Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

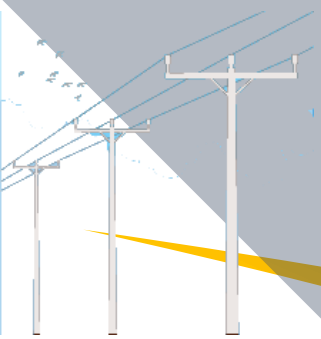
West African Power Pool

Promotion of a Climate Friendly Interconnected Electricity System in West Africa (ProCEM)

Report 2019

Reduction of Technical and non-Technical Electricity Losses in the Distribution Companines in the ECOWAS Region

November 2020



Background of the Study

The ProCEM programme aims to provide technical assistance to ECOWAS member states, and supporting those who promote grid-connected renewable energy projects at the level of electricity distribution. The challenge here is to develop good working practices and approaches to reduce technical/non-technical losses in electricity distribution companies. For the regional electricity market, the efforts are focussed on supporting both the design of technical regulatory instruments, plus efficient devices essential for seamless electricity exchanges across borders. In-depth and appropriate capacity building measures should support key market players in fulfilling their mission.

The WAPP-GIZ cooperation, regarding the reduction of distribution losses under the ProCEM framework between 2018 and 2020, is a continuation of some of the activities conducted by the BMZ[1] funded project *'Promotion of a Climate Friendly Interconnected Electricity System in West Africa'*. The implementation period was between 11/2013 and 12/2017, and included a segment on the reduction of distribution losses in the WAPP[2]member utility networks. During this period the WAPP, in cooperation with GIZ[3], conducted an in-depth study on technical and commercial distribution losses

The objectives of this current project are to provide responsible operators in the ECOWAS[4] region, with regional approaches to improve the energy efficiency of electrical equipment and the distribution network.

The indicators are defined as follows:

- Result of Indicator 2 – Loss Reduction

Eight (8) distribution companies in the ECOWAS region have reduced their technical, non-technical and collection losses in their distribution network by 5% since 2017

- Result of Indicator 4 - Course Attendance

70% (including 5% women) of the 100 participants surveyed in new or improved courses on renewable energy, the regional electricity market, and energy efficiency - supported by the project - confirmed that they had benefitted from attending the course, and noted a solid improvement in their work.

- Result of Indicator B1 - Approaches Introduced

Ten utility providers in the ECOWAS region that actively participated in a learning and knowledge exchange platform, have introduced five approaches to reduce technical, non-technical or commercial losses in the distribution network.

This report gives the various statistics of technical and non-technical losses up to 2017 in the region, and the main strategies for reducing these losses. It will also provide indicative analyses on their evolution.

[1] The Federal Ministry for Economic Cooperation and Development (BMZ)
[2] West African Power Pool (WAPP)
[3] German Development Cooperation (GIZ)
[4] Economic Community of West African States ECOWAS

CHAPTER 1 – Reduction of Losses (Result of Indicator 2)

The expected result is that eight electricity companies in the ECOWAS region have reduced their electricity losses (technical and commercial) in the distribution networks by a total of five percentage points compared to the 2017 baseline.

Reference value: 33% loss of electricity (according to date collected in 2017).

Target value: Eight electricity providers and a reduction of electricity loss by five percentage points.

Explanation:

At the end of the ProMERC reference period (a priori 3 years), the overall distribution loss rate should be reduced by 5 percentage points in electrical installations for at least all eight distribution companies and members of the West African Power Pool (WAPP). The GIZ will support both WAPP/ERERA[5] partners' activities. Their results will contribute to the reduction of loss by 5 percentage points.

The basic value to be considered is the overall loss rate (calculated for a total of at least eight companies) registered on its distribution installations as of 31 December 2017.

Essentially, the various rates for at least eight companies will be collected, and an average rate will be calculated for all of them. This rate will serve as a reference value. The same will be done at the end of ProMERC[6], and the rate of reduction will be determined accordingly.

As part of its objective, the ProMERC programme wanted to create a statistical database on technical and non-technical losses with the distribution companies in the ECOWAS region. The aim being to obtain a general overview and to support the exchange of best practices between these companies. This programme also supports distribution companies in how to implement loss reduction measures. The idea is to support these companies so that they are in a better position to integrate easily into the WAPP regional electricity market.

This chapter provides statistics on losses in distribution companies around the ECOWAS region from 2015-19, and offers indicative analyses on their evolution to achieve the results of 2019. The chapter is divided up as follows:

A. Total Losses
B. Technical Losses
C. Non-Technical Losses
D. Collection Losses

[5] ECOWAS Regional Electricity Regulatory Authority (ERERA)

[6] Promotion of a Climate Friendly Interconnected Electricity System in West Africa (ProMERC)

A. Total Losses

Total losses represent the technical and non-technical losses of the distribution companies. It is therefore the ratio of the total energy purchased or produced by the distribution company, divided by the energy actually sold when billing customers. Collection losses are not included in the total losses.

The following table summarises the statistical data on the total losses in the ECOWAS region from 2015 to 2019.

Table 1: Development of total losses in distribution companies around the ECOWAS countries in percentages

	Country	Company	2015	2016	2017	2018	2019	Rank 2019	Evolution 2017-2019	Results 2017-2019
7	Niger	NIGELEC	10,6%	12,6%	12,5%	12,2%	11,8%	1		0,7%
15	Nigeria, Lagos North	IKEJA	17,0%	25,0%	24,0%	17,0%	12,0%	2		12,0%
3	Ivory Coast	CIE	16,0%	15,0%	15,3%	15,0%	13,0%	3		2,3%
21	Nigeria, Lagos	EKEDC	11,0%	9,8%	13,3%	13,0%	13,0%	4		0,3%
4	Burkina	SONABEL	13,2%	13,5%	14,5%	13,6%	13,5%	5		1,0%
10	Gambia	NAWEC	22,9%	25,1%	23,0%	16,0%	14,8%	6		8,3%
8	Guinea	EDG	32,1%	35,2%	36,0%	30,0%	16,0%	7		20,0%
5	Togo	CEET	16,8%	16,3%	14,3%	15,9%	16,4%	8		-2,1%
17	Nigeria, Ibadan	IBEDC	24,8%	19,2%	29,8%	19,9%	17,1%	9		12,7%
20	Nigeria, Kano	KEDCO	19,7%	18,8%	18,0%	18,2%	17,9%	10		0,2%
1	Senegal	SENELEC	18,6%	20,1%	18,9%	17,7%	18,8%	11		0,1%
9	Guinea-Bissau	EAGB	27,2%	32,0%	23,2%	25,7%	20,4%	12		2,8%
6	Benin	SBEE	23,2%	23,9%	23,1%	22,4%	21,4%	13		1,7%
18	Nigeria, Abuja	AEDC	19,9%	21,5%	21,6%	18,8%	22,0%	14		-0,4%
2	Mali	EDM-SA	21,4%	20,3%	19,2%	21,6%	22,4%	15		-3,2%
22	Nigeria, Port Harcourt	PHED	16,4%	15,7%	24,4%	24,0%	24,0%	16		0,4%
12	Ghana	ECG	22,3%	23,7%	24,3%	24,3%	24,7%	17		-0,4%
16	Nigeria, Enugu	EEDC	37,2%	35,2%	28,8%	28,0%	27,0%	18		1,8%
11	Ghana	NEDCO	23,1%	27,4%	30,2%	30,0%	27,5%	19		2,7%
19	Nigeria, Kaduna	KAEDCO	30,2%	28,9%	29,9%	30,0%	29,0%	20		0,9%
23	Nigeria, Yola	YEDC	27,0%	27,7%	31,2%	34,4%	35,7%	21		-4,5%
13	Sierra Leone	EDSA	52,9%	47,6%	26,8%	38,0%	39,0%	22		-12,2%
24	Nigeria, Jos	JEDPLC	72,7%	72,7%	72,7%	66,6%	60,8%	23		12,0%
14	Liberia	LEC	29,8%	47,3%	53,4%	68,0%	67,0%	24		-13,6%
25	Nigeria, Benin	BEDC								
	Average		25,2%	26,4%	26,2%	25,8%	24,4%			1,8%

*Shaded cells are estimated from other years.

Total losses in MWh are calculated as: energy injected into the distribution system minus energy billed by the distribution company (DC) customers.

The total percentage losses shown in Table 1 are calculated as: 1 - losses in MWh / MWh injected. Billed sales are most frequently used to reflect consumption.

It is clear that the invoiced sales do not include usage by energy thieves. Other factors that may also lead to underestimation of consumption are mentioned in the paragraph on non-technical losses.

Note: the combined average losses of all power companies are the average of the companies' individual losses regardless of the amount of energy produced by those companies.

Table Source:
Activity reports from the companies and presentations given by the companies during the Dakar forum in November 2018 and by video conference in August 2020

Given that some electricity distribution companies have already made sufficient efforts to reduce their loss rates significantly, and are at less than 15%, it will be difficult to obtain yet more significant[7] improvement from these providers.

Statistics show that total losses vary greatly from one Distribution Company to another, for 2019 between 11.8% in Niger and 67% in Liberia. On average, total losses in ECOWAS countries have been almost constant between 2016 and 2019; about 24% on average during the years of 2016-19

At the distribution company level, there are 17 companies out of the 23 companies surveyed that managed to reduce total losses in the last few years from 2017-19.

The lowest overall loss rate of 11.8% was found in NIGELEC (Niger) and the highest in LEC (Liberia). LEC (Nigeria) also recorded the most negative progression with a 20% increase in losses between 2017 and 2019. Since 2019, LEC has put in place many loss reduction measures that should take effect in 2019 and 2020.

The best progress is illustrated by IKEJA (Nigeria), EDG (Guinea), IEBDC (Nigeria), JEDPLC (Nigeria) and NAWEC (The Gambia). They reduced their overall losses by more than 8%. For NAWEC (The Gambia), EDG (Guinea) and IKEJA (Nigeria), these companies have managed to drop below the 17% overall loss .measurement.

Most distribution companies' growth spanning the years 2017, 2018 and 2019 is uneven, with sometimes even positive and negative growth during these years. This shows that the statistics for overall loss rates are influenced by several factors. It is therefore difficult to quantify exactly the impact of loss reduction measures alone.

It is interesting to note that most of the companies that have reduced their overall losses are also following a strategy of generalising prepaid or even smart meters.

The installation of prepaid or even smart meters is an activity that must be prepared over several consecutive years and requires high investment compared to other existing meters.

However, smart meters have the particularity of being able to strongly reduce overall losses because they improve the technical situation of the system, and thus reduce the possibilities of fraud and billing errors.

The forum took place in August 2020 and involved WAPP plus all distribution companies in the ECOWAS region. The theme of reducing non-technical losses had helped to show the consensus around the acknowledged benefits of installing smart meters.

A total of 13 of the 23 companies surveyed confirmed their strategy of partial or total installation of these meters or also other communicating meter systems at their subscribers' premises.

These include SENELEC (Senegal), EDM (Mali), CIE (Ivory Coast), SONABEL (Burkina Faso), CEET (Togo), EDG (Guinea), NAWEC (The Gambia), NEDCO (Ghana), ECG (Ghana) and the Nigerian companies IKEJA, IBEDC, AEDC and JEDPLC.

Overall, companies that implement a combination of technical and non-technical loss reduction measures also achieve the best overall loss reduction rates on a general basis.

Indicator reference value 2017

For the year 2017, a combination of eight companies were selected to record their current loss rate. **An average of 33%** was calculated and is used as a benchmark for the loss reduction target indicator.

For 2019, this indicator increases to an **average of 28.1%**, thus confirming a positive evolution. The reduction in value the indicator's value between 2017 and 2019 reaches 5.2% and the objective is therefore achieved.

Conclusion on total losses

On the whole, it is noticeable that distribution companies are faced with fairly similar overall loss problems. Reducing these losses is slow and difficult. Amongst the rankings of the types of losses mentioned, some distribution companies are more often found at the top of the table, such as SONABEL (Burkina Faso), EKEDC (Nigeria), and NIGELEC (Niger), and others are more often found at the bottom of the table, such as LEC (Liberia), JEDPLC (Nigeria), and EDSA (Sierra Leone).

There has been constant, widespread improvement around the region.

Overall losses represent several tens of millions of dollars or several tens of billions of FCFA in lost revenues for distribution companies. Loss reduction must of course remain a priority for these companies.

[7] Additional notes on the interpretation of indicators in the matrix of results(BMZ)

B. Technical Losses

Technical energy loss is the energy lost due to the physical phenomena inherent in its transmission between the injection points in the distribution network and the metering points at the subscriber level.

Table 2: Estimates on technical loss in some distribution companies

	Country	Company	2015	2016	2017	2018	2019	Rank	Evolution over 3 years	Results over 3 years
8	Guinea	EDG	4,6%	4,6%	4,6%	4,6%	4,6%	1		0,0%
7	Niger	NIGELEC	5,6%	5,6%	5,6%	5,6%	5,6%	2		0,0%
10	Gambia	NAWEC	10,0%	11,0%	10,0%	6,4%	5,9%	3		4,1%
3	Ivory Coast	CIE	7,0%	7,0%	7,0%	7,0%	7,0%	4		0,0%
1	Senegal	SENELEC	7,1%	7,1%	7,1%	8,3%	7,1%	5		0,0%
2	Mali	EDM-SA	7,4%	7,4%	7,4%	7,4%	7,4%	6		0,0%
9	Guinea-Bissau	EAGB	4,1%	4,1%	4,1%	7,5%	7,5%	7		-3,4%
18	Nigeria, Abuja	AEDC	9,1%	9,1%	9,1%	9,1%	9,1%	8		0,0%
11	Ghana	NEDCO		10,8%	10,8%	10,8%	9,2%	9		1,6%
6	Benin	SBEE	6,5%	10,7%	10,4%	9,6%	9,6%	10		0,8%
4	Burkina	SONABEL	10,3%	10,3%	10,3%	10,3%	10,3%	11		0,0%
12	Ghana	ECG	10,6%	10,6%	10,6%	10,6%	10,6%	12		0,0%
21	Nigeria, Lagos	EKEDC		10,8%	10,8%	10,8%	11,6%	13		-0,8%
14	Liberia	LEC	12,5%	12,5%	12,5%	12,0%	12,0%	14		0,5%
19	Nigeria, Kaduna	KAEDCO		12,5%	12,5%	12,5%	12,5%	15		0,0%
20	Nigeria, Kano	KEDCO		13,4%	13,4%	13,4%	13,0%	16		0,4%
13	Sierra Leone	EDSA		14,0%	14,0%	14,0%	15,0%	17		-1,0%
24	Nigeria, Jos	JEDPLC	25,5%	16,1%	28,4%	31,5%	28,0%	18		0,4%
5	Togo	CEET								
15	Nigeria, Lagos North	IKEJA								
16	Nigeria, Enugu	EEDC								
17	Nigeria, Ibadan	IBEDC								
22	Nigeria, Port Harcourt	PHED								
23	Nigeria, Yola	YEDC								
25	Nigeria, Benin	BEDC								
	Average		9,3%	9,9%	10,5%	10,6%	10,3%			0,1%

*Shaded cells are estimated from other years.

The estimation of the technical energy losses is based on the measurements of the technical power losses, i.e. the instantaneous losses caused by the power passing through the conductor cables of the MV and LV lines and in the MV/LV transformers. With the help of load distribution calculation software, the power losses are converted into technical energy losses.

The technical losses are normally calculated for a section of the distribution network and for a certain period of time. The section is often the grid in the capital or a large city, and the period is the annual peak. The values are therefore only a rough estimate of the average value of service losses in the distribution system over the year.

Table Source:
Activity reports from the companies and presentations given by the companies during the Dakar forum in November 2018 and by video conference in August 2020

* Missing data is due to the unavailability of disaggregated data within companies and the lack of tools in place for realistic estimation.

Table 2 shows the situation of technical losses in distribution companies. It should be noted that on average over the years 2017 to 2019, the overall situation has not changed (+0.1%).

Unfortunately, the data collected is incomplete. Where data are missing, data from previous or subsequent years are repeated (if available) to fill in the missing years. These data sets have shaded cells in the table.

It should be noted that companies sometimes have difficulty calculating these losses due to a lack of information or adequate software to calculate said losses.

This general situation is difficult to understand because all companies are implementing measures to reduce technical losses. This suggests that these measures do not have the expected impact, or that the development of other parts of the network is affecting the efforts already undertaken.

The three-year trend rates are low on average and vary only between 0 and 4.1%.

The company JOS (Nigeria) is an exception because it has an underwriting loss rate almost twice as high as all other companies. Its development over the years 2015 to 2019 also varies very strongly. It seems likely that this statistical situation is due to inaccurate records, particularly for the year 2016.

These relatively low rates of change are generally understandable because the technical changes to be made to the network are often costly and have very localised impacts.

According to the information gathered from the companies regarding their technical loss reduction activities, all companies are restructuring their MV networks by reorganising the location and number of MV/LV transformers and optimising MV and LV lines.

Certain companies have indicated clearly that they have specifically-installed capacitor banks, replaced conductors, installed new source or distribution substations, managed the charter and optimised the future planning of the network. The end goal being with the objective of reducing technical losses.

Only a limited number of companies mentioned implementing measures to install high-efficiency transformers, phase rebalancing on LV feeders, optimisation of separation peaks and controlling demand. These activities are certainly opportunities to be taken into consideration in the future.

Pre-paid and smart meters represent a very special place within the technical distribution losses. Although installing them is not a direct measure to reduce technical losses, there is a consensus amongst all distribution companies that the installation of these meters lends itself strongly to it. Several companies mentioned their installation as either a localised or generalised measure to reduce both technical and non-technical losses. Meter work such as the installation of pre-paid meters, or replacing defective meters are purely non-technical measures in general.

There are different strategies for placing these meters between the companies. Some follow a strategy of general installation of smart meters, others choose to combine these meters with pre-payment meters. It was not possible, within the framework of the data received, to go into greater detail on impact of smart meters compared to other meters. It should also be noted that during the videoconference forum held in August 2020, the participants had expressed a clear interest in smart meters and that the main difficulty was the source to fund them.

In general, it can be said that the companies that implement the most technical loss reduction measures are also those that got the best results.

Conclusion on technical losses

Overall, with a stagnation in the rate of technical losses of distribution companies in the ECOWAS region over the last three years, it can be said that the situation of technical losses has not really evolved, at least not really for the better. The distribution companies are faced with similar technical loss problems and the reduction of these losses is generally slow and difficult.

C. Non-Technical Losses

Non-technical losses are calculated as: total losses minus technical losses. They are therefore only shown in Table 3 for distribution companies that have carried forward technical losses.

Table 3: Estimates on non-technical losses in certain distribution companies*

	Country	Company	2015	2016	2017	2018	2019	Rank	Evolution over 3 years	Results over 3 years
3	Ivory Coast	CIE	9,0%	8,0%	8,3%	8,0%	6,0%	1		2,3%
10	Gambia	NAWEC	14,1%	14,1%	13,0%	9,6%	8,9%	2		4,2%
1	Senegal	SENELEC	11,8%	11,8%	11,8%	8,2%	10,6%	3		1,2%
6	Benin	SBEE	13,1%	13,1%	12,7%	12,8%	11,8%	4		0,9%
9	Guinea-Bissau	EAGB		18,5%	18,5%	18,5%	12,5%	5		6,0%
12	Ghana	ECG	11,7%	13,2%	13,7%	13,8%	14,1%	6		-0,4%
19	Nigeria, Kaduna	KAEDCO		17,5%	17,5%	17,5%	16,5%	7		1,0%
11	Ghana	NEDCO		19,2%	19,2%	19,2%	18,3%	8		0,9%
13	Sierra Leone	EDSA		24,0%	24,0%	24,0%	24,0%	9		0,0%
14	Liberia	LEC	17,3%	34,8%	40,9%	56,0%	55,0%	10		-14,1%
2	Mali	EDM-SA								
4	Burkina	SONABEL								
5	Togo	CEET								
7	Niger	NIGELEC								
8	Guinea	EDG								
15	Nigeria, Lagos North	IKEJA								
16	Nigeria, Enugu	EEDC								
17	Nigeria, Ibadan	IBEDC								
18	Nigeria, Abuja	AEDC								
20	Nigeria, Kano	KEDCO								
21	Nigeria, Lagos	EKEDC								
22	Nigeria, Port Harcourt	PHED								
23	Nigeria, Yola	YEDC								
24	Nigeria, Jos	JEDPLC								
25	Nigeria, Benin	BEDC								
	Average		12,8%	17,4%	18,0%	18,8%	17,8%			0,2%

ND = No data available

*Shaded cells are estimated from other years.

Fraud is normally the main reason for non-technical losses. Either in the form of meter tampering by subscribers, or energy theft, or by deliberately submitting false meter readings (sometimes with complicit involvement of distribution company staff).

Other factors that produce non-technical losses is the under-estimation of consumption by flat-fee subscribers (unmetered subscribers), subscribers who are already connected but not yet in the sales' statistics, defective meters, and consumption within the distribution company that is not billed. These factors are present in all distribution companies.

Table Source:
Activity reports from the companies and presentations given by the companies during the Dakar forum in November 2018 and by video conference in August 2020

* Missing data is due to the unavailability of disaggregated data within companies and the lack of tools in place for realistic estimation.

Table 3 shows the situation of non-technical losses and it should be noted that on average, over the last three years 2017 to 2019, the situation has not really improved (+0.2%).

Only 10 companies out of 25 were able to provide the calculation of their non-technical losses and therefore the analysis made in this report may not be perfectly repre-

sentative. Where data is missing, data from prior or subsequent years is repeated (if available) to fill in the missing years. These data sets have shaded cells in the table.

Although statistical data are missing, much information on non-technical loss reduction measures implemented by companies has been collected.

In general, non-technical losses vary between 6% and 55%, although LEC (Liberia) shows a rate twice as high as all other companies.

AEGB (Guinea-Bissau) and NAWEC (The Gambia) both managed to reduce their non-technical losses by 4.2% and 6.0% respectively. The non-technical loss reduction measures implemented by these two companies therefore seem to have had significant impacts.

For NAWEC (The Gambia), the non-technical loss reduction measures implemented mainly include a public awareness campaign on the issue of fraud. Unfortunately, no information on the non-technical loss reduction measures of the company AEGB (Guinea-Bissau) could be collected that could explain this marked improvement.

The issue of smart metering is also noteworthy because most companies that have improved their non-technical loss rate have either undertaken to generalise their installations, or to combine the installation of pre-paid meters with that of smart meters for certain consumers. It appears that a metering strategy has a significant impact on reducing non-technical losses.

It can be observed that ECOWAS distribution companies are implementing many non-technical loss reduction measures. The main measures implemented are a customer census, customer connection to the switchyards, monitoring customers, reinforced meter protection measures and more stringent penalty measures.

A comparison of technical and non-technical losses shows that the latter account for the largest share of total losses. The amounts lost due to non-technical losses are enormous. Reducing non-technical losses requires above all the commitment of the management of the distribution company.

The investment costs of non-technical measures are relatively low compared to the reduction of technical losses. Data received from a few distribution companies show that such investments pay for themselves in the short term. This calls for making the reduction of non-technical losses a priority.

Conclusion on non-technical losses

Overall, with an average mid-range increase of +0.2% over the last three years, it can be said that the situation of non-technical losses is mostly unchanged. Unfortunately, the number of companies that have been able to provide their statistics on this type of loss remains very low. This does not allow us to give a representative character to this conclusion.

It should be noted that the potential for reducing non-technical losses is real and represents an enormous financial potential. Moreover, their investment cost is generally lower than measures aimed at reducing technical losses.

D. Collection Losses

Collection losses are calculated as: 1 - amount invoiced / amount collected.

The amount collected or cashed includes arrears and sometimes also payments from energy fraudsters, including a penalty. Collection losses may therefore be exceptionally negative.

Table 4: Development of collection losses in distribution companies in ECOWAS countries

	Country	Company	2015	2016	2017	2018	2019	Rank	Evolution over 3 years	Results over 3 years
12	Ghana	ECG	11,7%	17,8%	-5,0%	-5,0%	-5,0%	1		0,0%
2	Mali	EDM-SA	1,3%	1,0%	0,6%	0,6%	0,6%	2		0,0%
3	Ivory Coast	CIE	7,3%	10,8%	5,5%	3,9%	3,0%	3		2,5%
1	Senegal	SENELEC	7,0%	7,0%	5,0%	5,0%	5,0%	4		0,0%
4	Burkina	SONABEL	2,5%	3,9%	-1,3%	8,8%	8,4%	5		-9,6%
5	Togo	CEET	13,2%	14,3%	9,1%	9,1%	9,1%	6		0,0%
7	Niger	NIGELEC	8,8%	3,3%	2,9%	2,8%	12,3%	7		-9,4%
14	Liberia	LEC	-3,0%	9,2%	22,6%	-1,7%	12,8%	8		9,8%
21	Nigeria, Lagos	EKEDC	27,4%	26,8%	22,4%	19,3%	17,0%	9		5,4%
15	Nigeria, Lagos North	IKEJA	31,0%	32,0%	19,0%	19,0%	19,0%	10		0,0%
18	Nigeria, Abuja	AEDC	37,8%	38,8%	34,0%	24,9%	19,5%	11		14,5%
6	Benin	SBEE	18,8%	6,0%	20,0%	20,0%	20,0%	12		0,0%
11	Ghana	NEDCO	28,7%	38,8%	31,1%	31,1%	31,1%	13		0,0%
8	Guinea	EDG	34,0%	21,0%	16,6%	38,0%	32,0%	14		-15,4%
20	Nigeria, Kano	KEDCO	34,4%	32,3%	51,7%	40,8%	33,3%	15		18,4%
10	Gambia	NAWEC	35,8%	35,8%	35,8%	35,8%	35,8%	16		0,0%
17	Nigeria, Ibadan	IBEDC	33,0%	38,0%	35,0%	38,4%	37,3%	17		-2,3%
22	Nigeria, Port Harcourt	PHED	39,5%	48,0%	41,2%	41,2%	41,2%	18		0,0%
16	Nigeria, Enugu	EEDC	37,3%	42,8%	42,4%	42,4%	42,4%	19		0,0%
24	Nigeria, Jos	JEDPLC		51,3%	51,3%	51,3%	45,5%	20		5,8%
13	Sierra Leone	EDSA	11,0%	44,0%	47,0%	47,0%	47,0%	21		0,0%
23	Nigeria, Yola	YEDC		50,9%	50,9%	50,9%	48,4%	22		2,6%
19	Nigeria, Kaduna	KAEDCO	49,0%	46,6%	41,8%	56,0%	52,0%	23		-10,2%
9	Guinea-Bissau	EAGB								0,0%
25	Nigeria, Benin	BEDC								
	Average		22,2%	27,0%	25,2%	25,2%	24,7%			0,5%

*Shaded cells are estimated from other years.

Collection losses represent the unpaid debts of the distribution companies' customers.

There are several reasons for non-payment of bills such as the financial inability of the customer, as well as non-payment by public institutions, hospitals, or other public services that cannot be disconnected from the network in the event of non-payment.

It is necessary to know the context in which the distribution company operates in order to understand these losses. Real political will and the strict application of enforceable measures against non-payment are necessary.

Table Source:
Activity reports from the companies and presentations given by the companies during the Dakar forum in November 2018 and by video conference in August 2020

Table 4 shows the collection losses of distribution companies in the ECOWAS region. These collection losses decreased on average for all companies by 0.5%, although the trends differed between companies greatly. KEDCO (Nigeria) shows the best progress with a decrease of 18.4% and EDG (Guinea) is at the

bottom of the list with an increase of 15.4%. The distribution companies therefore face very different situations.

Missing data has been filled in with earlier or later data where available. This is the case for many distribution companies, with the unfortunate consequence that evolution rates over three years are sometimes zero.

Such contrasting data makes it difficult to make a general interpretation thus allowing for conclusions to be drawn.

Some negative statistics are due to the fact that during the year under review, amounts due from the previous year were finally paid in the current year and thus the revenue may even exceed the sales for the current year.

Nigerian companies all have high collection rates of over 17% and six of them have rates of over 40% in 2019.

It is interesting to note that LEC (Liberia) with an extremely high rate of non-technical and overall losses here has a reasonable rate of 12% for collection losses. LEC (Liberia) is also one of only two companies that have listed measures to create a culture that does not tolerate fraud within its management. It is also undertaking an awareness-raising campaign and training programme for its agents. Although these measures are mainly non-technical, they can certainly also have an impact on collection losses.

The data collected unfortunately does not allow testing the hypothesis that the higher the percentage of subscribers with a pre-paid meter, the lower the percentage of collection losses.

Company data distinguishing between collection losses of public and private subscribers indicate that public subscribers are, more often than not, the worst payers.

Conclusion on collection losses

On average, the collection rate of distribution companies in the ECOWAS region has decreased slightly. There are however large differences between companies. Nigerian companies have fairly high collection loss rates because of regulatory measures that greatly protect the customer.

CHAPTER 2 – Benefits of Training (Goal Indicator 4)

The expected result is that 70% (of which 5% are women) of the 100 participants in the new or improved training courses developed or improved with the support of the RE, EE or regional electricity market programme. When questioned, they confirmed that they had benefitted from the training, mentioning solid improvements in their work.

Benchmark value: 0 (as yet no participants in newly developed or improved courses).

Target value: 70% of the 100 participants surveyed (including 5% women), one improvement each.

Explanation:

70 of 100 participants - including 5 women - will be interviewed after a training course, which has been improved or newly developed by GIZ, on renewable energy. It will also include the regional electricity market and energy efficiency, in order to confirm that they have benefitted from the training and cite a solid improvement in their workplace.

The trainings are scheduled to take place in 2019 and 2020 and the corresponding evaluations will be carried out:

Time	Title	Type	Trainer	Nb.
June 2019	Training the Trainers - Calculation of MV/LV technical losses in power distribution networks - Application of NEPLAN software	Training the Trainers	Daniel d'Hoop (Power System Planning Expert) Gérard Dangla (Technical Training Expert)	18
June 2019	Distribution Loss Computation (GIZ)	Training the Trainers	Daniel d'Hoop (Power System Planning Expert)	7
July 2019	Distribution Loss Computation (GIZ)	Training company employees	Daniel d'Hoop (Power System Planning Expert)	7
July 2019	Reduction of Losses for Distribution Utilities Programme	Training company employees	Daniel d'Hoop (Power System Planning Expert)	18

An evaluation of the training took place through a questionnaire submitted to the participants. Out of 50 participants, 34 people returned their evaluation. It should be noted that this result indicator takes into account all the activities carried out within the Pro-MERC programme. The activities on loss reduction are only a part of it. The results of the criteria on training already carried out are given here:

Criteria for women's participation: **20%** of the participants that responded to the evaluation were women

Criteria for improvement in their context: **83%** of the participants confirmed that they had benefitted from the training, mentioning concrete improvements in their working context.

CHAPTER 3 – Approaches to Loss Reduction (Result of Indicator B1)

The expected result is that within the framework of a platform for dialogue and exchange, 10 electricity companies in the ECOWAS region have introduced 5 approaches for the reduction of technical and commercial losses in distribution networks.

Reference value: 0 approaches, as the platform for dialogue and exchange still does not yet exist

Target value: 5 approaches introduced

Explanation:

As part of a platform for dialogue and learning, 10 electricity companies in the ECOWAS region have introduced 5 approaches for reducing technical and commercial losses in distribution networks.

Each company has undertaken the implementation of solutions and approaches to reduce their loss rates. However, in view of these uncoordinated and non-harmonised actions within the ECOWAS region, it is necessary to define 5 pertinent approaches that have a real impact on the reduction of losses and that can be applied by the distribution companies.

These five approaches will have to be adopted by the companies which will introduce them in their strategic plan for loss reduction under the terms of ProMERC.

Approaches

Phase 1 of this project listed the main existing technical and non-technical loss reduction approaches. These approaches are summarised in Tables 6 and 7.

The distribution companies provided information on the technical and non-technical approaches implemented. These approaches have been listed again in Table 5 below to provide an overview of the loss reduction measures undertaken.

Result:

Distribution companies have introduced numerous measures to reduce their losses. The full list of possible measures is described in Tables 6 and 7 below.

On the basis of the information collected from the distribution companies, it has already been possible to identify the main measures that have been introduced, and those that seem to bring the best results. These measures are the following

1. Restructuring of the MV network
2. Connecting customers to the switchyard equipped with metering systems (geo-referencing)
3. Monitoring customers
4. Strengthening the legal context by enforcing penalties and sanctions
5. Smart meters or communicating systems

We also note that at least 10 distribution companies have implemented these five loss reduction measures:

1. SENELEC (Senegal)
2. EDMSA (Mali)
3. SONABEL (Burkina Faso)
4. NIGELEC (Nigeria)
5. EDG (Guinea)
6. NEDCO (Ghana)
7. EDSA (Sierra Leone)
8. EEDC (Nigeria, Enugu)
9. KAEDCO (Nigeria, Kaduna)
10. JEDPLC (Nigeria, Jos)

Table 5 on the next page summarises the loss reduction measures implemented by the distribution companies, as mentioned in the documents that could be collected from these companies.

The target value of 10 distribution companies introducing at least 5 approaches has been reached.

Table 5: Loss reduction approaches undertaken in distribution companies

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
Country:	Senegal	Mali	Ivory Coast	Burkina	Togo	Bénin	Niger	Guinea	Guinea-Bissau	Gambia	Ghana	Ghana	Sierra Leone	Liberia	Nigeria, Lagos North	Nigeria, Enugu	Nigeria, Ibadan	Nigeria, Abuja	Nigeria, Kaduna	Nigeria, Kano	Nigeria, Lagos	Nigeria, Port Harcourt	Nigeria, Yola	Nigeria, Jos	Nigeria, Benin	
Distribution Company:	**SENELEC**	**EDM-SA**	**CIE**	**SONABEL**	**CEET**	**SBEE**	**NIGELEC**	**EDG**	**EAGB**	**NAWEC**	**NEDCO**	**ECG**	**EDSA**	**LEC**	**IKEJA**	**EEDC**	**IBEDC**	**AEDC**	**KAEDCO**	**KEDCO**	**EKEDC/EKO**	**PHED**	**YEDC**	**JEDPLC**	**BEDC**	**Total**
TECHNICAL APPROACHES:																										
Installation of condenser banks	●							●		●																3
Replacing conductors		●		●			●	●	●	●																6
Restructuring of the MV network	●	●	●	●	●	●	●	●	●	●	●		●		●	●	●	●	●	●		●	●	●	●	22
Installation of new stations (source or distribution)	●	●		●			●	●	●	●	●		●				●	●		●			●			13
Use of high efficiency transformers							●																			1
Phase rebalancing on LV outgoing feeders								●										●								2
Optimisation of separation points																										0
Electricity demand management															●											1
Load management	●				●			●							●		●		●				●			7
Optimal network planning	●	●		●		●	●	●						●		●						●				9
																										0
NON-TECHNICAL APPROACHES:																										
Knowledge/client census	●	●	●	●			●	●			●		●	●	●	●	●		●			●	●	●		16
Connecting customers to departure stations equipped with metering systems	●	●	●	●			●	●			●		●	●		●	●	●						●		13
Customer inspections	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●		●	●			●	●	●	●	21
Making fraud difficult					●	●									●	●						●		●	●	7
Replacing defective meters				●							●	●	●	●				●				●		●		8
Creating a zero tolerance culture towards fraud	●	●			●			●						●		●			●							7
Commitment of the company's management in the fight against losses														●										●		2
Awareness campaign	●	●		●	●		●	●		●	●		●	●		●			●			●	●	●	I	16
Penalties and sanctions	●	●	●	●			●	●			●		●	●		●	●	●	●			●	●	●	●	17
Training programmes		●		●			●							●	●		●		●				●	●		9
Monitoring							●					●		●		●			●							5
Creating a 'Loss Reduction in Distribution Network' association								●							●											2
Other non-technical measures					●						●															2
Smart meters	●	●	●	●	●			●		●	●	●			●		●	●						●		13
Total number of approaches	**12**	**12**	**6**	**12**	**8**	**4**	**12**	**15**	**3**	**7**	**10**	**4**	**8**	**11**	**9**	**10**	**8**	**8**	**9**	**2**	**0**	**8**	**8**	**11**	**5**	**202**

Main implemented approaches

The following tables provide details and explanations for each of the measures listed in Table 5, broken down into technical and non-technical loss reduction approaches as follows:

- Approaches to reduce technical loss (ten types of actions)
- Approaches to reduce non-technical loss (12 types of actions)

Table 6: Approaches to reduce technical losses (10 types of actions)

Nr.	Title	Description of the Objective and Approach
1	Installation of condenser banks	Objective: To reduce the reactive component of underwriting losses. Approach: Introduction of condensers
2	Replacing conductors	Objective: Optimise the choice of drivers or their replacement Approach: 1) Internal standardisation, 2) Identification of overloaded conductors, 3) Economic analysis of replacements
3	Restructuring of the MV network	Objective: Relieve existing overloaded departures by changing the network structure Approach: Reconfigure the departures by transferring loads to existing departures with low loads or to new, as yet to be made, departures
4	Installation of new stations (source or distribution)	Objective: To install very small MV/LV distribution stations as close as possible to BT subscribers. Approach: Extend the MV network further to increase the number of MV/LV transformers and thus reduce the LV lengths
5	Use of high efficiency transformers	Objective: To identify whether a range of high-efficiency transformers allows a more cost-effective selection of transformers to be installed. Approach: The optimal transformer range will be identified based on economic analyses
6	Phase rebalancing on LV outgoing feeders	Objective: To reduce the imbalance of currents between phases caused by single-phase customers Approach: 1) Identifying large, single-phase consumers, 2) Installation of switches or reconnection of consumers to another phase
7	Optimisation of separation points	Objective: Optimise the configuration of the feeders that reach 'NO' (Normally Open) points in order to choose the configuration with the lowest loss. Approach: 1) Software acquisition and data entry, 2) Searching for the busiest sections and 3) Cross-checking and compatibility verification
8	Electricity demand management	Objective: Reduction of electricity demand and technical losses Approach: The types of actions on demand are: 1. energy efficiency standards, 2. energy efficiency labels, 3. rebates for high-efficiency equipment, 4. group purchasing, 5. voluntary agreements with manufacturers, 6. raising awareness.
9	Load management	Objective: Reduction of electricity demand at peak time Approach: Adapt electricity consumption to the needs of the electrical system, either to decrease (stopping a manufacturing process, stopping an air conditioner...) or increase (starting manufacturing processes or other appliances...) consumption
10	Optimal network planning	Objective: Optimisation of planning Approach: Carrying out studies on 1. Planning approaches, 2. Geographical information system, 3. Electricity demand forecasting, 4. Technical study of distribution networks, 5. 6. Structure of LV distribution networks, 7. Power flow studies and 8. Technical-economic comparison

Non-technical losses result in high monetary losses amounting to several million Euros per year, even if said losses are relatively small. Fraud in its various forms (energy theft such as bypassing or, meter tampering, etc.), outdated customer databases, missing meters, faulty meters, statistical errors, or errors in the methodology for calculating losses, are all sources of non-technical losses. Given this diversity, it is not surprising that several steps are always necessary to reduce non-technical losses.

The suggested approaches mentioned in the next section are all related to the reduction of non-technical losses. Approaches 1-5 are those where a cost-benefit analysis can often be made, and thus a return on the approach can be confirmed.

Approaches 6-12 are accompanying measures which do not represent individually profitable projects. They are measures that do have the effect of reducing non-technical losses, but their impact on the distribution company's income is not entirely quantifiable. These are measures such as training, for example.

Table 7: Approaches to reduce non-technical losses (12 types of actions)

Nr.	Title	Description of the Objective and Approach
1	Knowledge/client census	Objective: Detection of illegal connections, unbilled meters and anomalies (cut earth connections, broken insulators, bent armatures, etc.). Approach: Update and clean the customer database to reflect the real situation through visits, surveys and inspections
2	Connecting customers to departure stations equipped with metering systems	Objective: Compare the energy injected by substations with the energy billed to customers served by substations. Approach: Numbering of MT/BT positions and expansion of the customer database with information on their attachment to the corresponding positions
3	Customer inspections	Objective: Increase in checks and training of inspectors Approach: Establish a team of independent auditors well trained in energy theft detection methods and ensure the invoicing of penalties and adjustments to energy thieves
4	Making fraud difficult	Objective: Securing metering installations (making connections inaccessible) Approach: Installation of 1) security systems (numbered seals, locks, boxes, fences, etc.), 2) split meters (prepayment) and 3) communicating meters at large consumers
5	Replacing defective meters	Objective: To replace faulty (untampered) meters Approach: Identification and verification of older meters. Identify other faulty meters and replace them or, if meters are not available in stock, switch the subscriber's billing to flat rate mode
6	Creating a zero tolerance culture towards fraud (accompanying measure)	Objective: To communicate at a national level that fraud is unacceptable. Approach: Messages from the government to the population informing them that fraud is no longer acceptable, and that severe sanctions will be imposed energy thieves, etc.
7	Commitment of the company's management in the fight against losses (accompanying measure)	Objective: The highest level of management is committed to the cause Approach: The establishment of statistics to calculate losses, make regional heads accountable and encourage them to do so
8	Awareness campaign (accompanying measure)	Objective: Communication of the distribution company to the population/customers Approach: Regularly launch campaigns in the form of spots on television and radio. Provide information to influential groups such as religious leaders, community leaders and consumer associations
9	Penalties and sanctions (accompanying measure)	Objective: Strict imposition of penalties and sanctions Approach: establishing 'Electricity Tribunals' or other institutions to enable the legal penalties and sanctions in a more rapid and appropriate manner

Nr.	Title	Description of the Objective and Approach
10	Training programmes (accompanying measure)	Objective: To increase the distribution company's staff skills on how to reduce non-technical losses. Approach: Training on 1) calculating of different types of losses (global, non-technical, statistical, etc.), 2) monitoring subscribers and 3) network planning (GIS mapping, demand estimation, design and simulations, economic and financial analysis)
11	Monitoring (accompanying measure)	Objective: Assessment of the distribution company's performance regarding distribution losses Approach: Analysis of losses based on (i) consumption statistics and (ii) energy injected into the distribution network
12	Creating a 'Loss Reduction in Distribution Network' association	Objective: To replicate loss reduction measures that have worked for other distribution companies Approach: Establish meetings with other distribution companies in the country or region to exchange experiences in loss reduction measures

General conclusion

It can be seen that, on the whole, the distribution companies are faced with problems of fairly high losses in terms of technical, non-technical and collection losses. However, the statistics show very different situations and trends in these losses depending on the country. Often, the companies with the highest overall loss rates are also those with the highest specific (i.e. technical, non-technical and collection) loss rates. Although this may seem logical, it is clear that there is not one type of loss that is more important than the others.

There are some exceptions such as NAWEC (The Gambia), which has relatively low overall losses but high collection losses or LEC (Liberia), which has high overall losses but low collection losses.

Although companies have made efforts to produce the static data that could be collected for this report, this is sometimes insufficient. Moreover, some data vary too widely to properly explain these variations. This is certainly due to the fact that the data are strongly impacted by the different technical and non-technical loss reduction measures taken at the same time by the distribution companies and by their success. This can sometimes vary greatly from one Distribution Company to another. Nevertheless, it has been possible to present an overview of losses in the distribution networks of the ECOWAS region.

The loss reduction measures implemented by distribution companies are numerous and very varied. They concern technical, non-technical and collection losses at the same time and there is therefore a real effort being made at their level.

The economic, social and legal context in which distribution companies in the ECOWAS region operate plays an important role in the impact they can achieve through these measures. Changing behaviour is a long-term mission.

The ProMERC programme activities have supported these companies by providing a platform for exchange between distribution companies in the hope that the efforts already undertaken can be improved and have an even greater impact.