Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

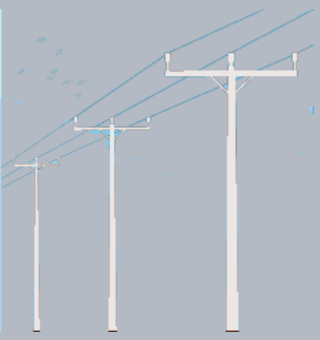
West African Power Pool

Promotion of a Climate-Friendly Electricity Market in the ECOWAS Region

Report 2017

Reduction of Electricity Losses in the Distribution Grids in the ECOWAS Region

June 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 2018-20, is a continuation of some of the activities conducted by the BMZ-funded project *'Promotion of a Climate Friendly Interconnected Electricity System in West Africa'*. The implementation period was between 11/2013 to 12/2017, and included a segment on the reduction of distribution losses in the WAPP member utility networks. During this period the WAPP, in cooperation with GIZ, 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 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

Since 2017, eight distribution companies in the ECOWAS region have reduced their technical, non-technical and collection losses in their respective distribution networks by 5%.

- 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.

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 bothWAPP/ARREC 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, 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 2015-17, and offers indicative analyses on their evolution. The chapter is divided up as follows:

A. Total losses
B. Technical losses
C. Non-technical losses
D. Collection losses

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 between 2015-17.

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

	Country	Company	2015	2016	2017	Rank	Progress over 3 years	Results over 3
7	Niger	NIGELEC	10,6%	12,6%	12,5%	1		-1,9%
21	Nigeria, Lagos	EKEDC	11,0%	9,8%	13,3%	2		-2,4%
5	Togo	CEET	16,8%	16,3%	14,3%	3		2,6%
4	Burkina Faso	SONABEL	13,2%	13,5%	14,5%	4		-1,3%
3	Ivory Coast	CIE	16,0%	15,0%	15,3%	5		0,7%
20	Nigeria, Kano	KEDCO	19,7%	18,8%	18,0%	6		1,7%
1	Senegal	SENELEC	18,6%	20,1%	18,9%	7		-0,3%
2	Mali	EDM-SA	21,4%	20,3%	19,2%	8		2,2%
18	Nigeria, Abuja	AEDC	19,9%	21,5%	21,6%	9		-1,7%
10	Gambia	NAWEC	22,9%	25,1%	23,0%	10		-0,1%
6	Benin	SBEE	23,2%	23,9%	23,1%	11		0,1%
9	Guinea-Bissau	EAGB	27,2%	32,0%	23,2%	12		4,1%
15	Nigeria, Lagos North	IKEJA	17,0%	25,0%	24,0%	13		-7,0%
12	Ghana	ECG	22,3%	23,7%	24,3%	14		-2,0%
22	Nigeria, Port Harcourt	PHED	16,4%	15,7%	24,4%	15		-8,1%
13	Sierra Leone	EDSA	52,9%	47,6%	34,0%	16		18,9%
16	Nigeria, Enugu	EEDC	37,2%	35,2%	28,8%	17		8,4%
17	Nigeria, Ibadan	IBEDC	24,8%	19,2%	29,8%	18		-5,0%
19	Nigeria, Kaduna	KAEDCO	30,2%	28,9%	29,9%	19		0,3%
11	Ghana	NEDCO	23,1%	27,4%	30,2%	20		-7,1%
23	Nigeria, Yola	YEDC	27,0%	27,7%	31,2%	21		-4,3%
8	Guinea	EDG	32,1%	35,2%	36,0%	22		-3,9%
14	Liberia	LEC	29,3%	46,0%	53,4%	23		-24,1%
24	Nigeria	JEDPLC	69,5%	68,6%	72,7%	23		-3,2%
	Average		25,1%	26,2%	26,5%			-1,4%

Source: Reports and presentations produced by the companies during the Dakar Forum in November 2018

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.

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 improvement from these providers.

Statistics show that total losses vary greatly from one distribution company to another, for 2017 between 12.5% in Niger and 53.4% in Liberia. On average, total losses in ECOWAS countries have been almost constant between 2015-17; about 24% on average.

At the distribution company level, only nine companies out of the 23 companies surveyed managed to reduce total losses in the last few years from 2016-17.

For CIE and CEET, the success factor was notably the improvement of inspections. The security of metering systems was another important factor. At EAGB, an improvement to the billing system proved to be the decisive factor.

It remains to be seen whether the total loss values of EDSA in Sierra Leone and EEDC in Nigeria (Enugu) confirm that the sharp reduction in 2017 is a true indication of a downward trend or just an exception.

There are also distribution companies where total losses show an upward (and therefore negative) trend over the three consecutive years in question. This is the case for SONABEL in Burkina Faso, AEDC and Yola in Nigeria, ECG and NEDCO in Ghana, EDG in Guinea and LEC in Liberia.

At EDG, the commissioning of the Kaleta power plant in 2015 proved to be the decisive factor for the increase in total losses. The vast majority of EDG's subscribers are flat-fee subscribers. Their consumption is estimated when they become subscribers but rarely updated afterwards. The addition of electrical appliances is not taken into account, nor is the illegal practice of energy theft by the subscribers' neighbours. Before Kaleta came into service, the energy supply to EDG subscribers was limited by a lack of production capacity. When this constraint was lifted, consumption increased significantly but, for the reasons mentioned above, consumption was not billed accordingly.

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.

Conclusion

It is noticeable that, on the whole, the distribution companies have faced similar loss problems over the last few years. Among the classification types of losses cited, some distribution companies are more often at the top of the table (Sonabel, EDM, Niger for example) and others more often at the bottom of the table (Sierra Leone, Liberia and Kaduna).

It is also noticeable that the evolutions, during the years of the study, are very irregular and it is often difficult to establish real trends. This is because the values change significantly from one year to another. It is also due to data sets being strongly impacted by the different technical and non-technical measures taken by the distribution companies to reduce losses and by their success. This can sometimes vary greatly from one distribution company to another.

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

Source: Reports and presentations produced by the companies during the Dakar Forum in November 2018

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 2 shows that few DCs reported technical losses; in particular no DCs from Nigeria. This is due to a lack of knowledge on how to calculate technical losses using software. For this reason, training in calculating technical losses is a part of this project.

The values in Table 2 suggest that the technical energy losses should be between 7% and 12%. Most of the rough estimates made with 2015 data by the consultant in the previous project were also in this range.

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	Rank	Progress over 3 years	Results over 3 years
3	Ivory Coast	CIE	9.0%	8.0%	8.3%	1		0.7%
1	Senegal	SENELEC	11.8%	11.8%	11.8%	2		0.0%
6	Benin	SBEE	13.1%	13.1%	12.7%	3		0.4%
10	Gambia	NAWEC	14.1%	14.1%	13.0%	4		1.1%
12	Ghana	ECG	11.7%	13.2%	13.7%	5		-2.0%
14	Liberia	LEC	17.3%	34.8%	40.9%	6		-23.6%
7	Niger	NIGELEC			ND			
21	Nigeria, Lagos	EKEDC			ND			
5	Togo	CEET			ND			
4	Burkina Faso	SONABEL			ND			
20	Nigeria, Kano	KEDCO			ND			
2	Mali	EDM-SA			ND			
18	Nigeria, Abuja	AEDC			ND			
9	Guinea-Bissau	EAGB			ND			
15	Nigeria, Lagos North	IKEJA			ND			
22	Nigeria, Port Harcourt	PHED			ND			
13	Sierra Leone	EDSA			ND			
16	Nigeria, Enugu	EEDC			ND			
17	Nigeria, Ibadan	IBEDC			ND			
19	Nigeria, Kaduna	KAEDCO			ND			
11	Ghana	NEDCO			ND			
23	Nigeria, Yola	YEDC			ND			
8	Guinea-Bissau	EDG			ND			
	Average		12.8%	15.8%	16.7%			-3.9%

Source: Reports and presentations produced by the companies during the Dakar Forum in November 2018

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 underestimation 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.

A comparison of technical losses with non-technical losses indicates that the latter accounts for the largest share of *total* losses. The amounts lost due to non-technical losses are enormous. Estimates made in the previous project resulted in each DC losing several million Euros in 2015 due to non-technical losses. For most of the DCs, the amounts have certainly not decreased since then but *increased*.

The reduction of non-technical losses requires, above all, commitment from the DC management. The investment costs are low when compared to the reduction of technical losses. The data received from some DCs show that the investments pay for themselves in the short term. This calls for priority to be given to the reduction of non-technical losses.

D. Collection Losses

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

The amount collected or cashed includes arrears and sometimes payments from energy thieves including a penalty too. It is therefore possible that collection losses may be negative, as was the case, for example, with SONABEL (Burkina Faso) and ECG (Ghana) in 2017.

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

	Country	Company	2015	2016	2017	Rank	Progress over 3 years	Results over 3
12	Ghana	ECG	11,7%	17,8%	-5,0%	1		16,8%
4	Burkina Faso	SONABEL	2,5%	3,9%	-1,3%	2		3,7%
2	Mali	EDM-SA	1,3%	1,0%	0,6%	3		0,7%
7	Niger	NIGELEC	8,8%	3,3%	2,9%	4		5,9%
1	Senegal	SENELEC	7,0%	7,0%	5,0%	5		2,0%
5	Togo	CEET	13,2%	14,3%	9,1%	6		4,1%
8	Guinea	EDG	34,0%	21,0%	16,6%	7		17,4%
15	Nigeria, Lagos North	IKEJA	31,0%	32,0%	19,0%	8		12,0%
6	Benin	SBEE	18,8%	6,0%	20,0%	9		-1,2%
21	Nigeria, Lagos	EKEDC	27,4%	26,8%	22,4%	10		5,0%
14	Liberia	LEC	-3,0%	9,2%	22,6%	11		-25,6%
11	Ghana	NEDCO	28,7%	38,8%	31,1%	12		-2,4%
18	Nigeria, Abuja	AEDC	37,8%	38,8%	34,0%	13		3,8%
17	Nigeria, Ibadan	IBEDC	33,0%	38,0%	35,0%	14		-2,0%
10	Gambia	NAWEC	35,8%	35,8%	35,8%	15		0,0%
22	Nigeria, Port Harcourt	PHED	39,5%	48,0%	41,2%	16		-1,7%
19	Nigeria, Kaduna	KAEDCO	49,0%	46,6%	41,8%	17		7,2%
16	Nigeria, Enugu	EEDC	37,3%	42,8%	42,4%	18		-5,1%
13	Sierra Leone	EDSA	11,0%	44,0%	47,0%	19		-36,0%
20	Nigeria, Kano	KEDCO	34,4%	32,3%	51,7%	20		-17,3%
24	Nigeria	JEDPLC	59,0%	62,6%	61,9%	23		-2,9%
3	Ivory Coast	CIE			ND			
9	Guinea-Bissau	EAGB			ND			
23	Nigeria, Yola	YEDC			ND			
	Average		24,7%	27,1%	25,4%			-0,7%

Source: Reports and presentations produced by the companies during the Dakar Forum in November 2018

Table 4 shows that a high percentage of the invoiced amounts are often not collected. The unpaid amounts for most of the distribution companies add up to several million Euros per year.

The situation is precarious in Nigeria, where collection losses in 2017 ranged from 19% to almost 52% of invoiced amounts. In countries outside Nigeria, collection losses are lower for most companies. Three companies, EDM-SA (Mali), SONABEL (Burkina Faso) and NIGELEC (Niger) almost always had collection losses of less than 5%.

It is encouraging that the collection losses of some distribution companies show a downward trend (SENELEC, CEET, EDG) but there are also companies where the opposite is true (NEDCo, EDSA). On average, collection losses show neither a downward nor an upward trend.

Data from the DCs, that distinguish between collection losses of public and private subscribers, indicate that public subscribers are almost always the worst in terms of making payments

The available data sets do not yet allow testing the hypothesis that the higher the percentage of subscribers who have a prepayment meter, the lower the percentage of collection losses. What is already evident is that the use of prepayment meters is not the decisive factor in all countries. In NIGELEC, where collection losses are low (2.9% in 2017), very few subscribers have prepayment meters.

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 training courses held were as follows:

- **From 17-21 June 2019 at the CME in Bingerville (Ivory Cost)**

Title of training course: Training the Trainers - Calculation of MV/LV technical losses in power distribution networks - Application of NEPLAN software

Trainers: Daniel d'Hoop (Power System Planning Expert) and Gérard Dangla (Technical Training Expert)

Number of Participants: 18

- **From 24-28 June 2019 at the VRA Academy in Accra (Ghana)**

Title of training course: Training the Trainers - Distribution Loss Computation (GIZ)

Trainer: Daniel d'Hoop

Number of participants: 7

- **From 15-19 July 2019 at the CME in Bingerville (Ivory Cost)**

Title of training course: Training DCs - Distribution Loss Computation (GIZ)

Trainer: Daniel d'Hoop

Participants: Distribution Companies

Number of Participants: 7

- **From 22-26 July 2019 at the VRA Academy in Accra (Ghana)**

Title of training course: Formation de SD - Reduction of Losses for Distribution Utilities Programme

Trainer: Daniel d'Hoop

Participants: Distribution Companies

Number of Participants: 18

Indicator Reference Value 2017

The present report is based on a baseline of zero participants in 2017 prior to the start of project activities.

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, ten electricity companies in the ECOWAS region have introduced five approaches for the reduction of technical and commercial losses in distribution networks.

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

Target value: 5 approaches introduced.

Explanation:

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

Each company has made moves to implement the solutions and approaches required to reduce their rates of loss. Nevertheless, in view of these uncoordinated and unharmonious actions within the ECOWAS space, it is necessary to define five 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 who will introduce them in their strategic plan for loss reduction under the terms of ProMERC.

Approaches

Phase one of this project listed the main existing technical and non-technical loss reduction approaches. These approaches are summarised below in:

Approaches to Reduce Technical Loss (ten types of actions)

- Approaches to Reduce Technical Loss (12 types of actions)

Table 5: Approaches to reduce technical loss (10 types of action)

No	Title	Description of the Objective and Approach
1	Installation of condenser canks	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 6: Appraoches to reduce non-technical losses (12 types of actions)

Nr.	Titre	Description de l'Objectif et de l'Approche
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
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

Nr.	Titre	Description de l'Objectif et de l'Approche
		Approach: Establish meetings with other distribution companies in the country or region to exchange experiences in loss reduction measures

This 2017 report lists existing approaches as proposed in Phase 1 of the programme. The progress of the project will analyse the approaches put in place by the distribution companies.

Indicator reference value 2017

This report is based on a baseline of zero approaches put in place by the distribution companies in 2017 prior to the start of project activities.

Conclusions

It is noticeable that, on the whole, distribution companies have faced similar loss problems in recent years. Among the rankings of loss types mentioned, some distribution companies are more often at the top of the table (Sonabel, EDM, Niger for example) and others more often at the bottom of the table (Sierra Leone, Liberia and Kaduna).

It is also noticeable that changes over the course of the study are very irregular, and it is often difficult to establish real trends because the values change sharply from one year to the next. This is due to the fact that the data sets are strongly impacted by the different technical and non-technical measures taken by the distribution companies to reduce losses. Also, by their success that can sometimes vary greatly from one company to another.