each grid in the Market Network Model.

Separate Initial Loss Percentage per Region

If separate initial loss percentages were configurable for each region, the average loss percentage of 1.84% in Luzon may be a viable initial loss percentage since its variability is narrow given its standard deviation being only 0.23%. It means that 95% of the loss percentages ranged from 1.38% to 2.30%.

However, the same cannot be assumed for Visayas, its variability is much wider with a standard deviation of 0.75%, and varies from as low as 0.86% to as high as 5.06%. If the same approach in Luzon was assumed, Visayas' average would be at 2.14%, and provided that its standard deviation is 0.75%, it would be assumed that 95% of the population ranged from 0.64% to 3.64%. However, this connotation would be sufficient provided that the population of data is normally distributed, in which there is equal distribution of data below

and above the mean. By shear inspection, the 0.64% is actually lower than the population's lowest loss percentage in Visayas, which was previously stated at 0.86%.

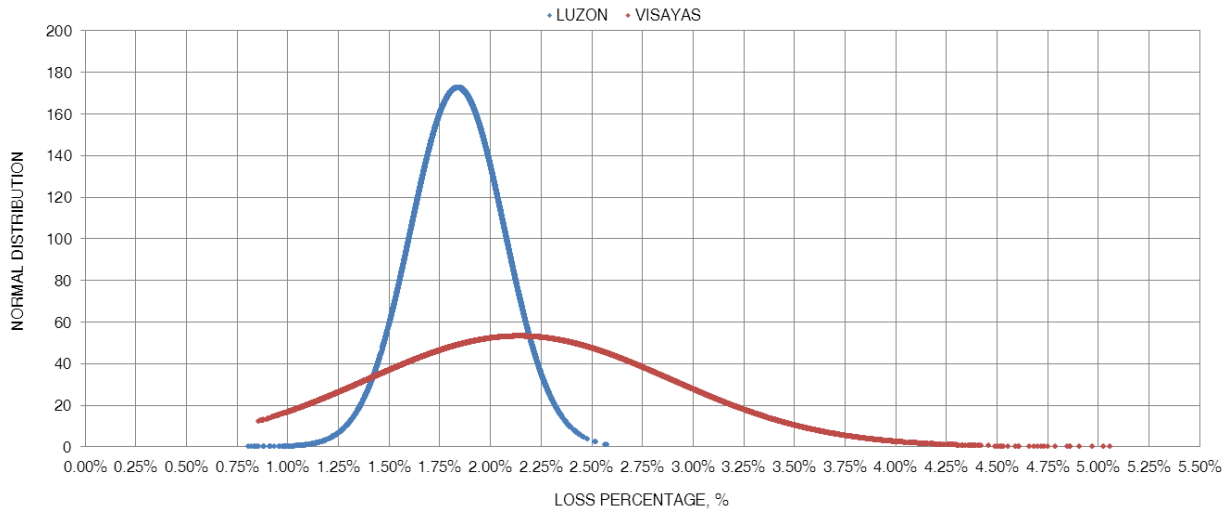


Figure 4. Distribution of Loss Percentages in Luzon and Visayas

The loss percentages in Visayas are widely distributed since power is transferred to a load through a radial network located far from the source (generation), particularly in the islands of Negros and Panay. Instances of low loss percentages occur at times when demand is either low, or more generation are produced at the islands where generation is mostly scarce.

It is possible that some of these loss percentages are extreme cases, in which it may be treated as outliers. We can assume that the outliers are those that have extremely high loss percentages. To isolate such cases, we would get the difference (d) between the minimum and the average, which would be the lower limit, and then the upper limit would be equivalent to the sum of the average and (d). After the removal of such outliers, we observed the following normal distribution curve in Visayas in Figure 5.

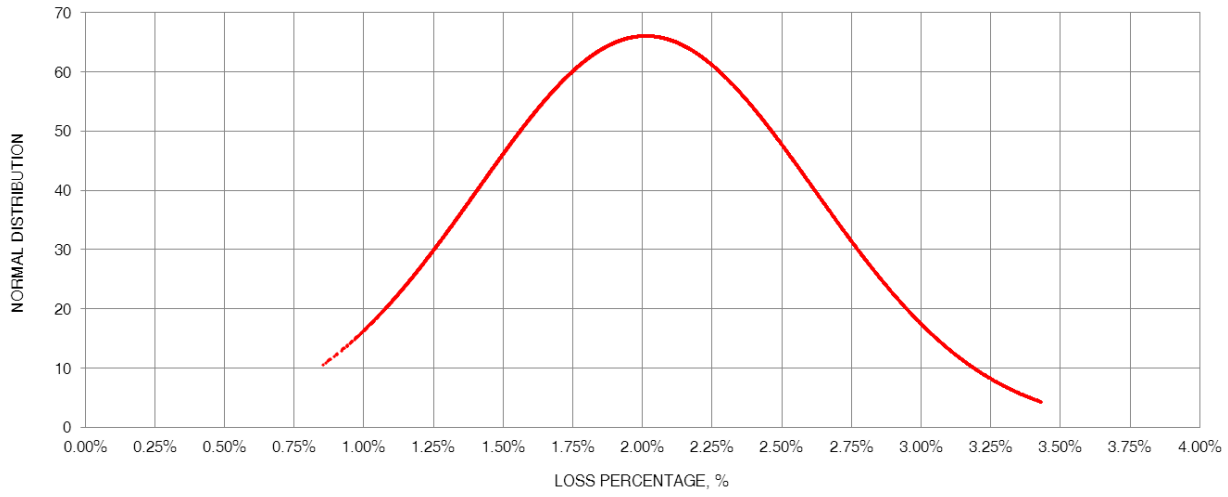


Figure 5. Distribution of Loss Percentages in Visayas w/o outliers

After the removal of such outliers, the data that was left comprise 93% of the complete data, which seems sufficient and justifies that there is less chance that the said outliers occur. The average of the new set of data in Visayas is 2.01% with a standard deviation of 0.6%, which is lower than the complete data's $\sigma$ of 0.75%.

Hence, if the initial loss percentage were to be set separately for each region, it is recommended to use 1.84% and 2.01% for Luzon and Visayas, respectively.

However, it must be noted that there is a higher risk for Visayas with the average value of 2.01% being set because of its high wider variance as observed in its standard deviation. The value 2.01% may be too low or too high in some instances given that there are cases where it reached a loss percentage of more than 3.5% at 6.27% of the time during the study period.

## 3.2. Detailed Historical Information of Loss Percentages

A more detailed perspective of the loss percentages may be worth looking at since we can form trends of data to better have an understanding of what the typical loss percentages are at different periods of time.

The next figure shows that Luzon's loss percentages tend to increase starting at 0800H, which is coincident to the period where demand starts to increase during the day. However, the hourly loss percentages are not significantly different from each other to suggest a

considerable trend. In a way, the losses generally conform at every level of demand during the day in Luzon.

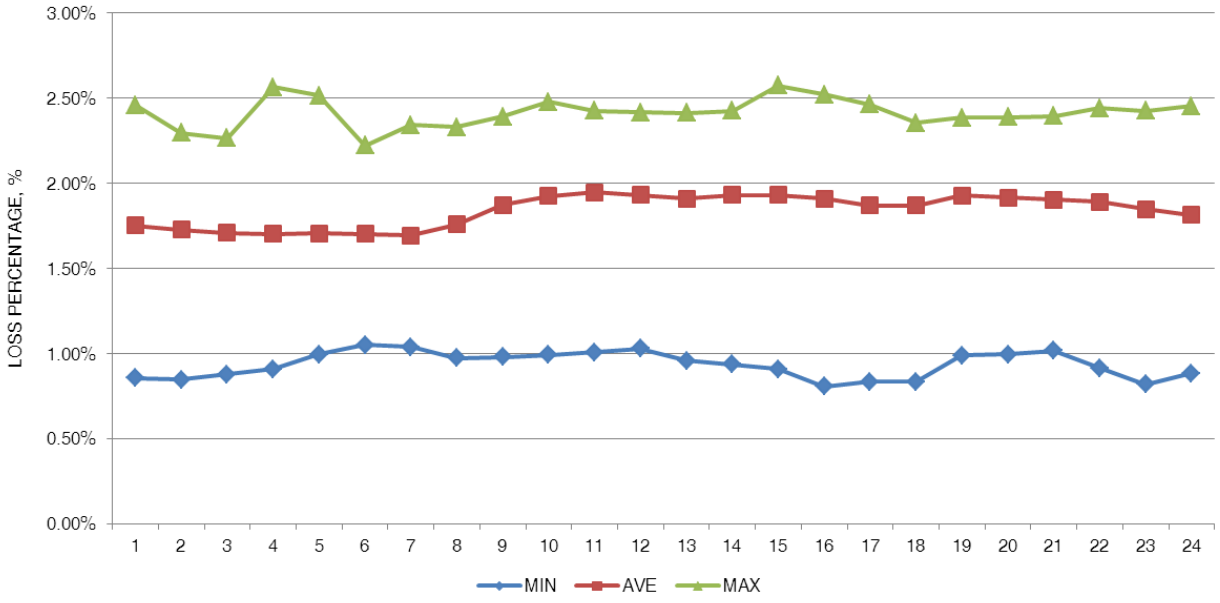


Figure 6. Hourly Min, Max, and Ave Loss Percentages in Luzon

However for Visayas, the loss percentages are much diverse at different periods during the day as illustrated in the next figure.

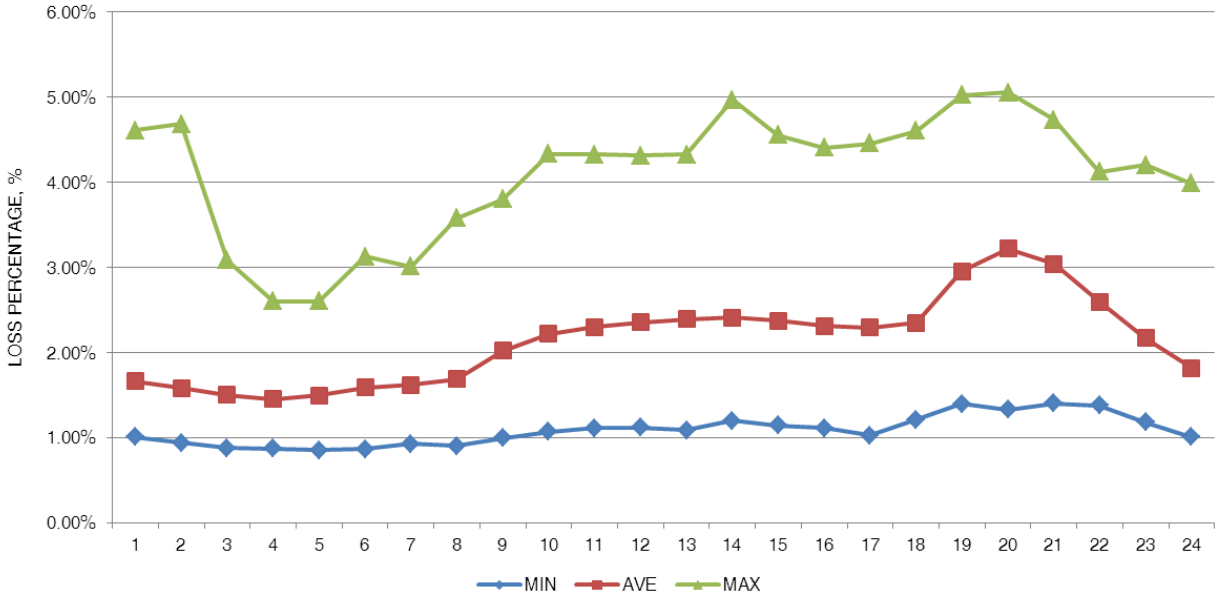


Figure 7. Hourly Min, Max, and Ave Loss Percentages in Visayas

Based on Figure 7, loss percentages start to increase at 0900H, which is coincident to the start of the increase of demand in Visayas. It then picks up significantly at 1900H, which is the same period where the peak demand in the region is observed, and then falls again after the 2100H since demand begins to decrease during the day.

The observations suggest that an increase in load will not directly result to a proportionate increase in losses. Rather, an increase in load translates to an even higher loss percentage in the region. This is where setting a single initial loss percentage for Visayas presents a risk since different periods observe different levels of loss percentages historically. If it were possible, it would be more appropriate to have a set of configurable initial loss percentages for each trading interval in each region.

| HOUR | LUZON | | | VISAYAS | | |
|---|---|---|---|---|---|---|
| | MIN | AVE | MAX | MIN | AVE | MAX |
| 1 | 0.86% | 1.75% | 2.46% | 1.01% | 1.67% | 4.61% |
| 2 | 0.85% | 1.73% | 2.30% | 0.94% | 1.58% | 4.68% |
| 3 | 0.88% | 1.71% | 2.27% | 0.88% | 1.51% | 3.08% |
| 4 | 0.91% | 1.70% | 2.56% | 0.87% | 1.46% | 2.60% |
| 5 | 1.00% | 1.71% | 2.52% | 0.86% | 1.50% | 2.60% |
| 6 | 1.05% | 1.70% | 2.22% | 0.87% | 1.59% | 3.13% |
| 7 | 1.04% | 1.69% | 2.34% | 0.93% | 1.62% | 3.01% |
| 8 | 0.97% | 1.76% | 2.33% | 0.90% | 1.69% | 3.58% |
| 9 | 0.98% | 1.87% | 2.39% | 1.00% | 2.02% | 3.80% |
| 10 | 0.99% | 1.93% | 2.48% | 1.07% | 2.22% | 4.33% |
| 11 | 1.01% | 1.95% | 2.43% | 1.11% | 2.30% | 4.33% |
| 12 | 1.03% | 1.93% | 2.42% | 1.12% | 2.36% | 4.31% |
| 13 | 0.96% | 1.91% | 2.41% | 1.09% | 2.39% | 4.33% |
| 14 | 0.94% | 1.93% | 2.43% | 1.20% | 2.41% | 4.97% |
| 15 | 0.91% | 1.93% | 2.57% | 1.14% | 2.37% | 4.56% |
| 16 | 0.81% | 1.91% | 2.52% | 1.11% | 2.31% | 4.41% |
| 17 | 0.84% | 1.87% | 2.46% | 1.03% | 2.29% | 4.46% |
| 18 | 0.83% | 1.87% | 2.36% | 1.22% | 2.35% | 4.60% |
| 19 | 0.99% | 1.93% | 2.39% | 1.40% | 2.96% | 5.03% |
| 20 | 0.99% | 1.92% | 2.39% | 1.33% | 3.22% | 5.06% |
| 21 | 1.02% | 1.90% | 2.39% | 1.40% | 3.04% | 4.73% |
| 22 | 0.91% | 1.89% | 2.44% | 1.38% | 2.60% | 4.12% |
| 23 | 0.82% | 1.85% | 2.43% | 1.18% | 2.17% | 4.20% |
| 24 | 0.89% | 1.81% | 2.45% | 1.01% | 1.82% | 3.99% |

Table 1. Historical Loss Percentages for each Region

## 4. Conclusion

It was observed that the initial loss percentage play a significant role in the current nodal forecasting methodology in WESM. And upon further assessment, it can be concluded that the previous initial loss percentage of 1.5% is not anymore applicable for both the Luzon and Visayas grids.

A single percentage that will be applied for both regions will definitely affect the other as one region's initial loss percentage may be too under-estimated while the other may be over-estimated. In effect, it will affect the forecasted load and eventually the regional and nodal forecasts.

Hence, initial loss percentages should be set separately for the different regions since Luzon and Visayas have entirely different network characteristics, wherein Visayas has a much higher loss percentage than Luzon.

And based on the statistical assessment made on this paper for the historical initial loss percentages of the Luzon and Visayas grids, the values of 1.84% and 2.01% are viable for use in the Luzon and Visayas grids to replace the previous system-wide value of 1.5%.

## 5. Recommendations

It is recommended that the initial loss percentage should be implemented on a region-specific basis given the distinct differences in network characteristics between regions, particularly between Luzon and Visayas.

Also, as prescribed in the WESM Manual on the Load Forecasting Methodology, it should be reviewed annually for possible change.

It is also possible for PEMC to explore different initial loss percentages for each hour in each forecast area as initially assessed in this paper. However, that would require an enhancement to the MMS.