ELECTRICITY CONTROL BOARD

NAMIBIA BALANCING FRAMEWORK

(DRAFT V0.2)

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1 DEFINITIONS

The definitions set out in the latest Market Rules shall apply in respect of the Balancing Framework.

2 INTRODUCTION

The Electricity Control Board (ECB) is the statutory regulatory authority for the electricity sector, established in terms of Electricity Act (Act 2 of 2000) repealed by (Act 4 of 2007).

The ECB has the core responsibility of exercising control over the electricity supply industry (ESI); which entails regulation of generation, transmission, distribution, supply, use, import and export of electricity in Namibia. In particular Part II, sections (4)(a) and (4)(b) of the electricity Act - 2007, empowers the Regulator, subject to certain conditions, to establish an electricity market, issue licenses to persons operating in the market and to publish Market Rules and regulations to govern the market.

In order to support the implementation of the Modified Single Buyer (MSB) model, the ECB developed a **Balancing Framework** to guide market participants that enter into new transactions in the MSB.

3 BALANCING FRAMEWORK OBJECTIVE

Balancing refers to the real time adjustment of supply and or demand to ensure the security and reliability of the electric system. In Namibia, the Systems Operations (SO) function in NamPower is responsible for balancing.

The need for balancing services and the cost to procure these services are the result of unforeseen fluctuations by suppliers and consumers of electricity. This framework addresses the commercial arrangements in the event an Eligible Generator or Importer deviates from the Final Dispatch Schedule published by the MO.

The objective of the Balancing Framework is to recover the cost of providing balancing services from the parties who cause the need for the service in accordance with the ‘user-pay’ principle.

4 BALANCING IN THE MSB

The SO is responsible to balance the electricity market in Namibia taking into account the demand supply situation in Namibia and its obligations in the SAPP. The SO shall procure balancing services from all available sources in accordance with least cost principles.

It should be noted that the SAPP is in the process of developing a Balancing Market, which will allow SAPP members to balance themselves. In the future, it is foreseen that Namibia will utilise this market in order to manage balancing requirements and the Balancing Mechanism will be realigned with this market.

5 PRINCIPLES

The Balancing Framework is based on the following principles:

1) Economic Efficiency: The framework strives to achieve economic efficiency to encourage the optimum use of scarce resources.
2) Fairness: The framework aims to treat all Eligible Sellers in a consistent and fair manner, whilst allowing the MO to recover the costs of balancing the market
3) Non-discriminatory: The framework aims to prevent discrimination between Bilateral Transactions. In practise this means that similar transactions will attract similar charges.
4) Transparency: The balancing methodology and charges are open and transparent which means it can be followed and if needed replicated by any interested party.
5) Simplicity: Avoid overly complex calculations and methodologies.
6) Ease of implementation: Balancing charges are levied as part of the settlement process already being undertaken for the market.

6 CHALLENGES

The following challenges are noted:

1) Real time balancing of the system requires constant adjustments to manage the imbalances volume, which can be caused by a range of factors, including: unplanned outages; supply and demand forecast errors, changing weather patterns, etc.
2) The cost of procuring balancing services will only be known 'after-the-fact'. However, users of balancing services want to know the cost of balancing 'before-the-fact' in order to make informed investment decisions. This will expose the MO to differences between cost recovered and cost incurred of marginal generation costs during peak hours, which will need to be recovered from Eligible Sellers.
3) Variable Renewable Energy (VRE) generators are "weather dependant" and their forecasting is therefore stochastic - they will therefore be subject to forecasting errors.
4) Forecasting for several plant over a larger area, tend to be more accurate due to the benefit of diversity; however, forecasts for single plant tend to be relatively less accurate.
5) The balancing framework should allow for a tolerance of some forecasting error, whilst ensuring that Eligible Sellers do not unduly benefit from inaccurate forecasting, resulting in subsidisation by other Market Participants.
6) The imbalance charge for Eligible Sellers that deviate, has the potential to influence the behaviour of Eligible Sellers – it needs to be set an appropriate level which encourages a reduction in forecasting error and allows for the recovery of imbalances costs borne by the MO.

7 BALANCING MECHANISM RULES

1) An Eligible Generator or Importer that deviates from the published Final Dispatch Schedule will be automatically balanced by the MO.

2) The amount of balancing required will be determined by the MO.

3) A Balancing Charge shall apply, subject to the rules set out below.

4) Bilateral transactions in the domestic Namibian market will attract Balancing Charges as set out below.

5) Imbalances in respect of Bilateral transactions for Export will be managed subject to the Exporter's arrangement with the MO.[1]

7.1 Balancing for Internal Transactions

7.1.1 Tolerance Band

1) The MO shall measure all Energy Imbalances as the difference between the Delivered Energy less the Final Dispatch Schedule in every Trading Period.

2) The MO shall apply a Tolerance Band when determining the Balancing Energy quantity that is used in calculating the Balancing Payment.

3) The following tolerance limits shall apply:

    (a) The Lower Limit is defined as the lesser of:

        i) -0.5 MW, or

        ii) -10% of the EG's (or Importer's) Final Dispatch Schedule

    (a) The Upper Limit is defined as the greater of:

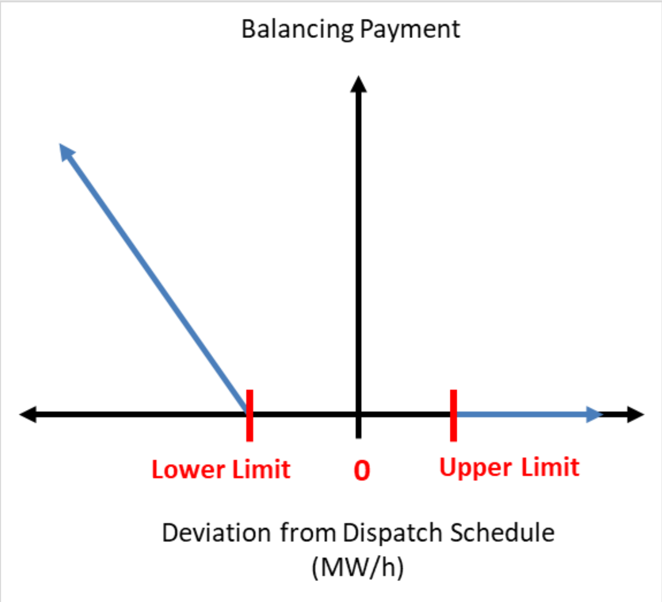
        i) +0.5 MW, or

        ii) +10% of the plant's Final Dispatch Schedule.

4) The figure below illustrates the relationships between deviation from the Final Dispatch Schedule and the Tolerance Band (which is the area between the Lower Limit and the Upper Limit).

[1] The MO will develop a procedure for the determination of balancing payments for SAPP imbalances, which is approved by the Regulator.

Figure 1: Balancing Payment Mechanism Diagram



7.1.2 Balancing Energy

1) The Balancing Energy quantity in every hour shall be determined as set out below:

Imbalance Energy = Delivered Energy – Final Dispatch Schedule

Lower Limit = Lower of (-0.5MW or -10% of Final Dispatch Schedule)

Upper Limit = Greater of (+0.5MW or +10% of Final Dispatch Schedule)

<u>If Imbalance Energy < 0, and</u>

Imbalance Energy > Lower Limit, then

Balancing Energy = 0, or

Imbalance Energy < Lower Limit, then

Balancing Energy = Imbalance Energy – Lower Limit

<u>If Imbalance Energy > 0, and</u>

Imbalance Energy < Upper Limit, then

Balancing Energy = 0, or

Imbalance Energy > Upper Limit, then

Balancing Energy = Imbalance Energy – Upper Limit

7.1.3 Balancing Charge

1) The following Balancing Charges shall apply in determining the Balancing Payment:

For Balancing Energy below the Lower Limit:

Lower Balancing Charge = 30% (thirty percent) of the NamPower retail energy TOU Tariff

For Balancing Energy above the Upper Limit:

Higher Balancing Charge = No charge shall apply

7.1.4 Balancing Payments

1) A Balancing Payment shall apply to Eligible Generator or Importer in the case where the Balancing Energy in any hour is not nil. The payment shall be calculated in accordance with the following formulae:

   If Balancing Energy < 0:

   *Balancing Payment = -(Balancing Energy * Lower Balancing Charge)*

   If Balancing Energy > 0:

   *Balancing Payment = (Balancing Energy * Higher Balancing Charge)*

7.2 Balancing for Export Transactions

To be developed by the MO and approved by the ECB.

8 ANNEX 1: BALANCING TOLERANCE BAND ANALYSIS

The objective of the Balancing Mechanism is both to recover costs for balancing services provided by the SO, as well as providing an economic signal to Generators and Importers, to encourage efficient operations. However, it is acknowledged that all generators are subject to forecast errors for a variety of reasons. In order to mitigate this challenge, the ECB have introduced a "Tolerance Band" in the Balancing Mechanism, which provides Generators and Importers, with some relief for a margin of error in their forecasts.

8.1 Key Issues

In setting the Tolerance Band, the ECB have taken the following key issues into account:

1) The Tolerance Band should incentivise Generators and Importers to submit accurate production forecast.
2) The Generator or Importer will be negatively impacted by inaccurate forecasting in two ways:
    a. Loss of revenue
    b. a Balancing Penalty
3) The Tolerance Band should aim to impact both smaller and larger plants equitably
4) The Balancing Penalty Charge that is levied, should aim to allow the MO to recover the difference between the marginal cost of balancing energy and the NamPower ToU wholesale energy tariff

8.2 Analysis

The ECB undertook an analysis in order to determine the following:

1) The appropriate Tolerance Band for Namibia
2) The appropriate Balancing Penalty Charge for Namibia

The data used for the analysis, was the hourly metered data from existing PV REFIT plant in Namibia from 1st July 2017- 1st May 2019.

8.2.1 Forecasting Error Assessment

There is an established body of research covering rates of unplanned outages for dispatchable generators. These unplanned outage rates can be assessed by technology in order to determine likely forecasting error.

However, in recent years attention has shifted to the forecasting accuracy of renewable energy technologies. Over the past decade, significant analysis has been conducted on PV and Wind forecasting accuracy, with on-going improvements. Based on recent peer-reviewed research, utilising data from South Africa, North America, South America and Europe, the following can be noted:

1) Solar power output is directly proportional to the magnitude of solar irradiance incident on the panels. Solar irradiance variations are caused primarily by cloud movement, cloud formation, and cloud dissipation.

2) There are several metrics that can be used to measure the accuracy of solar PV forecasts including Mean Absolute Error (MAE) or Mean Absolute Percentage Error (MAPE), which is the most common and widely accepted metric. Other commonly used metrics include Pearson's correlation coefficient and the Root Mean Squared Error (RMSE).
3) MAPE for single PV plant in these areas is recorded as between 4% - 15% with a slightly higher average RMSE of 8% - 17%

The research therefore shows that there is a wide range of MAPE for PV plant recorded globally.

In order to test a potential forecasting error for Namibia, the ECB developed a simple forecasting technique to test forecasting accuracy. The hourly REFIT plant production data was used as a basis for comparison. The forecast methodology effectively allowed the following days production to be equal to the previous days production i.e. the delivery day production would be equal to production from two days prior. This is an extremely simple forecasting method and it is anticipated that generators and importers will use more sophisticated forecasting techniques with much higher accuracy.

Nevertheless, the simple approach serves as a useful starting point to determine forecasting accuracy. The results from this method show a surprisingly high average correlation factor of 0.92 and an average MAPE of 9%.

Wind forecasting requires access to a number of data inputs which are not currently available to the ECB for this analysis – these include wind velocity and direction, humidity, pressure, and temperature. There are also not enough wind plants in Namibia to currently conduct a useful analysis of production vs. forecast. In this case, the ECB will rely on international benchmarks to test the level of forecasting error.

The global research shows an average MAPE of 4% - 10% for wind forecasts, which are generally considered to be more accurate than those for PV.

However, in developing the tolerance band, the ECB have taken into account a number of other variables including balancing costs and cost recovery for the MO, loss of revenue for generators and the cost of penalties for generators.

In order to test these impacts and costs, the ECB conducted an analysis of a number of penalty and tolerance band thresholds in order to balance cost recovery with the impact on generator and importers. Based on the analysis, the tolerance band and penalty threshold have been set as described in Section 7.1.

The results from the analysis for a tolerance band and penalty mechanism, as described above, are shown below.

8.2.2 Analysis Results

The following analysis has been made using Balancing mechanism discussed above.

Plant Parameters for a typical 5MW PV plant:

1) Actual production of 27,198 MWh over the period 1st July 2017- 1st May 2019
2) Forecast production of 27,172 MWh over the period 1st July 2017- 1st May 2019
3) A MAPE of 5.3%

Assumptions:

4) A selling price of 80 N$c/kWh
5) A penalty charge of 30% of NamPower ToU wholesale energy charge
6) Peak ToU charge is 133.45 N$c/kWh; Standard ToU charge is 100.09 N$c/kWh and Off-peak ToU charge is 66.73 N$c/kWh

Special Comments:

7) There is no penalty charge for over-production; however, generators can sell the excess energy within the upper tolerance limit as described above – this allows generators to recover some revenue for energy produced but not forecast.

Analyses

8) The total energy sold - taking into account the energy forecast, actual energy production and the tolerance band as set out above - is 25,557MWh (94% of total energy produced) with revenue of N$20,445,493
9) The total energy forecast but not delivered is 2,227 MWh of which 1,218 MWh is below the lower limit and will therefore be penalised resulting in a total penalty of N$ 381,580
10) The penalty cost is therefore 0.31N$/kWh (total penalty divided by the penalty volume) and 0.015N$/kWh on energy sold