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REPORT

3rd CEER Report on Power Losses

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INFORMATION PAGE

Abstract

This document (C24-EQS-106-03) is a Report on Power Losses from the Council of European Energy Regulators (CEER).

This report provides an overview of power losses in transmission and distribution electrical grids in 40 European countries. It focuses on the levels of losses, how they are defined and determined as well as their regulatory treatment. The report further analyses the relationship between losses and factors such as network length, system operator revenue, and the number of metering points in distribution.

Reducing power losses contributes to greater energy efficiency and security of supply and is an important goal, especially since the costs of power losses are often passed on to consumers. This report includes a set of recommendations for good practices that could be adopted to reduce power losses and enable easier comparison among countries. CEER's findings and recommendations are based on the results of a questionnaire sent to National Regulatory Authorities.

Target audience

European Commission, CEER Members and Observers, National Regulatory Authorities, Distribution System Operators, Transmission System Operators, Independent System Operators, energy suppliers, traders, electricity customers, electricity industry, consumer representative groups, academics and other interested parties.

Keywords

Power Losses; Transmission; Distribution; Energy Efficiency Directive; Transmission Grid; Distribution Grid; Electrical Grid; Cross-Sectoral; Networks; Market Monitoring; National Regulatory Authorities; Transmission System Operator; Distribution System Operator; Independent System Operator; Independent Transmission Operator; Distributed Generation; Smart Meter.

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Related documents

CEER Documents

- 2nd CEER Report on Power Losses, March 2020, Ref. C19-EQS-101-03.
- CEER Report on Power Losses, October 2017, Ref. C17-EQS-80-03.
- 7th CEER-ECRB Benchmarking Report on the Quality of Electricity and Gas Supply, December 2022, Ref. C22-EQS-103-03.
- Benchmarking Report 6.1 on the Continuity of Electricity and Gas Supply, July 2018, Ref. C18-EQS-86-03.
- 6th CEER Benchmarking Report on all the Quality of Electricity and Gas Supply (Introduction, Chapter 1-2), 6th CEER Benchmarking Report on all the Quality of Electricity and Gas Supply (Chapter 3-4), 6th CEER Benchmarking Report on all the Quality of Electricity and Gas Supply (Chapter 5-7), 6th CEER Benchmarking Report on all the Quality of Electricity and Gas Supply (Annexes), September 2016, Ref. C16-EQS-72-03.

External Documents

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EXECUTIVE SUMMARY

Background

In addition to the 2017 [1] and 2020 [2] Reports on Power Losses by the Council of European Energy Regulators (CEER), the subject of power losses (PL) has been analysed several times on a European level in the past decade or so. The European Regulators' Group for Electricity and Gas (ERGEG) conducted a consultation (in 2008) and issued a position paper (in 2009) on the treatment of losses by network operators in Europe. Moreover, the European Commission (EC) published a Communication on energy efficiency (in 2014) and a report (in 2015) in support of the implementation of Article 15 of the Energy Efficiency Directive (EED, 2012/27/EU) [3] which gives a comprehensive overview of losses across the EU [4].
Subsequently, CEER decided to publish a dedicated report focusing on this topic, rather than including power losses as a single chapter in another report. The result was the 1st CEER Report on Power Losses which was published in October 2017. It dealt with the definition, causes, calculation, procurement and values of power losses, in addition to the effect of smart meters (SM) and distributed generation on losses. That report was based on answers to a CEER questionnaire that were obtained from 27 CEER Member States and many stakeholders that filled out a dedicated questionnaire.

The 2nd CEER Report on Power Losses was published in February 2020. With the aim of providing an extended and more reliable database and expanding the number of participants, that report included eight Energy Community Regulatory Board (ECRB) Contracting Parties1, which increased the total number of participants to 35. In addition, the comparability of losses was improved by using an enhanced methodology for calculating loss percentages in distribution and transmission.

This 3rd CEER Report on Power Losses repeats the previous approach of including both CEER Members and ECRB Contracting Parties and raises the number of participants to 40, covering essentially the entire continent. The enhanced calculation methodology from the previous report was used again. The requirements of EED and influence of smart meters on power losses are also examined.

Objectives and contents of the document

As with the first two editions of the Power Losses Report, this third edition analyses the way that power losses are defined, calculated, procured and treated by the regulatory framework of the responding countries. Moreover, it statistically investigates the relationship between losses and certain other variables. Most importantly, the report provides comparisons between countries' distribution, transmission and total losses as a percentage of energy injected into their distribution or transmission grid (or a total energy volume injected into a country in the case of total losses). Readers should keep in mind that definitions of distribution and transmission grids are not standardised and that the voltage levels included in each differ across Europe.

As a result of a 2023 CEER questionnaire, input from National Regulatory Authorities (NRAs) of 40 countries was received. Analysis of responses revealed that there are significant differences in the treatment of losses among the responding countries.

The easiest way to categorise losses is to divide them into technical and non-technical components. The former is a consequence of the laws of physics and, although it could be reduced with more efficient equipment, it cannot be fully and economically eliminated with current technology. The latter component consists of the energy delivered but not metered or billed and often depends on socio-economic conditions of a country. Non-technical losses can be further broken down into multiple subcomponents, some of which are not considered to be part of power losses in every country due to differing definitions.

The lack of harmonised definitions and rules regarding the components included in losses presents an obstacle to straightforward benchmarking across Europe. Most responding countries simply consider power losses to be the difference between the energy injected into and taken off the grid.

Losses in transmission grids are, percentagewise, generally lower than their distribution counterparts due to the fact that higher voltages in transmission result in lower current, which leads to lower technical losses. In transmission, losses are mostly metered (or calculated from variables that are metered) whereas they are often estimated in distribution.

In this report, losses are presented as a percentage of injected energy. In transmission, this includes all energy injected into the transmission system, including energy imported from other countries, energy coming from distribution grid and generation connected to transmission. Energy injected into distribution includes energy that was passed on from transmission in addition to energy injected by generation connected directly to distribution grid. Total injections in any given country consist of injections in transmission in addition to those by generation connected to distribution. This approach ensures that no energy was counted twice and that the calculated percentages portray the accurate values in each country.

Brief summary of the conclusions

The definition of power losses is not standardised and can vary from country to country. In most cases, losses are understood to be the difference between the energy flowing into and out of a grid, but there are countries that do not use this approach.

All responding countries except for one include non-technical losses in the volumes included in this report either in their distribution losses only or both in their distribution and transmission losses. Non-technical losses have different definitions and different components that they include. In some countries there is no distinction between technical and non-technical losses in which case both components are incorporated in reported values.

Losses in distribution varied between 1.95% and 22.63% in the latest year data was available for (2022) which reveals substantial differences among the participants. While many respondents show a decreasing trend in distribution losses, there have also been increases over time in a few countries.

Losses in transmission vary between 0.99% and just under 3.96% in the latest year data was available for (2022). While increases in transmission losses (in percent) have been observed in the last few years in some countries, the rise is only on the level of a few tenths of a percent at the most. The percentage of losses depends not only on the absolute value of losses, but on the volume of injected energy as well. With decreased volumes, the percentage of losses will increase, even if losses remain unchanged in absolute terms.

In most European countries, transmission system operators (TSOs) or distribution system operators (DSOs) are responsible for the procurement of losses in their respective grids. There are only a few exceptions to this, where either a supplier or a balance responsible party (BRP) acquires the energy necessary to cover power losses.

According to EED, system operators are required to quantify the overall volume of network losses and, where it is technically and financially feasible, optimise networks and improve network efficiency. Among the strategies suggested by the EED to reach these objectives are incentive-based regulation and the deployment of smart grids.

Key recommendations

Harmonising definitions might not be easy, but a consensus on a clear differentiation between technical and non-technical losses could be possible and would simplify the benchmarking of power losses.

System operators should be given clear incentives to reduce power losses instead of just being allowed to pass the cost to consumers. Incentives to reduce power losses in distribution have been implemented in 27 countries, while 18 countries have implemented incentives in transmission. Additional mandatory requirements such as replacing older existing transformers with new high efficiency transformers could also be implemented. Properly set tariffs could be used to promote increased utilization of local renewable energy sources (RES).

Increased SM penetration can simplify and expedite matching supply to actual demand as the need to use load profiles to estimate demand would be reduced. Smart meters can help lower the non-technical losses, especially regarding causes such as faulty meter reading or illegal consumption. In any case, country-specific characteristics must be taken into consideration as CEER Members and Observers may require individual solutions rather than a single regulatory framework expected to be applied in all of Europe.

1 Introduction

1.1 Background

Power losses are a component of every electrical grid and originate as a consequence of transmission and distribution of electricity, where they constitute a significant amount of energy flows. Improvement of energy efficiency and grid reliability, in addition to economic and environmental benefits, are some of the major positive aspects of the reduction of power losses.

Article 15 of Directive 2012/27/EU [3] on energy efficiency, states that the "[EU] Member States shall ensure that network operators are incentivised to improve efficiency in infrastructure design and operation" and that the "[EU] Member States shall ensure that national energy regulatory authorities pay due regard to energy efficiency in carrying out the regulatory tasks specified in Directives 2009/72/EC and 2009/73/EC regarding their decisions on the operation of the gas and electricity infrastructure". In addition, European Commission published a Communication on energy efficiency in 2014[1] [5], noting the need to reduce the volume of network losses to achieve the 2030 objective.

The Directive (EU) 2023/1791 [6], elaborated in the context of the 'Fit for 55' package, has the objective to decrease the Union's final energy consumption by 11.7% compared to 2020 figures. The Energy Efficiency Directive introduces provisions to prioritize energy efficiency across sectors, aiming to address barriers and market failures hindering efficiency in energy supply, transmission, storage, and utilization. The effects of these developments do not only affect energy efficiency directly but also foster the European path to decarbonization.

While there had been some publications on power losses on a European level in the past, CEER started publishing their Reports on Power Losses in 2017, with the second edition published in early 2020. Both reports were based on questionnaires sent to participating countries (either the NRAs or NRAs and stakeholders) and focused on the treatment of losses as well as special topics such as the impact of smart meters and distributed generation.

1.2 Coverage and structure

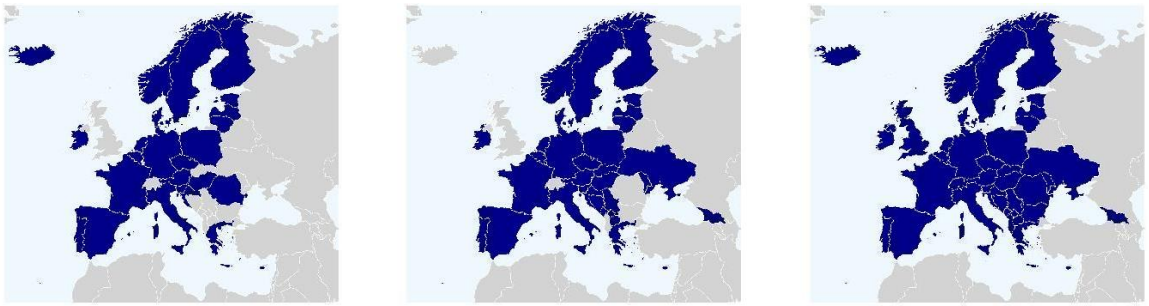
This third edition of the report is based on responses to the 2023 CEER questionnaire on power losses sent to National Regulatory Authorities. Thus, an analysis of the level and general treatment of losses in electricity networks of 40 European countries was conducted. These are: Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Great Britain, Greece, Hungary, Iceland, Ireland, Italy, Kosovo*[2], Latvia, Lithuania, Luxembourg, Malta, Moldova, Montenegro, The Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland and Ukraine.

As in the first two editions of the CEER Report on Power Losses, the objective is to make an inventory of the technical and regulatory aspects (definition, calculation, level, procurement and regulatory treatment) as well as the experience with the treatment of losses in Europe (the

[1] 'Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy', European Commission, July 2014, https://eur-lex.europa.eu/resource.html?uri=cellar:f0db7509-13e5-11e4-933d-01aa75ed71a1.0003.03/DOC_1&format=PDF

[2] Throughout this report, the term 'Kosovo*' refers to the following statement: This designation is without prejudice to positions on status and is in line with UNSCR 1244 and the ICJ Advisory Opinion on the Kosovo declaration of independence.

requirements of EED and influence of smart meters on power losses) and to present CEER's main findings and recommendations. Each aspect is presented in an individual section throughout this report. Moreover, a more-detailed analysis of practices in Portugal is included in the form of a case study. Finally, short country-specific fact sheets and additional graphs are presented in the annex.



1st PL Report | 2nd PL Report | 3rd PL Report

Figure 1 – Coverage of the editions of the CEER Report on Power Losses

2 Technical and regulatory aspects of losses

2.1 Definition of losses

In the simplest of terms, power losses can be described as the difference between the electric energy flowing into and out of a power grid, or in other words, the difference between injections and offtakes. As in the previous CEER Power Losses Reports, injections consist of electricity generated and fed into transmission and distribution grid in addition to energy imports from other countries. Offtakes consist of customer consumption, but also of energy exports across the border.

For this 3rd CEER Power Losses Report, definitions of technical and non-technical losses were already provided in the questionnaire and the respondents were asked whether the definitions in their countries differ in any way. The definitions provided were:

Technical losses
A common understanding of technical losses is that they are defined as physical losses, which consist of fixed losses (not related to load) and variable losses (load related): they depend on the design of the power grid, the voltage and transformation levels and the length of the power lines.

Non-technical losses
A common understanding of non-technical losses is that they include “hidden” non-technical losses (e.g. in-house consumption), non-metered consumption (e.g. public lighting), theft and other types of losses such as metering errors, differences in metering, billing and data processing.

Option	No. of responses	Countries
No	(1)	DE
Yes, in transmission and distribution	(28)	AL, AT, BA, BG, CZ, DK[3], EE, EL, ES[4], FI, GB, GE, HU, IE, IS, KS*, LT, LU, LV, MD, MK[5], NO, PT, RO, RS, SE, SI, UA
Yes, in distribution	(10)	BE, CH, CY, FR, HR, IT, ME, MT[6], PL, SK

Table 1 – Inclusion of non-technical power losses

[3] Does not distinguish between technical and non-technical losses.
[4] Does not distinguish between technical and non-technical losses.
[5] Does not distinguish between technical and non-technical losses.
[6] No transmission grid in Malta.

As seen in Table 1, all responding countries except Germany include non-technical losses in the volumes included in this report as either a component of losses in distribution or losses in both distribution and transmission[7]. Several countries (Belgium, Croatia, Cyprus and Switzerland) noted that there are no non-technical losses in their transmission systems. Norway reported that they cannot separate total losses into technical and non-technical losses, but that the latter are very marginal and not of a particular concern.

In Spain, there is no distinction between technical and non-technical losses. They are defined as the difference between injected and delivered energy. In Croatia, losses do not include public lighting. Otherwise, the same definition is used as in Spain.

In the Czech Republic, in-house consumption is not included in either component of losses. In Hungary, the definition of non-technical losses is slightly different, in that their non-technical losses do not include non-metered but billed consumption such as public lighting and other non-metered consumption that is billed in some way. Public lighting in Hungary is billed and calculated as a product of the power and the number of hours of operation. Another example of non-metered but billed consumption in Hungary would be detected theft in which case the perpetrator would need to pay a fee based on the calculated/estimated consumption hours.

Kosovo* does not have a definition of losses in their legislation. In Belgium, non-technical losses in distribution in Brussels and Wallonia differ from the definition above since unmeasured consumption such as street lighting is still calculated based on fixed power. The definition is also different in transmission in Belgium, but the difference was not specified.

Switzerland does not have a formal definition in their national laws. There are recommended formulas in the technical codes from the electricity sector (AES/VSE[8] recommendations). On transmission and distribution level, their technical losses are calculated based on metered data (which means metering errors are included in technical losses) and differential calculations. In distribution, other possibilities to calculate losses exist and are described in AES/VSE Swiss Metering Code MC-CH 2022 and in Swiss Distribution Code DC-CH 2020. Losses must be determined for every network level but if metered data is only available for total losses, a portion of total losses is allocated to each network level.

Denmark and North Macedonia do not distinguish between technical and non-technical losses. The definition of technical losses in Georgia is the same as above, but non-technical losses are divided into commercial and in-house consumption losses. Italy indicated that their non-technical losses primarily consist of electricity theft and errors in metering and are concentrated in distribution networks.

Norway does not have an official definition of non-technical losses. Portugal indicated that in-house consumption (consumption in network operator's facilities) and public lighting are subject to metering, so they are not considered losses. The definition of other components of non-technical losses is the same as above. In Slovakia, in-house consumption does not constitute non-technical losses since it is treated separately.

[7] Readers should keep in mind that definitions of distribution and transmission grids are not standardised and that the voltage levels included in each differ across Europe. Definitions from the 7th CEER/ECRB Benchmarking Report on the Quality of Electricity and Gas Supply were included in the questionnaire used to collect data for this report. https://www.ceer.eu/publication/7th-ceer-ecrb-benchmarking-report-on-the-quality-of-electricity-and-gas-supply/

[8] Association des entreprises électriques suisses / Verband Schweizerischer Elektrizitätsunternehmen (Association of Swiss Electricity Companies).

Table 2 shows what components are included in the local definition of non-technical losses. It is important to note, that the table includes even countries that do not officially distinguish between technical and non-technical losses, such as Denmark, North Macedonia and Spain.

Type of losses included	No. of responses	Transmission	No. of responses	Distribution
Hidden losses	(17)	AT, BE, BG, EL, FI, GE, HU, IE, IS, LU, MD, NO, PT, RO, RS, SE, UA	(25)	AL, AT, BE, BG, CH, CY, El, ES, FI, FR, GE, HR, HU, IE, IS, KS*, LU, MD, MT, NO, PT, RO, RS, SE, UA
Non-metered consumption	(8)	AL, DK, GB, LV, NL, RO, SE, UA	(18)	AL, BA, BE[9], CZ, DK, ES, FR, GB, HU, KS*, LV, MT, NL, PT, RO, RS, SE, UA
Theft	(17)	AT, BE, BG, CZ, DE, DK, EL, FI, GB, LU, LV, MD, NL, PT, SE, SI, UA	(36)	AL, AT, BA, BE, BG, CY, CZ, DE, DK, EE, EL, ES, FI, FR, GB, HR, HU, IE, IS, IT, KS*, LT, LU, LV, MD, ME, MT, NL, NO, PL, PT, RS, SE, SI, SK, UA
Others[10]	(26)	AT, BA, BE, BG, CH, CZ, DK, EE, EL, FI, GB, GE, HU, IE, IS, LU, LV, ME, NL, NO, PT, RO, RS, SE, SI, UA	(37)	AL, AT, BA, BE, BG, CH, CY, CZ, DK, EE, EL, ES, FI, FR, GB, GE, HR, HU, IE, IS, IT, KS*, LT, LU, LV, ME, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, UA

Table 2 – Components of non-technical losses included in definition

On a general note, Croatia pointed out that non-technical losses in their distribution network would comprise of theft and other types of losses such as metering errors, differences in metering, billing and data processing.

Hidden losses in Finland include in-house consumption of substations. Portugal explained that this component is indeed included in non-technical losses, but that the case does not apply since in-house consumption is subject to metering. Luxembourg reported including consumption of station auxiliaries in their hidden losses.

According to the AES/VSE Swiss Metering Code (MC-CH 2022), when losses in an installation occur due to short-circuit, ground fault or other reason, the network user has no right to subtract it from the amount of energy or power recorded by the meter. Hidden losses in Switzerland can also comprise voluntary/involuntary theft or unmetered consumption, inaccurate metering, obsolete electrical installation, owners or tenants with a common connection and/or metering point which could lead to unnoticed losses and excessive consumption. Those cases can also be used for the component of “other” non-technical losses. Smart meter roll-out is still ongoing in Switzerland (the target is 80% by 2027), resulting in some metering inaccuracies.

[9] Only in Wallonia and Brussels regions.

[10] Such as metering errors, differences in metering, billing, and data processing.

Non-metered public lighting in Switzerland is estimated and excluded from the losses. Non-metered consumption in Germany is not part of the balancing calculations by ordinance. Greece reported that they have no cases of lawful unmetered consumption by network users while Ireland includes such consumption in outflows based on estimates. There are no non-metered points of delivery under normal circumstances in Luxembourg. In Serbia, a small part of public lighting consumption is calculated since there are no meters at their connection points. In Slovakia on the other hand, public lighting is metered while non-metered consumption has a negligible volume.

If electricity theft is proven in Austria, that energy would have to be billed. Losses from theft in Finland are not measured but are known to be minimal. The Netherlands is not aware of electricity theft on transmission level.

Losses on lower voltage levels are not entirely metered in Austria so they are calculated as the difference between injected and consumed energy. In Finland, metering errors are the responsibility of network operators and their acquisition of energy to cover losses must be market-based.

2.2 Determining losses

Similar to what was reported in the previous CEER Reports on Power Losses, the predominant methodology to determine the network losses is based on the difference between total electricity injections (sourced from generation facilities and other network connections) and electricity offtakes, including those by final consumers and other interconnected networks.

Generally, the approach adopted to determine losses is the same for both distribution and transmission grids. The main exceptions have been reported in Austria (where the main parameters are metered in transmission while the difference between injected and consumed energy is used to calculate losses in distribution), in Switzerland (where only differential measuring is adopted in transmission, while in distribution estimates or differential calculations are allowed as well), in France (where profiled consumption/injection are also used in distribution) and Greece (where the volumes are estimated if the meter readings in distribution for a reference period are not available).

When assessing losses, input values can either be estimated or measured. It is a common practice (24 out of 39 respondents) to utilize a combination of measurement and estimation techniques for determining these loss values, as illustrated in Table 3.

Option	No. of responses	Countries
Measure	(9)	BE, BG, LV, MD, NO, PL, PT, RS, SE
Estimate	(6)	AL, FI, GE, IE, ME, SI
Both	(24)	AT, BA, CH, CY, CZ, DE, EE, ES, FR, GB, GR, HR, HU, IS, IT, KS*, LT, LU, MK, MT, NL, RO, SK, UA

Table 3 – Measurement/estimation of values used for calculating losses

Eleven responding countries reported new developments regarding treatment, calculation or regulation of power losses in the past few years, as shown in Table 4.

Option	No. of responses	Countries
New developments reported	(11)	BA, CY, CZ, DE, ES, GR, LU, MT, NL, SE, SI
No new developments reported	(26)	AL, AT, BE, BG, CH, EE, FI, FR, GB, HR, HU, IE, IS, IT, KS*, LT, LV, MD, ME, MK, NO, PL, PT, RS, SK, UA

Table 4 – New developments regarding treatment, calculation or regulation of power losses

The types of reported new developments concern both the regulatory treatment (7) and the determination of losses (4). Two countries (Greece and Slovenia) introduced regulatory incentive mechanisms for network operators to reduce their losses. Sweden, which introduced incentive mechanisms on power losses in 2016, reported that they improved their incentive for power losses for the regulatory period 2020-2023. The improvement was made to provide a stronger incentive to reduce power losses, as it includes benchmarking of local DSOs and allocating a smaller part of the incentive to the customers than before. The adoption of SM reading to improve data quality has been indicated by three countries (Luxembourg, Malta and Spain).

In most countries, there is a legal obligation to provide each final electricity consumer with a meter. In Switzerland the notion of final customer was extended to include some producers (usually PVs) grouped in (local) communities for on-site consumption. They are then considered as a final customer with a unique metering point. In this case, bill subdivision is not regulated but can be done by the community itself through private contracts.

Unmetered consumption is generally left as an option in those cases where the installation of a meter is not technically possible or financially reasonable. Reported cases of non-metered consumption are limited in number and do not have a significative impact on the total volume of energy offtake. In Georgia and Ireland there is a capacity threshold (1 kW and 2 kW, respectively) below which there is no obligation to install a meter (in Georgia this is possible only for non-domestic users). The most common cases of unmetered connections reported by the respondents are public lights (Austria, Belgium, Germany, Great Britain, Iceland, Ireland, Malta and Sweden), temporary connections, (Georgia and Latvia) and advertising signs (Austria and Poland). In most of these situations, it is relatively easy to estimate the electricity offtake due to constant consumption profiles.

Five NRAs (Cyprus, France, Italy, Portugal and Romania) reported that they have ongoing discussions or plans to implement regulations regarding the level of accuracy for determining network losses. For example, ARERA (the NRA of Italy) reported its intention to evaluate a new model for managing electricity metering data, following the deployment of second-generation (2G) smart meters and the end of regulated supply service ("maggior tutela") to market-based supply. The "maggior tutela" service still supplies all households that have not chosen a supplier and covers the difference between actual distribution losses and standard losses. In addition, Norway reported a very accurate determination of network losses due to its 99% complete rollout of smart meters.

2.3 Level of losses

When analysing data and making direct comparison between countries, it is important to keep in mind that there are differences in the way losses are defined across Europe. This means that the components might not be the same and what is considered a loss in one country, might be considered delivered energy in another.

To enable comparability, the percentages of losses are calculated as the ratio of the volume of losses and the volume of injected energy throughout the following figures. One reason for this is that losses occur before energy reaches customers and thus focusing on percentage of energy taken off would be equivalent to discarding a share of losses.[11] For transmission losses, this includes all energy injected in the transmission system including imported energy from other countries, energy coming from distribution grid and generation connected to transmission. Energy injected in distribution includes energy that was passed on from transmission in addition to energy injected by generation connected directly to distribution grids. Total injections in any given country consist of injections in transmission in addition to those by generation connected to distribution. This made sure that no energy was counted twice and that the calculated percentages portray the accurate values in each country.

Annex 4 provides tables with most of the values used for this Report. Not every country answered every question or sent values for every year resulting in some empty cells in those tables. Occasionally, only the more recent values were available: 2021 and 2022 for Bulgaria, 2018-2022 for distribution and total losses and 2017-2022 for transmission losses in Switzerland, 2014-2022 for all types of losses in Spain, 2018-2022 for all types of losses in Denmark and Latvia, 2014-2022 for distribution losses and 2017-2022 for total and transmission losses in Ireland, 2017-2022 for total losses in Luxembourg, 2014-2022 for distribution and total losses in Romania, 2016-2022 for Moldova, 2020-2022 for Slovakia and 2017-2022 for Ukraine. Even some more recent values were not provided, such as the 2018-2021 transmission losses in Great Britain which resulted in availability of 2013-2017 and 2022 for transmission, 2016-2022 for distribution and consequently, only 2016, 2017 and 2022 total losses in Great Britain.

Switzerland does not calculate distribution losses as a simple difference between the overall energy flowing into and out of their entire distribution grid. Overall distribution losses regarding Switzerland in this report are based on data provided to their NRA by most of their roughly 600 DSOs. This is Switzerland's first participation in a CEER Power Losses Report. Distribution losses they provided are an estimate since Switzerland does not publish distribution and transmission losses separately.

There are also cases where there are differences as to what is included in energy flows. The offtakes from distribution grid, as reported by DSOs in the Netherlands, only include the energy taken off by their own medium and low voltage consumers. This excludes the energy supplied to other system operators (either the TSO or other DSOs) which means that in the Netherlands, the distribution losses in Table 17 in Annex 4 are not equal to the difference between the energy that flows into and out of their distribution grid.

[11] Since the percentage of losses was not part of the questionnaire for this report, this calculation is done even in cases where countries might officially report their numbers as percentages of energy taken off.

Calculating the percentages was also not possible for some years due to missing energy flow data. Germany did not separately provide values for energy injected in transmission and distribution and was therefore, only included in percentage calculations for total losses. Luxembourg provided the total losses in absolute terms and the total energy flows (the sum of transmission and distribution) which were used to calculate the total losses as percentage. Moreover, Malta does not operate a transmission grid, which means that their total losses are equal to their distribution losses.

Since 40 countries provided data for this report, it was decided to split them into two groups in each time series figure which has no effect on data and was done only for reasons of clarity. The selected threshold was 7.5% for distribution, 2% for transmission and 7% for total losses. The analysed timeframe was between 2013 and 2022 and includes values for each year for which data was obtained. It should be mentioned that some countries were excluded from certain figures, depending on data availability, as explained above.

Losses in distribution vary between 1.95% and 22.63% in the latest year data was available for (2022). While many countries show a decreasing trend in distribution, losses have increased over time in Belgium, Greece and Georgia (see Figure 2 and Figure 3, the threshold dividing them set to 7.5%). The largest reductions are evident in Albania and Kosovo* which managed to cut down their distribution losses by more than 50% (Albania) and by nearly a third (Kosovo*) between 2013 and 2022. Nevertheless, their distribution losses are still very high (in 2022 approx. 20% and 22%, respectively) compared to those of the most efficient countries (approx. 2%), while their transmission losses show comparable values for recent years. One reason for that situation might be, that unbilled energy consumption is part of non-technical losses that are included in the reported numbers. In both Albania and Kosovo*, non-technical losses are higher than losses in transmission in absolute terms.

Losses in transmission vary between 0.99% and just under 3.96% in the latest year data was available for (2022). For clarity, the countries were divided into those where transmission losses did not exceed 2% in any year in the time series and those where the threshold of 2% was exceeded in at least one year since 2013 (see Figure 4 and Figure 5). Total losses were calculated for each country data was available for and presented in Figure 6 and Figure 7, with the dividing threshold for two figures set to 7%.

The boxplots (Figure 8 to Figure 10) include all countries provided that data was available. Without illustrating development of losses over time, they instead indicate the minimum, maximum and average values as well as the latest available value which was for the year 2022.

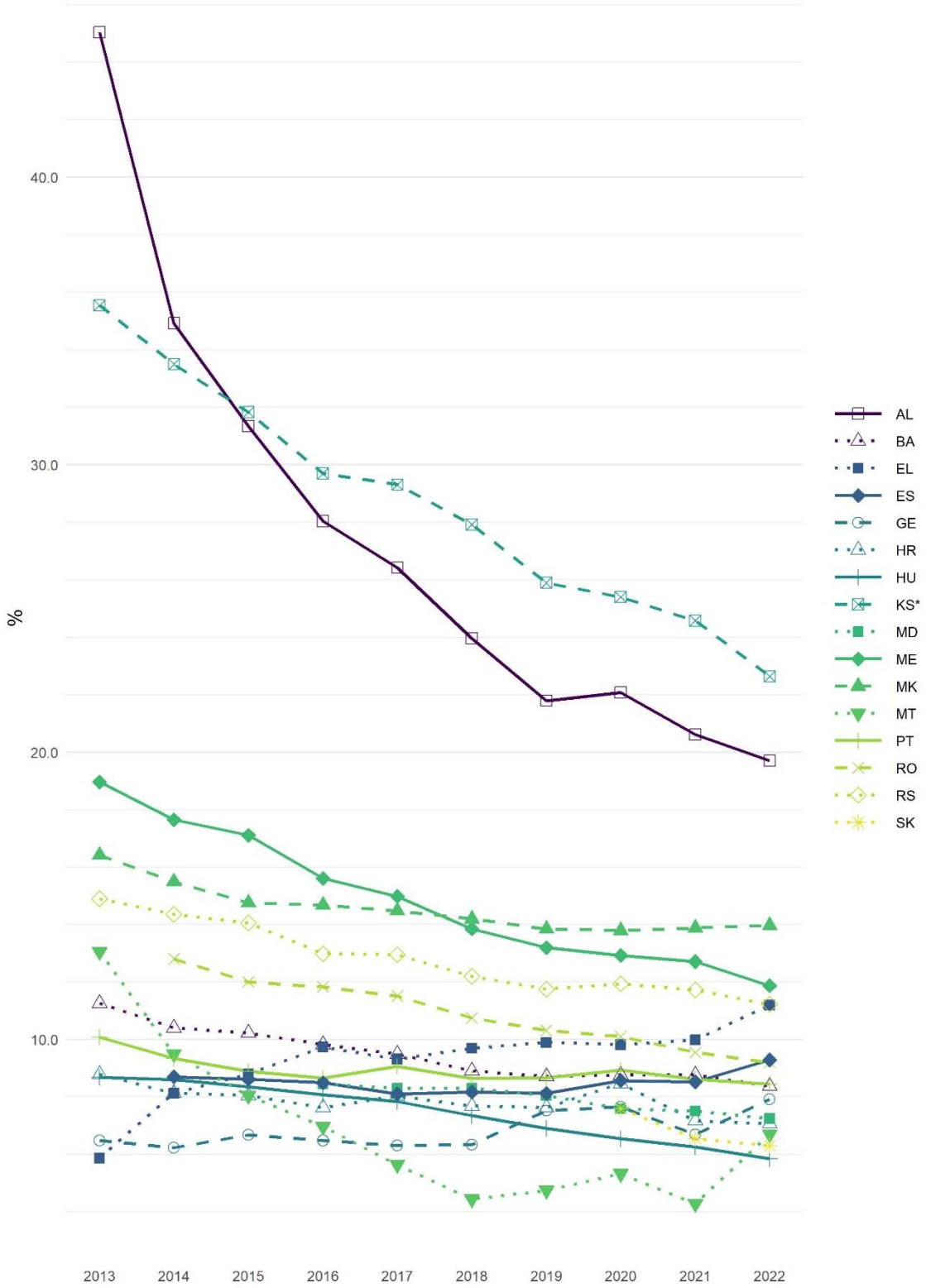


Figure 2 – Distribution losses as % of injected energy (countries exceeding 7.5% in at least one of the years data was obtained for)

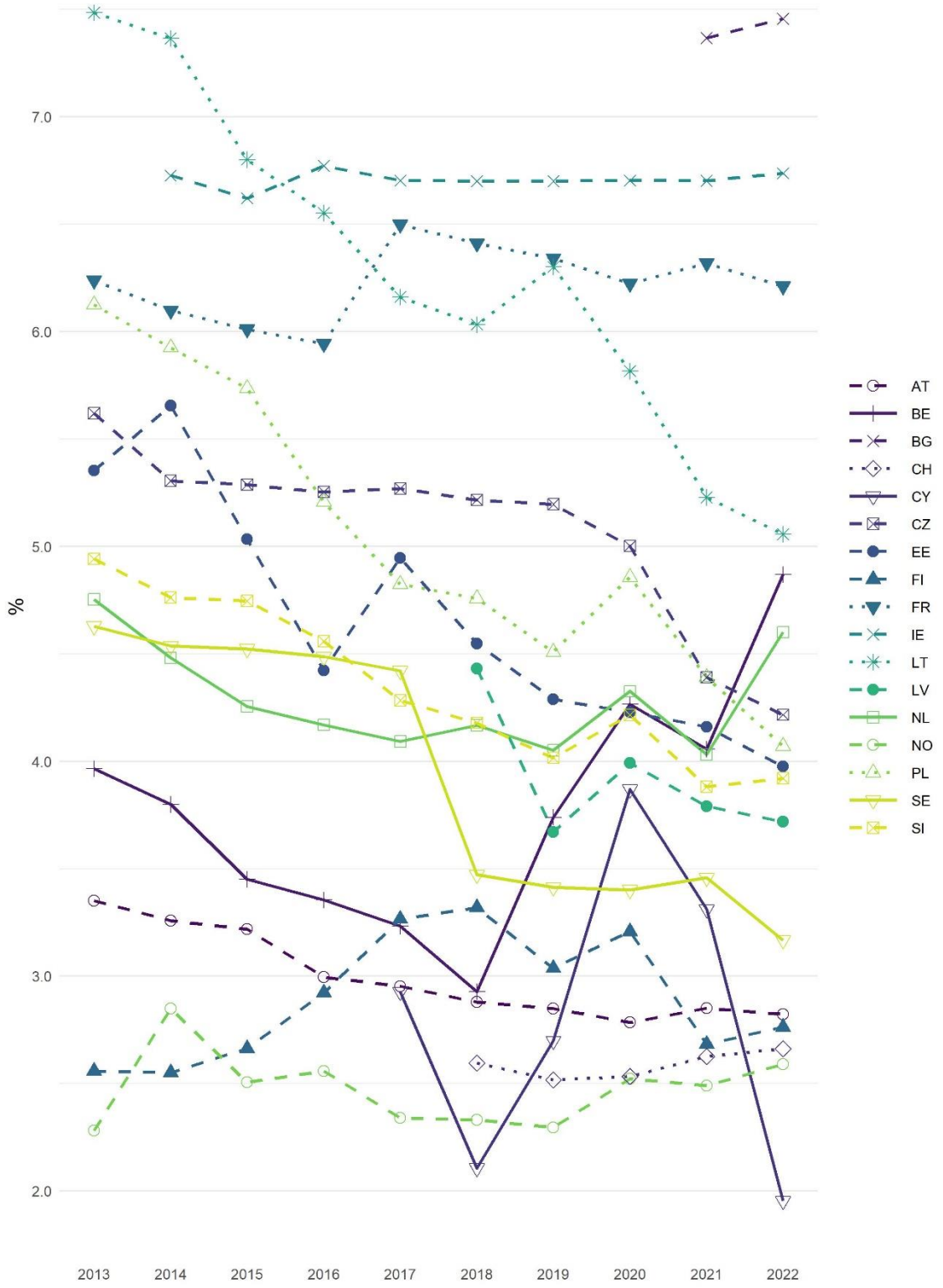


Figure 3 – Distribution losses as % of injected energy (countries not exceeding 7.5% in any of the years data was obtained for)

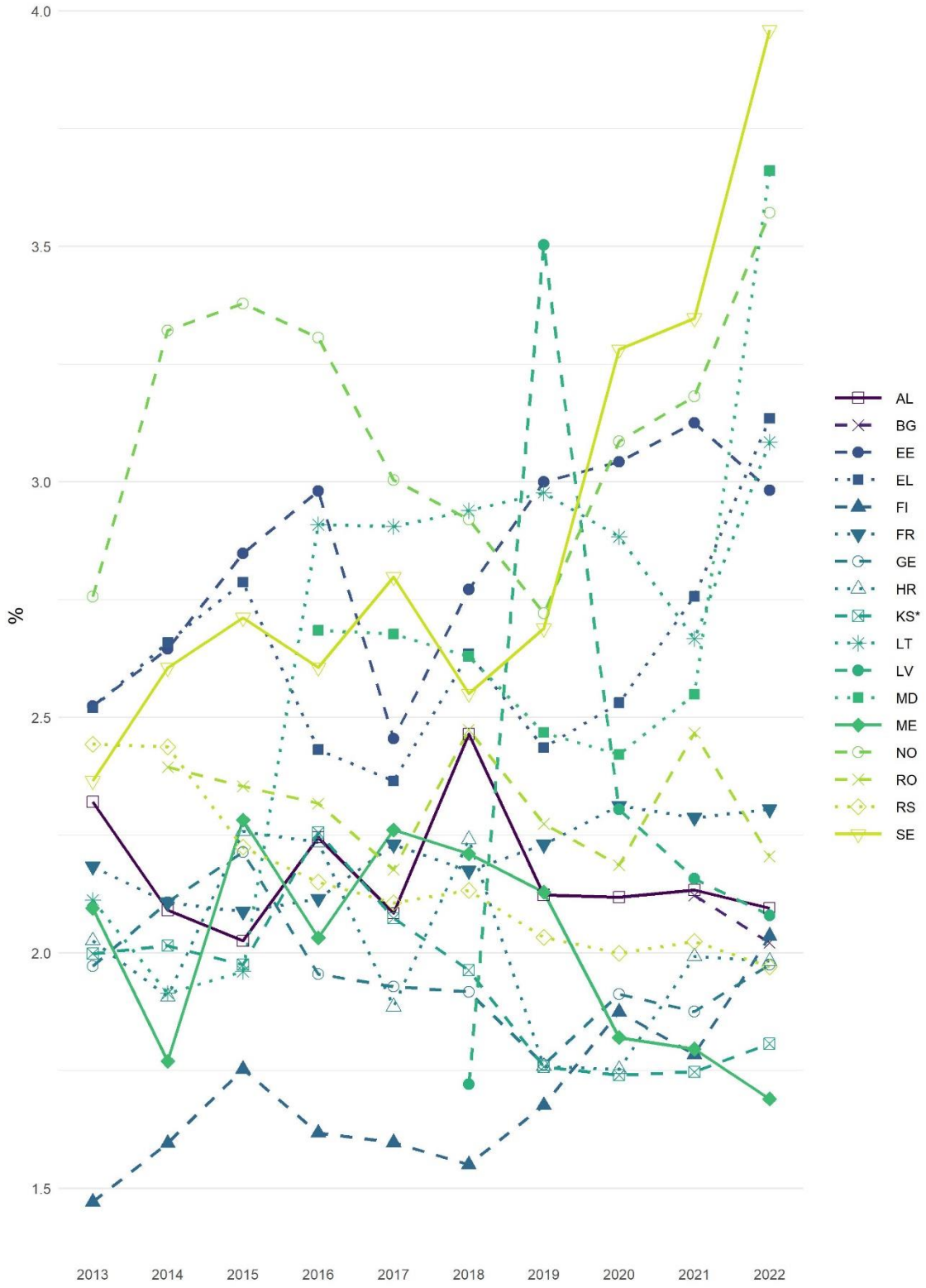


Figure 4 – Transmission losses as % of injected energy (countries exceeding 2% in at least one of the years data was obtained for)

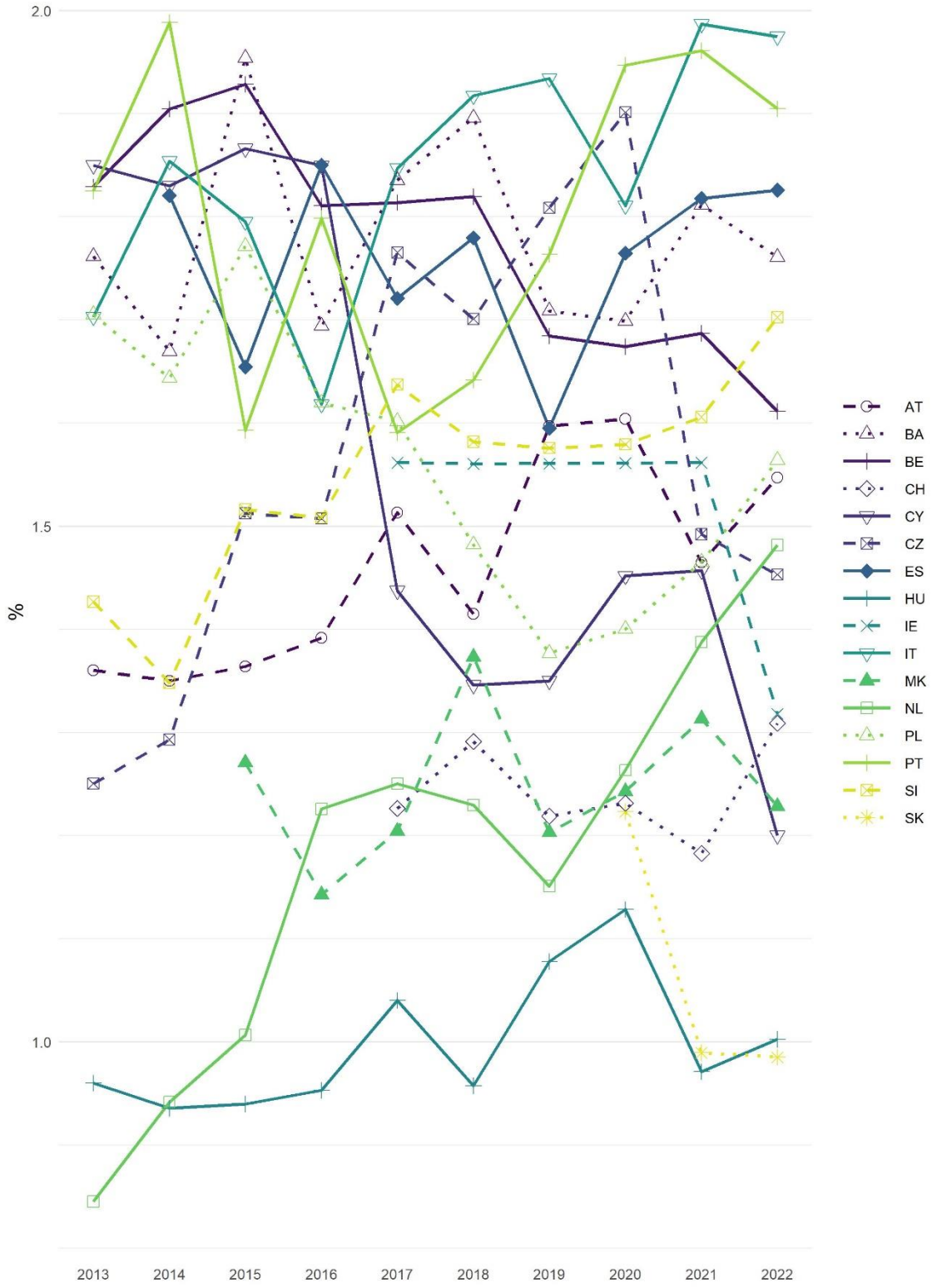


Figure 5 – Transmission losses as % of injected energy (countries not exceeding 2% in any of the years data was obtained for)

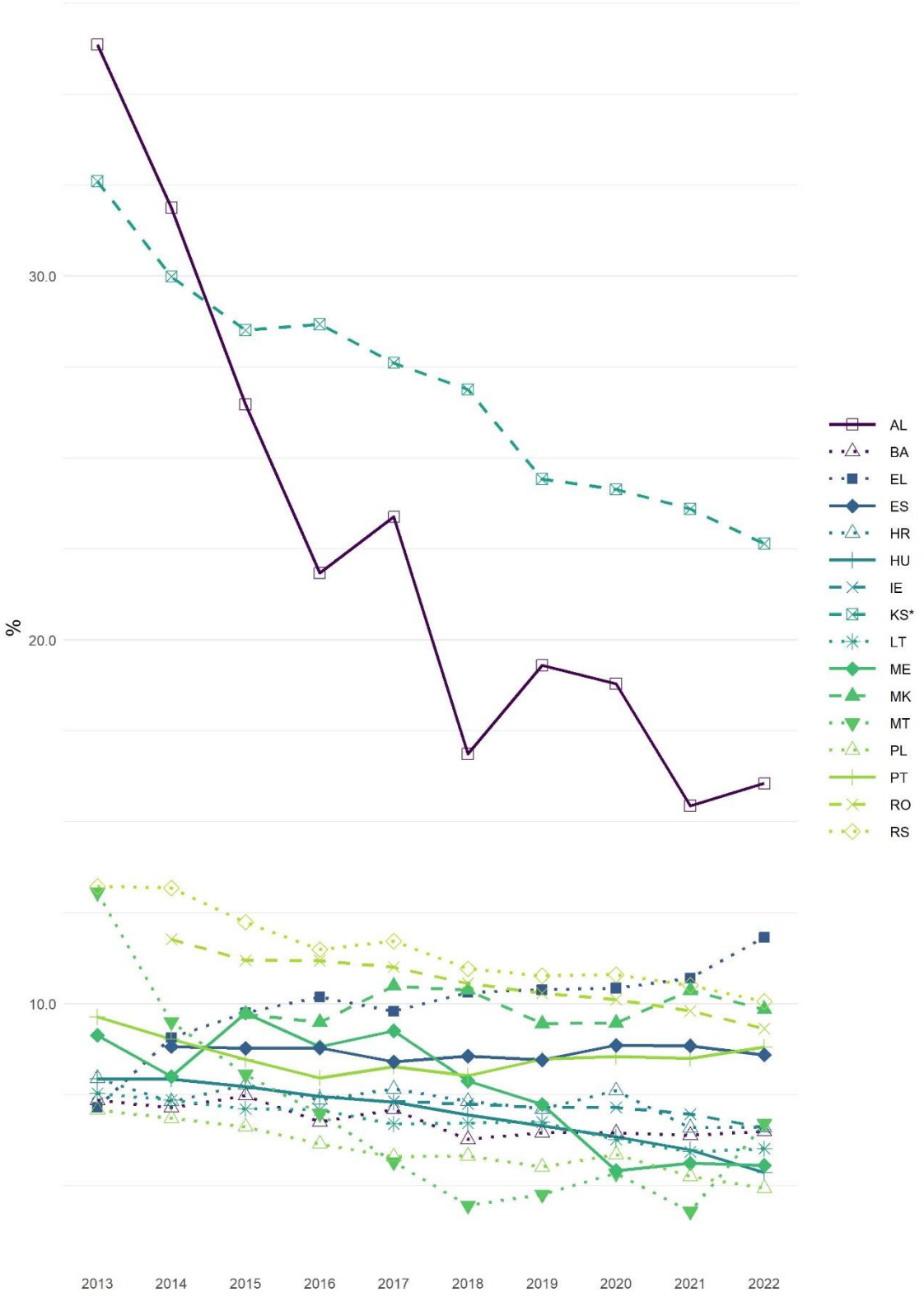


Figure 6 – Total losses as % of injected energy (countries exceeding 7% in at least one of the years data was obtained for)

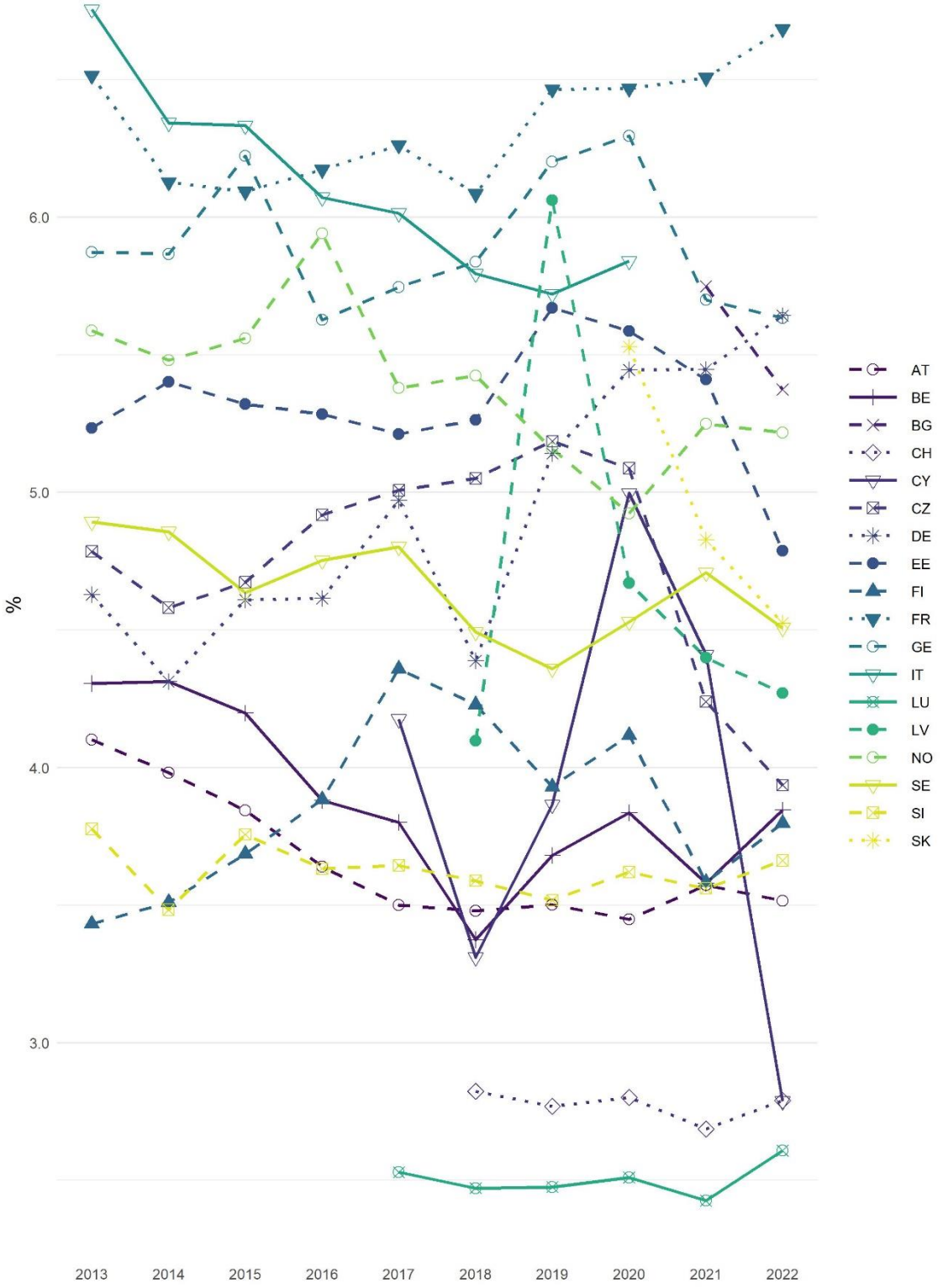


Figure 7 – Total losses as % of injected energy (countries not exceeding 7% in any of the years data was obtained for)

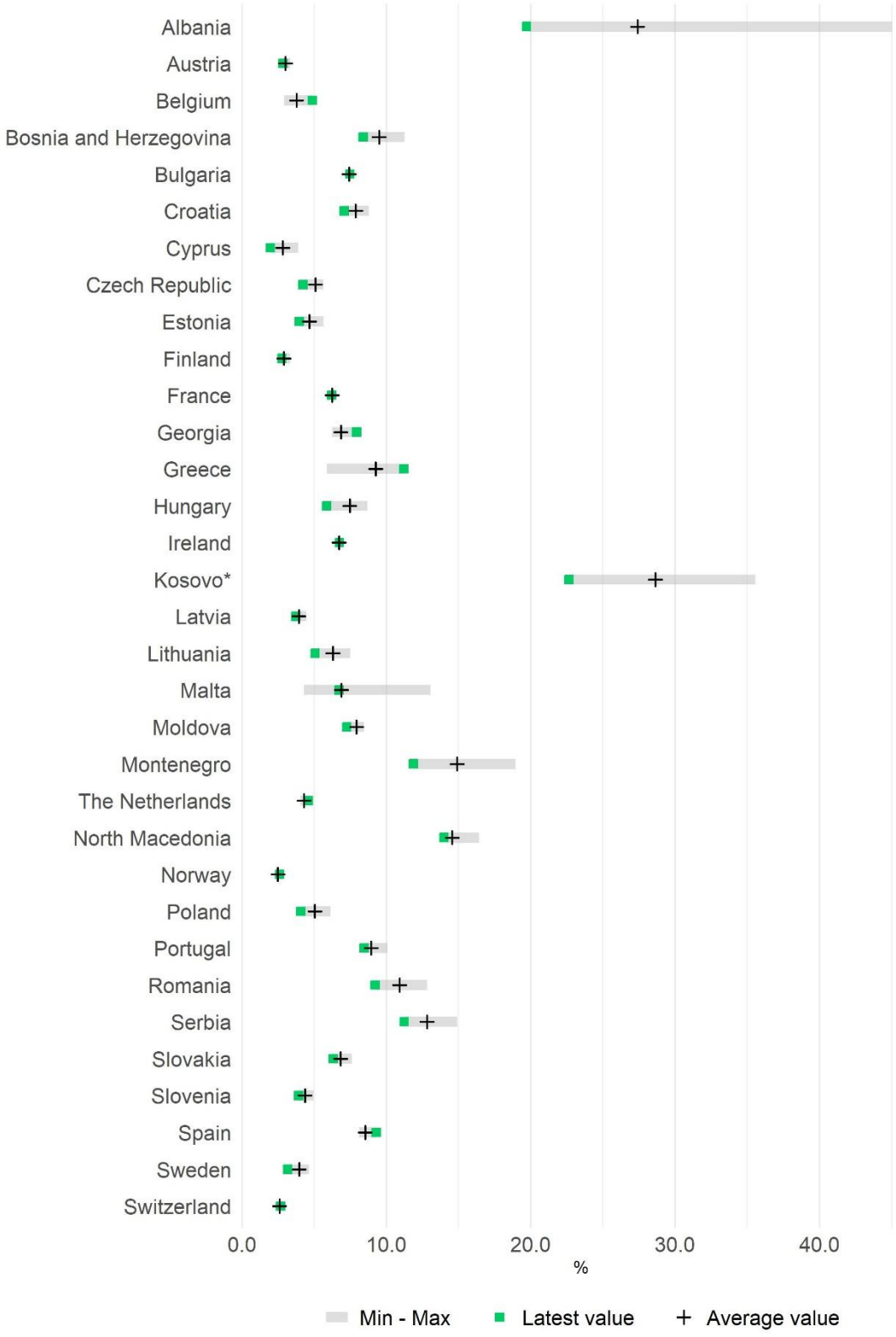


Figure 8 – Distribution losses as % of injected energy

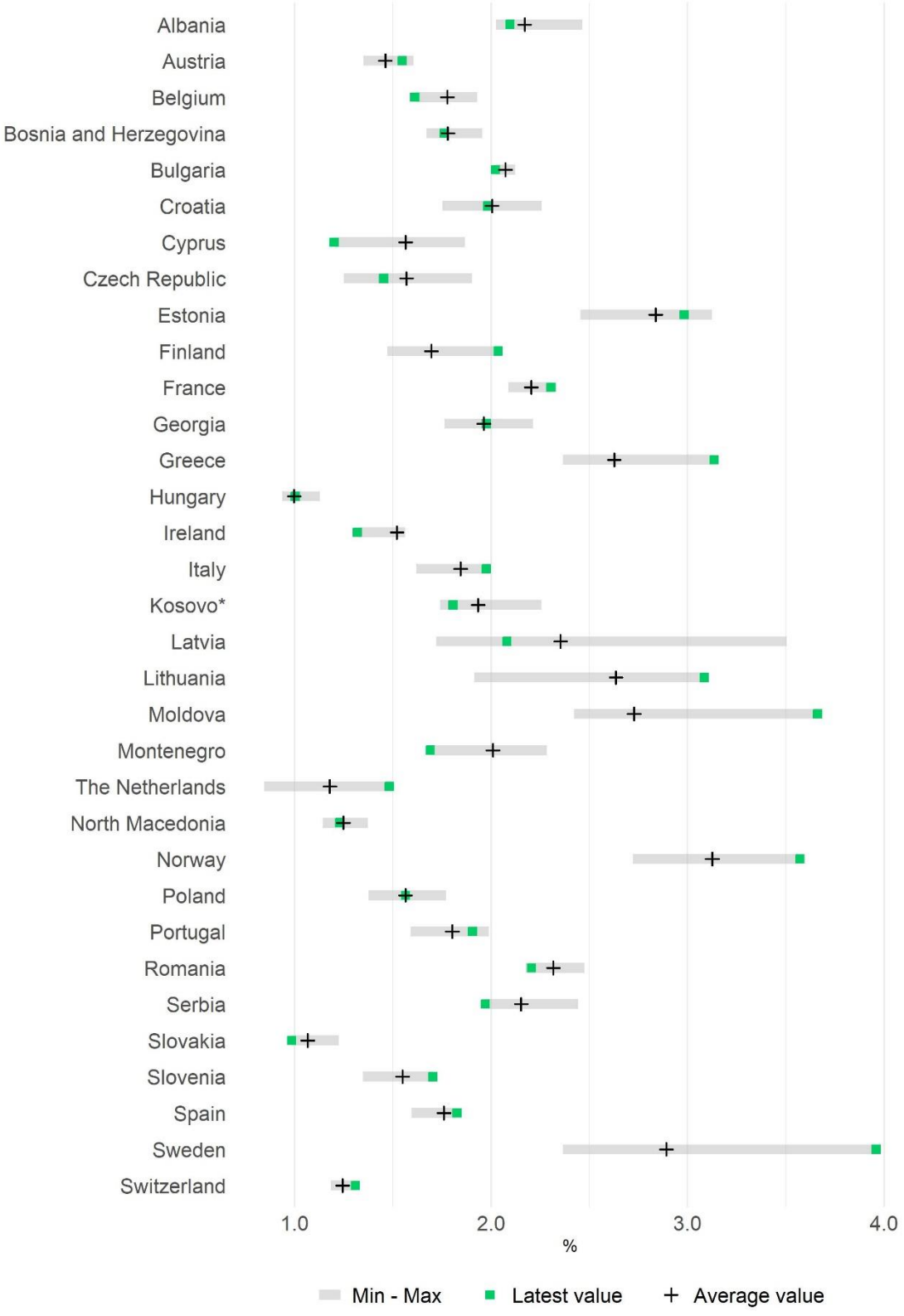


Figure 9 – Transmission losses as % of injected energy

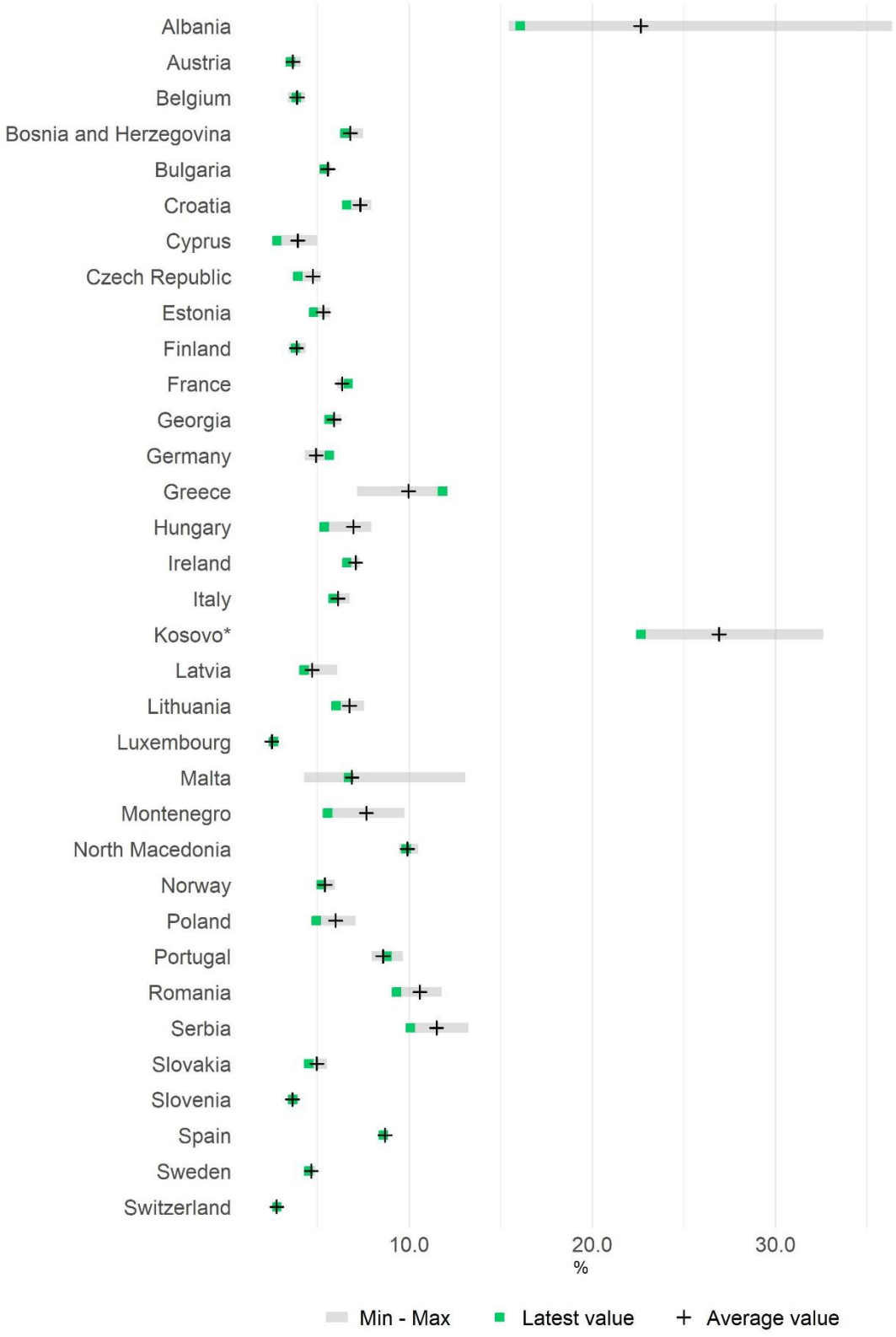


Figure 10 – Total losses as % of injected energy

2.4 Additional analysis

In addition to questions explicitly dealing with power losses, the questionnaire for this report included questions about the network length, the number of metering points and revenues in each country's distribution system. A basic analysis was performed investigating the relationship between losses in distribution and these additional parameters.

Figure 11 and Figure 12 represent the 2022 distribution losses in MWh in relation to some normalized measure of size, such as the network length or the number of metering points in distribution. Without normalising, longer lines would typically result in higher technical losses as energy would have to cover greater distance. Similarly, the higher number of metering points would indicate a higher number of customers which would also add up to higher losses, at least in absolute terms. However, looking into distribution losses divided by another variable, differences between countries are not as striking in most cases.

In a few cases, values from 2021 were used due to unavailability of data for 2022. This was done for Bosnia and Herzegovina and Switzerland in Figure 11 and Figure 12 and for Denmark in Figure 11.

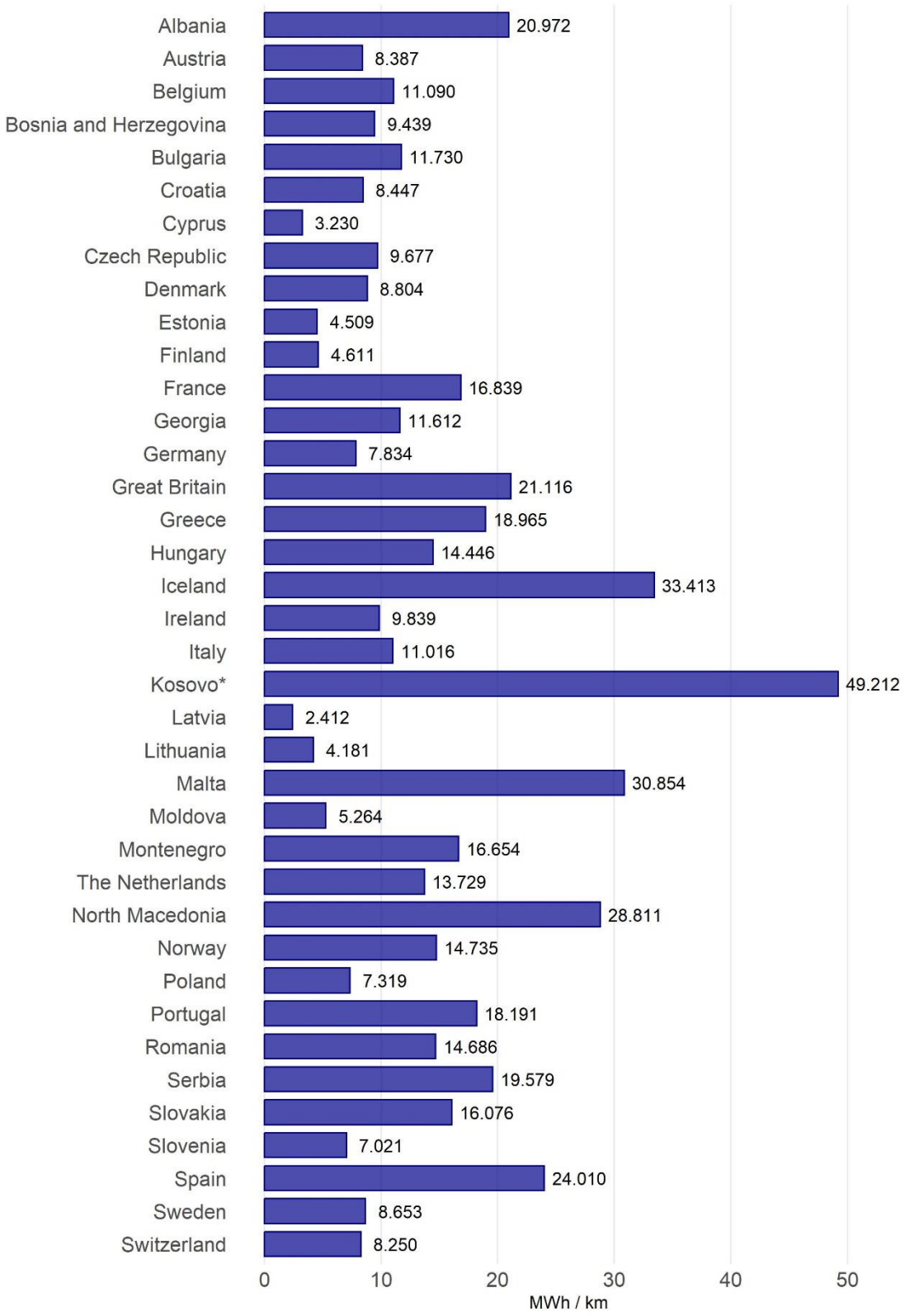


Figure 11 – Distribution losses per kilometre of distribution lines in 2022[12]

[12] The latest values from Bosnia and Herzegovina, Denmark, and Switzerland are for the year 2021.

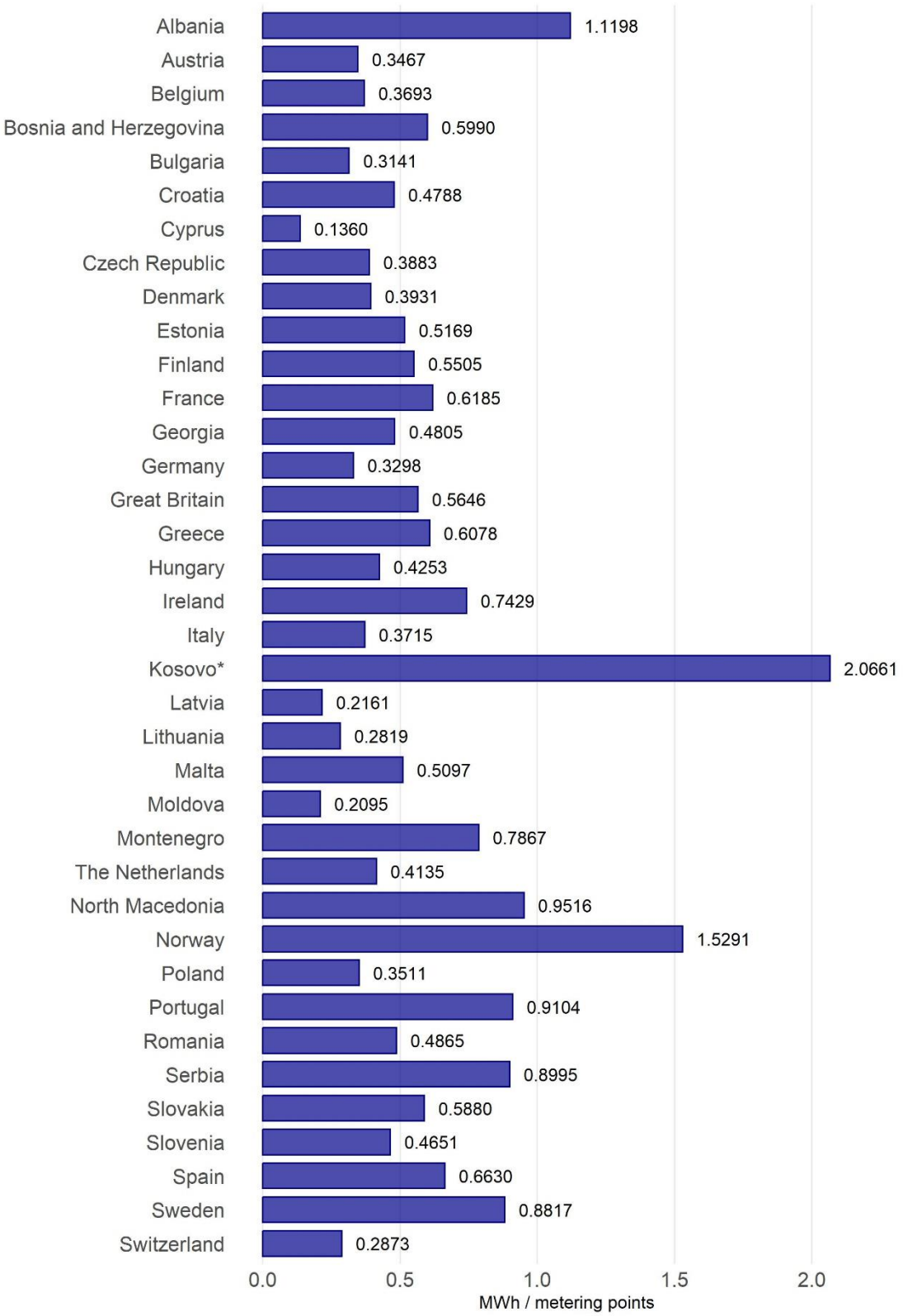


Figure 12 – Distribution losses per number of metering points in distribution in 2022[13]

[13] The latest values from Bosnia and Herzegovina and Switzerland are for the year 2021.

As a next step, a graphic presentation shows distribution losses (in %) as a function of revenues per kilometre (km) of lines in distribution networks (see Figure 13 and Figure 14). These two figures use a different number of observations: the first one uses all observations across all years and the second one only the most current observation available for each participating country. This might help to identify recent developments without using statistical measures. As already mentioned, the goal was to normalise the revenues for easier comparison among countries in order to assess whether the system operators with higher revenue invest in more efficient technology that results in lower power losses. A negative correlation coefficient represented by the negative slope reveals that losses in distribution are indeed lower in countries with higher DSO revenue per km.

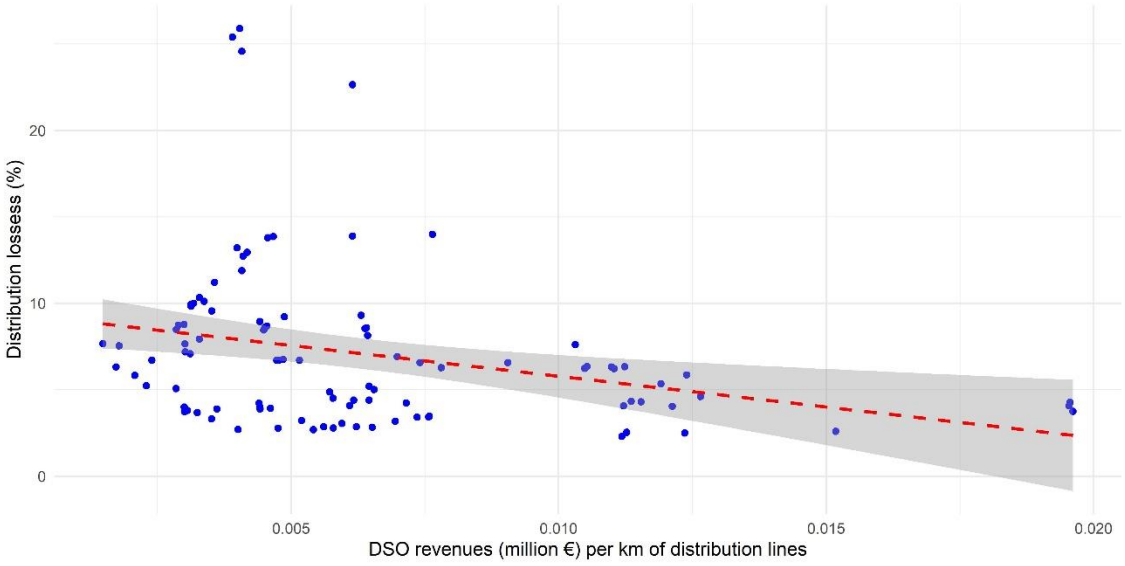


Figure 13 – Distribution losses (%) as a function of revenues per kilometre of lines in distribution (all years)

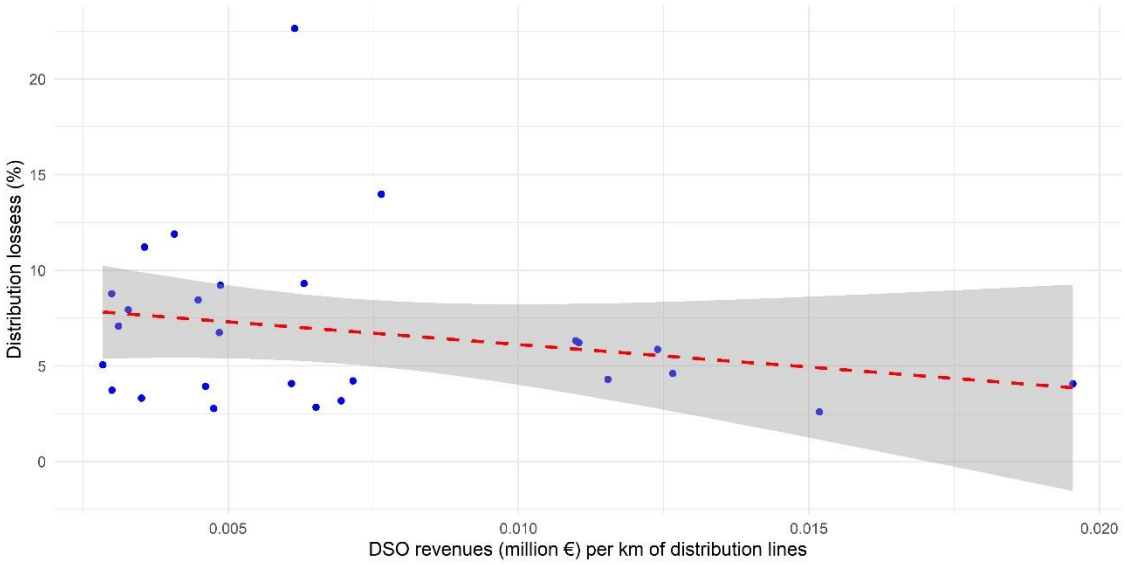


Figure 14 – Distribution losses (%) as a function of revenues per kilometre of lines in distribution (latest year)

The following two figures show distribution losses (%) as a function of kilometres per metering point in distribution networks (see Figure 15 and Figure 16). Lower distance per metering point represents the countries with higher population density and vice versa. The negative slope of the regression line indicates that countries with lower population density have lower distribution losses even though longer distances between metering points result in higher losses in MWh. It is important to keep in mind that non-technical losses probably have higher share of total losses in countries with higher population density than in those where distances between customers are longer. Since technical losses are proportional to conductor resistance, longer distances between customers (higher total conductor resistance) would result in technical losses having a more prominent share of total losses.

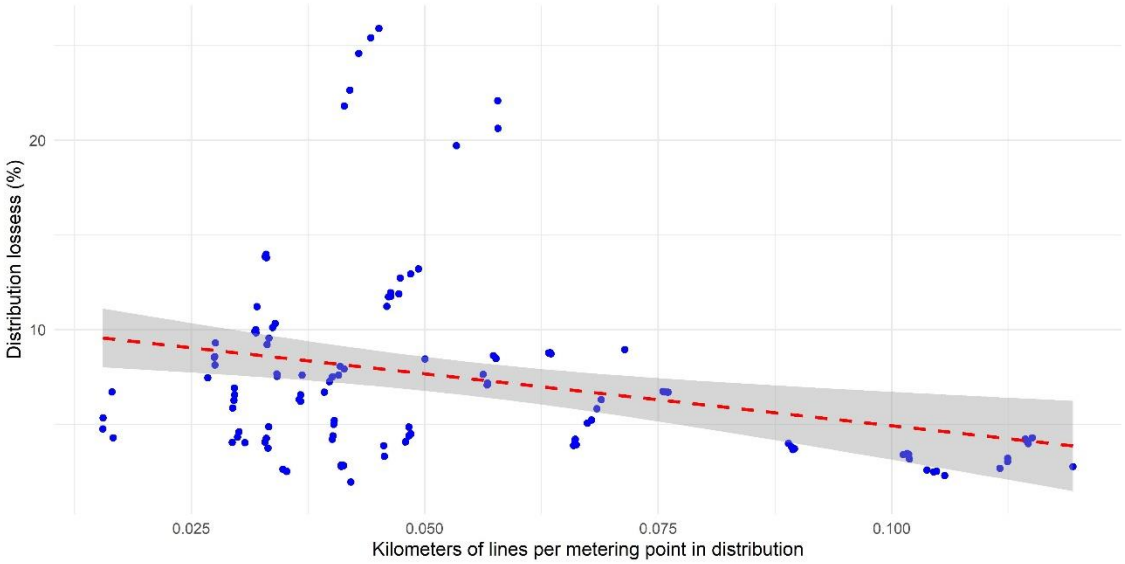


Figure 15 – Distribution losses (%) as a function of kilometre per metering point in distribution (all years)

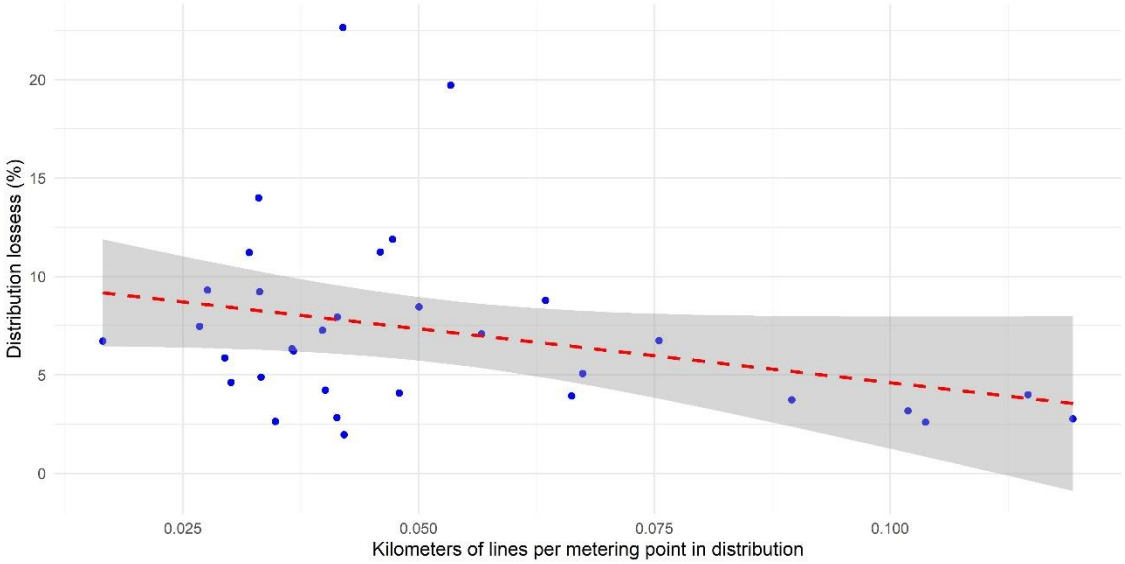


Figure 16 – Distribution losses (%) as a function of kilometre per metering point in distribution (latest year)

2.5 Procurement of losses

Procurement of losses or acquisition of energy necessary to cover power losses is an important element of electrical grid's operation. The provisions of Electricity Market Directive (2019/944/EC)[14] [7] oblige electricity system operators to procure the energy they use to cover power losses according to transparent, non-discriminatory and market-based procedures whenever they have such a function. Consequently, in most European countries system operators are responsible for procurement of losses in their respective grids. There are only a few exceptions to this, most notably Cyprus, Great Britain, Ireland, Portugal and Spain, where suppliers are tasked with procurement of energy to cover losses. In Belgium, system operators do it in their grids (in both distribution and transmission), but losses in transmission are additionally procured by a BRP.

Practices regarding procurement of losses in different countries are presented in Table 5. Some countries may use a mixture of practices and are consequently listed multiple times.

Option	No. of responses	Countries
System operator (DSO and/or TSO)	(33)	AL, AT, BA, BE[15], CH, CZ, DE, DK, EE, EL, FI, FR, GE, HR, HU[16], IS, KS*, LT, LU, LV, MD, ME, MK, MT, NL, NO, PL, RO, RS, SE, SI, SK, UA
Supplier	(5)	CY, ES, GB, IE, PT
Independent System Operator (ISO)	(1)	BA[17]
BRP	(1)	BE[18]

Table 5 – Parties responsible for procurement of energy to cover losses

To the survey question if there have been changes in the methodology since the year 2020, most of the respondents answered there have not been any changes in methodology. For these countries it is assumed that their responses would be the same as those submitted for the 2nd CEER Report on Power Losses. However, nine countries submitted an answer suggesting that there have been at least some changes in the methodology of procurement since the year 2020. In this chapter, procurement methodologies for the countries with significant changes in their methodologies have been revisited.

[14] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU, Official Journal of the European Union, June 2019, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32019L0944

[15] On distribution level

[16] Both TSO and DSOs have a legal authorization to sell the overbought electricity

[17] ISO is responsible for procurement of losses on transmission level and DSO on distribution level.

[18] On transmission level

In Bosnia and Herzegovina, energy to cover losses is procured in two different ways. On the transmission level losses are procured on the market, while on the distribution level losses are included in the network tariff. The current methodology for the transmission level took place in 2020. Until 2020 each BRP was responsible for their own losses, which they covered themselves. Since the TSO introduced a new approach, the system operator has been responsible for market procurement.

The Swiss TSO Swissgrid is responsible for procuring sufficient ancillary services (of which power losses are part of) including the energy to compensate for transmission losses. The TSO's procurement strategy is organised via long-term (yearly, quarterly, monthly) tenders and short-term spot markets (Day Ahead and Intraday). On distribution level, each DSO is responsible for quantifying and compensating active power losses in its own network. This means that DSOs' procurement strategies for power losses depend on each individual DSO, and they are usually part of their procurement strategy for electricity in general and not necessarily distinct for power losses as such. It seems that especially from 2021 onward, the DSOs adapted their own strategies or methodologies to procure power losses due to the surge of electricity prices to guarantee the security of supply.

In the Czech Republic, network operators procure the energy and there is a methodology of determination for the maximum acceptable price of electricity for covering the losses. The NRA Energy Regulatory Office (ERU/ERO) has approved the Price Control Principles for the fifth regulatory period taking place from January 2021 to December 2025. According to the Price Control Principles, the costs of procuring electrical energy for covering the planned loss profile are determined on the basis of the costs of electricity bought in electricity futures and electricity forwards and the costs of electricity bought at spot markets when it comes to the transmission system. For the distribution system, DSOs use the day-ahead market, and they also must buy electric energy in advance in yearly, quarterly and monthly futures. In addition to the costs mentioned, DSOs incur extra costs caused by the differences between the predicted and actual quantities of losses.[19] [8]

In Greece, the cost of energy to cover transmission and distribution network losses is borne by suppliers and ultimately passed to their customers through a competitive tariff. Regarding the transmission level, according to the Greek Market Codes, the energy to cover losses is procured by the TSO in the day-ahead and intraday markets. Before November 2020, the cost of transmission losses was borne by generators and importers by adjusting (reducing) their position to implicitly account for transmission losses corresponding to their bids to inject electric energy into the system. From November 2020, transmission losses are procured by the TSO. The TSO may also procure the energy for losses in the forward market or through bilateral agreements following an auction procedure. The TSO is also subject to imbalance costs related to the losses. The total cost for the TSO (related to the losses) is passed to supplier through uplift charges and at the end to their customers through the competitive tariff. Regarding the distribution level, losses that correspond to suppliers' bids on the wholesale market are added to the energy quantities allocated to them at market settlement. At initial settlement stages, this is done through loss coefficients. At final settlement, any difference that remains between measured offtakes (including corresponding losses calculated using loss coefficients) and measured injections is allocated to suppliers in proportion to their measured offtakes.

[19] The methodologies are described in detail in the Price Control Principles document: ERU/ERO, 'Price Control Principles for the 2021-2025 Regulatory Period in the Electricity and Gas Industries and for the Market Operator's Activities in the Electricity and Gas Industries, and for Mandatory Buyers', https://www.eru.cz/sites/default/files/obsah/prilohy/price-control-principles-2021-2025_1.pdf.

In Luxembourg, changes will be evaluated during 2024. Given the rise in prices and the impact of this cost on network tariffs, the TSO is considering selecting a portfolio manager, for example for a period of three years, who will then buy the required quantities on the market through more numerous transactions spread out over time. If proven relevant, the TSO would then commission a consultant to prepare a document that could later be used as a specification for the selection of the portfolio manager. Currently, the TSO and the DSOs purchase power losses from a third party.

In Slovakia, electricity to cover losses in TSO and/or for TSO's own consumption is purchased in tenders, which can be implemented in the following time horizons: a) long-term purchase (annual) - electricity is usually purchased for a period of one year. The subject of the demand is the total required amount of electricity for the relevant period. TSO reserves the right, if necessary, to announce a public procurement with a different announcement date; b) medium-term purchase - electricity is purchased for more than one calendar week and less than one calendar year; c) short-term purchase (daily) - electricity is purchased for individual business hours of the following day in the form of a selection procedure in TSO, or on the short-term electricity market. With the latest amendment of Slovak legislation (dated October 2018), DSO is not responsible for obligatory purchase of electricity produced by RES or highly efficient combined heat and power (CHP) since January 2020.

2.6 Regulatory treatment of losses

There are multiple ways to address the question of the regulatory approach to power losses. Since incentive-based regulation is typically implemented for European DSOs, the regulatory choice would be to decide how to incentivize system operators to reduce their losses and whether these incentives are reasonable and beneficial.

The incentives aim to enable NRAs to ensure that TSOs and DSOs implement all economically efficient operational and investment decisions aimed at limiting or reducing the volume of power losses and the cost of energy necessary to cover them. However, incentives must be efficient meaning that incentives should set adequate targets for a timeframe relevant to the matter. This is because inefficient incentives could lead to inefficient operational or investment decisions in addition to either a degradation of system operators' tariff income or undue gains if the targets are set at too high a level or if targets are set at too low a level respectively.

Answers to the CEER questionnaire show that 27 responding countries have implemented at least some type of incentive (in some cases indirect) to reduce losses on distribution level, as illustrated in Table 6. There is an increase in the number of countries using incentives, which was 20 in the 2nd CEER Report on Power Losses, although not all of them focus directly on losses.

Option	No. of responses	Countries
Yes	(27)	AT, BE[20], CH, DE, DK, EL, ES, FR, GB, GE, HR, HU, IT, KS*, LT, MD, ME, MK, NL, NO, PT, RO, RS, SE, SI, SK, UA
No	(7)	AL, BE[21], CY, CZ, LU, LV, PL

Table 6 – Regulatory incentives to reduce losses in distribution

The interpretation of some responses was not always straightforward as some incentives do not specifically address power losses. For example, Austria does not use incentives directly aimed at reducing losses, but there is an incentive to reduce the overall cost at the distribution level which losses are part of. In Norway, the cost of losses is included in an efficiency analysis (a benchmarking model) where all DSOs are evaluated. The cost of losses is treated similarly to capital costs and operation and maintenance costs. In this model, the DSOs will always have an incentive to reduce the total cost (including the costs related to power losses). DSOs with relatively high efficiency are rewarded by being able to achieve a higher rate of return on invested capital. The NRA of Serbia determines (estimates) the acceptable level of losses for DSO which is then approved through tariff calculation.

Both the Flemish and the Walloon regions of Belgium use incentives for power losses. In the Flemish region, a revenue cap is used for endogenous costs for net losses. In turn, the Walloon regulatory body sets an authorized maximum and minimum price for power purchase in order to cover losses each year. If the purchase price is within the range (between the minimum and the maximum price) of the tariff methodology, the difference between the budgeted cost and the actual cost constitutes a regulatory balance payable exclusively by consumers. If the purchase price is higher than the maximum price, part of the difference between the budgeted cost and the actual cost is a regulatory balance payable by consumers and the other part is a penalty payable by the DSO. On the other hand, if the purchase price is lower than the minimum price (meaning the DSO was efficient), part of the difference between the budgeted cost and the actual cost is a regulatory balance payable by consumers and the other part is a bonus in favour of the DSO. The Brussels region has no incentives for power losses.

As stated above, some countries may have answered that they have an incentive to reduce power losses even if there is no direct regulatory incentive. For example, in Switzerland there are three indirect regulatory incentives that might help to control power losses in the long run:

a) the "Cost+" regulation applied in Switzerland to electricity network infrastructure, which provides for a certain incentive to invest in both TSO's and DSO's network through the weighted average cost of capital (WACC): 3.83% from 2018-2023; 4.13% in 2024;
b) Energy Law: Public tenders can be launched at Federal level for supporting energy efficiency measures, including for reducing conversion losses (transformers) in electric power facilities for generation and distribution of electricity (this specific support measure is limited until 31.12.2030);

[20] Flemish region and the Walloon region

[21] Brussels region

c) digitalization of electric network operation may also contribute to contain or reduce power losses to some extent.

The above-mentioned incentives are also linked to expectations of technological progress and efficiency investment in the Swiss electricity networks.

In France, there is an incentive for both the price and the volume of losses. A reference volume is set using historical losses rates and the expected loss reduction due to SM deployment. The reference is based on price per kWh, itself based on an energy procurement strategy defined by the NRA for the DSOs and the TSO.

Similarly to the 2nd CEER Report on Power Losses, incentives in transmission are not implemented in as many countries as incentives in distribution are (Table 7). This is probably due to the fact that losses in transmission are mostly technical and therefore more difficult to reduce.

Option	No. of responses	Countries
Yes	(18)	BE, CH, DE, FR, GE, HR, HU, LT, ME, MK, NL, NO, RO, RS, SE, SI, SK, UA
No	(13)	AT, CY, CZ, EL, ES, GB, IT, KS*, LU, LV, MD, PL, PT

Table 7 – Regulatory incentives to reduce losses in transmission

Some countries use similar incentives to reduce losses in transmission and distribution grids. Sweden and Slovakia are two examples.

In some countries, the NRA takes part in incentivizing reduction of power losses ex-ante. In North Macedonia, the NRA approves a plan for decreasing the losses in the transmission system and afterwards, in accordance with this plan, calculates the cost that should be taken into consideration when calculating the maximum allowed revenue. Serbia uses the same methodology for transmission as they do for distribution losses.

As was the case in the 2nd CEER Report on Power Losses, most countries responded that they do not require system operators to consider their capitalized value of losses when investing in network components. However, 12 respondents (Albania, Croatia, France, Great Britain, Ireland, Italy, Latvia, Norway, Portugal, Romania, Slovakia and Spain) do have such provisions in place which is three more than in the previous report.

Two examples among the countries where there are no requirements to consider capitalized value of losses in their investments are Belgium and Switzerland. The TSO of Belgium takes the value of losses into account when doing a comparison between different investment options. Network operators in Switzerland are not required to consider the value of losses or expected reduction of losses in their investment decisions. However, they can evaluate them as operational costs for foreseen investment projects to help decide on the best option while taking short-term and long-term financial and technical aspects into account. The Swiss NRA ElCom does not have the final say on such investment decisions, though.

On the other hand, two examples among the countries whose network operators are required to consider capitalized value of losses in their investments are Ireland and Spain. Ireland

accounts for losses in the appraisal of new grid investments. The annual losses (in MWh) are estimated from power flow simulations, then monetized using the average system marginal price and finally capitalized by reflecting a present value of those losses (savings) attributed to the investment. Losses (savings) are also accounted for in socio-economic welfare calculations that determine the changes in production costs for competing investment. In Spain, a cost-benefit analysis is performed when planning investments in transmission network. Their system operator follows the general principles of cost-benefit methodology developed by the European Network of Transmission System Operators for Electricity (ENTSO-E) for the European Commission adapted to the particularities of the Spanish electrical system.

Some countries mentioned that their network operators must take into account the improvement of energy efficiency or optimal development during grid development planning.

Only ten countries reported having a requirement for network operators to provide calculation of the expected reduction in losses from their new investments. These are: Albania, Croatia, Georgia, Ireland, Italy, Kosovo*, Lithuania, Montenegro, Portugal and Romania, although in Italy, this only applies to transmission but not to distribution. In Croatia, calculation of losses is a part of a cost-benefit analysis for projects valued more than 5.3 million euros when it comes to their TSO. In Kosovo*, calculation and an expected reduction of losses by an investment is required for every year and regulatory period.

France has no such requirements, but their network operators have to communicate the reference price used for calculating the price for losses. In Estonia, this depends on the investment and on the current volume of losses of a DSO. If the purpose of an investment is to reduce losses, then the calculations of the expected reduction would be required, but if the purpose is to increase network reliability (for example, replacing overhead lines with underground cables and DSO's losses are at a level comparable to other DSOs), then no calculations are required. Great Britain answered the question with a "no", even though the cost-benefit analysis should consider the cost reduction gained from decisions if the losses are a driver for the works. Some countries may have answered with a "no" since there is no obligation in their law, but the network operators still provide the information within the network development plans.

Non-technical losses are included in published losses and in regulation of losses in the vast majority of countries (31). In Belgium and Cyprus, this applies only to distribution, but not to transmission. Estonia, Italy, Norway and Portugal publish their total losses which include both technical and non-technical losses.

Only three countries – Austria, Montenegro and Slovakia - have stated that there is a legal obligation to separately indicate the cost of losses on electricity bills and all three indicate the cost of losses as a cost of unit of energy on invoices. In addition, the energy price paid by consumers in Italy can be expressed with or without the losses. Depending on the case, losses can be expressed on the bill in different ways that do not change the total amount to be paid.

Differences in prices of losses for different network users depending on location or any other factor were reported by 15 countries. This typically depends on voltage level or location of a grid user. Norway reported that the differences depend on price areas which are determined based on several factors, the most important of which are bottlenecks, where there is limited ability to move electricity from one area to another in the transmission network.

3 Experiences with treatment of losses

3.1 Case study: Portuguese mechanism to encourage the reduction of losses in distribution networks

The incentive mechanism for reducing losses in distribution networks in mainland Portugal is established in article 143.º of the electricity sector Tariffs Code, approved by Regulation no. 828/2023, published in the Diário da República, 2nd series, of 28 July[22] [9]. This incentive mechanism is only applied to E-Redes which is the main DSO in Portugal and serves about 99% of customers. The mechanism operates a posteriori with a lag of two years (the value to be considered in tariffs in year t takes into account the losses occurred in year t-2).

Until 2021, the incentive mechanism consisted of only one component, based on the annual energy balance that allows rewards for the performance of E-Redes if it reduces losses in its network below a reference value established by ERSE or penalties if the value of losses is greater than this reference value.

For the 2022-2025 regulatory period, this incentive mechanism is made up of three components, one of which is directly linked to the results of the annual energy balance (component 1), while the other two are linked to the results achieved with the actions to mitigate illicit consumption carried out by E-Redes (components 2 and 3).

The incentive to reduce losses in the distribution network (PP_{t-2}) is calculated as follows:

$$PP_{t-2} = PP_{1,\,t-2} + PP_{2,\,t-2} + PP_{3,\,t-2}$$

where:

- $PP_{1,\,t-2}$: Component 1, related to the annual balance of losses, expressed in Euro;
- $PP_{2,\,t-2}$: Component 2, related to the amounts returned to the electric system, expressed in Euro;
- $PP_{3,\,t-2}$: Component 3, related to an incentive to reinforce the mitigation of illicit consumption, expressed in Euro.

3.1.1 Component 1

Component 1 of the incentive mechanism for reducing losses in distribution networks is based on the annual energy balance with the percentage values of losses referring to the energy measured at the input and corresponds to a symmetrical mechanism with the value indexed to the unit value of energy on the market and which includes a dead band zone, as illustrated in Figure 17.

[22] https://www.erse.pt/media/00vlfhng/regulamento-828_2023.pdf.

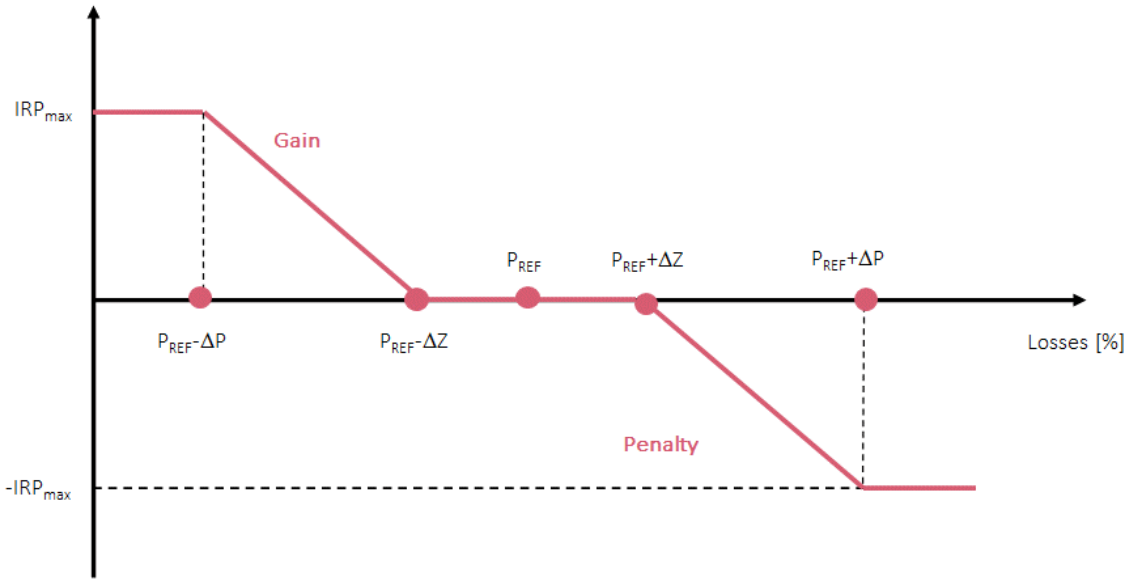


Figure 17 – Component 1 of the incentive mechanism for the 2022-2025 regulatory period

Component 1 (PP_1) depends on the value of the losses, P_{t-2} in the following terms:

When: $P_{t-2} < P_{REF,t-2} - \Delta Z$

$$PP_{1,t-2} = \text{Min}\{IRP_{max,t-2}, [(P_{REF,t-2} - \Delta Z) - P_{t-2}] \times E^{D}_{t-2} \times V_{p1,t-2}\}$$

When: $P_{t-2} > P_{REF,t-2} + \Delta Z$

$$PP_{1,t-2} = \text{Max}\{IRP_{min,t-2}, [(P_{REF,t-2} + \Delta Z) - P] \times E^{D}_{t-2} \times V_{p1,t-2}\}$$

When: $P_{REF,t-2} - \Delta Z \leq P_{t-2} \leq P_{REF,t-2} + \Delta Z$

$$PP_{1,t-2} = 0$$

in which:

$$IRP_{max,t-2} = -IRP_{min,t-2} = (\Delta P - \Delta Z) \times E^{D}_{t-2} \times V_{p1,t-2}$$

where:

$PP_{1,t-2}$	Incentive to reduce losses in the distribution network for a given year, expressed in Euro;
$IRP_{max,t-2}$	Maximum reward value as an incentive to reduce losses for a given year, expressed in Euro;
$IRP_{min,t-2}$	Maximum penalty value as an incentive to reduce losses for a given year, expressed in Euro;
$V_{p1,t-2}$	Valorisation of losses in the distribution network for a given year, expressed in Euro/kWh, to be defined by Portuguese NRA;

$P_{REF,t-2}$ Reference value of losses in the distribution network for a given year, expressed in %;

P_{t-2} Level of losses in a given year, computed by the quotient between losses and active energy measured at the entrance to the distribution network, expressed in %;

E^{D}_{t-2} Total electrical energy measured at the entrance to the distribution network in a given year, expressed in kWh;

ΔZ Dead band variation, expressed in %;

ΔP Maximum range variation, expressed in %, for applying the loss reduction incentive mechanism that ensures a maximum value of reward or penalty associated with this incentive.

Component 1 parameters in 2022

For the purposes of component 1 of the incentive and for the entire 2022 - 2025 regulatory period, a daily market energy price of 0.05 Euro/kWh was assumed. Table 8 summarises the parameters of component 1 of the incentive to reduce losses in 2022.

Parameters	Values
Value of reference losses $P_{REF,\ 2022}$ (%)	8.50
Value of ΔZ (%)	0.75
Value of ΔP (%)	2.5
Valorisation of losses $V_{P1,\ 2022}$ (Euros/kWh)	0.025
Maximum premium or penalty $IRP_{max,\ 2022}$=-$IRP_{min,\ 2022}$ (Euros)	20,000,000

Table 8 – Parameters for component 1 in 2022

Implementation in 2022 of component 1

In 2022, the value of losses in distribution networks in relation to the energy input was 8.45 %, as shown in Figure 18, which shows the evolution of losses in the distribution networks between 1999 and 2022, in the input reference.

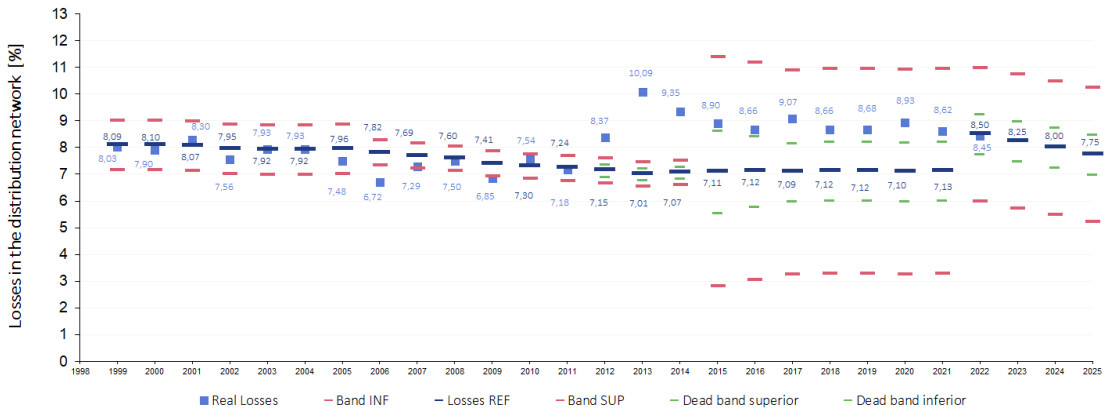


Figure 18 – Evolution of verified losses in distribution networks in the input reference

Since 8.45 % of the losses are verified, this is below the reference losses (8.50 %), but since it is within the dead band (limit 7.75 %), there is no premium for its performance. In these terms, component 1 of the incentive is nil:

$$PP_{1,\,2022} = 0$$

3.1.2 Component 2

Component 2 of the incentive mechanism for reducing losses in distribution networks corresponds to a direct sharing of the results obtained in actions to combat illicit consumption with E-Redes. The amount recovered from these actions (MR) is shared according to the value of a sharing percentage (k), defined for the regulatory period.

Component 2 (PP2) is calculated as follows:

$$PP_{2,\,t-2} = k \times MR$$

where:

- k: Percentage to be defined by the Portuguese NRA;
- MR: Value recovered within the scope of actions to mitigate illicit consumption in a given year, expressed in Euros.

Component 2 parameters in 2022

The sharing percentage (k) defined for the 2022-2025 regulatory period is k = 25 %. According to information from the RND operator, the amount recovered under component 2 in 2022 was 7,082,148 Euro. Since the sharing percentage k = 25%, the premium to be received under component 2 is

$$PP_2 = 0.25 \times 7{,}082{,}148 = 1{,}770{,}537 \text{ Euro}.$$

3.1.3 Component 3

Component 3 of the incentive mechanism for reducing losses in distribution networks corresponds to an additional incentive (premium or penalty) applied to the success of actions to combat illicit consumption. It corresponds to a linear incentive mechanism, limited to a maximum premium or penalty depending on the energy recovered each year, as illustrated in Figure 19.

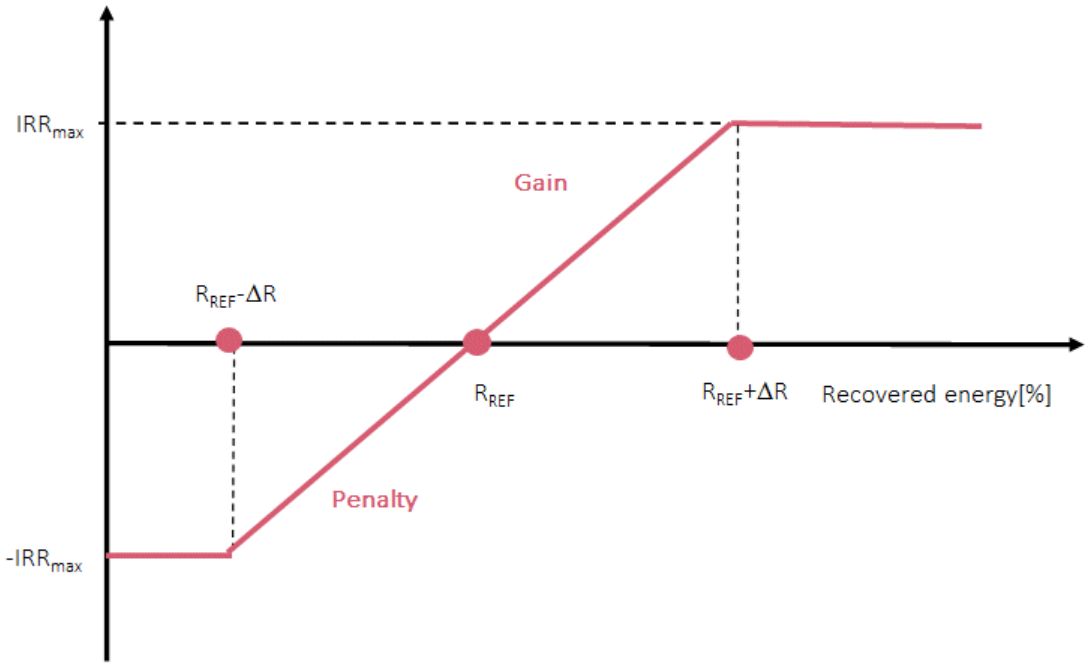


Figure 19 – Component 3 of the incentive mechanism for reducing losses in distribution networks

Component 3 ($PP_{3,\ t-2}$) depends on the value of the recovered energy, R_{t-2}, in the following terms:

When: $R_{t-2} < R_{REF,t-2}$

$$PP_{3,t-2} = Max\left[-IRR_{max,t-2}, \left(R_{t-2}-R_{REF,t-2}\right)\times V_{p3,t-2}\right]$$

When: $R_{t-2} > R_{REF,t-2}$

$$PP_{3,t-2} = Min\left[IRR_{max,t-2}, \left(R_{t-2} - R_{REF,t-2}\right)\times V_{p3,t-2}\right]$$

where:

$$IRR_{max,t-2} = -IRR_{min,t-2} = \Delta R \times V_{p3,t-2}$$

and being:

$PP_{3,t-2}$	Incentive dedicated to mitigating illicit consumption in a given year, expressed in Euro;
$IRR_{max,t-2}$	Maximum reward value as an incentive dedicated to mitigating illicit consumption for a given year, expressed in Euro;
$-IRR_{max,t-2}$	Maximum penalty value as an incentive dedicated to mitigating illicit consumption for a given year, expressed in Euro;
$V_{p3,t-2}$	Unit value of recovered energy in the distribution network for a given year, expressed in Euro/kWh, to be defined by Portuguese NRA;
$R_{REF,t-2}$	Reference value of energy recovered in the distribution network, as a percentage of the estimated illicit consumption, expressed in kWh;

R_{t-2} Energy recovered, computed by the quotient between energy recovered and the estimate of total illicit consumption, expressed in kWh.

Component 3 parameters in 2022

Table 9 summarises the parameters of component 3 of the incentive to reduce losses in the distribution networks in 2022.

Parameters	Values
Reference value $R_{REF,\ 2022}$ (kWh)	120,000,000
Unit value of recovered energy $V_{p3,\ 2022}$ (Euro/kWh)	0.05
Maximum premium or penalty $IRR_{max,\ 2022} = -IRR_{min,\ 2022} = R_{REF,\ 2022} \times V_{p3,\ 2022}$ (Euro)	6,000,000

Table 9 – Parameters for component 3 in 2022

According to information from E-Redes, the energy recovered under component 3 of the incentive totaled 125,817,000 kWh. With $R_{REF,\ 2022}$ = 120,000,000 kWh, and $V_{p3,\ 2022}$ = 0.05 Euro/kWh, the main Portuguese DSO is entitled to a premium of

$$PP_{3,\ 2022} = (125{,}817{,}000 - 120{,}000{,}000) \times 0.05 = 290{,}850 \text{ Euro.}$$

3.1.4 Implementation of the incentive to reduce losses in distribution networks in 2022

Under the terms described above, the application of the incentive to reduce losses in the distribution network for the year 2022 results in a premium of:

$$PP_{2022} = PP_{1,\ 202} + PP_{2,\ 2022} + PP_{3,\ 2022}$$
$$= 0 + 1{,}770{,}537 + 2{,}061{,}387 \text{ Euro.}$$

Figure 20 shows the evolution of the amounts resulting from the application of the incentive mechanism to reduce losses in the distribution networks since 1999, and it should be noted that from 2012 to 2021 there was a penalty for the fact that the value of the actual losses incurred was higher than the limit value of the dead band.

In 2022, as mentioned above, the operator receives a premium of 2.061 million Euros due to the performance of components 2 and 3 of the incentive, given that component 1 had no contribution due to the fact that the value of the losses occurred in the dead band.

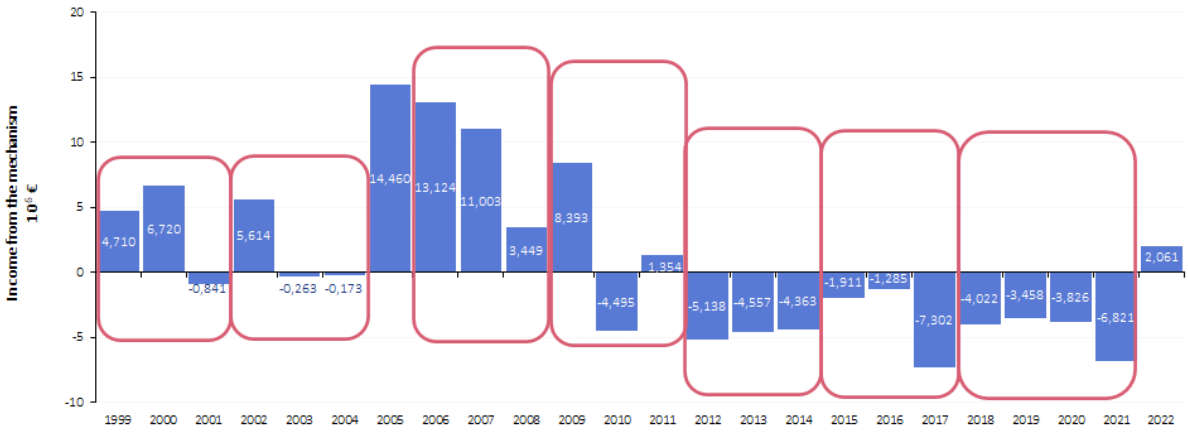


Figure 20 – Evolution of the amounts associated with the application of the incentive mechanism to reduce losses in the distribution networks

3.2 Energy efficiency directive

Energy efficiency is a cornerstone of the European Union's Energy Policy, playing a vital role in meeting the European decarbonization goals and reducing primary energy demands, thereby also strengthening its security of energy supply. The Directive (EU) 2023/1791 (Energy Efficiency Directive) [6], elaborated in the context of the 'Fit for 55' package, has the objective to decrease the Union's final energy consumption by 11.7% compared to 2020 figures. The EED introduces provisions to prioritize energy efficiency across sectors, aiming to address barriers and market failures hindering efficiency in energy supply, transmission, storage, and utilization. By introducing the Energy Efficiency First Principle (EE1P), this directive not only advances energy efficiency but also contributes

> "to the Union being an inclusive, fair and prosperous society with a modern, resource-efficient and competitive economy."[23]

The proposed rules aim to accelerate Member States' energy efficiency efforts by augmenting annual energy savings obligations and reducing energy consumption in public sector buildings.

3.2.1 EED and why it applies to power losses

The reduction of power losses is one of the tools envisaged by the EED in order to improve the overall efficiency of energy networks. Power losses are embedded with the fact that the location of energy production is not the same as that of its consumption. Due to technical, but also non-technical reasons, part of the energy injected by generators into the grid does not reach any final consumers but rather gets 'lost' in the transportation process. Energy losses need to be recovered by system operators, ultimately through network tariffs, which means they contribute to increased costs of energy bills.

In some countries, network losses represent one of the single biggest components of electricity consumption and considering the central role of electricity grid in the energy transition, it is of paramount importance that improvements in this area are taken.

[23] Article 1.1 of Directive (EU) 2023/1791, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AJOL_2023_231_R_0001&qid=1695186598766.

For these reasons the reduction of power losses has been addressed since the first edition of the EED in 2012. Network operators were identified as one of the obliged parties subjected to national energy efficiency obligation schemes, and energy savings achieved in distribution and transmission grids were explicitly included in the amount of energy savings to be reported[24] [3].

Since network operators are regulated entities, role of NRAs has been identified as critical in order to ensure the reduction of power losses, in particular through the setting of incentives and tariffs designed to reach these objectives[25] [3].

The improvement of the efficiency of electricity networks has also been the scope of European Commission's Joint Research Center (JRC) Report[26] [10] published as per Article 15.2(a) of the first revision of the EED in 2018.

3.2.2 New requirements for network operators and NRAs regarding losses

The introduction of the EE1P, that was included as general principle in the scope of 2018 revision of the EED[27] [11], has been one of the main developments of the 2023 EED. The energy efficiency first principle requires to always consider the implications from an energy-saving perspective when making decisions about rules and investments. Energy efficiency, as a central pillar of the energy union policy, should always be promoted together with other policy dimensions.

The EE1P should be taken into consideration by transmission and distribution system operators, especially when developing their network development plans[28] [6]. When evaluating investments and their operational costs, the system operators' contribution to the provision of energy savings should be considered. This would ensure that energy efficiency solutions, including demand-side resources, are assessed effectively by operators. National Regulatory Authorities should also apply the EE1P when approving, verifying or monitoring energy infrastructure projects and when setting network tariffs.

An important obligation addressing transparency and accountancy of power losses is in Article 27.3 of EED. System operators are required to quantify the overall volume of network losses and, where it is technically and financially feasible, optimise networks and improve network efficiency. TSOs and DSOs are expected to report measures implemented as well as the expected energy savings through reduction of network losses to the NRAs. Among the strategies suggested by the EED to reach these objectives are incentive-based regulation and the deployment of smart grids, which have also become eligible for the status of Projects of Common Interest[29] [12].

[24] Article 7.2(c) of Directive 2012/27/EU, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012L0027.

[25] Articles 15.1 and 15.4 of Directive 2012/27/EU, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012L0027.

[26] European Commission: Joint Research Centre, Bompard, E., Serrenho, T. and Bertoldi, P., 'Improving energy efficiency in electricity networks – Addressing network losses & EU regulations under Article 15 (2) (a) of the Energy Efficiency Directive', Publications Office of the European Union, 2020, https://data.europa.eu/doi/10.2760/176745.

[27] Article 1.1 of Directive (EU) 2018/2002, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2002&from=DE.

[28] Article 27.2 of Directive (EU) 2023/1791, https://eur-lex.europa.eu/eli/dir/2023/1791/oj.

[29] Annex II of Regulation (EU) 2022/869, https://eur-lex.europa.eu/eli/reg/2022/869/oj.

NRAs are mandated to include a specific section about the progress achieved in energy efficiency improvements regarding the operation of the gas and electricity infrastructure in their annual report to the Commission and the European Union Agency for the Cooperation of Energy Regulators (ACER)[30] [6]. This assessment should evaluate the overall efficiency of electricity (and gas) infrastructure operation and examining the measures implemented by TSOs and DSOs. Additionally, NRAs could offer recommendations for enhancing energy efficiency, suggesting cost-effective alternatives aimed at diminishing peak loads and reducing overall electricity consumption.

Moreover, there is the provision to encourage the localization of cogeneration plants close to areas of peak demand through reducing the connection and use-of-system charges[31] [6]; this action usually has a beneficial effect on power losses since it generally brings these plants closer to the areas of electricity consumption, favouring the reduction of technical losses.

3.2.3 (Some) potential measures

Both the network operators and NRAs have to cope with the increased responsibility in this transition process towards decarbonisation of energy and economic systems and this can be achieved through regulatory and technical measures.

First, an appropriate regulation could include both mandatory elements and incentives. Among mandatory requirements, the substitution of existing transformers at the end of their technical life with high efficiency ones is vital in order to notably reduce energy losses in power grids. NRAs could also promote actions for the implementation of more flexible local RES, for instance through cost-reflective tariffs or by incentivising digitalisation of the networks to ensure the integration of information and communication technologies. In this regard it is necessary to take into consideration that the different situations characterising CEER Members and Observers might require individual solutions, rather than a general unique regulatory framework to be applied in all of Europe.

In order to further encourage DSOs to act, setting appropriate incentives might be the best option for enhancing energy efficiency. This could entail a bonus for DSOs pushing the implementation of efficiency improvements and penalties for DSOs with non-efficient network. One promising approach could be the inclusion of the cost of losses as part of the revenue cap, i.e. treating losses as any other cost component and considering them as controllable costs, which seems more effective in motivating DSOs to make the effort – in a transparent and verifiable way – to increase their net efficiency. This system is already applied in some countries.

From the technical point of view, there are several measures that help to support the efficiency enhancement. Among those measures,

- the replacement of old transformers by low losses transformers and the corresponding sizing and
- the replacement and sizing of conductors

are crucial and are applied already by many TSOs and DSOs. However, other improvements are still possible and the question of network configuration and the optimal development of the grid are considered key aspects for this purpose.

[30] Article 27.4 of Directive (EU) 2023/1791, https://eur-lex.europa.eu/eli/dir/2023/1791/oj.

[31] Article 27.9 of Directive (EU) 2023/1791, https://eur-lex.europa.eu/eli/dir/2023/1791/oj.

3.3 Smart meters and power losses

3.3.1 Background

It is obvious that smart meters provide more functionality than simply conveying an understanding about the (nearly) real time consumption figures to the consumer. In general, it is assumed that the major benefit of the SM data can be seen in

- a better match of supply and demand, which reduces the costs of generating and distributing energy;
- an improved energy efficiency and a reduction of energy waste;
- helping unexpected power outages to be addressed and resolved faster.

Considering that electricity networks are changing by moving from traditional unidirectional power flows to bi-directional flows, smart meters can help match demand to generation. This may be done through time-of-use tariffs with the goal of making electric energy cheaper when there is an excess of wind or PV generation or more expensive when it is in short supply.

Traditionally, network capacity has been determined based on peak usage. This usage may only reflect energy consumption during a few hours of the year; late afternoon in the middle of winter for instance. Through smart metering, network operators get a better insight into each part of the network allowing them to better plan their investments and manage their infrastructure in response to the requirements of their customers. As a consequence, costly future network reinforcements can be avoided if these energy consumption peaks can be shifted. This is more relevant as energy generation patterns change and become increasingly dependent on RES rather than traditional power stations. In addition, households have the potential to become more independent from electricity grid with increased availability of energy storage and generation.

In a best practice review, UK Power Networks[32] undertook a comparison among European, Canadian, and US network operators to assess their activities[33] [13]. The main focus of that comparison was to increase knowledge about economically feasible ways to reduce losses through utilisation of SM data.

The main findings of that comparison are the following:

- The reduction of non-technical losses appears to be the focus of almost all network operators that implemented the using of SM. There are various causes of non-technical losses ranging from illegal consumption to faulty metering equipment. The potential for a significant reduction may vary but is not irrelevant at all.[34]
- In order to bring about a distinct reduction in non-technical losses, a significant level of SM penetration is key.
- There is an indication that the use of smart meters will lead to a reduction of energy consumption once consumers are more aware of their usage patterns.[35] As SM provide close to real-time feedback on energy consumption, they enable consumers to better manage their use, save energy and lower their bill by adapting their energy usage to

[32] Distribution network operator (DNO) maintaining the electricity networks across London, the South East and East of England.

[33] UK Power Networks, 'Smart Meters and Losses: Best Practice Review', https://losses.ukpowernetworks.co.uk/losses/static/pdfs/smart-meters-and-losses-best-practice-review.bbbb974.pdf.

[34] The greatest success was seen in Canada, where the network operator (BC Hydro) reported a reduction of non-technical losses of almost 50% within a three-year period.

[35] Although smart meters could consume more energy than the older meters they replace, this effect is likely to be overcompensated by the reduction of energy consumption by customers.

different energy prices throughout the day. This reduction in consumption will also lead to a reduction in network losses.[36]

- It is becoming more common to accompany the dissemination of smart meters by implementing Demand-Side Response (DSR), i.e. tariff schemes that financially incentivize customers to lower or shift their electricity use at peak times and that help to manage the load and voltage profiles on an electricity network. The idea is to encourage customers to reduce load, rather than relying on tariff increases to discourage consumption.
- Smart meter data can help network operators to manage network voltages to reduce losses.
- Smart meters will notify network operators when there is an interruption of electricity supply, which can help them improve service. Instead of waiting for the first customer to notify them, network operators will be able to respond once the first SM outage alert is received. Smart meters will also notify network operators where and when the quality of supply, such as voltage level, falls outside predefined levels helping them better understand the quality of electricity supply to their customers.

3.3.2 Data on Smart Meters and Power Losses

In addition to questions explicitly dealing with power losses, the CEER questionnaire also included questions about the number of metering points and the number of smart meters in distribution networks for the years 2019 to 2022. From these two numbers, the share of SM was calculated and the relationship between this number and the percentage of distribution losses was analysed.

Figure 21 shows that the share of smart meters in distribution networks in 2022[37] varies across the participating countries data was available for. A geographic split can be observed, with northern Europe and some countries in southern Europe showing relatively high adoption rates, often nearing full roll-out. In contrast, central and eastern European countries exhibit significantly lower shares of smart meters, typically not exceeding 50%, but there are also exceptions to this (Austria and Slovenia). Fact sheets in the annex list the calculated Smart Meter penetration rate for every country that provided their numbers.

[36] A study commissioned by UK Power Networks ('Strategies for reducing losses in distribution networks', 2018) mentions that a 2.8% reduction in energy consumption by their customers would reduce network losses on the lower levels by 5.5%. https://losses.ukpowernetworks.co.uk/losses/static/pdfs/strategies-for-reducing-losses-in-distribution-networks.d1b2a6f.pdf This information comes from the 2014 Impact Assessment by the former Department of Energy and Climate Change (DECC) of the United Kingdom. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/276656/smart_meter_roll_out_for_the_domestic_and_small_and_medium_and_non_domestic_sectors.pdf

[37] Data for the year 2022 was not available for Bosnia and Herzegovina, so the 2021 value was used instead.

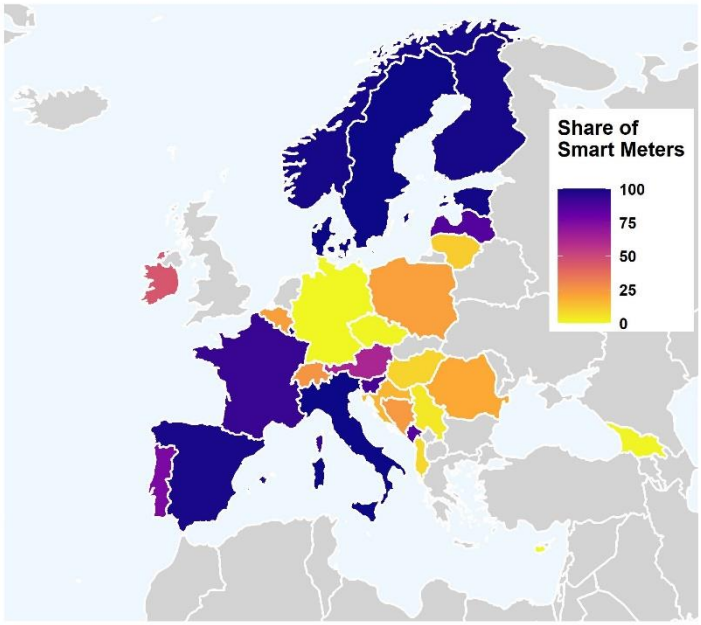


Figure 21 – Share of smart meters in distribution in 2022 (%)

The next two figures illustrate the relationship between the share of smart meters and the power losses in distribution networks. While Figure 22 uses all observations that are available for the years 2019 to 2022, Figure 23 only captures the most current data for every responding country.

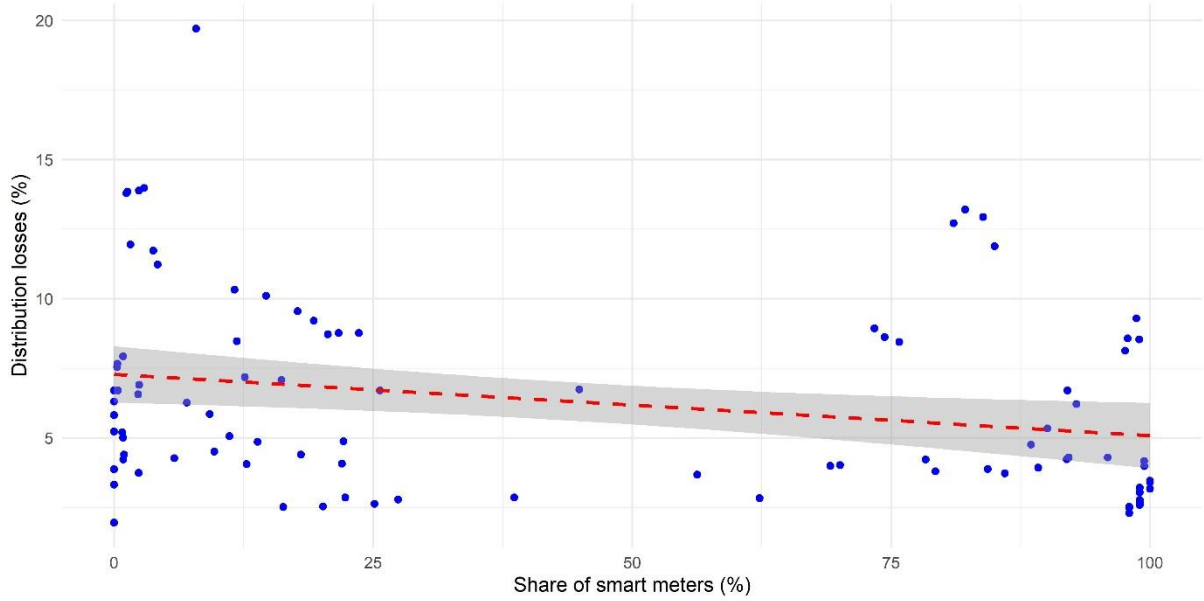


Figure 22 – Distribution losses (%) as a function of the share of smart meters (%) (all observations)

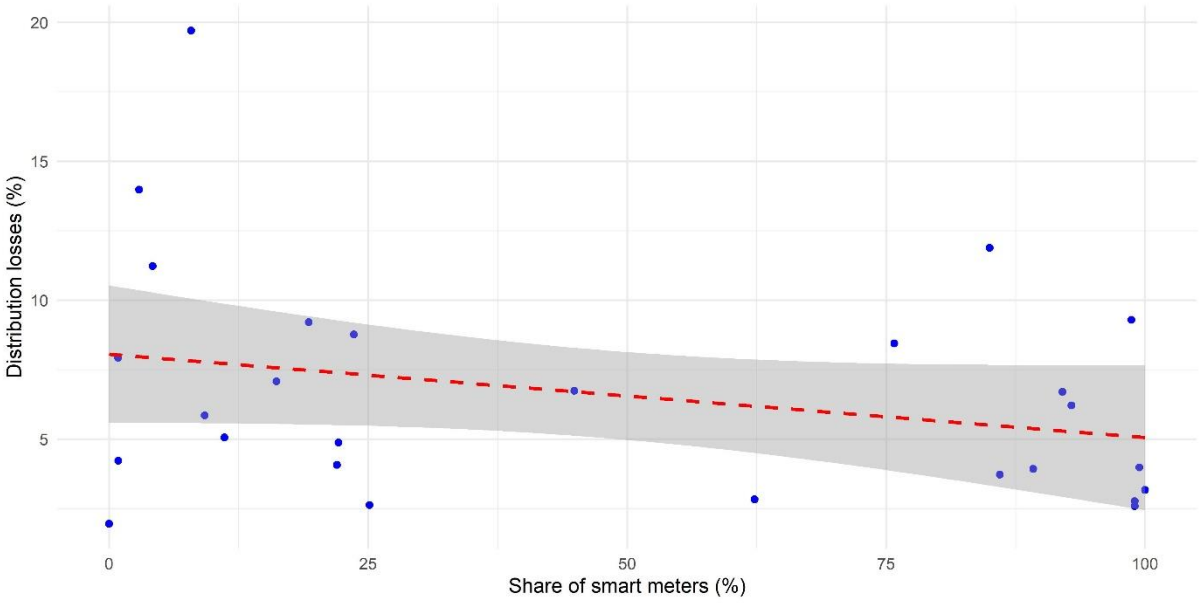


Figure 23 – Distribution losses (%) as a function of the share of smart meters (%) (only the latest observation available)

Both figures show what is already indicated in Figure 21: that there are vast differences in SM penetration rate across Europe with one group of countries having a relatively low share (up to 25%) and another group with penetration rate ranging from 75% up to nearly 100%. In both cases there are only few observations in the middle range from 25% to 75%.

Figure 23 covers the most current data for each country and has an estimated regression line with a steeper negative relationship than Figure 22, although the confidence interval is slightly wider (caused by the smaller number of observations). However, both figures support the finding mentioned before, that a relevant reduction in (non-technical) losses is noticeable in countries with a higher level of SM penetration.

4 Findings and Recommendations

As was determined in the previous CEER Reports on Power Losses, their definition is not standardised and can vary from country to country. In most cases, losses are understood to be the difference between the energy flowing into and out of a grid, but there are countries that do not use this approach. The lack of harmonised definitions and rules regarding the components included in losses presents an obstacle to straightforward benchmarking across Europe.

Harmonising definitions might not be easy, but a consensus on a clear differentiation between technical and non-technical losses could be possible and would simplify the benchmarking of power losses. All responding countries except for one include non-technical losses in the volumes included in this report either in only their distribution losses or in both their distribution and transmission losses. Non-technical losses have different definitions and different components that they include. Several countries responded that there is no distinction between technical and non-technical losses and that they simply report both these elements in their volume of losses.

Losses in distribution varied between 1.95% and 22.63% in the latest year data was available for (2022) which shows substantial differences among the participants. The countries with the highest distribution losses (in percent) have managed to reduce them. While many respondents show a decreasing trend in distribution losses, there have also been increases over time in a few countries.

Losses in transmission vary between 0.99% and just under 3.96% in the latest year data was available for (2022). While increases in transmission losses (in percent) have been observed in the last few years in some countries, the rise is only on the order of a few tenths of a percent at the most. The percentage of losses depends not only on the absolute value of losses, but on the volume of injected energy as well. With decreased volumes, the percentage of losses will increase, even if losses remain unchanged in absolute terms.
In most European countries, system operators are responsible for the procurement of losses in their respective grids. There are only a few exceptions to this, where either a supplier or a BRP acquires the energy necessary to cover power losses.

With regards to the European transition process towards decarbonisation, it seems important to emphasize that the increased responsibility lies with both the network operators and the NRAs. From the regulators' perspective, a proper regulation could include mandatory elements and/or incentives, such as mandatory requirements to replace existing transformers at the end of their technical life with high efficiency ones, which is an important factor in the reduction of technical losses in power grids. NRAs could also promote actions for the implementation of more flexible local RES, for instance through cost-reflective tariffs or by incentivising digitalisation of power grids in order to ensure the integration of information and communication technologies.
According to EED, system operators are required to quantify the overall volume of network losses and, where it is technically and financially feasible, optimise networks and improve network efficiency. Among the strategies suggested by the EED to reach these objectives are incentive-based regulation and the deployment of smart grids. The EE1P should be taken into consideration by transmission and distribution system operators, especially when developing their network development plans.

System operators should be given clear incentives to reduce power losses instead of just being allowed to pass the cost to consumers. Incentives to reduce power losses in distribution have been implemented in 27 countries, while 18 countries have implemented incentives in transmission.

Increased SM penetration can simplify and expedite matching supply to actual demand as the need to use load profiles to estimate demand would be reduced. Smart meters can help lower the non-technical losses, especially regarding causes such as faulty meter reading or non-billed consumption. In any case, country-specific characteristics must be taken into consideration as CEER Members and Observers may require individual solutions rather than a single regulatory framework expected to be applied in all of Europe.

Annex 1 – List of abbreviations

Term	Definition
ACER	European Union Agency for the Cooperation of Energy Regulators
AES/VSE	Association des entreprises électriques suisses / Verband Schweizerischer Elektrizitätsunternehmen (Association of Swiss Electricity Companies)
ARERA	L'Autorità di Regolazione per Energia Reti e Ambiente (National Regulatory Authority of Italy)
BRP	Balance Responsible Party
CEER	Council of European Energy Regulators
CHP	Combined heat and power
DNO	Distribution Network Operator
DSO	Distribution System Operator
DSR	Demand-Side Response
EC	European Commission
ECRB	Energy Community Regulatory Board
EE1P	Energy Efficiency First Principle
EED	Energy Efficiency Directive
ENTSO-E	European Network of Transmission System Operators for Electricity
EQS WS	Energy Quality of Supply Work Stream
ERU/ERO	Energetický Regulační Úřad / Energy Regulatory Office (National Regulatory Authority of the Czech Republic)
ERGEG	European Regulators' Group for Electricity and Gas
ISO	Independent System Operator
JRC	(European Commission's) Joint Research Center
MC-CH	(Swiss) Metering Code
MW	Megawatt
MWh	Megawatt hour
N/A	Not Applicable
NRA	National Regulatory Authority
PL	Power Losses
RES	Renewable energy sources
SM	Smart Meter
WACC	Weighted Average Cost of Capital

Annex 2 – List of Country Abbreviations

Term	Definition
AL	Albania
AT	Austria
BA	Bosnia and Herzegovina
BE	Belgium
BG	Bulgaria
CH	Switzerland
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
GB	Great Britain (England, Scotland and Wales)
GE	Georgia
HR	Croatia
HU	Hungary
IE	Ireland
IS	Iceland
IT	Italy
KS*	Kosovo*
LT	Lithuania
LU	Luxembourg
LV	Latvia
MD	Moldova
ME	Montenegro
MK	North Macedonia
MT	Malta
NL	The Netherlands
NO	Norway
PL	Poland

Term	Definition
PT	Portugal
RO	Romania
RS	Serbia
SE	Sweden
SI	Slovenia
SK	Slovakia
UA	Ukraine

Annex 3 – Fact Sheets

Albania

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	69,515 km
Number of metering points in distribution network	1,301,905
Number of smart meters (SM) with active remote reading in distribution network	103,000
Penetration of SM with active remote reading in distribution network (per metering point)	7.9%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in distribution
- Non-metered consumption (e.g. public lighting)	Yes, in both distribution and transmission
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in distribution
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Estimated

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Calculated in the tariff

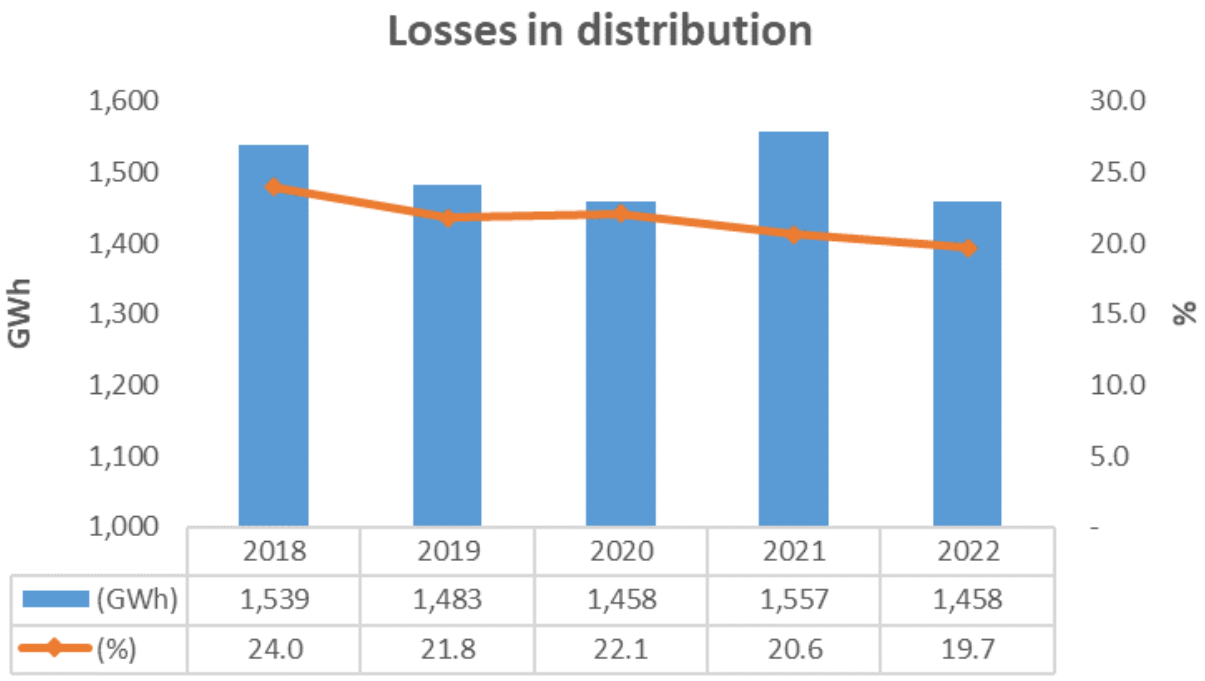
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	No
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

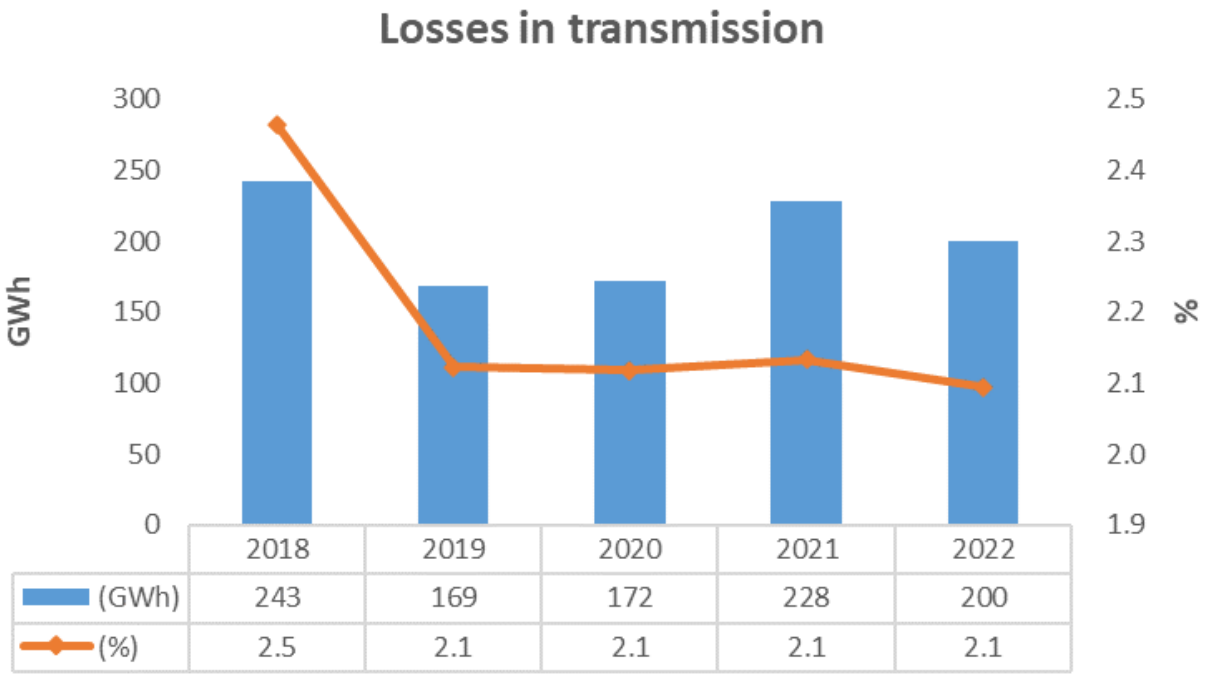
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	N/A
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	N/A

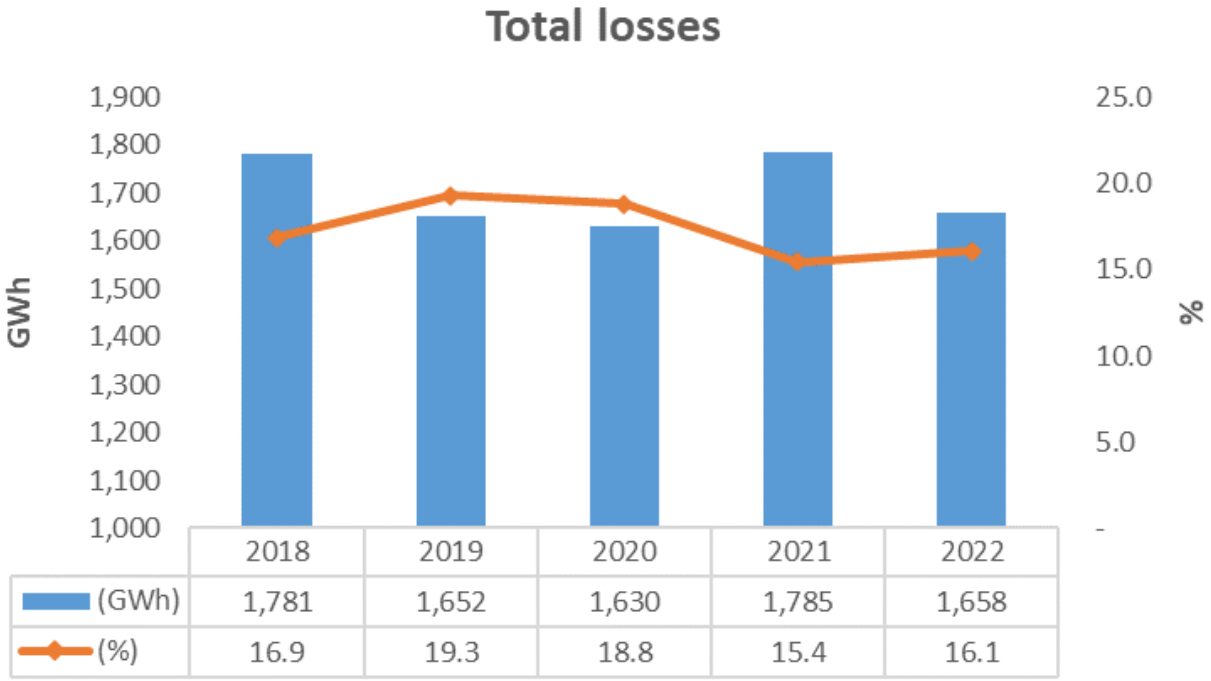
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	1,539	1,483	1,458	1,557	1,458
(%)	24.0	21.8	22.1	20.6	19.7



	2018	2019	2020	2021	2022
(GWh)	243	169	172	228	200
(%)	2.5	2.1	2.1	2.1	2.1



	2018	2019	2020	2021	2022
(GWh)	1,781	1,652	1,630	1,785	1,658
(%)	16.9	19.3	18.8	15.4	16.1

Austria

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	261,741 km
Number of metering points in distribution network	6,331,593
Number of smart meters (SM) with active remote reading in distribution network	3,944,893 (the number refers to low voltage level only)
Penetration of SM with active remote reading in distribution network (per metering point)	62.3%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy. On higher voltage levels, they are indirectly metered.
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	TSO (but some DSOs procure energy for their own losses)
Party responsible for forecasting / estimating power losses	TSO (and some DSOs)
How are costs of procuring losses covered?	Included in network tariff. All consumers, but only producers with capacity above 5 MW pay for losses

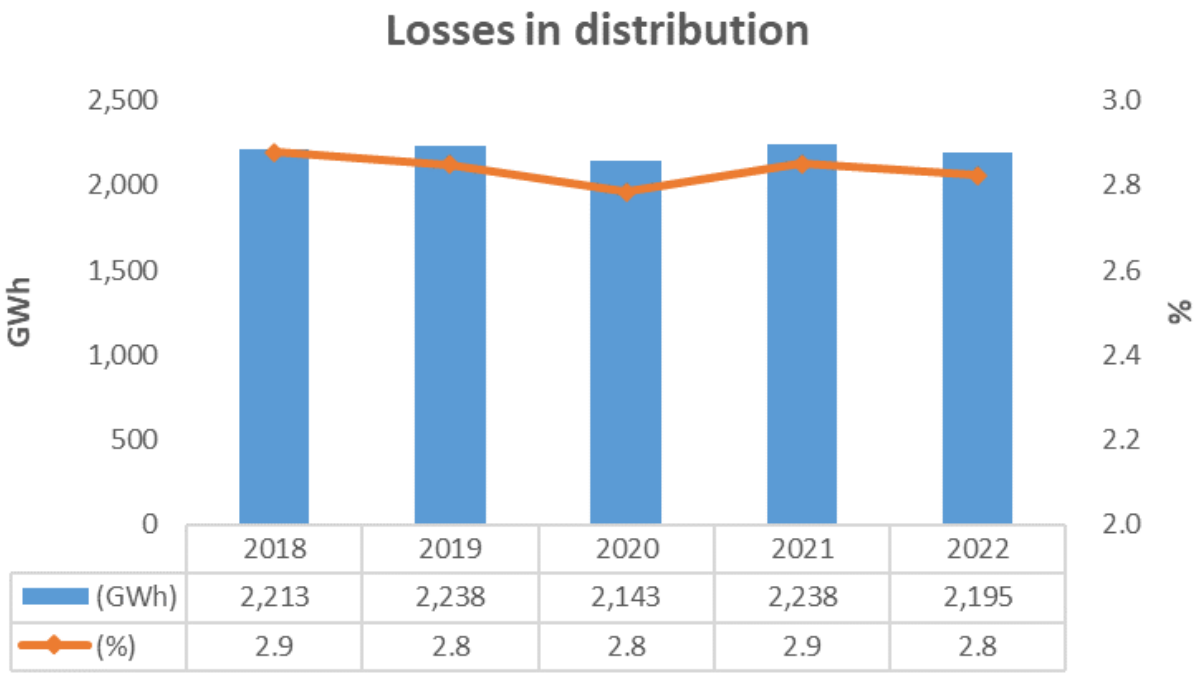
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	No (only incentives to reduce the overall cost)
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	Yes
Different prices of losses for different network users?	Yes

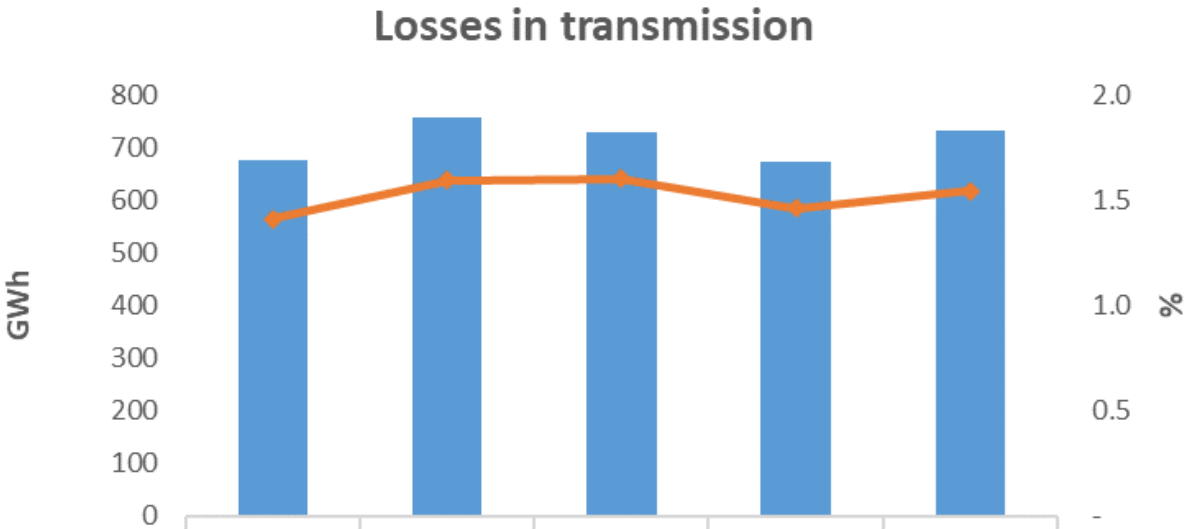
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	Yes
Any measures to combat the currently high prices of energy to cover losses?	Yes (enhancement of the forecast quality)

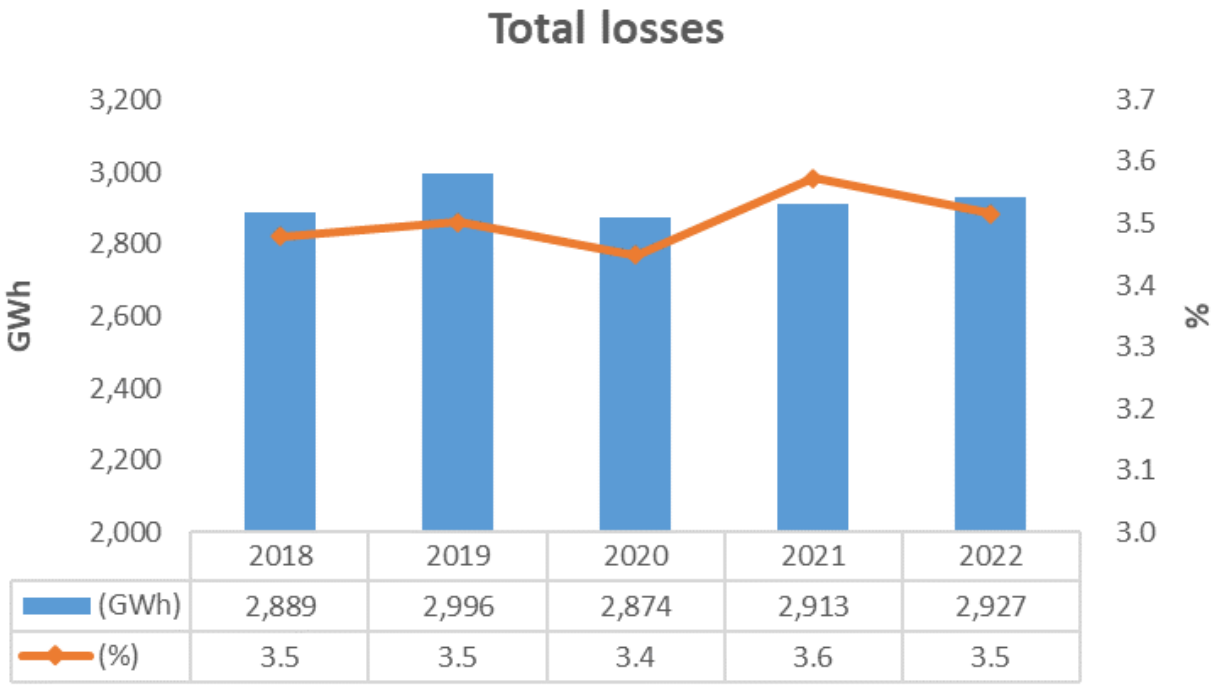
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	2,213	2,238	2,143	2,238	2,195
(%)	2.9	2.8	2.8	2.9	2.8



	2018	2019	2020	2021	2022
(GWh)	677	758	731	674	732
(%)	1.4	1.6	1.6	1.5	1.5



	2018	2019	2020	2021	2022
(GWh)	2,889	2,996	2,874	2,913	2,927
(%)	3.5	3.5	3.4	3.6	3.5

Belgium

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	211,999.02 km
Number of metering points in distribution network	6,366,639
Number of smart meters (SM) with active remote reading in distribution network	1,409,855
Penetration of SM with active remote reading in distribution network (per metering point)	22.1%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in distribution
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	Yes, in distribution (Brussels and Wallonia)
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy.
Are losses measured or estimated	Measured

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Included in distribution and transmission tariffs

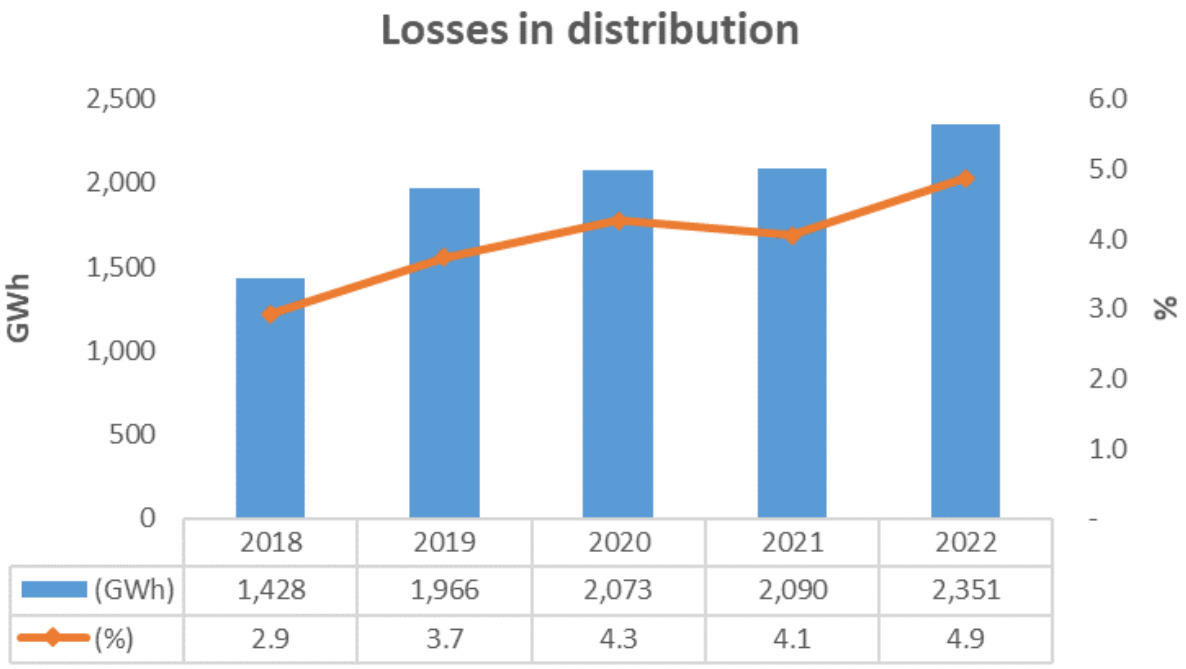
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes (Flanders and Wallonia)
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes
Are non-technical losses included in published losses and in regulation of losses?	Yes, in distribution
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	Yes, in distribution (Flanders and Wallonia)

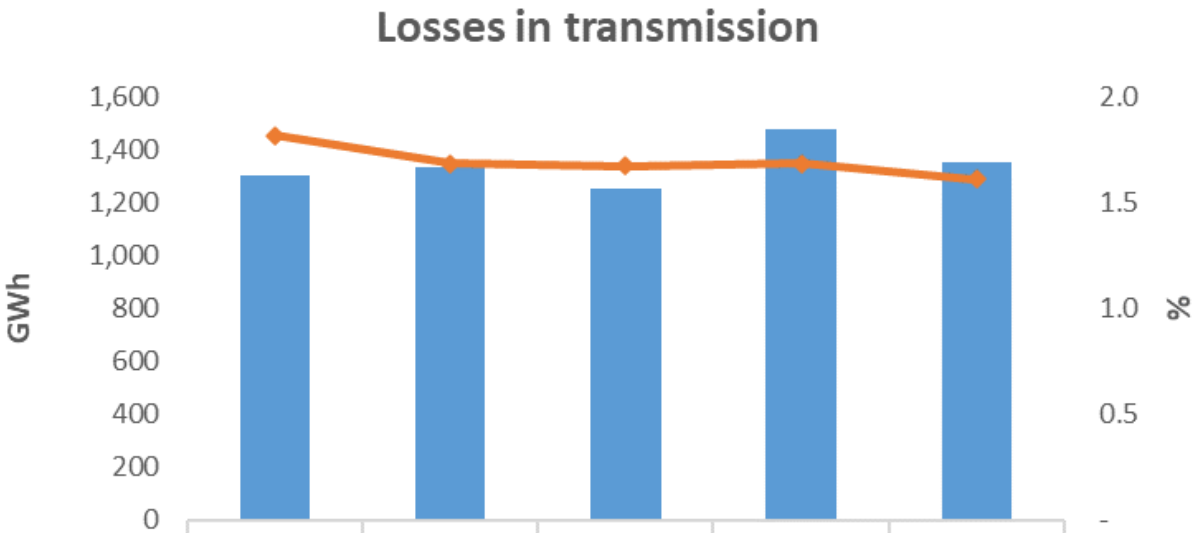
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	Yes, in transmission (TSO is responsible for balancing)
Any measures to combat the currently high prices of energy to cover losses?	Yes

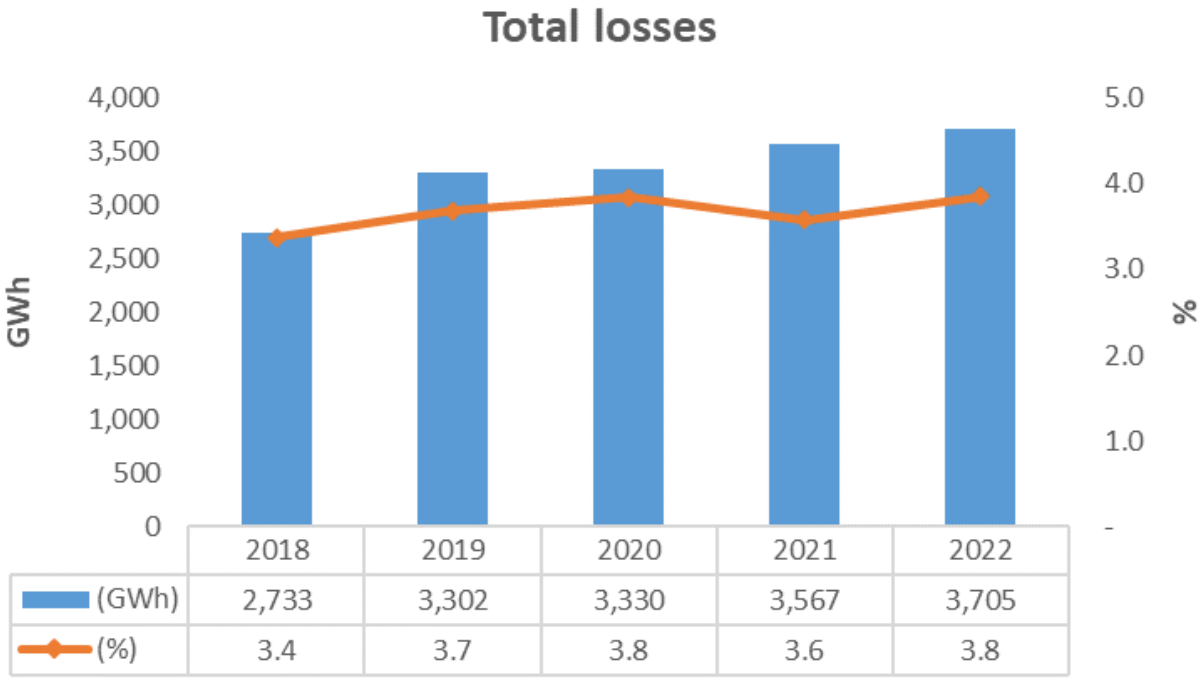
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	1,428	1,966	2,073	2,090	2,351
(%)	2.9	3.7	4.3	4.1	4.9



	2018	2019	2020	2021	2022
(GWh)	1,305	1,336	1,257	1,477	1,354
(%)	1.8	1.7	1.7	1.7	1.6



	2018	2019	2020	2021	2022
(GWh)	2,733	3,302	3,330	3,567	3,705
(%)	3.4	3.7	3.8	3.6	3.8

Bosnia and Herzegovina

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	102,328 km
Number of metering points in distribution network	1,610,940
Number of smart meters (SM) with active remote reading in distribution network	380,614
Penetration of SM with active remote reading in distribution network (per metering point)	23.6%
Year	2021

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	No
- Non-metered consumption (e.g. public lighting)	Yes, in distribution
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	By metering devices and through calculations with predefined formulas
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and ISO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs

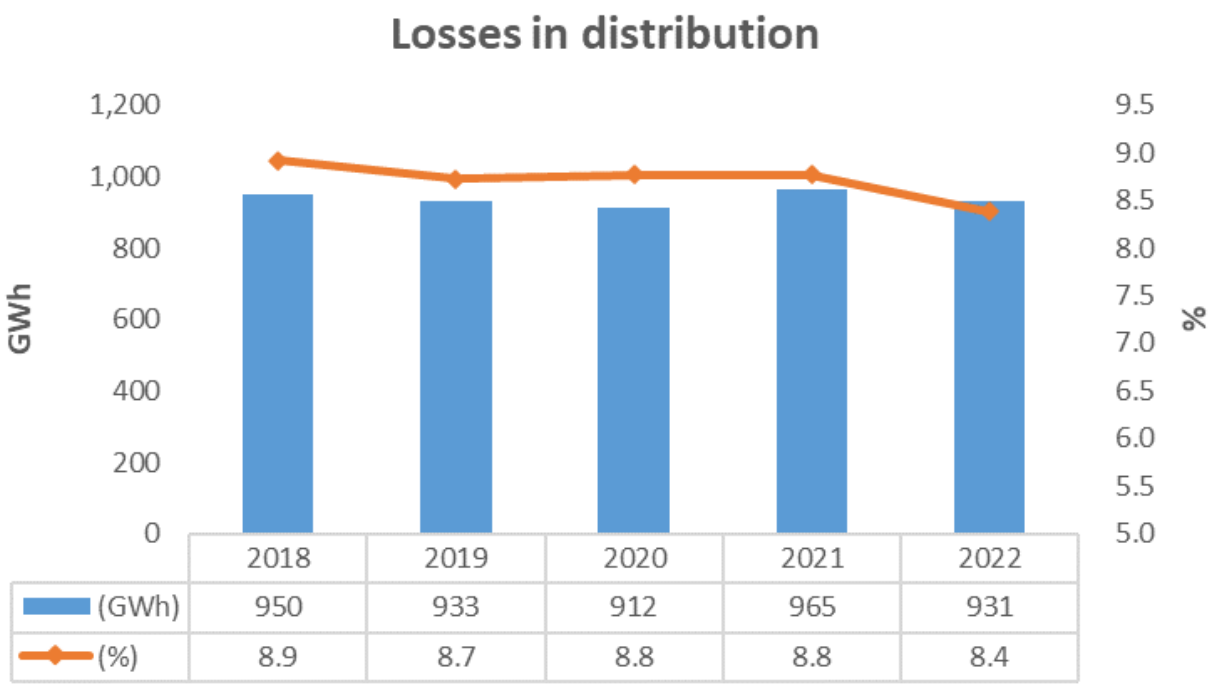
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	
Regulatory incentives to reduce losses or costs related to losses in transmission?	
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

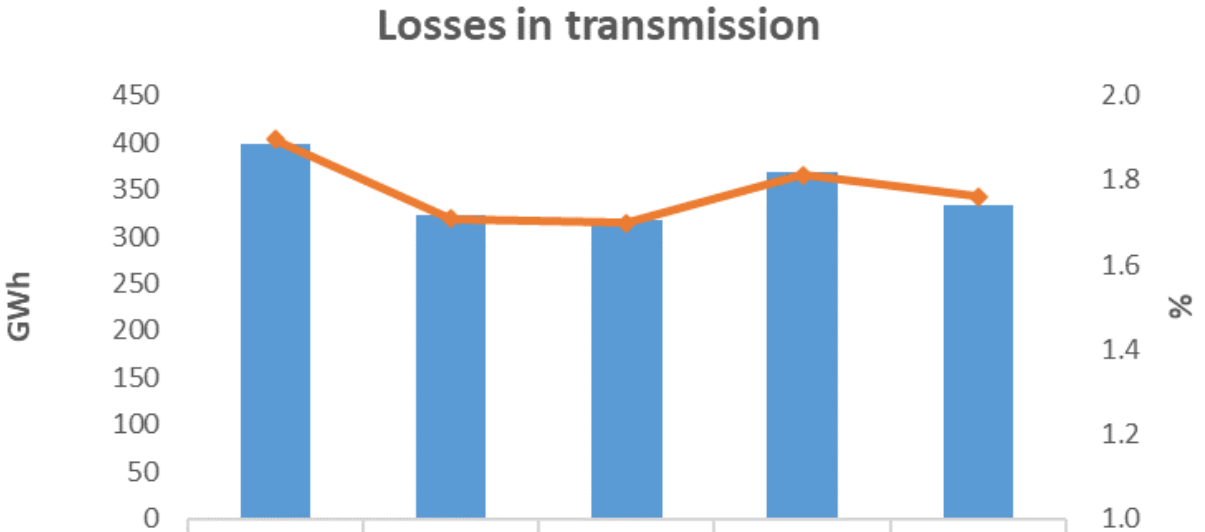
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	Yes

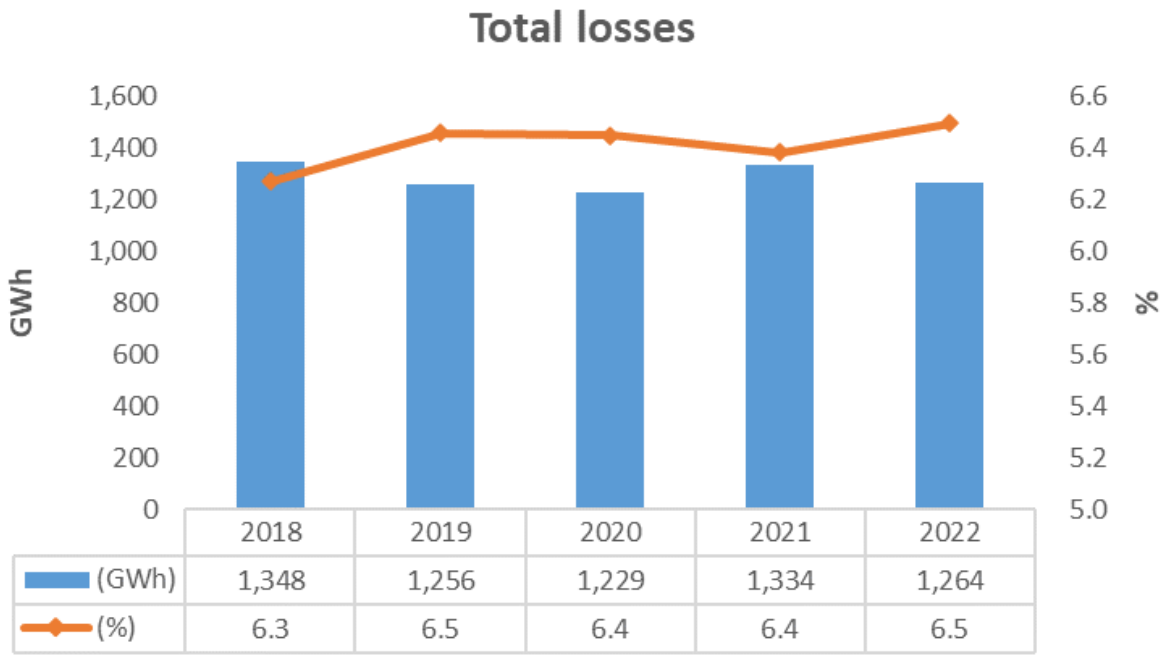
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	950	933	912	965	931
(%)	8.9	8.7	8.8	8.8	8.4



	2018	2019	2020	2021	2022
(GWh)	398	323	317	369	333
(%)	1.9	1.7	1.7	1.8	1.8



	2018	2019	2020	2021	2022
(GWh)	1,348	1,256	1,229	1,334	1,264
(%)	6.3	6.5	6.4	6.4	6.5

Bulgaria

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	139,753 km
Number of metering points in distribution network	5,219,020
Number of smart meters (SM) with active remote reading in distribution network	
Penetration of SM with active remote reading in distribution network (per metering point)	
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Expert assessment
Are losses measured or estimated	Measured

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	
Party responsible for forecasting / estimating power losses	NRA
How are costs of procuring losses covered?	Network tariffs

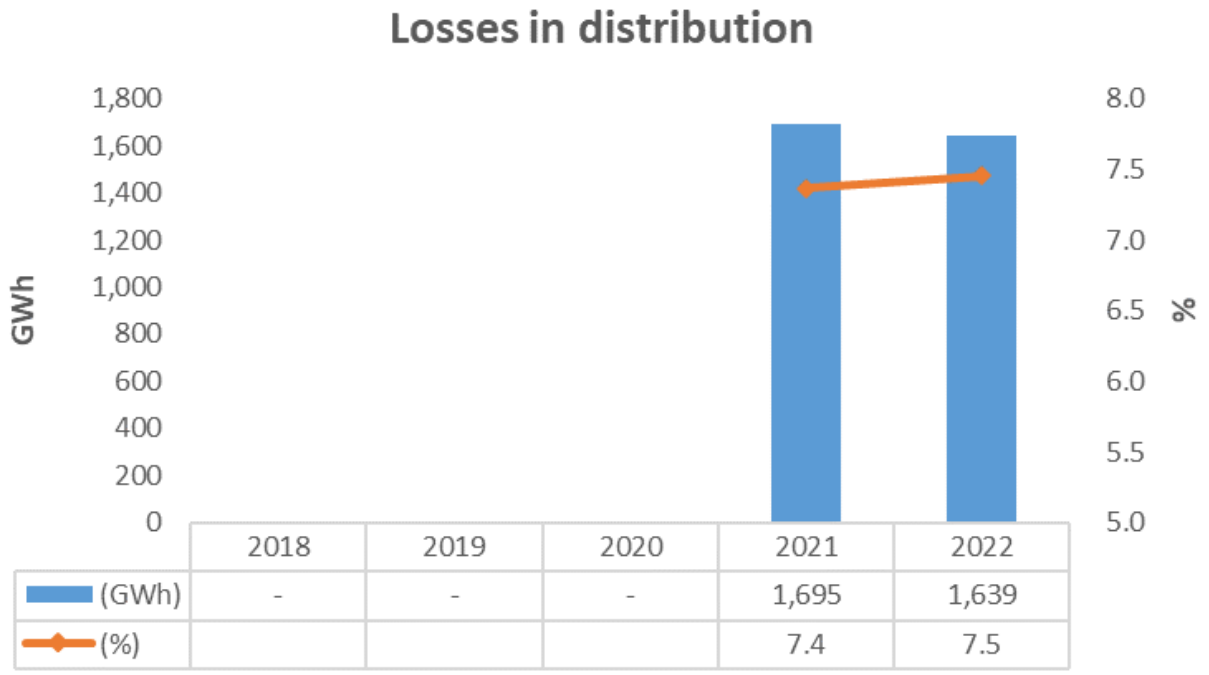
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	
Regulatory incentives to reduce losses or costs related to losses in transmission?	
Are non-technical losses included in published losses and in regulation of losses?	No
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	Yes

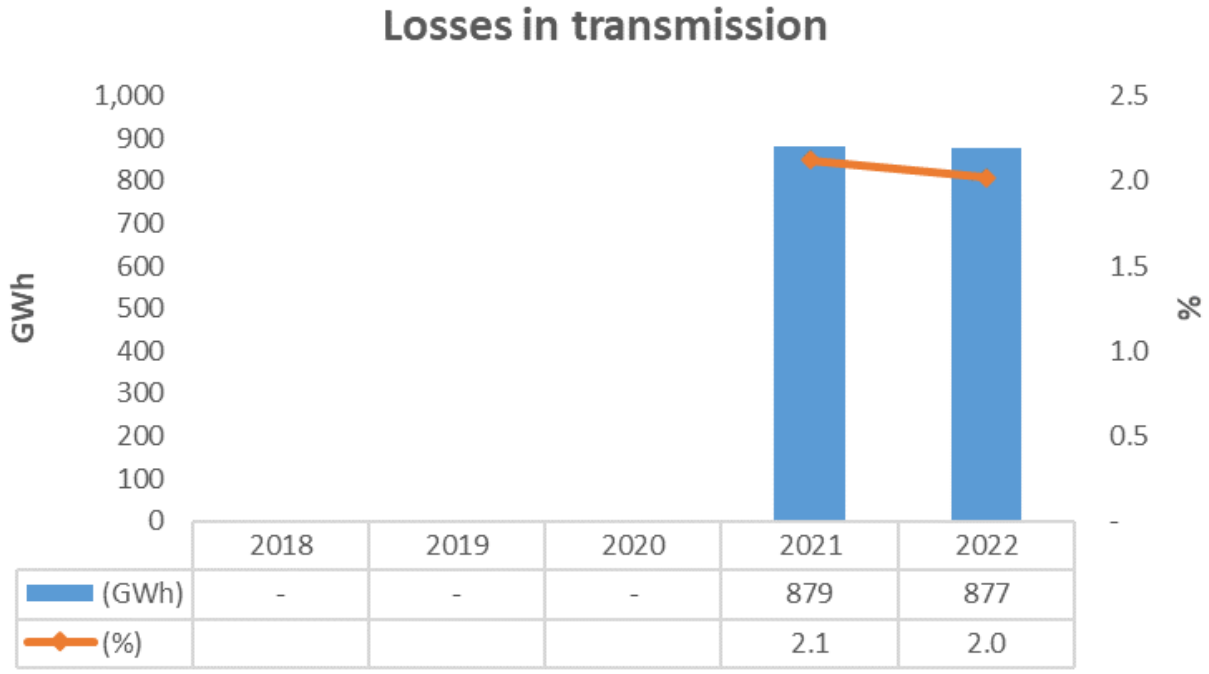
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	Yes
Any measures to combat the currently high prices of energy to cover losses?	Yes

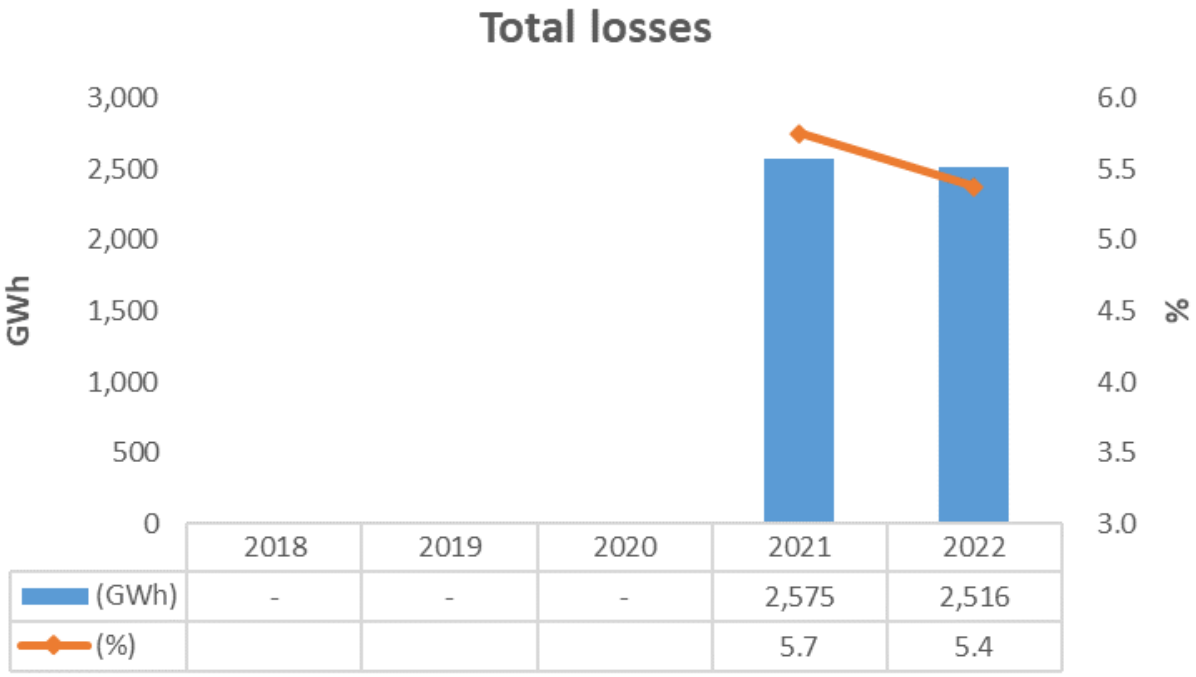
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	-	-	-	1,695	1,639
(%)				7.4	7.5



	2018	2019	2020	2021	2022
(GWh)	-	-	-	879	877
(%)				2.1	2.0



	2018	2019	2020	2021	2022
(GWh)	-	-	-	2,575	2,516
(%)				5.7	5.4

Data for 2018, 2019 and 2020 not available.

Croatia

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	141,937 km
Number of metering points in distribution network	2,503,960
Number of smart meters (SM) with active remote reading in distribution network	404,596
Penetration of SM with active remote reading in distribution network (per metering point)	16.2%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in distribution
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in distribution
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in distribution
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Both. Measured in transmission, calculated in distribution

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Transmission and distribution tariffs

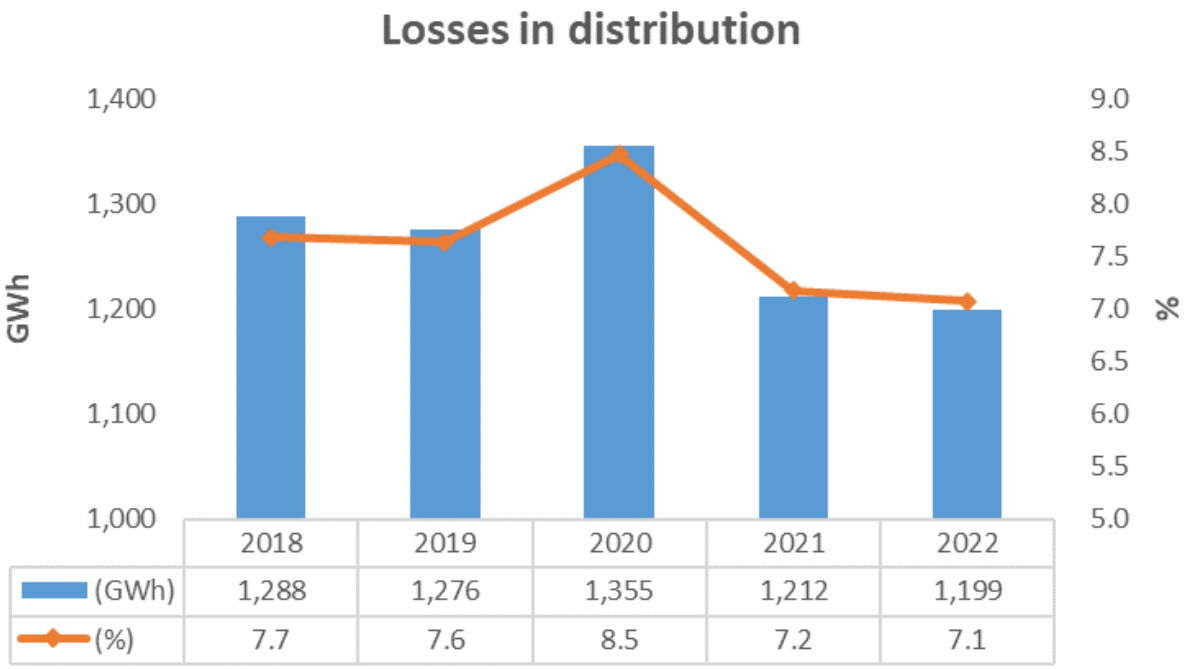
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

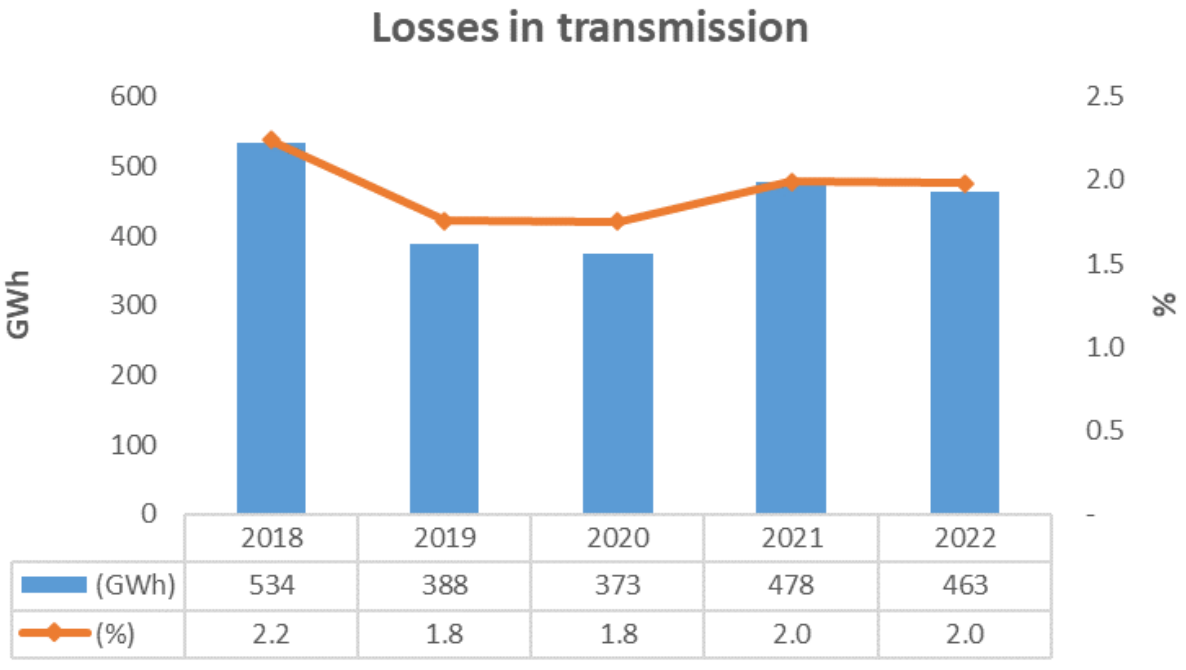
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	Yes
Any measures to combat the currently high prices of energy to cover losses?	No

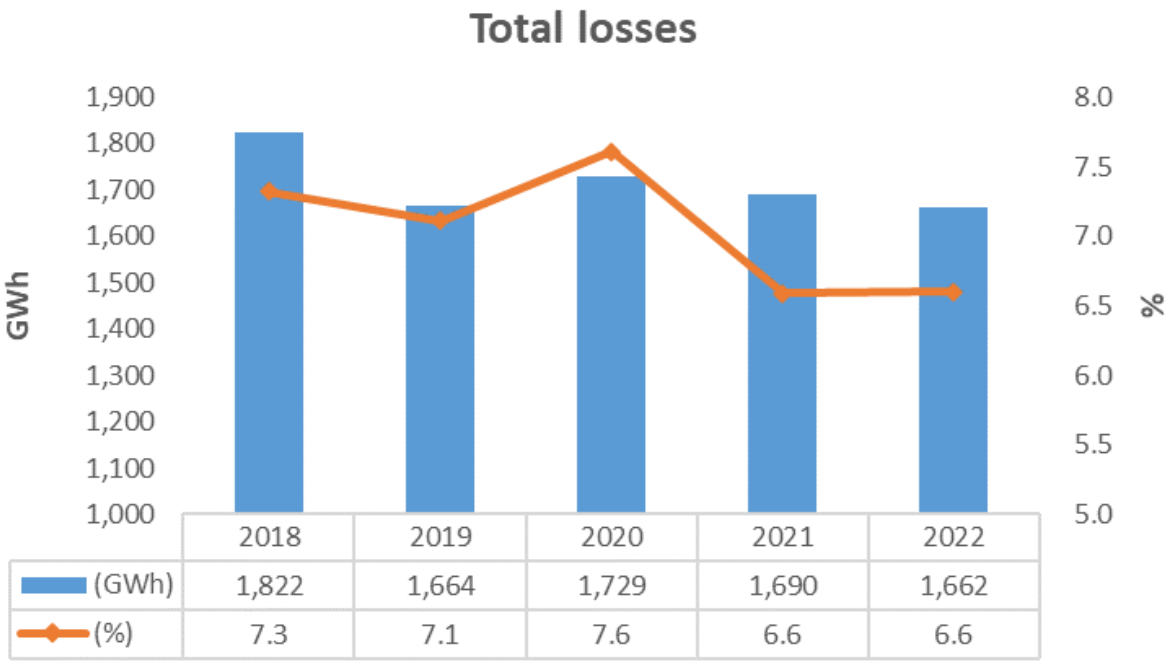
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	1,288	1,276	1,355	1,212	1,199
(%)	7.7	7.6	8.5	7.2	7.1



	2018	2019	2020	2021	2022
(GWh)	534	388	373	478	463
(%)	2.2	1.8	1.8	2.0	2.0



	2018	2019	2020	2021	2022
(GWh)	1,822	1,664	1,729	1,690	1,662
(%)	7.3	7.1	7.6	6.6	6.6

Cyprus

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	28,170 km
Number of metering points in distribution network	669,033
Number of smart meters (SM) with active remote reading in distribution network	0
Penetration of SM with active remote reading in distribution network (per metering point)	0%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in distribution
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in distribution
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in distribution
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Both. Measured in transmission, both measured and estimated in distribution

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	Supplier
Party responsible for forecasting / estimating power losses	TSO
How are costs of procuring losses covered?	Included in tariffs

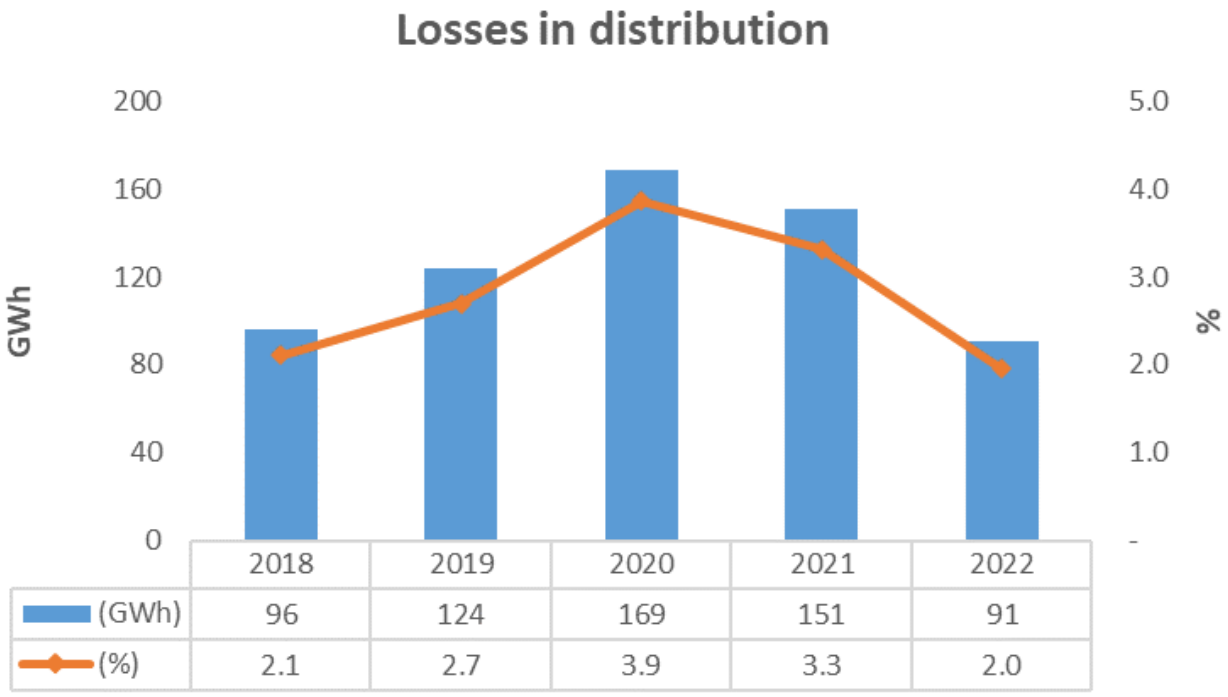
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	No
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	Yes, in distribution
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

PRICE OF LOSSES

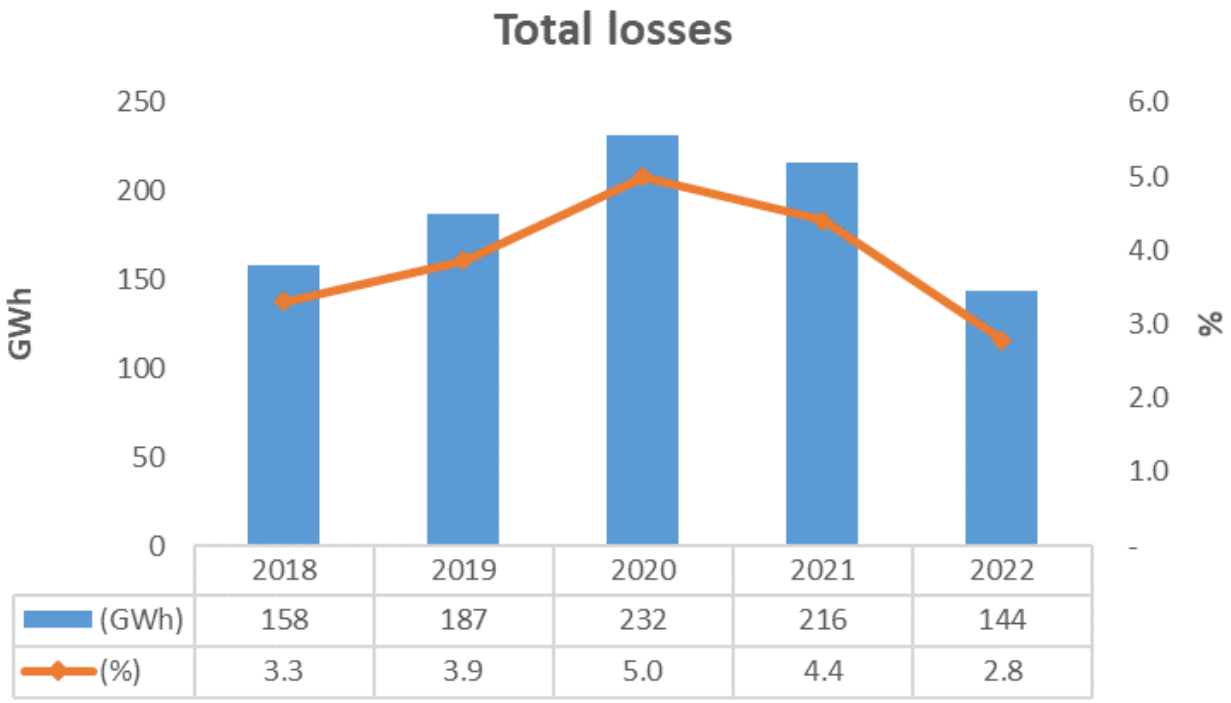
Is the price of losses regulated (e.g. set by the NRA)?	N/A
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	N/A

VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	96	124	169	151	91
(%)	2.1	2.7	3.9	3.3	2.0

	2018	2019	2020	2021	2022
(GWh)	62	63	63	65	53
(%)	1.3	1.4	1.5	1.5	1.2



	2018	2019	2020	2021	2022
(GWh)	158	187	232	216	144
(%)	3.3	3.9	5.0	4.4	2.8

Czech Republic

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	248,211 km
Number of metering points in distribution network	6,186,471
Number of smart meters (SM) with active remote reading in distribution network	55,581
Penetration of SM with active remote reading in distribution network (per metering point)	0.9%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	No
- Non-metered consumption (e.g. public lighting)	Yes, in distribution
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Combination of metering and estimation
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO (the NRA can change the forecast value that is included in price regulation)
How are costs of procuring losses covered?	Included in tariffs

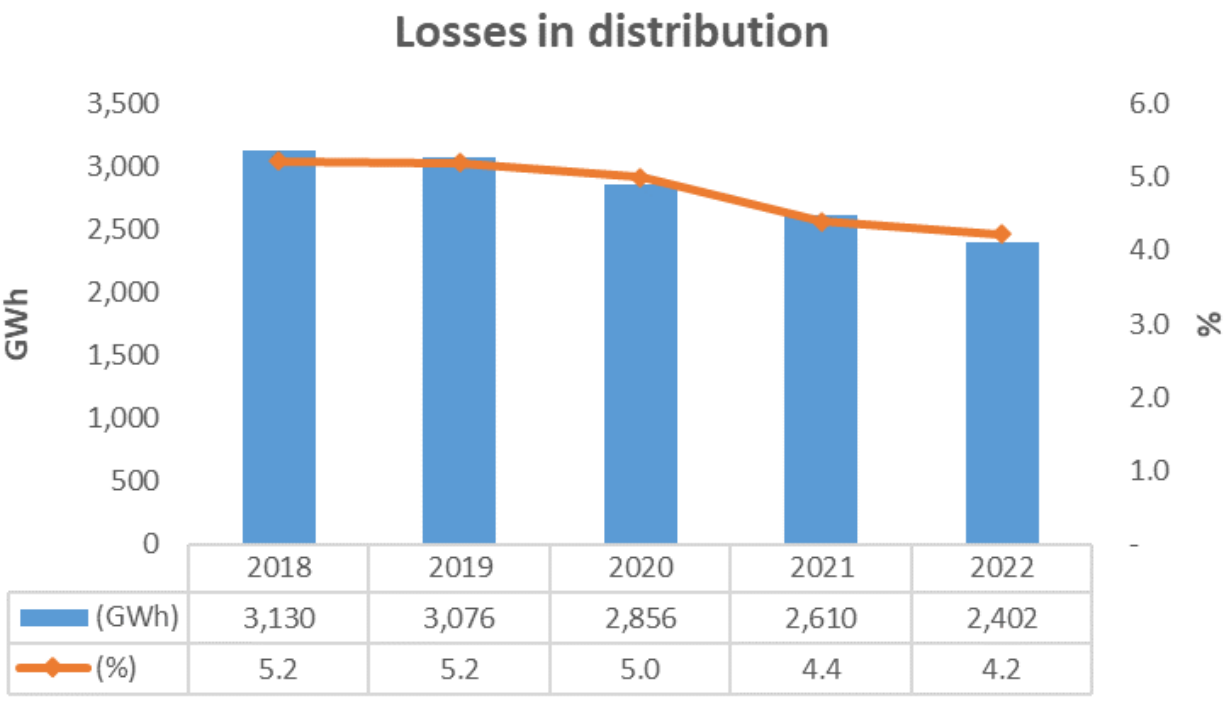
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	No
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	Yes. The price is set for each DSO and individually for each voltage level, so it depends on the DSO of the user's grid.

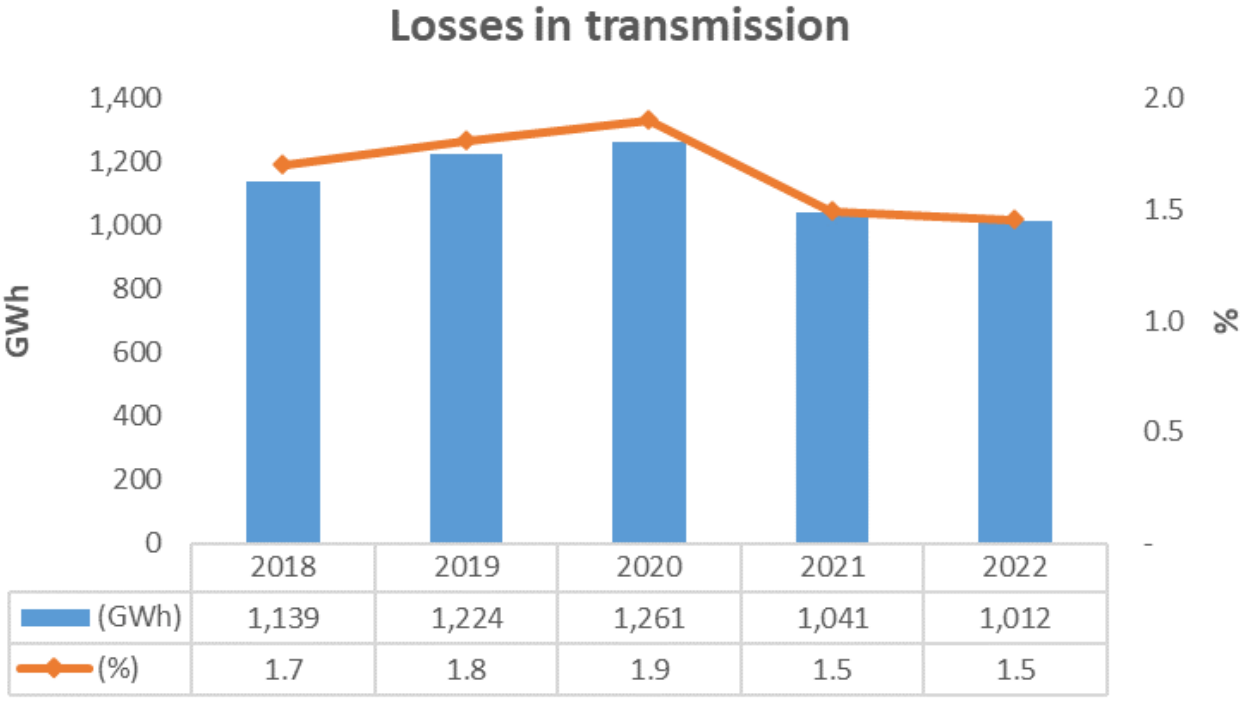
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	Yes

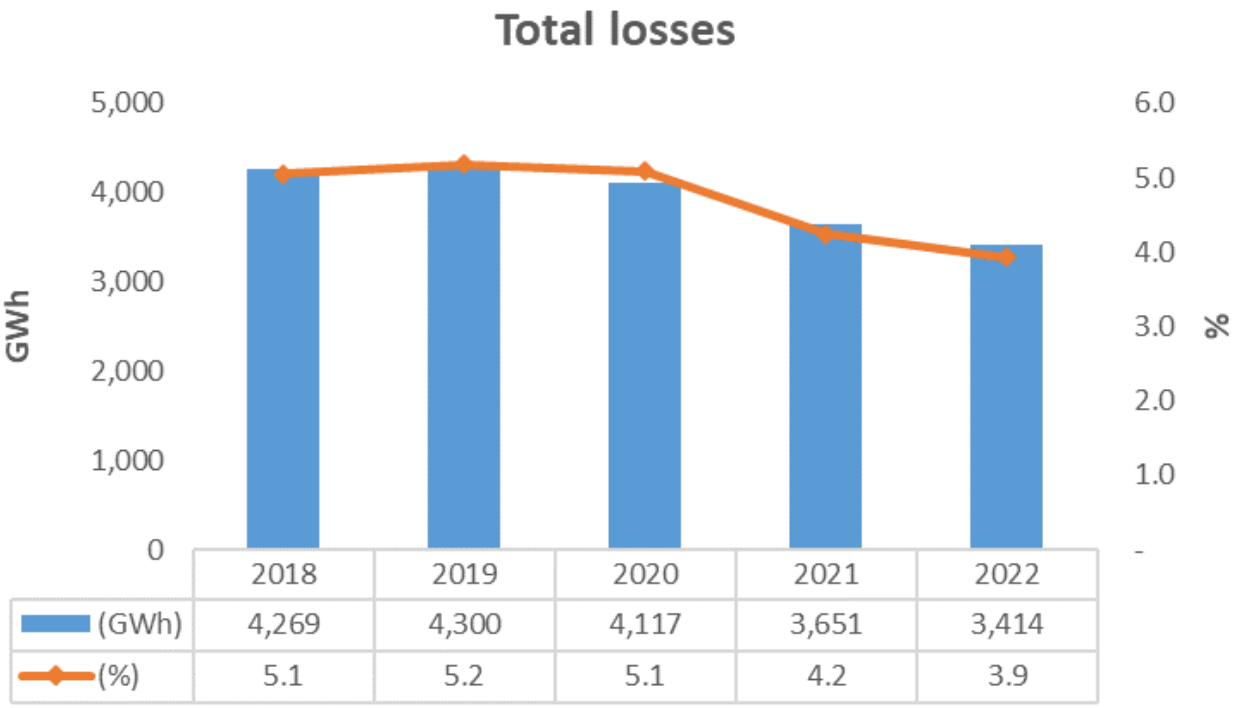
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	3,130	3,076	2,856	2,610	2,402
(%)	5.2	5.2	5.0	4.4	4.2



	2018	2019	2020	2021	2022
(GWh)	1,139	1,224	1,261	1,041	1,012
(%)	1.7	1.8	1.9	1.5	1.5



	2018	2019	2020	2021	2022
(GWh)	4,269	4,300	4,117	3,651	3,414
(%)	5.1	5.2	5.1	4.2	3.9

Denmark

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	159,588 km
Number of metering points in distribution network	3,494,643
Number of smart meters (SM) with active remote reading in distribution network	3,494,572
Penetration of SM with active remote reading in distribution network (per metering point)	Nearly 100% (99.99%)
Year	2021

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	
- Non-metered consumption (e.g. public lighting)	Yes, in both distribution and transmission
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Measured by TSO
Are losses measured or estimated	Measured

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Through tariffs

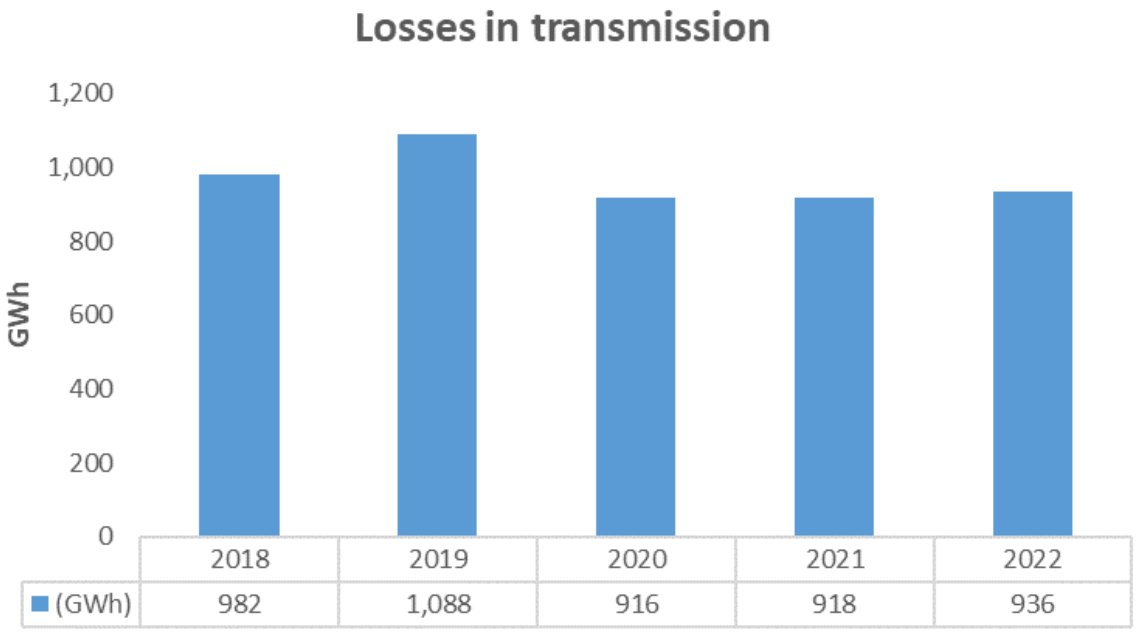
REGULATORY FRAMEWORK

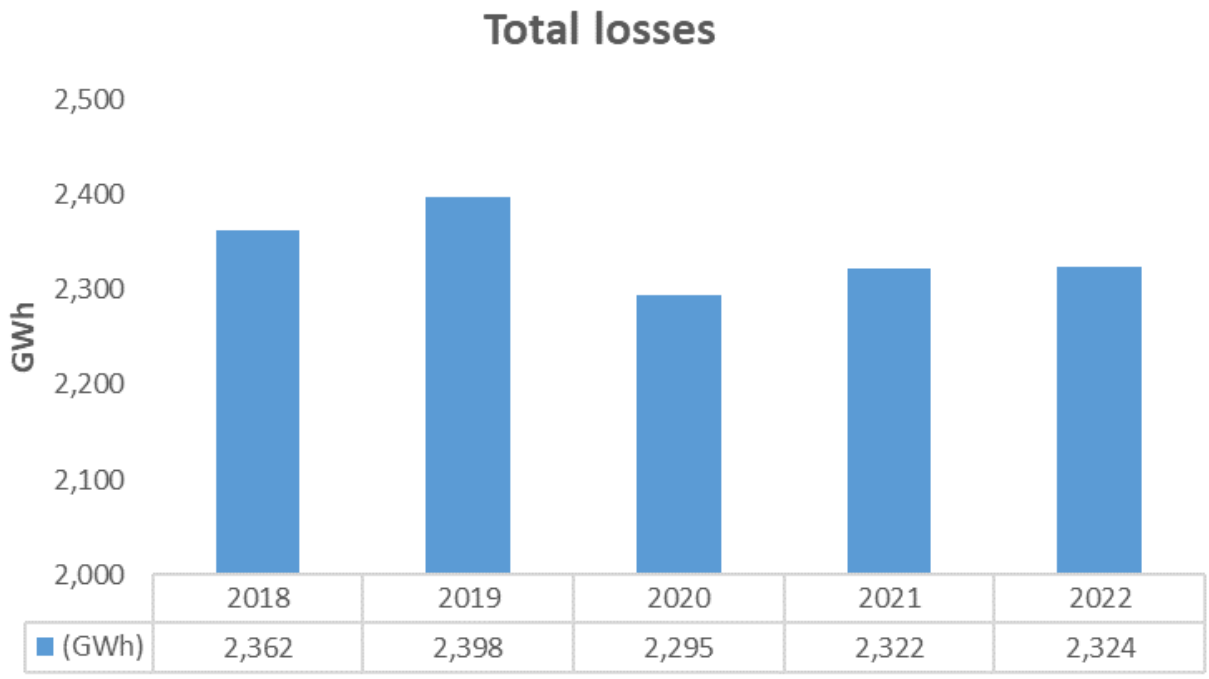
Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes (incentive to be more efficient which includes losses)
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes (incentive to be more efficient which includes losses)
Are non-technical losses included in published losses and in regulation of losses?	No
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	Yes

PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	N/A
Any measures to combat the currently high prices of energy to cover losses?	No. System operators are fully compensated for losses

VALUES OF LOSSES





Losses as percentage could not be calculated due to missing data.

Estonia

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	66,126 km
Number of metering points in distribution network	576,871
Number of smart meters (SM) with active remote reading in distribution network	573,789
Penetration of SM with active remote reading in distribution network (per metering point)	99.5%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	No
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	They are measured
Are losses measured or estimated	Both. Losses for previous periods are calculated. Losses for the network tariffs are estimated.

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs, but procurement costs are not covered separately.

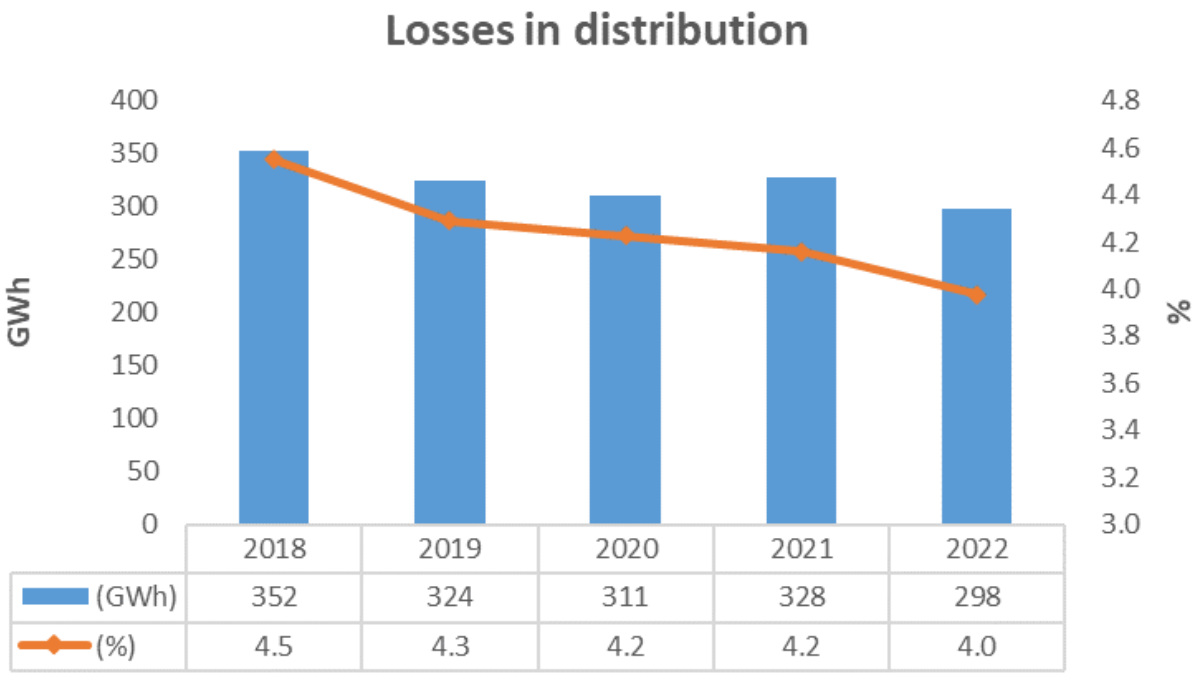
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	N/A
Regulatory incentives to reduce losses or costs related to losses in transmission?	N/A
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	Yes

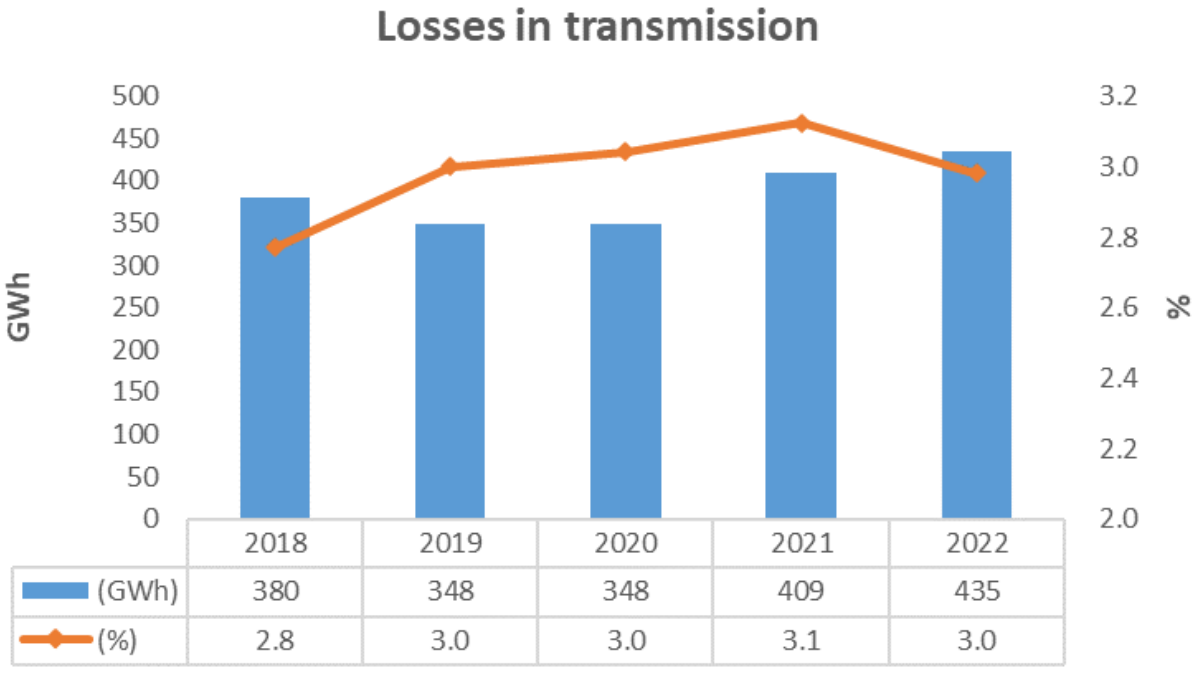
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	Yes

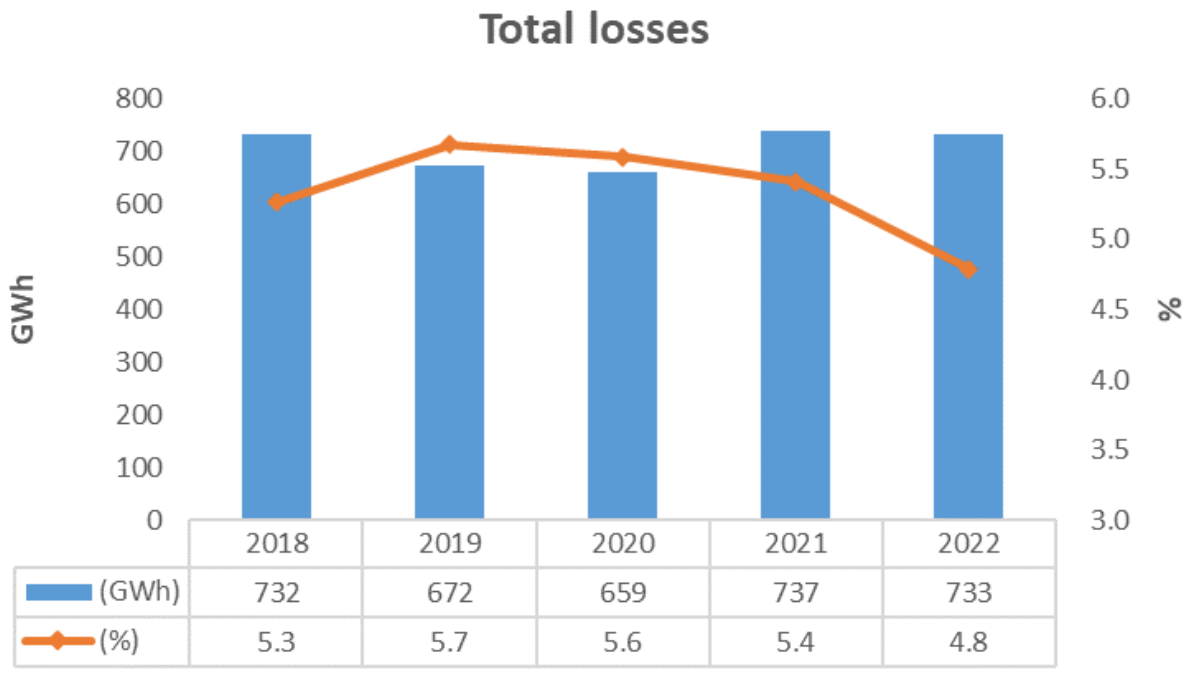
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	352	324	311	328	298
(%)	4.5	4.3	4.2	4.2	4.0



	2018	2019	2020	2021	2022
(GWh)	380	348	348	409	435
(%)	2.8	3.0	3.0	3.1	3.0



	2018	2019	2020	2021	2022
(GWh)	732	672	659	737	733
(%)	5.3	5.7	5.6	5.4	4.8

Finland

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	453,910 km
Number of metering points in distribution network	3,801,683
Number of smart meters (SM) with active remote reading in distribution network	
Penetration of SM with active remote reading in distribution network (per metering point)	Finland reported that approximately 99.9% of meters are digital with active remote reading
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Estimated

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO
Party responsible for forecasting / estimating power losses	DSO
How are costs of procuring losses covered?	Passthrough cost

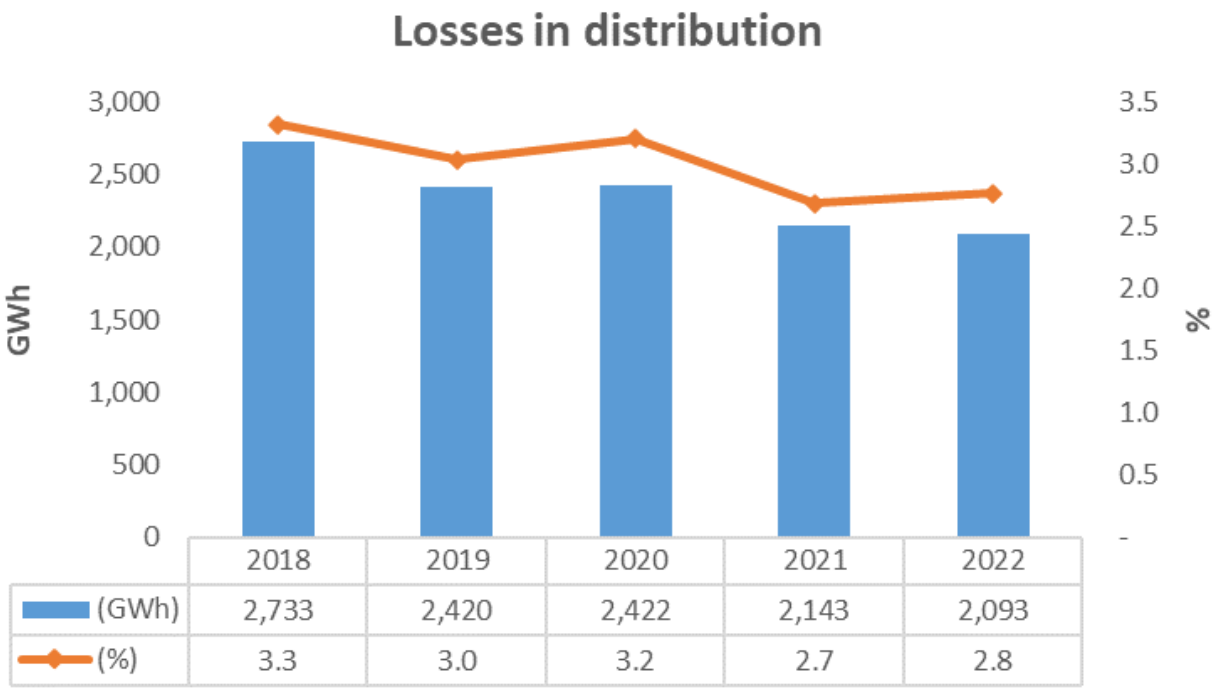
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	
Regulatory incentives to reduce losses or costs related to losses in transmission?	
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

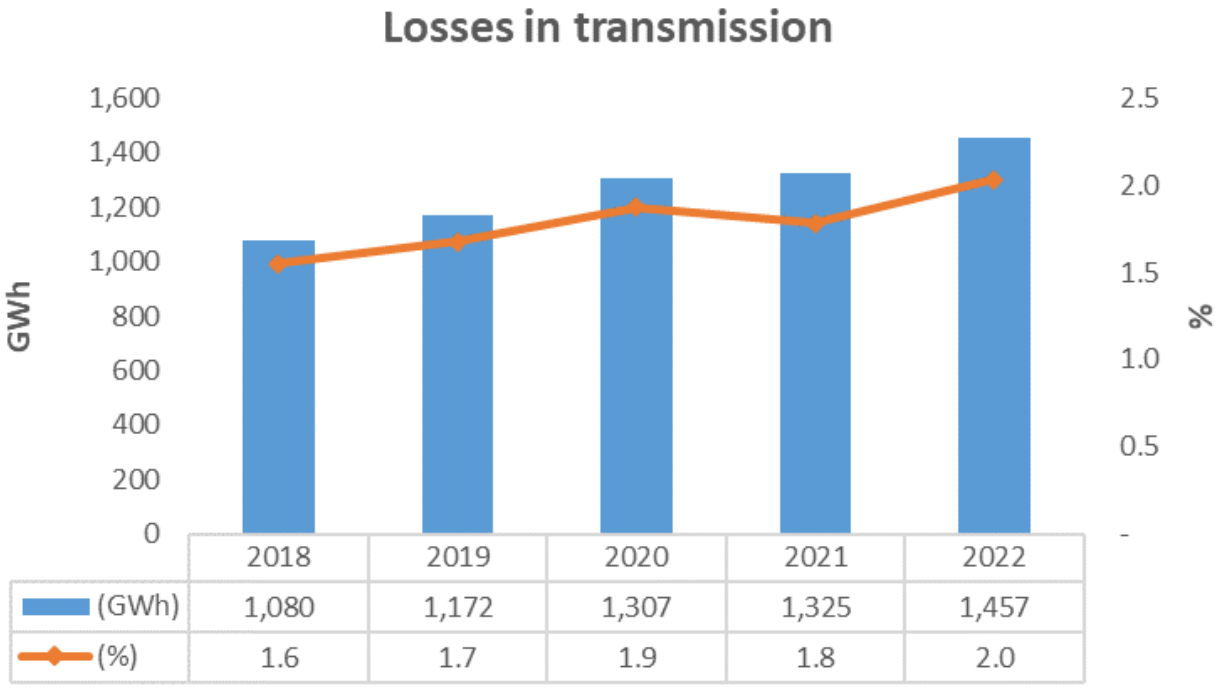
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	N/A
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	No

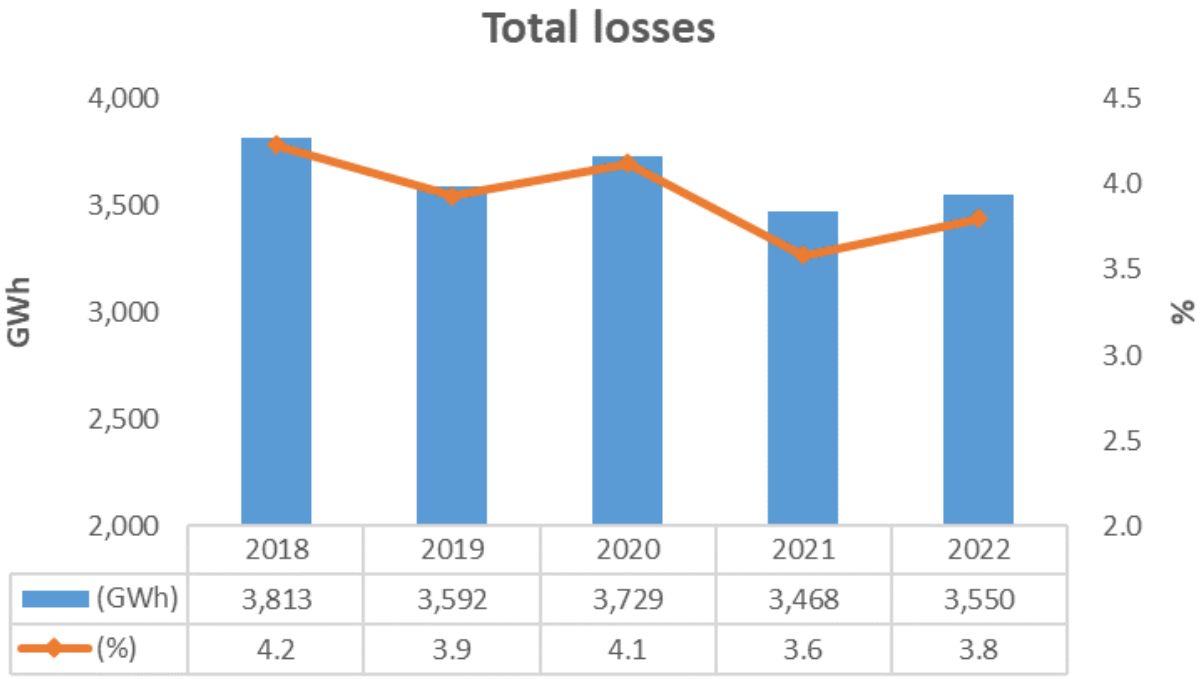
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	2,733	2,420	2,422	2,143	2,093
(%)	3.3	3.0	3.2	2.7	2.8



	2018	2019	2020	2021	2022
(GWh)	1,080	1,172	1,307	1,325	1,457
(%)	1.6	1.7	1.9	1.8	2.0



	2018	2019	2020	2021	2022
(GWh)	3,813	3,592	3,729	3,468	3,550
(%)	4.2	3.9	4.1	3.6	3.8

France

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	1,401,479 km (data for DSO Enedis which covers 95% of France)
Number of metering points in distribution network	38,157,684
Number of smart meters (SM) with active remote reading in distribution network	35,450,974
Penetration of SM with active remote reading in distribution network (per metering point)	92.9%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in distribution
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in distribution
- Non-metered consumption (e.g. public lighting)	Yes, in distribution
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in distribution
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Both. Measured in transmission. Measured and estimated in distribution.

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Through tariffs

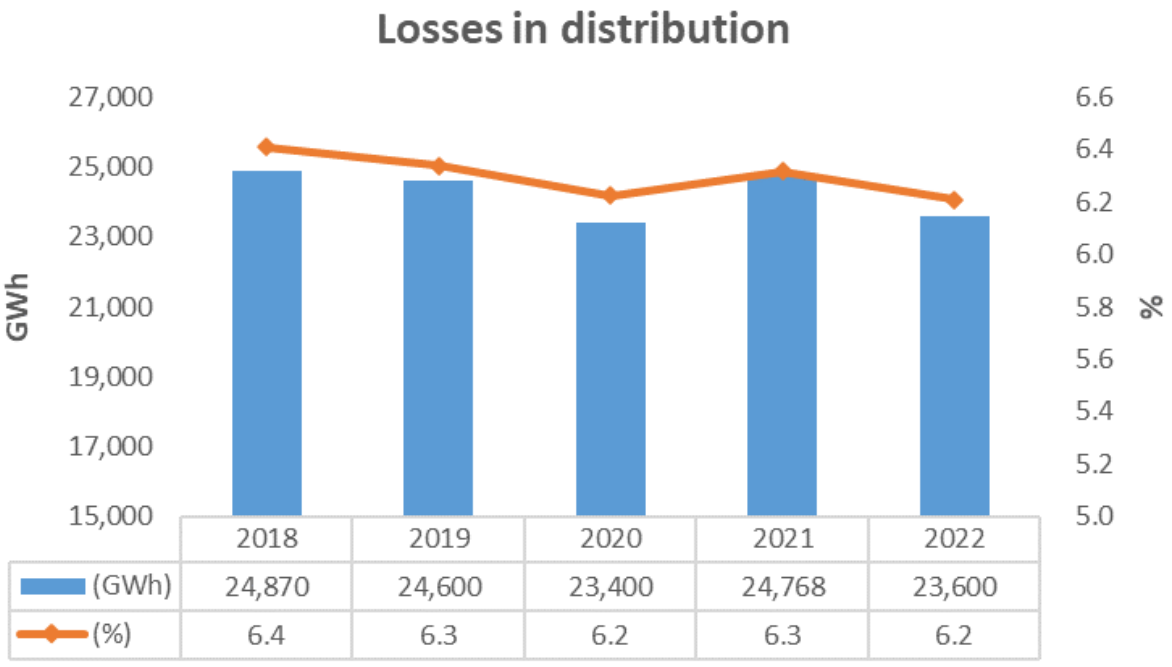
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes (both for the price and volume)
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes (both for the price and volume)
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

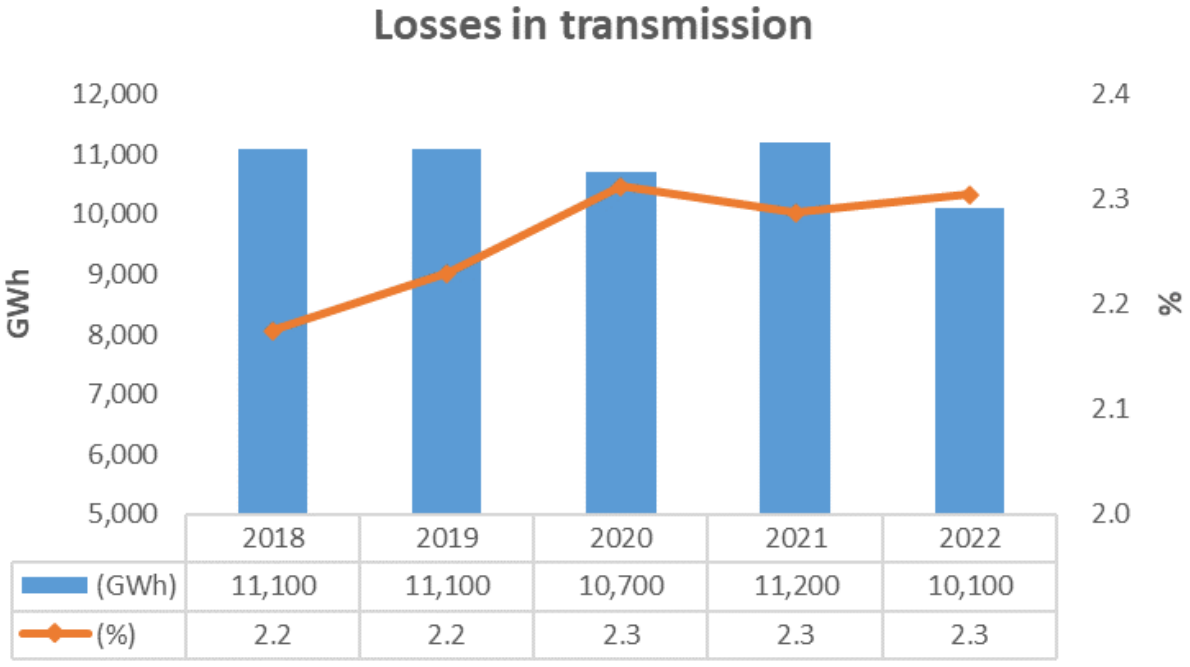
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No, except for DSOs with less than 100,000 consumers for which the price is regulated and for overseas territories.
Are costs associated with possible imbalances included in the price of losses?	Yes
Any measures to combat the currently high prices of energy to cover losses?	No

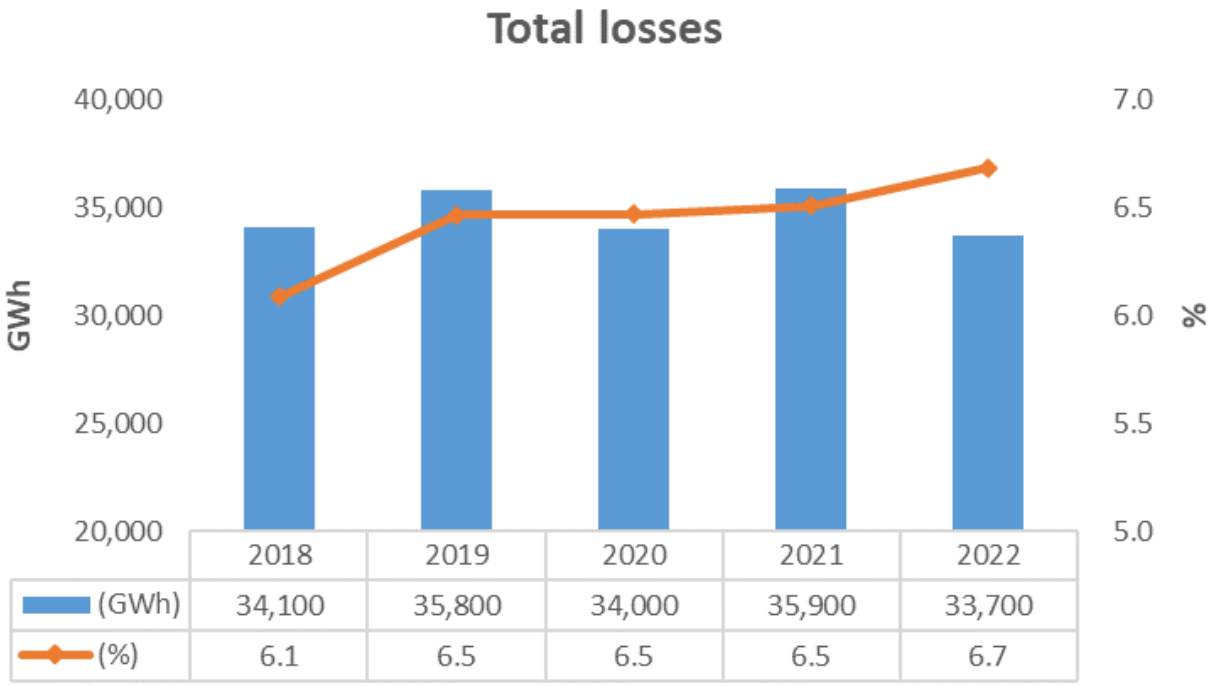
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	24,870	24,600	23,400	24,768	23,600
(%)	6.4	6.3	6.2	6.3	6.2



	2018	2019	2020	2021	2022
(GWh)	11,100	11,100	10,700	11,200	10,100
(%)	2.2	2.2	2.3	2.3	2.3



	2018	2019	2020	2021	2022
(GWh)	34,100	35,800	34,000	35,900	33,700
(%)	6.1	6.5	6.5	6.5	6.7

Georgia

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	66,140 km
Number of metering points in distribution network	1,598,426
Number of smart meters (SM) with active remote reading in distribution network	13,950
Penetration of SM with active remote reading in distribution network (per metering point)	0.9%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	No
- Theft	No
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	The NRA has a specific methodology to determine losses.
Are losses measured or estimated	Estimated

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	NRA
How are costs of procuring losses covered?	Network tariffs

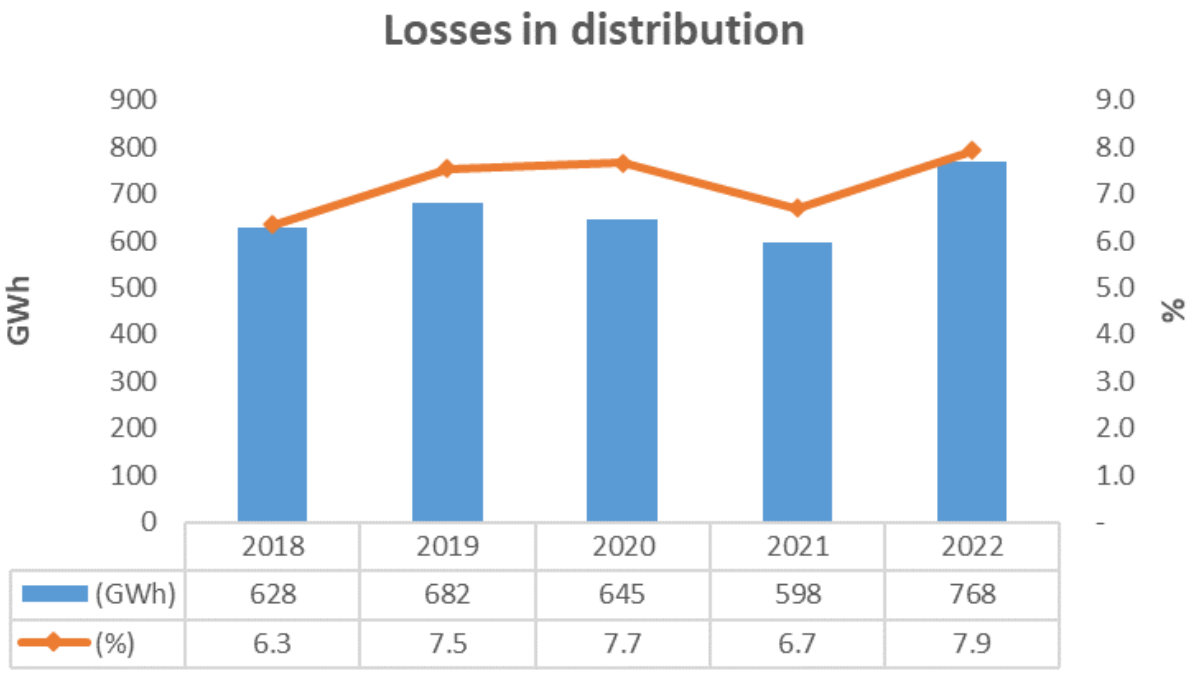
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

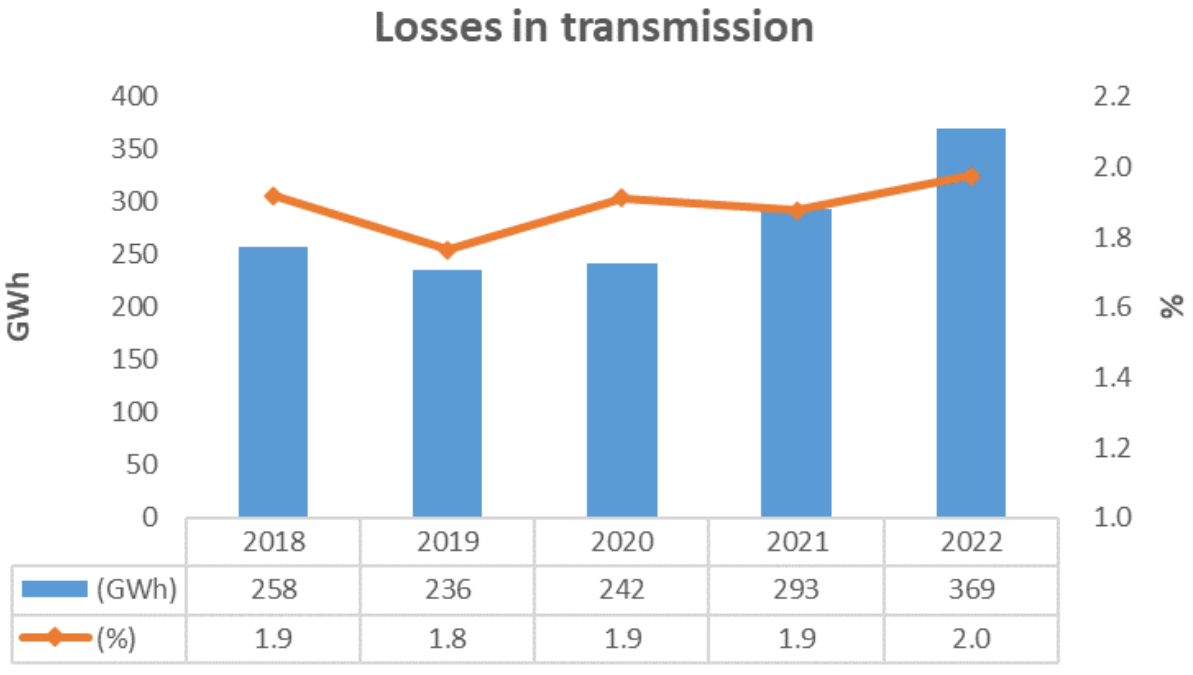
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	No

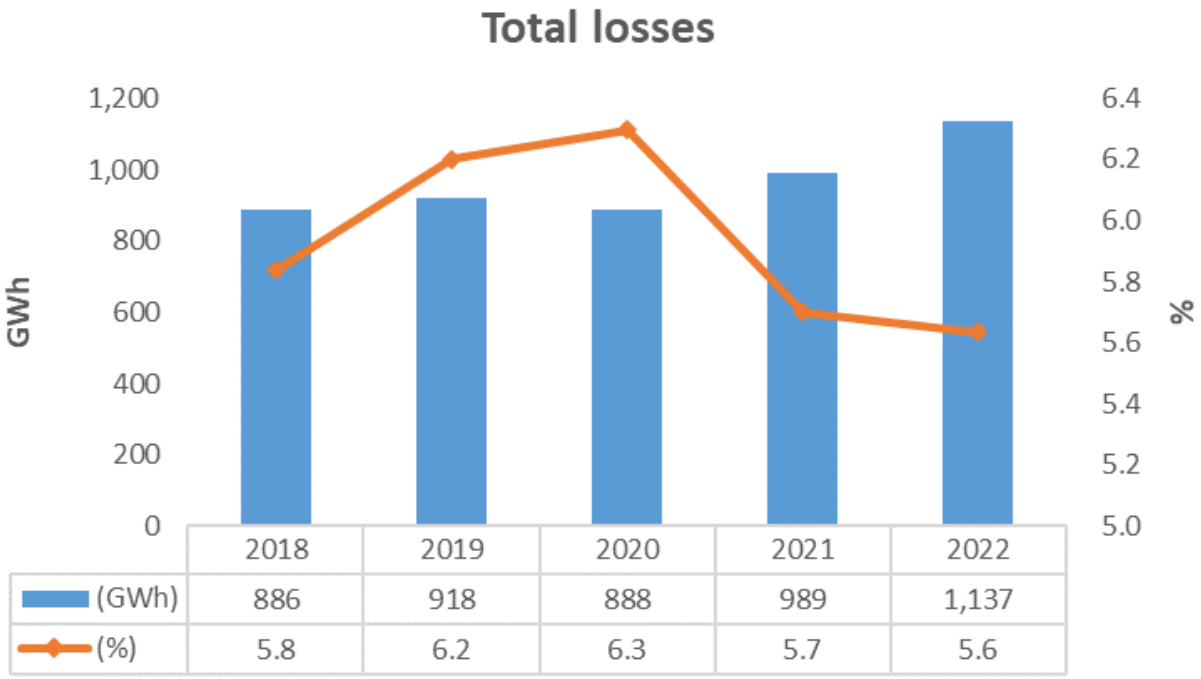
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	628	682	645	598	768
(%)	6.3	7.5	7.7	6.7	7.9



	2018	2019	2020	2021	2022
(GWh)	258	236	242	293	369
(%)	1.9	1.8	1.9	1.9	2.0



	2018	2019	2020	2021	2022
(GWh)	886	918	888	989	1,137
(%)	5.8	6.2	6.3	5.7	5.6

Germany

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	2,195,600 km
Number of metering points in distribution network	52,158,400
Number of smart meters (SM) with active remote reading in distribution network	270,095
Penetration of SM with active remote reading in distribution network (per metering point)	0.5%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	No
Components included in definition of non-technical losses	
- "hidden" non-technical losses	No
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Any method to derive the volume of losses is allowed. This includes measurement, estimation, free valuation, and calculation.
Are losses measured or estimated	Every system operator can use a method that works best for him.

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs

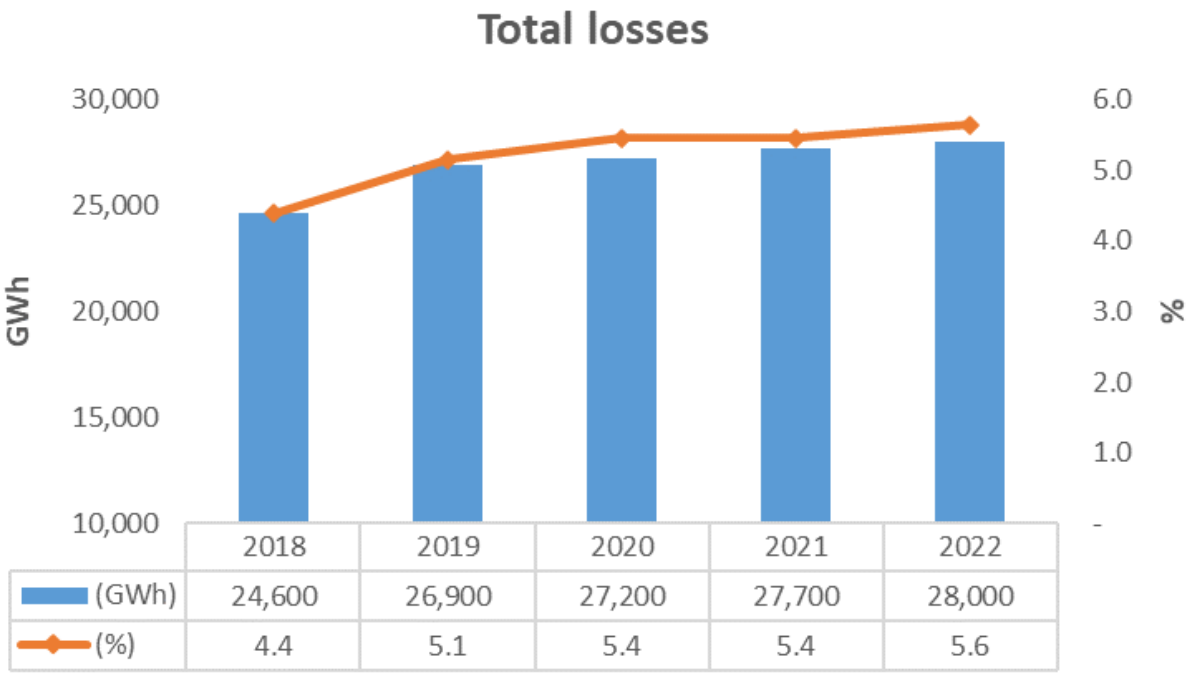
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	No (only incentives to reduce the overall cost)
Regulatory incentives to reduce losses or costs related to losses in transmission?	No (only incentives to reduce the overall cost)
Are non-technical losses included in published losses and in regulation of losses?	No
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes (set by the NRA BNetzA)
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	No

VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	24,600	26,900	27,200	27,700	28,000
(%)	4.4	5.1	5.4	5.4	5.6

Losses as percentage in distribution and transmission could not be calculated due to missing data.

Great Britain

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	807,504 km
Number of metering points in distribution network	30,200,980
Number of smart meters (SM) with active remote reading in distribution network	
Penetration of SM with active remote reading in distribution network (per metering point)	
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	No
- Non-metered consumption (e.g. public lighting)	Yes, in both distribution and transmission
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Measured at transmission level between the infeed and output. It is then modelled as to the losses on the actual components.
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	Supplier
Party responsible for forecasting / estimating power losses	No specific requirement to forecast losses
How are costs of procuring losses covered?	

REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	No
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	Yes (for transmission)

PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	N/A
Any measures to combat the currently high prices of energy to cover losses?	No

VALUES OF LOSSES

Losses as percentage could not be calculated due to missing data.

Greece

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	245 876 km
Number of metering points in distribution network	7,671,479
Number of smart meters (SM) with active remote reading in distribution network	
Penetration of SM with active remote reading in distribution network (per metering point)	
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Through tariffs

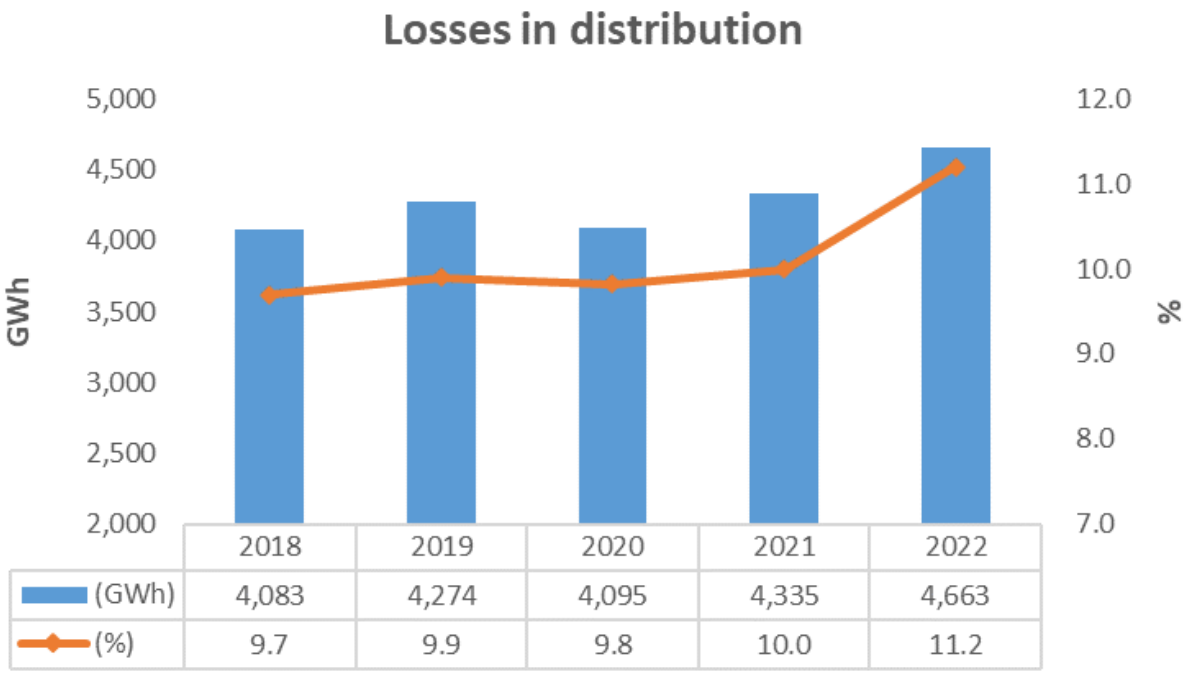
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

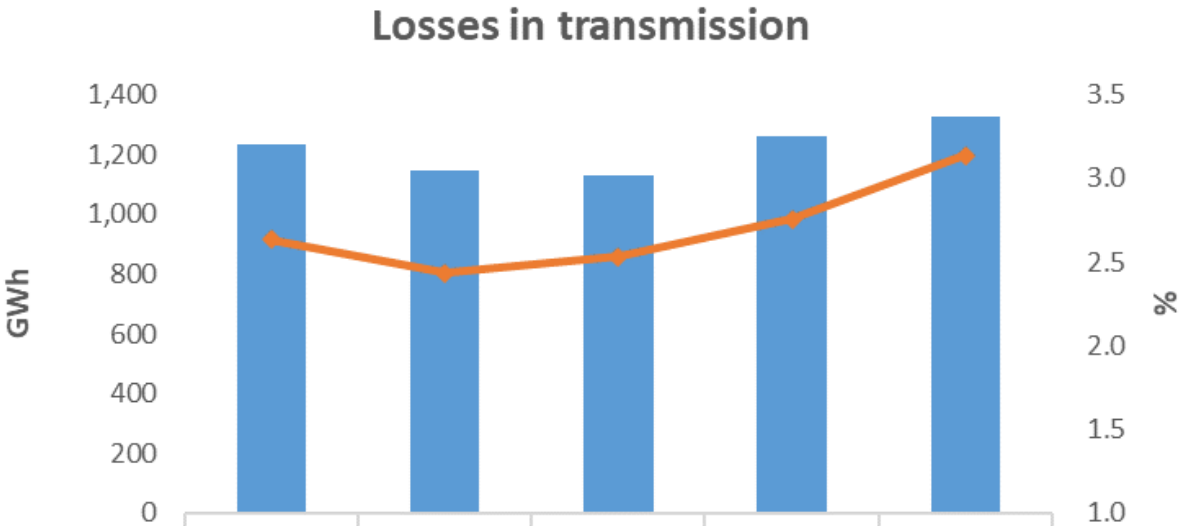
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	Yes
Any measures to combat the currently high prices of energy to cover losses?	No

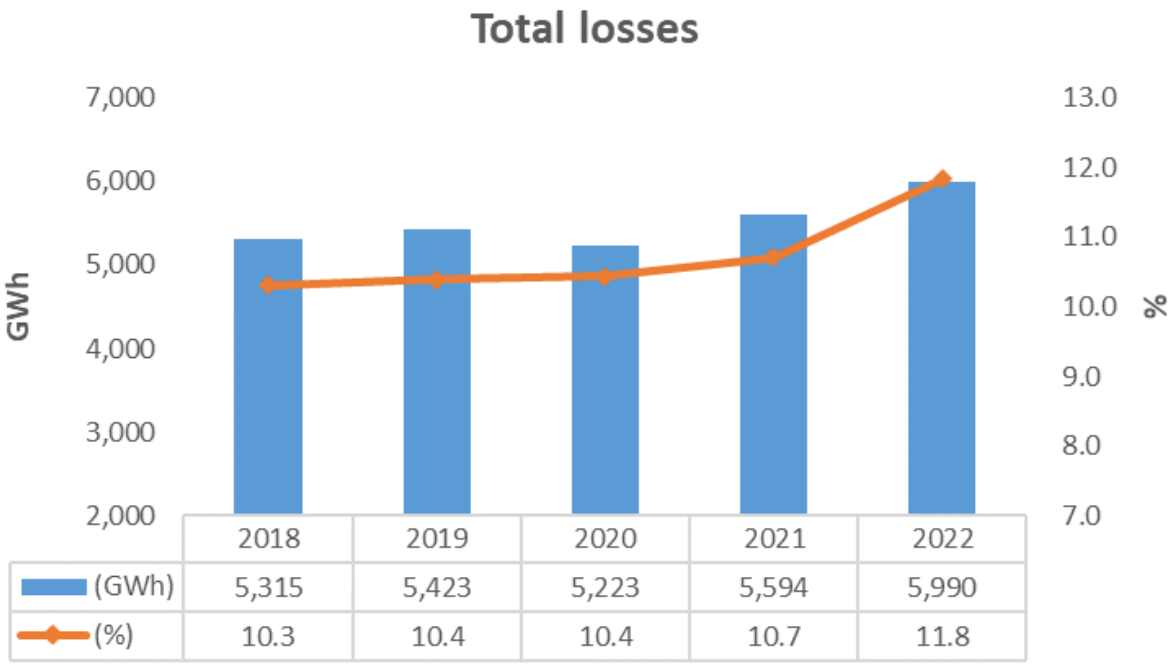
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	4,083	4,274	4,095	4,335	4,663
(%)	9.7	9.9	9.8	10.0	11.2



	2018	2019	2020	2021	2022
(GWh)	1,232	1,149	1,128	1,259	1,327
(%)	2.6	2.4	2.5	2.8	3.1



	2018	2019	2020	2021	2022
(GWh)	5,315	5,423	5,223	5,594	5,990
(%)	10.3	10.4	10.4	10.7	11.8

Hungary

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	167,796 km
Number of metering points in distribution network	5,698,942
Number of smart meters (SM) with active remote reading in distribution network	525,163
Penetration of SM with active remote reading in distribution network (per metering point)	9.2%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	Yes, in distribution
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Measured in transmission. Estimated in distribution.
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	TSO
How are costs of procuring losses covered?	Included in tariffs

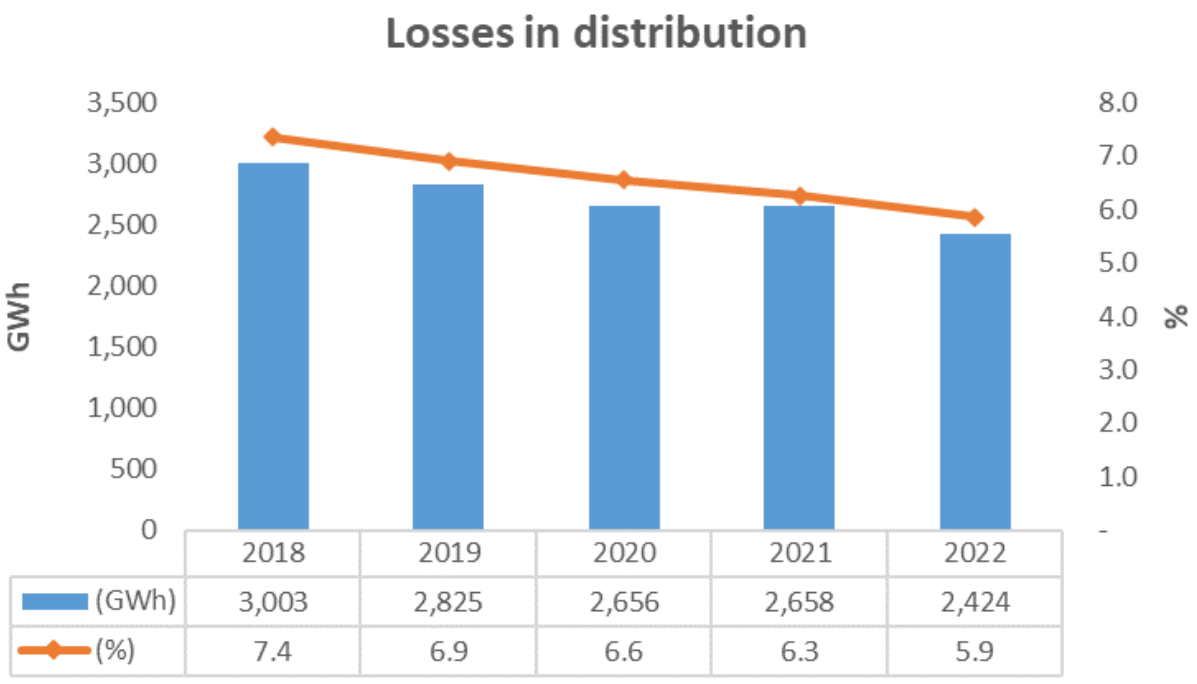
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

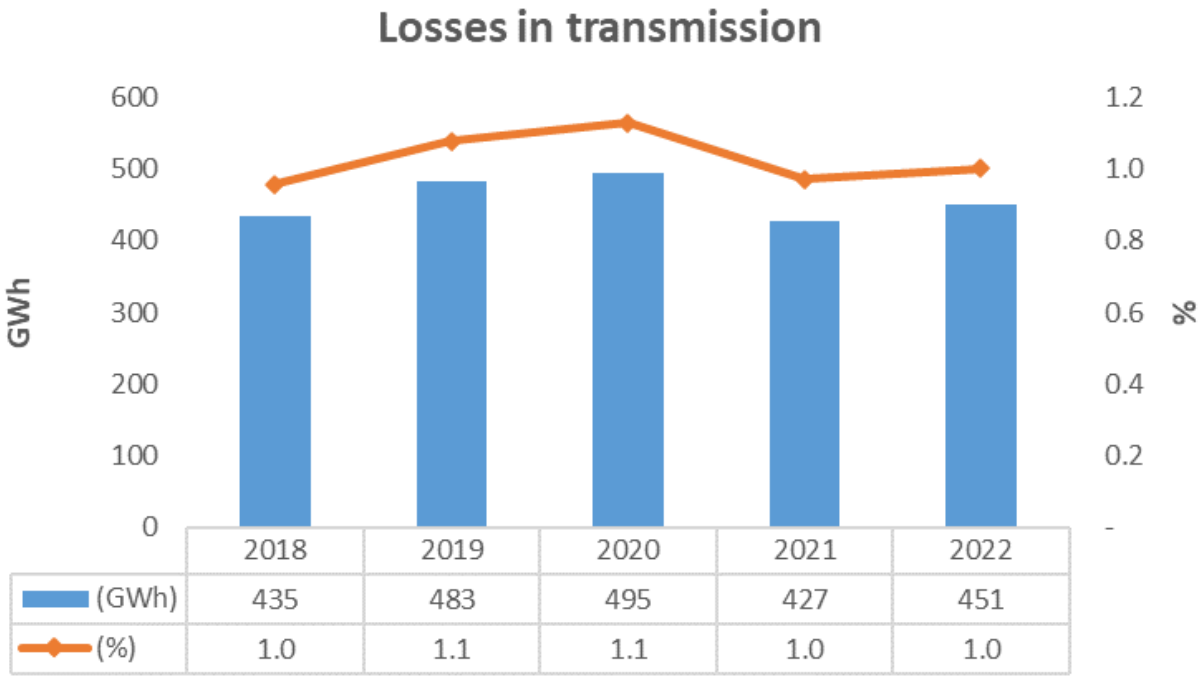
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	N/A

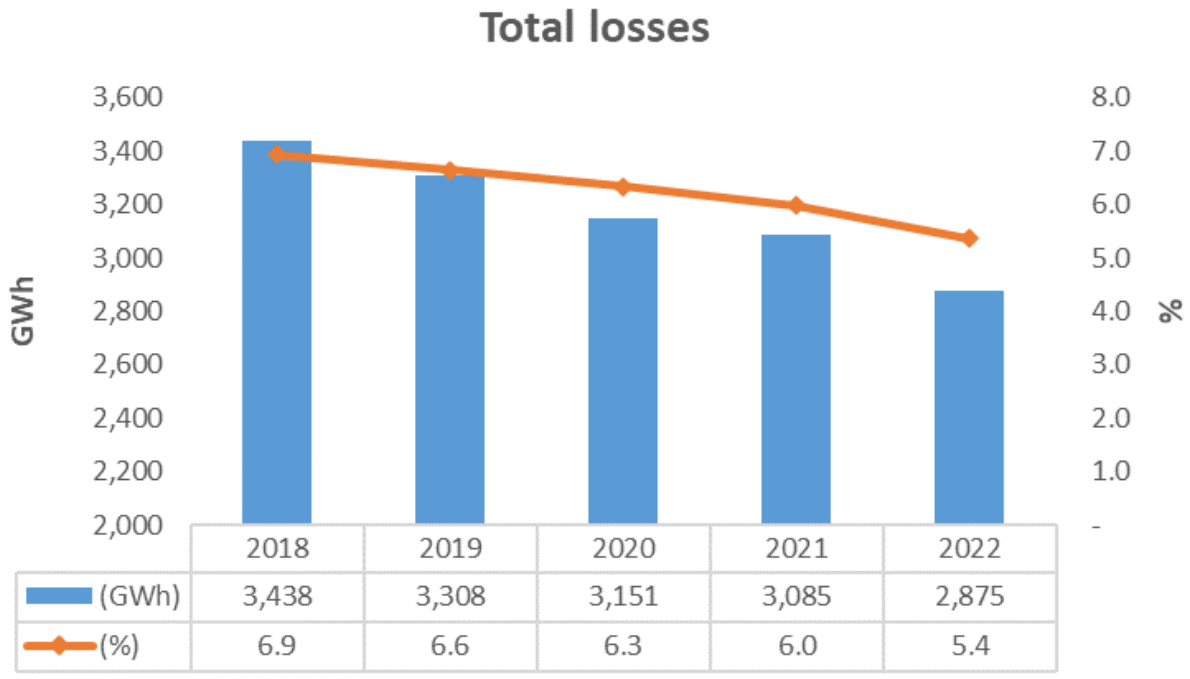
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	3,003	2,825	2,656	2,658	2,424
(%)	7.4	6.9	6.6	6.3	5.9



	2018	2019	2020	2021	2022
(GWh)	435	483	495	427	451
(%)	1.0	1.1	1.1	1.0	1.0



	2018	2019	2020	2021	2022
(GWh)	3,438	3,308	3,151	3,085	2,875
(%)	6.9	6.6	6.3	6.0	5.4

Iceland

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	4,998 km
Number of metering points in distribution network	
Number of smart meters (SM) with active remote reading in distribution network	
Penetration of SM with active remote reading in distribution network (per metering point)	
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Auction for TSO

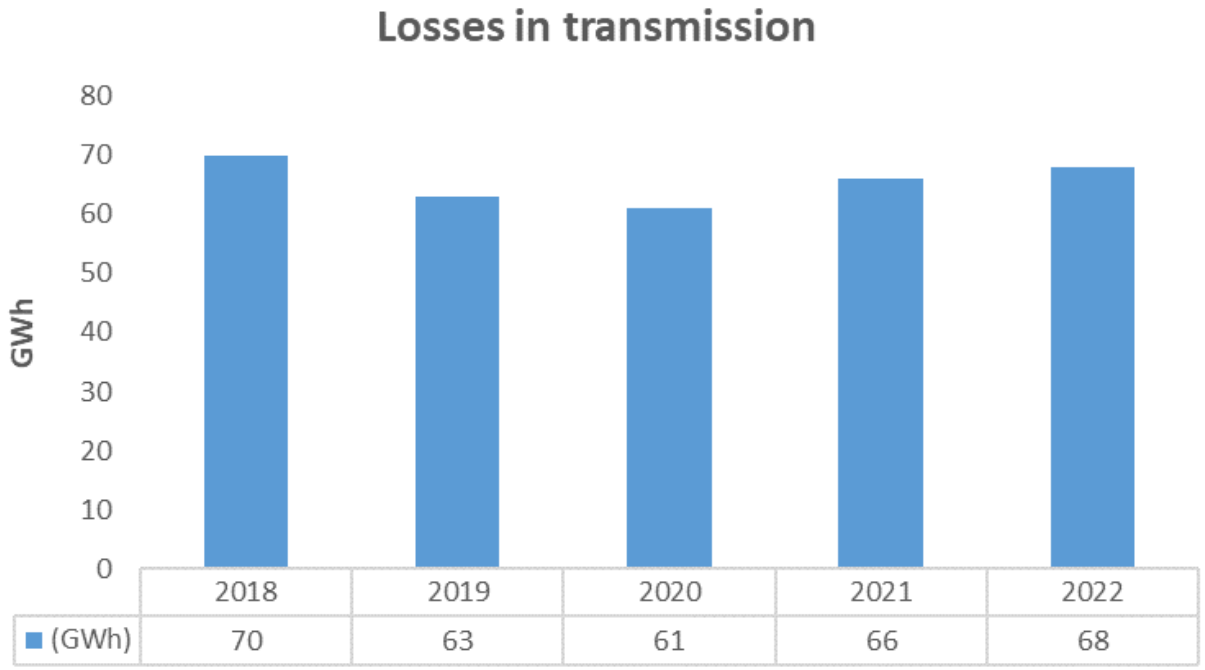
REGULATORY FRAMEWORK

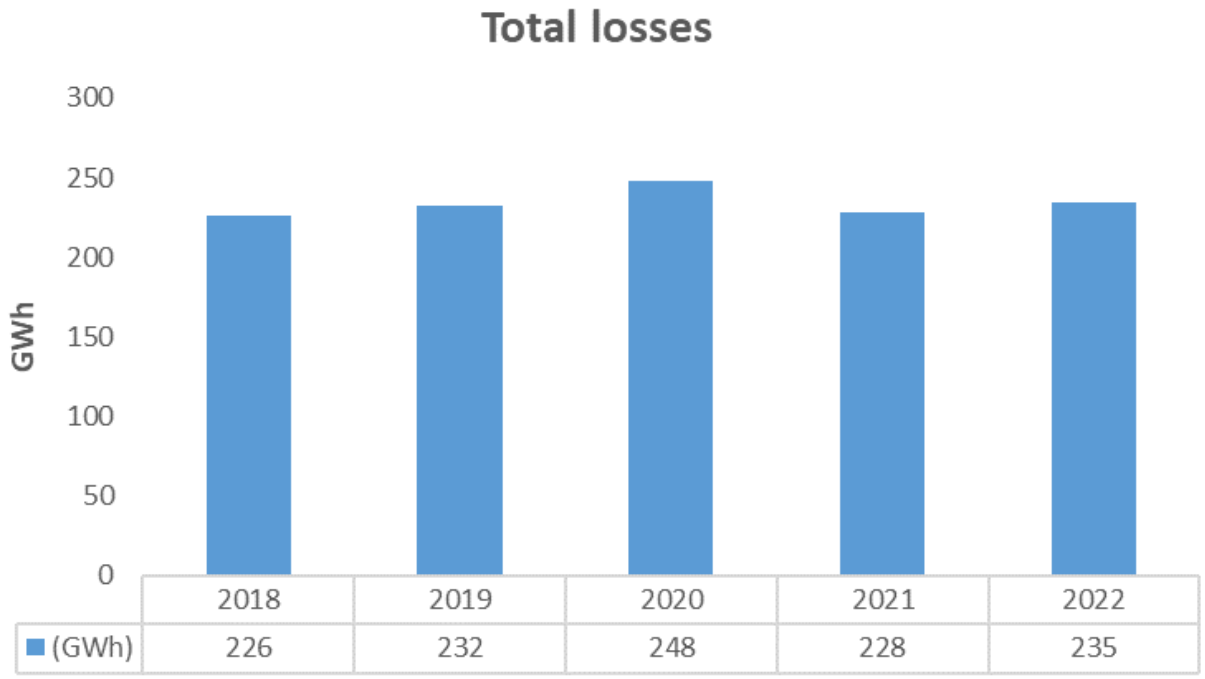
Regulatory incentives to reduce losses or costs related to losses in distribution?	N/A
Regulatory incentives to reduce losses or costs related to losses in transmission?	N/A
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	Yes

PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	N/A
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	N/A

VALUES OF LOSSES





Losses as percentage could not be calculated due to missing data.

Ireland

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	179,900 km
Number of metering points in distribution network	2,382,707
Number of smart meters (SM) with active remote reading in distribution network	1,070,000
Penetration of SM with active remote reading in distribution network (per metering point)	44.9%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Estimated

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	Supplier
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Through the market

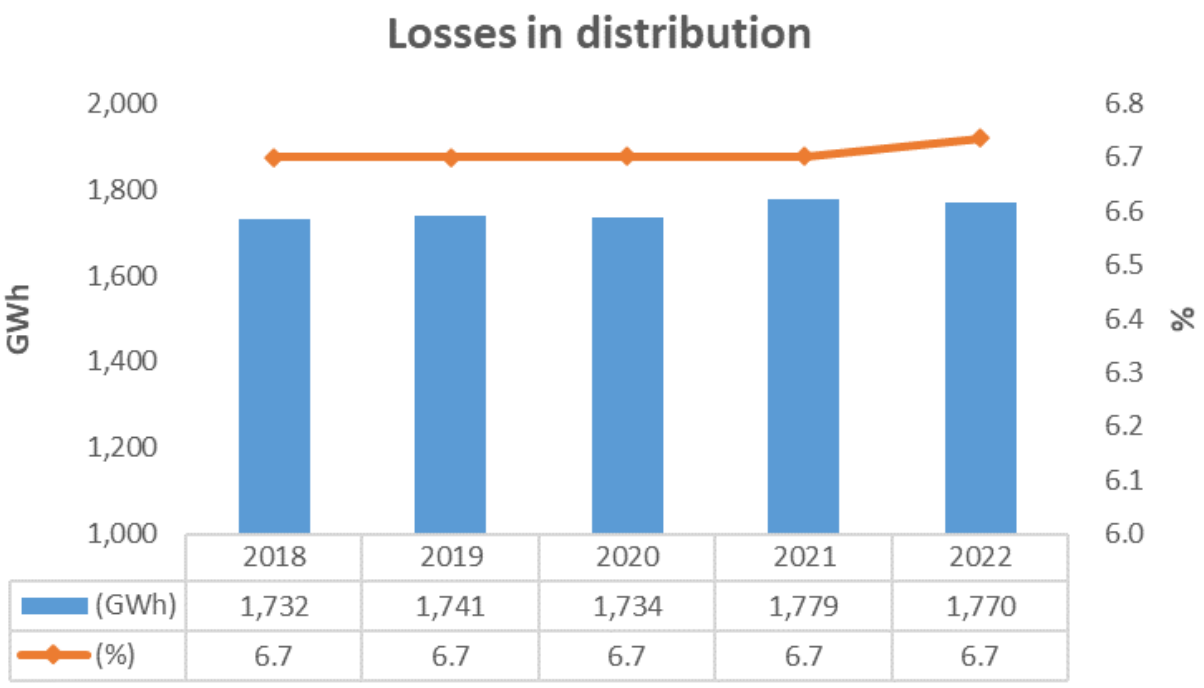
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	N/A
Regulatory incentives to reduce losses or costs related to losses in transmission?	N/A
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	Yes

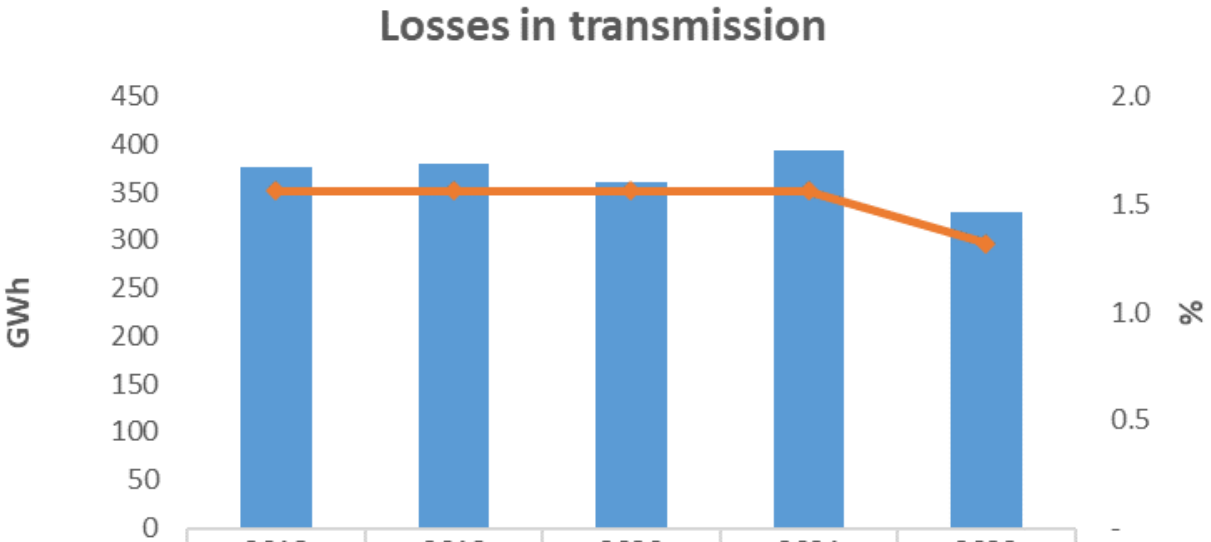
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	No
Any measures to combat the currently high prices of energy to cover losses?	No

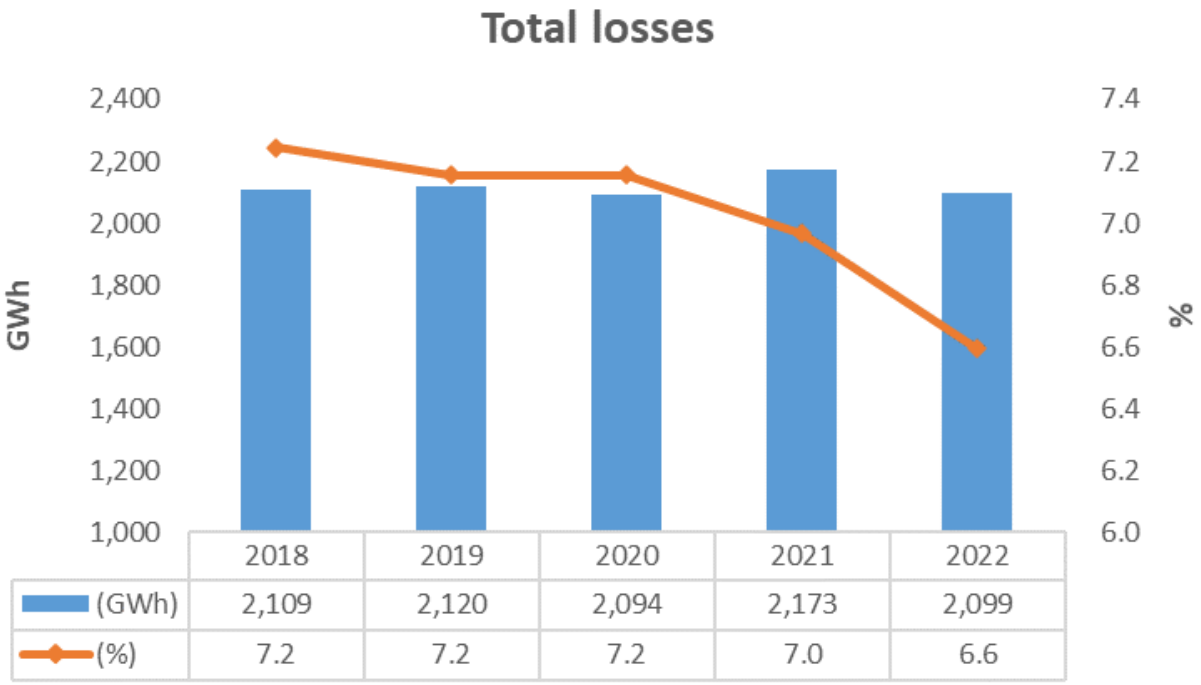
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	1,732	1,741	1,734	1,779	1,770
(%)	6.7	6.7	6.7	6.7	6.7



	2018	2019	2020	2021	2022
(GWh)	376	379	360	394	329
(%)	1.6	1.6	1.6	1.6	1.3



	2018	2019	2020	2021	2022
(GWh)	2,109	2,120	2,094	2,173	2,099
(%)	7.2	7.2	7.2	7.0	6.6

Italy

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	1,281,547 km
Number of metering points in distribution network	Approx. 38,000,000
Number of smart meters (SM) with active remote reading in distribution network	Approx. 38,000,000
Penetration of SM with active remote reading in distribution network (per metering point)	99.7%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in distribution
Components included in definition of non-technical losses	
- "hidden" non-technical losses	No
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in distribution
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	Supplier
Party responsible for forecasting / estimating power losses	NRA
How are costs of procuring losses covered?	BRP (through suppliers) pass the costs to end consumers

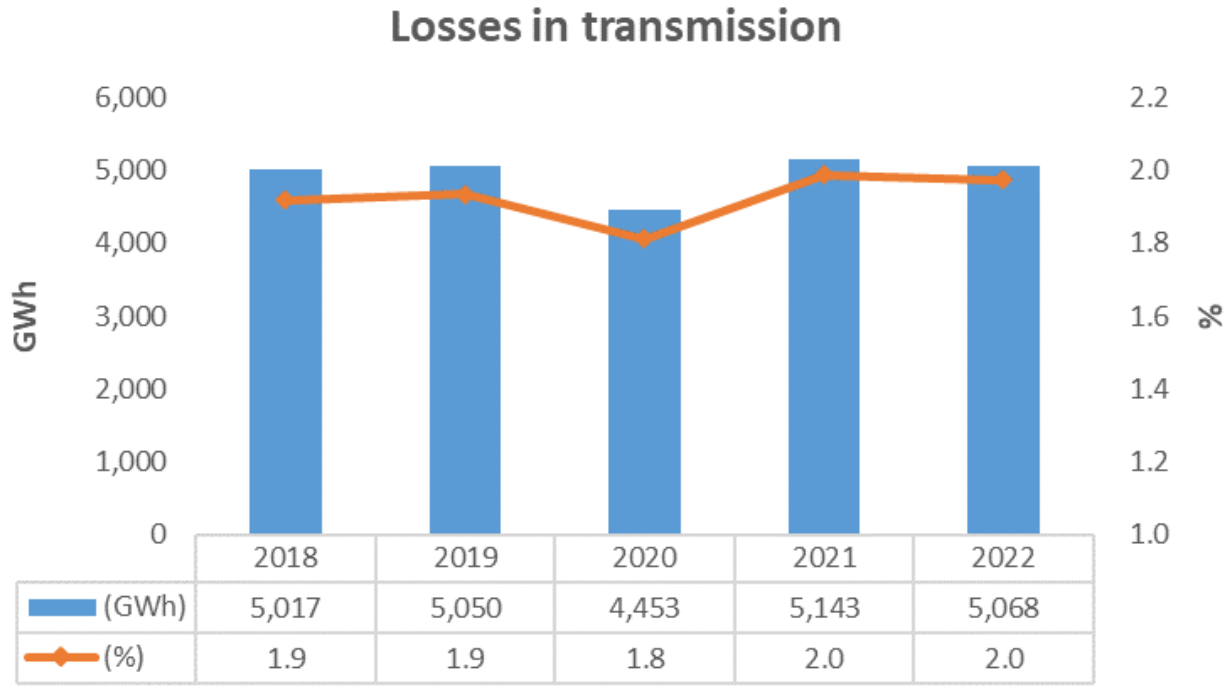
REGULATORY FRAMEWORK

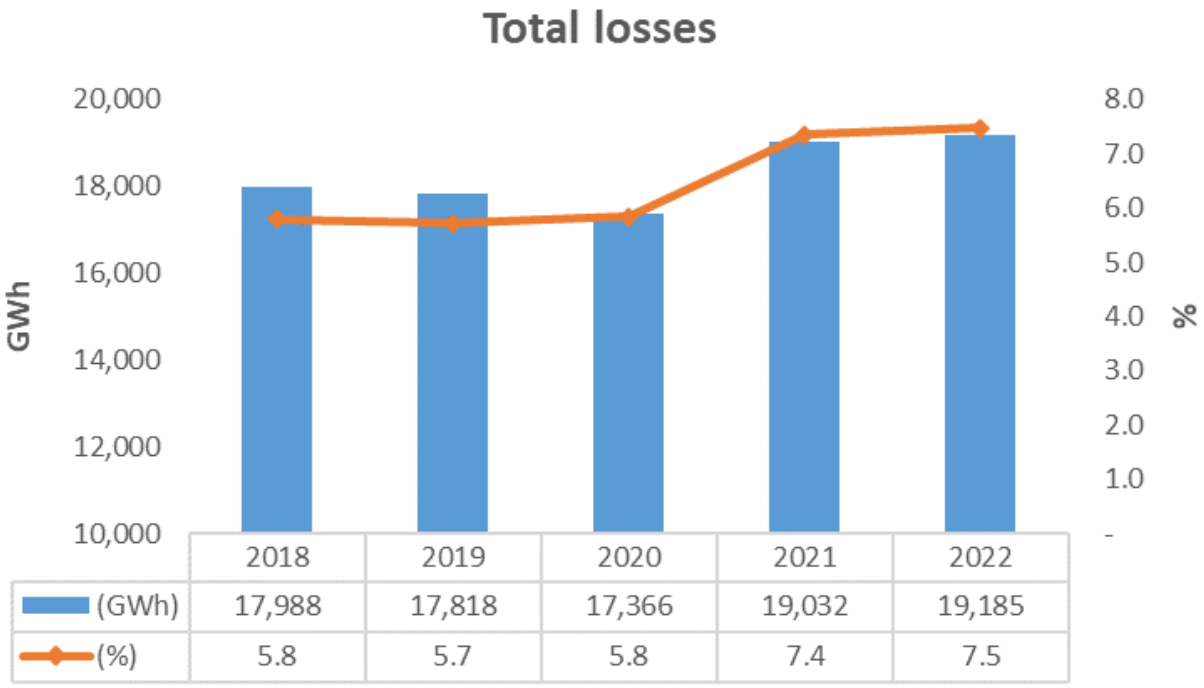
Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	No
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	No

VALUES OF LOSSES





	2018	2019	2020	2021	2022
(GWh)	17,988	17,818	17,366	19,032	19,185
(%)	5.8	5.7	5.8	7.4	7.5

Losses as percentage (in distribution) could not be calculated due to missing data.

Kosovo*

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	1,430.1 km
Number of metering points in distribution network	678,816
Number of smart meters (SM) with active remote reading in distribution network	
Penetration of SM with active remote reading in distribution network (per metering point)	
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in distribution
- Non-metered consumption (e.g. public lighting)	Yes, in distribution
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in distribution
How are losses determined?	
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	

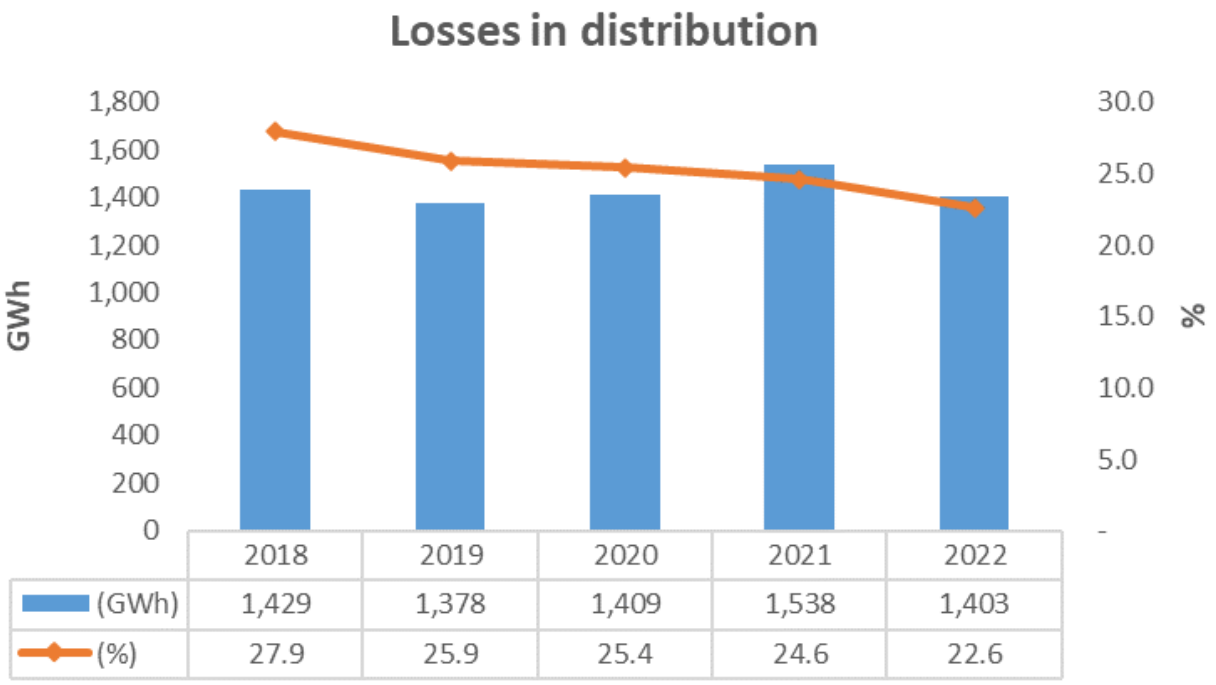
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	No
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

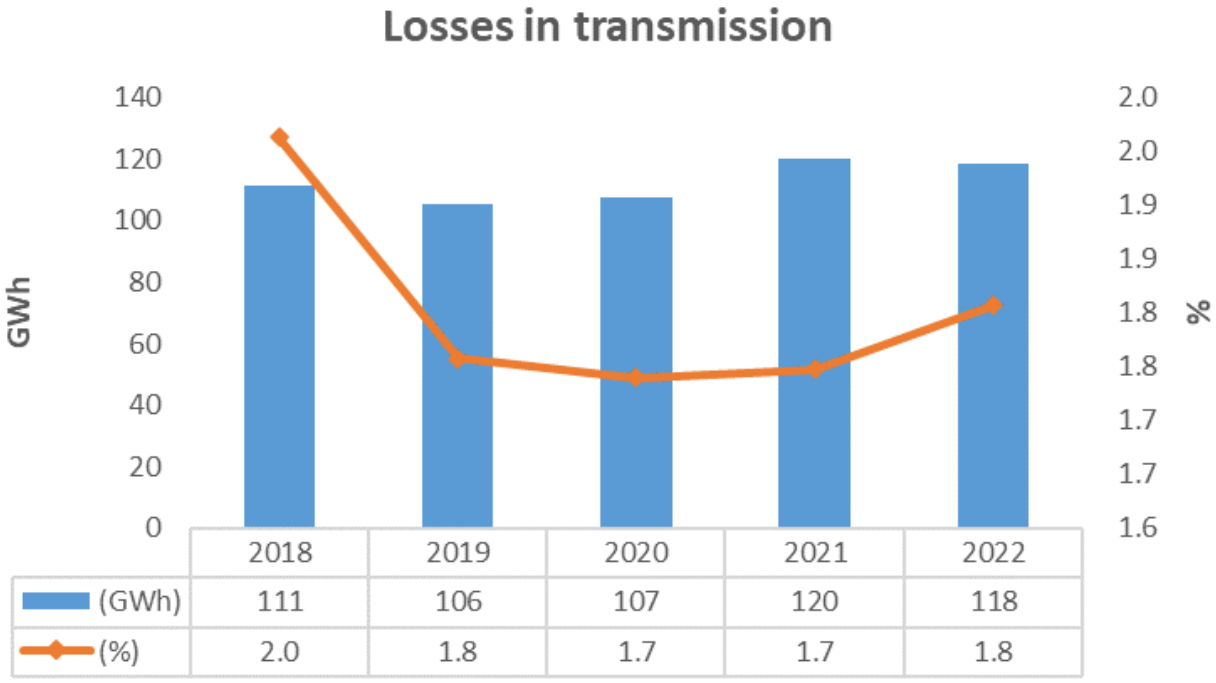
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	

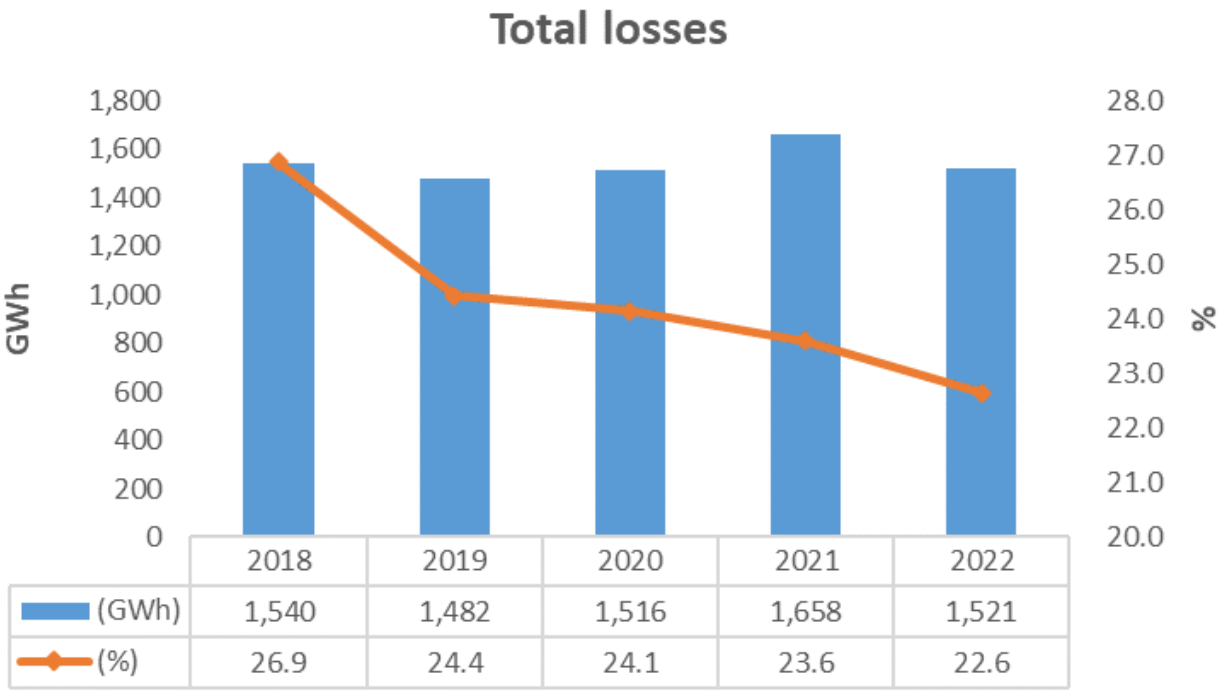
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	1,429	1,378	1,409	1,538	1,403
(%)	27.9	25.9	25.4	24.6	22.6



	2018	2019	2020	2021	2022
(GWh)	111	106	107	120	118
(%)	2.0	1.8	1.7	1.7	1.8



	2018	2019	2020	2021	2022
(GWh)	1,540	1,482	1,516	1,658	1,521
(%)	26.9	24.4	24.1	23.6	22.6

Latvia

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	100,191 km
Number of metering points in distribution network	1,118,342
Number of smart meters (SM) with active remote reading in distribution network	961,673
Penetration of SM with active remote reading in distribution network (per metering point)	86.0%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	No
- Non-metered consumption (e.g. public lighting)	Yes, in both distribution and transmission
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Measured

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs

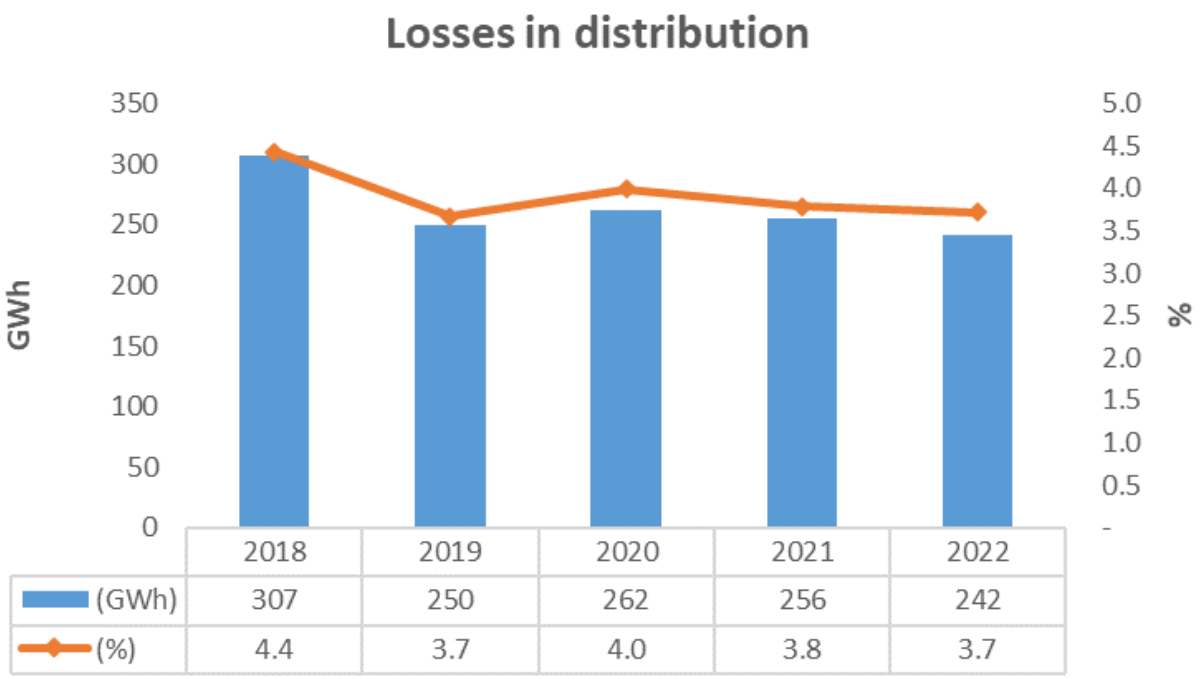
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	No
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

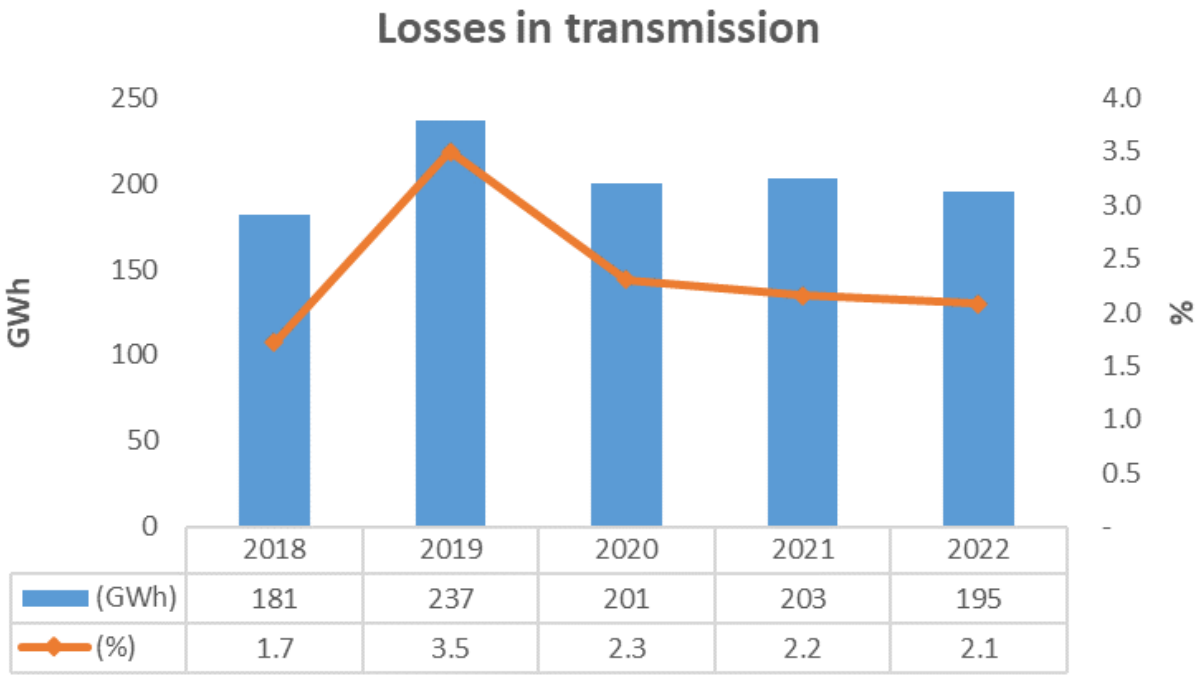
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	No
Any measures to combat the currently high prices of energy to cover losses?	No

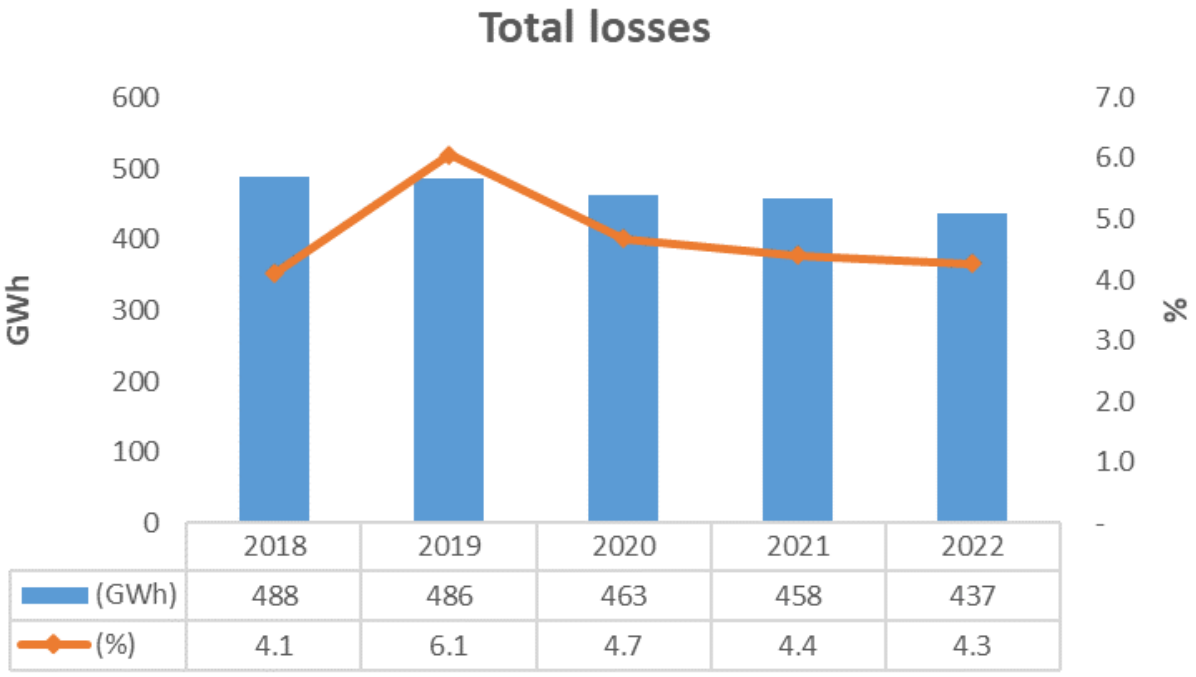
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	307	250	262	256	242
(%)	4.4	3.7	4.0	3.8	3.7



	2018	2019	2020	2021	2022
(GWh)	181	237	201	203	195
(%)	1.7	3.5	2.3	2.2	2.1



	2018	2019	2020	2021	2022
(GWh)	488	486	463	458	437
(%)	4.1	6.1	4.7	4.4	4.3

Lithuania

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	127,504 km
Number of metering points in distribution network	1,891,217
Number of smart meters (SM) with active remote reading in distribution network	210,464
Penetration of SM with active remote reading in distribution network (per metering point)	11.1%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	No
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in distribution
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs

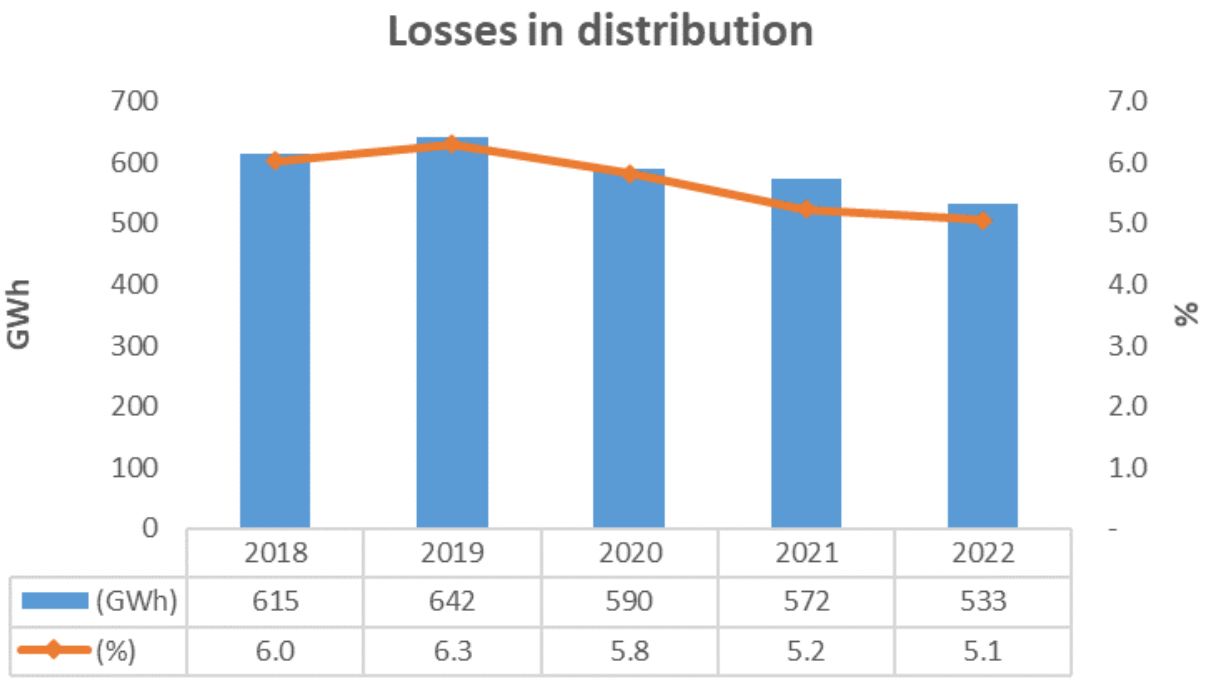
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	N/A

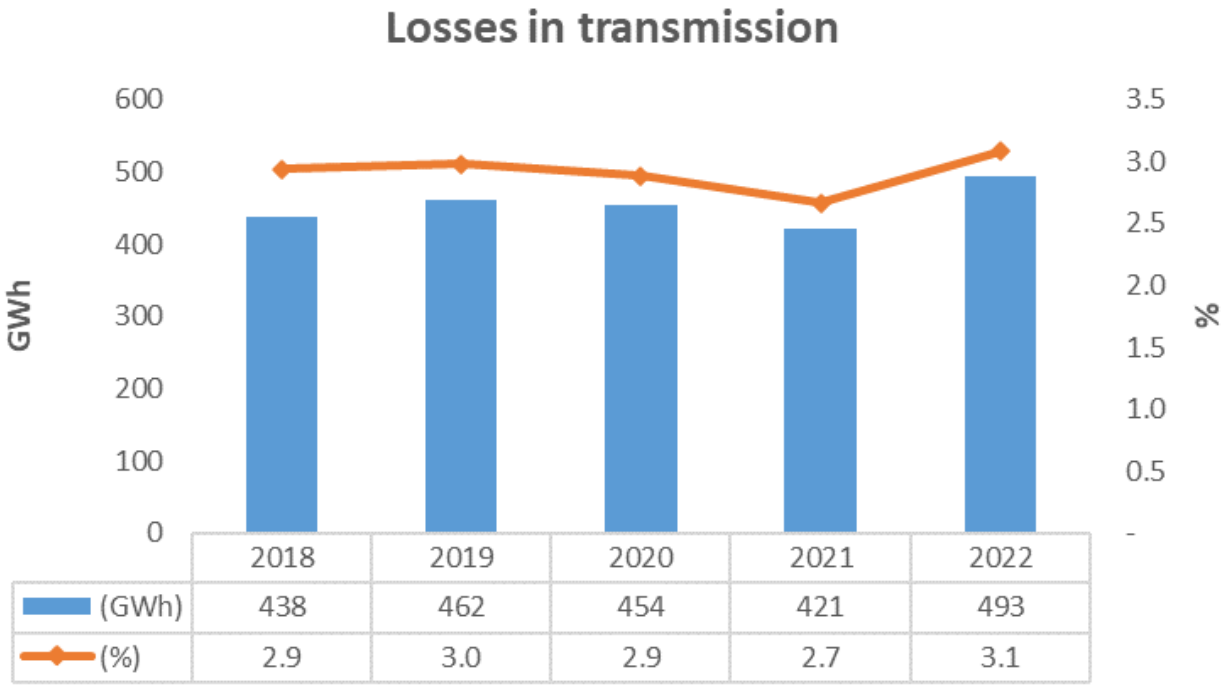
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	N/A
Any measures to combat the currently high prices of energy to cover losses?	Yes

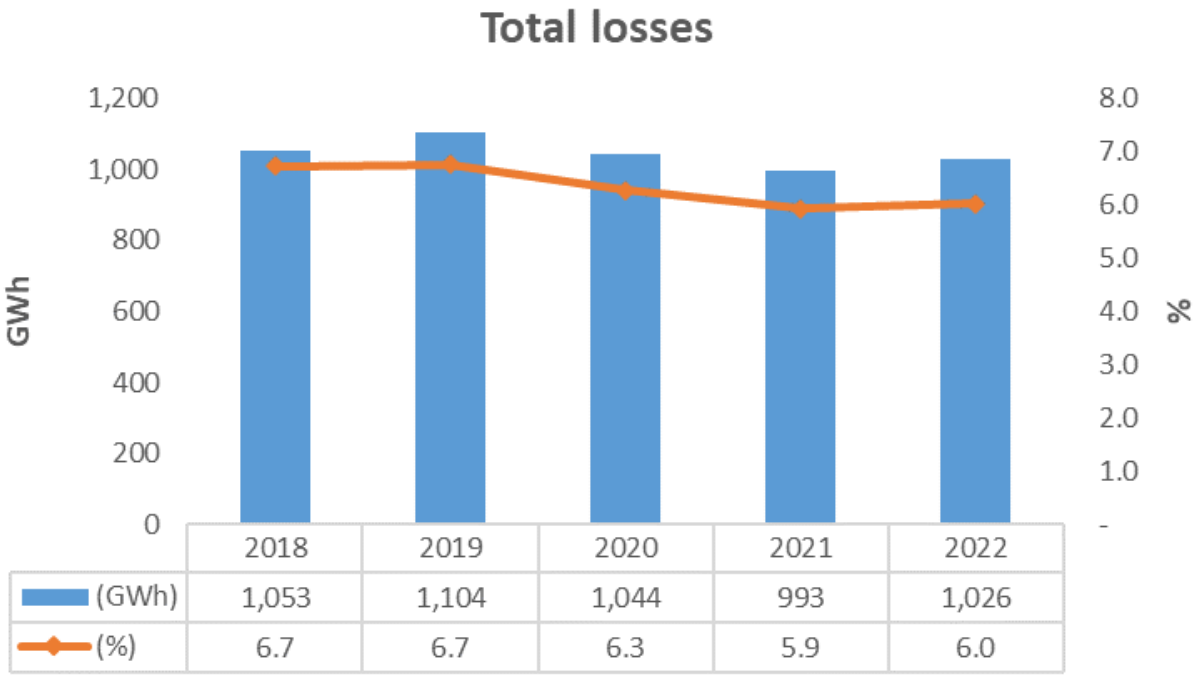
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	615	642	590	572	533
(%)	6.0	6.3	5.8	5.2	5.1



	2018	2019	2020	2021	2022
(GWh)	438	462	454	421	493
(%)	2.9	3.0	2.9	2.7	3.1



	2018	2019	2020	2021	2022
(GWh)	1,053	1,104	1,044	993	1,026
(%)	6.7	6.7	6.3	5.9	6.0

Luxembourg

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	12,330 km
Number of metering points in distribution network	337,811
Number of smart meters (SM) with active remote reading in distribution network	334,201
Penetration of SM with active remote reading in distribution network (per metering point)	98.9%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Calculation by TSO and difference between injected and consumed energy
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	TSO (TSO and the main DSO with >90% of customers are the same company)
How are costs of procuring losses covered?	System operator grid fees (provided the costs are reasonable)

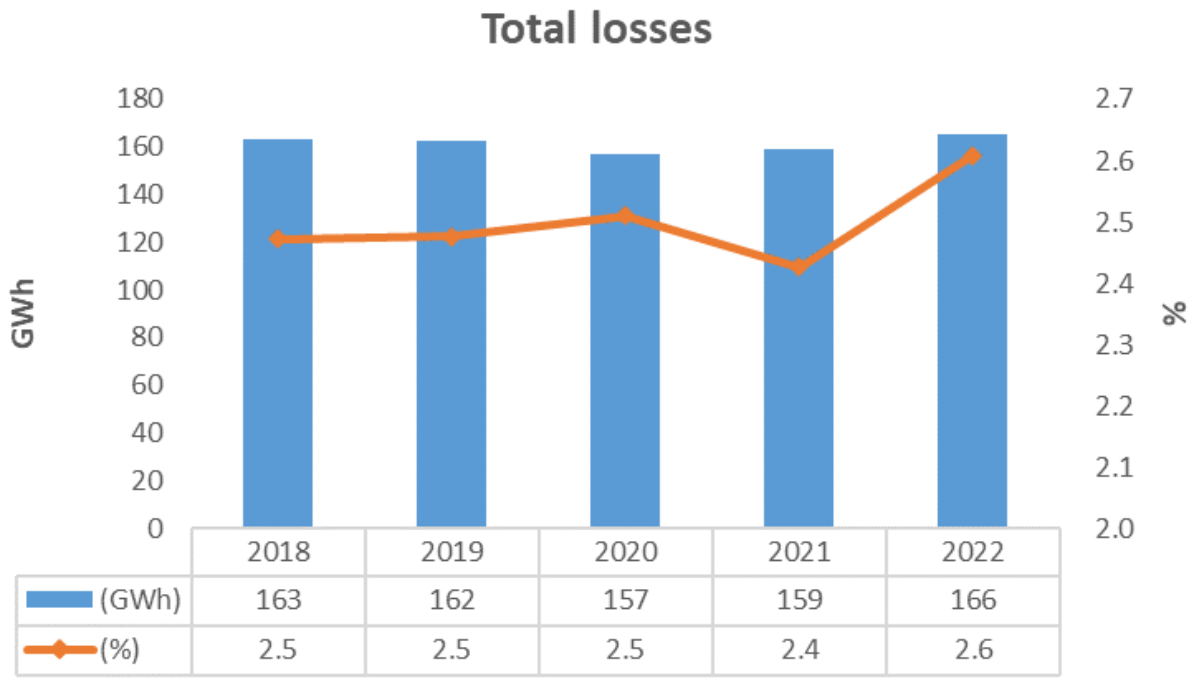
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	No (the cost of losses is pass-through)
Regulatory incentives to reduce losses or costs related to losses in transmission?	No (the cost of losses is pass-through)
Are non-technical losses included in published losses and in regulation of losses?	
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	Yes
Any measures to combat the currently high prices of energy to cover losses?	Yes

VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	163	162	157	159	166
(%)	2.5	2.5	2.5	2.4	2.6

Losses in distribution and transmission could not be separately calculated due to missing data.

Malta

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	6,066.26 km
Number of metering points in distribution network	367,195
Number of smart meters (SM) with active remote reading in distribution network	337,922
Penetration of SM with active remote reading in distribution network (per metering point)	92.0%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in distribution (no transmission system in Malta)
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in distribution (no transmission system in Malta)
- Non-metered consumption (e.g. public lighting)	Yes, in distribution (no transmission system in Malta)
- Theft	Yes, in distribution (no transmission system in Malta)
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in distribution (no transmission system in Malta)
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO
Party responsible for forecasting / estimating power losses	DSO
How are costs of procuring losses covered?	Covered by all-inclusive retail tariffs. There is no separate tariff to cover losses.

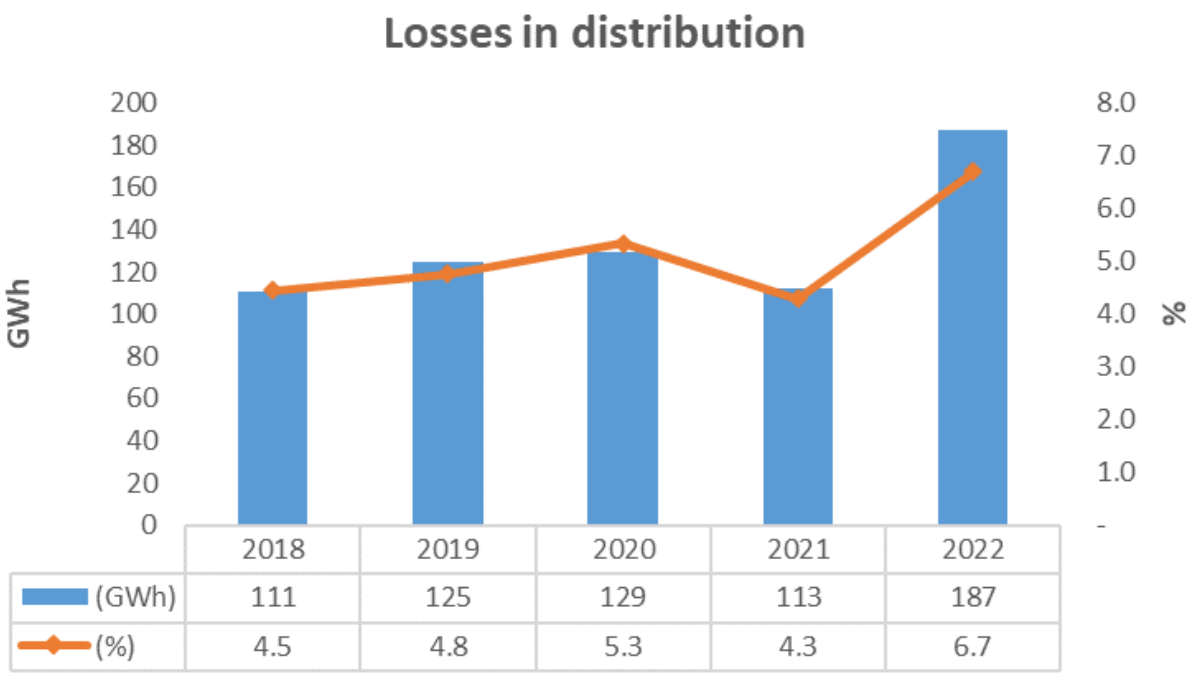
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	No
Regulatory incentives to reduce losses or costs related to losses in transmission?	
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

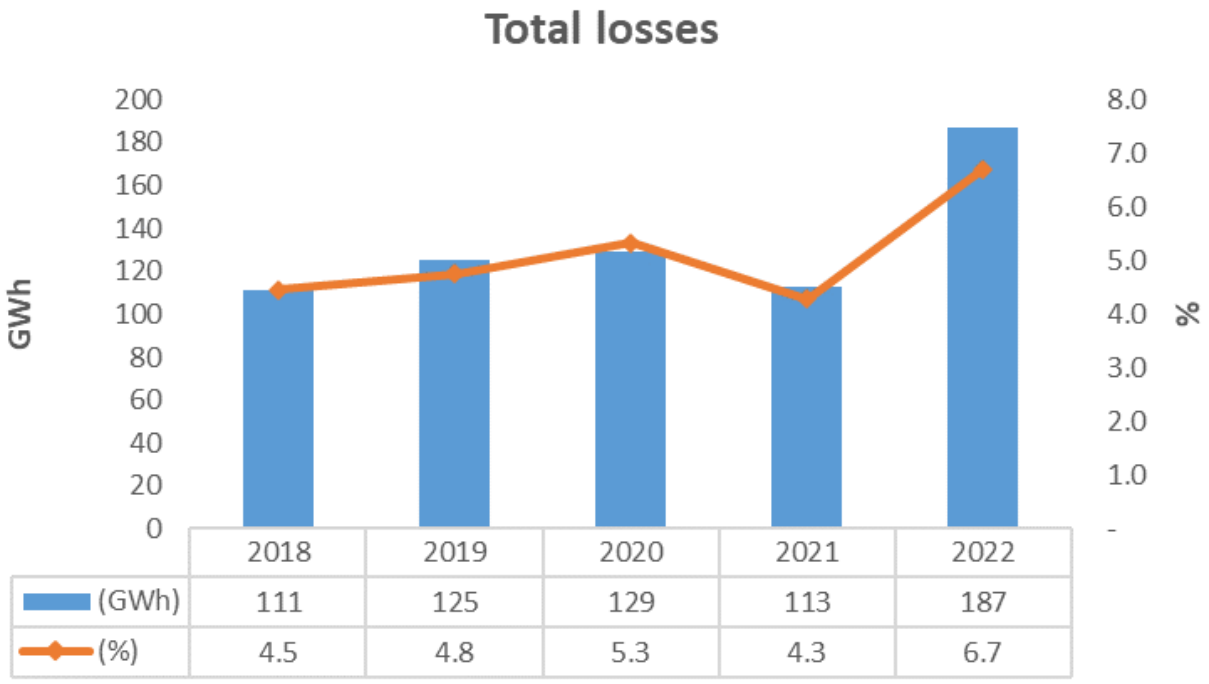
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	No

VALUES OF LOSSES



There is no transmission grid in Malta, so the losses in distribution are equal to total losses. Malta has been importing energy from Italy since the electricity link became operational in 2015.



Moldova

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	56,993 km
Number of metering points in distribution network	1,431,997
Number of smart meters (SM) with active remote reading in distribution network	
Penetration of SM with active remote reading in distribution network (per metering point)	
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	No
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Measured

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO
Party responsible for forecasting / estimating power losses	NRA
How are costs of procuring losses covered?	Network tariffs

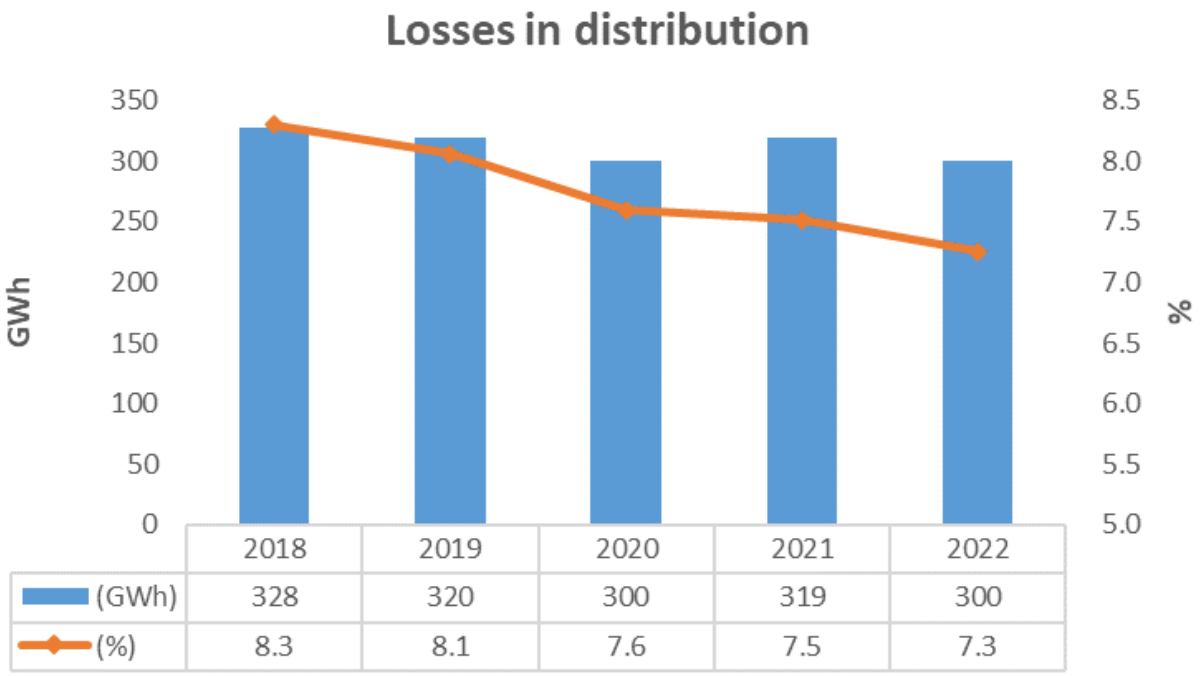
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

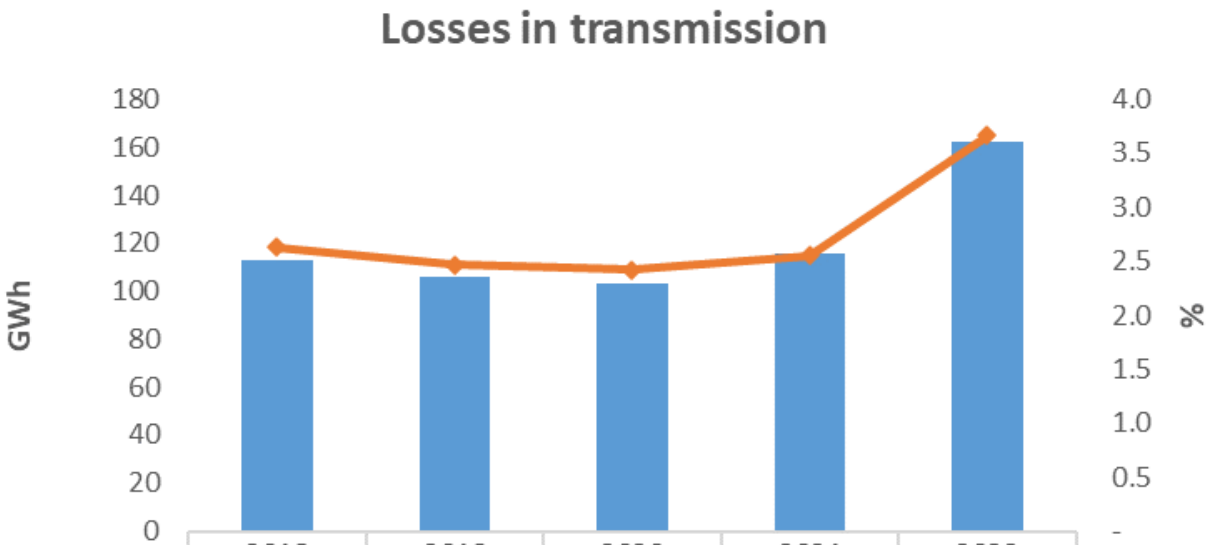
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	Yes
Any measures to combat the currently high prices of energy to cover losses?	

VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	328	320	300	319	300
(%)	8.3	8.1	7.6	7.5	7.3



	2018	2019	2020	2021	2022
(GWh)	113	106	103	116	162
(%)	2.6	2.5	2.4	2.5	3.7

Total losses as percentage could not be calculated due to missing data.

Montenegro

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	20,115 km
Number of metering points in distribution network	425,816
Number of smart meters (SM) with active remote reading in distribution network	361,943
Penetration of SM with active remote reading in distribution network (per metering point)	85.0%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in distribution
Components included in definition of non-technical losses	
- "hidden" non-technical losses	No
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Estimated

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	System operators
Party responsible for forecasting / estimating power losses	System operators
How are costs of procuring losses covered?	Network tariffs (technical losses only)

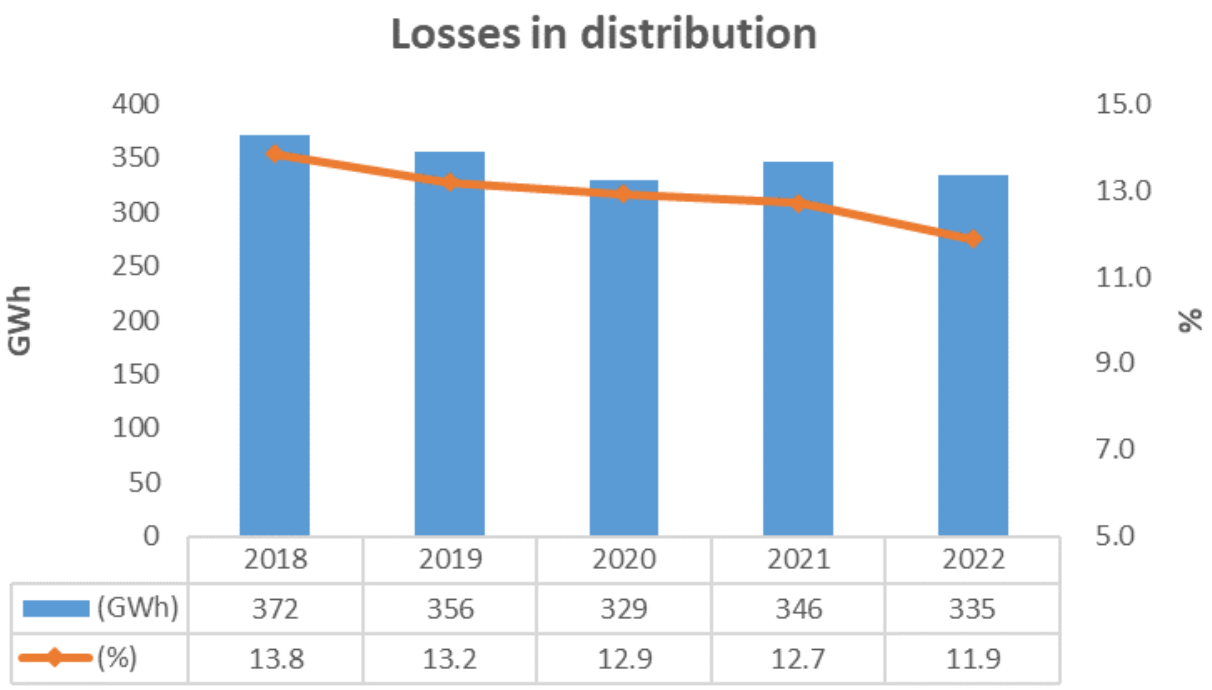
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes, implicitly. Approval of investments which will have positive effect on losses reduction will have a priority.
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	Yes
Different prices of losses for different network users?	Yes

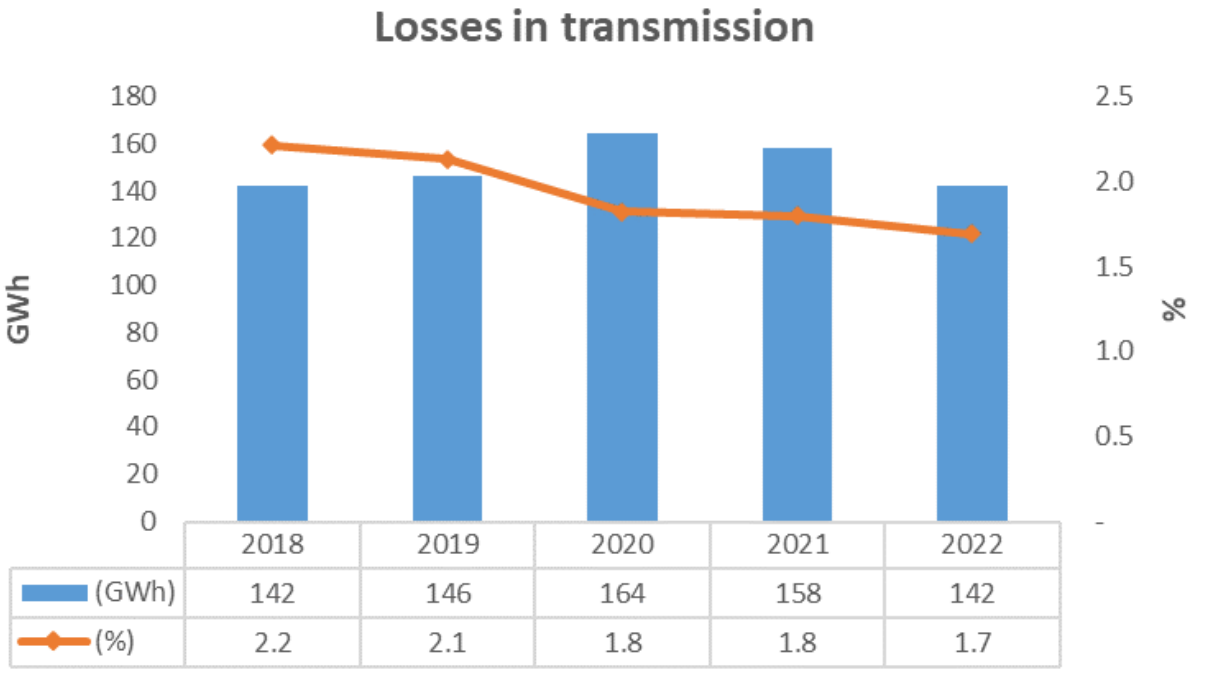
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	No

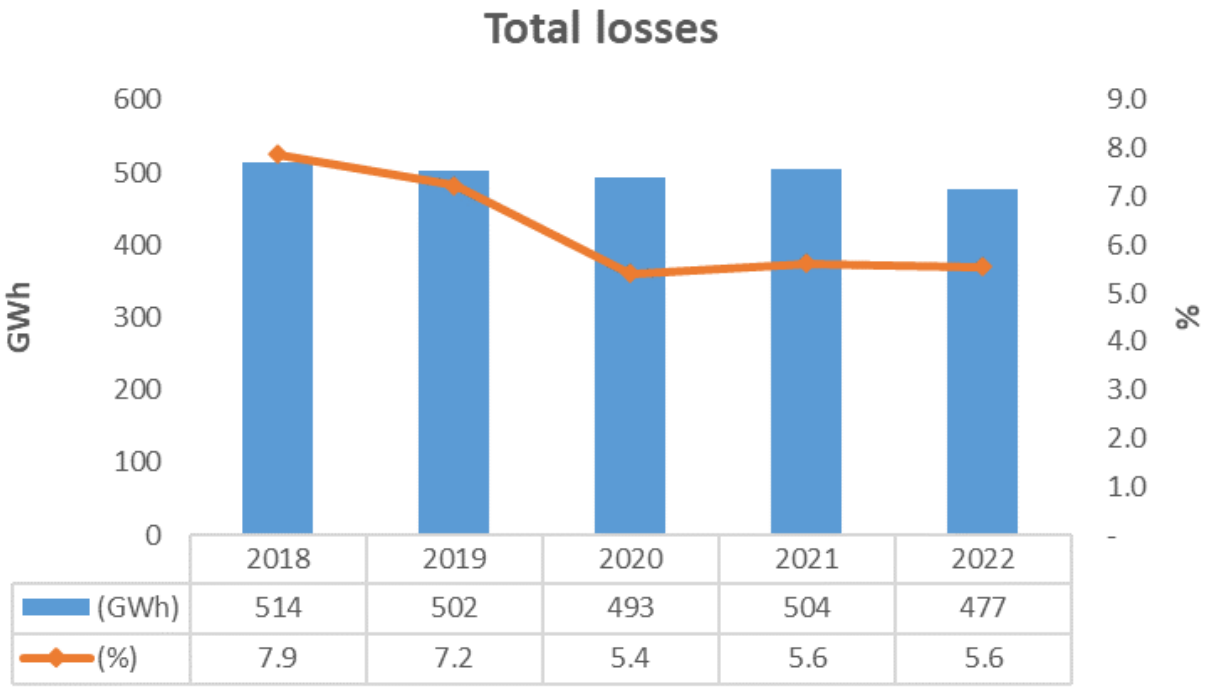
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	372	356	329	346	335
(%)	13.8	13.2	12.9	12.7	11.9



	2018	2019	2020	2021	2022
(GWh)	142	146	164	158	142
(%)	2.2	2.1	1.8	1.8	1.7



	2018	2019	2020	2021	2022
(GWh)	514	502	493	504	477
(%)	7.9	7.2	5.4	5.6	5.6

The Netherlands

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	268,625 km
Number of metering points in distribution network	8,918,042 (total number of distribution grid connections)
Number of smart meters (SM) with active remote reading in distribution network	
Penetration of SM with active remote reading in distribution network (per metering point)	
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	
Components included in definition of non-technical losses	
- "hidden" non-technical losses	No
- Non-metered consumption (e.g. public lighting)	Yes, in both distribution and transmission
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Both (measured in transmission, first estimated in distribution, then updated with measured values)

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs

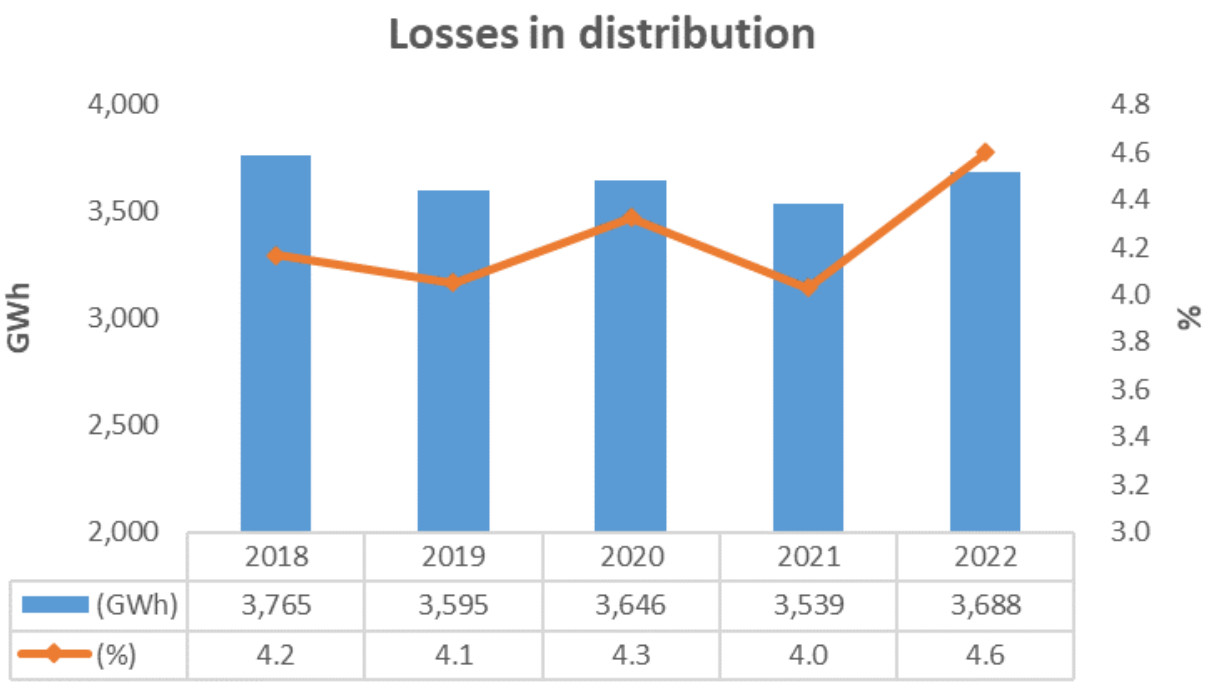
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

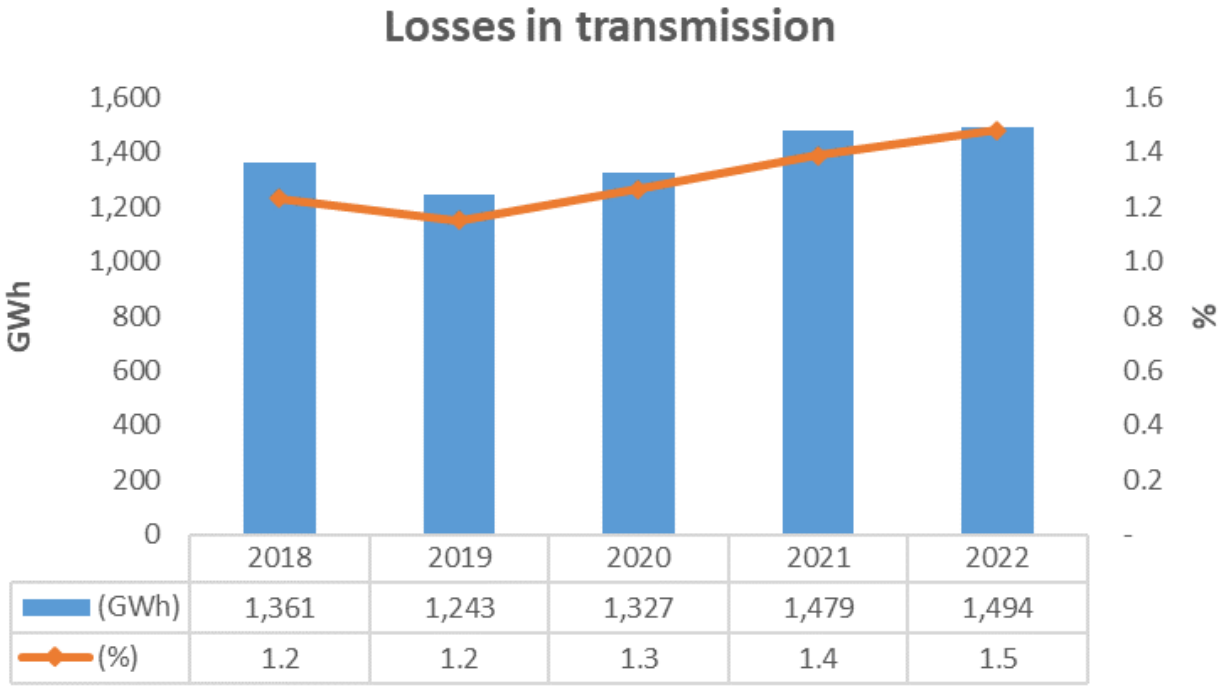
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	No
Any measures to combat the currently high prices of energy to cover losses?	Yes

VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	3,765	3,595	3,646	3,539	3,688
(%)	4.2	4.1	4.3	4.0	4.6



	2018	2019	2020	2021	2022
(GWh)	1,361	1,243	1,327	1,479	1,494
(%)	1.2	1.2	1.3	1.4	1.5

Total losses as percentage could not be calculated due to missing data.

North Macedonia

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	29,711 km
Number of metering points in distribution network	899,522
Number of smart meters (SM) with active remote reading in distribution network	26,019
Penetration of SM with active remote reading in distribution network (per metering point)	2.9%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	No distinct definitions of technical and non-technical losses
- "hidden" non-technical losses	
- Non-metered consumption (e.g. public lighting)	
- Theft	
- Others (e.g. metering errors, differences in metering, billing and data processing)	
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs

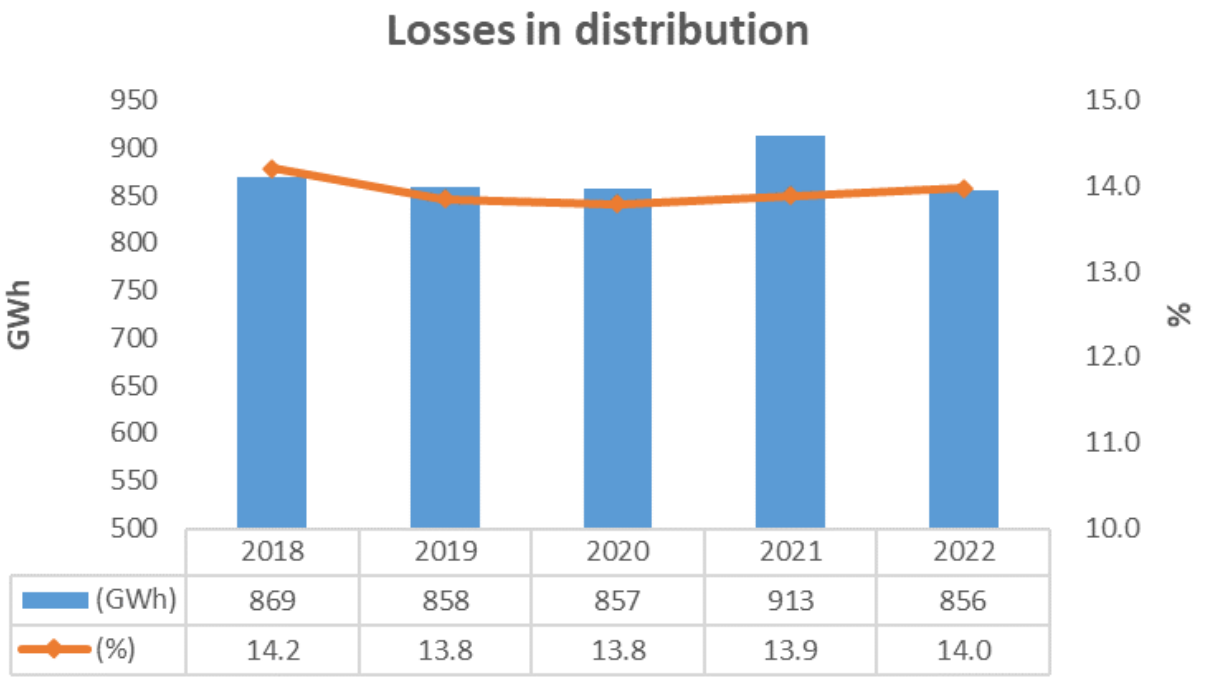
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes (implicit)
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes (implicit)
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

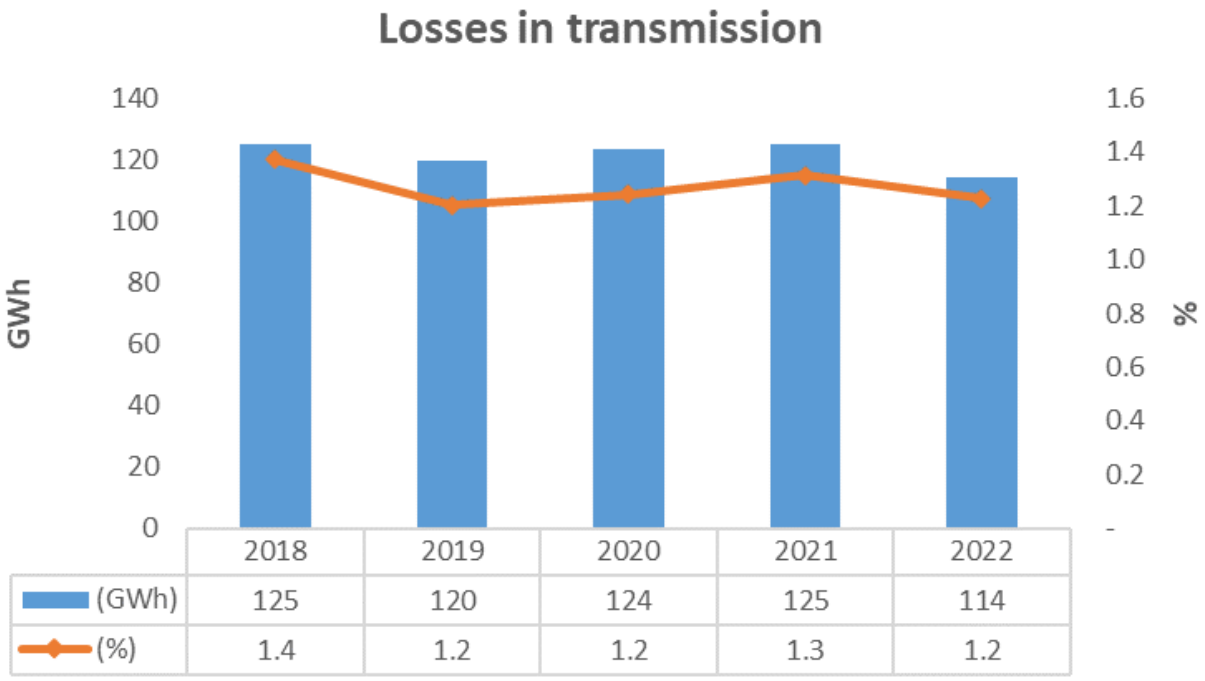
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	Yes (only when calculating the maximum allowed revenue)
Any measures to combat the currently high prices of energy to cover losses?	Not by NRA, but the government has subsidized part of the cost of generators and is obligated to bid on public tender for procurement of losses

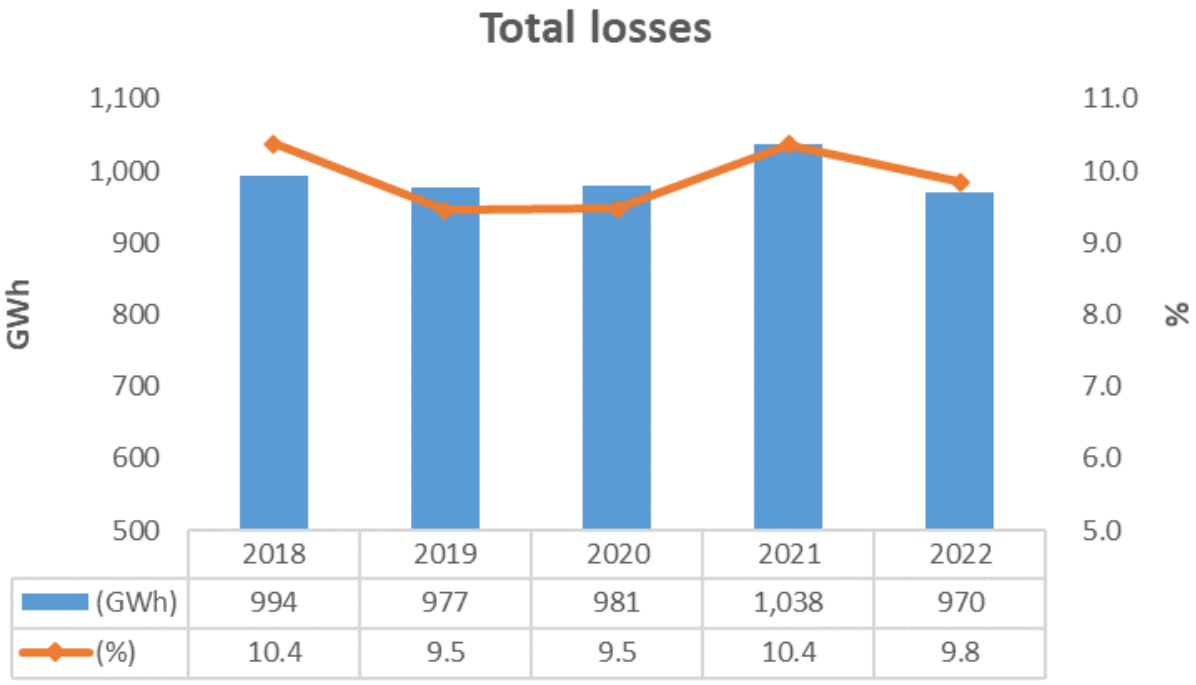
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	869	858	857	913	856
(%)	14.2	13.8	13.8	13.9	14.0



	2018	2019	2020	2021	2022
(GWh)	125	120	124	125	114
(%)	1.4	1.2	1.2	1.3	1.2



	2018	2019	2020	2021	2022
(GWh)	994	977	981	1,038	970
(%)	10.4	9.5	9.5	10.4	9.8

Norway

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	346,579 km
Number of metering points in distribution network	3,339,969
Number of smart meters (SM) with active remote reading in distribution network	3,306,569
Penetration of SM with active remote reading in distribution network (per metering point)	99.0%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	In Norway, total losses cannot be separated into technical and non-technical losses.
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Measured

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs

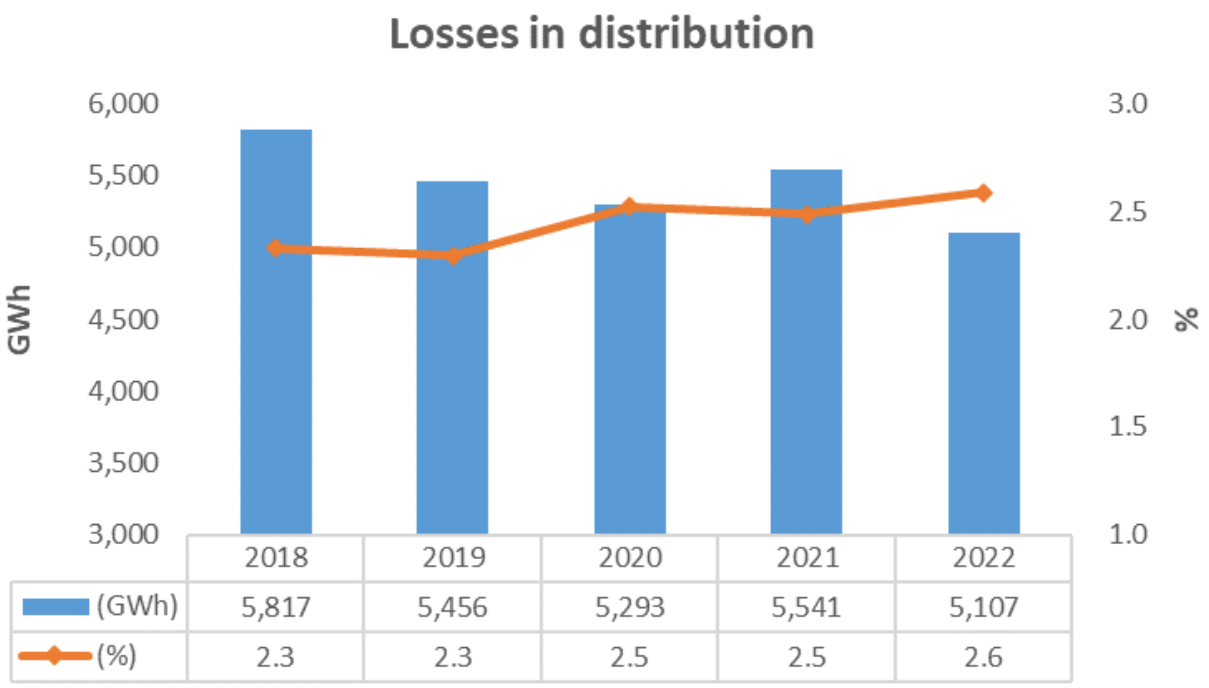
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes, implicitly (only in local distribution – the costs of losses are included in the total expenditure (TOTEX) which undergoes the benchmarking (efficiency) analysis)
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes (cost of losses is included in a separate efficiency analysis for the TSO. In this model, a ratio of cost and output is compared for a given year with the same ratio for previous years.)
Are non-technical losses included in published losses and in regulation of losses?	Yes (technical and non-technical losses are not distinguished)
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	Yes

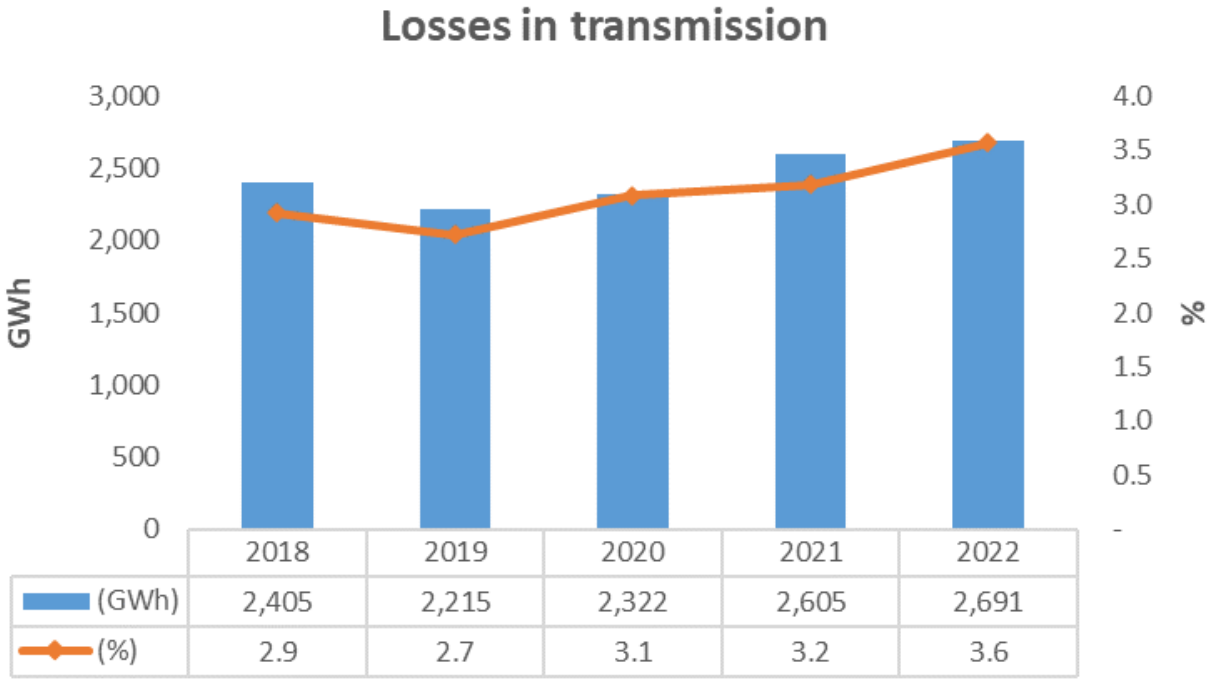
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	No
Any measures to combat the currently high prices of energy to cover losses?	No

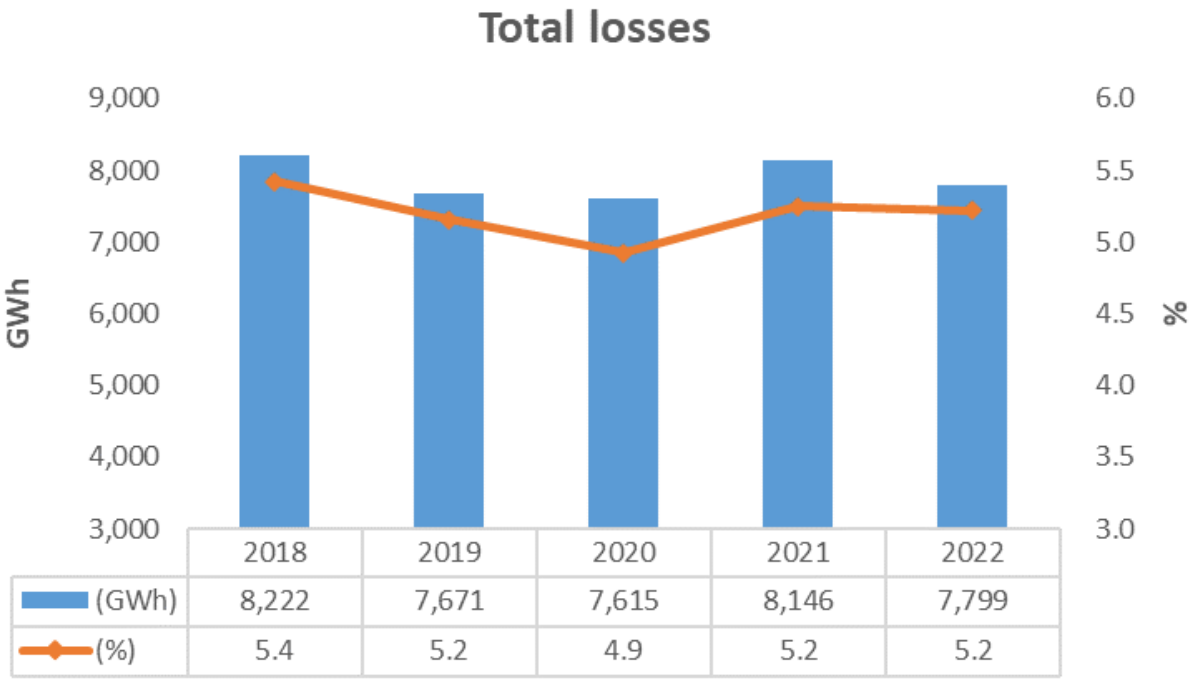
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	5,817	5,456	5,293	5,541	5,107
(%)	2.3	2.3	2.5	2.5	2.6



	2018	2019	2020	2021	2022
(GWh)	2,405	2,215	2,322	2,605	2,691
(%)	2.9	2.7	3.1	3.2	3.6



	2018	2019	2020	2021	2022
(GWh)	8,222	7,671	7,615	8,146	7,799
(%)	5.4	5.2	4.9	5.2	5.2

Poland

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	898,654 km
Number of metering points in distribution network	18,734,422
Number of smart meters (SM) with active remote reading in distribution network	4,119,233
Penetration of SM with active remote reading in distribution network (per metering point)	22.0%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in distribution
Components included in definition of non-technical losses	
- "hidden" non-technical losses	No
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in distribution
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Measured

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs

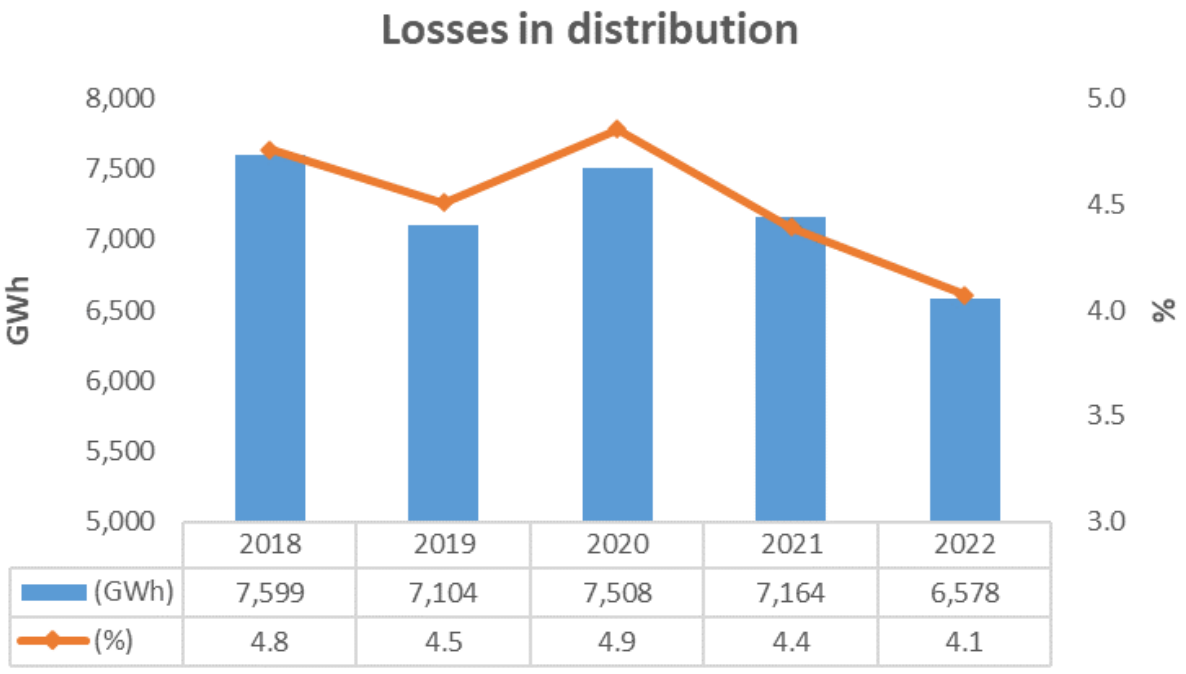
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	No
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

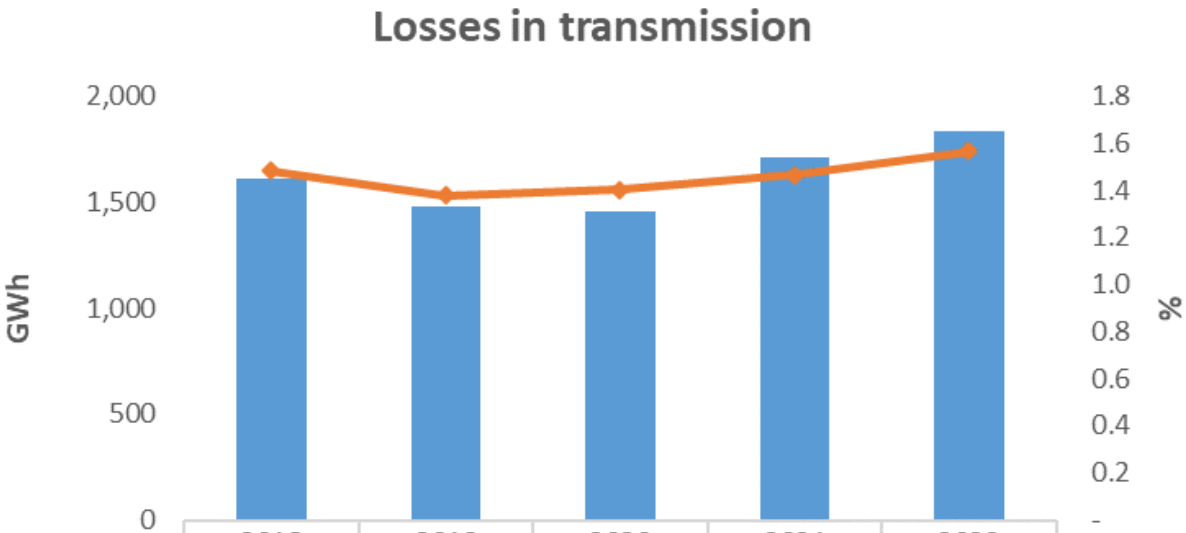
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	No

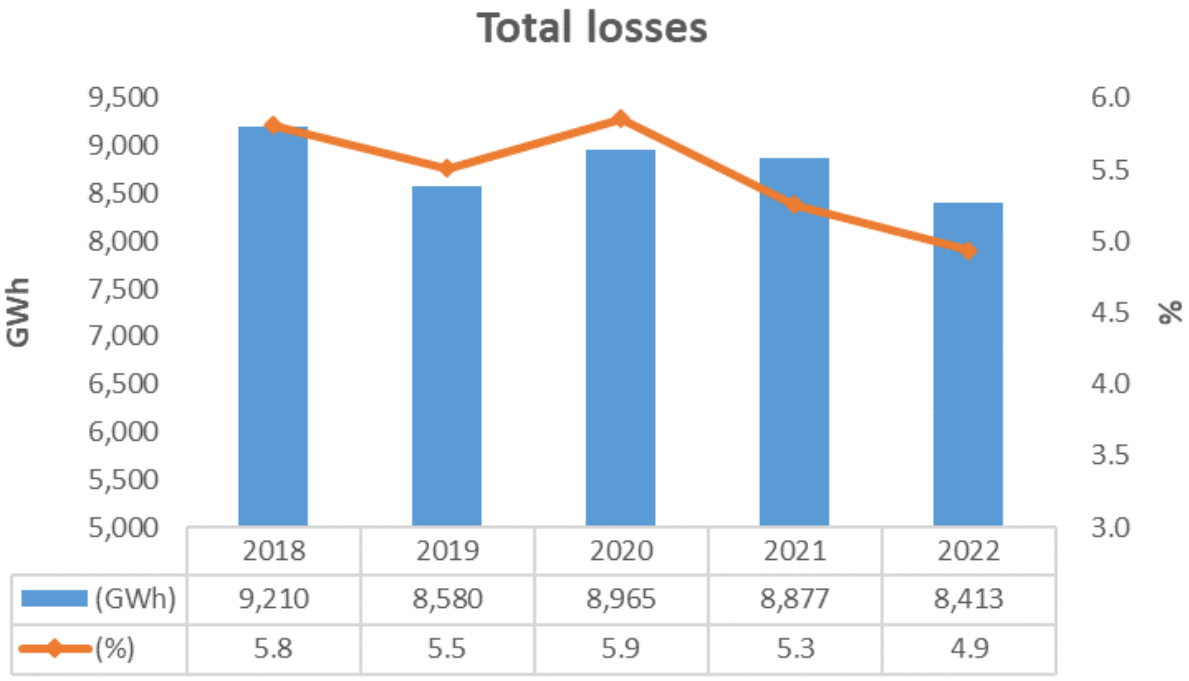
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	7,599	7,104	7,508	7,164	6,578
(%)	4.8	4.5	4.9	4.4	4.1



	2018	2019	2020	2021	2022
(GWh)	1,611	1,476	1,458	1,713	1,835
(%)	1.5	1.4	1.4	1.5	1.6



	2018	2019	2020	2021	2022
(GWh)	9,210	8,580	8,965	8,877	8,413
(%)	5.8	5.5	5.9	5.3	4.9

Portugal

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	232,089 km
Number of metering points in distribution network	4,637,752
Number of smart meters (SM) with active remote reading in distribution network	3,515,406
Penetration of SM with active remote reading in distribution network (per metering point)	75.8%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	Yes, in both distribution and transmission
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Measured

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	Supplier
Party responsible for forecasting / estimating power losses	NRA
How are costs of procuring losses covered?	Covered by suppliers when buying energy on the market.

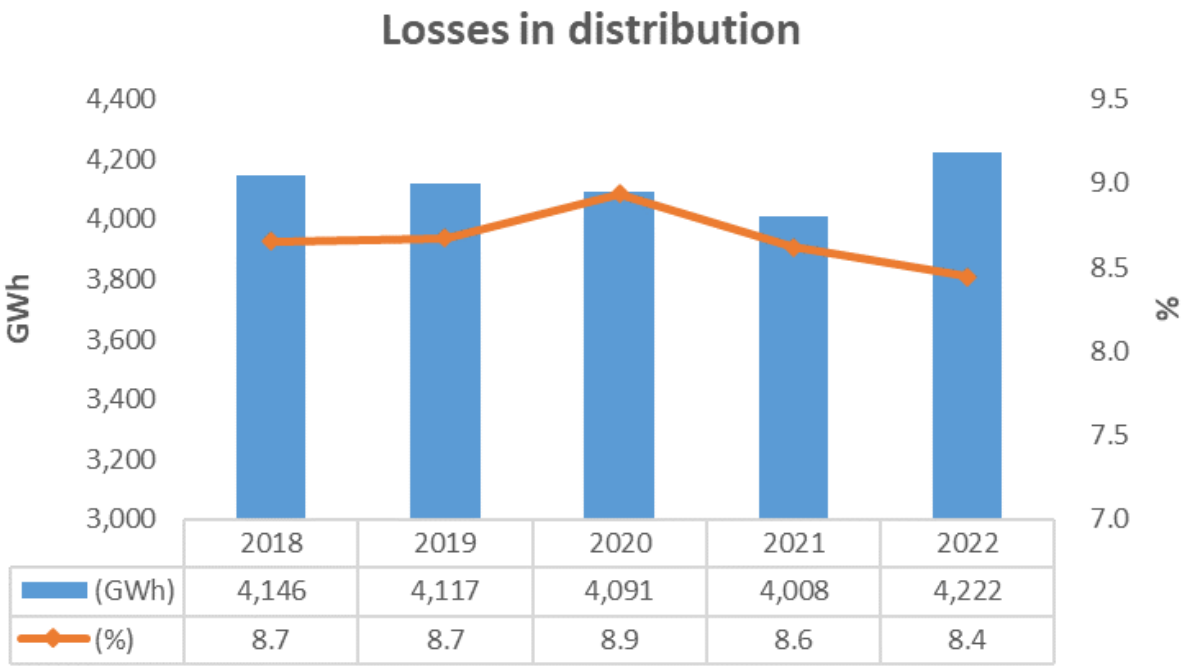
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

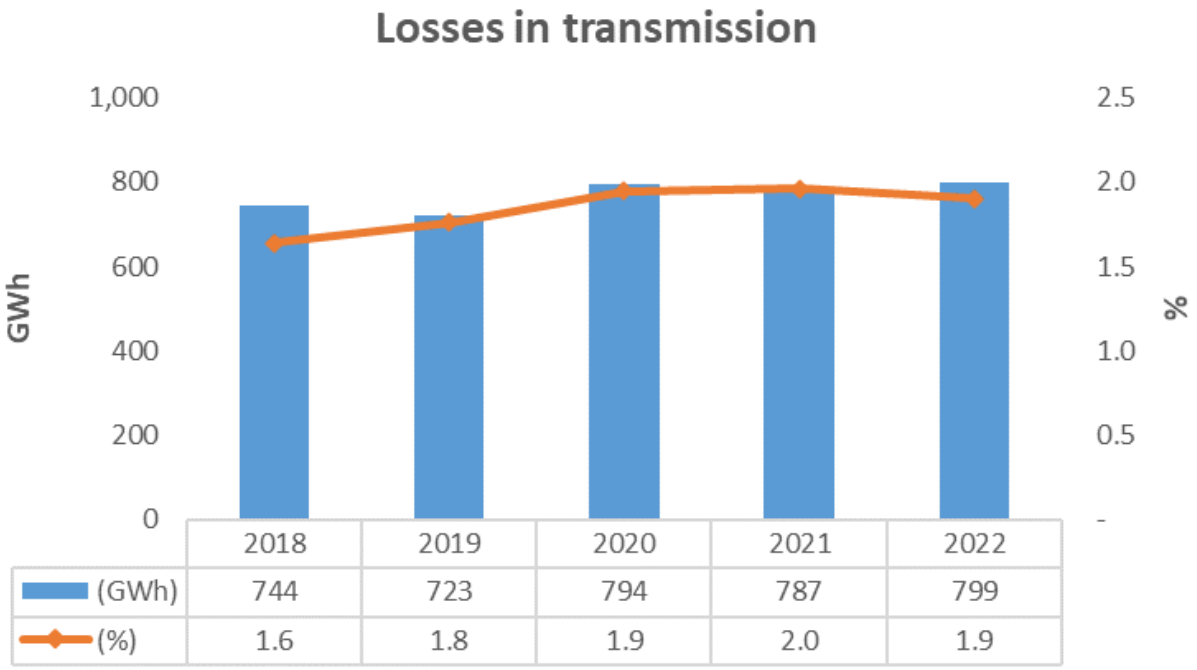
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	Yes
Any measures to combat the currently high prices of energy to cover losses?	Yes

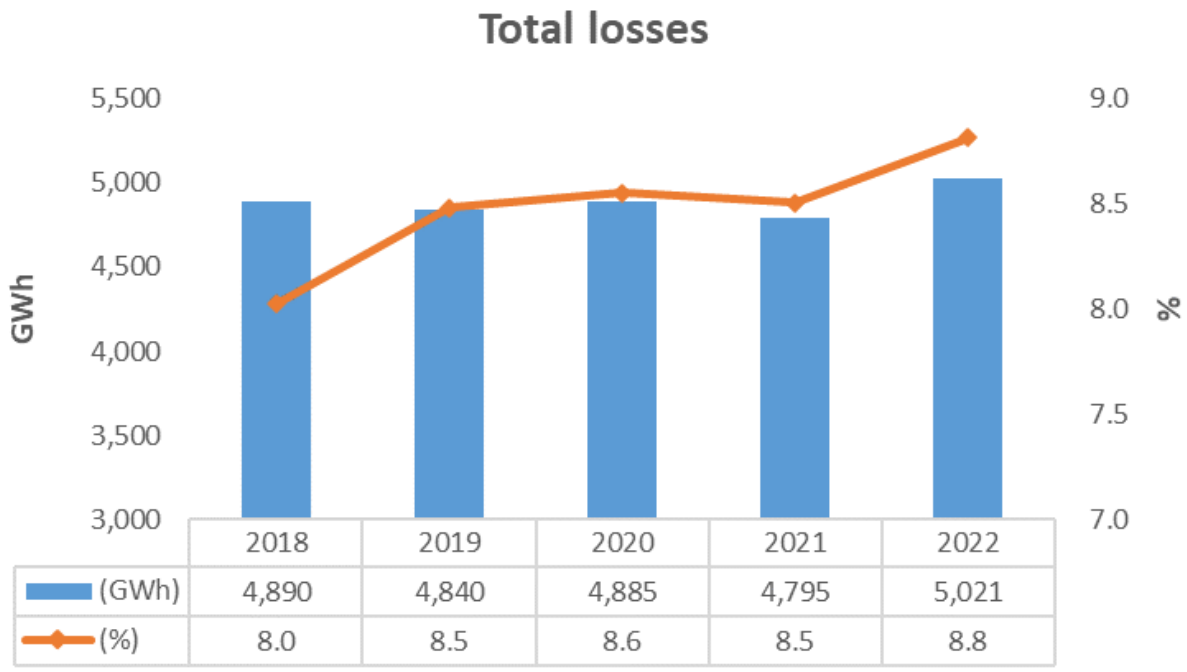
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	4,146	4,117	4,091	4,008	4,222
(%)	8.7	8.7	8.9	8.6	8.4



	2018	2019	2020	2021	2022
(GWh)	744	723	794	787	799
(%)	1.6	1.8	1.9	2.0	1.9



	2018	2019	2020	2021	2022
(GWh)	4,890	4,840	4,885	4,795	5,021
(%)	8.0	8.5	8.6	8.5	8.8

Romania

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	329,231 km
Number of metering points in distribution network	9,937,430
Number of smart meters (SM) with active remote reading in distribution network	1,914,798
Penetration of SM with active remote reading in distribution network (per metering point)	19.3%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	Yes, in both distribution and transmission
- Theft	Yes
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs

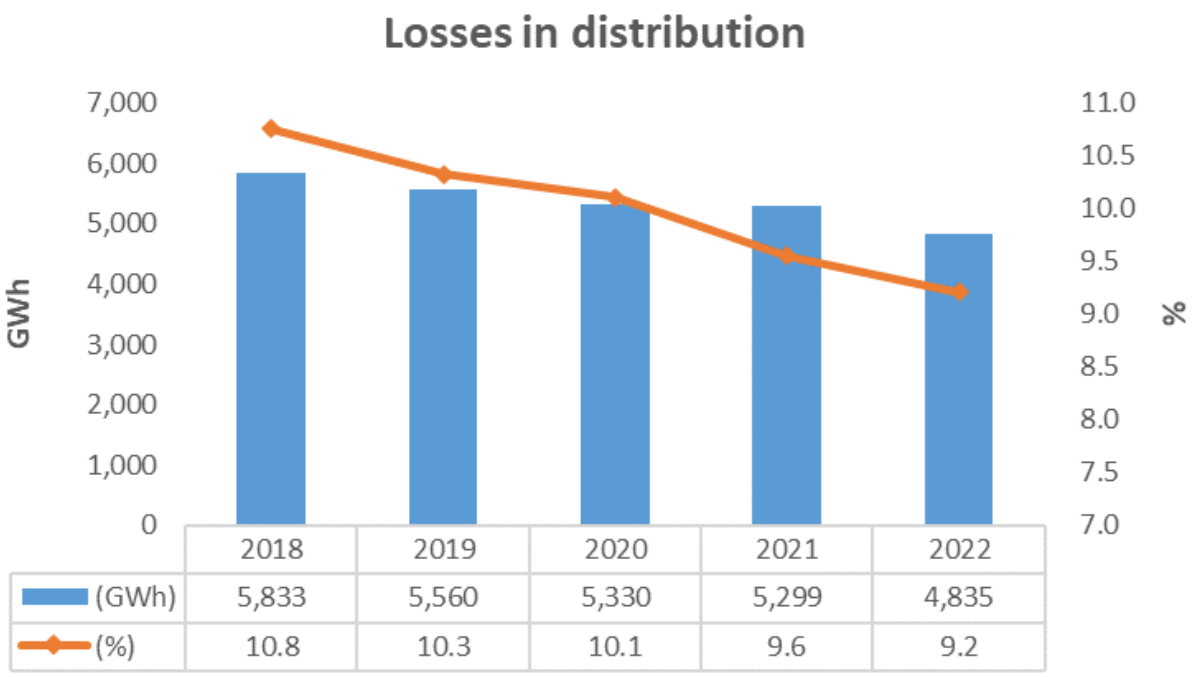
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	N/A

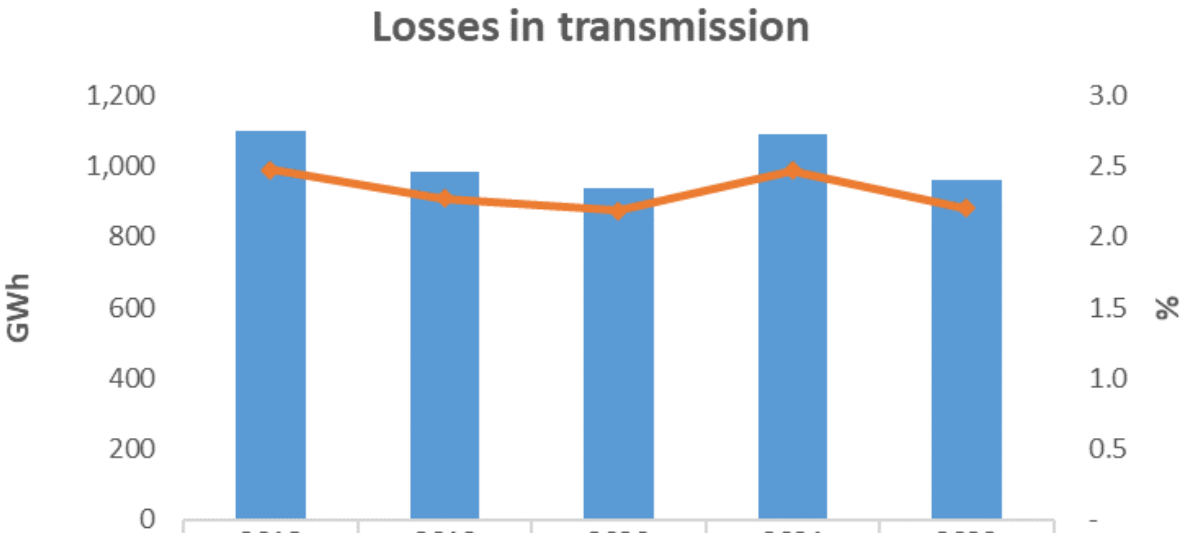
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	No

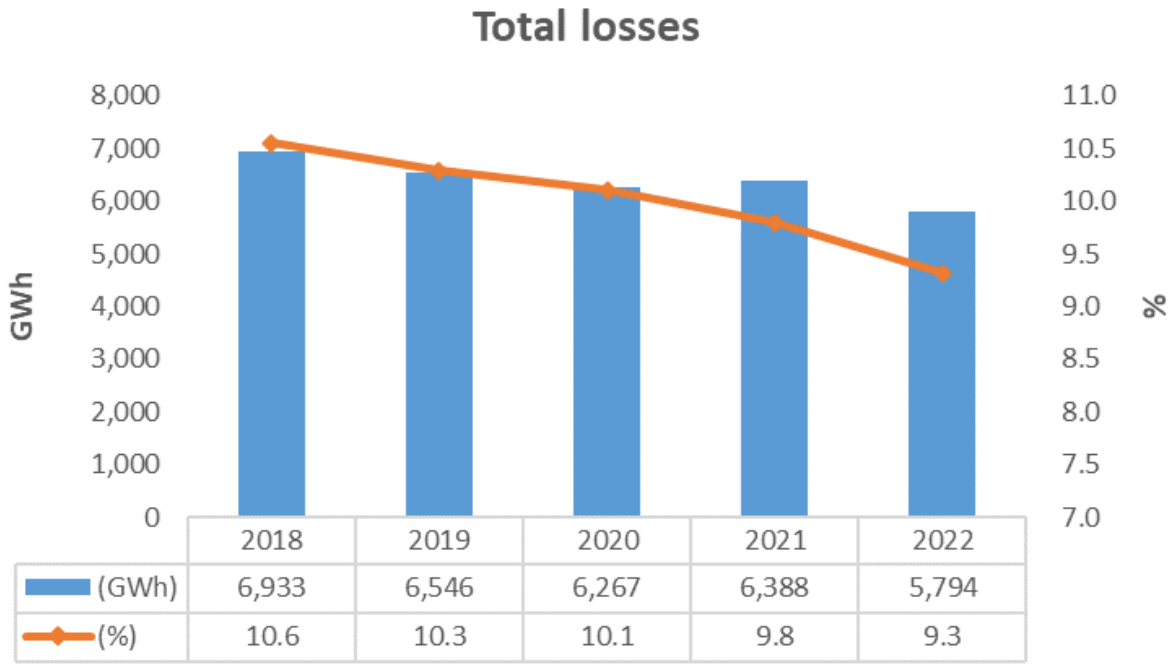
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	5,833	5,560	5,330	5,299	4,835
(%)	10.8	10.3	10.1	9.6	9.2



	2018	2019	2020	2021	2022
(GWh)	1,101	985	937	1,089	959
(%)	2.5	2.3	2.2	2.5	2.2



	2018	2019	2020	2021	2022
(GWh)	6,933	6,546	6,267	6,388	5,794
(%)	10.6	10.3	10.1	9.8	9.3

Serbia

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	172,788.986 km
Number of metering points in distribution network	3,761,101
Number of smart meters (SM) with active remote reading in distribution network	157,821
Penetration of SM with active remote reading in distribution network (per metering point)	4.2%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	Yes, in distribution
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Measured

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs

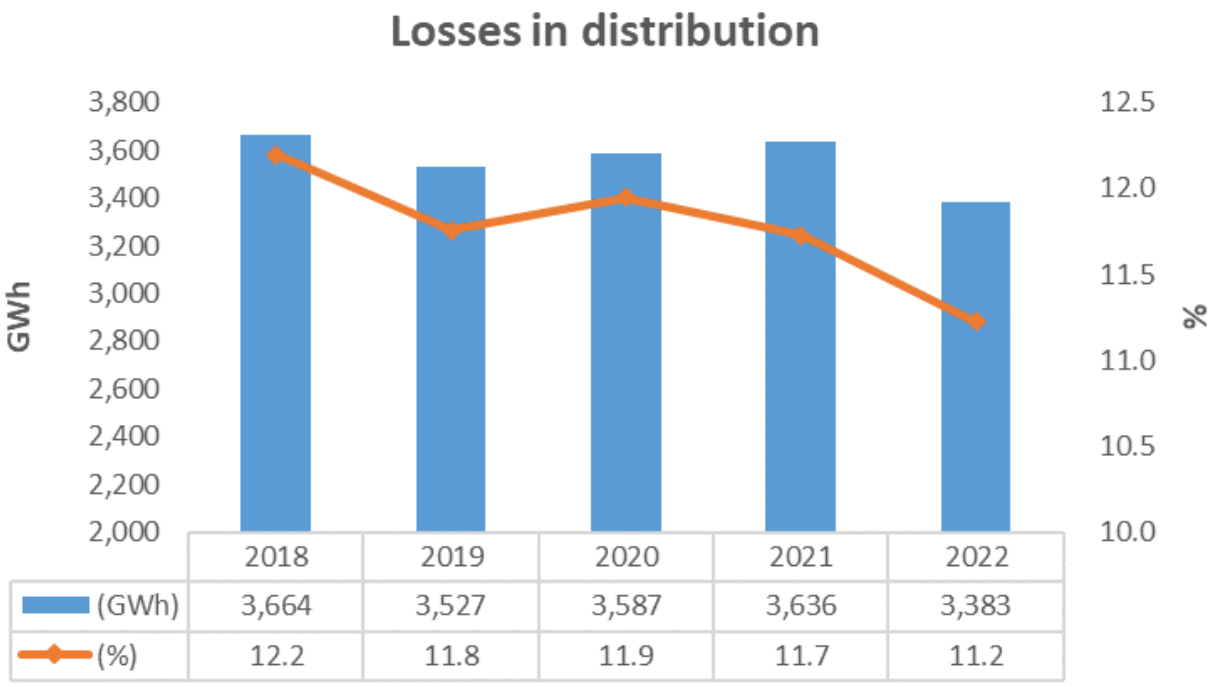
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes, implicitly (the NRA determines the acceptable level of losses which is approved for tariffs)
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes, implicitly (the NRA determines the acceptable level of losses which is approved for tariffs)
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

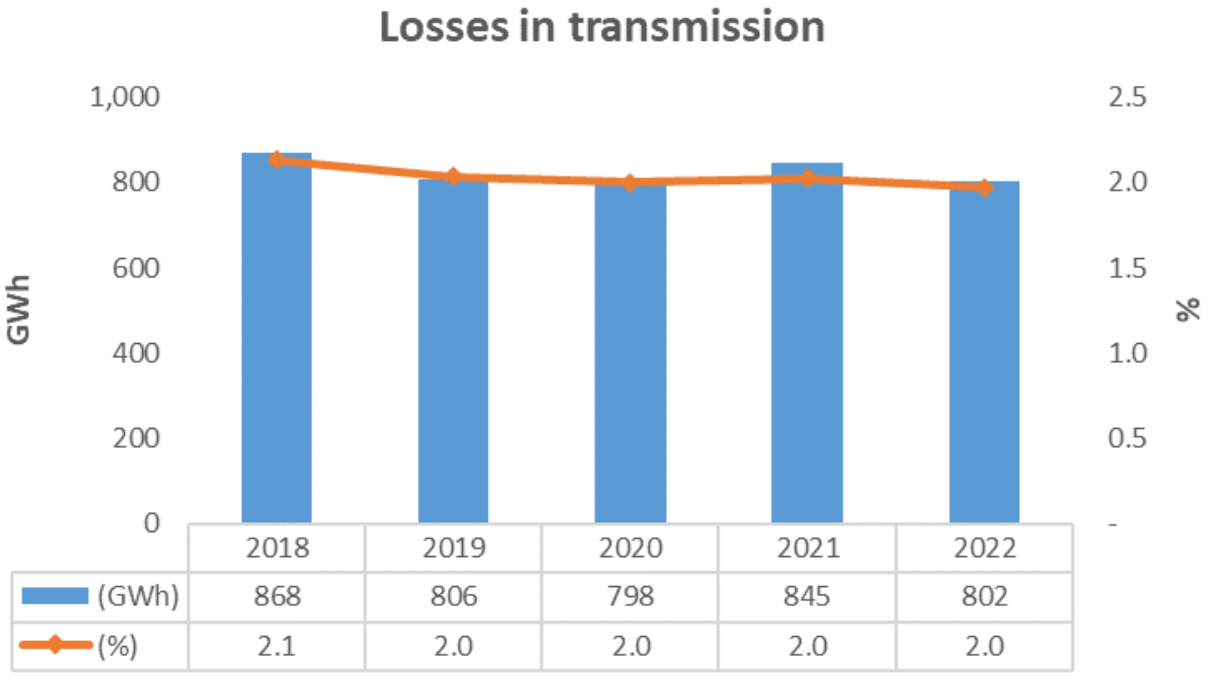
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	Yes
Any measures to combat the currently high prices of energy to cover losses?	No

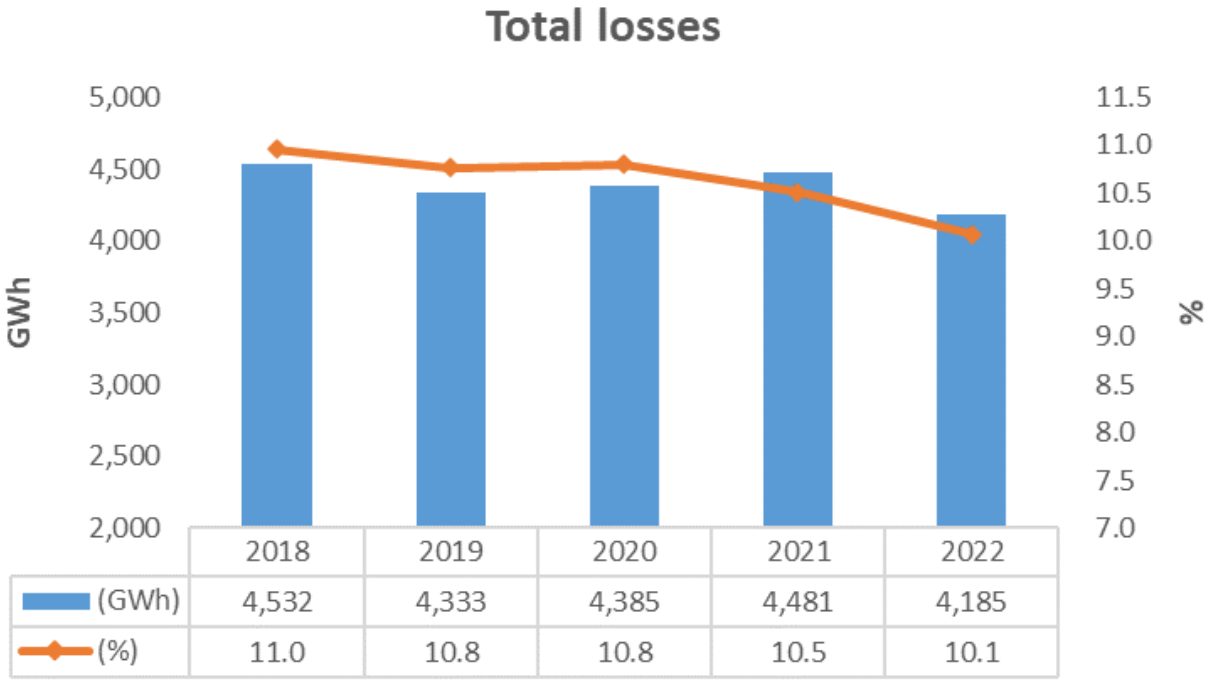
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	3,664	3,527	3,587	3,636	3,383
(%)	12.2	11.8	11.9	11.7	11.2



	2018	2019	2020	2021	2022
(GWh)	868	806	798	845	802
(%)	2.1	2.0	2.0	2.0	2.0



	2018	2019	2020	2021	2022
(GWh)	4,532	4,333	4,385	4,481	4,185
(%)	11.0	10.8	10.8	10.5	10.1

Slovakia

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	98,112 km
Number of metering points in distribution network	2,682,543
Number of smart meters (SM) with active remote reading in distribution network	
Penetration of SM with active remote reading in distribution network (per metering point)	
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in distribution
Components included in definition of non-technical losses	
- "hidden" non-technical losses	No
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in distribution
How are losses determined?	Difference between injected and consumed energy. The allowed volume in % is set by NRA URSO.
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO
Party responsible for forecasting / estimating power losses	DSO
How are costs of procuring losses covered?	Tariffs for losses

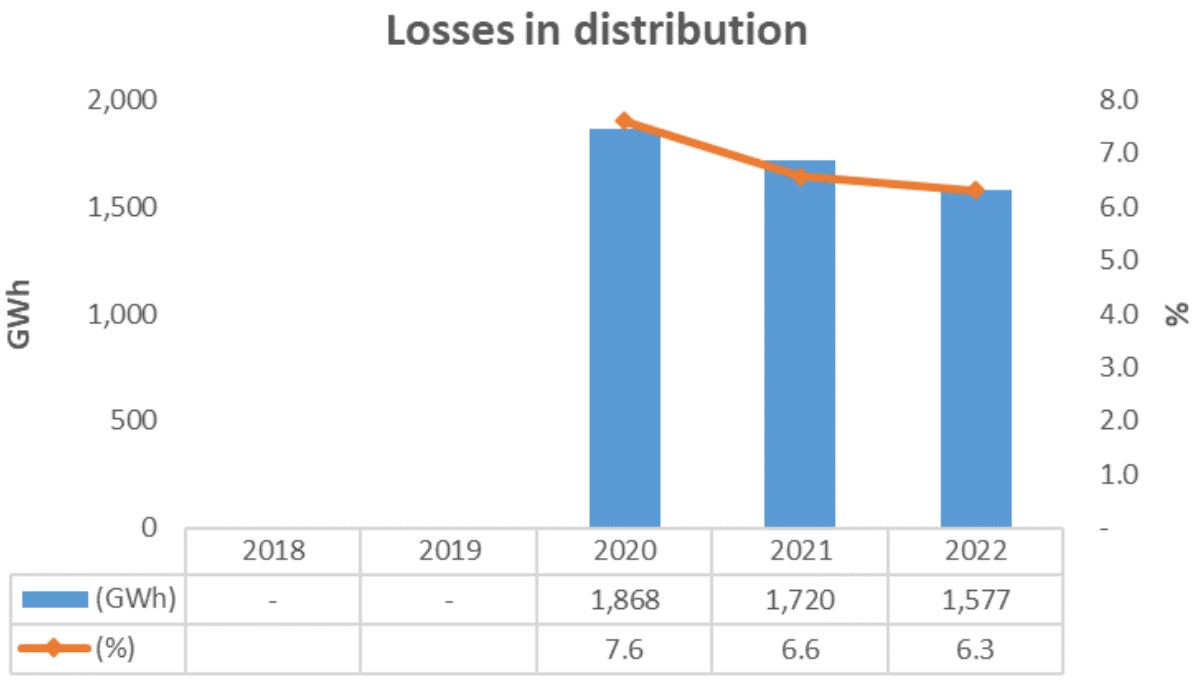
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	Yes
Different prices of losses for different network users?	Yes

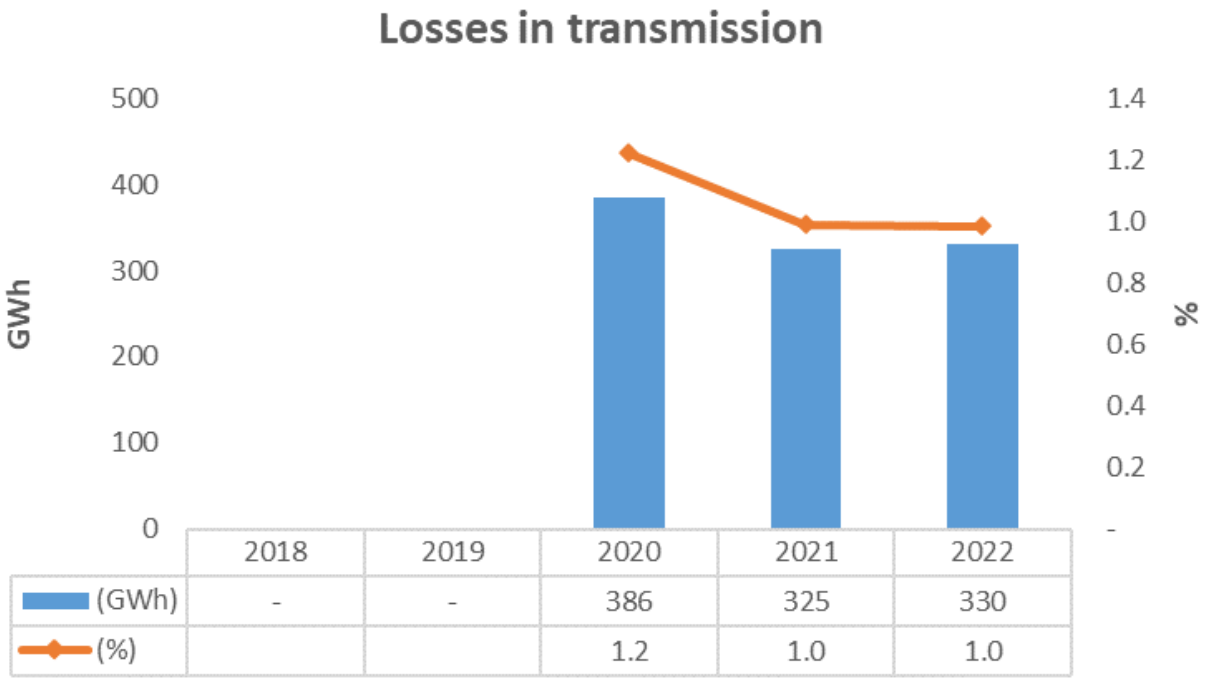
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	Yes

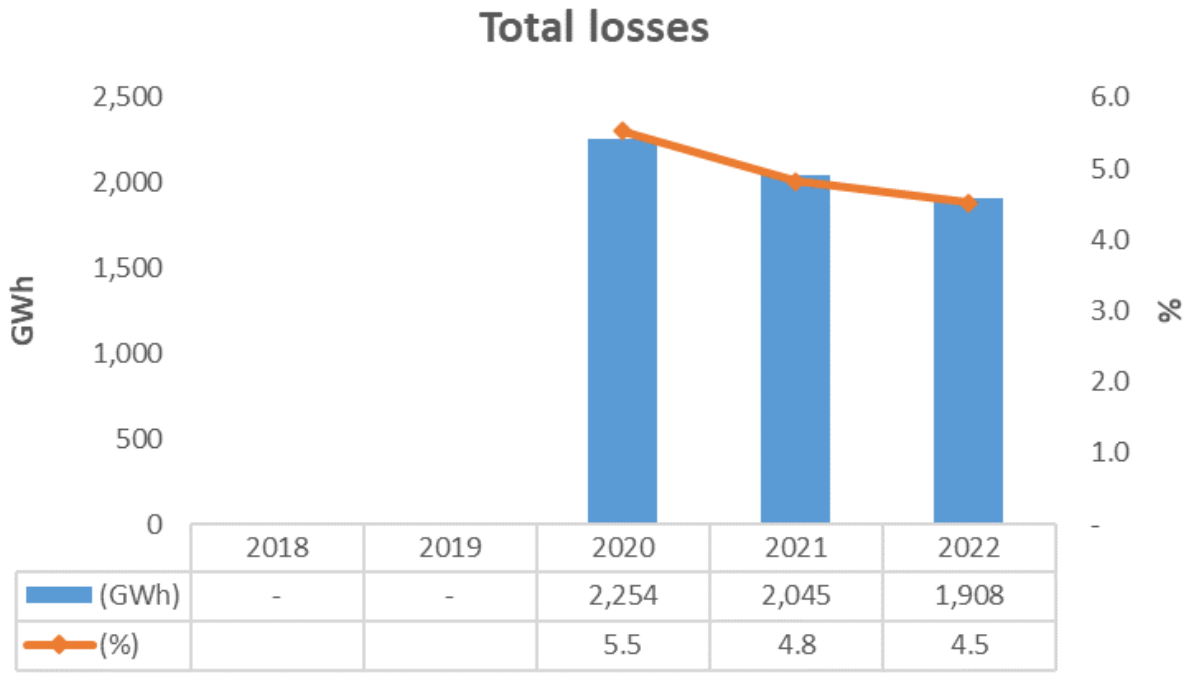
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	-	-	1,868	1,720	1,577
(%)			7.6	6.6	6.3



	2018	2019	2020	2021	2022
(GWh)	-	-	386	325	330
(%)			1.2	1.0	1.0



	2018	2019	2020	2021	2022
(GWh)	-	-	2,254	2,045	1,908
(%)			5.5	4.8	4.5

Data for 2018 and 2019 not available.

Slovenia

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	64,946 km
Number of metering points in distribution network	980,494
Number of smart meters (SM) with active remote reading in distribution network	874,590
Penetration of SM with active remote reading in distribution network (per metering point)	89.2%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	No
- Non-metered consumption (e.g. public lighting)	No
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Estimated

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs

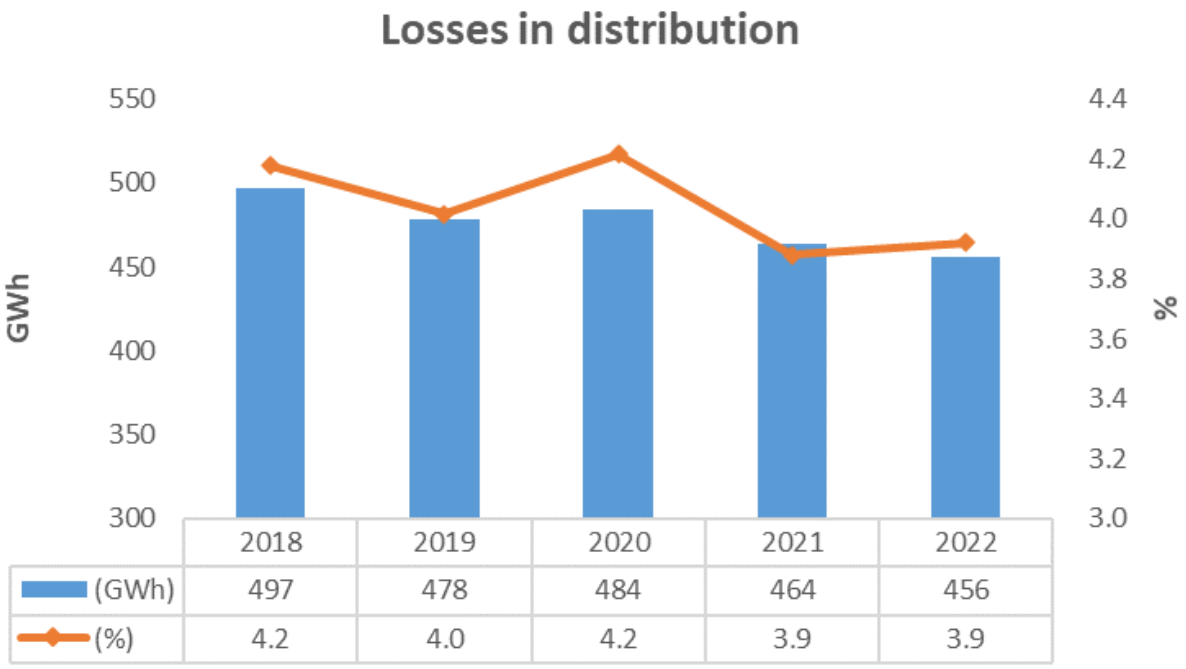
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No

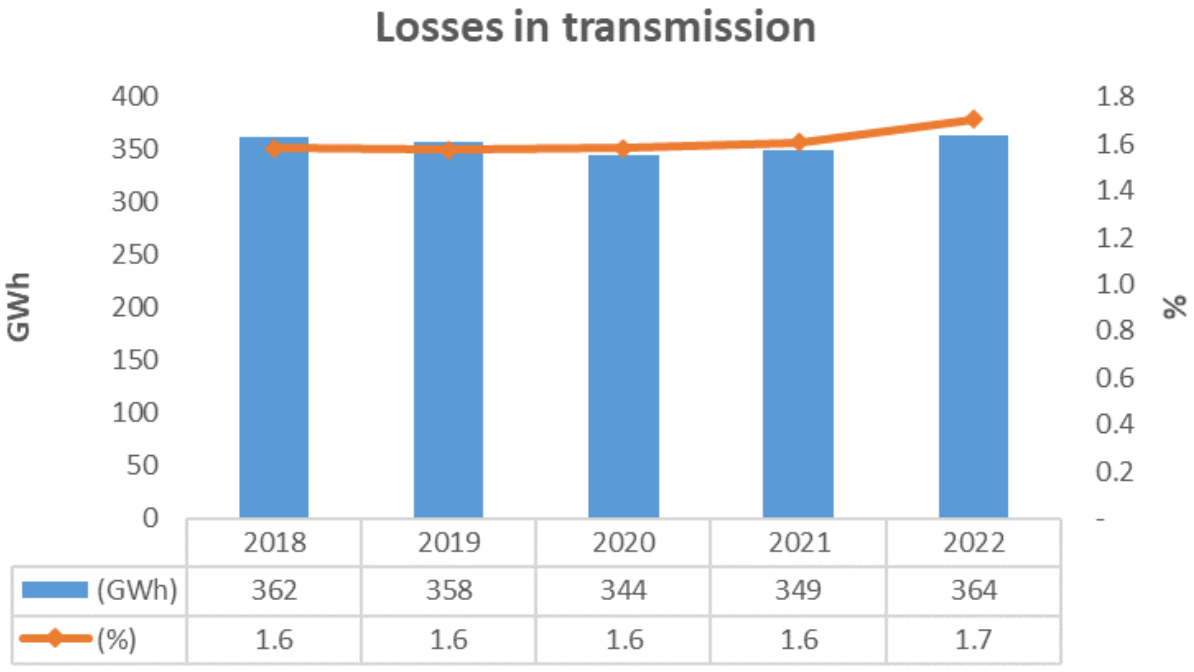
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	N/A

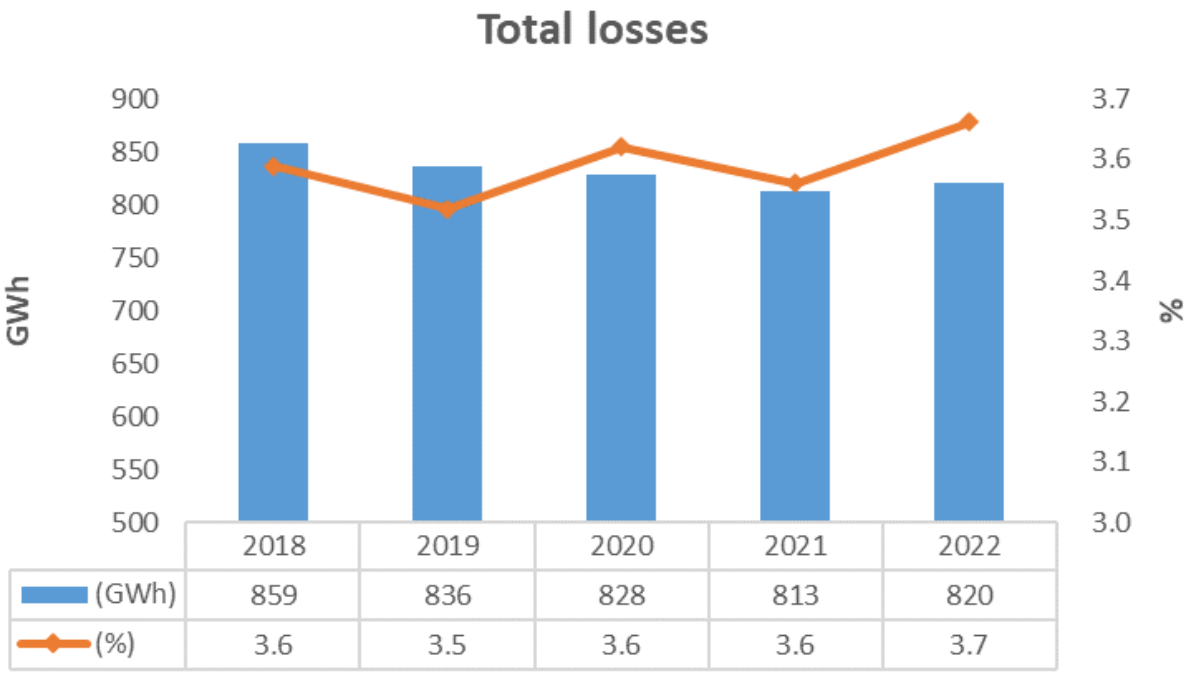
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	497	478	484	464	456
(%)	4.2	4.0	4.2	3.9	3.9



	2018	2019	2020	2021	2022
(GWh)	362	358	344	349	364
(%)	1.6	1.6	1.6	1.6	1.7



	2018	2019	2020	2021	2022
(GWh)	859	836	828	813	820
(%)	3.6	3.5	3.6	3.6	3.7

Spain

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	829,346 km
Number of metering points in distribution network	30,034,449
Number of smart meters (SM) with active remote reading in distribution network	29,638,630
Penetration of SM with active remote reading in distribution network (per metering point)	98.7%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in distribution
- Non-metered consumption (e.g. public lighting)	Yes, in distribution
- Theft	Yes, in distribution
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in distribution
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	Supplier
Party responsible for forecasting / estimating power losses	TSO
How are costs of procuring losses covered?	Estimated losses by suppliers, due to the activity of their customers, are priced at the same level as the wholesale market price to supply the consumption.

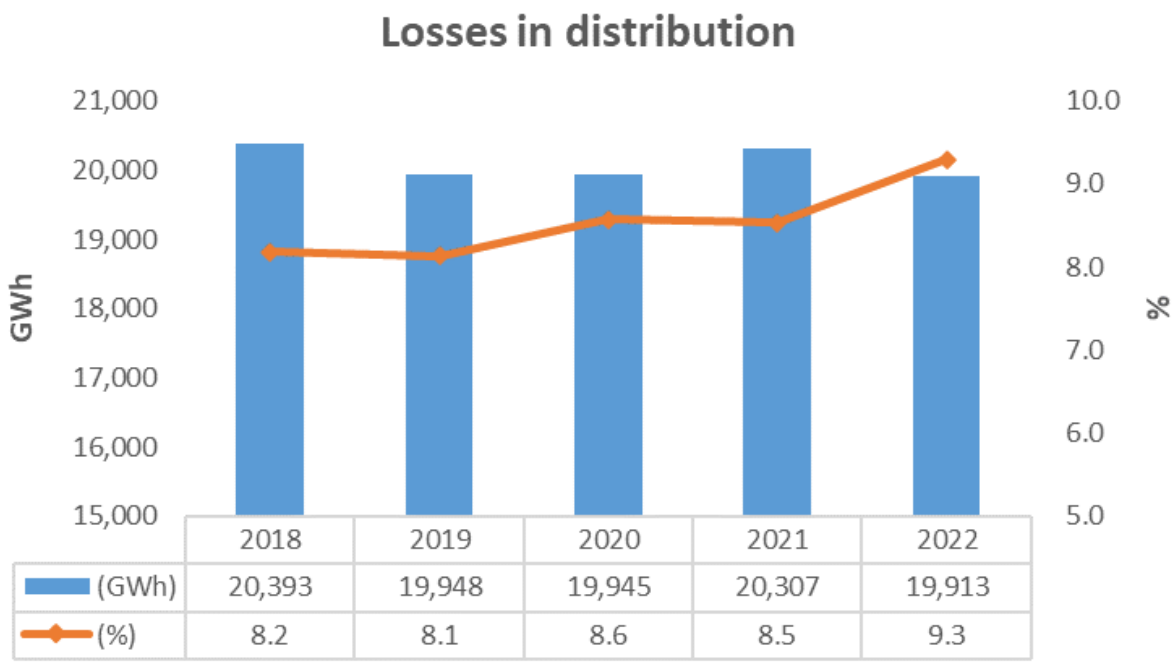
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	No
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	Yes

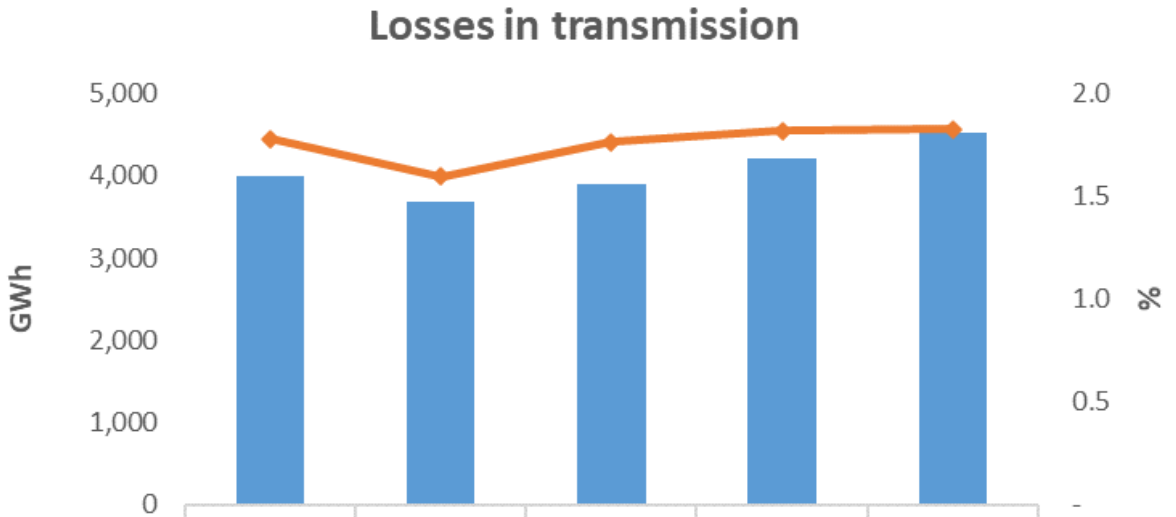
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	Yes

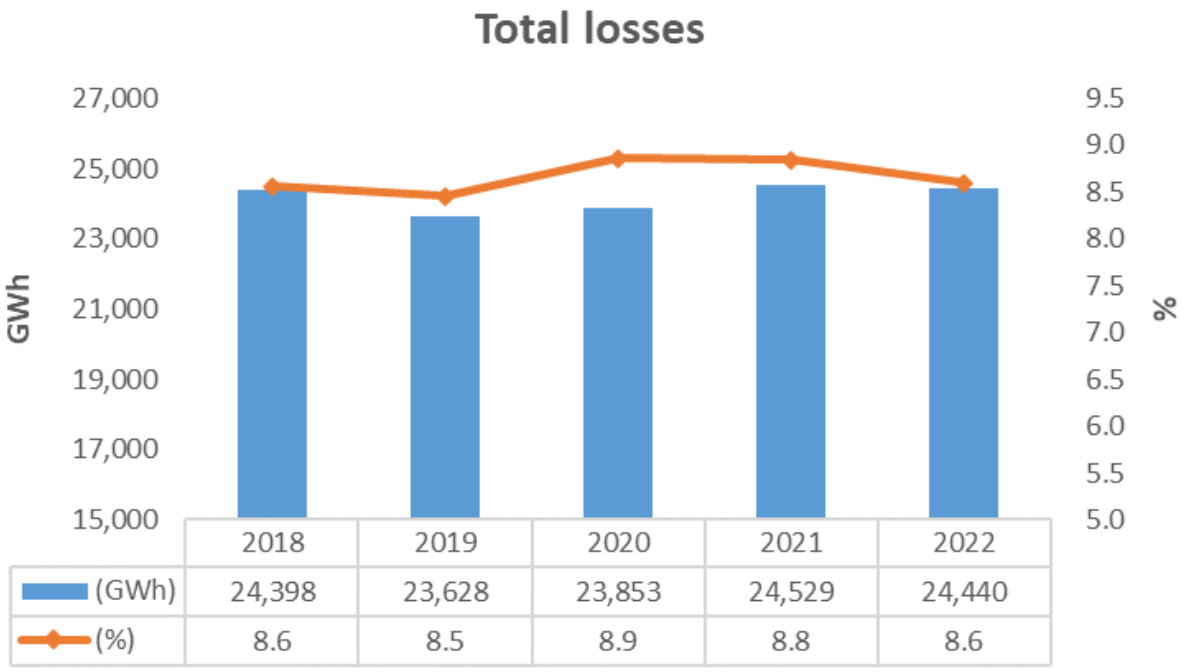
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	20,393	19,948	19,945	20,307	19,913
(%)	8.2	8.1	8.6	8.5	9.3



	2018	2019	2020	2021	2022
(GWh)	4,005	3,680	3,908	4,221	4,527
(%)	1.8	1.6	1.8	1.8	1.8



	2018	2019	2020	2021	2022
(GWh)	24,398	23,628	23,853	24,529	24,440
(%)	8.6	8.5	8.9	8.8	8.6

Sweden

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	576,450 km
Number of metering points in distribution network	5,657,243
Number of smart meters (SM) with active remote reading in distribution network	
Penetration of SM with active remote reading in distribution network (per metering point)	100%
Year	2022

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	Yes, in both distribution and transmission
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy
Are losses measured or estimated	Measured

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs

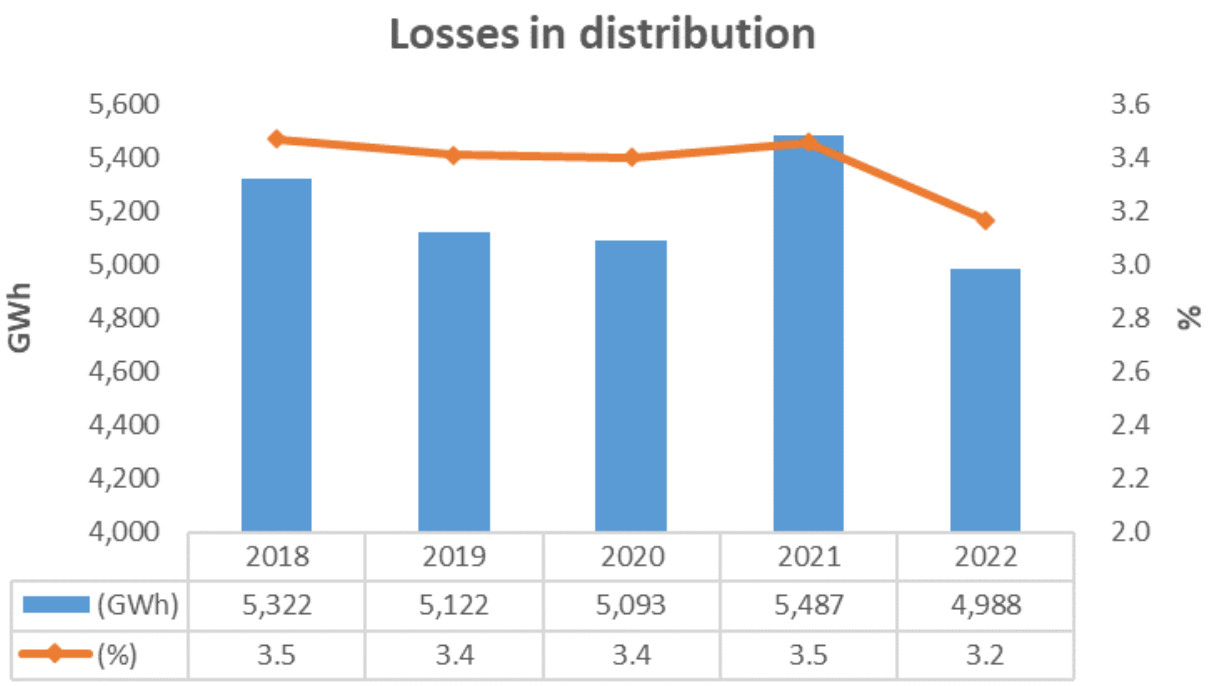
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	Yes
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	No (however, all DSOs do not necessarily get the same electricity price and DSOs are allowed to both cover losses by own production and by buying electricity)

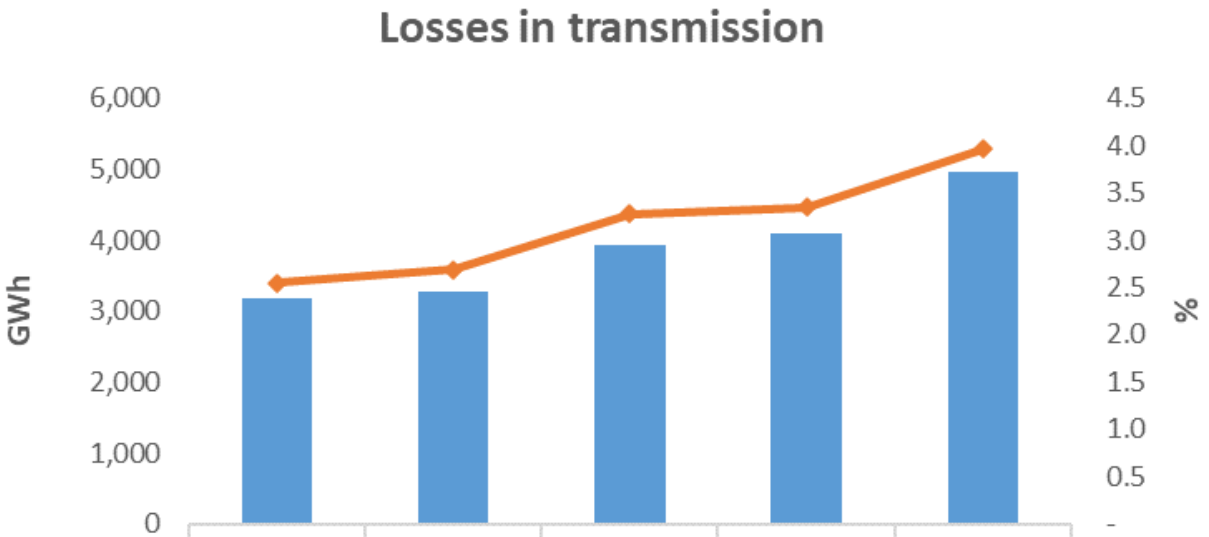
PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	N/A
Any measures to combat the currently high prices of energy to cover losses?	Yes (TSO has used some of its congestion revenues to put a roof on how high the transmission cost for losses can be for 2022 and 2023, in accordance with the Council Regulation (EU) 2022/1854)

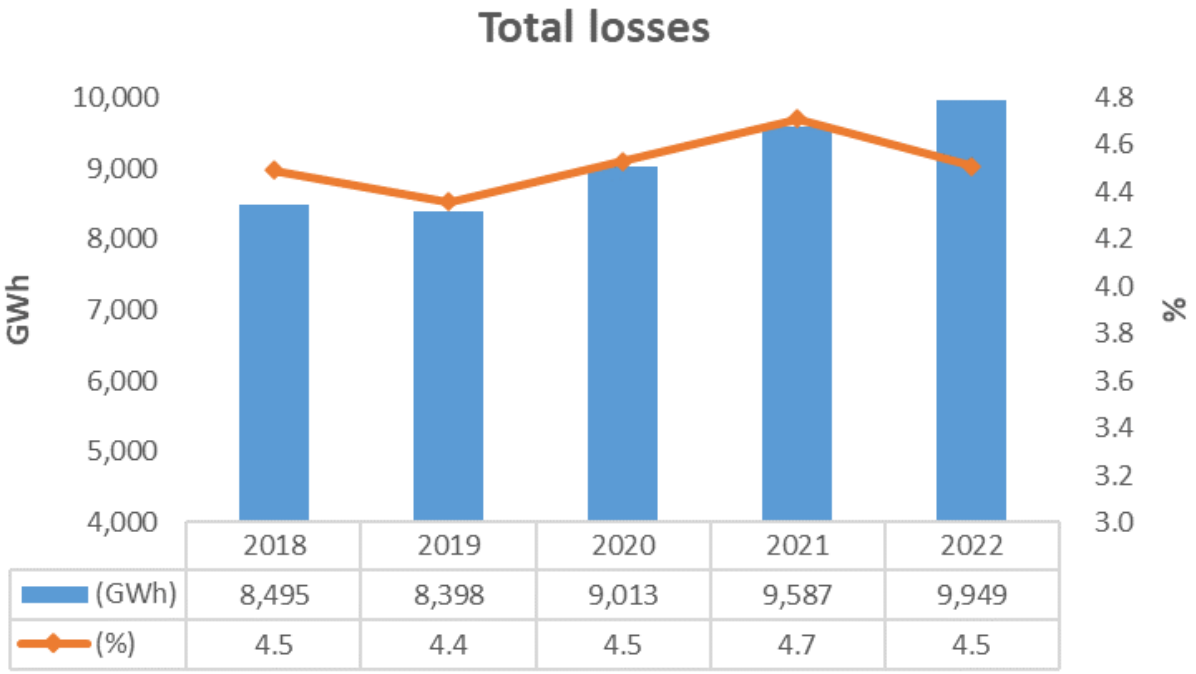
VALUES OF LOSSES



	2018	2019	2020	2021	2022
(GWh)	5,322	5,122	5,093	5,487	4,988
(%)	3.5	3.4	3.4	3.5	3.2



	2018	2019	2020	2021	2022
(GWh)	3,173	3,276	3,921	4,099	4,961
(%)	2.6	2.7	3.3	3.3	4.0



	2018	2019	2020	2021	2022
(GWh)	8,495	8,398	9,013	9,587	9,949
(%)	4.5	4.4	4.5	4.7	4.5

Switzerland

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	207,279 km
Number of metering points in distribution network	5,951,287
Number of smart meters (SM) with active remote reading in distribution network	1,496,309
Penetration of SM with active remote reading in distribution network (per metering point)	25.1%
Year	2021

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in distribution
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in distribution
- Non-metered consumption (e.g. public lighting)	No
- Theft	No
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	Difference between injected and consumed energy or calculation by DSO
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO (but also suppliers)
Party responsible for forecasting / estimating power losses	DSO and TSO
How are costs of procuring losses covered?	Network tariffs

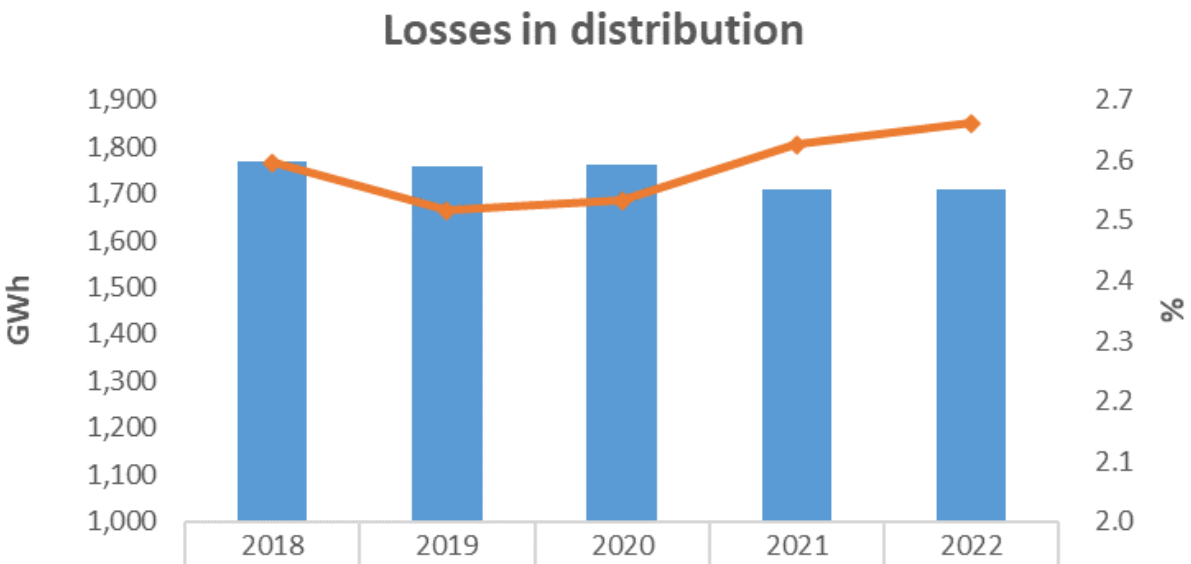
REGULATORY FRAMEWORK

Regulatory incentives to reduce losses or costs related to losses in distribution?	No
Regulatory incentives to reduce losses or costs related to losses in transmission?	No
Are non-technical losses included in published losses and in regulation of losses?	Yes
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	Yes

PRICE OF LOSSES

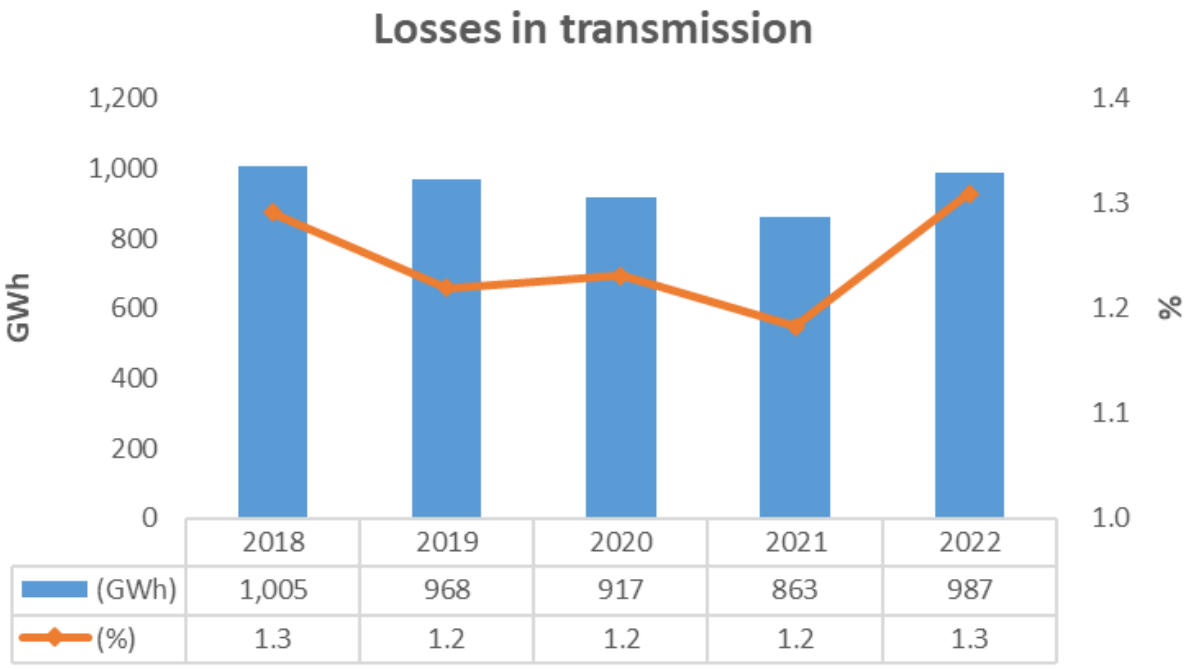
Is the price of losses regulated (e.g. set by the NRA)?	No
Are costs associated with possible imbalances included in the price of losses?	Yes
Any measures to combat the currently high prices of energy to cover losses?	No

VALUES OF LOSSES

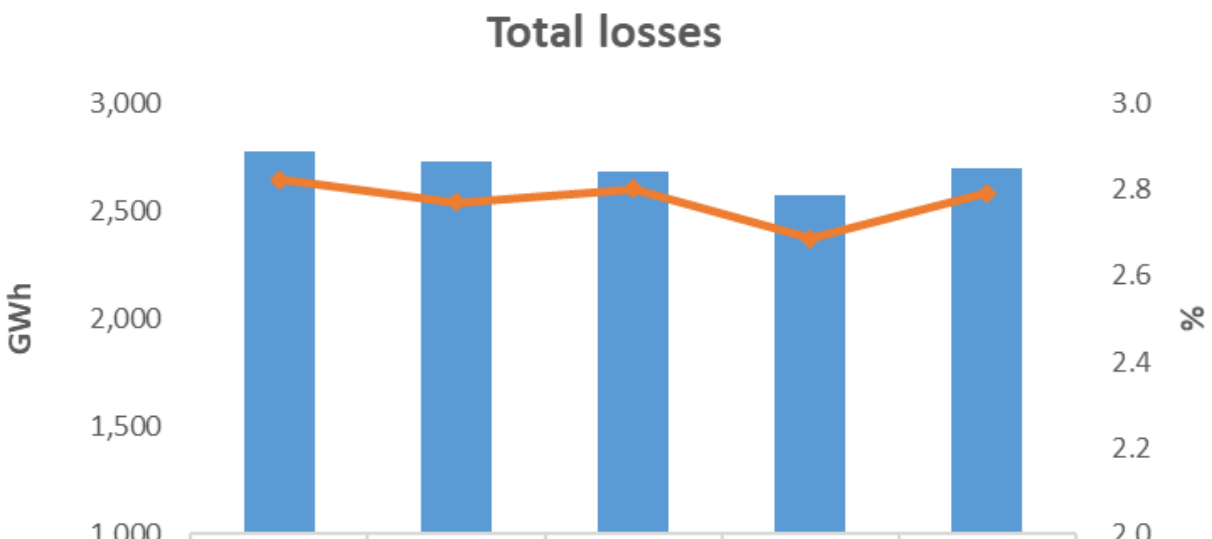


	2018	2019	2020	2021	2022
(GWh)	1,767	1,758	1,762	1,710	1,709
(%)	2.6	2.5	2.5	2.6	2.7

Switzerland does not calculate distribution losses as a simple difference between the overall energy flowing into and out of their entire distribution grid. Overall distribution losses regarding Switzerland in this report are based on data provided to their NRA by most of their roughly 600 DSOs. This is Switzerland's first participation in a CEER Power Losses Report. Distribution losses they provided are an estimate since Switzerland does not publish distribution and transmission losses separately.



	2018	2019	2020	2021	2022
(GWh)	1,005	968	917	863	987
(%)	1.3	1.2	1.2	1.2	1.3



	2018	2019	2020	2021	2022
(GWh)	2,772	2,726	2,679	2,573	2,696
(%)	2.8	2.8	2.8	2.7	2.8

Ukraine

GENERAL INFORMATION

Network length of distribution networks (all lines and cables)	
Number of metering points in distribution network	
Number of smart meters (SM) with active remote reading in distribution network	
Penetration of SM with active remote reading in distribution network (per metering point)	
Year	

DEFINITION AND DETERMINATION OF LOSSES

Are non-technical losses included in values submitted for this report?	Yes, in both distribution and transmission
Components included in definition of non-technical losses	
- "hidden" non-technical losses	Yes, in both distribution and transmission
- Non-metered consumption (e.g. public lighting)	Yes, in both distribution and transmission
- Theft	Yes, in both distribution and transmission
- Others (e.g. metering errors, differences in metering, billing and data processing)	Yes, in both distribution and transmission
How are losses determined?	
Are losses measured or estimated	Both

PROCUREMENT OF LOSSES

Party responsible for procurement of power losses	DSO and TSO
Party responsible for forecasting / estimating power losses	TSO
How are costs of procuring losses covered?	

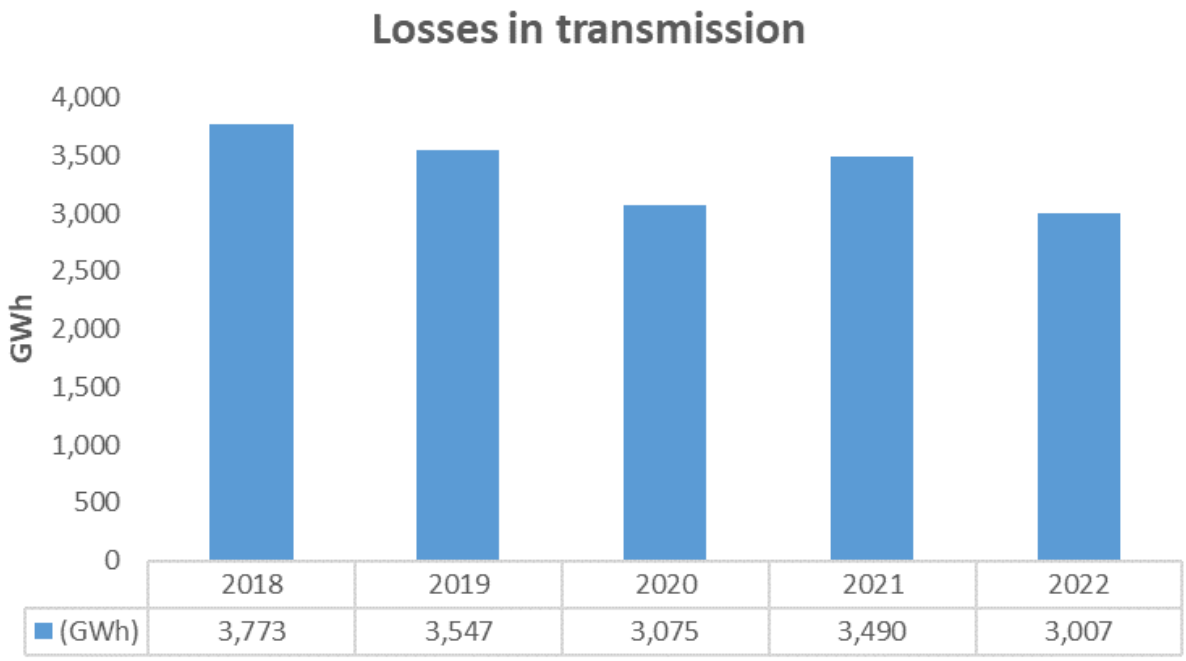
REGULATORY FRAMEWORK

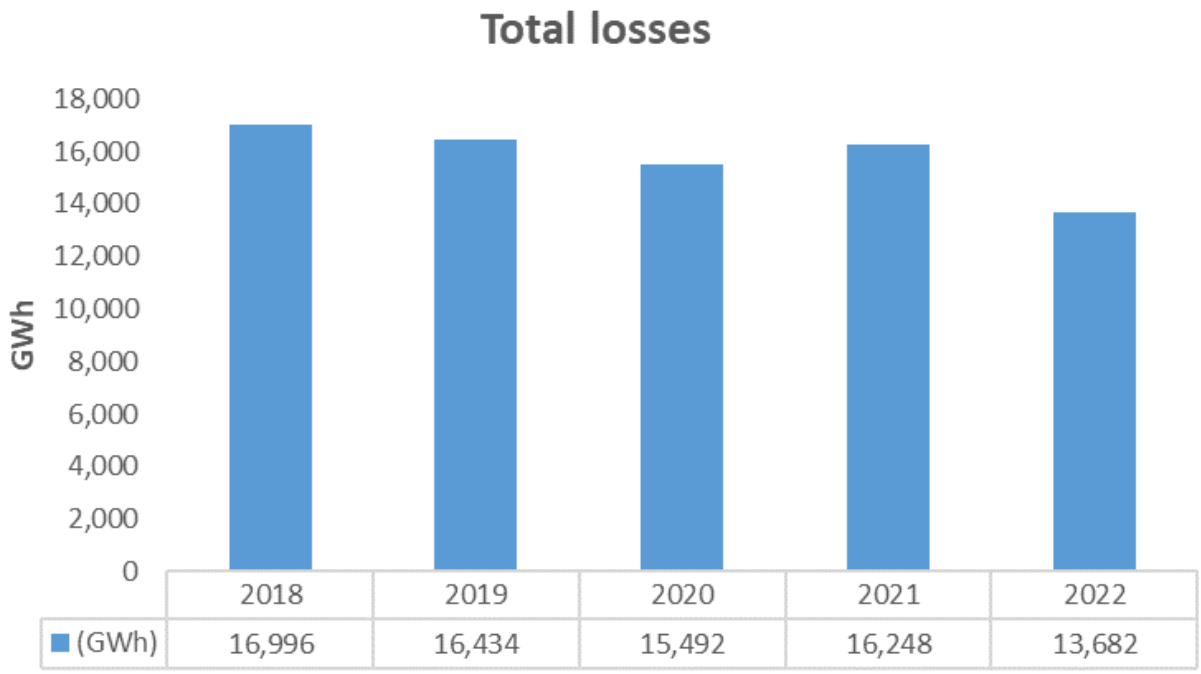
Regulatory incentives to reduce losses or costs related to losses in distribution?	No (only incentives to reduce the overall cost)
Regulatory incentives to reduce losses or costs related to losses in transmission?	Yes
Are non-technical losses included in published losses and in regulation of losses?	
Legal obligation to separately indicate the cost of losses on electricity bills?	No
Different prices of losses for different network users?	Yes

PRICE OF LOSSES

Is the price of losses regulated (e.g. set by the NRA)?	Yes
Are costs associated with possible imbalances included in the price of losses?	
Any measures to combat the currently high prices of energy to cover losses?	

VALUES OF LOSSES





Losses as percentage could not be calculated due to missing data.

Annex 4 – Data

Injection in transmission (GWh)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AL	9,035	7,699	7,830	8,462	7,577	9,848	7,943	8,131	10,685	9,547
AT	43,732	44,558	46,802	45,666	50,206	47,825	47,489	45,594	46,023	47,324
BA	19,469	18,207	18,373	19,654	18,579	20,992	18,899	18,657	20,367	18,910
BE	80,047	75,011	72,015	77,112	76,453	71,730	79,277	75,074	87,542	84,007
BG									41,445	43,369
CH					77,388	77,828	79,400	74,463	72,952	75,400
CY	4,000	3,989	4,126	4,487	4,591	4,606	4,666	4,339	4,461	4,416
CZ	63,254	64,261	66,577	63,877	68,654	66,964	67,671	66,320	69,764	69,637
EE	13,826	14,402	14,115	13,690	13,238	13,710	11,599	11,438	13,088	14,587
EL	46,505	45,953	46,717	46,510	47,313	46,751	47,179	44,570	45,668	42,326
ES		208,517	224,812	219,227	225,181	225,024	230,679	221,446	232,199	247,943
FI	65,753	68,243	69,080	69,621	67,247	69,657	69,920	69,733	74,265	71,574
FR	522,151	507,849	512,481	505,950	502,208	510,413	497,800	462,700	489,700	438,200
GE	10,345	11,008	11,292	12,684	13,067	13,456	13,390	12,655	15,621	18,681
HR	23,854	22,547	22,449	22,828	22,098	23,829	22,058	21,291	23,996	23,361
HU	42,184	42,745	43,937	44,478	45,460	45,418	44,807	43,865	43,961	44,974
IE	22,673	22,673	22,673	23,191	23,567	24,093	24,284	23,059	25,232	24,959
IT	266,998	257,480	264,305	262,169	263,726	261,655	261,082	245,901	258,835	256,637
KS*	5,520	5,399	5,570	5,343	5,686	5,671	6,001	6,167	6,885	6,547
LT	11,553	11,493	11,222	13,784	14,490	14,902	15,519	15,745	15,787	15,983
LV						10,544	6,760	8,710	9,408	9,385
MD				4,097	4,147	4,297	4,295	4,254	4,551	4,425
ME	6,779	6,893	5,916	5,857	5,617	6,424	6,859	9,010	8,799	8,403
MK			10,269	10,159	9,216	9,124	9,948	9,936	9,532	9,314
NL	98,313	100,561	106,788	99,354	108,448	110,676	107,979	105,026	106,573	100,825
NO	81,269	70,931	72,217	77,704	77,127	82,345	81,404	75,234	81,875	75,347
PL	99,320	102,970	103,464	104,038	104,197	108,701	107,216	104,097	116,866	117,318
PT	39,337	39,480	41,242	44,481	45,634	45,318	40,994	40,776	40,134	41,947
RO		42,851	43,762	43,674	44,337	44,469	43,358	42,861	44,137	43,495
RS	41,463	38,891	41,891	41,401	40,454	40,715	39,640	39,928	41,752	40,707
SE	119,328	116,725	117,837	118,046	122,338	124,421	121,825	119,507	122,450	125,286
SI	21,515	22,475	22,030	22,476	23,085	22,884	22,719	21,779	21,731	21,379
SK								31,524	32,807	33,523

Table 10 – Injection in transmission in GWh

Injection in distribution (GWh)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AL	7,145	6,935	6,495	6,400	6,499	6,422	6,806	6,605	7,552	7,399
AT	74,114	73,431	74,622	76,908	78,112	76,853	78,523	76,963	78,514	77,763
BA	9,810	9,769	10,116	10,418	10,580	10,653	10,699	10,402	11,005	11,102
BE	51,816	49,537	49,725	49,863	49,385	48,774	52,577	48,609	51,527	48,279
BG									23,017	21,989
CH						68,067	69,866	69,548	65,135	64,222
CY					4,510	4,557	4,595	4,368	4,560	4,658
CZ	57,376	56,836	57,877	59,354	60,028	60,004	59,200	57,100	59,441	56,973
EE	7,192	7,215	7,171	7,416	7,623	7,739	7,554	7,360	7,889	7,498
EL	41,782	41,178	42,176	41,938	42,663	42,100	43,165	41,673	43,375	41,621
ES		238,954	243,996	245,394	248,499	249,343	245,331	232,630	238,030	214,235
FI	79,968	78,385	80,322	81,161	81,822	82,331	79,693	75,515	79,865	75,744
FR	396,000	369,000	381,000	387,000	387,000	388,000	388,000	376,000	392,000	380,000
GE	7,715	8,214	8,201	8,801	9,374	9,895	9,049	8,423	8,930	9,689
HR	16,601	15,441	16,076	16,159.8	16,695	16,764	16,703	15,998.9	16,877	16,943
HU	37,482	37,986	39,000	39,151	40,194	40,775	40,897	40,477	42,421	41,414
IE		23,749	24,116	24,692	25,020	25,852	25,986	25,871	26,547	26,275
KS*	4,794	4,555	4,677	4,807	4,997	5,120	5,322	5,550	6,260	6,196
LT	8,874	9,061	9,152	9,605	9,825	10,201	10,194	10,138	10,942	10,543
LV						6,927	6,800	6,563	6,741	6,497
MD				3,807	3,828	3,951	3,971	3,948	4,246	4,137
ME	2,531	2,448	2,607	2,588	2,670	2,686	2,697	2,544	2,721	2,820
MK	6,031	5,898	6,111	6,062	6,165	6,120	6,195	6,215	6,576	6,125
MT	2,133	2,126	2,272	2,312	2,431	2,490	2,628	2,420	2,625	2,792
NL	94,395	93,042	90,485	91,229	91,188	90,345	88,749	84,296	87,804	80,168
NO	263,229	194,633	231,090	242,440	245,216	249,514	237,787	209,791	222,579	197,245
PL	145,323	145,530	148,723	152,351	156,448	159,703	157,606	154,614	163,175	161,594
PT	46,450	45,997	46,218	46,513	46,846	47,898	47,461	45,783	46,490	49,987
RO		51,748	52,566	53,516	53,827	54,214	53,857	52,740	55,478	52,510
RS	30,068	29,351	30,131	30,162	30,503	30,040	30,002	30,027	31,004	30,133
SE	115,071	113,239	115,148	119,290	119,416	153,284	150,062	149,716	158,710	157,502
SI	10,968	10,858	11,169	11,364	11,696	11,894	11,902	11,483	11,956	11,631
SK								24,588	26,214	24,985

Table 11 – Injection in distribution in GWh

Energy injected by generators connected to distribution grid (GWh)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AL	391	403	458	625	440	709	613	540	878	778
AT	31,309	30,630	32,299	35,079	37,420	35,227	38,062	37,730	35,478	35,934
BA	239	288	270	431	401	515	557	409	538	557
BE	1,684	1,761	1,958	1,990	2,061	9,263	10,421	11,736	12,110	12,313
BG									3,342	3,450
CH						20,357	19,029	21,167	22,828	21,219
CY					150	167	172	303	437	587
CZ	20,643	19,686	20,450	19,104	18,707	17,555	15,242	14,610	16,358	17,097
EE	197	204	223	237	231	196	252	362	539	724
EL	4,214	4,462	4,714	4,734	4,764	4,798	5,041	5,507	6,593	8,324
ES		70,305	57,597	64,454	60,887	59,976	48,871	47,881	45,224	36,501
FI	22,063	19,750	21,793	20,440	18,675	20,510	21,471	20,834	22,520	21,898
FR	32,000	34,000	39,000	40,000	44,000	50,000	56,000	63,000	62,000	66,000
GE	1,660	1,691	1,532	1,889	1,623	1,721	1,412	1,449	1,730	1,500
HR	590	540	720	900	880	1,060	1,350	1,420	1,660	1,820
HU	3,970	3,575	3,613	3,664	4,214	4,076	4,995	5,843	7,580	8,621
IE		3,560	4,160	3,872	4,385	5,021	5,343	6,209	5,965	6,874
IT	46,639	49,170	47,046	46,675	46,652	48,789	50,405	51,421		
KS*	44	50	34	52	43	58	68	114	140	168
LT	501	577	632	763	837	788	843	916	956	1,075
LV						1,377	1,265	1,196	1,014	843
ME	30	32	46	76	67	102	81	101	175	183
MK	218	256	359	443	357	458	386	417	477	538
MT[38]	2,133	2,126	1,218	785	1,534	1,859	1,971	2,000	2,078	2,145
NO	66,281	73,231	75,798	69,877	72,591	69,237	67,312	79,426	73,289	74,125
PL	50,302	47,652	53,215	52,327	54,940	49,717	48,496	48,992	52,116	53,176
PT	16,723	16,890	15,075	16,174	14,509	15,624	16,066	16,350	16,260	15,035
RO		22,176	21,833	22,046	20,744	21,204	20,255	19,219	21,032	18,685
RS	104	267	321	448	538	642	612	693	898	873
SE	47,185	51,641	63,440	59,268	58,881	64,667	70,838	79,471	81,191	95,428
SI	961	1,061	969	1,116	1,032	1,050	1,044	1,089	1,100	1,012
SK								9,241	9,559	8,629

Table 12 – Energy injected by generators connected to distribution grid in GWh

[38] Since 2015, Malta has been electrically connected to Italy and has been importing energy since. For this reason, energy injected in distribution is the same as energy injected by generators connected to distribution only until 2014. They begin differing in 2015 when Malta started importing energy from Italy. Since there is no transmission grid in Malta, the electricity imports are fed directly into the distribution grid.

Offtake from transmission (GWh)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AL	8,825	7,538	7,672	8,272	7,419	9,606	7,775	7,959	10,457	9,347
AT	43,137	43,957	46,164	45,031	49,446	47,149	46,731	44,863	45,349	46,592
BA	19,126	17,903	18,014	19,321	18,238	20,594	18,576	18,340	19,998	18,577
BE	78,583	73,583	70,626	75,715	75,067	70,425	77,941	73,817	86,065	82,654
BG									40,566	42,493
CH					76,439	76,823	78,433	73,546	72,089	74,413
CY	3,926	3,916	4,049	4,404	4,525	4,544	4,603	4,276	4,396	4,363
CZ	62,462	63,430	65,570	62,914	67,442	65,825	66,447	65,058	68,723	68,624
DE	365,408	357,586	367,710	352,863	341,092	341,704	321,970	304,064	326,398	315,533
EE	13,477	14,021	13,713	13,282	12,912	13,330	11,251	11,090	12,679	14,152
EL	45,333	44,731	45,415	45,379	46,194	45,519	46,030	43,442	44,409	40,999
ES		204,720	221,092	215,171	221,305	221,019	226,999	217,538	227,977	243,416
FI	64,786	67,154	67,869	68,496	66,173	68,577	68,748	68,426	72,940	70,116
FR	510,751	497,149	501,781	495,250	491,008	499,313	486,700	452,000	478,500	428,100
GE	10,141	10,774	11,042	12,435	12,815	13,198	13,154	12,413	15,328	18,313
HR	23,371	22,117	21,942	22,318	21,681	23,295	21,670	20,918	23,518	22,898
HU	41,779	42,345	43,524	44,054	44,987	44,983	44,324	43,370	43,534	44,523
IE	23,339	23,339	23,339	23,339	23,199	23,717	23,905	22,699	24,838	24,630
IS	13,981	13,983	14,357	14,334	14,870	15,260	15,145	14,831	15,246	15,692
IT	262,450	252,706	259,559	257,926	258,855	256,639	256,032	241,448	253,692	251,569
KS*	5,410	5,290	5,460	5,222	5,568	5,559	5,896	6,059	6,765	6,429
LT	11,309	11,272	11,002	13,383	14,069	14,464	15,056	15,291	15,366	15,490
LV						10,362	6,523	8,509	9,205	9,190
MD				3,987	4,035	4,184	4,188	4,151	4,434	4,264
ME	6,636	6,771	5,781	5,738	5,490	6,282	6,713	8,846	8,641	8,261
MK			10,139	10,043	9,105	8,999	9,828	9,812	9,406	9,199
NO	79,029	68,575	69,776	75,135	74,810	79,939	79,189	72,913	79,270	72,656
PL	97,626	101,277	101,631	102,353	102,528	107,089	105,739	102,639	115,153	115,483
PT	38,619	38,695	40,585	43,681	44,908	44,574	40,271	39,982	39,347	41,148
RO	39,868	41,825	42,732	42,662	43,372	43,368	42,373	41,924	43,048	42,536
RS	40,450	37,943	40,959	40,511	39,601	39,846	38,834	39,129	40,907	39,905
SE	116,505	113,683	114,642	114,971	118,915	121,248	118,549	115,587	118,350	120,325
SI	21,209	22,172	21,695	22,137	22,707	22,521	22,361	21,435	21,383	21,015
SK								31,130	32,473	33,184

Table 13 – Offtake from transmission in GWh

Offtake from distribution (GWh)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AL	3,927	4,513	4,459	4,605	4,782	4,884	5,323	5,147	5,995	5,941
AT	71,631	71,039	72,220	74,604	75,805	74,640	76,286	74,820	76,276	75,567
BA	8,705	8,752	9,081	9,394	9,575	9,703	9,766	9,490	10,040	10,171
BE	49,761	47,655	48,009	48,190	47,788	47,346	50,611	46,536	49,437	45,928
BG									21,322	20,350
CH	59,323	57,466	58,246	58,239	58,483	57,647	57,198	55,714	58,113	57,030
CY					4,378	4,461	4,471	4,199	4,409	4,567
CZ	54,152	53,821	54,817	56,236	56,865	56,873	56,124	54,244	56,831	54,571
DE	469,600	460,600	449,700	449,900	445,200	443,000	433,400	418,100	428,300	409,300
EE	6,807	6,807	6,810	7,088	7,247	7,387	7,230	7,049	7,561	7,200
EL	39,325	37,829	38,463	37,850	38,684	38,017	38,891	37,578	39,040	36,958
ES		218,152	222,940	224,533	228,340	228,950	225,383	212,685	217,722	194,322
FI	77,922	76,384	78,183	78,789	79,150	79,598	77,273	73,094	77,723	73,651
GE	7,214	7,700	7,653	8,229	8,782	9,267	8,367	7,778	8,234	8,921
HR	15,142	14,184	14,781	14,925	15,352	15,476	15,427	14,644	15,665	15,744
HU	34,224	34,713	35,740	35,987	37,042	37,772	38,072	37,821	39,763	38,990
IE		22,152	22,520	23,020	23,344	24,120	24,245	24,137	24,768	24,505
IS	3,316	3,339	3,606	3,384	3,524	3,682	3,507	3,474	3,501	3,616
KS*	3,090	3,029	3,188	3,379	3,532	3,691	3,944	4,140	4,721	4,794
LT	8,209	8,394	8,529	8,976	9,220	9,586	9,552	9,548	10,370	10,010
LV						6,620	6,551	6,301	6,486	6,255
MD				3,484	3,509	3,623	3,652	3,648	3,927	3,837
ME	2,051	2,016	2,161	2,184	2,271	2,315	2,341	2,215	2,375	2,485
MK	5,041	4,984	5,209	5,172	5,272	5,251	5,337	5,358	5,663	5,269
MT	1,854	1,924	2,089	2,151	2,294	2,379	2,503	2,291	2,512	2,604
NL[39]	84,346	83,106	80,228	81,607	81,973	80,525	81,881	77,514	79,910	72,690
NO	257,223	189,089	225,300	236,239	239,479	243,697	232,331	204,498	217,038	192,138
PL	136,421	136,908	140,192	144,419	148,901	152,104	150,502	147,106	156,010	155,017
PT	41,763	41,695	42,104	42,484	42,595	43,752	43,345	41,692	42,482	45,766
RO		45,120	46,253	47,180	47,628	48,380	48,297	47,409	50,179	47,675
RS	25,584	25,136	25,894	26,246	26,549	26,376	26,476	26,440	27,368	26,750
SE	109,745	108,102	109,940	113,938	114,136	147,962	144,940	144,623	153,223	152,514
SI	10,426	10,340	10,639	10,846	11,195	11,398	11,425	10,999	11,491	11,175
SK								22,719	24,494	23,407

Table 14 – Offtake from distribution in GWh

[39] The offtakes from distribution grid, as reported by DSOs in the Netherlands, only include the energy taken off by their own medium and low voltage consumers. This excludes the energy supplied to other system operators (either the TSO or other DSOs).

Total losses (GWh)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AL	3,428	2,583	2,194	1,984	1,874	1,781	1,652	1,630	1,785	1,658
AT	3,078	2,994	3,040	2,940	3,067	2,889	2,996	2,874	2,913	2,927
BA	1,448	1,321	1,394	1,357	1,346	1,348	1,256	1,229	1,334	1,264
BE	3,519	3,311	3,105	3,069	2,984	2,733	3,302	3,330	3,567	3,705
BG									2,575	2,516
CH						2,772	2,726	2,679	2,573	2,696
CY	183	172	212	226	198	158	187	232	216	144
CZ	4,015	3,846	4,067	4,081	4,375	4,269	4,300	4,117	3,651	3,414
DE	26,200	23,900	25,800	26,000	27,500	24,600	26,900	27,200	27,700	28,000
DK						2,362	2,398	2,295	2,322	2,324
EE	734	789	763	736	702	732	672	659	737	733
EL	3,629	4,571	5,015	5,219	5,098	5,315	5,423	5,223	5,594	5,990
ES		24,599	24,776	24,917	24,035	24,398	23,628	23,853	24,529	24,440
FI	3,014	3,089	3,350	3,498	3,745	3,813	3,592	3,729	3,468	3,550
FR	36,100	33,200	33,600	33,700	34,200	34,100	35,800	34,000	35,900	33,700
GB				23,306	23,633					23,534
GE	705	745	798	820	844	886	918	888	989	1,137
HR	1,942	1,687	1,802	1,745	1,760	1,822	1,664	1,729	1,690	1,662
HU	3,663	3,673	3,673	3,588	3,625	3,438	3,308	3,151	3,085	2,875
IE					2,045	2,109	2,120	2,094	2,173	2,099
IS	250	192	252	190	283	226	232	248	228	235
IT	21,187	19,452	19,717	18,753	18,668	17,988	17,818	17,366	19,032	19,185
KS*	1,814	1,635	1,598	1,548	1,582	1,541	1,483	1,517	1,658	1,521
LT	908	887	842	1,030	1,026	1,053	1,104	1,044	993	1,026
LU					166	163	162	157	159	166
LV						488	486	463	458	437
MD				432	429	441	426	403	435	462
ME	622	554	581	523	526	514	502	493	504	477
MK	1,149	1,066	1,033	1,006	1,004	994	977	981	1,038	970
MT	279	202	183	161	137	111	125	129	113	187
NL	5,318	5,116	4,925	5,022	5,088	5,126	4,838	4,973	5,018	5,182
NO	8,246	7,901	8,230	8,769	8,054	8,222	7,671	7,615	8,146	7,799
PL	10,595	10,315	10,363	9,618	9,216	9,210	8,580	8,965	8,877	8,413
PT	5,405	5,087	4,771	4,829	4,977	4,890	4,840	4,885	4,795	5,021
RO		7,654	7,343	7,348	7,165	6,933	6,546	6,267	6,388	5,794
RS	5,495	5,163	5,168	4,807	4,805	4,532	4,333	4,385	4,481	4,185
SE	8,148	8,178	8,403	8,428	8,703	8,495	8,398	9,013	9,587	9,949
SI	849	820	864	857	879	859	836	828	813	820
SK								2,254	2,045	1,908
UA					16,787	16,996	16,434	15,492	16,248	13,682

Table 15 – Total losses in GWh

Losses in transmission (GWh)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AL	210	161	159	190	158	243	169	172	228	200
AT	595	602	638	636	760	677	758	731	674	732
BA	343	304	359	333	341	398	323	317	369	333
BE	1,464	1,429	1,389	1,396	1,387	1,305	1,336	1,257	1,477	1,354
BG									879	877
CH					949	1,005	968	917	863	987
CY	74	73	77	83	66	62	63	63	65	53
CZ	791	831	1,007	963	1,212	1,139	1,224	1,261	1,041	1,012
DE	6,300	6,400	8,100	8,400	9,900	7,200	9,300	9,900	9,900	10,800
DK						982	1,088	916	918	936
EE	349	381	402	408	325	380	348	348	409	435
EL	1,172	1,222	1,302	1,131	1,119	1,232	1,149	1,128	1,259	1,327
ES		3,797	3,720	4,056	3,876	4,005	3,680	3,908	4,221	4,527
FI	967	1,089	1,211	1,126	1,074	1,080	1,172	1,307	1,325	1,457
FR	11,400	10,700	10,700	10,700	11,200	11,100	11,100	10,700	11,200	10,100
GB	6,351	6,509	7,394	6,235	6,235					6,482
GE	204	232	250	248	252	258	236	242	293	369
HR	483	430	507	510	417	534	388	373	478	463
HU	405	400	413	424	473	435	483	495	427	451
IE					368	376	379	360	394	329
IS	62	54	57	57	61	70	63	61	66	68
IT	4,547	4,774	4,745	4,243	4,871	5,017	5,050	4,453	5,143	5,068
KS*	110	109	110	121	118	111	106	107	120	118
LT	244	220	220	401	421	438	462	454	421	493
LV						181	237	201	203	195
MD				110	111	113	106	103	116	162
ME	142	122	135	119	127	142	146	164	158	142
MK	159	152	131	116	111	125	120	124	125	114
NL	831	947	1,075	1,218	1,356	1,361	1,243	1,327	1,479	1,494
NO	2,240	2,356	2,440	2,569	2,317	2,405	2,215	2,322	2,605	2,691
PL	1,694	1,693	1,833	1,685	1,669	1,611	1,476	1,458	1,713	1,835
PT	718	785	657	800	726	744	723	794	787	799
RO	1,031	1,026	1,030	1,012	965	1,101	985	937	1,089	959
RS	1,013	948	932	890	852	868	806	798	845	802
SE	2,822	3,041	3,195	3,076	3,423	3,173	3,276	3,921	4,099	4,961
SI	307	303	334	339	378	362	358	344	349	364
SK[40]								386	325	330
UA					3,855	3,773	3,547	3,075	3,490	3,007

Table 16 – Losses in transmission in GWh

[40] Transmission losses in Slovakia include self-consumption: 8.9 GWh in 2020, 9.17 GWh in 2021 and 9.11 GWh in 2022.

Losses in distribution (GWh)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AL	3,218	2,422	2,035	1,794	1,717	1,539	1,483	1,458	1,557	1,458
AT	2,483	2,392	2,402	2,304	2,307	2,213	2,238	2,143	2,238	2,195
BA	1,105	1,017	1,035	1,024	1,005	950	933	912	965	931
BE	2,055	1,882	1,716	1,673	1,597	1,428	1,966	2,073	2,090	2,351
BG									1,695	1,639
CH[41]						1,767	1,758	1,762	1,710	1,709
CY	109	99	135	143	132	96	124	169	151	91
CZ	3,224	3,015	3,060	3,118	3,163	3,130	3,076	2,856	2,610	2,402
DE	19,900	17,500	17,700	17,600	17,600	17,400	17,600	17,300	17,800	17,200
DK						1,380	1,310	1,379	1,405	1,388
EE	385	408	361	328	377	352	324	311	328	298
EL	2,457	3,349	3,713	4,088	3,979	4,083	4,274	4,095	4,335	4,663
ES		20,802	21,056	20,861	20,159	20,393	19,948	19,945	20,307	19,913
FI	2,046	2,000	2,139	2,372	2,672	2,733	2,420	2,422	2,143	2,093
FR	24,700	22,500	22,900	23,000	25,150	24,870	24,600	23,400	24,768	23,600
GB				17,071	17,398	17,567	16,255	16,654	17,279	17,051
GE	501	513	548	571	592	628	682	645	598	768
HR	1,459	1,257	1,295	1,235	1,343	1,288	1,276	1,355	1,212	1,199
HU	3,258	3,273	3,260	3,164	3,152	3,003	2,825	2,656	2,658	2,424
IE		1,597	1,597	1,672	1,677	1,732	1,741	1,734	1,779	1,770
IS	188	138	195	133	222	156	169	187	162	167
IT	16,640	14,678	14,972	14,510	13,797	12,971	12,768	12,913	13,889	14,117
KS*	1,704	1,526	1,488	1,427	1,464	1,429	1,378	1,409	1,538	1,403
LT	664	667	622	629	605	615	642	590	572	533
LV						307	250	262	256	242
MD				322	318	328	320	300	319	300
ME	480	432	446	404	400	372	356	329	346	335
MK	990	914	902	890	893	869	858	857	913	856
MT	279	202	183	161	137	111	125	129	113	187
NL	4,487	4,169	3,850	3,804	3,732	3,765	3,595	3,646	3,539	3,688
NO	6,006	5,545	5,790	6,201	5,737	5,817	5,456	5,293	5,541	5,107
PL	8,901	8,622	8,530	7,933	7,547	7,599	7,104	7,508	7,164	6,578
PT	4,687	4,302	4,114	4,029	4,251	4,146	4,117	4,091	4,008	4,222
RO		6,628	6,313	6,336	6,200	5,833	5,560	5,330	5,299	4,835
RS	4,482	4,215	4,236	3,917	3,953	3,664	3,527	3,587	3,636	3,383
SE	5,326	5,137	5,208	5,352	5,280	5,322	5,122	5,093	5,487	4,988
SI	542	517	530	518	501	497	478	484	464	456
SK								1,868	1,720	1,577
UA					12,932	13,223	12,887	12,417	12,758	10,675

Table 17 – Losses in distribution in GWh

[41] Switzerland does not calculate distribution losses as a simple difference between the overall energy flowing into and out of their entire distribution grid. Distribution losses they provided are an estimate since Switzerland does not publish distribution and transmission losses separately.

Low voltage losses (GWh)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AL	3,197	2,622	2,035	1,794	1,717	1,539	1,483	1,458	1,557	1,458
CH						697	699	716	677	676
CY	60	54	74		73	53	56	69	67	50
CZ	1,463	1,333	1,402	1,388	1,418	1,416	1,401	1,271	963	792
DE	9,700	8,600	8,700	8,800	8,600	8,500	8,700	8,600	8,800	8,200
EL	1,572	2,060	2,340	2,578	2,494	2,551	2,707	2,622		
HU	1,741	1,710	1,711	1,606	1,507	1,338	1,236	1,130	1,149	1,146
IE		488	482	447	545	557	546	531	541	518
KS*	769	709	722	627	614	674	684	696	780	757
LT	338	343	337	312	330	335	310	317	335	319
MD				215	227	248	241	225	240	226
PL	3,482	3,313	3,107	2,804	2,706	2,641	2,452	2,798	2,663	2,280
PT										2,810
RO		4,266	3,973	3,937	3,831	3,541	3,357	3,214	3,154	2,847

Table 18 – Low voltage losses in GWh

Non-technical losses (GWh)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AL	2,111	1,520	669	448	469	468	529	525	528	478
CY					3	4	4	5	5	5
EL	404	1,166	1,504	1,799	1,662	1,739	1,949	1,863	2,129	2,359
FR	11,618	11,411	11,844	12,139	12,343	12,237				
HU	639	633	653	569	457	332	276	217	242	343
IE		90	90	90	155	155	155	149	149	131
KS*	717	590	519	548	585	483	400	334	424	283
LT	190	186	154	186	152	146	217	145	151	108
MT	187	111	55	18	24	2	14	33	6	74

Table 19 – Non-technical losses in GWh

Total losses in %

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AL	36.36	31.88	26.47	21.84	23.38	16.87	19.30	18.80	15.44	16.06
AT	4.10	3.98	3.84	3.64	3.50	3.48	3.50	3.45	3.57	3.52
BA	7.35	7.14	7.48	6.76	7.09	6.27	6.46	6.45	6.38	6.49
BE	4.31	4.31	4.20	3.88	3.80	3.37	3.68	3.84	3.58	3.85
BG									5.75	5.37
CH						2.82	2.77	2.80	2.69	2.79
CY					4.18	3.31	3.87	5.00	4.41	2.79
CZ	4.79	4.58	4.67	4.92	5.01	5.05	5.19	5.09	4.24	3.94
DE	4.63	4.31	4.61	4.61	4.97	4.39	5.14	5.45	5.45	5.64
EE	5.23	5.40	5.32	5.28	5.21	5.26	5.67	5.58	5.41	4.79
EL	7.16	9.07	9.75	10.18	9.79	10.31	10.38	10.43	10.70	11.83
ES		8.82	8.77	8.78	8.40	8.56	8.45	8.86	8.84	8.59
FI	3.43	3.51	3.69	3.88	4.36	4.23	3.93	4.12	3.58	3.80
FR	6.51	6.13	6.09	6.17	6.26	6.08	6.46	6.47	6.51	6.68
GE	5.87	5.87	6.22	5.63	5.75	5.84	6.20	6.30	5.70	5.63
HR	7.95	7.31	7.78	7.35	7.66	7.32	7.11	7.61	6.59	6.60
HU	7.94	7.93	7.72	7.45	7.30	6.95	6.64	6.34	5.99	5.36
IE					7.32	7.24	7.16	7.15	6.97	6.59
IT	6.76	6.34	6.33	6.07	6.01	5.79	5.72	5.84	7.35	7.48
KS*	32.60	29.99	28.51	28.68	27.61	26.88	24.42	24.14	23.60	22.65
LT	7.53	7.35	7.11	7.08	6.70	6.71	6.75	6.26	5.93	6.02
LU					2.53	2.47	2.48	2.51	2.43	2.61
LV						4.10	6.06	4.67	4.40	4.27
ME	9.13	8.00	9.75	8.82	9.25	7.88	7.23	5.41	5.62	5.56
MK			9.71	9.49	10.49	10.38	9.45	9.47	10.37	9.85
MT	13.06	9.50	8.05	6.98	5.65	4.46	4.76	5.33	4.29	6.70
NO	5.59	5.48	5.56	5.94	5.38	5.42	5.16	4.92	5.25	5.22
PL	7.08	6.85	6.61	6.15	5.79	5.81	5.51	5.86	5.25	4.93
PT	9.64	9.02	8.47	7.96	8.28	8.02	8.48	8.55	8.50	8.81
RO		11.77	11.19	11.18	11.01	10.56	10.29	10.11	9.80	9.32
RS	13.22	13.18	12.24	11.49	11.72	10.96	10.76	10.80	10.51	10.06
SE	4.89	4.86	4.64	4.75	4.80	4.49	4.36	4.53	4.71	4.51
SI	3.78	3.48	3.76	3.63	3.64	3.59	3.52	3.62	3.56	3.66
SK								5.53	4.83	4.53

Table 20 –Total losses in %

Losses in transmission in %

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AL	2.32	2.09	2.03	2.25	2.08	2.46	2.12	2.12	2.13	2.09
AT	1.36	1.35	1.36	1.39	1.51	1.42	1.60	1.60	1.46	1.55
BA	1.76	1.67	1.95	1.69	1.84	1.90	1.71	1.70	1.81	1.76
BE	1.83	1.90	1.93	1.81	1.81	1.82	1.68	1.67	1.69	1.61
BG									2.12	2.02
CH					1.23	1.29	1.22	1.23	1.18	1.31
CY	1.85	1.83	1.87	1.85	1.44	1.35	1.35	1.45	1.46	1.20
CZ	1.25	1.29	1.51	1.51	1.77	1.70	1.81	1.90	1.49	1.45
EE	2.52	2.65	2.85	2.98	2.46	2.77	3.00	3.04	3.13	2.98
EL	2.52	2.66	2.79	2.43	2.37	2.64	2.44	2.53	2.76	3.14
ES		1.82	1.65	1.85	1.72	1.78	1.60	1.76	1.82	1.83
FI	1.47	1.60	1.75	1.62	1.60	1.55	1.68	1.87	1.78	2.04
FR	2.18	2.11	2.09	2.11	2.23	2.17	2.23	2.31	2.29	2.30
GE	1.97	2.11	2.21	1.96	1.93	1.92	1.76	1.91	1.88	1.98
HR	2.03	1.91	2.26	2.23	1.89	2.24	1.76	1.75	1.99	1.98
HU	0.96	0.94	0.94	0.95	1.04	0.96	1.08	1.13	0.97	1.00
IE					1.56	1.56	1.56	1.56	1.56	1.32
IT	1.70	1.85	1.80	1.62	1.85	1.92	1.93	1.81	1.99	1.97
KS*	2.00	2.02	1.97	2.26	2.07	1.96	1.76	1.74	1.75	1.81
LT	2.11	1.91	1.96	2.91	2.91	2.94	2.98	2.88	2.67	3.08
LV						1.72	3.50	2.30	2.16	2.08
MD				2.68	2.68	2.63	2.47	2.42	2.55	3.66
ME	2.09	1.77	2.28	2.03	2.26	2.21	2.13	1.82	1.80	1.69
MK			1.27	1.14	1.20	1.37	1.20	1.24	1.31	1.23
NL	0.85	0.94	1.01	1.23	1.25	1.23	1.15	1.26	1.39	1.48
NO	2.76	3.32	3.38	3.31	3.00	2.92	2.72	3.09	3.18	3.57
PL	1.71	1.64	1.77	1.62	1.60	1.48	1.38	1.40	1.47	1.56
PT	1.83	1.99	1.59	1.80	1.59	1.64	1.76	1.95	1.96	1.90
RO		2.39	2.35	2.32	2.18	2.47	2.27	2.19	2.47	2.20
RS	2.44	2.44	2.22	2.15	2.11	2.13	2.03	2.00	2.02	1.97
SE	2.36	2.61	2.71	2.61	2.80	2.55	2.69	3.28	3.35	3.96
SI	1.43	1.35	1.52	1.51	1.64	1.58	1.58	1.58	1.61	1.70
SK								1.22	0.99	0.99

Table 21 – Losses in transmission in %

Losses in distribution in %

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AL	45.04	34.92	31.34	28.04	26.41	23.96	21.79	22.07	20.62	19.70
AT	3.35	3.26	3.22	3.00	2.95	2.88	2.85	2.78	2.85	2.82
BA	11.26	10.41	10.23	9.83	9.50	8.92	8.72	8.77	8.77	8.39
BE	3.97	3.80	3.45	3.36	3.23	2.93	3.74	4.26	4.06	4.87
BG									7.37	7.45
CH						2.60	2.52	2.53	2.63	2.66
CY					2.93	2.11	2.70	3.87	3.31	1.95
CZ	5.62	5.30	5.29	5.25	5.27	5.22	5.20	5.00	4.39	4.22
EE	5.35	5.65	5.03	4.42	4.95	4.55	4.29	4.23	4.16	3.98
EL	5.88	8.13	8.80	9.75	9.33	9.70	9.90	9.83	9.99	11.20
ES		8.71	8.63	8.50	8.11	8.18	8.13	8.57	8.53	9.29
FI	2.56	2.55	2.66	2.92	3.27	3.32	3.04	3.21	2.68	2.76
FR	6.24	6.10	6.01	5.94	6.50	6.41	6.34	6.22	6.32	6.21
GE	6.49	6.25	6.68	6.49	6.32	6.35	7.54	7.66	6.70	7.93
HR	8.79	8.14	8.06	7.64	8.04	7.68	7.64	8.47	7.18	7.08
HU	8.69	8.62	8.36	8.08	7.84	7.36	6.91	6.56	6.27	5.85
IE		6.73	6.62	6.77	6.70	6.70	6.70	6.70	6.70	6.74
KS*	35.55	33.50	31.83	29.70	29.31	27.92	25.89	25.40	24.57	22.63
LT	7.48	7.36	6.80	6.55	6.16	6.03	6.30	5.82	5.23	5.06
LV						4.43	3.67	3.99	3.79	3.72
MD				8.46	8.31	8.30	8.06	7.60	7.51	7.25
ME	18.96	17.65	17.11	15.61	14.98	13.85	13.20	12.93	12.72	11.88
MK	16.42	15.50	14.76	14.68	14.48	14.20	13.85	13.79	13.88	13.98
MT	13.06	9.50	8.05	6.98	5.65	4.46	4.76	5.33	4.29	6.70
NL	4.75	4.48	4.25	4.17	4.09	4.17	4.05	4.33	4.03	4.60
NO	2.28	2.85	2.51	2.56	2.34	2.33	2.29	2.52	2.49	2.59
PL	6.13	5.92	5.74	5.21	4.82	4.76	4.51	4.86	4.39	4.07
PT	10.09	9.35	8.90	8.66	9.07	8.66	8.67	8.94	8.62	8.45
RO		12.81	12.01	11.84	11.52	10.76	10.32	10.11	9.55	9.21
RS	14.91	14.36	14.06	12.99	12.96	12.20	11.76	11.95	11.73	11.23
SE	4.63	4.54	4.52	4.49	4.42	3.47	3.41	3.40	3.46	3.17
SI	4.94	4.76	4.75	4.56	4.28	4.18	4.02	4.21	3.88	3.92
SK								7.60	6.56	6.31

Table 22 – Losses in distribution in %

Annex 5 – List of references

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Annex 6 – About CEER

The Council of European Energy Regulators (CEER) is the voice of Europe's national energy regulators. CEER's members and observers comprise 39 national energy regulatory authorities (NRAs) from across Europe.

CEER is legally established as a not-for-profit association under Belgian law, with a small Secretariat based in Brussels to assist the organisation.

CEER supports its NRA members/observers in their responsibilities, sharing experience and developing regulatory capacity and best practices. It does so by facilitating expert working group meetings, hosting workshops and events, supporting the development and publication of regulatory papers, and through an in-house Training Academy. Through CEER, European NRAs cooperate and develop common position papers, advice and forward-thinking recommendations to improve the electricity and gas markets for the benefit of consumers and businesses.

In terms of policy, CEER actively promotes an investment friendly, harmonised regulatory environment and the consistent application of existing EU legislation. A key objective of CEER is to facilitate the creation of a single, competitive, efficient and sustainable Internal Energy Market in Europe that works in the consumer interest.

Specifically, CEER deals with a range of energy regulatory issues including wholesale and retail markets; consumer issues; distribution networks; smart grids; flexibility; sustainability; and international cooperation.

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