ELECTRICITY CONTROL BOARD

ECB REPORT: DETERMINATION OF DISTRIBUTION LOSSES TARGETS

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Signed:

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Evangelina Nailenge
Board Chairperson

Date: 16/12/2025

Table of Contents

1. BACKGROUND 5
2. INTRODUCTION 5
3. METHODOLOGY 6
3.1. Obtaining Historical Losses Data 6
3.2. Categorising Distribution Licensees 6
3.3. Analysing the Losses Data 7
3.4. Reviewing of Existing Losses Determination Methodology 7
3.5. Setting of Annual Losses Targets 7
4. REVIEW OF EXISTING METHODOLOGY 7
4.1. Shortcomings of the existing methodology 7
5. FINDINGS AND DISCUSSION 8
5.1. Distribution Licensees' Categories 8
5.2. Historical Distribution Losses for All Distribution Licensees 9
5.3. Current Levels of Distribution Losses 11
5.4. Historical Distribution Losses Per Category of Licensees 12
5.4.1. Major distribution licensees (REDs, CoW, OPE and NamPower Distribution) 13
5.4.2. Municipalities and Town Councils 13
5.4.3. Village Councils and Regional Councils 15
5.4.4. Farmers' schemes 17
5.4.5. Other distribution licensees (i.e. Estates) 18
6. SETTING OF ANNUAL DISTRIBUTION LOSSES TARGETS FOR INDIVIDUAL LICENSEES 20
6.1. REDs, CoW, OPE and NamPower Distribution 20
6.2. Municipalities and Town Councils 20
6.3. Village Councils and Regional Councils 20
6.4. Farmers' Schemes 20
6.5. Other distribution licensees (i.e. Estates) 21
7. BEST PRACTICES FOR IMPLEMENTATION IN THE DETERMINATION OF DISTRIBUTION LOSSES 21
8. TARGET DATE FOR THE IMPLEMENTATION OF THE ANNUAL DISTRIBUTION LOSSES 22
9. CONCLUSION AND RECOMMENDATIONS 22
10. REVIEW OF THE REPORT 22
11. APPROVAL AND EFFECTIVE DATE 22

Table of Figures

Figure 1. Current levels of distribution losses 11
Figure 2. Average distribution losses per category 12
Figure 3. Major distribution licensees' losses figure 13
Figure 4. Municipalities and Town Councils losses figure 15
Figure 5. Village Councils and Regional Councils losses figure 17
Figure 6. Farmers' Schemes losses figure 18
Figure 7. Other Distribution Licensees' losses figure 19

Table of Figures

Table 1. Categories of distribution licensees 9
Table 2. Historical distribution losses data for all distribution licensees during 2020-2024 10
Table 3. Historical distribution losses data for major distribution licensees during 2020-2024 13
Table 4. Historical distribution losses data for municipalities and town councils during 2020-2024 14
Table 5. Historical distribution losses data for village councils and regional councils during 2020-2024 16
Table 6. Historical distribution losses data for farmers' schemes during 2020-2024 18
Table 7. Historical distribution losses data for other distribution licensees during 2020-2024 19
Table 8. Annual distribution losses targets 21

1. BACKGROUND

The Electricity Control Board (ECB) initiated a study in 2016 to determine the distribution network losses for the Namibian Electricity Supply Industry (ESI). EMCON Consulting Group was appointed by the ECB through an open tender process for consultancy services for the "Determination of Distribution Losses for the Namibian ESI.

The scope of work included:

- Reviewing and assessing the robustness of the existing methodology used to determine distribution losses.
- Proposing best practice methodology for determining distribution losses.
- Establishing and providing a separation between technical and non-technical losses and identifying main/common sources of the losses.
- Reviewing existing measures to determine non-technical losses.
- Use historical load data to come up with typical average loss figures for a twelve-month period.
- Proposing principles and a methodology to be agreed upon by the ECB to implement and follow for each tariff adjustment application process.
- Proposing strategies to minimise existing and future technical and non-technical losses.

This study could not come to a successful conclusion due to insufficient data; hence all the objectives were not achieved. It is for that reason that the ECB initiated another project in 2024 to determine Distribution Losses Targets for the ESI. The scope of work laid out in the project's Terms of Reference have slightly been adjusted and this project is more aligned to determining distribution losses targets using historical distribution losses data obtained from the distribution licensees over a 5-year period, from 2020 to 2024.

2. INTRODUCTION

Distribution network losses are an important factor in the operation of the Namibian power grid, and they have a direct impact on the financial perspective across the Namibian ESI. Distribution losses form part of the input into the request for yearly adjustment of the electricity tariffs for distribution licensees and impacts the utilities as well as customers and consumers. Losses result in less energy available to customers given a fixed amount of generation.
Knowing the total current levels of distribution losses in the country is imperative for the regulator to set appropriate annual losses targets for individual distribution licensees. It is therefore important to ensure that the methodologies used to determine total losses, technical losses and non-technical losses are correct and that these methodologies are aligned with world's best-practises.

The scope of work for this project includes:

- Establishing the current levels of total distribution losses of Distribution licensees in Namibia.

- Establishing best practices for implementation in the country in the determination of distribution losses, identifying and proposing required investments to reduce especially the non-technical losses to reduce total losses to optimal levels.
- Determining appropriate annual loss targets for various Distribution licensees in Namibia.

This report excludes items that were explicitly explained in the 2016 study conducted by EMCON Consulting Group. These include definitions of terms such as the various types of losses and their underlying causes.

This report details the findings of the project and recommendations, based on research that the ECB conducted. This report was also compiled in conjunction with the findings of the 2016 EMCON Study.

3. METHODOLOGY

3.1. Obtaining Historical Losses Data

In order to determine the annual loss targets for individual distribution licensees, historical losses data for each licensee was obtained. The historical losses data analysed in this report covers a five-year period, from 2020 to 2024. This data came from the Operating and Reporting Manual (ORM) forms that each distribution licensee submits to the ECB during their tariff review applications. Each distribution licensee is required to include their annual losses figures as part of every tariff review application.

3.2. Categorising Distribution Licensees

Since distribution licensees' network sizes differ, their total distribution losses will differ significantly. For that reason, it was necessary to categorise distribution licensees into various groups. Each group contains distribution licensees that have similar characteristics. The categories are:

a. REDs, Oshakati Premier Electric, NamPower Distribution and City of Windhoek
These are large distribution licensees distinguished by extensive distribution networks that span vast geographic areas.

b. Municipalities and Town Councils
This includes all the municipalities and town councils that have distribution licences.

c. Village Councils and Regional Councils
This includes all the village and regional councils that have distribution licences.

d. Farmers' schemes
This category includes all farmers' schemes.

e. Other distribution licensees (i.e. Estates)
This category includes the rest of distributors such as Estates.

3.3. Analysing the Losses Data

The historical losses data were visualised and analysed in order to assess trends in distribution loss figures. Data charts were drawn to show the levels and trends of distribution network losses data for each licensee. This enabled the ECB to get an overall overview of the total distribution network losses and to analyse the trend of distribution losses over the 5-year period.

3.4. Reviewing of Existing Losses Determination Methodology

The current methodology that is used to determine distribution losses was reviewed.

3.5. Setting of Annual Losses Targets

Setting of annual losses targets for individual distribution licensees is important to ensure that distribution licensees improve efficiency of their distribution networks.

4. REVIEW OF EXISTING METHODOLOGY

The ECB currently uses the metering and billing data to calculate the total system losses and are typically expressed in terms of a percentage of purchase based on the following formula:

$$Total\ percentage\ losses = \frac{\boldsymbol{Energy\ received\ - Energy\ delivered}}{\boldsymbol{Energy\ received}} \times 100$$

Energy Received = Energy purchased + Export

Energy Delivered = Energy billed + Public lights consumption

$$Total\ \%\ losses\ = \frac{(\boldsymbol{kWh\ purchased + Export}) - (\boldsymbol{kWh\ billed + Public\ lights})}{(\boldsymbol{kWh\ purchased + Export})} \times 100$$

This is the same formula that distribution licensees use to compute their losses too, as it shows on their ORM forms that they submitted to the ECB for tariff reviews.

This study reviews a loss determination methodology that considers total distribution losses. The scope of this study does not extend to the separate identification of technical and non-technical losses; rather, it considers the combined total of both categories.

4.1. Shortcomings of the existing methodology

The current methodology used to determine total losses, based on the metering and billing data, has several shortcomings.

- Self-reading of meters by the customers. The City of Windhoek (CoW) employs a system in which some customers are responsible for reading their own meters and submitting the readings directly

to the utility. This approach introduces potential inaccuracies in loss calculations, stemming from both unintentional errors and deliberate misreporting of meter readings by customers.

Mitigation of shortcoming

This shortcoming can be mitigated by implementing measures to ensure accurate meter readings. Distribution licensees may achieve this by periodically conducting their own meter readings, for example, on a bi-annual basis.

- Aligning the time periods for purchases and sales is essential, as inconsistencies in meter reading across billing cycles can result in loss data that do not accurately correspond to the intended reporting period.

Mitigation of shortcoming

This issue can be mitigated by evaluating losses on an annual basis and making a concerted effort to ensure that purchase and sales data are accurately aligned within the same reporting period.

The total losses figure, submitted by the utilities as part of their ORM, constitutes both technical and non-technical losses. The utilities and the regulator do not yet have a methodology of separating the two. The current methodology explained above is the only methodology used. As a result, it is challenging to determine whether technical or non-technical losses constitute the greater share of total losses. For larger licensees, it might be more feasible to estimate the proportion of technical losses as their networks comprise relatively long lines and are therefore likely to have higher technical losses (line losses due to resistance, corona discharge, etc.). For smaller licensees, with shorter lines, technical losses may be lower. Non-technical losses resulting from electricity theft or fraudulent meter reading and billing practices can be substantially high. The lack of a methodology to distinguish between technical and non-technical losses has the following implications:

- Utilities may be experiencing non-technical losses that are not necessarily attributable to operational inefficiencies. If non-technical losses are not adequately accounted for in the tariff application, this may adversely affect the utility's revenue collection.
- Consumers may end up paying for utilities' network operational inefficiencies.

5. FINDINGS AND DISCUSSION

5.1. Distribution Licensees' Categories

Distribution licensees were categorized based on their distribution network sizes, as shown in the table below.

Table 1. Categories of distribution licensees

REDs, Oshakati Premier Electric , NamPower Distribution and City of Windhoek	❖ NORED ❖ CENORED ❖ Erongo RED ❖ NamPower Distribution ❖ City of Windhoek ❖ Oshakati Premier Electric
Municipalities and Town Councils	❖ Aranos Town Council ❖ Rehoboth Town Council ❖ Gobabis Municipality ❖ Karasburg Town Council ❖ Keetmanshoop Municipality ❖ Luderitz Town Council ❖ Mariental Municipality ❖ Oranjemund Town Council ❖ Roshskor Township
Village and Regional Councils	❖ Aroab Village Council ❖ Berseba Village Council ❖ Bethanie Village Council ❖ Gibeon Village Council ❖ Koes Village Council ❖ Maltahohe Village Council ❖ Tses Village Council ❖ Gochas Village Council ❖ Leornardville Village Council ❖ Witvlei Village Council ❖ Hardap Regional Council ❖ //Kharas Regional Council
Farmers' schemes	❖ Epacha ❖ Naukluft ❖ Osire power
Other distribution licensees (i.e. Estates)	❖ Finkenstein ❖ Omeya

5.2. Historical Distribution Losses for All Distribution Licensees

For a period of 5 years, starting from 2020 to 2024, distribution licensees have applied to the ECB for tariff reviews. One of the requirements is for licensees to provide their total distribution losses for that particular year. As highlighted in the 2016 study, the ECB seeks to encourage utilities to implement measures aimed at reducing losses within their distribution networks. The regulator would also like to ensure that consumers do not pay for utilities' inefficiencies or negligence.

The table below shows total distribution losses figures for all distribution licensees, from 2020 to 2024.

Table 2. Historical distribution losses data for all distribution licensees during 2020-2024

Licensees	2020	2021	2022	2023	2024
NORED	9.20%	12.40%	12.90%	13.30%	11%
CENORED	10.13%	10.11%	9.45%	6.73%	6.73%
Erongo RED	6.60%	7.80%	7.80%	6.40%	6.10%
CoW	6%	8%	8.10%	5.90%	8.70%
OPE	6%	5.50%	6.20%	6.10%	6.40%
NamPower Distribution	11.90%	10.60%	9.40%	9.40%	9.90%
Aranos Town Council	10.30%	8.70%	9.50%	10.30%	8.40%
Aroab Village Council	3%	2%	2.00%	2%	2%
Berseba Village Council	7.80%	7.80%	7.80%	8%	8%
Bethanie Village Council	5.30%	9%	7%	7%	7%
Gibeon Village Council	1.10%	31%	4.80%	5%	4.80%
Koes Village Council	2.10%	2.10%	2.10%	22%	22.20%
Maltahohe Village Council	7.00%	7.00%	21.30%	7%	7%
Tses Village Council	6.00%	14%	6%	6%	6.40%
Rehoboth Town Council	10.60%	6.20%	5.50%	8.20%	9.90%
Gobabis Municipality	8.10%	8.10%	8.10%	10%	10.00%
Hardap Regional Council	10%	28.30%	15.70%	19.80%	5.90%
Karasburg Town Council	11.20%	6.90%	1.80%	1.80%	1.80%
Keetmanshoop Municipality	10.90%	10.80%	7.20%	5.10%	7.90%
Luderitz Town Council	8.70%	6.50%	6.60%	4.90%	3.30%
Mariental Municipality	9.80%	9.80%	10.60%	22.30%	12.50%
Oranjemund Town Council	8.80%	8.80%	8.80%	8.80%	8.80%
Osire power Farmer Scheme	9.60%	11.60%	11.50%	13.90%	18.70%

Roshskor Township	4.10%	9.60%	3.80%	5.50%	10%
Epacha Farmer Scheme	8.60%	8.60%	8.60%	8.60%	8.60%
Witvlei Village Council	7.10%	20.30%	20.30%	20.30%	20.30%
Finkenstein	6.10%	15.50%	5.80%	6.90%	6.90%
Gochas Village Council	7.90%	4.40%	4.40%	4.40%	4.40%
Leornardville Village Council	10.30%	13.70%	13.70%	10%	13.70%
Naukluft Farmer Scheme	8.60%	8.60%	8.60%	8.60%	8.60%
Omeya	10.60%	10.60%	10.60%	10.80%	10.80%

5.3. Current Levels of Distribution Losses

The figure below shows the current level of distribution network losses in Namibia. The weighted average losses per year (2020 to 2024) based on electricity units consumed for each licensee are shown in the graphical chart in Figure 1. The trend shows a gradual decline in the total losses over the 5-year period.

Annual combined weighted average losses for all licensees (2020-2024)

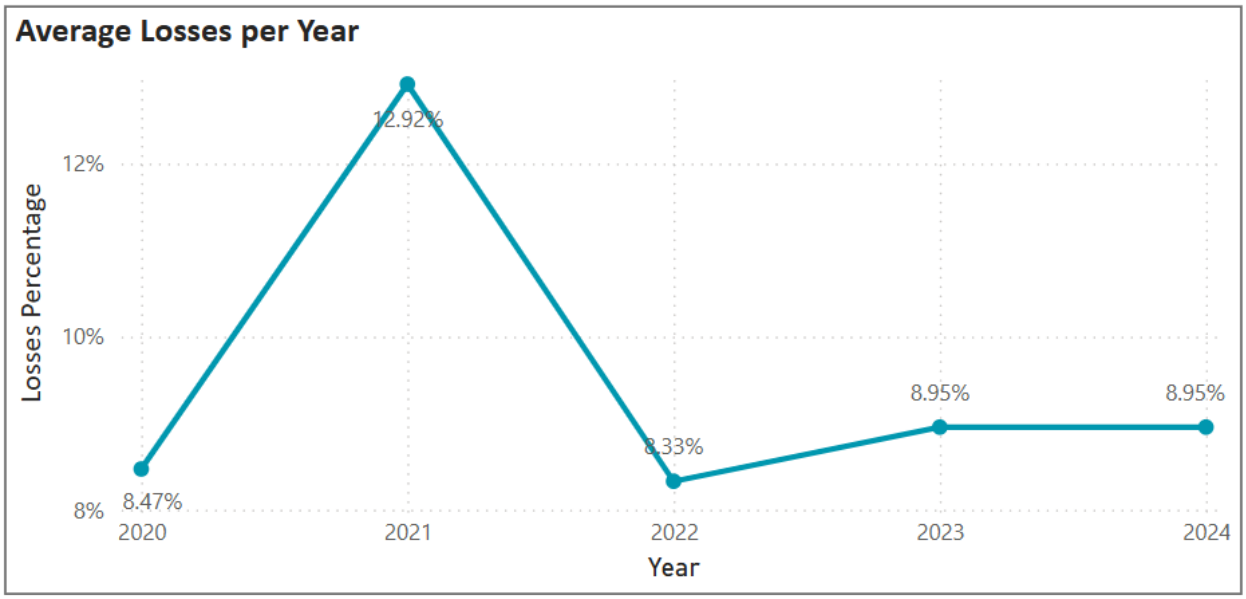


Figure 1. Current levels of distribution losses

Figure 2 below illustrates the distribution of licensees with the highest weighted average distribution losses over the five-year period from 2020 to 2024.

- The Village Councils and Regional Councils show the highest percentage of distribution network losses followed by Others (Estates).
- Municipalities and Town Councils have the lowest percentage of distribution network losses.

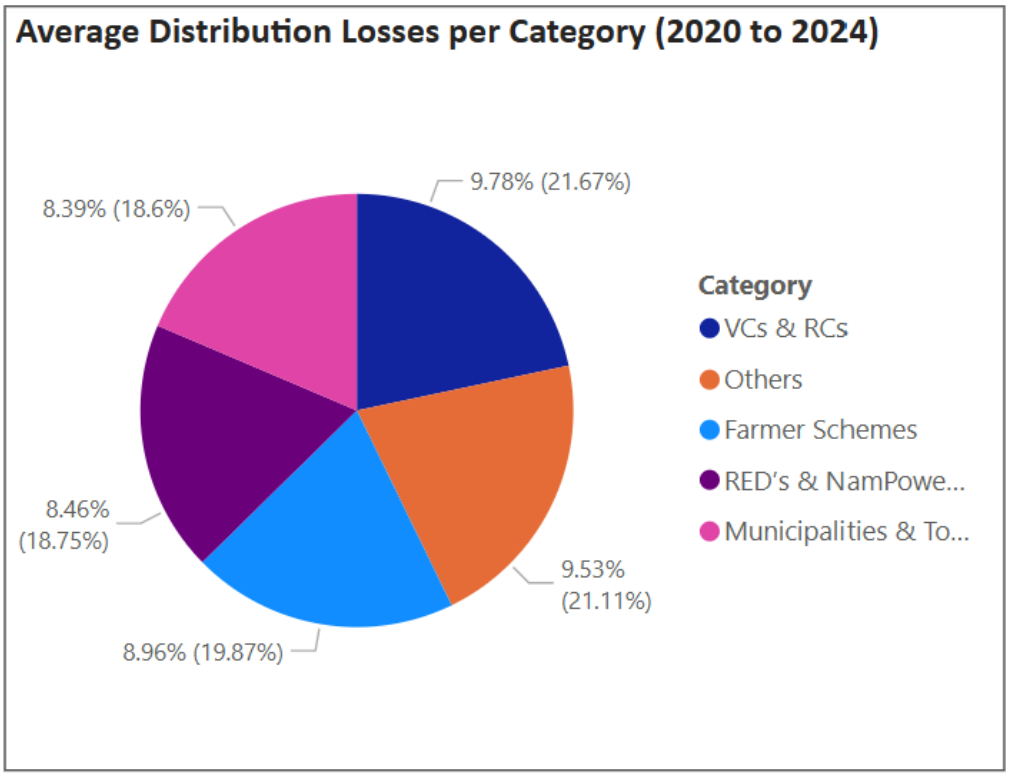


Figure 2. Average distribution losses per category

5.4. Historical Distribution Losses Per Category of Licensees

Table 1 above shows the different categories that distribution licensees were grouped into:

- Major distribution licensees (REDs, OPE, CoW and NamPower Distribution),
- Town Councils and Municipalities,
- Village Councils and Regional Councils,
- Farmers' schemes, and
- Other distribution licensees, such as estates.

Table 2 shows the historical distribution losses figure for each individual licensees over a period of 5 years from 2020 to 2024. These losses figures were used to come up with charts to analyse the current levels of distribution losses. Data analysis was conducted using Microsoft Power BI. The figures are shown below:

5.4.1. Major distribution licensees (REDs, CoW, OPE and NamPower Distribution)

Table 3. Historical distribution losses data for major distribution licensees during 2020-2024

Licensees	2020	2021	2022	2023	2024
NORED	9.20%	12.40%	12.90%	13.30%	11%
CENORED	9.60%	9.81%	8.68%	6.47%	4.59%
Erongo RED	6.60%	7.80%	7.80%	6.40%	6.10%
CoW	6%	8%	8.10%	5.90%	8.70%
OPE	6%	5.50%	6.20%	6.10%	6.40%
NamPower Distribution	11.90%	10.60%	9.40%	9.40%	9.90%

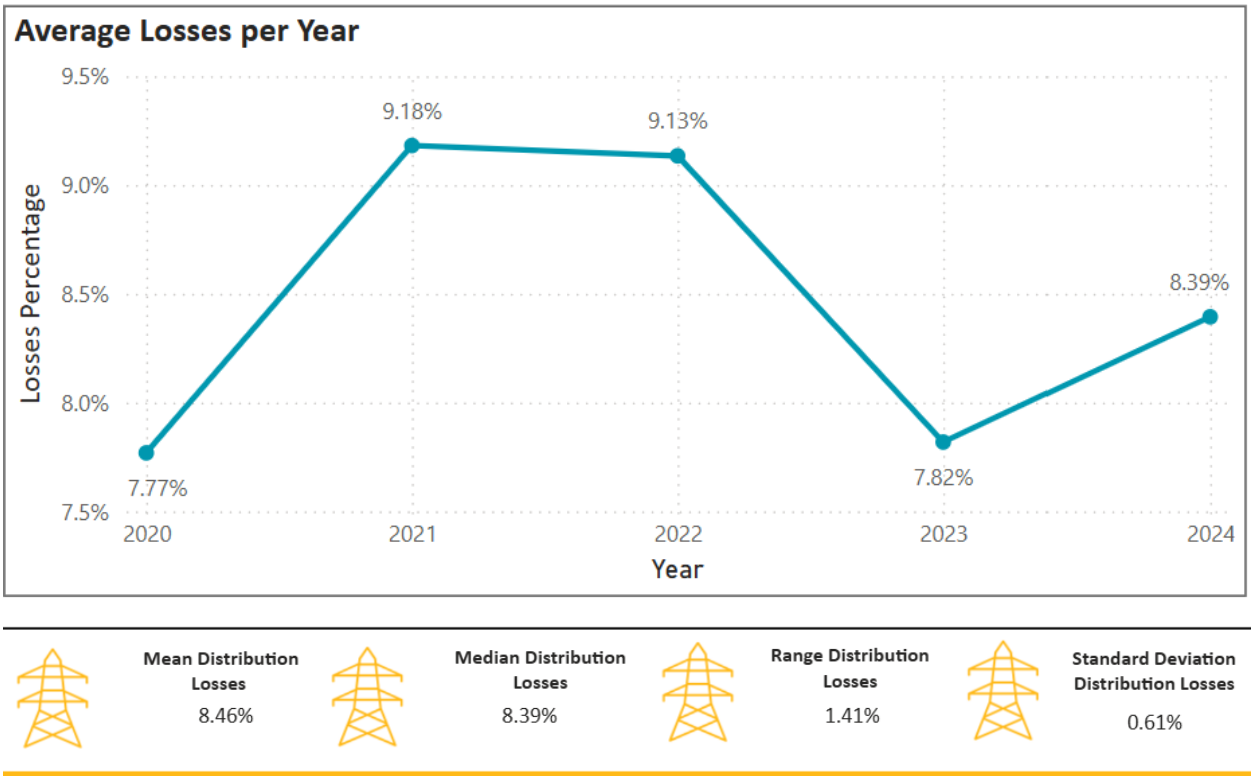


Figure 3. Major distribution licensees' losses figure

5.4.2. Municipalities and Town Councils

Note on Data Adjustments and Substitute Values

In preparing the distribution losses analysis, specific adjustments were made to ensure data consistency and to minimise distortions caused by missing or incomplete data.

Municipalities, Town Councils, and Regional Councils (Section 5.4.2)

- Where 2024 data was missing for any licensee, the 2023 data was carried forward to fill empty cells (Kharas Regional Council is shown as an example).
- For other licensees, missing data in any year was filled using data from the nearest available year's data to maintain continuity.

These adjustments were made solely for analytical consistency and to provide meaningful comparisons over time. All substituted values and replacements are clearly documented to ensure transparency.

Table 4. Historical distribution losses data for municipalities and town councils during 2020-2024

Licensees	2020	2021	2022	2023	2024
Aranos Town Council	10.30%	8.70%	9.50%	10.30%	8.40%
Gobabis Municipality	8.10%	8.10%	8.10%	10%	10%
Luderitz Town Council	8.70%	6.50%	6.60%	4.90%	3.30%
Oranjemund Town Council	8.80%	8.80%	8.80%	8.80%	8.80%
Rehoboth Town Council	10.60%	6.20%	5.50%	8.20%	9.90%
Karasburg Town Council	11.20%	6.90%	1.80%	1.80%	1.80%
Keetmanshoop Municipality	10.90%	10.80%	7.20%	5.10%	7.90%
Mariental Municipality	9.80%	9.80%	10.60%	22.30%	12.50%
Roshskor Township	4.10%	9.60%	3.80%	5.50%	10%

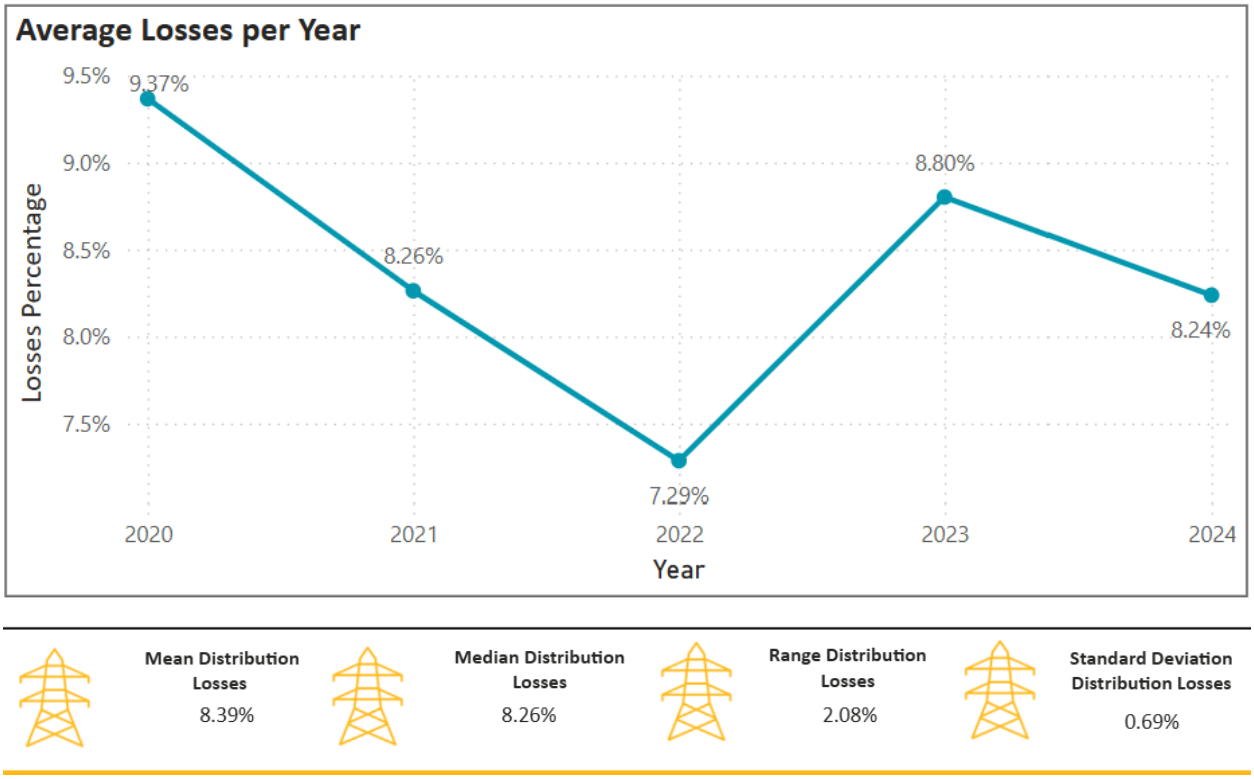


Figure 4. Municipalities and Town Councils losses figure

5.4.3. Village Councils and Regional Councils

Note on Data Adjustments and Substitute Values

In preparing the distribution losses analysis, specific adjustments were made to ensure data consistency and to minimise distortions caused by missing or incomplete data.

Village Councils & Regional Councils (Section 5.4.3)

- For other licensees, missing data in any year was filled using data from the nearest available year's data to maintain continuity.

These adjustments were made solely for analytical consistency and to provide meaningful comparisons over time. All substituted values and replacements are clearly documented to ensure transparency.

Table 5. Historical distribution losses data for village councils and regional councils during 2020-2024

Licensees	2020	2021	2022	2023	2024
Aroab Village Council	3%	2%	2%	2%	2%
Berseba Village Council	7.80%	7.80%	7.80%	8%	8%
Bethanie Village Council	5.30%	9%	7%	7%	7%
Gibeon Village Council	1.10%	31%	4.80%	5%	4.80%
Koes Village Council	2.10%	2.10%	2.10%	22%	22.20%
Maltahohe Village Council	7%	7%	21.30%	7%	7%
Tses Village Council	6%	14%	6%	6%	6.40%
Hardap Regional Council	10%	28.30%	15.70%	19.80%	5.90%
Witvlei Village Council	7.10%	20.30%	20.30%	20.30%	20.30%
Gochas Village Council	7.90%	4.40%	4.40%	4.40%	4.40%
Leornardville Village Council	10.30%	13.70%	13.70%	10%	13.70%

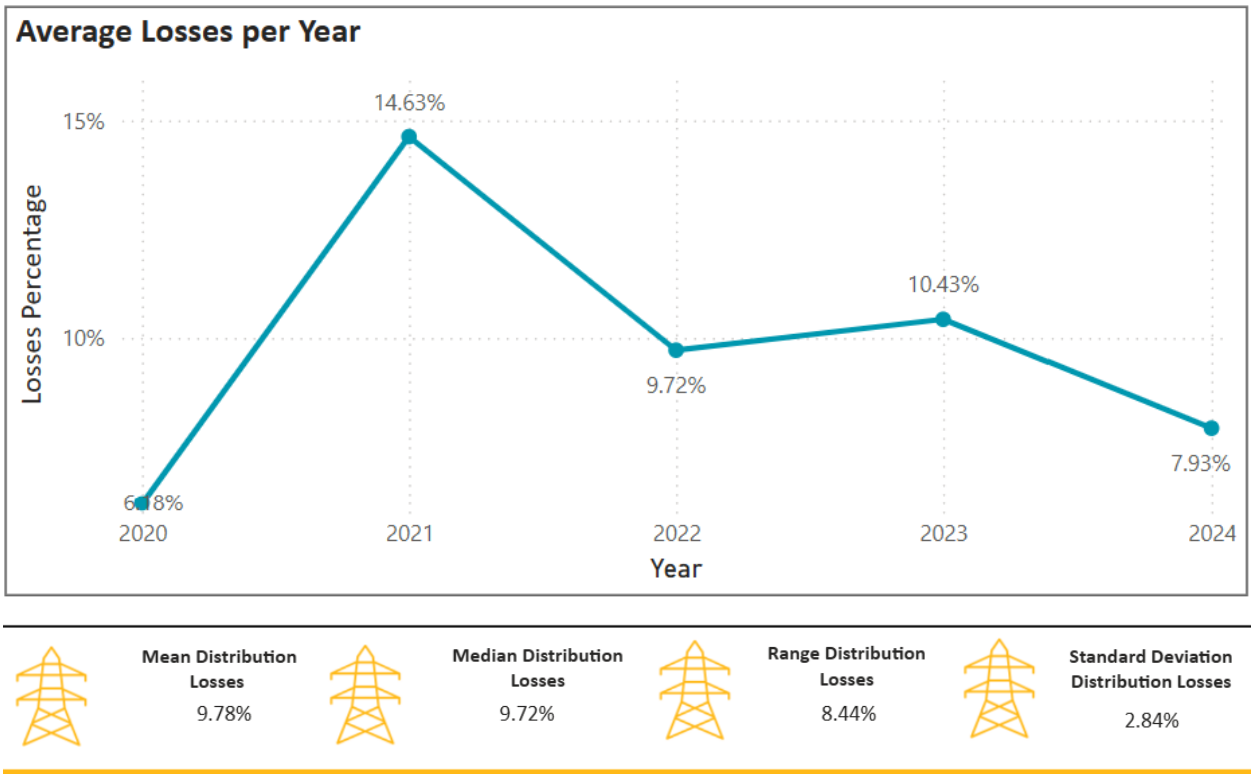


Figure 5. Village Councils and Regional Councils losses figure

5.4.4. Farmers' schemes

Note on Data Adjustments and Substitute Values

In preparing the distribution losses analysis, specific adjustments were made to ensure data consistency and to minimise distortions caused by missing or incomplete data.

Farmer Schemes

- The Swartrand Power farmer scheme was removed from the analysis.
- For Epacha and Naukluft Farmer Schemes, missing data cells were replaced using values from the single year for which data was available, ensuring the trends reflect the most accurate information. A substitute value of 8.60% was applied where no other data existed.

These adjustments were made **s**olely for analytical consistency and to provide meaningful comparisons over time. All substituted values and replacements are clearly documented to ensure transparency.

Table 6. Historical distribution losses data for farmers' schemes during 2020-2024

Licensees	2020	2021	2022	2023	2024
Epacha	8.60%	8.60%	8.60%	8.60%	8.60%
Naukluft	8.60%	8.60%	8.60%	8.60%	8.60%
Osire Power	9.60%	11.60%	11.50%	13.90%	18.70%

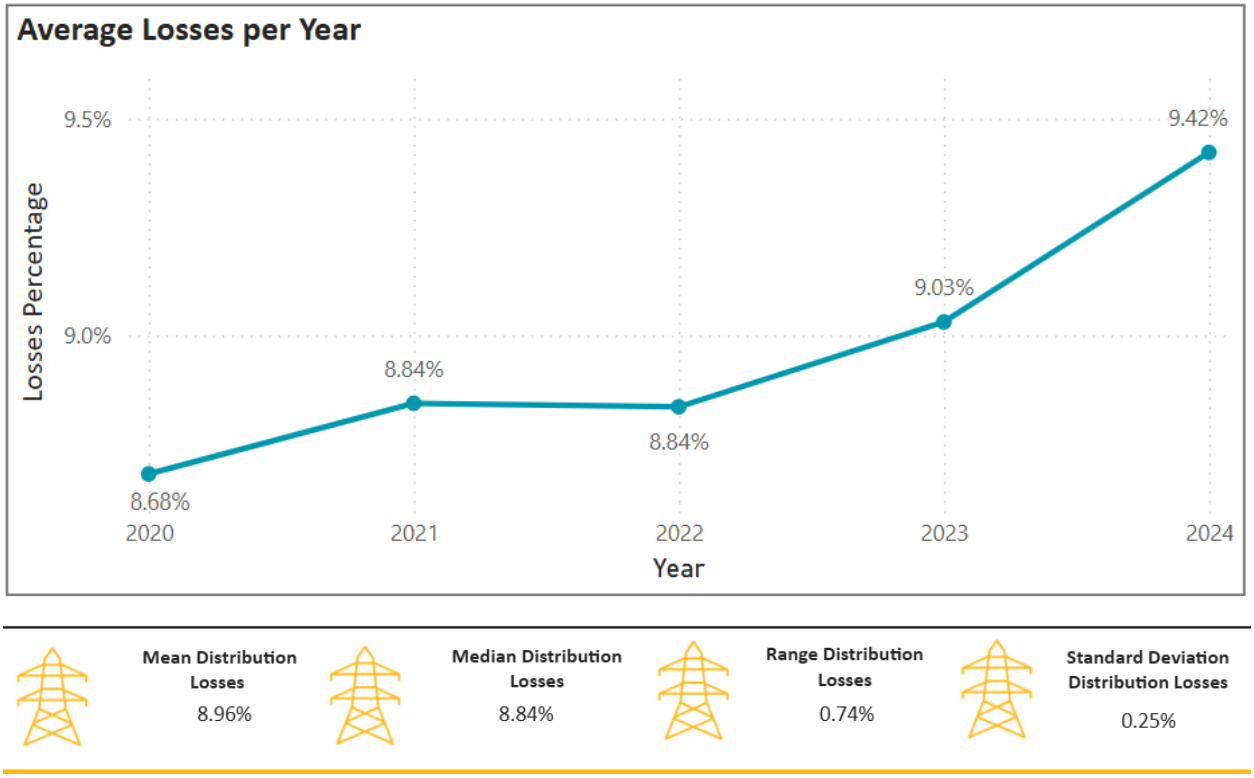


Figure 6. Farmers' Schemes losses figure

5.4.5. Other distribution licensees (i.e. Estates)

Note on Data Adjustments and Substitute Values

In preparing the distribution losses analysis, specific adjustments were made to ensure data consistency and to minimise distortions caused by missing or incomplete data.

Other Distribution Licensees – Estates (Section 5.4.6)

- For Omeya, missing data for 2020 and 2021 was replaced with the 2022 value to maintain continuity, using a substitute value of 10.60% where needed.
- Sungate and Regenstein schemes were excluded to avoid distortion: Sungate had no data, and Regenstein's reported losses were very low in recent years.

- For Finkenstein, the 2023 value was used to replace the missing 2024 cell, ensuring the series remains complete.

These adjustments were made solely for analytical consistency and to provide meaningful comparisons over time. All substituted values and replacements are clearly documented to ensure transparency.

Table 7. Historical distribution losses data for other distribution licensees during 2020-2024

Licensees	2020	2021	2022	2023	2024
Finkenstein	6.10%	15.50%	5.80%	6.90%	6.90%
Omeya	10.60%	10.60%	10.60%	10.80%	10.80%

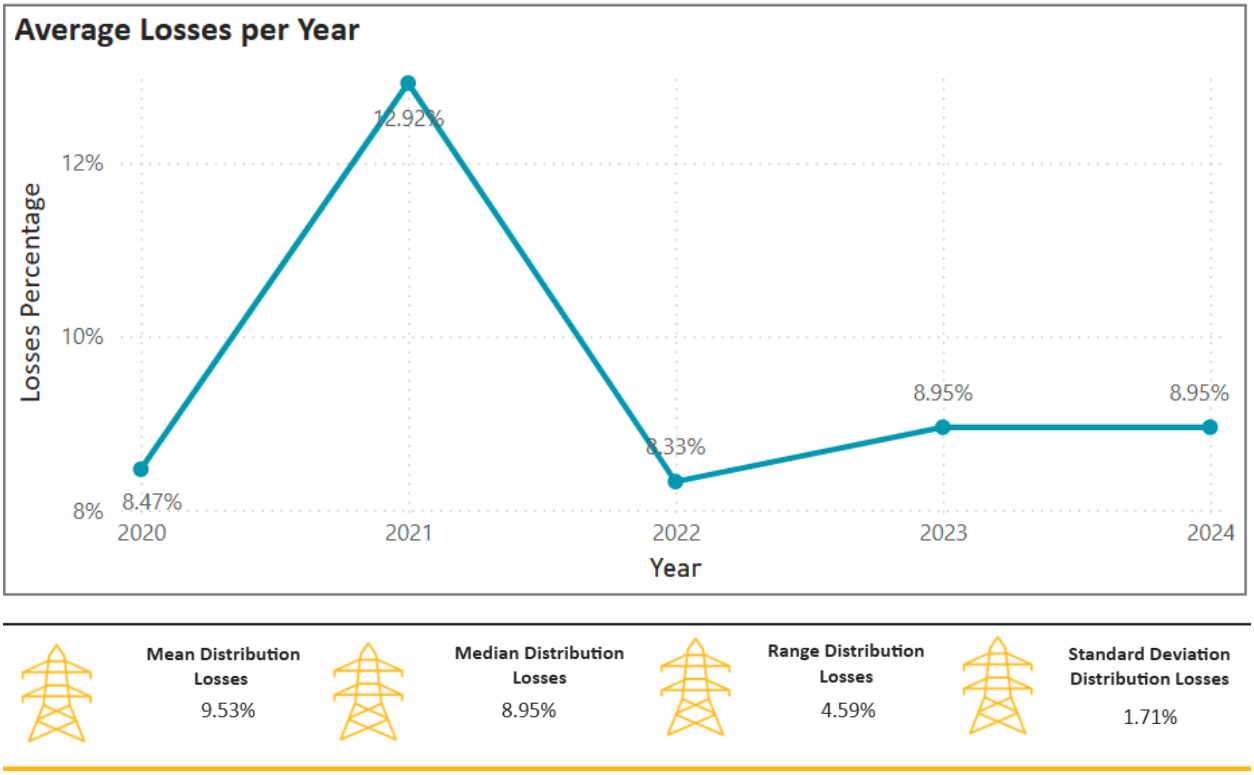


Figure 7. Other Distribution Licensees' losses figure

The figures above illustrate the historical distribution losses data for licensees as categorized. The figures include:

- The mean value of distribution losses per year for all licensees in that particular category.
- The mean value of distribution losses for the entire category, over the entire 5-year period.
- The median value of distribution losses for the entire category, over the entire 5-year period.
- The range value of distribution losses for the entire category, over the 5-year period.

It is based on this analysis that the ECB has recommended distribution losses targets for each category of distribution licensees. Distribution licensees are expected to reduce their distribution network losses to less than the set targets. The next section presents the annual distribution losses targets set for each category.

6. SETTING OF ANNUAL DISTRIBUTION LOSSES TARGETS FOR INDIVIDUAL LICENSEES

After thoroughly analysing the historical distribution network losses, the ECB has set annual distribution losses targets for each group/category of distributors. The regulator believes that this strategy will help to reduce total distribution losses as utilities will be penalised, in their tariff adjustments, for losses exceeding the set targets.

The targets or caps of distribution losses were set using the method:

$$\boldsymbol{Cap = mean + (k \times standard\ deviation)}$$
$$\boldsymbol{Cap = mean + (1 \times standard\ deviation)}$$

Where *k* is a number that represents how tight the regulator decided to set the losses targets. In this case, 1 was chosen for the value of *k* which represents 100% of the standard deviation added to the average distribution loss for each category.

The standard deviation in the historical data set for each category was applied.

6.1. REDs, CoW, OPE and NamPower Distribution

Target = 8.46 + (1 × 0.61)

= **9.07%**

6.2. Municipalities and Town Councils

Target = 8.39 + (1 × 0.69)

= **9.08%**

6.3. Village Councils and Regional Councils

Target = 9.78 + (1 × 2.84)

= **12.62%**

6.4. Farmers' Schemes

Target = 9.56 + (1 × 0.25)

= **9.81%**

6.5. Other distribution licensees (i.e. Estates)

Target = 9.53 + (1 ×1.71)

= **11.24%**

The table below shows the annual distribution losses targets for distribution licensees in Namibia.

Table 8. Annual distribution losses targets

Category of Licensees	**Annual Distribution Losses Targets**	**Rounded Off Figures of Annual Distribution Losses Targets**
REDs, City of Windhoek, Oshakati Premier Electric and NamPower Distribution	9.07%	9%
Municipalities and Town Councils	9.08%	9%
Village and Regional Councils	12.62%	13%
Farmers' Schemes	9.81%	10%
Other Distributors (i.e. Estates)	11.24%	11%

The established losses targets will serve as the foundation for incentive-based regulation under the forthcoming Performance Management Framework. During implementation, these category-level targets will be benchmarked against the actual loss performance of individual licensees. Licensees whose losses exceed the prescribed targets will be required to make appropriate budgetary provisions within their tariff applications to achieve compliance. Conversely, licensees that maintain losses below the set targets will be rewarded through incentives designed to encourage further reductions in network losses under the same framework.

7. BEST PRACTICES FOR IMPLEMENTATION IN THE DETERMINATION OF DISTRIBUTION LOSSES

The 2016 study by the ECB to determine Distribution Network Losses for the Namibian ESI revealed that there is no scientific way to determine non-technical losses due to their nature. The only way to compute non-technical losses is by first getting the total distribution network losses (percentage difference between power purchased and power sold) and then subtracting technical losses from the total losses figure. What remains is non-technical losses.

The determination of technical losses is done by using simulation software to conduct load flow studies. The accuracy of the simulation results depends on key several factors that distribution licensees should consider in order to get accurate results. Licensees should therefore consider these factors.

1. **Modelling of the Power System** - Simplified or incomplete models can lead to inaccurate loss calculations.

The level of detail in the power system model (e.g. accurate representation of lines, transformers, generators, loads, and other components) directly affects the accuracy.

2. **Accuracy of Input Data** - The accuracy of impedance, reactance, and resistance values for transmission lines, transformers, and other components plays a major role. Any errors in these parameters will distort loss calculations.

This is also where human error comes in. Accurate and consistent input is therefore crucial.

8. TARGET DATE FOR THE IMPLEMENTATION OF THE ANNUAL DISTRIBUTION LOSSES

The implementation of the annual Distribution Losses Targets will coincide with the envisaged implementation of the Performance Management Framework spearheaded by the ECB's Economic and Market Regulation Department. The financial year 2026/2027 is envisaged to be the pilot phase for the implementation of the Performance Management Framework and the actual implementation will commence during 2027/2028. Therefore, annual Distribution Losses Targets will be implemented from the 2027/2028 financial year of the licensees as this will give licensees sufficient time to prepare accordingly and licensees will be informed.

9. CONCLUSION AND RECOMMENDATIONS

The Review of the Performance Management Framework for the Namibian ESI by the ECB in 2014 sets out annual losses targets for distribution licensees. In the framework, the categories that existed were: small urban (towns), large urban (cities and municipalities), rural localities (NORED rural networks) and rural farm networks.

This project has introduced new categories of distribution licensees and set annual distribution losses targets for them. The targets shown in Table 8 are thus the recommended annual distribution losses that licensees should not exceed.

10. REVIEW OF THE REPORT

The Report will be reviewed if required when circumstances change.

11. APPROVAL AND EFFECTIVE DATE

The Report will be effective from the date of approval by the Board.