MED22-34 GA 4.5.1

UPDATE ON TECHNICAL AND NON-TECHNICAL LOSSES

Empowering Mediterranean regulators for a common energy future

Consumer Working Group (CUS WG)

Co-funded by the European Union

ABSTRACT

This update on technical and non-technical losses provides insight into the status of the Mediterranean system regarding these losses.

This report presents an analysis of how countries define power losses, how they calculate them, and how they distinguish between them. Furthermore, the report provides state-of-the-art techniques from some countries, showcasing methods to calculate and distinguish the loss types. In addition, the report offers insight into how some countries in the Mediterranean exerted efforts towards reducing the losses, featuring some of the best practices in the region, as provided by our members.

The novelty of this report, compared to the last MEDREG report on technical and non-technical losses, is that it analyses the effect of the COVID-19 pandemic on the losses, especially at the distribution level. From the results, it is evident that different countries were affected differently; while some countries were heavily affected and found solutions to minimize the losses, others were better prepared for emergency scenarios.

Finally, the effect of the COVID-19 pandemic on losses, especially non-technical ones due to theft and fraud, raises the topic of energy poverty and vulnerable consumers, which are two interlinked terms but are unique in their definitions. In the Mediterranean region, some countries have a legal definition for either or both, and hence, they find different ways to manage the situation.

ACKNOWLEDGEMENTS

This report is the result of a project carried out by the MEDREG Consumer Working Group (CUS WG), which provided the data and comments. MEDREG wishes to thank the CUS WG for their contribution and efforts.

DISCLAIMER

This publication was produced with financial support from the European Union. The contents are the sole responsibility of MEDREG and do not necessarily reflect the views of the European Union.

ABOUT MEDREG

MEDREG is the association of Mediterranean energy regulators, bringing together 27 regulators from 22 countries that span the European Union (EU), the Balkans, and the MENA region.

MEDREG acts as a platform for facilitating information exchange and assisting its members while also fostering capacity development activities through webinars, training sessions, and workshops. Mediterranean regulators work together to improve the harmonization of regional energy markets and legislations, seeking a progressive market integration in the Euro-Mediterranean basin.

Through constant cooperation and information exchange among members, MEDREG aims to foster consumer rights, energy efficiency, infrastructure investment, and development by employing safe, secure, cost-effective, and environmentally sustainable energy systems

The MEDREG Secretariat is in Milan, Italy.
For more information, visit www.medreg-regulators.org

If you have any inquiries regarding this paper, please contact:
MEDREG Secretariat

Email: info@medreg-regulators.org

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

1
INTRODUCTION AND METHODOLOGY

1.1. Objective

The reduction of technical and non-technical power losses contributes to a stable and reliable energy supply while boosting energy efficiency and consumer protection and satisfaction. Being one of the main pillars of the distribution and transmission network, MEDREG has continuously been working on identifying the causes of the problems related to this matter, aiming to address them as efficiently as possible.

This report serves as an update to the article 'Regulatory Practices in Handling Technical and Non-Technical Losses for Electricity' published in 2019. This report may provide an updated summary of the definitions and outcomes covered in the previous report while expanding further on recent findings. Furthermore, this report analyses the impact of the COVID-19 pandemic on the energy market while focusing on the consumer.

1.2. Methodology

This report is based on the replies of the MEDREG members to a benchmarking prepared by the Consumer Working Group (CUS WG) chairs in collaboration with the MEDREG secretariat.

This benchmarking template communicated with the WG members and chairs contained four parts, as shown below:

1. An overview of power losses
2. The experiences in the Mediterranean region
3. The effect of the COVID-19 pandemic
4. Energy poverty

The MEDREG secretariat collected the data and information from the members and formed the following report jointly with the CUS WG chairs.

The NRAs from Albania, Algeria, Bosnia and Herzegovina, Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Malta, Montenegro, Portugal, Spain, and Türkiye provided their responses, which have been considered in this report.

Figure 1 – The Countries' Replies to the Questionnaire

2

OVERVIEW ON POWER LOSSES

Power losses are broken down into transmission and distribution losses, which are the losses in the transmission and distribution systems, respectively. Transmission systems usually carry high voltage (HV) and extra high voltage (EHV); meanwhile, the distribution is often at medium voltage (MV) and low voltage (LV) (in Portugal, HV is also there in the distribution system). The losses are further broken down into technical and non-technical losses. Technical losses happen because of electricity flowing in the system, while nontechnical losses, also referred to as commercial losses, are unmetered losses.

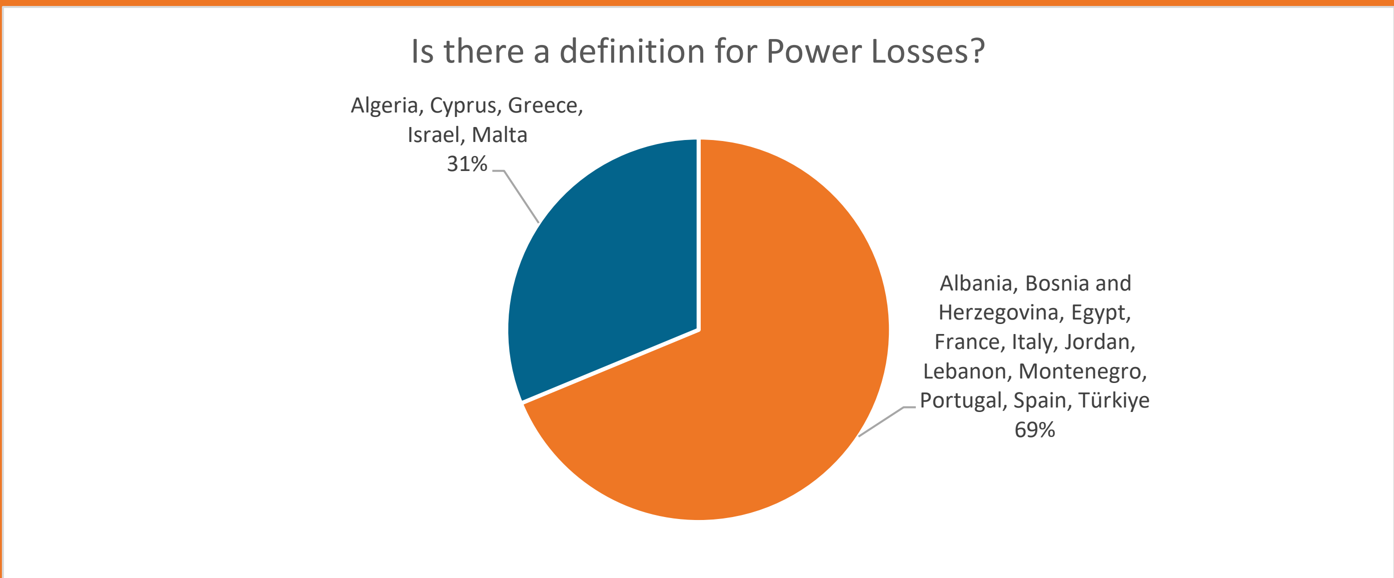
Almost all transmission system losses are technical losses, while distribution system losses could either be technical or non-technical losses.

This chapter discusses how countries define power losses, if any. Furthermore, the chapter covers how the countries calculate their respective technical and non-technical losses.

2.1. Power Losses – Definition

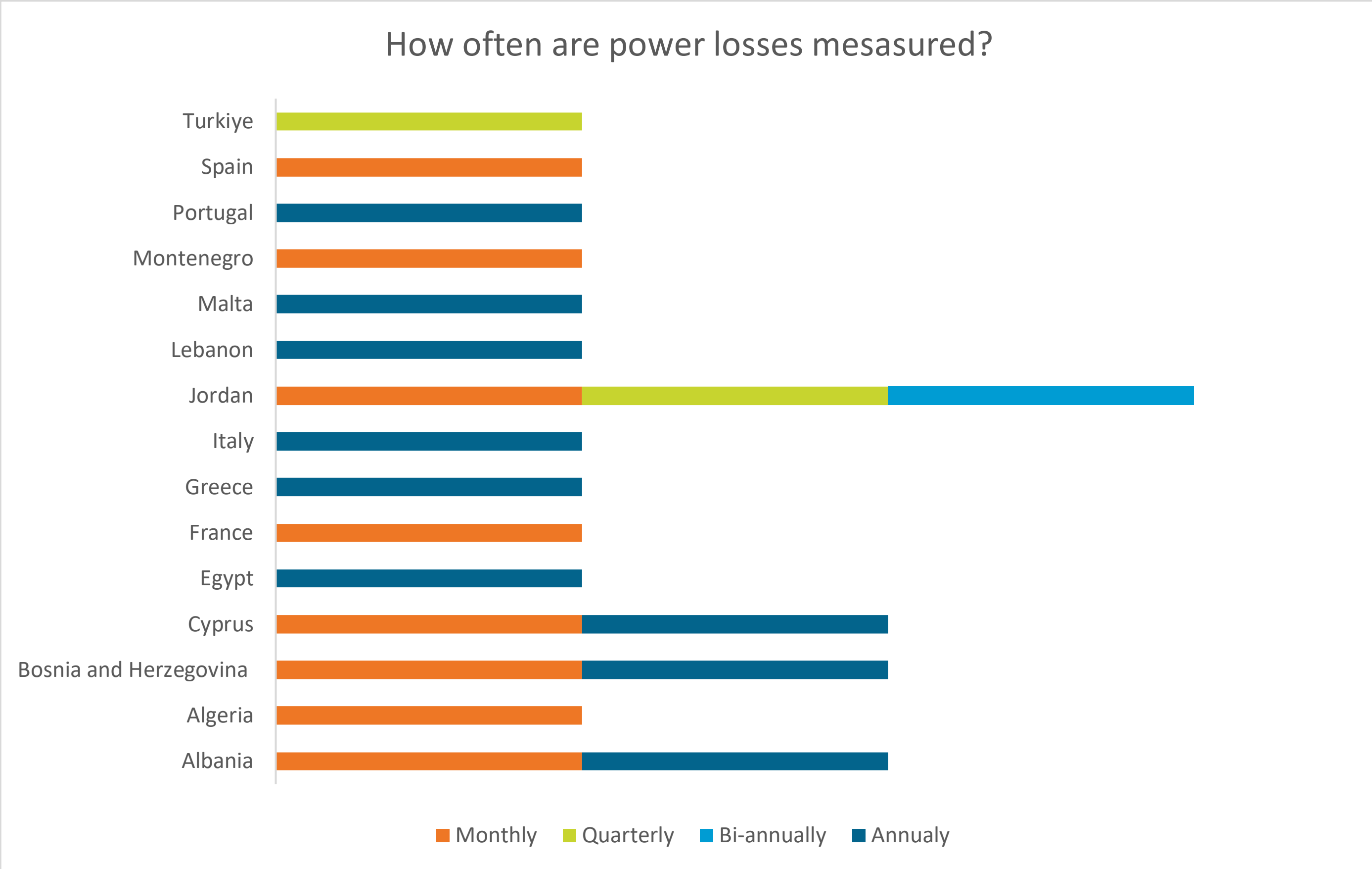
This sub-chapter summarizes how the Mediterranean countries define power losses, providing insight into some perspectives regarding how they are calculated and some of the KPIs that countries measure. The analysis showed that out of the 15 countries in the Mediterranean region who responded, five do not have the definition of power losses in their legislation, while 10 have a legal and formal definition. This statistic is depicted in the figure below.

Figure 2 - Presence of a Legal Definition for Power Losses



It is also noteworthy that different countries choose to measure and calculate their losses at different time increments, which can be seen in the figure below. Most countries measure their losses either on a monthly or annual basis or both; however, in Jordan, the losses are accumulated quarterly and bi-annually.

Figure 3 – The Rate at Which Power Losses Are Measured and Calculated



2.1.1. The countries that have not defined power losses

Israel and **Malta** do not have a definition for power losses.

Also, in **Algeria,** there is no definition for power losses. However, losses are defined at the level of transmission and distribution. In the transmission network, losses are the active energy consumed by the network while using the network (Executive Decree No. 06-430 of 26 November 2006, laying down the technical rules for the design, operation, and maintenance of the electricity transmission network). Regarding the distribution network, Executive Decree No.°10-138 of 13 May 2019 establishes the technical rules for the design, operation, and maintenance of electricity and gas distribution networks in the following way:

Electrical technical losses: the active energy consumption induced by the operation and use of the network.

Gas technical losses: the gas consumption induced by the operation and use of the network.

In **Cyprus,** power losses are not described explicitly in the legislation. However, like in Algeria, the definition of transmission and distribution losses is understood in the industry. Transmission losses are the losses that amount to the difference between imported and exported energy. Meanwhile, distribution losses are the losses of energy in the medium and low voltage networks that cover the load of the offtake energy meters in the distribution system.

In **Greece**, no formal definition has been included in the legislation. The total power losses are understood and referred to as the difference between the energy injected in the network and the energy withdrawn (metered and billed) by the final consumer.

However, even though there is no legal definition for power losses in the respective countries' legislations, they are still measured and considered when it comes to enhancing the networks to reduce losses.

2.1.2. The countries that have defined power losses

Most of the countries have defined power losses in their legislations.

According to **Albania's** transmission and distribution code, total distribution loss is the difference between total energy, entering from the transmission grid and power plants connected directly to the distribution, and the withdrawn energy injected into the transmission grid plus the billed energy from the distribution network.

Similarly, in **Bosnia and Herzegovina**, power loss is the difference between the network input energy and the network output energy.

In **Egypt** and **Jordan**, power loss is measured monetarily, where the loss is the difference between the purchased and sold energy.

In **France**, **Italy,** and **Montenegro** power loss is the difference between the energy injected in the network and the energy withdrawn for consumption from the system.

In **France**, power loss is calculated as follows:

France uses the indicators RTE Losses, where *RTE Losses = (generation + imports) – (consumption + exports),* and RTE Rate of Losses, where *RTE Rate of Losses ≃ RTE Losses/Consumption.* RTE (Réseau de Transport d'Électricité) is the transmission system operator of France.

Furthermore, in **France** and **Montenegro**, distribution loss is defined as the difference between all the injections into the distribution network (TSO injections, injections from LDCs, and injections from decentralized generation) and all the withdrawals (consumption and backflow of the transmission network).

Italy uses the term actual losses, which are measured annually by subtracting electricity withdrawals from electricity injections. Injections and withdrawals are measured using settlement reconciliation processes. Actual losses include both actual technical and non-technical losses since there is no separate measurement for both; however, the regulation assumes that 'actual losses' consist of 'standard technical losses' plus a residual, attributable difference due to 'standard non-technical losses.'

In **Lebanon**, power losses are calculated from a factor resembling technical and nontechnical losses as follows, *Network Losses [%] = [1 – (1-Technical Losses) x (1-Non-technical Losses)] x 100]*

In **Portugal** and **Spain**, even though the calculation is similar, the exact definition of power loss is the balance resulting from the difference between the energy produced and the energy demanded by the suppliers.

In **Türkiye**, according to the electricity market law, technical and non-technical loss refers to the loss due to a difference between the energy entering the distribution system and the amount of energy that is accrued to the consumers in the distribution system and affects the cost; this loss arises from reasons such as technical loss and/or illegal use and is not based on a technical reason.

Quick Look

Egyptian Case Study: Losses in the Gas Market

In the Egyptian **gas market**, the difference in the gas quantities between in and out points of the grid is calculated as unaccounted gas and refereed in the network code. Any deviation from the figure could be measured as technical losses, while the commercial losses can be identified through 'gas theft, commercial misbalance, unpaid bills, and others.

2.2. Types of Power Losses

2.2.1. Technical power losses

Technical power losses naturally occur in a network due to the action of electricity transfer. Such losses can be from the transformers, equipment, and even the cables themselves and can happen in both the transmission and distribution systems.[1]

Technical power losses can come in two forms, variable and fixed losses.

Variable losses are losses that change with time, and they are usually a function of the current flowing through the cables, causing variable resistance that is lost due to heat. Since power is a function of the current, the variable losses can be tied to demand through the behaviour of the final consumer.

Fixed losses are losses that are constant but are not a function of current flow, as in the case of variable losses. These losses usually occur in the transformers and connection points and are also usually in the form of heat. Fixed losses exist in the cables, and they occur since current is required to energise the cable and keep it ready for utilisation.

The definitions and calculation methods vary among the countries in the Mediterranean region.

In **Albania**, the technical losses refer to the energy that gets converted to heat in the lines and transformers. There is no specific formula to calculate technical losses.

In **Algeria**, technical losses are generally defined as the consumption of active power induced by the operation and use of the electrical network. For the transmission grid (HV), technical losses correspond to the difference between the total energy injected into the transmission grid and the energy extracted from the grid. It is noteworthy that the CREG also assesses *gas technical losses*, where gas technical losses refer to the gas consumption induced by the operation and use of the network.

In **Bosnia and Herzegovina, Egypt,** and **Lebanon**, technical losses are simply defined as the losses that relate to technical issues, such as resistance of conductors, losses in transformers, and other technical issues related to electricity.

[1] Source : https://www.spenergynetworks.co.uk/

In **Lebanon**, there is no specific formula for calculating the losses; however, in **Egypt**, the methodology for calculating technical losses is under development. For time being, Distribution Companies (DisCos) calculate technical losses as follows:

Each DISCO identifies samples for each network, where the samples carry data about loads, power factor, and voltage.

A loss calculation program calculates the losses for the cluster.

The network cluster losses calculations determine the losses for the MV network, LV network, and transformers.

In **Jordan**, the percentage of technical losses = (power purchased – power consumed)/ (power purchased)

In **Cyprus**, transmission and distribution technical losses have unique definitions and calculation methods. Transmission system technical losses = energy imported into the transmission system – energy exported from the transmission system. Meanwhile, the distribution system's technical losses are a summation of the load and no-load losses. No-load losses refer to the incurred losses that are necessary to keep the grid energized but are independent of power flows (e.g., transformer shunt losses). The load losses refer to the incurred losses that are a (non-linear) function of power flows (i.e., conductor and transformer windings' losses).

In **France,** a quadratic formula is used as follows:

$$L(t) = a\,X^2(t) + b\,X(t) + c * Y(t) + d$$

In **Greece,** besides having a formal definition for power losses, there is no definition for technical losses. However, a common understanding of technical losses is that they are physical losses comprising fixed losses (not related to the load) and variable losses (related to the load). They depend on the design of the power grid, the voltage and transformation levels, and the length of the power lines. Total losses on both the transmission and distribution networks are calculated as the difference between metered quantities of injected and withdrawn energy over a specific period (calendar year). Moreover, losses on the various components (transformers and lines) and voltage levels (MV, LV) of the distribution network are estimated using a model network and actual network data and loads. This exercise is done to estimate the part of the total distribution network losses that may be attributed to technical losses and to allocate technical losses to voltage levels and network components.

In **Italy**, technical losses are related to the inevitable dissipation of electric energy into the equipment necessary for energy transmission and distribution. An Italian peculiarity in that regard is that a number known as the 'standard technical losses' exists. The said number signifies a constant that is placed by the regulator as a pre-determined value per voltage level based on estimation. The standard technical losses account was 7,8% of energy withdrawals in 2022.

In **Malta**, given that only a distribution system exists, technical losses are only measured on the distribution level and are determined by the DSO as a percentage of energy sent out to the distribution grid. They are estimated through periodic studies that calculate the energy losses per network element according to the methodology prescribed by the World Bank. Energy losses over the interconnector Italy–Malta (this interconnector is treated as a part of the distribution network) are determined through differences in meter readings at its extremities.

In **Montenegro,** all the losses, except for unauthorized electricity consumption, are considered as technical losses. All the losses in the transmission system are considered as technical losses, while losses in the distribution system are divided into technical and non-technical losses. Technical losses are determined in a study on the losses prepared by network operators and revised by an independent institution according to the energy law.

In **Portugal,** technical losses are also referred to as physical losses, and they result from the heating of the lines and transformers that make up the networks. They can be calculated through the energy balance of the system by identifying the difference between the total injections and total withdraws or through load flow simulations.

Quick Look

Cypriot Case Study: State-of-the-Art Calculation Method

Technical losses are divided into two categories, i.e., the no-load and the load losses, as follows:

$$DL_{TL} = DL_{LL} + DL_{NLL}$$

The no-load losses are calculated through power flow simulations using DIgSILENT PowerFactory. The consumption of all loads and the generation of all DERs is set to zero to determine the energy needed to keep the distribution system energized.

On the other hand, the load losses are calculated using the following formula:

$$DL_{LL} = DL - DL_{NLL} - DL_{NTL} = TDBO - C_{MV} - C_{LV} + G_{MV} + G_{LV} - DL_{NLL} - DL_{NTL}$$

where

DL: Total losses

DL_{TL}: Technical losses

DL_{LL}: Load losses

DL_{NLL}: No-load losses

DL_{NTL}: Non-technical losses

$TDBO$: Transmission/distribution boundary offtake

C_{MV}: Consumption at the MV network

C_{LV}: Consumption at the LV network

G_{MV}: Generation at the MV network

G_{LV}: Generation at the LV network

Spanish Case Study: State-of-the-Art Calculation Method

The following formula includes the energy losses in each network and is used to financially compensate each company. The result of the formula is not energy, but within the formula, the lost energy is introduced for this economic retribution.

This formula includes technical and non-technical losses.

$$\boldsymbol{E_{perd}{}^{i}_{p,n-2} = \sum_{pf,j} E^{p,i}_{pfGD,n-2,j} \cdot (1 + C^{p}_{j+1,n-2}) + \sum_{pf,j} E^{p,i}_{pTD,n-2,j} \cdot (1 + C^{p}_{j,n-2}) - \sum_{cons,j} E^{p,i}_{cons,n-2,j} \cdot \left(1 + C^{p}_{j,n-2} + CZ^{i}_{j}\right)}$$

$\boldsymbol{E^{p,i}_{pfGD,n-2,j}}$ energy, expressed in kWh, is measured during the tariff period p of year n-2 at each of the pf generation–distribution and distribution–distribution border points, considering the generation of all technologies at each voltage level j for the distribution company i.

$\boldsymbol{E^{p,i}_{pTD,n-2,j}}$energy, expressed in kWh, is measured during the tariff period p of year n-2 at each of the transmission–distribution frontier points pf, at each voltage level j for the distribution company i.

For these purposes, the energy that enters the networks of the distribution company, and in each of its border points, with the networks of other distribution companies, generation points, and transmission networks is considered with a positive sign, and the energy outgoing through these points is considered with a negative sign.

$\boldsymbol{E^{p,i}_{cons,n-2,j}}$energy, expressed in kWh, is measured in the consumer's meter during the tariff period p of year n-2 of each of the consumers connected to the voltage level j of the distribution company's networks i.

$\boldsymbol{C^{p}_{j,n-2}}$ is the standard coefficient of losses of the tariff period p in force in year n-2 for the elevation to central bars of the energy of each type of consumer according to the voltage level j or for the elevation to power plant bars from the generation–distribution, transport–distribution, and distribution–distribution border points of company i. These standard loss coefficients will be set out in the circular of the CNMC establishing the methodology of tolls for the transmission and distribution of electricity.

$\boldsymbol{CZ^{i}_{j}}$ being the zonal correction coefficient applicable to each distribution company i, is calculated according to the percentage of supplies connected to its networks in each distribution area according to the following formulation:

$$\boldsymbol{CZ^{i} = \sum_{z} K_{z} \left(\frac{CUPS^{i}_{z}}{CUPS^{i}_{T}}\right)}$$

where

i is the distribution company to which the incentive applies.

z is the distribution area considered according to the classification established in article 99 of Royal Decree 1955/2000 of 1 December:

U: Urban area.

SU: Semi-urban area.

RC: Concentrated rural area.

RD: Dispersed rural area.

$\boldsymbol{CUPS^{i}_{z}}$ is the number of supplies of company i in zone z.

$\boldsymbol{CUPS^{i}_{T}}$ is the number of total supplies connected to the company's networks?

2.2.2. Non-technical power losses

Non-technical losses consist of energy that has been delivered and consumed but not metered or billed or recorded as sales. Non-technical losses often depend on the socio-economic conditions of the country. Non-technical losses can be further broken down into multiple categories. However, due to differing definitions and calculations per country, some factors that lead to non-technical losses are not considered. Yet, some of the most common forms of non-technical losses include theft and fraud, errors in reading the meters, and incorrect billing of consumed energy.

It is noteworthy that non-technical losses are always present in the distribution systems and rarely present in the transmission system, specifically in the LV compared to MV.

In this sub-chapter, a focused analysis of the definitions of non-technical losses will be studied. Besides that, this section will feature calculation methods and what some countries consider to be non-technical losses.

In **Albania,** for instance, the definition of non-technical losses is similar to the one provided above, where it is defined as the energy delivered and consumed but, for some reason, is not billed. Non-technical losses are mostly related to defective meters and errors in the meter reading, billing of customer energy consumption, lack of administration, financial constraints, estimation of the unmetered supply of energy, and energy that is stolen.

In **Algeria**, a specific formula is used:

$$\boldsymbol{Distribution\ Losses}\ (\%) = \frac{(\sum \boldsymbol{Purchases} + \Delta \boldsymbol{Exchanges}) - (\sum \boldsymbol{Sales\ LV} + \sum \boldsymbol{Sales\ MV})}{(\sum \boldsymbol{Purchases} + \Delta \boldsymbol{Exchanges})}\ \mathbf{X\ 100}$$

where

$\Delta \boldsymbol{Exchanges}$ = $\sum$ Received energies - $\sum$ Emitted energies

$\boldsymbol{Sales\ LV\ and\ MV}$ = Issued sales – cancelled sales + off-cycle (manual) sales

In **Bosnia and Herzegovina,** non-technical losses are defined as unauthorized consumption and losses accumulated from various measurement difficulties and tariff changes.

In **Cyprus**, the DSO (EAC) defines non-technical losses as unmetered energy due to thefts and fraud as well as measurement and data-collection errors. Unmetered energy was not considered while calculating non-technical losses during the last few years. However, the DSO will proceed with enhancing its existing methodologies (for calculating distribution losses and their factors) by employing statistical analysis tools to estimate the unmetered energy due to theft, fraud, and measurement and data-collection errors.

In **Egypt,** non-technical losses are the remaining types of losses that are not considered to be technical losses; these are usually due to thefts and unmetered activity.

In **France**, non-technical losses comprise the consumption of non-recorded energy, which may be linked to metering biases, fraud, meter reading errors, billing errors, etc. It is measured at the end as the loopback of the electricity system.

In **Greece**, there is no formal definition for non-technical losses; however, a common understanding is that they include 'hidden' losses (i.e., non-metered, in-house network consumption), non-metered consumption (e.g., public lighting), theft and fraud, and other types of losses, such as metering errors and differences in metering, billing, and data processing. Non-technical losses on the distribution network are calculated by deducting technical losses from total losses.

Just like in Greece, in **Israel**, the authorities have not defined non-technical losses. However, it is noteworkthy to say that such losses are not monetised.

In **Italy,** non-technical losses are related to losses such as power thefts, and errors in metering, billing, and data management. Standard non-technical losses can only be calculated conventionally, as the difference between 'actual losses' and 'standard technical losses.' The average MV standard NTL is the same throughout the country and is equal to 0,3% of energy withdrawals in 2022. The average LV standard non-technical losses are equal to 2,29% of energy withdrawals (the value is from 2022), with geographical differences that can be attributed to higher levels of energy thefts in some areas of southern Italy. Even though there is no dedicated tariff in Italy, standard losses are covered by BRPs in the wholesale market and then passed on to their clients. For LV consumers, for example, standard losses (technical plus non-technical) are equal to 10,09 % (7,8% + 2,29%), and the final price of energy for LV customers is increased by this value**.**

In **Lebanon**, no specific formula is used to calculate the non-technical losses. The losses are estimated by measuring the power transmitted on the outputs of the power plants and the input of the main substations, where the difference between the two readings is estimated to be the transmission loss. Also, the distribution losses are estimated by measuring the difference in input power of the MV outgoings in the substations and the power that reaches the consumers.

In **Malta**, non-technical losses are determined as the difference between energy sent out to the distribution grid by generators and energy metered at the consumer's end minus technical losses.

In **Montenegro**, non-technical losses represent the difference between all the losses and technical losses.

In **Portugal,** non-technical losses mainly include thefts and metering errors. Non-technical losses are calculated as the difference between the total real losses calculated in the annual energy balance and the best estimate for technical losses, resulting from the heating of the lines and transformers of the networks, which include physical losses, unavoidable thefts, and metering errors. Regarding fraud, once detected, they are subject to the criminal procedure without prejudice of operators, who shall be compensated based on an estimated value. In-house consumption and public lighting are measured and charged through tariffs like normal consumption.

In **Spain**, there is no formula to calculate the non-technical losses.

3

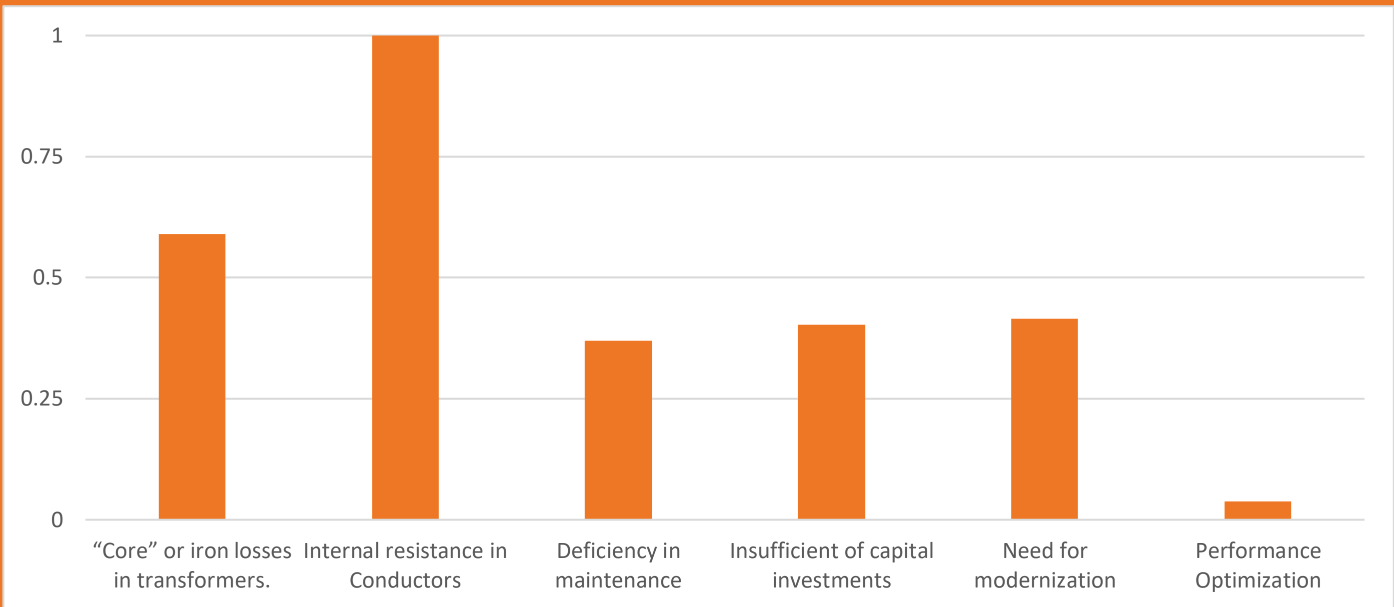
MEDITERRANEAN EXPERIENCES WITH TECHNICAL AND NON-TECHNICAL LOSSES

This sub-chapter provides an in-depth analysis of the technical and non-technical losses of each MEDREG member. The data may be presented in a graphical and/or schematic format instead of the textual form for clarity and ease of comparison, if necessary. This subchapter focuses on how a consumer is affected and whether they are household consumers or businesses.

3.1. Technical Losses in the Mediterranean Region

Even though, theoretically, technical losses do not accumulate in most of power losses, countries try to reduce them as much as possible. As per the Mediterranean region, the most common and severe form of technical loss is due to the internal resistance of the conductors as seen in the figure below.

Figure 4 - Severity of Variables that Cause Technical Losses



The figure above shows that the second-most severe variable that leads to technical losses is the core loss in the transformers. The figure above was generated using the sum of reciprocals method to show the significance of the variables that are leading to technical losses.

Quick Look

Maltese Case Study: Technical Losses Breakdown

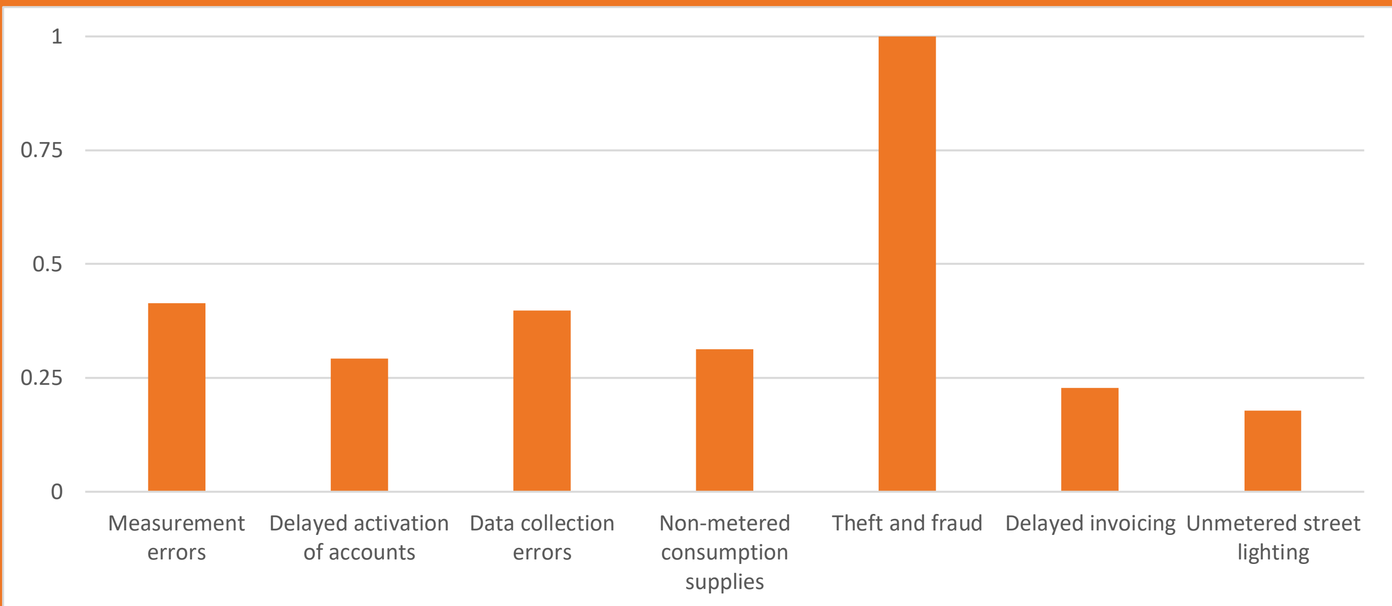
The table below shows the breakdown of the technical losses suffered by Malta. It is noteworthy that their technical losses are in the distribution system since Malta <u>does not</u> have a <u>transmission system</u>. It is also noteworthy that, unlike the technical losses, Malta does not assess non-technical losses by breaking them down by source of non-technical loss due to technological limitations.

Type of technical loss (2020 data)	Severity
Energy losses 220 kV Interconnector	3.600%
Energy losses 132 kV Networks	0.143%
Energy losses 132/33 and 33/11 kV Transformers	0.470%
Energy losses 33 kV Networks	0.294%
Energy losses 11 kV Networks	0.546%
Energy losses 11/04 kV Transformers	0.788%
Energy losses 0.4 kV Network	0.888%
Energy losses 0.4 kV Connection cables	0.007%
Energy losses 0.4 kV Meters	0.213%

3.2. Non-Technical Losses in the Mediterranean Region

Non-technical losses in the Mediterranean region are mainly caused by theft and fraud, as can be seen in the figure below. In fact, theft and fraud are almost considered to be too frequent and some of the hardest forms of non-technical losses to be solved compared to the other causes of non-technical losses.

Figure 5 - Severity of Variables that Cause Non-Technical Losses



The above figure shows that other relatively severe non-technical losses include measurement and data collection errors. Like Figure 4 on severe technical losses, Figure 5 was generated using the sum of reciprocals method to show the significance of the causes of the non-technical losses.

3.3. Measures Taken to Handle Power Losses

3.3.1. Technical losses

In **Bosnia and Herzegovina,** network reconfiguration was the main measure considered. Furthermore, the transformers fleet was upgraded to a much better one, which reduced the core losses significantly.

In the last seven years, **Albania** has prioritized investments in the distribution system. The said investments have given a positive impact on the network performance indicators, such as technical losses, continuity of supply of electricity to consumers, and achievement of the objectives of loss reduction. Such improvements came in the form of the following:

- Swap to electronic meters and smart meter investment
- WFM management – improving the performance of field activities
- An IT system, SW investment, and a new CRM/billing system
- Inflow energy monitoring
- Target-oriented campaigns

Quick Look

Albanian Case Study: Bold Targets to Reduce Technical Losses at the Distribution Level.

Being among the top countries in the region that suffers from technical losses in the distribution level, Albania has laid down bold targets aiming towards a solid reduction. So far, Albania has witnessed a reduction every year and is still striving for more, hence deeming the measures taken and foreseen as successful. The table below shows the targeted and actual distribution of technical loss readings across the country for the years 2020 and 2021 as well as the forecasted technical losses for this year.

Table 1 - Targeted and Actual Technical Losses in Albania (2020–2022)

<table>
<tr><th></th><th>2020</th><th>2021</th><th>2022 forecasted</th></tr>
<tr><td>Tech Losses Target %</td><td>15,00%</td><td>13,55%</td><td rowspan="2">13,1%</td></tr>
<tr><td>Tech Losses Actual %</td><td>13.75%</td><td>13,62%</td></tr>
<tr><td>Delta Actual vs Target %</td><td>-1,25%</td><td>0,07%</td><td></td></tr>
</table>

As shown above, the actual technical losses have reduced slightly between the years 2020 and 2021. It is important to highlight that the massive difference between the target and actual losses in 2020 is mainly attributed to the improvement of the estimation methodology.

In **Cyprus**, **Italy,** and **Portugal,** measures were mainly applied to the distribution system. The Cypriot, Italian, and Portuguese transmission systems appeared to be sturdy, thus leaving the losses without an official target to be met.

In **Cyprus**, losses in transmission decreased further given the current massive penetration of RES energy. The only measures that have been applied in that regard aim to improve the accuracy of calculating the technical losses, especially at all the import/export points to and from the transmission system. However, regarding the distribution system, the measures to reduce technical losses included the following:

- Replacement of old oil transformers
- Replacement of old MV cables
- Promotion of the right way to consume energy (consume energy when the rooftop PV system is generating to avoid the use of the grid)
- Promotion of the installation of Diesel Generating (DG) set in certain locations
- Setup and configuration of modern grid management tools in the existing SCADA/DMS.

In **Italy** and **Portugal,** regarding the distribution system, an incentive mechanism has been applied. This mechanism allows the DSO to be rewarded or penalized whenever its actual losses are below or above the target level set by the regulator for overall standard losses (technical + non-technical). The transmission system is not subject to that incentive mechanism.

Quick Look

Italian and **Portuguese** Case Study: Incentive Mechanisms for Loss Reduction.

Italy's incentive mechanism has proven to be highly efficient. Indeed, in 2020, 78% of the biggest distribution companies in Italy (those representing 99% of the volumes distributed) reported that the actual losses were lower than the standard pre-set losses' target level.

In **Portugal,** on the other hand, in 2020, the target for losses was 7,80%. The incentive included a neutral band (between 6,60% and 9%) below and above which the penalty and the premium were applied, respectively. In 2020, the actual losses stood at 9,81%. As a result, the penalty incurred by regulated entities (DSO) amounted to €3,8 million.

In both countries, the mechanism performs annually based on the data on energy injections and withdrawals that result from the settlement reconciliation process. In Portugal, for the regulatory period 2022–2025, the percentage will be calculated based on electricity injections.

Regarding Portugal, more information can be found in the 'Regulatory Parameters for the Period 2022 to 2025'[2] and the document 'Allowed Revenues and Adjustments for 2022 for the Regulated Entities of the Electricity Sector',[3] both of which are on the Portuguese Energy Regulator's (ERSE) website.

In **Egypt,** the TSOs and DSOs were tasked with upgrading the cables and transformers' sizes and capacities and further bolstering their efficiencies, especially in the transformers. Cable lengths have also been shortened by adding new connection points. Other changes included:

[2] https://www.erse.pt/media/bjdnrr05/par%C3%A2metros-2022-2025.pdf

[3] https://www.erse.pt/media/fubhensu/proveitos-e-ajustamentos-2022.pdf

- Upgrading the MV rating to 22 kV
- Mitigating the load imbalance
- Inspecting for hot connection points periodically

In **France**, like in Cyprus, measures were taken for the transmission and distribution systems separately. For the transmission part, the TSO, RTE, can reduce losses during network operation in several ways, such as by maintaining voltages at the highest values allowed by technical reference standards and optimizing the operational scheme of the network. On the distribution level, the ***Linky project***, even though oriented to enhance non-technical losses, brought some minor improvements in terms of technical losses.

In **Israel**, the NRA recognizes normative losses within the tariff, so the monopoly should improve the losses so that it does not lose revenue.

Lebanon has the highest overall power losses, and they appear to be among the leaders in terms of power losses from a technical and non-technical perspective. Some measures have been implemented to counter the technical losses in the system, which accumulate to around 18% as per recent calculations. The measures that have been applied include the following:

- Implementing the investments in the transmission sector as per the master plan 2018–2030.
- Implementing the expansion of the generation fleet as per the least cost generation plan.
- Rebuilding the National Control Centre (NCC) and Électricité Du Liban (EDL) building to ensure the proper functioning of EDL's transmission system and the overall EDL operations after the destruction during the Port of Beirut explosion on 4 August 2020.

In addition, the following measures should be implemented.

- Transition away from the 150 kV voltage network and base the transmission system on 220 Kv and 66 kV levels as the standard transmission/sub-transmission voltages as per the master plan transmission.
- Modify the voltage level at the distribution system by increasing the voltage levels from 11 kV and 15 kV to 20 kV as per the distribution master plan.
- Increase the efficiency of the EDL transformers.
- Reduce the system reactive power by implementing a power factor correction in specific nodes of the network where the voltage level is below the required level to prevent transmitting reactive power from the power plants and, hence, decrease the technical losses.
- Expand the interacting renewable energy into the grid (PV or wind farms) as distributed energy to prevent transmitting power from long distances (from power plants) and accordingly reduce the technical losses.

Jordan's measures included boosting the efficiencies of the equipment. Indeed, new equipment has been purchased in terms of cables and superconductors. Furthermore, the voltage was increased to reduce discrepancies and improve the quality of service.

In **Malta**, only the distribution system is considered. In that regard, like in Israel, the system operator is responsible for operating, maintaining, and developing an efficient electricity distribution system while also considering environmental impact and energy efficiency.

In **Montenegro,** investments have been made in grid and network reconfiguration.

In **Türkiye,** it has been adopted as the correct method to consider both technical and non-technical loss costs within the scope of the distribution price 'in line with the target loss–theft ratio' given to the DSOs. In this context, the target loss rates of DSOs for 2023 have been determined. Reducing losses is encouraged by applying a performance-based reward/punishment system according to actual and target loss rates. More measures that have been taken include network investments made in relevant distribution regions and the development of R&D projects of DSOs on technical and non-technical losses.

3.3.2. Non-technical losses

Non-technical losses tend to be in the distribution system.

In **Albania,** like the heavy steps taken to counter technical losses, numerous measures have been applied to lower non-technical losses. The country managed to eliminate illegal connections, repair meters to reduce errors, and reduce unmetered energy supplies to the rural areas, where theft was common. The NRA has also imposed a decision of economic fining if theft and fraud are detected. The other measures that have been implemented include the following:

- Investment in grid infrastructure and a metering system, which indirectly contributes to the reduction of abusive consumption (metering bypass).
- Increase in the billing quality (reduction of reference/replacing consumption application, reading errors, data collection and processing, etc.)
- Improvement of the analysis quality for the identification of rooms for non-technical losses reduction and scoping of field actions because of more accurate estimations of non-technical losses calculation (partly owed to the use of modelling applications for the most typical grid scenarios) and monitoring of inflow energy.
- Smart metering, although it has a small footprint.

The above measures have allowed Albania to reduce their nontechnical losses every year, and they are currently at 6,99% non-technical losses, which is forecasted to be 6,5% in the next calculation.

In **Bosnia and Herzegovina**, elimination of theft and fraud, minimization of measurement errors, better data collection, and appropriate invoicing were the main measures applied in the past. The Balkan country has witnessed a gradual decrease over the years, coming down from 10,68% in 2014 to 9,22% in 2021.

In **Cyprus,** periodical data measurement validation has been applied as well as periodical calibration and verification of energy meters.

In **Egypt,** stronger steps have been taken to reduce massive losses. These measures include the following:

- Using prepaid meters
- Using smart meters
- Periodical inspection of meters
- Theft inspection campaigns
- Compensation of revenue due to self-consumption loads

In **France,** the deployment of the smart meters, called Linky, is expected, among others, to considerably decrease non-technical losses in the form of fraud and billing errors as well as reduce reading costs and the costs of minor intervention and, to a lesser extent, reduce the technical losses. As a part of an ‘incentive regulation on the volume of losses’, the following reference rate gain targets were retained in terms of percentage: 2,9% for 2021; 2,8% for 2022; 2,6% for 2023; and 2,5% for 2024. This compares, respectively to 10,9; 10,3; 9,8; and 9,4 TWh.

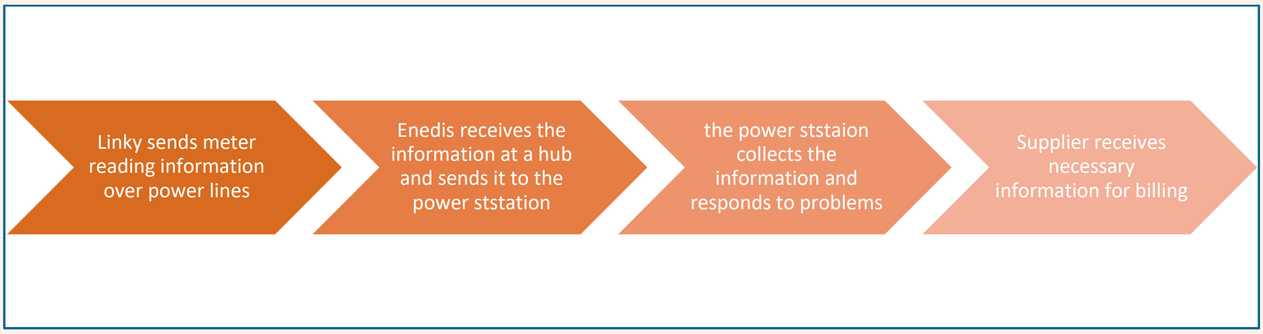
The cost savings from non-technical losses, mainly related to fraud and billing errors, will be progressive over the TURPE 6 HTA-BT period (2021–2024) and should reach €118 million/year in 2024. Overall, approximately €1 billion in costs will be saved over the TURPE 6 HTA-BT period.

Quick Look

French Case Study: Linky Project

Linky meters are smart meters that are currently being deployed all over France by Enedis, the French power grid operator. The link meters work as shown in the figure below:

Figure 6 - How the Linky Meter Works



The advantages of Linky include

- No need to report meter readings
- Consumer benefits from actual consumption offers
- More accurate information about energy consumption
- Single to triple phase changes can be done remotely.

Linky facilitates household renewable energy installations as it records the consumed and produced energy.[4]

In **Israel,** there is no recognition of the tariff, so the monopoly itself oversees this issue to prevent such losses.

In **Italy**, since 2016, a path to reduce commercial losses in the LV line has been introduced. This path established an average annual reduction of 4% of NTL (defined as the difference between actual losses and standard technical losses), which was gradually reduced after the initial three-year period to consider the burden related to energy theft management in some geographic areas. The reduction path has been defined for each of the geographical zones of the country. Targets have been set for the north, centre, and south of Italy, and the estimates can be seen in the table below as established by the regulator.

[4] Linky: The Smart Meter for Electricity in France

Table 2 - Italian Losses Targets

Area	Standard NTL initial level (fixed in 2015)	Standard NTL target level for 2023
North Italy	1%	0,9%
Center Italy	2%	1,72%
South Italy	6,3%	4,87%
National Average	2,7%	2,2%

Meanwhile, given that **Lebanon** is among the heaviest sufferers of non-technical losses, numerous measures have been proposed and applied. These measures include the following:

- Organization of a national campaign on all the Lebanese territories in collaboration with the concerned parties from the Ministry of Interior, the Ministry of Defence, the Lebanese Army, and the Ministry of Justice for the removal of the illegal grid connections, the issuance of infringement notices, and the quick processing of the claims of theft of electricity by the competent judiciary units.
- Completion of the distribution projects and the smart grid to reduce losses and control the billing and collection.
- Improving bill collection with DSPs by implementing the 2019 collection plan, which entails mechanisms for the collection and issuance of consumer bills.
- Deploy the Advanced Metering Infrastructure (AMI) system, which provides for improved billing, loss and network outage reduction, and improved load management. Smart meters, which are an integral part of the AMI program, would allow for timely and accurate billing and detect the location of distribution losses. These meters would allow remote disconnect/reconnect of customers to strengthen enforcement actions for theft and non-payment, which will result in increased collection rates.

Jordan has only proposed campaigns against theft through the authority and companies.

In **Malta**, no targets have been set. However, the DSO is legally responsible for operating, maintaining, and developing an efficient electricity distribution system in Malta with due regard for the environment and energy efficiency.

In **Montenegro**, investments in the grid, especially in smart metering and displacement of meters on the borders of properties, have been applied. Due to these measures, Montenegro has witnessed a constant reduction in their losses. Furthermore, non-technical losses are not included in distribution tariffs; hence, they are not covered by consumers or producers.

In **Portugal,** the incentive mechanism applied for technical losses has also been applied to the non-technical losses.

3.3.3. Other ways of calculating losses

In **Algeria,** most of the applied measures to decrease the technical and non-technical losses were based on replacing traditional meters with electronic smart meters for all customers. Furthermore, a systematic and generalized remote reading was adopted for medium and high voltage/pressure customers (industrial customers). The measures in Algeria were applied by the distributor. The targets for the power losses, both technical and non-technical, in the distribution were defined by distribution concession and not at a national level. For the year 2021, the targets ranged from 5% to 13,74%, where 81,25% of concessions achieved their targets.

In **Greece**, the total losses in the transmission and distribution systems were respectively assessed without distinguishing between technical and non-technical losses. Some of the measures that have been applied to enhance the total power losses include an incentive regulation aiming to reduce the distribution losses portion of the overall losses. Specific measures that would reduce non-technical losses include a regulation that is aimed to discourage theft and fraud and to increase the efficiency of DSO operations to discover and handle cases of theft and fraud. Other enhancements include the expansion and modernization of the network and the deployment of smart meters.

In **Spain**, technical and non-technical losses were calculated together.

Spanish Case Study: State-of-the-Art Calculation Method

To calculate the remuneration for distribution companies corresponding to the years from 2022 to 2025, the CNMC established the following values:

- The adjustment to the incentive $E_{perd\,k}^{\;i}$
- The coefficient I
- The maximum penalty PMP_n^i
- The maximum bonus BMP_n^i

The incentive is based on the comparison of each company's losses with the standard losses. To do this, the loss energy (Eperd) of each distribution company (i) was obtained by raising the central bars (using the standard coefficients of losses C), both the energy measured at each of the border points (pf) and the energy measured in meter of the consumers connected to its network (cons), considering the tariff period (p) of the year (k) and the voltage level (j) according to the following expression:

$$E_{perd\,p,n-2}^{\;i} = \sum_{pf,j} E_{pfGD,n-2,j}^{p,i} \cdot (1 + C_{j+1,n-2}^{p}) + \sum_{pf,j} E_{pTD,n-2,j}^{p,i} \cdot (1 + C_{j,n-2}^{p}) - \sum_{cons,j} E_{cons,n-2,j}^{p,i} \cdot \left(1 + C_{j,n-2}^{p} + CZ_j^i\right)$$

Based on these losses (Eperd), the amount (I) in € corresponding to them is calculated for each distribution company (i), valuing them at the daily market price (Price) taking into count the tariff period (p) and a coefficient of price adequacy (CA_{n-2}^p):

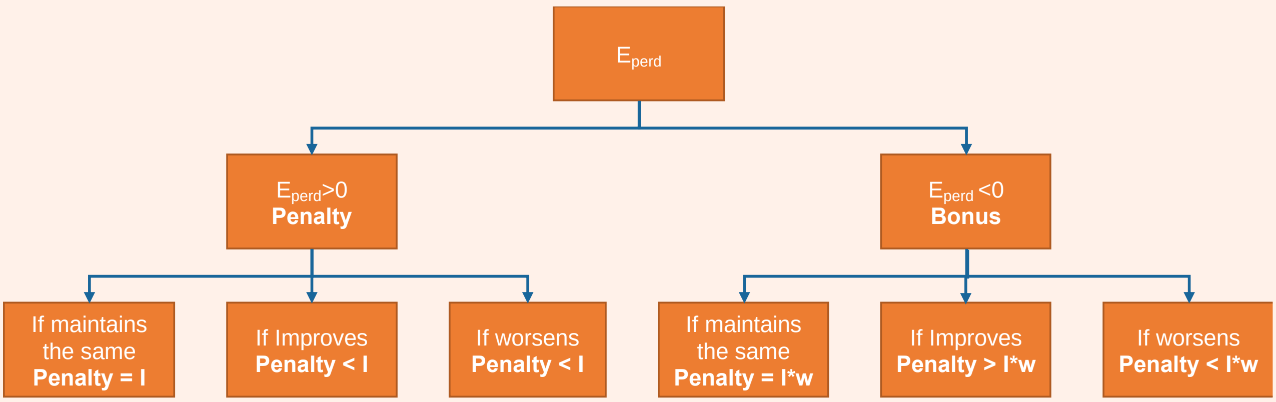
$$I_{n-2}^i = \sum_{p,n-2} Price_{n-2}^p \cdot CA_{n-2}^p \cdot Eperd_{p,n-2}^i$$

To determine the incentive of each distribution company, first, the situation of each company with respect to the sector is evaluated:

If $Eperd_k^i > 0$, the company must pay a penalty, as its losses exceed the standard losses.

If $Eperd_k^i < 0$, the company will receive an incentive, as its losses are less than the standard losses.

Second, the corresponding penalties or bonuses are established according to the degree of improvement or worsening of the company's situation with respect to the previous year.



Additionally, the incentive is defined as neutral for the system; that is, the bonuses are financed through penalties, introducing the distribution coefficient w.

Finally, maximum penalty and bonus values are established (PMP_n^i and BMP_n^i) that must be set by the CNMC at the beginning of each regulatory period.

For the next regulatory period, the following values have been approved:

	2022	2023	2024	2025
PMP_n^i	$-2\%R_n^i$	$-3\%R_n^i$	$-4\%R_n^i$	$-4\%R_n^i$
BMP_n^i	$2\%R_n^i$	$3\%R_n^i$	$4\%R_n^i$	$4\%R_n^i$

4

IMPACT OF THE COVID-19 PANDEMIC

Since losses in the transmission system are usually technical losses and are considered very minimal compared to the distribution level losses, the effect of the COVID-19 pandemic will only be studied on the distribution level.

Figure 7 - Map of the Mediterranean Showing the Least and Highest Distribution Losses

The overall status of distribution losses in the Mediterranean region is shown in the figure above. The colours indicate the range losses affecting the country, with darker shades implying higher distribution losses.

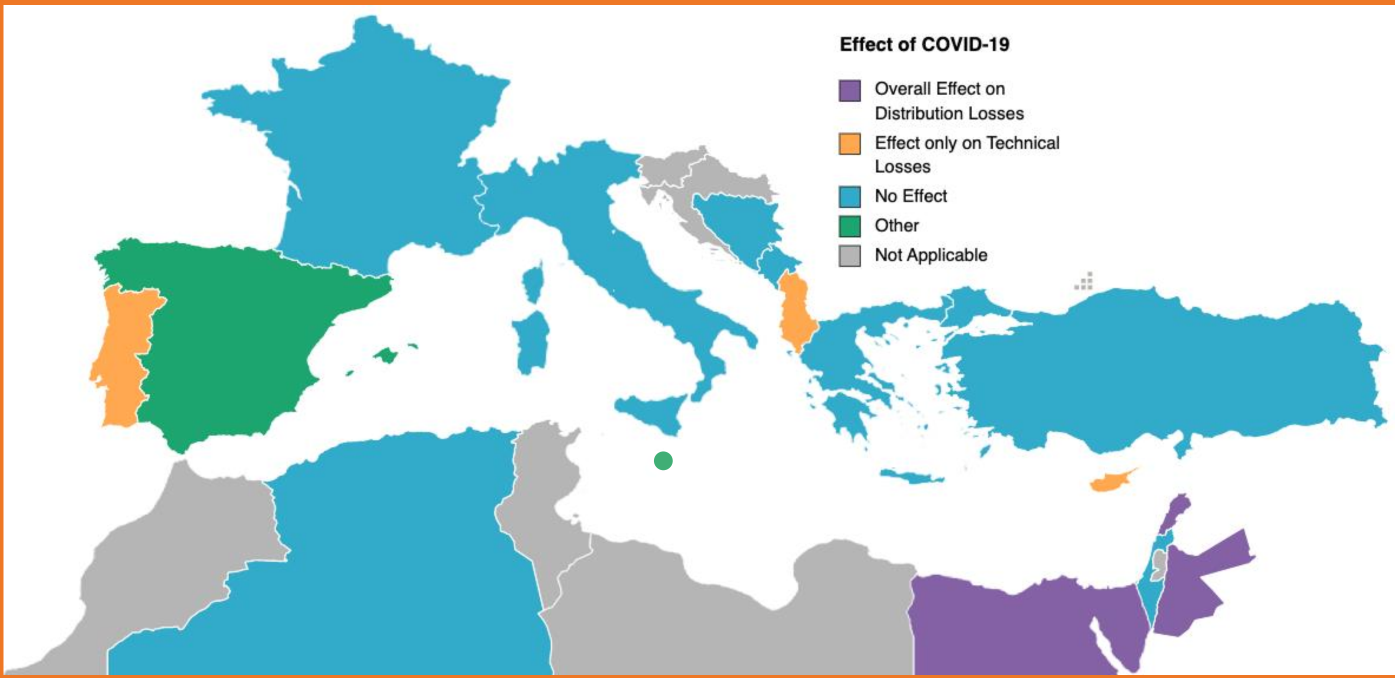
This chapter does not only study the impact of the COVID-19 pandemic on the technical and non-technical losses at the distribution level per country but also provides an overview of how the countries reacted to achieve their targets and minimize losses.

4.1. Impact of the COVID-19 Pandemic

Besides the health issues brought by the pandemic to the world, there was a definite economic recession due to the slowing down of businesses as we know them. All markets, including the energy market, were impacted in one way or the other.

The Mediterranean region witnessed a variation where, in some countries, the pandemic affected the distribution system from a technical and non-technical perspective, some countries were affected from a technical perspective only, while some other countries were not affected.

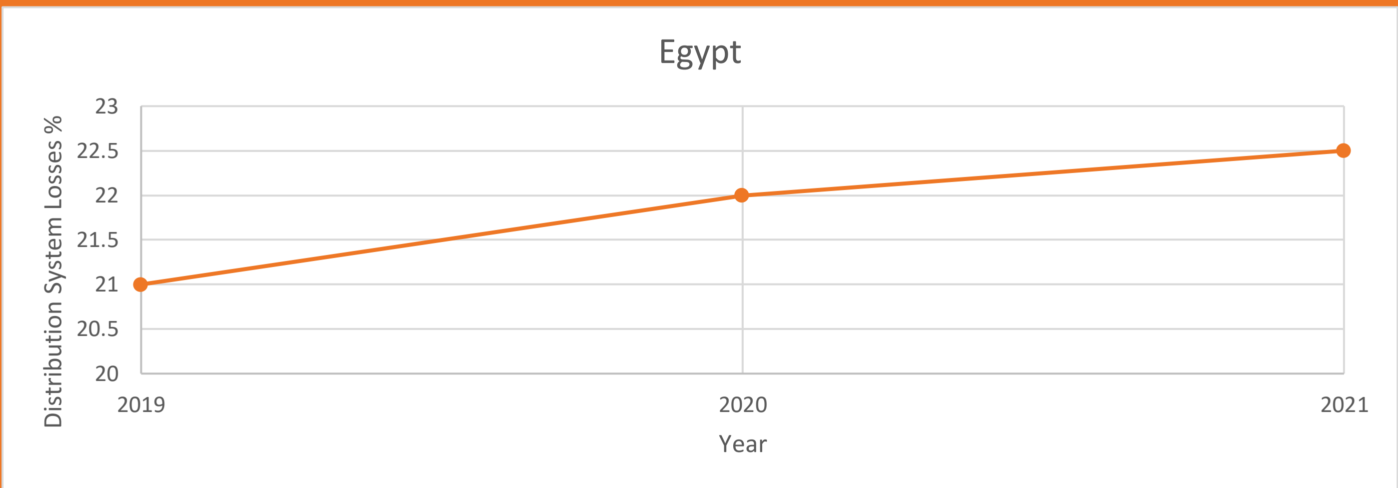
Figure 8 - Map of the Mediterranean Region Showing the Effect of the COVID-19 Pandemic on the Countries



4.1.1. The overall effect on distribution system losses

In **Egypt**, even though not explicitly mentioned in their reply, according to the figure below, one can see that the year 2020 has more losses in the distribution system compared to 2019. By the end of 2021, the losses appeared to have further increased to a staggering 22,5%.

Figure 9 - Distribution System Losses in Egypt (2019–2021)



In **Jordan**, there was an unexplainable increase in distribution losses, which was probably due to the same reasons faced by Albania.

Meanwhile, in **Lebanon**, in addition to the shift from commercial MV consumption to higher LV consumption due to the work-from-home policy and the extended lockdown, the bill collection process almost stopped, and it is still affecting the country. It is noteworthy that Lebanon has the highest recorded distribution losses in the region with around 40,1% in both technical and non-technical losses combined.

(Although the COVID-19 pandemic directly affected the power sector in Lebanon, the current situation results not only from the confluence of multiple crises hitting the country [such as the pandemic, 4 August 2020, port explosion, and the sudden economic collapse] but also the long-standing structural inefficiencies in the power sector that remained unaddressed for decades despite many past attempts.)

4.1.2. Countries where only the technical losses were affected

Among the countries that were impacted by the COVID-19 pandemic was **Albania.** In the first months of the pandemic, the Balkan country faced problems with meter readings, especially with individual ones. It was evident that a sudden rise in demand happened during the first wave of COVID-19 in March 2020 and the second wave during Q4/2020. This growth in demand happened mostly due to higher consumption in the residential segments due to smart working and because there was a shift in consumption from business and commercial segments to residential segments. Overall, the pandemic reduced the effectiveness of the working activities in the field and in the NRA itself. This came after a reduction in the available workforce by 15%, which had a direct impact on the meter reading and verification of the metering systems. The sudden shift of consumption from non-household to household segments mainly affected the technical losses in the distribution system since technical losses in the LV are higher than losses in the MV.

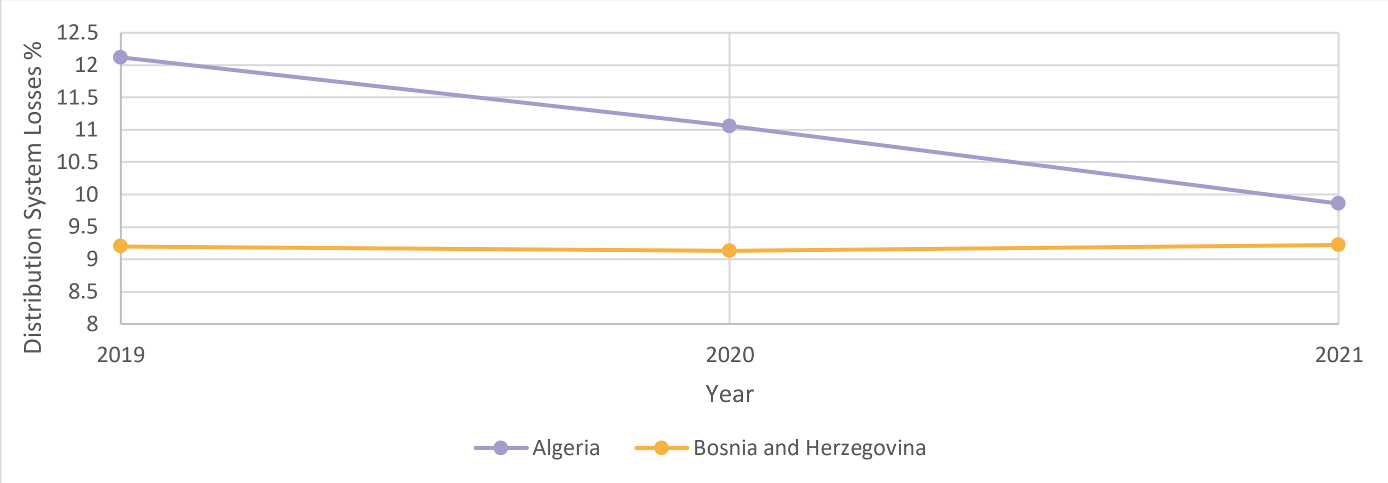
Like in Albania, the pandemic's effect seemed to resonate mainly in **Cyprus's** and **Portugal's** technical losses, possibly due to the same reasons, with higher consumption of the less efficient LV network. Cyprus had almost no effect when it came to non-technical losses.

In **Portugal**, even though the country historically suffered from non-technical losses due to the economic crisis of 2012, they applied extreme measures, which helped keep losses due to theft and fraud and the reading of meters to a minimum.

4.1.3. Countries that were not impacted by the COVID-19 pandemic

In **Algeria** and **Bosnia and Herzegovina**, even though not explicitly mentioned in the countries' replies, according to the data seen in the graph below, the distribution losses decreased during COVID-19. However, in Bosnia and Herzegovina's case, the distribution losses increased once again in 2021. Bosnia attempted to eliminate theft and fraud and tried better data collection methods in 2020.

Figure 10 - Distribution System Losses in Algeria and Bosnia and Herzegovina (2019–2021)



Quick Look

French Case Study: The Pandemic's Impact on the Transmission System.

In **France,** the NRA, CRE, did not take any measures to prevent non-technical losses since no real and tangible impact of the COVID-19 pandemic was witnessed on the non-technical losses. However, the overall situation was marked by a sharp decline in electricity consumption in 2020 due to the pandemic and its resulting decline in losses. Electricity losses are a function of several factors, the most important of which is power consumption. As consumption was declining in 2020, electricity generation was adjusted downward, mainly in the nuclear fleet. Thus, at the transmission level in 2020, they fell to 10,7 TWh from 11 TWh in 2019.

However, the loss rate, as a percentage of consumption, increased over the year. This is due to another factor that must be considered: the distance between where the electricity is generated and where it is consumed, i.e., the greater the distance, the higher the losses. When the health crisis caused the availability of nuclear power plants to decrease, imports accounted for a higher share of exchanges than in 2019 at all borders, especially Spain, Great Britain, and Italy, and the imported electricity, comparatively, put more distance between some main consumption centres and the source of their power supply. Thus, generation schedules and cross-border exchanges affected the loss levels. Consequently, the loss rate at the transmission level increased relative to 2019: in 2020, 2,31% of the power produced and imported was 'lost' compared to 2,22% in 2019.

The first analysis was done by CRE during the first trimester of 2021. The aim was to identify the impact of the pandemic at every level: business activities, revenue, investment programs, operational charges, and incentive regulation. CRE published a deliberation on 25 March 2021 with the results of the analysis.

In **France**, **Greece,** and **Montenegro**, there was no impact on the overall distribution losses. Further, there was no impact on the technical and non-technical losses as well. In Greece, the impact of the losses was not fully assessed.

In **Israel,** from a monetary perspective, there seemed to be an obvious delay in the paying of electricity bills. However, more losses were due to the COVID-19 pandemic.

In **Italy,** there was no evidence of an impact on distribution losses due to the COVID-19 pandemic.

In **Türkiye**, in 2020, a regulation was made by the EMRA, including the postponement of bill payments and the opportunity to pay in instalments to consumers. One of the aims of this regulation was to ensure that the electricity of consumers who could not pay their bills would not be cut off and that these consumers would not attempt illegal electricity consumption. Accordingly, it aimed to reduce non-technical losses. According to the data, the measures taken by Türkiye were effective, and hence, no obvious changes in the distribution losses were visible; on the contrary, the distribution losses decreased.

4.1.4. Others

Malta and **Spain** are still yet to calculate their losses for 2020 and 2021.

4.2. How Were the Targets Reached?

In **Albania,** during the pandemic, there was an institutional collaboration of all the institutions, starting from the government and all the stakeholders. The priority of the situation was the security of supply. The Energy Regulatory Authority ERE, with specific decisions, adopted the measurements for electricity metering reading and billing. The main role of those decisions was to avoid physical contact as much as possible and to obtain correct electricity billing through corrections in the coming months.

Algeria further strengthened its position by pledging a constant supply of energy to the consumers, even those who failed to pay their bills due to the pandemic, especially during the first half of 2020. The distributor also suspended energy cut-offs. To do this, CREG, the Algerian NRA, worked closely with the distributor and the Ministry of Energy to manage this situation and ensure the target priorities of energy security were met.

France took a series of brave steps to ensure that the consumers were well protected during such tough times. The focus was on two main areas:

- Possibility of deferral for the payment of bills, where on 26 March 2020, CRE called on network operators to allow energy suppliers to defer or stagger the payment of their network bills if the suppliers in question granted their customers the staggering or deferral of their energy bill payments (something that was mandated by governmental measures). This was to allow for burden-sharing between energy suppliers and network operators.
- Extension of 'winter truce', where according to French law, suppliers are prohibited from disconnecting household consumers from their energy supply. This truce ranged from 1 November to 31 March. In the first half of 2020, the French authorities extended this winter truce until 10 July 2020. Similarly, the 2020–2021 winter truce was also extended until 31 May 2021.

The French experience showed the full cooperation of all stakeholders in a cascading manner for the benefit of the final consumers. This is, however, not at the expense of the suppliers, to whom CRE agreed to offer payment facilities whenever, in their turn, they have granted such facilities to their customers.

In **Israel**, regulations provided for exceptions regarding the integration of production facilities in which they extended the deadlines and allowed the monopoly to assess power consumption because they did not read the meters. The monopoly determined that, at that time, there would be no power outages and that it would be possible to get full service by phone. It should be remembered that at the beginning of the outbreak of the virus, the staffing of the offices was not full, and there were areas with no access clearance due to fear of the outbreak of the virus.

Even though losses have not been assessed in **Malta**, the NRA ensured contingency plans were put in place. Online tools to interact with customers were encouraged. To make it easier for the consumers, applications were available that could be filled out electronically. During the first wave of the pandemic, the Maltese NRA, REWS, experienced an increased collaboration with the ministry responsible for energy and the DSO.

In **Montenegro**, in 2020, the government adopted programs to provide support to the economy and citizens in mitigating the negative effects of the COVID-19 pandemic, which, in the field of energy, included the following:

- Exempting business undertakings, whose activities were prohibited by the Ministry of Health, from the payment of the fixed part of the bill for consumed electricity by all energy undertakings for April, May, and June.
- Doubling the amount for subsidized electricity bills for socially vulnerable households during the ministry's measurement application by EPCG.

In **Portugal**, the incentive mechanism was applied to all the distribution networks, including the HV, MV, and LV. Note that the transmission system of Portugal comprises only EHV.

Spain, also without the calculation of the 2020 and 2021 losses, elaborated its definition of vulnerable consumers. The factors included in the national concept were income level and big families. The safeguards were prevention of disconnection in case of non-payment, special energy prices (social tariffs), and a free basic supply of energy for those consumers under exclusion risk. The safeguards improved during the pandemic period, lowering the percentage to pay from 25% and 40% to 60% and 70% and preventing disconnection during the pandemic period.

5

ENERGY POVERTY AND VULNERABLE CONSUMERS

The topic of theft and fraud, the factor that contributes to most of the non-technical losses, opens the discussion on the topic of energy poverty.

Vulnerable consumers and energy poverty are linked; however, they are considered to be two different issues. To address energy poverty, it is essential to define who the vulnerable consumer is and define the necessary actions needed to assist the said vulnerable consumer. Vulnerable consumers are those who may not have full access to competitive tariffs or need additional support due to a range of reasons, including financial, social, or medical reasons. Hence, the severity of energy poverty could be assessed from a country's policy on affording the needed protection and support to vulnerable consumers.[5]

From a non-technical losses perspective, resulting from an increase in theft and fraud, the issue could be due to a lack of action to support vulnerable consumers.

A preliminary analysis showed that different countries recognized energy poverty differently; hence, a chapter has been dedicated to studying the definition of energy poverty, vulnerable consumers, and the regulators' role in taking action to support the said vulnerable consumers.

5.1. Definitions

5.1.1. Countries with a legal definition for energy poverty

The European Commission has shown the need for the EU member states to address energy poverty:[6]

> *Energy poverty negatively affects living conditions and health. It has many causes, mostly resulting from a combination of low-income and general poverty conditions, inefficient homes and a housing tenure system that fails to encourage energy efficiency. Energy poverty can only be tackled by a combination of measures, mainly in the social field and within the competence of authorities on the national, regional, or local levels.*
>
> – (EC, 2015)

In **Cyprus**, according to the provisions of the Law Regulating the Electricity Market of 2021, the Ministry of Energy, Commerce, and Industry issued, after consulting with the Ministry of Labour, Welfare, and Social Insurance, a decree that defined and published all the criteria for determining energy poverty, which may include low-income, high-energy expenditure relative to the disposable income, and low energy efficiency. According to the decree issued by the Minister of Energy, Commerce, and Industry in 2015, the concept of energy poverty includes recipients of public assistance from the social welfare services and the beneficiaries of the minimum guaranteed income.

In **France**, there is indeed a legal definition for energy poverty. Moreover, France has a specific institutional setup to monitor and assess energy poverty. Finally, energy poverty is embedded in two important articles of the energy law: objectives of the energy policy and those related to public service obligations of the energy sector. The law of 10 July 2010 on the national commitment to the environment, known as the Grenelle II law, clearly defines energy poverty in the following terms: 'in a situation of energy poverty [...] a person who experiences particular difficulties in obtaining the energy supply necessary to satisfy his or her basic needs in his or her residence because of the inadequacy of his or her resources or housing

[5] https://www.cairn.info/revue-l-europe-en-formation-2015-4-page-64.htm

[6] European Commission 2015

conditions.'[7] The Grenelle II law also allowed the creation of l'*Observatoire National de la Précarité Énergétique* (ONPE)[8] – the National Energy Poverty Observatory in March 2011. This institution was designed as a reference for monitoring and analysing the phenomenon and policies that serve as a support tool for decision-making by the various stakeholders. The objective of having a reliable and shared knowledge of the phenomenon in France was satisfied.

The ONPE uses a combination of indicators to measure energy poverty:

1. The first indicator considers the energy effort ratio (*Taux d'Effort Energétique* [TEE]): According to this criterion, any household that spends more than 10% of its income on energy and is in the first three income deciles is in energy poverty.
2. The second indicator is low income with high expenditure (*Bas Revenus avec Dépenses Elevées* (BRDE)): According to this double condition, a household is in a situation of energy poverty when it has a low income (below the poverty line) and, given the size of the residence and the composition of the family, has high energy expenditure (above the national median).
3. The third indicator, which is based on a subjective criterion, considers the feeling of discomfort, i.e., the sensation of cold expressed by the households.

The protection of vulnerable consumers is among the seven objectives of the energy policy presented in the first article of the French energy code. Article L. 100-1, which defines the general objectives of the energy policy, lists combating energy poverty among other objectives (namely, a competitive economy in line with green growth, security of supply, competitive energy prices, protection of human health and the environment, social and territorial cohesion, and achieving the European Energy Union).[9]

Second, according to Art L. 121-1 et seq. of the energy code,[10] prevention of 'fuel poverty' counts as one of the Public Service Obligations (PSOs) that are borne by all electricity sector companies, whether as generators, network operators, or suppliers. This article stipulates that the Public Services Obligation bears 'upholding – in accordance with article L. 115-3 of the code of social action and families – of a supply to persons in situation of precariousness.'

In **Spain**, energy poverty is defined as 'the situation where a household customer cannot satisfy the basic energy supply because of insufficient income level and that, in its situation, it can be worsened when having an energy inefficient living place.'

In many countries, even though energy poverty is not being defined, the status of the energy poor is recognized. In **Türkiye**, for instance, energy poverty has recently gained the attention of the public in the last months because of the energy price surge. In Türkiye's case, illegal consumption can be caused by

[7] https://www.legifrance.gouv.fr/jorf/article_jo/JORFARTI000022470520

[8] ONPE | Observatoire National de la précarité énergétique

[9] TITRE PRELIMINAIRE : LES OBJECTIFS DE LA POLITIQUE ENERGETIQUE (articles L.100-1 A à L100-5) – Légifrance (legifrance.gouv.fr) https://www.legifrance.gouv.fr/codes/article_lc/LEGIARTI000031063189/2018-05-31

[10] Article L.121-1 – Code de l'énergie – Légifrance (legifrance.gouv.fr)

https://www.legifrance.gouv.fr/codes/article_lc/LEGIARTI000023985549 energy poverty in some cases because people who cannot afford energy bills can connect their electricity after they faced a disconnection for non-payment.

5.1.2. Countries with a definition for the vulnerable consumer

In **Albania**, article 95 of Law nr.43/2015 on the power sector and article 97 of the Law nr.102/2015 on the Natural Gas Sector, address the definition of vulnerable consumers as well as the bodies responsible for protecting said vulnerable consumers. As per article 3.30 of the power sector law, the definition of a vulnerable customer is a household customer who, due to social reasons, is entitled to certain special rights regarding the electricity supply ensured in explanatory cases according to the definitions of this law. Meanwhile, article 4.34 of the natural gas law defines a vulnerable customer as a household customer who, due to his social position, retains special rights concerning natural gas supply, where the rights are guaranteed in exceptional cases as per the law.

In the **Egyptian** gas market, there is no legal definition for natural gas poverty. On the other hand, there is an economic definition for the 'poverty line.' The poverty line is determined by economic and social factors and is considered by the government. Those under the poverty line automatically qualify as vulnerable consumers.

In **Italy,** there is also no explicit definition for energy poverty in the Italian legislation; the definition of 'vulnerable customers' for electricity includes, inter alia, consumers who are in economically disadvantaged conditions or who are in serious health conditions such as those requiring the use of electromedical equipment to keep them alive or who have disabilities.

In **Malta**, even though there is no legal definition for energy poverty, the electricity regulations (S.L.545.34) impose an obligation on the minister responsible for social policy to ensure the protection of the energy poor and vulnerable customers. For example, '4(2) The Minister responsible for social policy shall ensure the protection of energy poor and vulnerable household customers pursuant to regulations 25 and 26 if protection of energy poor and vulnerable household customers shall not be achieved by means of public interventions in the price setting for the supply of electricity.'

Regulation 25 (1) of the Maltese Electricity Regulations, 2021, also links the concept of 'vulnerable customer' with that of the 'energy poor customer', whereby it states that '25. (1) Vulnerable customer, for the purposes of these regulations, means energy poor customers, which includes customers with low-income levels and for whom the share of energy expenditure is a significant part of disposable income. Vulnerable customers shall also be customers who are critically dependent on electrical equipment for health reasons or other criteria determined by the Minister responsible for social policy.' It is worth noting that the Social Policy Ministry is the entity that determines the criteria for a person to be considered energy poor. Monetary assistance is provided to the energy poor directly through the social security system.

Meanwhile, Regulation 26 states the following: '26. The Minister responsible for social policy shall establish and publish a set of criteria for the assessment of the number of households in energy poverty, which may include low income, high expenditure of disposable income on energy, and poor energy efficiency.'

Montenegro also has provisions regarding vulnerable consumers. Vulnerable consumers are defined by energy law (article 198).

- Vulnerable customers who need health and social care, in terms of this law, represent households with

   1. Disabled persons, persons with special needs and persons of poor health conditions, who may be exposed to a threat to life or health because of a limitation or suspension of energy supply, and
   2. Persons who need social care as determined by the state authority competent for social care affairs.
- Vulnerable customers who are socially handicapped represent households with persons who need social care, as defined by a competent public institution, i.e., public authorities competent in social care affairs.

In **Portugal,** article 186 of Decree-Law no. 15/2022 of 14 January defines economically vulnerable final customers as those who have access to

- The social electricity tariff
- The supply of electricity by the Supplier of Last Resort at a tariff defined by the ERSE after the extinction of the legally established transitory tariffs if they so desire
- Support mechanisms established in the National Long-Term Strategy to Combat Energy Poverty.

Furthermore, economically vulnerable final customers are those who fulfil the requirements defined in the instruments referred to above, with those established for access to the social tariff being applied supplementary in the absence of a definition for those requirements.

In **Türkiye**, there is no legal definition for energy poverty; however, their vulnerable consumers are supported, and there are measures in place to ensure such support is delivered.

Israel, **Jordan,** and **Lebanon** do not have a legal stance in their legislation that defines energy poverty and who are the vulnerable consumers.

5.2. Effect of Energy Poverty on Energy Losses Calculation

Regarding vulnerable consumers in **Albania**, article 95.4.5 of the power sector law defines that vulnerable customers benefit from financial support from the state budget and shall use the benefited funds to pay their electricity liabilities. The financing and support of the vulnerable consumers shall be in a non-discriminatory way, not permitting financing from other categories of electricity customers. Also, in the natural gas sector, vulnerable customers benefiting support from the Council of Ministers to pay for the gas supply service shall not be allowed to use such funds for other purposes (article 97).

In **Cyprus,** energy poverty-related losses are calculated as the percentage of vulnerable consumers included in the special tariff.

Similarly, in **Egypt**, **France, Italy, Jordan, Lebanon, Malta, Montenegro**, **Portugal,** and **Spain,** the effect of energy losses is not calculated and accounted for as a loss of any kind.

In **Israel**, 1,5% is already incorporated in the electricity tariff, the purpose of which is to give a discount to disadvantaged groups. The groups are fixed by law, and the discount is given to specific consumers.[11]

[11] https://www.iec.co.il/en/content/tariffs/contentpages/discountentitled

5.3. Measures Taken for Energy Poverty

In **Albania**, since 2006, an electricity compensation scheme has been applied to eligible consumers. The compensation mechanism consists of a cash benefit of 640 ALL for all those entitled as consumers in need of the monthly consumption threshold of 200 kWh.[12] Also, according to the government's decision, in 2015, it applied another compensation scheme for an additional subsidized cash benefit of 648 ALL, applied every month to protect vulnerable households that consume up to 300 kWh per month. So, considering the two-mechanism schemes, consumers can receive up to 1288 ALL per month in direct support from the state budget.[13]

In **Cyprus**, special prices are listed for vulnerable consumers. Those consumers are also given the right to defer their payments into monthly instalments. Furthermore, it is restricted from disconnecting those under the energy poverty 'umbrella' from the energy supply in case of non-payment. Lastly, financial investments are given as follows:

- Vulnerable consumers receive a grant of €750 per installed kW for PV systems using net metering (maximum grand amount of €3750)
- Participation in the housing upgrade program and improved energy efficiency
- Replacement of high-energy consuming electrical appliances.

In the **Egyptian** gas market, two main measures were taken. Firstly, gas prices were classified according to consumption, where the lowest consumption level was priced with the lowest price as follows:

- 1st: Consumption from zero to 30 cubic meters, LE 2,50 per cubic meter.
- 2nd Consumption from 30 to 60 cubic meters, LE 3,25 per cubic meter.
- 3rd Consumption of 60 cubic meters and above, LE 3,75 per cubic meter.

Second, the government started a mega project to deliver natural gas to low-income families with different payment plans, which include huge subsidies that may reach 100%.

In **France**, ONEP has identified and regularly assesses 24 instruments[14] for preventing and combating energy poverty. However, in this text, first, only two sets of flagship policy measures, namely 'Energy Cheque' and 'MaPrimRenov' will be presented as ordinary measures to curb energy poverty. Second, six sets of exceptional measures to limit energy poverty, which have been adopted during the current energy crisis, will be presented.

In **Israel**, the law and authority do not prevent electrical poverty. However, the authority has defined highly restrictive collection procedures for disadvantaged groups and prevents power cuts to the minimum required.

In **Italy**, an economic relief scheme ('bonus') has been established to benefit electricity and natural gas consumers who are in economic or physical hardship. Economic hardship is measured using an indicator (ISEE) calculated considering income, assets, and the number of family members, which is generally used to allow access to social benefits, including the electricity, natural gas, and water 'bonus' scheme. Customers

---

[12] Albanian Government decision 565/2006

[13] Albanian Government decision nr.8 date 14.1. 2015

[14] https://www.onpe.org/dispositifs_daide/tout_savoir_sur_les_aides_financieres_pour_prevenir_et_traiter_la_precarite

who benefit from the 'bonus' scheme receive a discount directly on their electricity and natural gas bill (or a direct payment if they use natural gas through a centralized heating system), which covers about 30% of annual electricity costs and about 15% of annual natural gas costs, calculated on different conventional consumption profiles.

Since 2022, to counter the effects of growing energy prices, an additional discount has been introduced in the 'bonus' scheme, aimed at covering the expense increase caused by higher electricity and natural gas prices, while the ISEE level, which gives access to the 'bonus' scheme, has been raised to broaden the number of beneficiaries. As a further measure to reduce the impact of rising prices, to the benefit of all domestic customers, a reduction in general system charges and the taxation of electricity and natural gas was introduced.

In **Malta,** assistance to vulnerable customers, including the energy poor, was mainly provided through assistance in the payment of bills ('energy benefit'). Moreover, other measures that were previously undertaken involved the replacement of old and inefficient appliances belonging to Maltese and Gozitan citizens classified as socially vulnerable persons. Energy audits were also provided for free to these socially vulnerable persons.

In **Lebanon,** on the other hand, no concrete actions necessarily fall under the energy poverty initiatives; however, the residential tariff rate structure in Lebanon favours vulnerable consumers. Since vulnerable consumers tend to be on the lower end of the consumption range, the bill is automatically lower based on a lower tariff rate since the tariff structure is divided into five different categories, starting with 1 to 100 kWh at a rate of 35 LBP/kWh and ending with >500 kWh at a rate of 200 LBP/kWh.

Quick Look

Lebanese Case Study: New Tariff and Protecting Vulnerable Consumers

As per the latest policy statement issued by the Ministry of Energy and Water on March 2022, the plan is to achieve financial sustainability by implementing a new tariff, indexed to international oil price and USD exchange rate as per the SAYRAFA platform, covering the cost as of 2023. The new tariff will gradually take effect once daily supply hours are increased to 8–10 hours while ensuring cost recovery and supporting with a special tariff for limited-income households consuming less than 500 kWh per month as well as relevant productive sectors. The new tariff will provide approximately 70% savings for moderate consumption households, compared to the cost of private generators.

The ongoing economic crisis requires that such tariff adjustments be introduced in parallel with tangible macro-economic measures aimed at reviving economic activity, incentivizing the industrial sector (e.g., tax rebate for industrials associated with efficient use of electricity), protecting vulnerable households (e.g., targeted cash transfer through the social safety system), and stabilizing the continuing erosion of purchasing power of Lebanese households. Such conditions would ultimately lead to worse energy poverty levels, thus making it even harder to materialize the significant capital investments envisaged herein.

In **Montenegro** as well, no measures have been taken for energy poverty. For vulnerable customers, subventions for all endangered categories are 40% of the bill if it is up to €60; for bills of more than €60, it is a fixed subvention of €24. The government pays for the subventions.

In **Portugal**, in the event of a significant number of households in energy poverty, based on an assessment of verifiable data, the member states must include in their National Energy and Climate Plans (PNEC) an indicative national objective to reduce energy poverty.

According to the PNEC 2030, to combat energy poverty and improve the instruments that protect vulnerable customers, the following action measures are foreseen:

- Promote a long-term strategy to fight energy poverty
- Establish a national energy poverty assessment and monitoring system, including the number of households in energy poverty
- Continue with the mechanisms to protect vulnerable consumers and study the introduction of new mechanisms
- Develop programs to promote and support energy efficiency and the integration of renewable energies to mitigate energy poverty
- Promote and support local strategies to combat energy poverty
- Disseminate information to mitigate energy poverty

Resolution of the Assembly of the Republic no. 247/2021 of 19 August, recommends that the government reinforce the incentives to improve the energy efficiency of housing and combat energy poverty.[15]

In **Spain**, vulnerable consumers have the right to get a social electricity bonus. The social electricity bonus is a discount on the electricity bill of the Last Resort Supplier (SoLR). The consumer must have a contract with the SoLR. These contracts have dynamic prices and are called PVPC. The discount is 25% for vulnerable consumers who meet the established requirements. However, exceptionally, until 31 December 2022, the discount will be 60% and 65% until 31 December 2023. The discount is 40% for severely vulnerable consumers who meet the established requirements. However, exceptionally, until 31 December 2022, the discount will be 70% and 80% until 31 December 2023. If the consumer is also at risk of social exclusion because it is being served by the social services of an autonomous or local administration that pays at least 50% of the bill, they will not have to face the electricity bill and, in case of temporary impossibility to face the payment, the electricity supply may not be interrupted.

In **Türkiye**, there are two different measures towards the consumers. One of them is financial support, which is executed and funded by the Ministry of Family and Social Affairs for electricity bills, and the other is a measure taken by the Turkish NRA towards disconnection for non-payment. Different types of social aid are funded by the Ministry of Family and Social Affairs. The income limit for households with a per capita income of less than 1/3 of the net minimum wage (for 2022, it's 1.833,45-TL, about 92,5 €). Furthermore, the amount of support depends on age, disabilities, and the number of children, where 1–2 persons = 75 kWh, 3 persons = 100 kWh, 4 persons = 125 kWh, 5+ persons = 150 kWh. Another measure that is in place to protect the final consumer is the protection of the non-paying consumers from their disconnection from the grid, and this is provided by the EMRA. This measure is in place for elderly people, disabled people, and

[15] https://www.dgeg.gov.pt/pt/areas-transversais/relacoes-internacionais/politica-energetica/proposta-de-estrategia-nacional-de-longo-prazo-para-o-combate-a-pobreza-energetica/

families of martyrs and veterans. Normally, one unpaid bill is enough to disconnect electricity in Türkiye, but it is three unpaid bills for this group.

6

CONCLUSION

CONCLUSION

The issue of power losses remains a major topic since these losses, both technical and non-technical losses, are still considered monetary losses that should be evaded to ease the burden.

Even though a few countries in the Mediterranean region do not have a definition for power losses or a calculation method, they still realise their existence within the system and try to limit them as much as feasibly possible. For the countries that have defined power losses, the definitions almost completely align, except for the fact that some countries do not consider unpaid bills as a part of the losses, while other countries consider any electricity that has been used and unpaid as a power loss. This especially holds during the evaluation of non-technical losses at the distribution levels.

Furthermore, regarding the split between technical and non-technical losses in the transmission and distribution systems, all countries appear to suffer mostly from distribution system losses, where from a technical perspective, the lower the voltage level of the cables, the lower their efficiency and hence, the higher the losses. Meanwhile, from a non-technical losses perspective, transmission systems in all countries have shown that there are none. As for the non-technical losses in the distribution system, theft and fraud have weighed in as the main source of such losses.

Among the measures that have been applied mostly to the losses at the transmission system level, most countries appeared to have reconfigured the voltage levels in the transmission lines and maintained them at that higher level to ensure higher efficiency. Regarding technical losses in the distribution system, transformers are being maintained more frequently, and there are heavier investments oriented towards ensuring a stable flow. Meanwhile, regarding non-technical losses in the distribution system, among the most common measures are the rolling out of smart meters and the more frequent calibration of the said meters. Generic measures that have been set by the regulators on the TSOs and DSOs include the incentive mechanisms, where if power losses are less than the pre-set target, the system operators would get an incentive, while if power losses are more than the pre-set target, the system operators would get penalized.

As for the impacts of the COVID-19 pandemic on power losses in the distribution system, it was interesting to know that many countries could maintain the losses, whether technical or non-technical. The initial understanding was that since the pandemic has had a strong financial impact on some consumers, the levels of theft and fraud could have increased. The countries that showed no impact due to the COVID-19 pandemic showed the significance of the measures adopted, where some of these measures could serve as a potential benchmark for other countries that were impacted by the pandemic.

Thus, the topic of energy poverty has never been of as much importance as it is currently. With the surge in energy prices, consumers that have never been considered vulnerable consumers and still do not fit within the definition of vulnerable consumers, given their household income, are starting to find difficulties paying the energy bills, leading to a potential new dynamic definition for the term vulnerable consumers. As mentioned in the previous chapter, the terms energy poverty and vulnerable consumers are closely linked but have completely different definitions. Indeed, the term energy poverty is directly proportional to the number of vulnerable consumers and their effect on a country's energy market.

Discussions relevant to the topic have found that different countries in the Mediterranean deal with vulnerable consumers in different ways, especially those that end up not paying their energy bills at all. Different countries have varying strategies and terms towards cutting energy supplies to consumers who do not pay over prolonged periods, with some countries opting for never cutting the energy supply regardless of the status of the household and its inhabitants.

To conclude, the term energy poverty has been raised on the regional level within the EU, where it has been given a major spotlight, however, till now and within the current energy crisis and the price surge, no suggestions have been made on the EU level, leaving the governments taking individual decisions in their respective countries regarding how to find a solution for the energy crisis, where some countries are relying on windfall profits to cap the prices, while others use these windfall profits to subsidize natural gas for power plants that operate on the said energy source.

Vaulting back to the topic of technical and non-technical losses, and their correlation to energy poverty, a potential way forward would be to discover and analyse whether said losses, especially non-technical ones in the distribution system could be directly correlated to the Mediterranean countries' GDPs, average incomes, and other KPIs to estimate realistic targets that could be reached by the countries. Although not the optimal solution, it could be considered a feasible and realistic solution and a step towards having more efficient energy systems in the region.

For energy regulators, a part of their role is to protect the consumers and ensure a constant, high-quality supply of energy, regardless of the demand. Besides incentivizing premium quality of supply from the system operators, to achieve such goals, empowering the consumer and giving them an active role within the energy market could be an essential element. The behaviour of the consumer could assist in the overall reduction of losses and hence give back to the whole energy system. Potential future work in that regard could assess the levels of consumer empowerment and its correlation to power losses and the efficiency of the energy system.

ANNEXES

Annexe 1: Data

Table of Power Losses (end of 2019 – end of 2021)

	Transmission System Losses (%)			Distribution System Losses (%)		
	2019	2020	2021	2019	2020	2021
Albania	2,12	2,1	2,13	21,79	21,48	20,61
Algeria	3,48	3,45	3,59	12,12	11,06	9,86
BiH	1,77	1,75	1,87	9,2	9,13	9,22
Cyprus	1,35	1,45	1,46	2,81	3,81	3,6
Egypt	4	4,2	3,8	21	22	22,5
France	2,22	2,31	2,8	6,34	6,25	
Greece	2,434	2,534	3,033	9,903	9,827	
Israel	1,2	1,2	1,2	2,45	2,45	2,45
Italy	1,55	1,45		4,02	4,31	
Jordan	2,18	1,7		12,58	13,48	
Lebanon	5,34	5	5	28,9	35,9	40,1
Malta				6,39		
Montenegro	2,13	1,82	1,79	13,1	12,93	12,39
Portugal	1,44	1,63	1,59	8,17	8,38	8,1
Spain	1,95			8,47		
Türkiye	2,2	1,9	1,9	11,43	11,23	10,77

Annexe 2: Extras

Albania's Policy on Vulnerable Consumers

Based on the power sector law and the natural gas law, the bodies responsible for the proposal of criteria, procedures for benefiting from the status of 'customer in need', and the manner of their treatment are the Ministry of Infrastructure and Energy – the ministry responsible for social affairs – the Ministry of Finance, and ERE. Approval of these criteria is subject to the Council of Ministers' approval. Article 96 defines that the Ministry of Infrastructure and Energy – the ministry responsible for social affairs – shall, within one year of this law's entry into force, develop, in cooperation with the ministry responsible for energy and the Ministry of Finance and in consultation with the Albanian Energy Regulatory Authority (ERE) and other stakeholders and entities, a detailed procedure for establishing the status of socially vulnerable customers and to be approved by the Council of Ministers.

Also, the above-mentioned laws foresee that the criteria for benefiting the vulnerable customer status shall consider the following:

In the electricity sector, a) customers with low income, which use electricity to supply their permanent residence; b) customers whose electricity consumption is connected to the single-phase grid with a maximum power of about 16 amperes; c) maximum level of energy consumption per person, depending on the season; d) direct support from the State Budget.

In the natural gas sector, a) customers with lower incomes, who use natural gas to supply their permanent residence; b) the maximum level of gas consumption per person reflecting seasonality and total consumption of up to 30 cubic meters/month for a family with up to four (4) members; c) the manner of direct support by the State Budget.

The ERE is also responsible for approving the rules of service termination for this category of customers. Under the law, vulnerable customers are supplied with electricity according to the tariffs approved by the ERE under universal service supply.

In-Depth Analysis of Vulnerable Consumers in Cyprus

The concept of vulnerable customers is determined by a Ministerial Decree, after consultation with the Minister of Labour, Welfare, and Social Insurance and the Minister of Health, in which reference may be made to energy poverty as well as, among other things, to the prohibition of disconnection of such consumers in critical periods and may include income levels, the share of energy expenditure in disposable income, the energy efficiency of homes, critical reliance on electrical equipment due to health reasons, age, geographic location, and other criteria.

The categories of vulnerable customers, the criteria, and the conditions are determined by the Decree of the Minister after consultation with the Minister of Labour, Welfare, and Social Insurance and the Minister of Health.

The categories of vulnerable consumers defined by the Ministerial Decree in 2016 include the following:

- The recipients of public assistance provided by the Social Welfare Services of the Ministry of Labour, Welfare, and Social Insurance
- The beneficiaries of guaranteed minimum income provided by the Welfare Benefits Administration Service of the Ministry of Labour, Welfare, and Social Insurance
- Families with more than three dependent children with an annual gross family income of up to €51 258. The income criterion of €51 258 for annual combined gross family income is increased by €5 126 for each additional child after the fourth one
- The recipients of severe motor disability allowance provided by the Department for Social Inclusion of Persons with Disabilities, Ministry of Labour, Welfare, and Social Insurance
- The recipients of care allowance for paraplegic individuals granted by the Department for Social Inclusion of Persons with Disabilities, Ministry of Labour, Welfare, and Social Insurance
- The recipients of care allowance for quadriplegic individuals granted by the Department for Social Inclusion of Persons with Disabilities, Ministry of Labour, Welfare, and Social Insurance
- The recipients of the grant to the blind granted by the Department for Social Inclusion of Persons with Disabilities, Ministry of Labour, Welfare, and Social Insurance
- Haemodialysis renal patients who receive a mobility allowance from the Department of Social Inclusion of Persons with Disabilities of the Ministry of Labour, Welfare, and Social Insurance
- Individuals with multiple sclerosis who are registered members of the Cyprus Multiple Sclerosis Association.

CERA, based on the decree, issued a regulatory decision imposing public service obligations (PSOs) to all electricity supply licensees, with respect to specific vulnerable groups of consumers. Vulnerable consumers are included in a special tariff, which compared to the normal domestic tariffs, has reduced charges.

France’s Policy on Energy Poverty

I. Ordinary policy instruments in the fight against energy poverty: \

Following the two-pronged definition of the energy policy, which combines ‘resources’ and ‘housing conditions’ elements, all the preventive and remedial measures are also grouped into two categories based on their focus either on the ‘resource leverages’ or on the ‘housing conditions.’ In this framework, the ‘energy cheque’ is the best example of a policy instrument as resource leverage. This category is sometimes labelled as ‘aid to person or aid to energy.’ The second measure, illustrative of the ‘aid to stone’ policy measures, is the ‘MaPriveRenov’ and thus concerns ‘housing conditions.’

1.1 Energy cheque

Definition and origin

The energy cheque is a payment aid scheme for energy expenses designed for low-income households. It was established by article 201 of law no. 2015-992 of 17 August 2015 on the energy transition for green growth. Following an experimental period, the energy cheque replaced the social energy tariffs on 1 January 2018. The latter, known as the 'primary necessity tariff' for electricity and the 'special solidarity tariff' for natural gas, ended on 31 December 2017.

Decree no. 2016-555 of 6 May 2016 determines the conditions for implementing the energy cheque by defining the amount, payment methods, form, conditions of use and recipients of this instrument.

The energy cheque is allocated based on a single revenue criterion. It enables beneficiary households to pay their energy bill, regardless of the type of heating they use (electricity, gas, fuel oil, wood, etc.) and to finance part of the work necessary to achieve energy savings in the housing of its beneficiaries.

Eligibility requirements, entitlement levels, and receipt modalities

The energy cheque is subject to income conditions. This means that eligibility to receive the cheque and its face value varies according to the reference income (RFR – ‘revenu fiscal de reference’) of the household determined by its composition. A household, first, is understood to be all the occupants of the same dwelling (without necessarily being related to each other). Second, the value of the consumption units (CU) constituting the household is calculated as follows: One person represents one consumption unit, the second person corresponds to half a unit, and each additional person accounts for one-third of a unit.

Based on the above formulae, in 2022, its amount ranged from €48 to €277 per year, with an average of €200. To be eligible, the annual amount of taxable income should not exceed €10 800 for 1 person’s household. As the number of consumption units increases, the amount of the cheque increases as explained (with the application of the coefficient of 0,5 for the second CU and 0,3 for additional units). For example, the eligibility threshold for a household of 4 persons is a maximum of €22 680 annual revenue (1 CU + 0,5 + 0,3 + 0,3 = 2,1 * €10 800, i.e., €22 680]. The minimum amount of the energy cheque is €48 for an annual income between €7 700 and €10 800 for a single person (i.e., 1 unit of consumption as mentioned above). The lower the annual income, the higher the amount of the cheque according to the following levels: for incomes below €5,600 per CU, the amount is €194; for incomes between €5600 and €6700, the amount is €146; and for incomes between €6700 and €7700 per CU, the amount of the cheque equals €98.

As far as the modality of receiving the cheque is concerned, beneficiaries do not need to take any action. The tax administration is responsible for establishing the list of persons who meet the conditions for receiving the cheque. This list is then transmitted to the *Agence de services et de paiement* (ASP). The ASP then sends the energy cheque to its beneficiaries. The cheque is nominative, i.e., the name of the beneficiary is indicated on the cheque. However, the energy cheque is not a bank cheque and, therefore, cannot be cashed at a bank or credited to a bank account.

The energy cheque can also be used to directly pay eligible energy expenses online. Finally, it is possible to ask to 'pre-allocate' the energy cheque to the energy supplier instead of receiving it at home by post. Its amount is consequently directly deducted from the electricity or gas bill. This can be done either online or by ticking the pre-allocation box on the energy cheque before sending it to the supplier.

To verify eligibility for the energy cheque and estimate its amount, a simulator has been set up on a dedicated website: https://chequeenergie.gouv.fr/beneficiaire/eligibilite. Beneficiaries can obtain help by email (https://chequeenergie.gouv.fr/beneficiaire/assistance) or by calling 0 805 204 805, which is a freephone number.

1.2. 'MaPrimRenov'

Definition and criteria

'MaPrimeRénov' is a grant for individuals to finance energy renovation work. It has been distributed through 'France Rénov,' which has become the unique public service for home energy renovation since 1 January 2022.

Under this scheme, the levels of assistance provided correspond to four categories of households according to family composition and income – blue, yellow, purple, and pink – for works relating to insulation, changing the heating system, installing ventilation and/or carrying out an energy diagnosis and audit, and overall renovation works.

This grant initially targeted low-income households only, but it was extended to all occupying owners and renovation work in common areas of co-ownerships on 1 October 2020. Since 1 July 2021, it has been open to lessor owners. To ensure the quality of the renovations financed, a bonus of €1 500 is also provided under this grant when the work makes it possible to get the property out of the 'thermal sieve' state or to achieve label A or B in the 'energy performance diagnostic.'

Data and analysis

The analysis of the applications for this aid in 2021 shows that 40% concern very low-income households and 23% concern modest households. As far as the content of the applications is concerned, 64% of them are related to the heating system and 32% are related to the insulation of opaque walls. The programme aims to renovate 500 000 homes per year. In 2020, 141 143 MaPrimeRénov' applications were accepted. That represents 74% of the applications submitted. The number of demands were highly dynamic in 2021. This was particularly significant at the end of 2020, following the post-pandemic economic recovery and the communication linked to the government recovery [lan [*Plan de Relance*]. In the first half of the year, 297 003 applications were accepted out of 382 442 submitted. This mechanism was financed until 2022 to a total amount of €2 billion as part of the recovery plan.

It is possible to apply for MaPrimRénov through a unique web platform called France Rénov, which is run by the National Housing Agency (Anah). The platform is available in three ways: through its website (www.france-renov.gouv.fr), by a single telephone number to contact a France Rénov' advisor (0 808 800 700), and through a network of advice centres throughout the country.

II. Exceptional measures in response to the energy crisis

To complement the existing policy measures in favour of vulnerable consumers, the French government had to adopt the following exceptional measures in the context of the energy crisis: 1) issuing a complementary energy cheque, 2) freezing tariffs, 3) taking tax measures, 4) implementing fuel discounts, 5) granting an inflation allowance, and finally, promoting the adoption of some additional voluntary measures. Each of these measures is detailed below.

2.1. Energy cheque top up

To address the sharp rise in energy prices that is affecting the purchasing power of low-income households, an additional energy cheque of €100 was granted by the government.

The complementary energy cheque was sent in December 2021 and will be valid until 31 March 2023. This exceptional measure came to supplement the energy cheque, which is granted annually according to the ordinary timetable. These were automatically sent to beneficiaries in April 2021 with amounts ranging from €48 to €277 as described above.

This targeted support for the poorest households represents nearly €600 million of aid. The additional energy cheque of €100 should, however, not be confused with the inflation allowance of €100. They are not linked to each other and are, therefore, not mutually exclusive.

2.2. Tarif shield

For electricity, first, the government blocked the increase in regulated electricity sales tariffs to 4% [incl. VAT] on 1 February for residential consumers. Then, given the exceptional situation, it was decided to extend the tariff shield by limiting the increase in regulated electricity sales tariffs to 4% for small professional consumers who benefit from them in metropolitan France as well as for all professional consumers in the overseas territories and Corsica (non-interconnected areas) who benefit from these tariffs.

As of 31 March 2022, the TRVEs [regulated tariffs] represent 21,75 million residential sites (i.e., 65% of the sites) for an estimated annualized consumption of 106,5 TWh and 1,5 million 'small professional' sites (i.e., 33% of the sites) for an estimated annualized consumption of 10,8 TWh. The cost of the measure will depend on the evolution of the gas price.

For gas, a decree of the prime minister on 23 October 2021 set the regulated sales tariffs for natural gas from 1 November 2021 to 30 June 2022, according to the scale applicable on 1 October 2021. Then, as energy prices continued to soar, the freeze on regulated gas sales tariffs was extended by a text dated 25 June 2022[16] until 31 December 2022.

In practical terms, this means that consumers who have a gas contract at the regulated rate with ENGIE, a fixed-price contract or a contract whose prices are indexed on the regulated rates, will not be subject to an increase during this period and will be protected by this freeze. It should be noted that customers who have a contract at the regulated tariff benefit from this until 1 July 2023, when the regulated tariffs for the sale of natural gas will be abolished for residential subscribers. The state will bear the excess cost of this freeze for suppliers, in accordance with the provisions of the 2022 Finance Act.

---

[16] Arrêté du 25 juin 2022 modifiant la date de fin de gel des tarifs réglementés de vente du gaz naturel

https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000045964347

Without this freeze on tariffs, the average level of regulated sales tariffs on 1 September 2022 would have been 116,50% higher (excluding VAT) or 105,10% higher (including VAT) than the level in force on 1 October 2021.

2.3. Fiscal measures

As a part of the measures adopted to combat the rise in electricity prices in 2022, the government has decided to reduce the tax on electricity (TICFE) for one year to its minimum level provided for by European law. This reduction represents a budgetary cost of €8 billion for the state. These measures will apply to all professional and residential end-users of electricity, regardless of their contractual offer, from 1 February 2022 to 31 January 2023.

In accordance with Decree No. 2022-84 of 28 January 2022, the new CSPE rates, for the main categories, are set (from a full rate of 22.5 €/MWh) to 0,5 €/MWh.

The Contribution to the Public Service of Electricity (CSPE) also known as TICFE (*Taxe intérieure sur la Consommation Finale d'Electricité*), currently represents about a quarter of the final bill.

This tax on electricity is paid by final consumers and is used to finance policies to support renewable energies, part of the additional costs of electricity production in non-interconnected areas (ZNI).

2.4. Fuel discounts

Fuel discounts at pump stations

To contain the impact of soaring fuel prices at the pump stations, a discount of 15 cents per litre, excluding tax, was applied from 1 April 2022 until 31 July 2022. With VAT, this reduction reached 18 cents in mainland France. This measure was then extended to 1st August 2022. A second phase was extended until the end of the year with a modulation of the fuel discount. Indeed, it would go from 18 to 30 cents between early September and 15 November and to 10 cents from 16 November to the end of December 2022.[17] The reduction applied to all fuels. It also benefited all private and professional uses: road, rail, river and sea vehicles, agricultural and forestry machinery, construction, public works, mining, as well as stationary engines in companies. The discount was applied by the wholesalers distributing the fuel to the petrol stations, and the state paid them a subsidy corresponding to the volumes delivered. At the stations, the discounted prices will be displayed both on the totem boards and on the prices at the pump. The amount of discount was reflected on the receipt.

Support to domestic fuel oil users

The 2022 amended budget provided €230 million in aid for households heating with fuel oil. This was justified by the rising prices of this commodity, which affected those households that used it, while gas and electricity prices had been already blocked thanks to the state's tariff shield. The credits would finance targeted support measures for low-income households still heating with oil. The sending of €100 or €200 cheques for 'operation fuel oil' began on 8 November without the need for the identified beneficiaries to undertake any further formalities. However, for those households that were not yet identified as fuel oil users through utilization of their 'ordinary' energy cheques, details of the implementation measures were

[17] Décret n° 2022-1355 du 25 octobre 2022 modifiant le décret n° 2022-423 du 25 mars 2022 https://www.legifrance.gouv.fr/download/pdf?id=7aHxBNib2Z56Nq3rDaD6JsiBBOvFBquP8SLVDhQ4mrg=

specified through an online application portal later in November. It should be noted that these energy cheques are cumulative. Thus, a household could obtain in 2022, if it was eligible, a regular energy cheque paid each year in the spring; a fuel oil energy cheque if the household is heated with fuel and meets the eligibility criteria, and an exceptional energy cheque by the end of the year.

2.5. Inflation allowance

Rational and amounts

The inflation allowance is an exceptional individualized aid of €100 paid by the state to preserve the purchasing power of the most modest incomes in the face of inflation at the end of 2021. This sum was intended to compensate for the average impact of the increase in fuel prices compared to the 2018–2019 average during this cyclical peak in prices and was justified, against a general cut in fuel taxes, less fair because it was not targeting the neediest. Its total amount for 38 million people was therefore €3,8 billion, distributed between 2021 and 2022. This measure aimed to support the purchasing power in general and not only the increase in fuel prices.

Eligibility and payment modality

The inflation allowance was paid to people with an income (from activity or replacement) of less than €2 000 net (or €2 600 gross) per month from 1 January 2021 to 31 October 2021.[18] The aid was paid automatically to the beneficiaries without having to apply for it. The payment was made in one go by the employer or by a partner organization of the state, depending on their situation (job centre, social security organizations, etc.) to the very large categories of its recipients (employees and self-employed persons, public servants, job seekers, retired persons, students receiving grants and those receiving housing aid, recipients of social aid, etc.). The timetable for the payment of this aid was set for the end of December for employees, the end of January 2022 for the civil service, and a little later for pensioners.

2.6. Additional voluntary measures

The prime minister called on companies and distributors to make an extra effort on their side to lighten the bill at the pump. In this context and on their huge profits, some companies in the sector proposed such measures. Two examples are provided here:

- First, the Engie group announced on 28 July 2021 that it would pay 'a supplement' to 'all [its] customers' who are beneficiaries of the government's energy cheque, 'i.e., 880 000 people.' 'It will take the form of a discount, amounting to an average of €100 per customer in November.' This measure will, according to the group, cost '€90 million' to Engie.[19]
- The second example concerns the Total group. After a discount in some parts of the country, Total has put in place a second scheme until the end of the year with a national discount of 20 cents from 1 September until 1 November, then 10 cents until the end of the year. On the other hand, according to the information provided on the Total website, the Total Energies group is planning to send a cheque of €100 to its gas customers in a situation of energy poverty (around 200 000 customers

[18] https://www.gouvernement.fr/actualite/toutes-les-reponses-a-vos-questions-sur-l-indemnite-inflation#fr-sidemenu__link-0f704b69-0256-4cbc-8be6-5267293cd58d

[19] https://www.francetvinfo.fr/economie/energie/le-groupe-engie-va-verser-une-remise-complementaire-de-100-euros-en-moyenne-pour-ses-clients-qui-beneficient-du-cheque-energie_5282449.html

according to Total). The sending of this cheque is conditional on the granting of the energy cheque by the government.

Social action and family code[20]

According to article L. 115-3, any person or family experiencing difficulties – notably about their assets, the inadequacy of their resources or their living conditions – shall be entitled to assistance from the community to have access to the supply [...] of energy.

Regarding the protection of consumers in fuel poverty, in the event of non-payment of bills, the supply of energy [...] shall be maintained until a decision has been taken on the request for assistance.

From 1 November of each year to 31 March of the following year, electricity, heat, and gas suppliers [...] may not interrupt, in a principal residence, the supply of electricity, heat or gas [...] to the persons or families mentioned in the first paragraph and benefiting or having benefited, in the last twelve months, from a favourable decision to grant aid from the housing solidarity fund, including by terminating the contract for non-payment of bills.

Electricity suppliers may, nevertheless, proceed to a reduction in power, except for consumers mentioned in article L. 124-1 of the energy code.

When a consumer has not paid their bill, the electricity, heat, or gas supplier [...] shall notify them by letter of the period and conditions, defined by decree, within which the supply may be reduced or suspended or the contract may be terminated in the event of non-payment.

Order [Arrêté] of 24 February 2021 modifying the eligibility threshold for the energy cheque and instituting a cap on the management costs that can be deducted from the specific aid (OJ 25 Feb). (JO 25 févr.)[21]**.**

According to article 1, as of 1 January 2021, the benefit of the energy cheque is open to households whose annual reference income per consumption unit is less than €10 800.

According to article 2, as of 1 January 2021, the face value (inclusive of all taxes) of the energy cheque, defined in article R. 124-3 of the energy code is set as follows:

[20] Non-official translation of the French legal texts are provided only for ease of reference : article L.115-3 – Code de l'action sociale et des familles – Légifrance (legifrance.gouv.fr) https://www.legifrance.gouv.fr/codes/article_lc/LEGIARTI000031130667/

[21] https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000043178875/#:~:text=A%20compter%20du%201er%20janvier,inf%C3%A9rieur%20%C3%A0%2010%20800%20%E2%82%AC.&text=La%20valeur%20faciale%20TTC%20de,est%20fix%C3%A9e%20%C3%A0%20192%20%E2%82%AC.

	Level of income [RFR = Revenue Fiscal de Réference]/CU			
RFR/CU	**RFR/UC < €5 600**	**€5 600 ≤ RFR/UC < €6 700**	**€6 700 ≤ RFR/UC < €7 700**	**€7 700 ≤ RFR/UC < €10 800**
1 CU	194 €	146 €	98 €	48 €
1 < CU < 2	240 €	176 €	113 €	63 €
2 CU ou +	277 €	202 €	126 €	76 €

According to article 3, the face value, including all taxes of the specific aid for social residences defined in article R. 124-5 of the energy code, is set at €192.

According to article 4, the management fees of social residence operators, as defined in II of article R. 124-5 of the energy code, may not exceed 5% of the amount of the aid distributed.

According to article 5, the order [l'arrêté] of 26 December 2018 modifying the ceiling and face value of the energy cheque is repealed.

[...]

Decree No. 2021-1541 of 29 November 2021 concerning the re-evaluation of the energy cheque for the year 2021[22]

Art. 1 I. – The face value of the energy cheque (inclusive of all taxes) for the year 2021 was increased by €100.

This re-evaluation gives rise to the issuance of an additional energy cheque under the conditions set out in article R. 124-2 of the energy code, subject to II of this article.

II. – By derogation from article R. 124-2 of the energy code,

1. the validity of the additional energy cheque was set till 31 March 2023. For a cheque that was reissued or issued late, the validity date was set at the same date or on 31 March of the year following its issue date, if this date is later than the previous one.

2. the expiry date of the certificates mentioned in the third paragraph of the aforementioned article R. 124-2 was set as 30 April 2022.

Art. 2 – By derogation from article R. 124-2 of the energy code,

1. the legal persons and organizations mentioned in II of article R. 124-4 of the same code are only required to accept the energy cheque mentioned in article 1 in payment until 31 March 2023, or for the cheque that was reissued or issued late, until the same date or until 31 March of the year following its issue date, if this date is later than the previous one.

---

[22] *Légifrance – Publications officielles – Journal officiel - JORF n° 0279 du 01/12/2021 (legifrance.gouv.fr)https://www.legifrance.gouv.fr/download/pdf?id=6Bj9bgUjCI9pG8w00sXHCKbt54LjalMnIl9DzASfZ7w=*

2. the documents corresponding to the energy cheque mentioned in article 1 may only be presented for reimbursement until 31 May 2023, or for the cheque that is reissued or issued late, until the same date or until 31 May of the year following its issue date, if this date is later than the previous one. Documents presented after this date are definitively expired.

Art. 3 – The face value (inclusive of all taxes) of the specific aid for social residences, defined in the fifth paragraph of article L. 124-1 of the energy code, for the year 2021 was increased by €100.

[...]

Co-funded by
the European Union

MEDREG – Association of Mediterranean Energy Regulators
Via Lazzaretto 3, 20124 Milan, Italy – Tel: +39 3402938023
info@medreg-regulators.org www.medreg-regulators.org