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Reimbursable Advisory Services Agreement on the Bucharest Urban Development Program (P169577)

## **COMPONENT 1. ELABORATION OF BUCHAREST'S IUDS, CAPITAL INVESTMENT PLANNING AND MANAGEMENT**

**Output 3. Urban context and identification of key local issues and needs, and visions and objectives of IUDS and Identification of a long list of projects.**

### **Chapter 5. Public utilities**

March 2021



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## ABREVIATIONS AND ACRONIMS

AIHC	Henri Coandă International Airport
ALU	Active Local Units
ANAF	National Agency for Fiscal Administration.
ANRSC	National Regulatory Authority for Community Services of Public Utilities
AROPE	A composite indicator adopted at European Union level
BPO	Business Processes Outsourcing
CBD	Central Business District
CFR	Romanian Railways
CLLD	Community-led local development
CMMTB	Bucharest Traffic Management Municipal Enterprise
COR	Romanian Classification of Occupations
DGASMB	Bucharest General Directorate for Social Assistance
DGASPC	and the Bucharest General Directorate for Social Assistance
DGASPC	General Directorates for Social Assistance and Child Protection
EDN	Electricity Distribution Network
EU	European Union
EUROSTAT	Statistical office of the European Union.
FDI	Foreign Direct Investment
FUA	Functional Urban Area
GDP	Gross Domestic product
GVA	gross value added
HORECA	Hotel/Restaurant/Catering
ICT	Information Communication and Technology
INSSE/INS	National Institute of Statistics
IT	Information Technology
IT&C	Information Technology and Communication
IUDP	Integrated Urban Development Plan
IUDS	Integrated Sustainable Urban Development Strategy
JICA	Japan International Cooperation Agency
LAG	Local Action Group
MPWDA	Ministry of Public Works, Development and Administration
MRDPA	Ministry of Regional Development and Public Administration
NACE	Nomenclature Statistique des Activités Économiques dans la Communauté Européenne
NBR	National Bank of Romania
NGO	Non-Governmental Organization
NIS	National Institute of Statistics
NTRO	National Trade Register Office
NUTS	The common classification of territorial units for statistics
PHC	Primary Health Care
PMB	Municipality of Bucharest
PUG	General Urban Plan
RDI	Research, Development, Innovation

ROP	Regional Operational Programme
SCB	Strategic Concept Bucharest
SME	small medium enterprises
SUMP	Sustainable Urban Mobility Plan
TAU	Territorial administrative unit
UDP	Urban Development Plan
UMA	Urban Marginalized Areas
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNICEF	United Nations Children's Fund
VAT	Value Added Tax
WWTP	Wastewater Treatment Plant

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# 1. WATER SUPPLY

## 1.1. Institutional issues regarding the water supply and sewage system

In 2020, Apa Nova Bucharest, part of the Veolia Group, won by public tender, the 25-year concession for the Bucharest water supply and sewerage services. The concession contract requires the operator to meet 24 “Performance levels”. The operator makes, directly from its own funds, investments regarding the modernization of production facilities, of pumping stations, the rehabilitation, modernization and extension of water supply and sewerage networks (including replacement of water connections) - the value of these investments being about EUR 400 million in the period 2000-2017. However, the company cannot access non-reimbursable funds, which is why large infrastructure projects (e.g. extension of the Glina treatment plant, rehabilitation of the drainage system of Tineretului, Titan and Carol lakes, rehabilitation of sewer collectors, construction of the drainage system etc.) were/are made by the Municipality of Bucharest, by accessing European funds.

In parallel, the Municipality of Bucharest (PMB), as the owner of the water supply and sewerage infrastructure, can also start projects aimed at expanding the networks. An example is the project “No unpaved streets without public utilities”, started in 2018, where PMB will make the network for rainwater harvesting, which is not an investment obligation for Apa Nova. At that time, PMB inventoried 270 non-modernized streets without public utilities in the Capital, most of them being located in Sector 1 (94), Sector 6 (77), Sector 4 (40) and Sector 3 (33), while in Sector 5 and Sector 2 were reported the fewest (11 in each). However, this list was to be updated with the help of the sector municipality and of the Street Administration. Later on, PMB took over from the sector municipality (e.g. Sector 1) part of these streets in order to carry out the actual works, but the stage of program implementation could not be determined exactly.

Tariffs for water supply and sewerage services are established through a mechanism that takes into account the evolution of costs and fees. The change of tariffs is done with the approval of the National Regulatory Authority for Community Services of Public Utilities (ANRSC), based on the concession contract and its addenda, as well as on the methodology for adjusting water tariffs in Bucharest, adopted by Government Decision.

Although the operator Apa Nova, unlike the regional operators in the country, makes significant investments from its own sources, the tariffs are lower than in 33 major cities in the country. However, the company also benefits from a high population density per km of network (second place nationwide, after Ploiești).

According to the concession contract no. 1329/29.03.2000 concluded between Bucharest City (as concession provider) and S.C. Apa Nova Bucharest S.A. (as a concessionaire), all components of the water supply system and of the sewerage system are taken over in concession by S.C. Apa Nova București S.A., respectively:

- For the water supply system: raw water transmission mains, water treatment plants, water supply network (water transmission mains, tanks, pumping stations, distribution network).
- For the sewerage system: wastewater box, sewers, service canals, wastewater pumping stations, sewerage treatment plants.

## 1.2. Water supply sources

The Bucharest Municipality area includes the largest drinking water deposit in the country, the Bucharest Multilayer Aquifer. It includes a shallow aquifer (Colentina Aquifer - 2-15 m deep, 5-10 m thick, interdependent with the surface water bodies Colentina and Pasărea), medium depth aquifer (Mostiștea Sands - 3-30 m thick) and the deep aquifer - Frătești Formation (multilayer aquifer - A, B, C). Because of the low water quality, the consumption from the Colentina aquifer is low, the water table not meeting the criteria for drinking purposes.

Moreover, it is considered that the surface aquifers (Mostiștea and Colentina) in the area of Bucharest City were degraded as a result of the pollution caused by industrial and agricultural activities in the municipality's area of influence, and the massive exploitation of the Frătești aquifers, until 1990, also led to significant changes in the water quality. Although industrial activity declined after 1990, the negative impact on groundwater quality continued because of inadequate drilling, uncontrolled waste storage or the lack of a functional treatment plant. However, the problems of quality degradation appear only locally (loading with ammonium and phosphate, iron), the groundwater from the Frătești strata being used in public spaces, but also for the supply of several households or economic agents from other areas.

According to the Master Plan for the Water Supply and Sewerage Service in Bucharest City, as a result of the continuous degradation of groundwater quality, the use of city wells and of those related to underground fronts (862 drillings in Bragadiru, Arcuda, Ulmi and on the territory of the municipality) is stopped, the capacities being put into conservation. However, the Master Plan recommends, in the future, the construction of new wells in the catchment fronts from Ulmi and Arcuda to ensure a flow of 0.63 m<sup>3</sup>/s, as well as the construction of 35 new wells in Bucharest, evenly distributed within the city's surface, to ensure the water supply for the population in case of need (for example, massive pollution of surface waters).

Thus, the main water sources of Bucharest City remain the Argeș and Dâmbovița rivers, the raw water being caught from the Dâmbovița river through the Brezoale water intake, and from the Argeș river through the Crivina water intake. According to the data provided by Apa Nova Bucharest, investments are needed for both water intakes: rehabilitation of the dam system at the Brezoale intake (Dâmbovița river) and continuation of the gates rehabilitation program and maintenance in accordance with safe operation measures in the case of Crivina water intake (Argeș river). According to INSSE data, the capacity of water production facilities in Bucharest City is very high in relation to the current consumption (below 500,000 cubic meters), being between 1.5 and 1.43 million cubic meters per day in the period 2008-2018 (see the table below).

**Table 1: Evolution of capacity of water production facilities in Bucharest City (2008-2018)**

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Water production facilities capacity (millions m <sup>3</sup> /day)	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.43	1.43	1.43	1.43

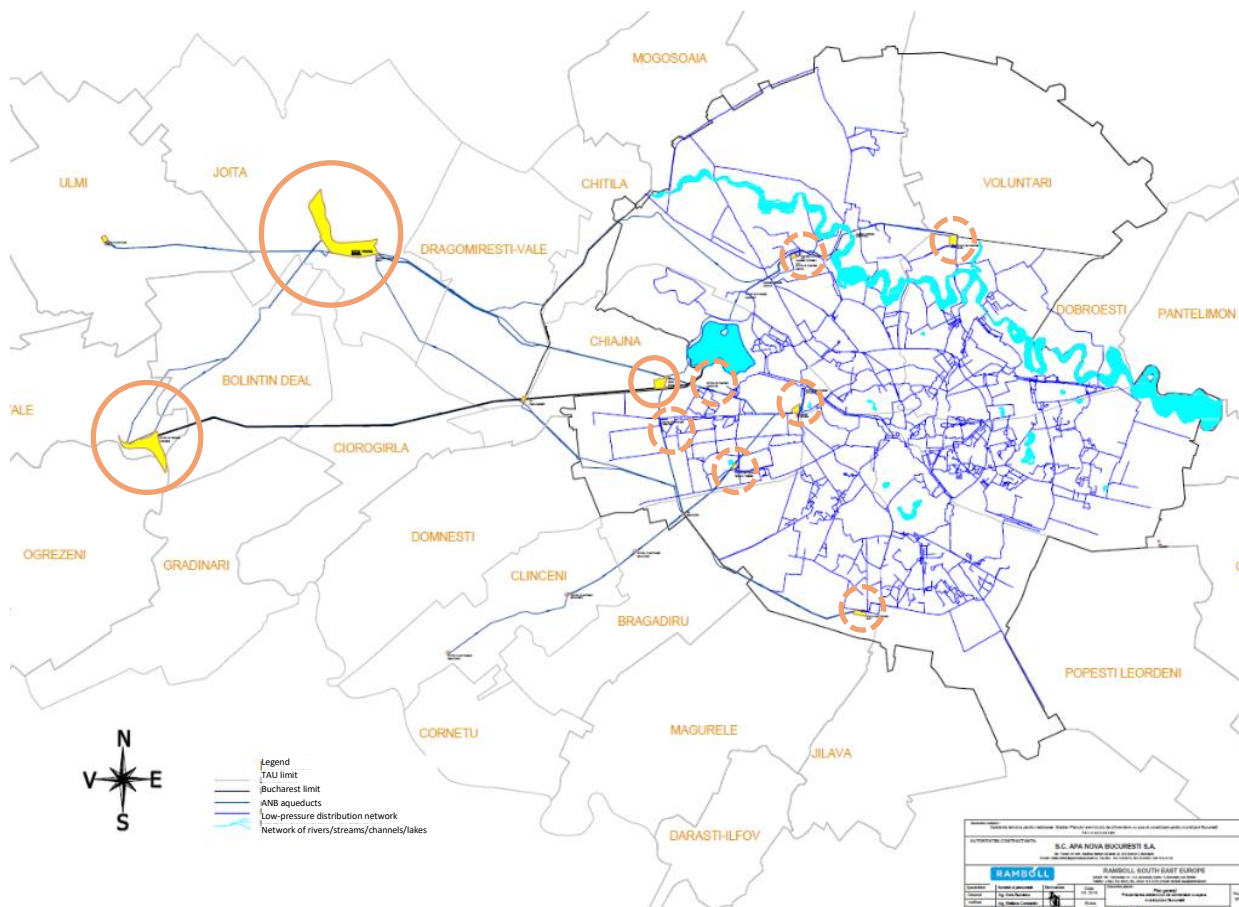
Source: INSSE – Tempo Online

The drinking water supply is ensured by three raw water treatment plants for the water transmitted from the aforementioned water intakes, with a total nominal capacity of 1,430,000 m<sup>3</sup>/day: the Roșu plants (520,000 m<sup>3</sup>/day, the only drinking water treatment and production plant on the administrative territory of Bucharest City), Arcuda (750,000 m<sup>3</sup>/day according to the data from Apa Nova, 650,000 m<sup>3</sup>/day according to the Master Plan – the biggest treatment plant in the country) and Crivina

(built in 2006, nominal capacity of 260,000 m<sup>3</sup>/day). The Roșu and Arcuda stations are old (45 and 145 years, respectively), but they have benefited from modernizations after 2011. Currently, the Arcuda station ensures about 2/3 of the Bucharest drinking water consumption, the Roșu station about 25 %, and the Crivina station, even if it is the newest, only 8 %. It should be mentioned here that the higher share of water produced at the Arcuda Station is due to the fact that it has a gravitational technological flow, which means that it can treat water even in the absence of electricity, with a range of about 12 hours. In addition, it is equipped with its own high-capacity generator. The fact that the share of Roșu Station is ranked on the 2nd place is related to the fact that it is located closer to the city and is more efficient in regulating (by decreasing or increasing) the volume of water transmitted to tanks, having a vital role in unforeseen situations (e.g. failure, fires, etc.). All stations disinfect the raw water by chlorination, to ensure its potability along the distribution network, but in the case of the Crivina station, ozonation is also used.

These water treatment plants are supplied with raw water through about 83 km of water transmission mains (according to the 6). Two of these water transmission mains are in conservation (Ulmi-Arcuda I and Ulmi-Arcuda II – being related to groundwater intakes from Ulmi), and two others are damaged (Crivina-Arcuda I and Crivina-Arcuda II). In the future, two raw water transmission mains will have to be made: one between the Brezoeale intake and the Arcuda treatment plant (closed canal, to prevent contamination from the adjacent area of the Brezoeale mains - Joița bridge), and one between the Polder Crivina intake and the Crivina treatment plant. Upstream of the Arcuda treatment plant, a pollution alert station is needed, similar to the one already existing on the Argeș River.

**Figure 1: Bucharest water supply system: drinking water treatment plants and pumping stations**



Source: Master Plan for the Water Supply and Sewerage Service in Bucharest City. Circle, continuous line – water treatment plants Circle, dotted line – pumping stations

Another potential dysfunction is the expansion of buildings in the lagoon area where the sludge from Roșu treatment plant is discharged. Thus, it is necessary to modernize the sludge separation system and the evacuation of clean water into Dâmbovița river, in order to avoid the clogging of Morii Lake over time. For this, it is necessary to cooperate with the Romanian Waters National Agency and with Chiajna TAU, since on the platform of the Roșu drinking water treatment plant it is not possible to manage the sludge, because of lack of space (according to the Master Plan). Another dysfunction in the case of the Roșu treatment plant is represented by the chlorine facility, which presents a high risk because of the constructions built in the meantime in the neighboring area.

Another important aspect to mention here is the fact that these treatment plants also ensure the consumption needs of some cities and communes in Ilfov County, which are attached to the capital (Voluntari, Popești Leordeni, Otopeni, Chitila, Chiajna, Bragadiru, Pantelimon, Glina, Dobroești).

From the 3 treatment plants, the drinking water is transported through 22 aqueducts (about 192 km long), which represent the drinking water transmission mains networks, to 20 municipal storage tanks, with a total storage capacity of 359,000 m<sup>3</sup>. Of these aqueducts, the A1 water transmission mains (Arcuda - Cotroceni I) is in conservation status until the Roșu station (built in 1888, made of brick), and the A9 water transmission mains (NH Bragadiru - Drumul Taberei, built in 1975, of concrete tube) is partially under consolidated (according to the Master Plan).

Almost half of the tanks (9, of which 8 functional - 99,000 m<sup>3</sup> total volume) are located in Cotroceni, the others being located at the pumping stations (2-Grivița 50,000 m<sup>3</sup>), Nord (3-125,000 m<sup>3</sup>), Sud (4-81,000 m<sup>3</sup>), Drumul Taberei (2-30,000 m<sup>3</sup>) and Precizia (1-1,500 m<sup>3</sup>). For the Cotroceni tank complex there is an ongoing study to identify solutions for optimizing the stored volume. Currently, the tanks in the 7 pumping stations are supplied according to the capacity and the average consumption in those areas. However, they have a minimum safety threshold of 160,000 cubic meters of drinking water (about 45 % of the total storage capacity), which is activated only if the power supply of the Roșu station is interrupted, simultaneously with the failure of one of the 7 pumping stations. The energy range of the tanks is 6 hours, being ensured by generators.

Along with the development of the treatment capacities, the progressive development of water transmission mains was achieved, so that today the Roșu and Arcuda stations are connected to all tanks by at least two transmission systems (according to the Master Plan).

In addition to the water supply system for the population, Bucharest also has a system for providing industrial water, with the Pantelimon intake still in operation, working at a reduced capacity of 15,000-28,000 m<sup>3</sup>/day (compared to a design capacity of 120,000 m<sup>3</sup>/day). The industrial water supply network has only 61.76 km currently active, with the consumers still in operation located at a great distance: Jilava, CHP Sud and Sere sticlărie (according to the Master Plan) - see the figure below.



### 1.3. Water supply systems

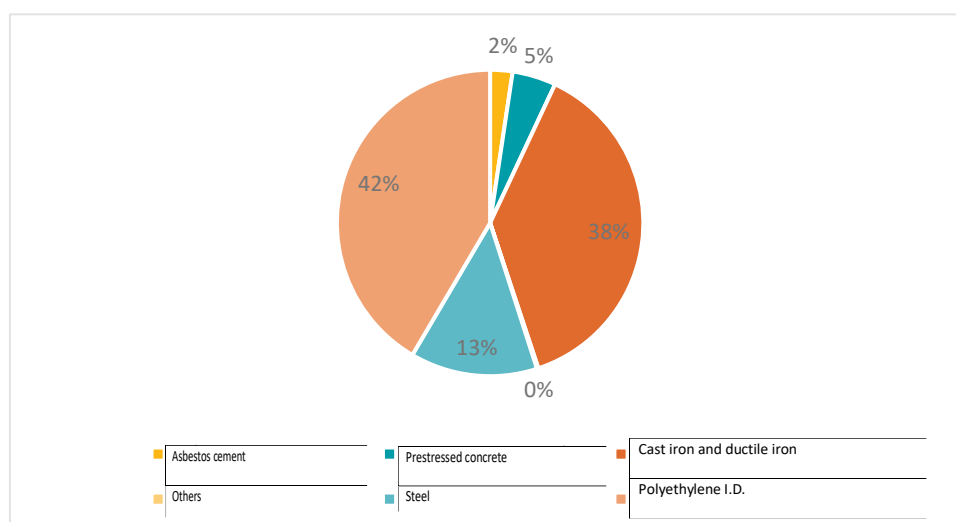
In addition to the 7 city pumping stations in operation (Nord, Grivița, Drumul Taberei, Preciziei, Uverturii, Grozăvești, Sud), the drinking water distribution system consists of 29 functional pumping stations (40 in total) and 108 functional hydrophore pumping stations (200 in total), which allow to raise the pressure in tall buildings (higher than GF+4) in the areas where they are located. They are interconnected in a ring network with several power supplies, which increases the level of security of supply. All pumping stations have been rehabilitated after 2000 (according to the Master Plan), but investments are still needed in order to increase the energy efficiency of the pumps. It is also recommended to build and put into operation a new station in the eastern part of Bucharest, which will supply water to consumers currently served by pumping stations.

In 2018, the drinking water simple distribution network was 2,513.3 km long in Bucharest, according to INSSE data, which differs insignificantly from the data provided by the Geographic Information System of Apa Nova. The latter indicates (also for 2018) a length of 2,567 km for the transmission and distribution pipes of (of which 670 km represent the transmission pipes and 1,897 km the distribution pipes), to which were added 912 km of connections (a total of about 132,000) .

The evolution of the drinking water distribution network was marked by important extensions in the period 2008-2018 (+309 km, in absolute terms, + 14%, in percentages, respectively), achieved especially with the beginning of the Bucur program for water and sewerage network extension, in 2009. The program started with the signing of the addendum no. 6 to the concession contract no. 1329/29.03.2000, concluded between Bucharest City (as concession provider) and S.C. Apa Nova Bucharest S.A. (as concessionaire) regarding the provision of water supply and sewerage services for Bucharest City. The addendum provided for the concessionaire's obligation to make, from its own funds, investments worth RON 200 million for the extension of the water and sewerage network in Bucharest until 2025, respectively 243 km of water network and 210 km of sewerage network.

The distribution network consists of about 682 km of main pipes (250-1,000 mm diameter), the rest being distribution pipes with a diameter below 225 mm. The material analysis indicates that 38 % of the network (approximately 970 km) is still made of cast iron and ductile iron, while 42 % (1,066 km) is a newer or modernized network made of polyethylene (see figure below).

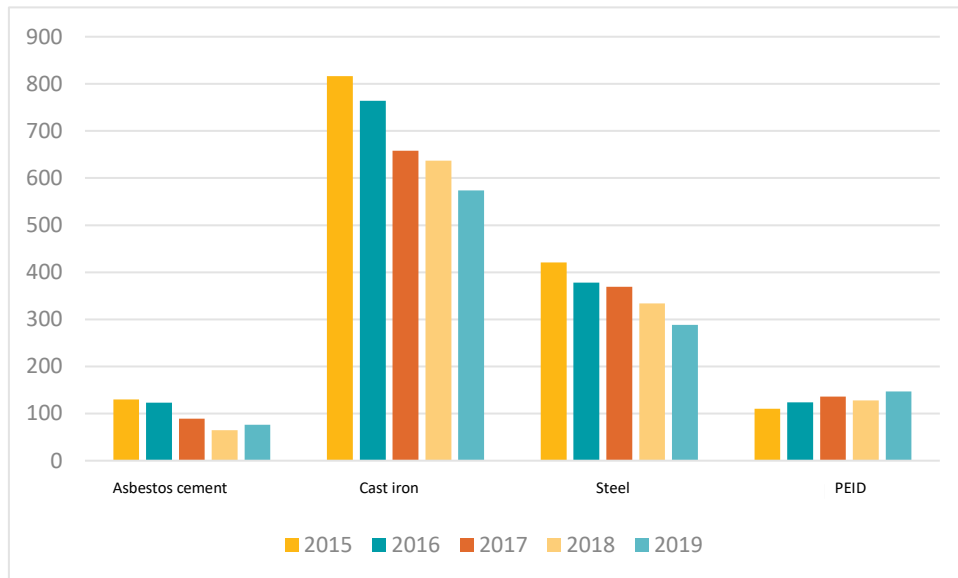
**Figure 3: Structure of the drinking water distribution network for Bucharest City, according to the pipe material, in 2018**



Source: Data processed from Apa Nova digital map

About 34 % of the distribution network consists of pipes over 50 years old, which should urgently enter a rehabilitation program. Thus, water distribution is ensured by 526 km cast iron pipes older than 50 years, especially in the central area of the city. The reduced transmission sections of these pipes, caused by deposits, cause problems related to water quality, reduced transmission capacity and numerous failures. In fact, in the period 2015-2019 there were 3,449 failures (about 54 %) on cast iron distribution pipes (see figure below). Most of the cast iron pipes are located in the central and northern area of Bucharest, but also in the Bucharest-Noi, Drumul Taberei, Berceni and Titan neighborhoods. However, in the same period the total number of failures on the distribution pipes decreased by about 26 %, from 1,477 in 2015 to 1,085 in 2019.

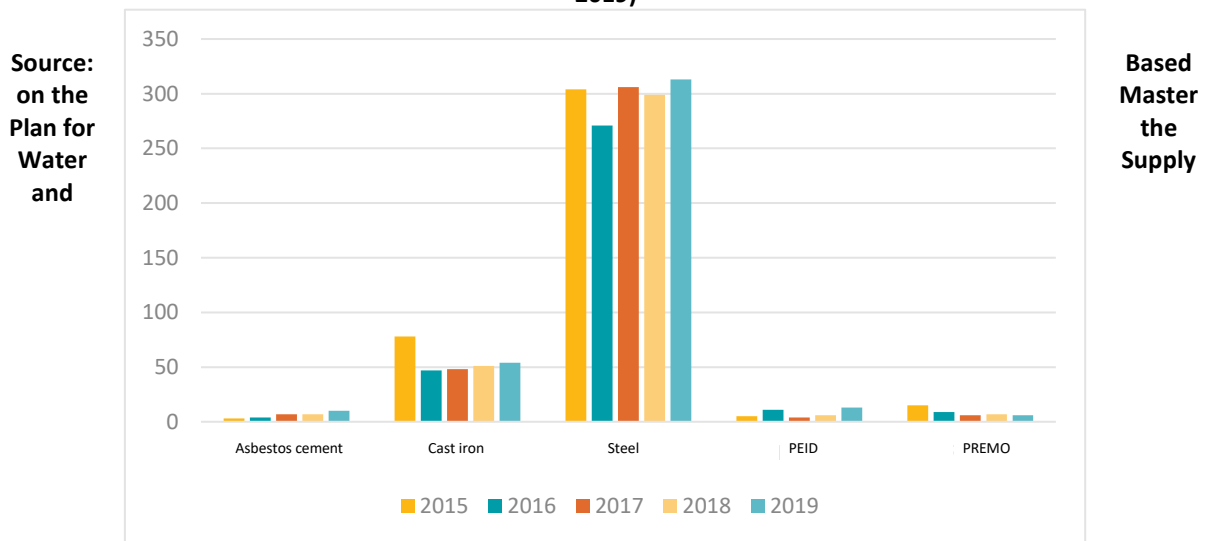
**Figure 4: Number of failures on distribution pipes, according to the type of material (2015-2019)**



Source: Based on the Master Plan for the Water Supply and Sewerage Service in Bucharest City

The situation differs on the arterial water mains, where most of the failures registered in the period 2015-2019 (1,493 failures – about 80% of the total) occur on steel pipes (according to the data from the Master Plan and those provided by Apa Nova - see figure below).

**Figure 5: Number of failures on arterial mains (transmission pipes), according to the type of material (2015-2019)**



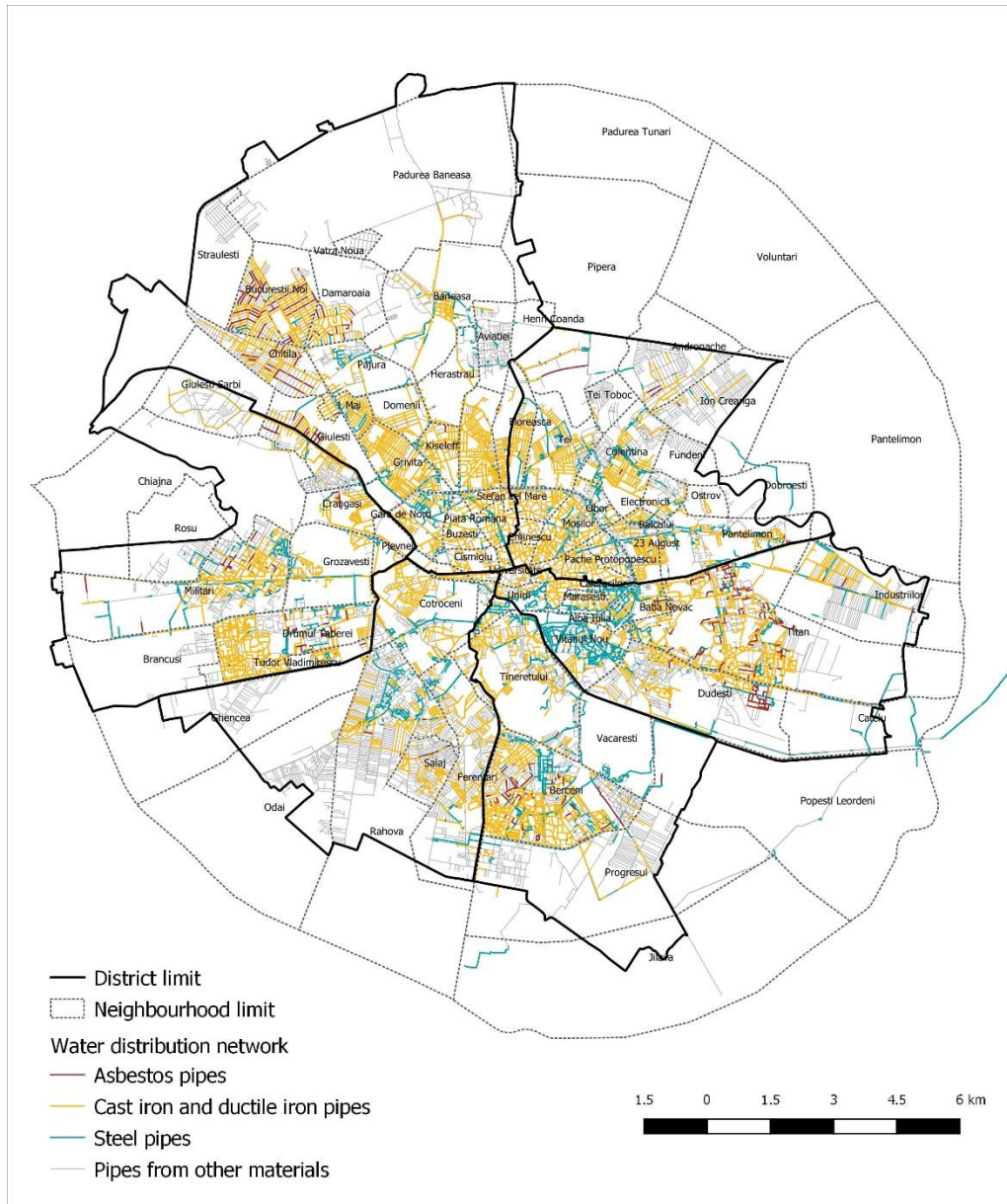
Source: on the Plan for Water and

Based Master the Supply

Sewerage Service in Bucharest City

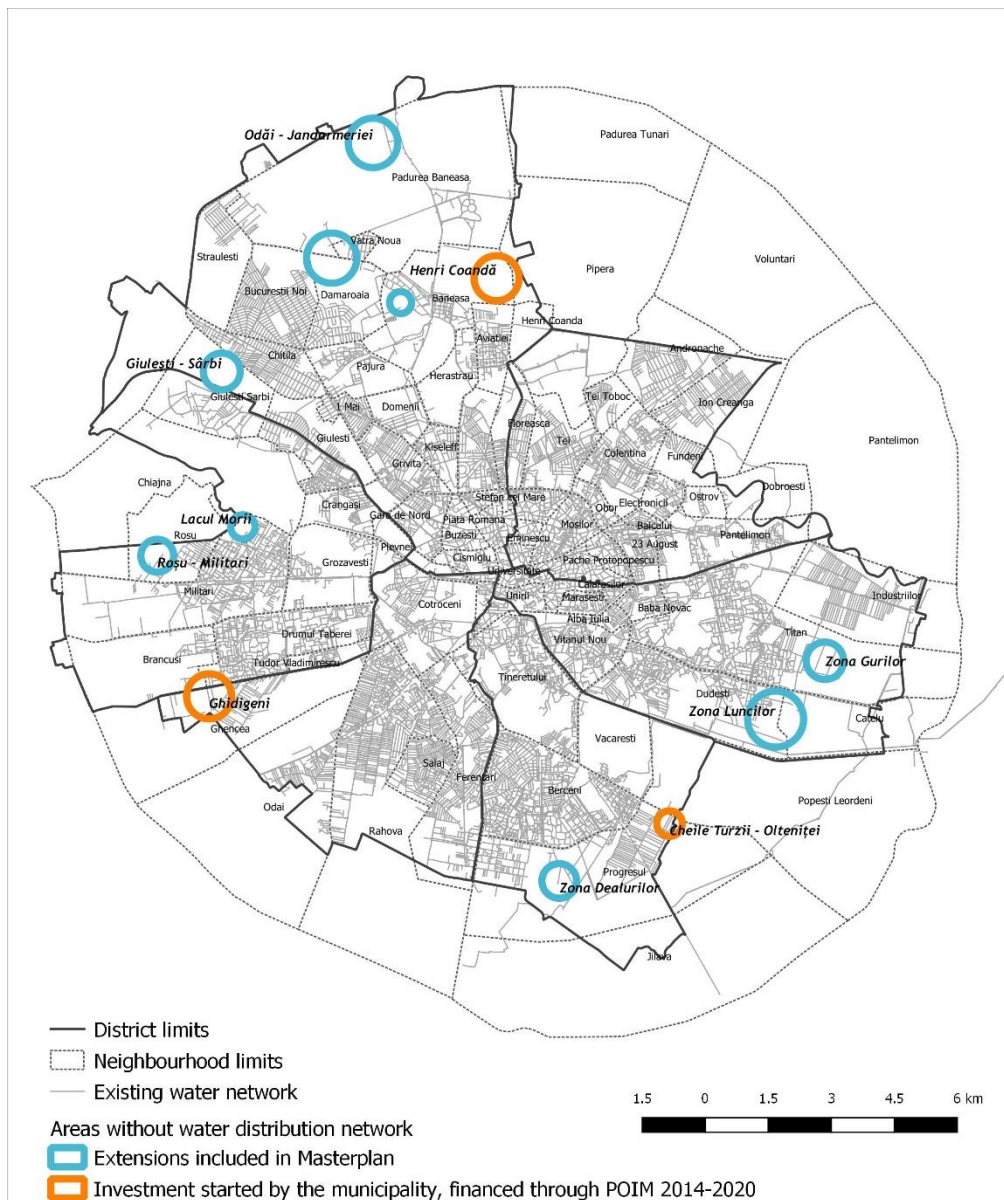
Therefore, over the time horizon of the Master Plan (30 years – 2047), it is recommended to resize/replace the drinking water distribution pipes made of cast iron (almost 1,000 km, in total), as well as to resize the steel drinking water transmission arterial mains. (Ring 1 area, Bd. Unirii, Splaiul Unirii, Calea 13 Septembrie, Vitan neighborhood, Bd. Pache Protopopescu, Șos. Iancului, Calea Griviței).

**Figure 6: Water supply network for Bucharest City – asbestos cement, cast iron, steel pipes**



Source: Processed from Apa Nova digital map

**Figure 7: Bucharest City areas without water supply network**



**Source: Processed from Apa Nova digital map**

It is to be noticed that there are still streets in Bucharest not served by the water supply network. These are especially larger areas, undergoing an urbanization process, located in Sector 1 (Henri Coandă , Giulești-Sârbi neighborhood), Sector 3 (Luncilor area – the area between Splaiul Unirii and Bd. Theodor Pallady), Sector 5 (Prelungirea Ghencea) and Sector 6 (Military – Roșu). Besides, the investment priorities from the Master Plan for providing water supply and sewerage services propose the extension of the water supply network in the areas located at the administrative limit of the municipality: Henri Coandă neighborhood (about 13 km), North area (Șos. Odăi – Șos. București-Ploiești – Str. Jandarmeriei – Șos. Ionescu-Sisești – Șos. București Târgoviște – about 60 km), Ghencea area (about 8 km), area of Străulești street (about 2 km), Morii Lake (about 2,5 km) and Giulești-Sârbi (about 7 km). Also, the Master Plan considers to extend the distribution networks for drinking water supply in the Luncilor areas (between Theodor Pallady and Splaiul Unirii – 18.8 km proposed network and construction of a pumping station), Gurilor (north of Bd. Theodor Pallady - 19.5 km proposed network and construction of pumping station), Dealurilor (near CHP Progresul – 9.7 km proposed

network and construction of pumping station) and Ghidigeni (Prelungirea Ghencea – extension of distribution network by 1.7 km and rehabilitation of aqueducts 3,3 km).

Some of these investments have already been started. In 2019, the budget approved by the General Council of the Capital included works to expand the networks, including water supply and sewerage, in the Henri Coandă neighborhood (lots I and II). Amounts for this objective are also provided in the budget for 2020, along with the extension and rehabilitation of networks in the areas of Ghidigeni, Olteniței, Cheile Turzii. For these investments PMB attracted EUR 68 million financing from European funds, through LIOP 2014-2020.

Asbestos cement pipes are also a problem, as asbestos cement is a material that must be replaced and removed from the site, according to the rules in force. Since 2005, 80 km have already been replaced, and today 66 km still need to be replaced, which will be done gradually by 2025 (according to the Master Plan). Most of the remaining asbestos cement pipes are located in the area of Șos. Chitilei – Bucureștii Noi, but also in parts of the Titan, Berceni or Militari neighborhood.

According to Apa Nova statistics, presented in the Master Plan for the Water Supply and Sewerage Service in Bucharest City, most failures occur at connections (62 %), followed by service pipes (30 %) and main pipes (arterial mains) – with 8 % of the number of failures.

**Figure 8: Localization of failures (left) and of complaints regarding the improper quality of drinking water (right) in Bucharest**



**Source: Master Plan for the Water Supply and Sewerage Service in Bucharest City**

The figure above illustrates the fact that most of the failures are concentrated in the central area of Bucharest, being closely related to the arrangement of cast iron distribution pipes, and if steel transport pipes, respectively.

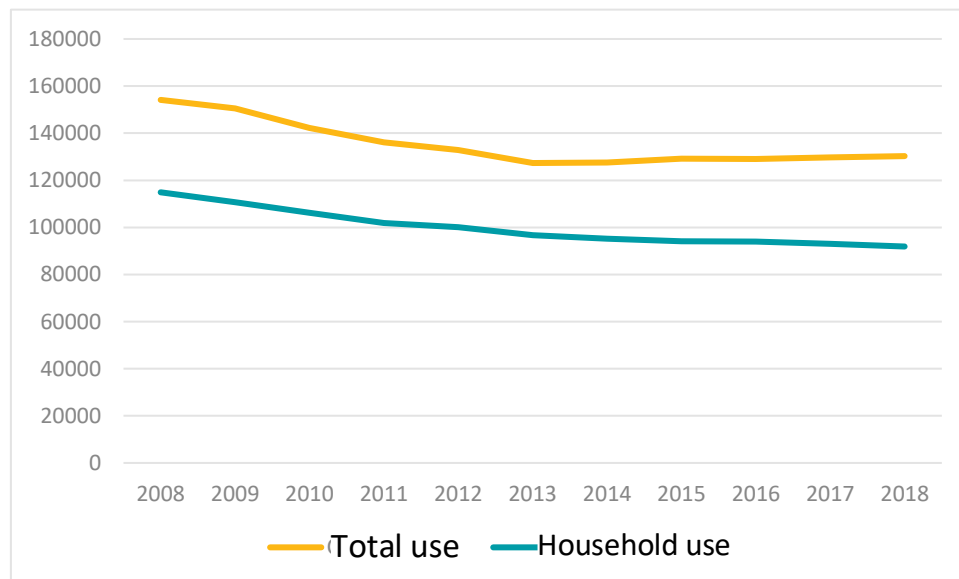
The long-term investment plan (part of the Master Plan for the Water Supply and Sewerage Service in Bucharest City) proposes the resizing of pipes with small diameters (<300 mm), as follows:

- Asbestos cement pipes, L = 60.7 km;
- Pipes more than 80 years old, L = 298 km;
- Pipes more than 50 years old, L = 276 km;
- Pipes more than 30 years old, L = 563 km.

It is also proposed to resize the distribution network pipes, namely the large diameter steel pipes (total length – 221.8 km). Therefore, in order to reduce water losses and increase the network efficiency, it is necessary to resize 1,419.5 km of water supply network (about 55 % of the existing network - transmission and distribution pipelines).

The graph below illustrates the evolution of water consumption in Bucharest, in the period 2008-2018. Note that, during the analyzed period, there was a constant decrease in water consumption, in 2008 it was about 130 million cubic meters (decrease by about 24 million cubic meters compared to 2008 - about 15 %). During the same period, the water consumption for household use decreased by about 20 %, reaching the level of almost 92 million cubic meters (about 43 cubic meters/inhabitant/year), while the non-household water (companies, institutions, etc.) decreased by only 2 % . .

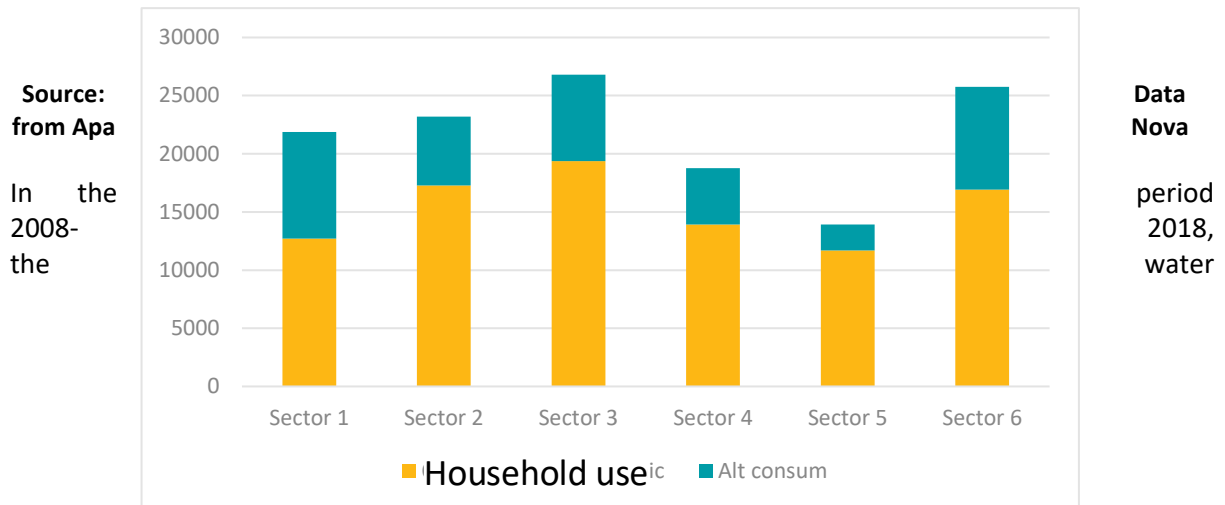
**Figure 9: The evolution of water consumption in Bucharest (thousands of cubic meters, 2008-2018)**



Source: Data from Apa Nova

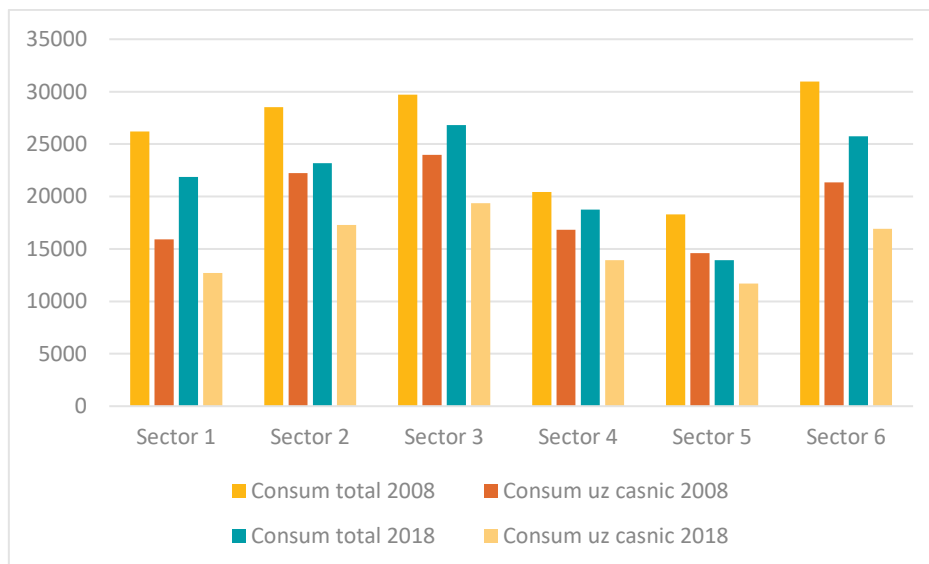
The decrease in consumption can be explained by the increase in the efficiency of the distribution network (continuous decrease in the volume of water lost). Thus, the average water consumption decreased from 161 liters/inhabitant/day to 148 liters/inhabitant/day (according to the Master Plan). The efficiency of the network, expressed as the ratio between the billed water and the water introduced in the network, is currently about 77 %, according to the data from Apa Nova, which ranks Bucharest's water supply network in the first places in the country, in terms of efficiency. In fact, the efficiency of the network increased considerably compared to 2000, when it was only 51 %.

**Figure 10: Water consumption in the sectors of Bucharest (thousands of cubic meters, 2018)**



consumption for non-household consumers increased as a share of the total consumption, from about 25 % in 2008 to almost 30 % in 2018. There is a lower share of household water consumption, especially in sectors 1 (about 60 %) and 6 (about 69 %), while in sectors 4 and 5 the share of household consumption is the highest – see figure above. Also, the evolution of water consumption in the sectors of Bucharest illustrates the decreasing trend of total consumption and household consumption (about 20 % on average) for all sectors. However, sectors 3 and 4 show increases of around 30 % in the non-household water consumption.

**Figure 11: Evolution of water consumption, by types of consumers, in the sectors of Bucharest (thousands of cubic meters, 2008-2018)**

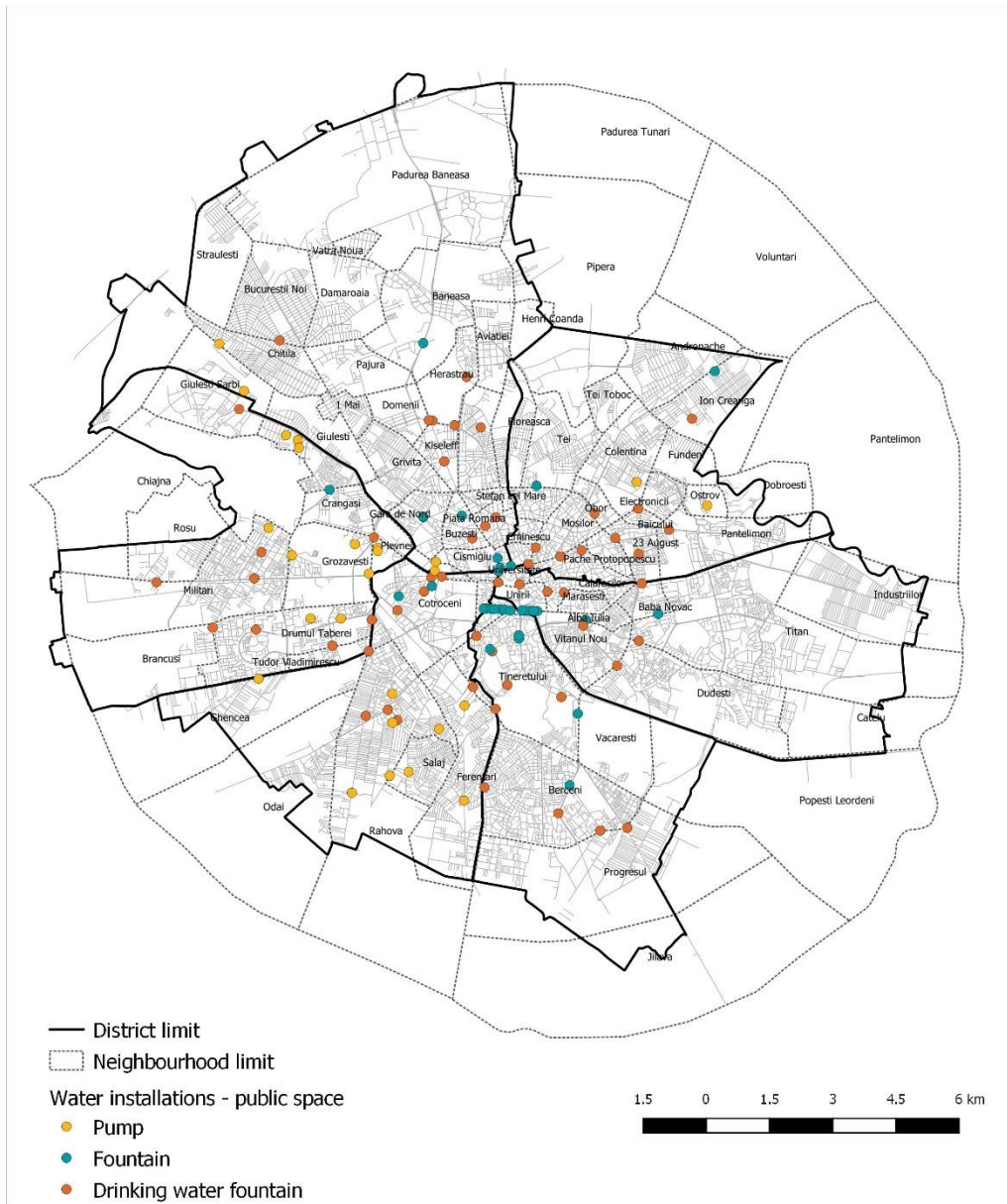


Source: Data from Apa Nova

The analysis of water age (the duration of water flow between tanks and consumers) reflects the fact that for a large part of the network the values are of over 8 hours (downtown Bucharest, Giulești-Sârbi and Titan neighborhoods), and even over 12 hours, in areas such as Bd. Theodor Pallady, Apărătorii Patriei or Timpuri Noi). High water age values are determined by the low flow rate, which is below 0.5 m/s at maximum flow and below 0.2 m/s at minimum flow (provided only for 3-6 hours/day). The eastern part of Bucharest is the most affected by the high water age, as it is the furthest from the

water entry points (and from the points where water chlorination is performed) in the supply system, which are located mainly in the west/northwest of the city.

**Figure 12: Water facilities in the public space**



**Source: Processed from Apa Nova digital map**

The degree of connection of the population to the water supply service increased from 82.3 % in 2011 to 92.3 % in 2016, according to data from Apa Nova Bucharest. For 2018, the INS data indicate a number of 1,771,000 Bucharest residents served by the drinking water supply system, an increase by 71,000 (+ 4.2 %) compared to 2008. Representing 96.8 % of the resident population of the Capital on July 1<sup>st</sup>, 2018. The results of the 2011 census mentioned that 98.5 % of the households in the Capital were connected to the centralized water supply system (either in the house, or in the residential building or in the yard), 1.1 % had their own water supply system (e.g.. hydrophore in a well dug in the yard), while only 0.3 % (i.e. just over 2,900 households) did not have access to drinking water. Therefore, the figures vary depending on the source and the percentage is difficult to establish in the absence of a clear record of the actual number of Capital's inhabitants. Still, most likely over 99 % of them have access to drinking water from the public network, the census data being the most plausible because they are relatively exhaustive.

According to the data from the digital map provided by Apa Nova Bucharest, there are 17,461 hydrants in the city, that cover the entire territory currently served by water supply networks. Also, in Bucharest there are 115 water facilities in the public space – pumps (26), public fountains (33) and drinking fountains (56), most of them being located inside the first traffic ring. However, the number of facilities is very small for a city the size of Bucharest: it would be necessary to expand this type of facilities, both to increase the thermal comfort in public spaces during the summer (the case of public fountains), especially in the context of identifying large urban heat islands, as well as to ensure easy access to drinking water in public space.

If we take into account the global perception on the water supply and sewerage system in Bucharest, the results of the sociological questionnaire applied to substantiate IUDS indicate that the lack of individual metering for water and sewerage is considered a problem by only 3.6 % of the respondent population (rank 9/11 of problems), while the lack of connection to public utilities (gas, water, sewerage, heating) is a problem for only 3.1 % of the population (rank 10/11 of problems). However, the quality of drinking water received a score of only 6.53 out of 10 in terms of satisfaction of the population related to various issues in Bucharest, occupying a medium position among the issues assessed by respondents. The cold water pressure was considered to be a positive aspect by the respondents to the questionnaire, receiving a score of 8.53 out of 10.

## 2. SEWERAGE NETWORKS

### 2.1. Sewerage systems

In Bucharest, the collection of wastewater and meteoric water is done through a network of service canals and sewers. The wastewater box culvert, the general collector, is located under the landscaped bed of the Dâmbovița River, has a length of 17.6 km (from Morii Lake to Glina Wastewater Treatment Plant) and takes over the wastewater and meteoric water brought by the 12 main collectors and 12 secondary collectors. Total length of collectors is about 118 km. Due to the low flow rate (under 0.7 m/s), the minimum self-cleaning speed cannot be ensured on all collectors (in dry weather), thus it is necessary to identify solutions for their periodic hydraulic washing (according to the Master Plan).

According to the data provided by Apa Nova, the sizing of the box culvert was done considering a collection area and a degree of waterproofing characteristic for the development perspective of 40 years ago (about 1 million inhabitants served – distributed over 5,000 ha, compared to 2 million and 20,000 ha currently), as well as a flow corresponding to a rain with a frequency of 1:3, falling uniformly on the territory of the city. Thus, in the area of Piața Unirii, the box culvert allows a flow of about 30 m<sup>3</sup>/s. Therefore, complex work will be needed to ensure a better functioning of the wastewater box culvert – first of all, adapting it to a calculation frequency of 1:10 in case of rains. The problem of rainwater drainage is accentuated by the high degree of waterproofing found on the territory of Bucharest (about 80 %).

The sewerage system is based mainly on gravitation, being mostly unitary/mixed (both wastewater and meteoric water are collected in the same system). In low-lying areas or at the ends of collection basins, there are 68 small pumping stations that transport wastewater to collectors. As far as they are concerned, significant malfunctions may occur in case of heavy rains or power outages – only the Colentina and Progresu wastewater pumping stations have a dual power supply (according to the Master Plan).

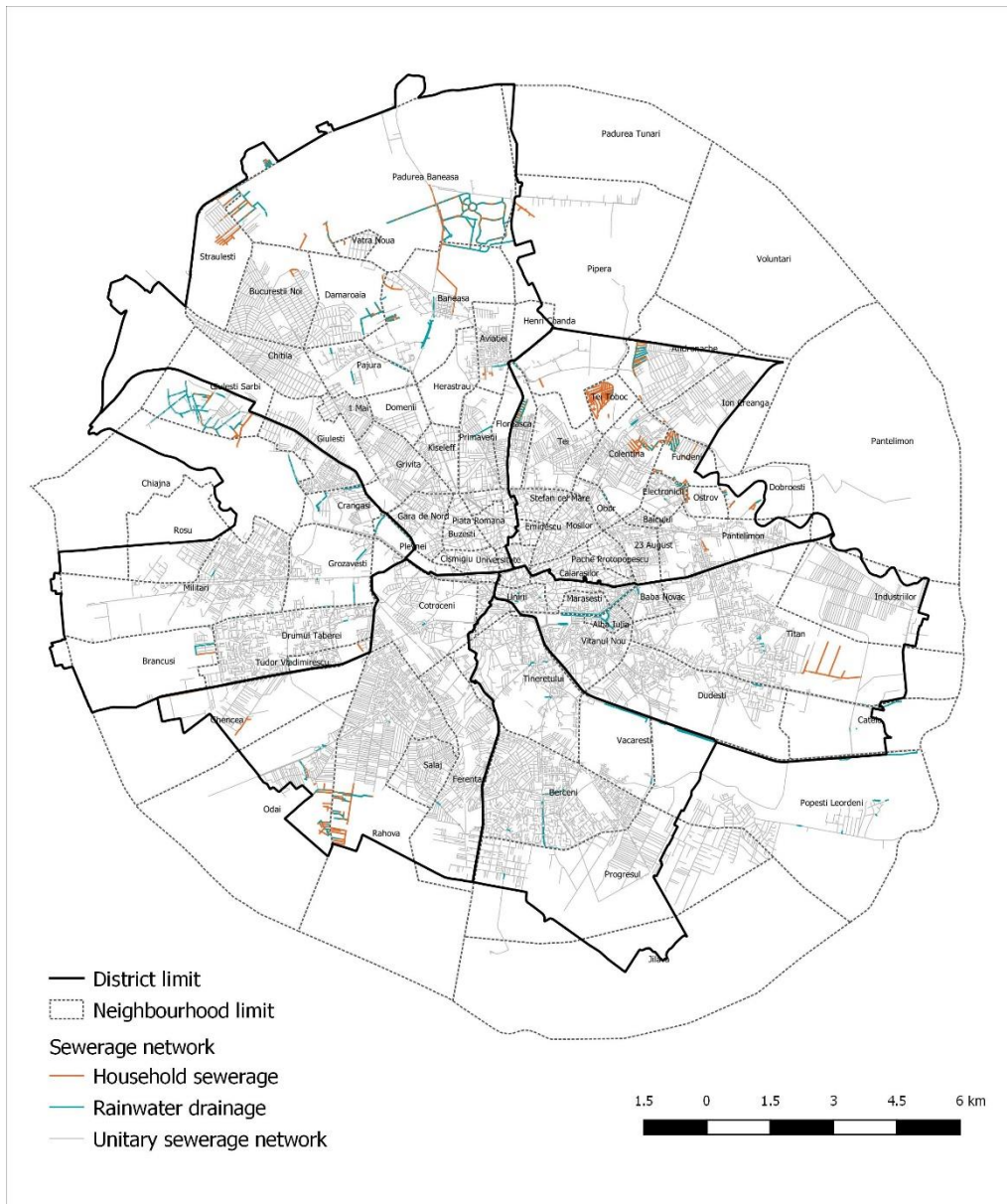
The data from the geographical information system of Apa Nova indicate a total length of the sewerage network, in 2018, of 2,469 km, to which are added approximately 930 km related to the 126,000 connections (including the Apa Nova network on the territory of Popești-Leordeni). Of this length of the network there is a separate rainwater collection network along only 89 km (3.61 % of the network), and the separate domestic water collection network is currently only 78 km long (3.16 % of the network). Therefore, about 93 % of the sewerage network in Bucharest operates in unitary mode. To the pipes are added about 51,000 drains, 67,000 inspection chambers, as well as 46 hydrocarbon separators, located mainly in the Petricani area.

The separate network for collecting rainwater and domestic water had been developed either in older areas, where the expansion of sewerage networks was done in a separate system (Andronache, Tei-Toboc, Fundeni, Giulești-Sârbi neighborhoods), or in more recent developments (Brâncuși, Străulești neighborhoods, Șos. Bucharest-Măgurele). There are also several important arteries where a separate rainwater collection network has been set up: Bd. Unirii Boulevard (partially), Bd. Decebal, Bd. Burebista or Bd. Constantin Brâncoveanu.

The unitary system of the Bucharest sewerage network represents an important dysfunction, since it puts pressure on the main collector system, especially considering the amplification of extreme phenomena (torrential rains – climate analyses reveal the increase of intensity of these rains in the last 30 years). The risks generated by the impossibility of taking over the flows of meteoric waters in case of heavy rains were aggravated by the increase of the impermeable surface in Bucharest City and by the elements of underground infrastructure, which can be flooded in case of heavy rainfall.

Visitable collectors were designed during the communist period at 1:2 or 1:3 return probabilities, and the collectors parallel to the lakes on the Colentina River and the Dâmbovița River were designed at a frequency of 1:2. Otherwise, the sewerage system is designed for the 1:1 frequency, although the specific norms in force require the sizing of the sewerage network at a frequency of 1:10 for all towns with more than 100,000 inhabitants. Considering this, it is necessary to carry out the extension works of the network according to this norm, to make them exclusively of separate type, and to discharge the rainwater collected by the rainwater network in the nearest natural receiver (rivers and lakes). Also, the extended network must be resized according to the norm, simultaneously with the separate collection and the removal of rainwater from the system in critical areas up to a certain threshold.

**Figure 13: Sewerage network - separate network for collecting domestic sewage and rainwater**



**Source: Processed from Apa Nova digital map.**

The Master Plan envisages, in the long-term investment plan, the intervention in the case of critical areas, such as the passages in Bucharest (rehabilitation and modernization of rainwater drainage facilities in the underground passages Mărășesti, Lujerului, Jiu, Victoriei and Unirii). It is also proposed to build retention basins in the area of the parks Izvor (reservoir volume 11,000 cubic meters) and Opera (reservoir volume 15,000 cubic meters), as well as the landscaping of Văcărești Lake, with a view to store rainwater in the southeastern part of the city. In a broad sense, in addition to the investments made for the rehabilitation of the sewerage network, one can also study the possibility of using the Colentina valley (and the lake chain) as an emissary for rainwater collected in the northern part of the capital (after making separate systems).

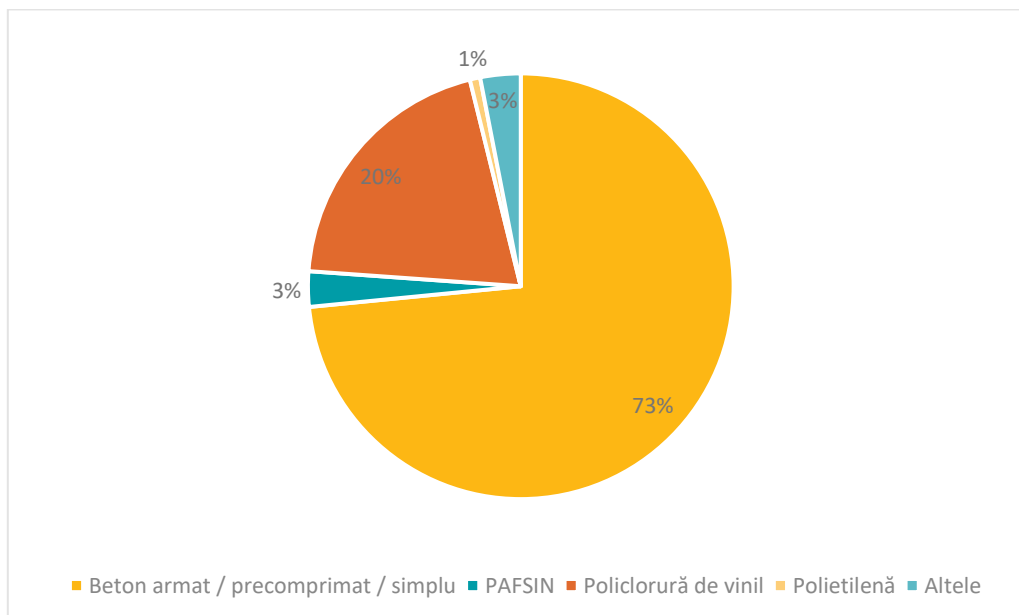
**Table 2: Length of sewerage network (sewers and service canals), types of materials**

Type of material	Length of the sewerage network (km)
Plain concrete	1807.67
Polyvinyl chloride	494.28
GRP-UP	66.31
Polyethylene	19.43
Steel	8.00
Reinforced or prestressed concrete	5.88
Polypropylene	2.38
Cast iron	1.29
Asbestos cement	1.19
Others	62.77

**Source: Processed according to data from the Apa Nova geographical information system**

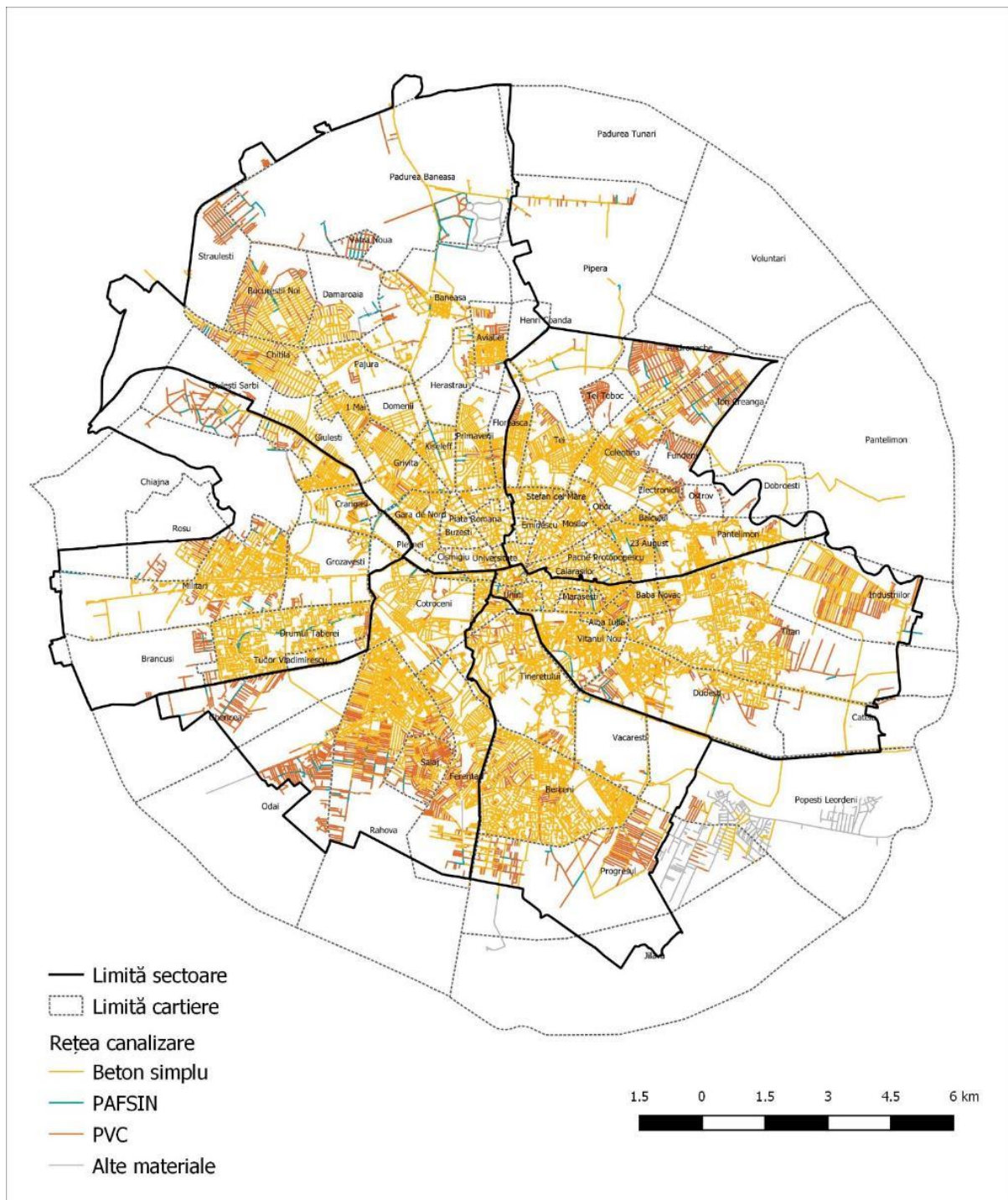
The table above and the graph below illustrate the situation of the sewerage network in terms of the materials from which the pipes are made (service canals and sewers). Thus, 73 % (1,813.55 km) of the sewerage network is made of plain concrete pipes (1,807.67 km) or reinforced or prestressed concrete. Only 3 % of the sewerage network (66.31 km) currently consists of GRP-UP pipelines.

**Figure 14: The share of different types of materials in the composition of the pipes in the sewerage system**



**Source: Processed according to data from the Apa Nova geographical information system**

Figure 15: Sewerage network – types of material: plain concrete, PVC, GRP-UP



Source: Processed from Apa Nova digital map.

As concerns the age of the sewerage network, the oldest materials are plain concrete (1,100 km of network more than 50 years old), followed by PVC (polyvinyl chloride) and cast iron (more than 40 years old). Thus, over 50 % of the sewerage network is in an advanced state of degradation, requiring frequent interventions to solve local problems (according to the Master Plan). The figure above shows the distribution of plain concrete pipes in Bucharest. As it can be seen, these pipes currently serve most of the central area and large residential areas. The newer pipelines, made of GRP-UP, are found only in isolated places in newer developments (Ionescu-Sisești - Vatra Nouă), in areas with recent

network extensions (Andronache, Ion Creangă, Odăi neighborhoods) or on boulevards where the network has already been rehabilitated (Drumul Taberei).

The long-term investment plan in the Master Plan provides for the resizing of large sewer collectors, approximately 100 km requiring rehabilitation works due to age and significant existing malfunctions. There is also a proposal to build new collectors: on Bd. Uverturii - Str. Orșova (southern area of Morii Lake, L = 1.5 km) and in the southern area (L = 9 km).

Other important intervention areas, where it is proposed to resize the existing sewerage network, are the areas of Cotroceni (replacement of about 6.5 km of concrete pipes), Regina Maria (replacement of 7.4 km of concrete pipes) and Tineretului (replacement of 1.6 km concrete pipes), but also the area of Slobozia street (Gramont plot), where new collectors are proposed (about 7.8 km), a bi-compartmental retention basin with a total volume of 9,300 m<sup>3</sup>, as well as a pumping station for emptying basins.

The analysis of the Bucharest areas that are not served by the sewerage network lead to conclusions similar to the analysis of the areas not served by water supply systems. The problems are concentrated in the area of Sector 3 located north and south of Bd. Theodor Pallady, but also in the northern area and in the Henri Coandă, Giulești-Sârbi neighborhoods or in the Prelungirea Ghencea area. To solve these problems, the following investments are proposed in the Master Plan:

- Building sewerage network of divisor type in Henri Coandă neighborhood: 12.6 km domestic sewerage network, unitary sewerage system L = 1524 and 10 km rain sewerage network (with retention and discharge basin in Valea Saulei River);
- Building a unitary sewerage system for taking over the domestic and rainwater wastewater from the Ghidigeni street basin - about 1.5 km;
- Extension of sewerage networks of divisor type in the north area (Sos. Odăi – Șos. București-Ploiești – Str. Jandarmeriei – Șos. Ionescu-Sisești – Șos. Bucharest Târgoviște): about 60 km of domestic sewerage network and about 67 km of rainwater sewerage network, with gravitational discharge towards Grivița lake and Nadeș pond;
- Extension of sewerage networks in the areas Luncilor (18.8 km of domestic network, 19.9 km of rainwater network), Gurilor (19.5 km of domestic network, 19.5 km of rainwater network), Dealurilor (9.7 km of domestic network, 15 , 5 km of rainwater network), Chitila (4.6 km unitary network), North right (9.7 km of domestic network, 6.9 km of rainwater network), Ghencea (7.8 km of domestic network, 7.8 km of rainwater network) ), the exit area to Mogoșoaia - Buftea (3.1 km of domestic network, 3.1 km of rainwater network), Morii Lake (2.6 km of domestic network, 2.6 km of rainwater network) and Giulești-Sârbi (6.9 km of domestic network, 6.9 km of rainwater network).

The expansion of sewerage networks is accompanied by the achievement of investment objectives such as wastewater pumping stations, retention basins, rainwater pumping stations or pre-treatment plants.

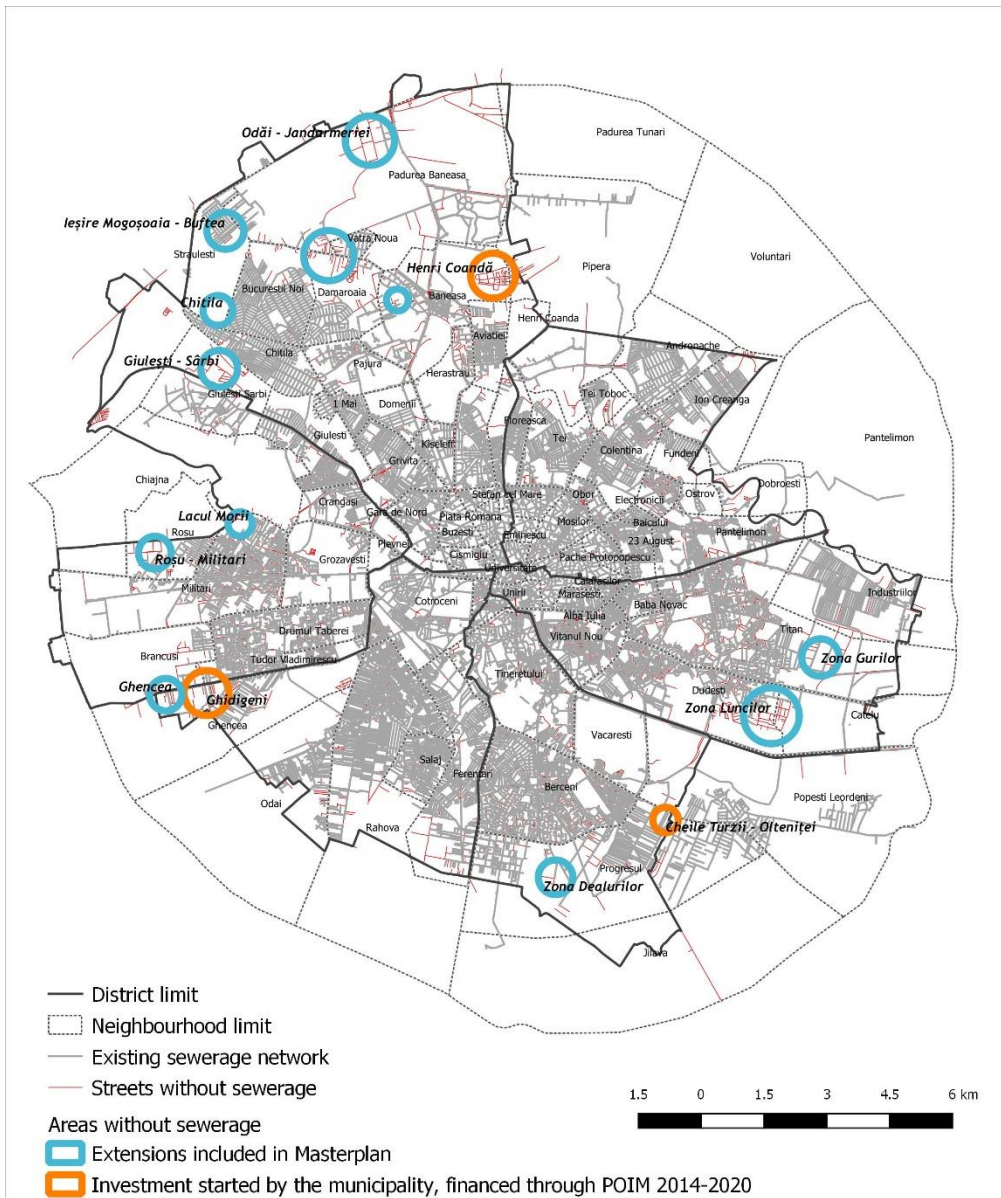
It should be mentioned here that PMB is currently carrying out, with European funds (through LIOP 2014-2020), projects to extend the sewerage network in the areas of Ghidigeni, Olteniței, Cheile Turzii, Henri Coandă, to build the drainage system on the right of the box culvert below Dâmbovița River and the one of Titan, Tineretului and Carol lakes, rehabilitation of the main sewer collectors (A0 and B0), rehabilitation of the box culvert and of the main drainage system on its left side, rehabilitation and replacement of sewerage network, respectively the construction of secondary drains in the Cotroceni, Regina Maria and Tineretului areas.

The degree of connection to the sewerage system increased from 81.5 % in 2011 to 92.2 % in 2016. For 2018, INS data indicate a number of 1,771,000 Bucharest residents connected to sewerage and

wastewater treatment systems (with tertiary stage), increasing by only 8,000 compared to 2008, which means a degree of service of about 96,8 % for the Bucharest residents (as of July 1<sup>st</sup>, 2018). In other words, the results of the 2011 census mentioned that 98.3 % of households in the Capital were connected to the centralized sewerage system, 0.8 % were connected to their own system (e.g. septic tank), while only 7,400 homes (0.9 % of the total) had no form of sewerage, most likely using dry latrines.

Also, the volume of wastewater per household decreased, considering the reduction of drinking water consumption, from 170 liters/person/day to 159 liters/person/day. The volume of wastewater per consumer is higher than the volume of drinking water distributed per consumer, because the volume of rainwater entering the sewerage network is added to the volume of domestic wastewater.

Figure 16: Area not served by the sewerage network



Source: Processed from Apa Nova digital map

## 2.2. Wastewater treatment

The box culvert transports wastewater and domestic water to the Glina Wastewater Treatment Plant (WWTP), located in Glina commune, 11 km southeast of Bucharest, and built during the communist period (70s-80s). For stage I (put into operation in July 2011, with ISPA funds), the treatment plant has the capacity to partially (mechanically) treat up to 10 m<sup>3</sup>/s, of which only 5 m<sup>3</sup>/s complete treatment (biological and tertiary). Considering the average wastewater flows in the recent years (2014-2017), it results that an average wastewater flow of about 3 m<sup>3</sup>/s passes only through the primary treatment stage. In addition, the sludge resulting from the station is processed by anaerobic fermentation and mechanical dehydration on 4 lines, the latter process being considered obsolete at European level. The existing sludge line of the treatment plant allows, through the dehydration plant, to obtain a sludge concentration of about 30 % dry matter (which allows the use in agriculture) or, as the case may be, 35 % (possibility of use as a support for landfills). Also, the biogas produced after the

fermentation process is stored in two gas meters of 3,000 m<sup>3</sup> each, being used in the cogeneration station that produces electricity and heat.

It should be mentioned here that the Glina station also serves a large part of the important localities of Ilfov County, namely Chitila, Chiajna, Popești-Leordeni, Dobroești, Pantelimon, Glina, Jilava, Mogoșoaia, Voluntari, Cernica.

The fact that almost 40 % of the wastewater is treated only primarily is visible in the comparative analysis of Dâmbovița river water quality between the monitoring section at the entrance in Bucharest (upstream of Morii Lake) and the section downstream of Glina WWTP. If at the entrance in Bucharest the water quality is considered to be good, both in terms of biological elements and chemical status, downstream of the treatment plant the chemical status is assessed as degraded, and the water quality in terms of the biological elements is a moderate one. For example, the concentration of chlorides in the Dâmbovița River is about 3 times higher after receiving the wastewater of Bucharest, and the values of the CBO5 indicator show a degraded ecological status.

Glina WWTP is dimensioned for a 1,728,000 p.e. (population equivalent), but currently the project for the second phase is being implemented, which will expand the capacity to 2,417,000 p.e, will ensure the mechano-biological treatment with removal of nutrients and sewage flows of 12 m<sup>3</sup>/s for the primary and biological stage, respectively rainwater flows of 12 m<sup>3</sup>/s for the mechanical stage. Also, the project will include building an incinerator, in order to add the incineration technology to the anaerobic fermentation technology of the resulting sludge. The incinerator will reduce the amount of sludge to less than 10 % of the current mass and will increase the methane production, but this investment will also lead to a significant increase in the station's energy consumption. This investment is considered to be the zero priority of the Master Plan for the Water Supply and Sewerage Service in Bucharest City, in order to comply to the requirements of European directives regarding wastewater treatment.

### 3. ELECTRICITY INFRASTRUCTURE

#### 3.1. Introduction

Currently, as a result of the specific conditions of economic development in the Bucharest area, the increase in electricity consumption has been higher than the national average.

Considering the other specific aspects of the area:

- lack of land available for development works and its extremely high price,
- very high concentration of consumption,
- consumers with a high degree of sensitivity to supply interruptions,
- high number of cables and problems with the volume of reactive energy,
- scrapping of generating groups,
- the development of generation from renewable sources, especially from Dobrogea and from the areas adjacent to Bucharest, having as a consequence the increase of the power flows that transit the electrical substations that supply electricity to the Capital,

the possible need for projects in this area to consolidate/develop the electricity transmission/distribution network.

The users of the electricity distribution network (EDN), mostly consumers (end customers), are directly connected to the electricity networks of public interest managed by E-Distribuție Muntenia S.A., a private company, part of the ENEL group.

#### 3.2. The energy situation in Bucharest City

Table 1 shows the number of users divided in six categories - urban HV, urban MV, urban LV, rural HV, rural MV, rural LV.

Table 3- Number of users of the electric power system, in 2018, served by e-Distribuție Muntenia

Environment	Rated voltage	e-Distribuție Muntenia
Urban	HV	12
	MV	1556
	LV	1029380
<b>TOTAL</b>		1030948

Source: ANRE

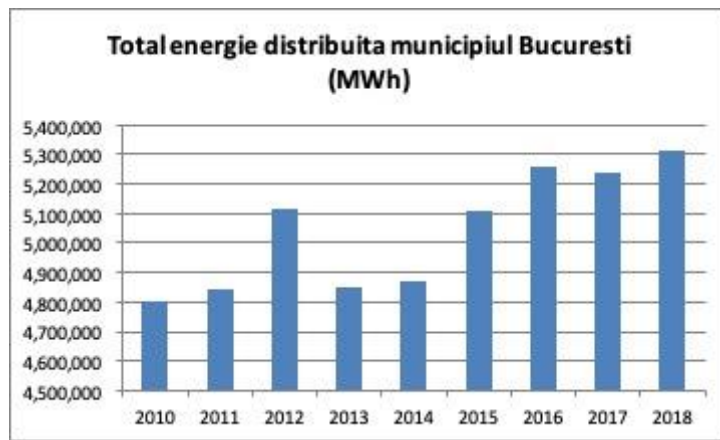
The number of consumers in Bucharest is 981137, including domestic and economic operators.

The number of consumers in Bucharest is 981137, including domestic and non-domestic operators (companies, institutions, etc.). Bucharest has 4980 transformer substations. The total length of the HV, MV, LV overhead (OPL) and underground (UPL) lines network is 27,758 km.

The electricity consumption data registered at the level of Bucharest City in the period 2010-2018 indicate a continuous increase starting with 2013, in 2018 being recorded a historical maximum level for the last decade. This is most likely the result of Capital's economic growth, but also of the increase

in domestic consumption, especially considering that households are increasingly equipped with various equipment that use electricity.

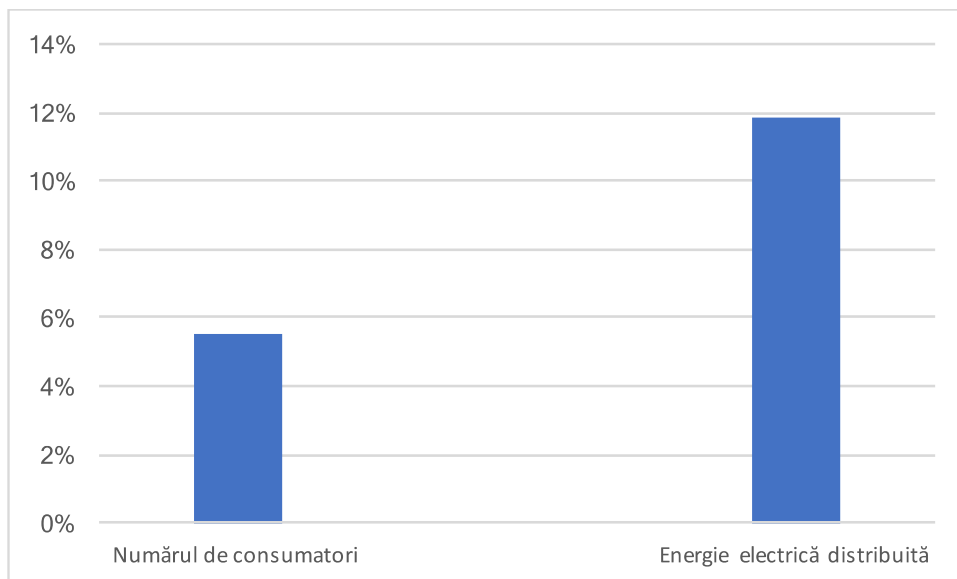
**Figure 17 – Dynamics of the electricity consumption in Bucharest City, between 2010 and 2018**



Source: ENEL

In the national context, Bucharest concentrated in 2018 about 5.56 % of the total electricity consumers in Romania, respectively over 11.85 % of the total consumption, resulting an average annual consumption, per consumer, of 5.41 MWh.

**Figure 18– The share of the number of consumers and of energy consumption in Bucharest in the total values registered at national level in 2018**



Source: ANRE

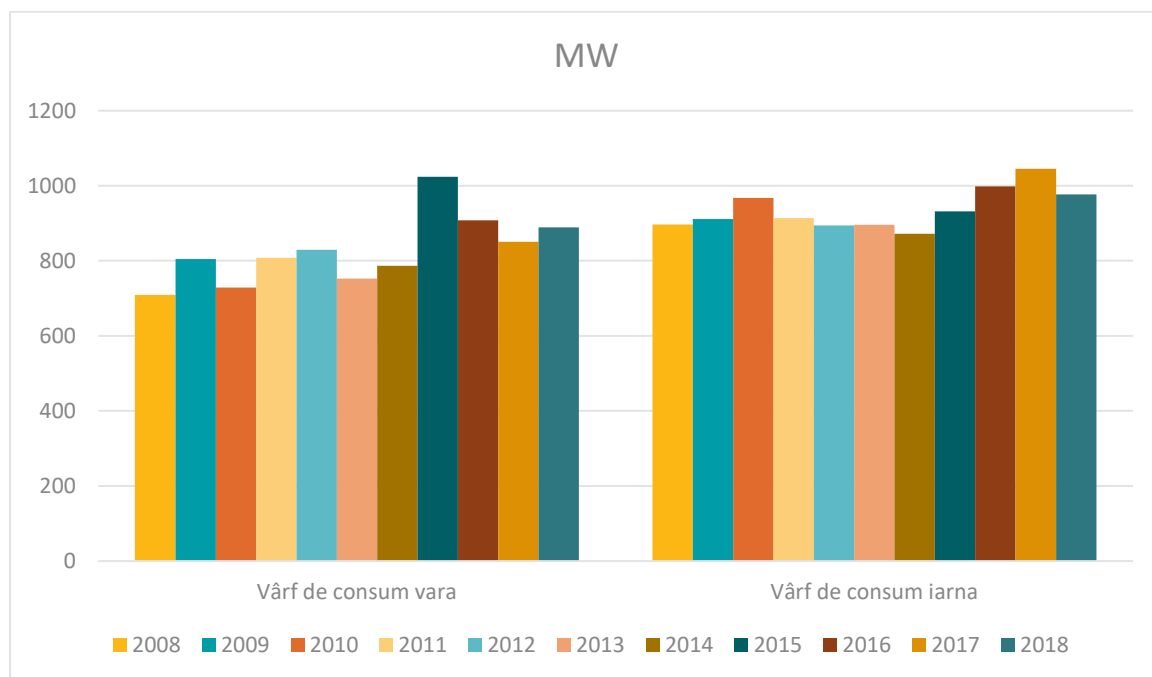
On the territory of Bucharest City, development works are intended in the North area: Henri Coandă HV/MV electrical substation - located in the neighborhood with the same name, Mircea Eliade HV/MV electrical station - located at the intersection of Calea Floreasca and Str. Mircea Eliade and the new HV/MV electrical substation in the Industriilor area.

The electricity consumption in the Bucharest area exceeded 1500 MW at the peak load of winter 2017-2018, a value that represents about 64 % of the injection capacity from the electricity transmission

network (ETN) to the electricity distribution network (EDN) in the area (2350 MW) and leads to reaching the limit of injection capacity in each of the three areas inside Bucharest, operating unlooped. The injection capacity from ETN to EDN is dimensioned in accordance with the technical regulations in force and should comply with the principle that triggering any source of injection from ETN to EDN should not lead to interruptions in the supply of electricity to consumers.

The power consumption in Bucharest for characteristic intervals (summer peak load – the third Wednesday of July at 14:00 and winter peak load – the third Wednesday of January at 19:00) in the period 2008 – 2018 is presented in the tables below, expressed in MW. As it can be seen, there is an increasing trend for consumption peaks in both seasons, but more pronounced during the summer, caused by the more frequent heat waves experienced in Bucharest, which make necessary the intensive use of air conditioners. However, consumption can reach higher values than those in the characteristic intervals, being influenced mainly by weather phenomena.

**Figure 19– Energy consumption in Bucharest, winter and summer peak, during 2008-2018**



**Source: TRANSELECTRICA**

The gross installed capacity in the classic power plants for the generation of electricity in Bucharest, under the administration of the state company ELCEN, is 595 MW, distributed as follows:

- CHP București Sud – 2 groups x 100 MW (200 MW);
- CHP București Vest – a combined cycle (195 MW);
- CHP Progresul – 2 groups x 50 MW (100 MW);
- CHP Grozăvești – 2 groups x 50 MW (100 MW).

To these large combined heat and power plants are added small thermoelectric groups (43 MW), respectively renewable power sources:

- photovoltaic power plants: Installed capacity = 12 MW
- biomass power plants: Installed capacity = 4 MW

Therefore, the total available installed capacity in the Bucharest area, including Ilfov County, is 654 MW, which can provide just over a third of the Capital's consumption at peak load. The rest of the

consumption is ensured by transmitting electricity from other sources in the country or even from imports.

The gross installed capacity in ELCEN-owned block heating power plants has fallen to less than half in the last decade due to equipment wear and environmental restrictions. Thus, ten years ago (2009) they could produce 1,295 MW, a capacity distributed as follows:

- CHP București Sud – 2 groups x 50 MW, 2 groups x 100 MW, 2 groups x 125 MW (550 MW);
- CHP București Vest – 2 groups x 125, a combined cycle (two groups) x 195 MW (445 MW);
- CHP Progresul – 4 groups x 50 MW (200 MW);
- CHP Grozăvești – 2 groups x 50 MW (100 MW).

The age of the generator sets of the power plants installed in the area can lead to unavailability during critical periods. The operation of the groups belonging to ELCEN Bucharest depends on the district heating regime, so during the summer the generation capacity is around 100-150 MW, while during the peak winter period it reaches 500-550 MW.

Currently, in the area of Bucharest and its surroundings there are three electrical substation that connect the electricity transmission network (ETN) and the electricity distribution network (EDN), respectively: București Sud 400/220/110 kV electrical substation, Domnești 400/110 kV electrical substation and Fundeni 220/110 kV electrical substation. Figure 5 illustrates, for example, part of the existing medium voltage network in Bucharest.

**Figure 5 - Part of the MV network in Bucharest**



**Source: ENEL**

The electricity supply network of Bucharest City consists of the following electrical substations and the related power lines:

- 400 kV electrical substations: București Sud substation (Latitude 44.89658, Longitude 25.97239) and Domnești substation (Latitude 44.40548, Longitude 25.96762). The București Sud 400/220/110/10 kV substation is completely refurbished. The 400/110/20 kV Domnești substation is being refurbished, the works will be completed in 2020.
- 220 kV electrical substations: Fundeni substation (Latitude 44.456389, Longitude 26.169722). The 220/110/10 kV substation is completely refurbished.
- The 110 kV electrical substations belong to E-Distribuție Muntenia.

In the short and medium term, the refurbishment of the 400/110/20 kV Domnești substation and the implementation of two projects in the existing substations are envisaged:

- amplification of power in the 400/220/110/10 kV București Sud substation, by installing a transformer unit between the voltage levels of 400 kV and 110 kV, which will lead to the increase of the injection capacity from the electricity transmission network to the electricity distribution network;
- the flexibility of the operation scheme of the 220/110/10 kV Fundeni substation and the amplification of the power in the substation, by installing a transformer unit between the voltage levels of 220 kV and 110 kV, which will lead to the increase of the injection capacity in the electricity transmission network to the electricity distribution network.

Transelectrica has identified possible solutions for the development of ETN in the Capital area, in the medium and long term, which will be analyzed in detail in the study:

- building 400 kV or 220 kV electrical substations for injection in the electricity distribution network inside Bucharest City, in the consumption centers;
- closing the 400 kV ring of Bucharest City, in the eastern area, by building a 400 kV overhead/underground power line from the București Sud transmission substation to the Domnești electrical substation, including the construction of a new 400/110 kV transmission substation in the northeastern part of Bucharest, in one of the localities of Otopeni, Tunari, Voluntari. This new substation could also have 400/220 kV transformer units and could be connected to the 220 kV Fundeni substation through a 220 kV underground power line.

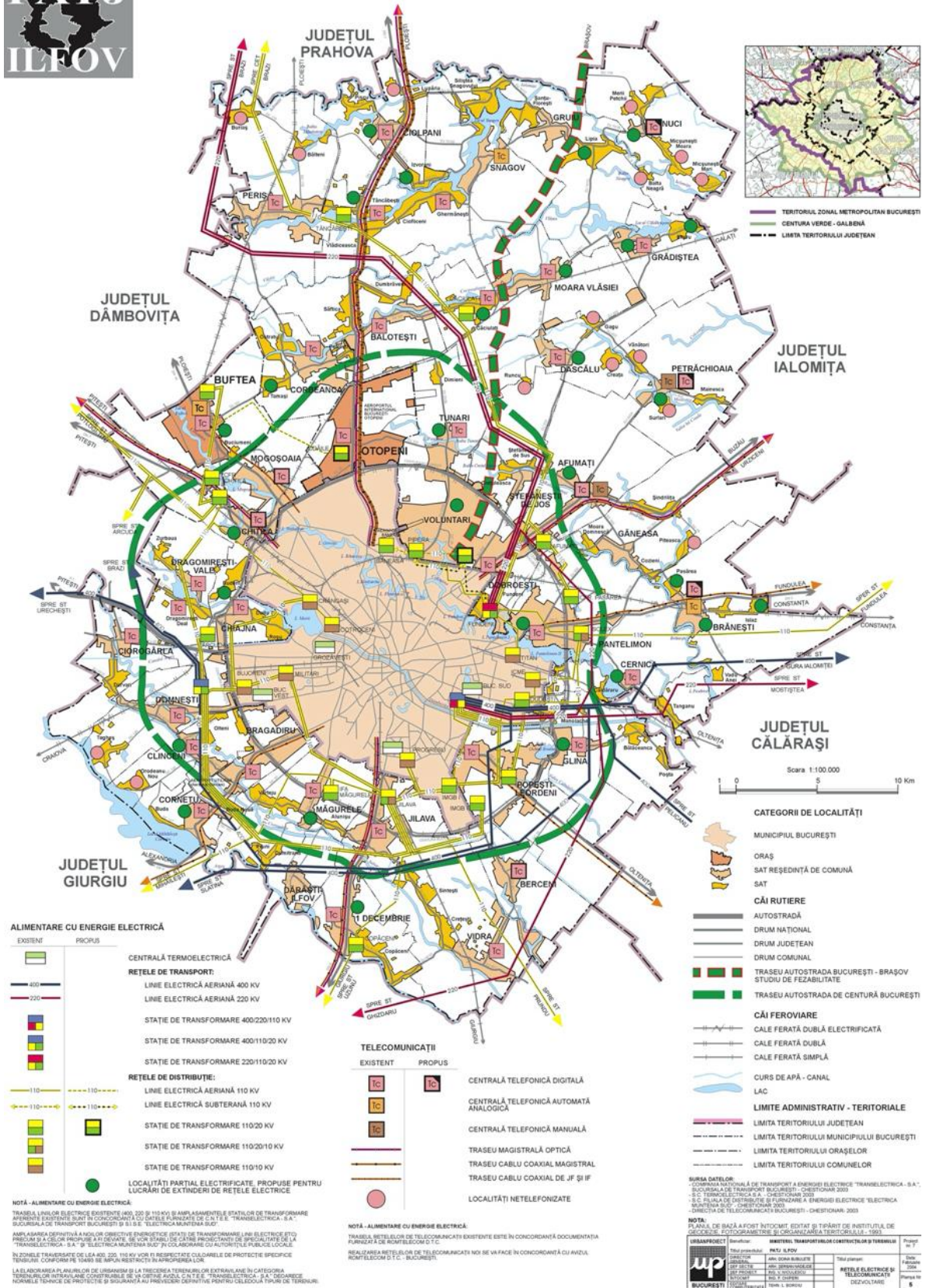
From the ETN Development Plans elaborated in 2008 and 2015, in which the evolution of consumption and of the electricity distribution network in the Bucharest area was analyzed, resulted the opportunity to build the Grozăvești 400kV/110 kV injection substation connected to the existing 400 kV Domnești and București Sud substations by the underground power line (UPL) 400 kV Domnești-Grozăvești and 400 kV UPL București Sud-Grozăvești. The consultations with E-Distribuție Muntenia confirmed the need to build the 400/110 kV Grozăvești substation in the city's consumption center. This electrical substation adjacent to the existing 100 kV substation belonging to ELCEN (CHP Grozăvești) could be built on a part of the land belonging to CHP Grozăvești. Figure 6 shows the electric power system in Bucharest City.

The energy strategy of Bucharest City should also take into account the installation of power plants with the possibility of energy storage, which should lead to the increase of energy efficiency, but also to the flexibility of operation.

Figure 6 - Electric power system in Bucharest



# RETELE ELECTRICE SI TELECOMUNICATII



Source: Ilfov CSP

The total number of *requests for technical approvals* (TCA) for connecting to the electricity network of public interest in 2017 for E-Distribuție Muntenia was 38771 (98.73 % of the total requests for TCA in 2017 being issued, respectively 14.07 % of the total number of TCA issued by distribution operators). In 2018, the total number of requests for technical approvals (TCA) for connecting to the electricity network of public interest for E-Distribuție Muntenia was 40946 (out of a total of 250135 requests at national level), 98.74 % of the total TCA requests from 2018 being issued.

The average time for issuing a TCA when the solution is given based on a solution study has far exceeded the maximum 10 days limit allowed by the *Norm* in the case of E-Distribuție Muntenia.

Table 4- Average time for issuing a TCA by E-Distribuție Muntenia in 2017

Average time (days) for issuing a TCA for the solution set by:	E-Distribuție Muntenia	
	2017	2018
Solution study	19.25	27.70
Solution design document	20.74	19.90

**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017/2018**

The main activity indicators of the distribution operator were:

- The total number of *requests for connection contracts* in 2017 was 125501, and in 2018 135393. E-Distribuție Muntenia received in 2017 a number of 32929 requests for connection contracts, and 36064 in 2018, which means an increase of approximately 10 % compared to 2017. In 2017, out of the total requests for connection contracts, 21711 were residential, while in 2018 a number of requests of 11389 were for residential consumers;
- The total number of connection contracts concluded in 2017 was 32558, and in 2018 it was of 35849;
- Average time needed to conclude the connection contract: 3 days
- Number of requests for connection contracts that were did not received an answer within the legal deadline: 32212 in 2017 and 2464 in 2018
- The number of pending/unresolved requests for connection contracts was of 81 in 2017 and 191 in 2018, also determined by the higher volume of requests.

In 2017, *the total number of requests for concluding contracts for the distribution service* in the case of E-Distribuție Muntenia was 39561, and in August 2018 it was 53305.

Table 5- Average time for concluding contracts for the electricity distribution service in Bucharest

Average time (days) for concluding contracts for the distribution service:	E-Distribuție Muntenia	
	2017	2018
LV	9.66	10
MV	15.9	7
HV	9.33	18

**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017/2018**

As can be seen in Table 3, the average time to conclude distribution contracts falls within the maximum period provided by the standard, namely 20 days. In 2018, the average time for concluding distribution contracts was 9 days for LV, 7 days for MV and 7 days for HV.

The average duration of the connection process, which represents the time between the date of submitting the connection request along with the full justification documentation and the date of commissioning the installation that uses electricity, has the following distribution.

Tabel 6- Average duration of the connection process to the electricity distribution network in Bucharest

Average duration (days) for connection process:	E-Distribuție Muntenia	
	2017	2018
LV	87	93
MV	433	441
HV	-	-

**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017/2018**

The average duration of the connection process, at the level of the entire country, was of 90 days at LV and 235 days at MV; as a note, E-Distribuție Muntenia exceeds the average values. Also, the value of 441 days at MV level represent the maximum duration for the connection process in Romania.

Table 7– Average cost of connection to the electricity distribution network in Bucharest

Average connection cost (RON) <sup>1</sup> :	E-Distribuție Muntenia	
	2017	2018
LV	978	1001
MV	132465	215614
HV	-	-

**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017/2018**

The average cost of connection to LV network was RON 1775 at the level of the entire country (compared to RON 1884 in 2017), the minimum value being registered at E-Distribuție Muntenia. The average cost of connection to MV network was RON 92033 at the level of the entire country (RON 68645 in 2017) with a maximum value of RON 215614 at E-Distribuție Muntenia. It can be seen that, for E-Distribuție Muntenia, the average cost of connection to the MV network increased in 2018 by about 60 % compared to 2017.

Looking at the data dynamics for the period 2015-2018, it is obvious a continuous increase in the length of the distribution network, especially in the case of underground connections. High voltage lines (especially overhead lines) decreased in length until 2017, then in 2018 there was a slight increase, while medium voltage lines increased insignificantly (exclusively due to underground lines, since the length of overhead lines has decreased). Although there is a growth trend of underground power lines, the overhead lines continue to measure over 17,000 km, i.e. 36 % of the total network, these being the most exposed to bad weather, without taking into consideration their negative aesthetic impact.

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<sup>1</sup> Average connection cost per connected user, paid to the distribution operator (tariff for issuing the TCA + cost of solution study + connection tariff).

Table 8- Dynamics of the length of the electricity distribution network in Bucharest, by voltage levels, in the period 2015-2018

N o.	Category	2015			2016			2017			2018		
		OPL (km route)	UPL (km route)	TOT AL (km route)	OPL (km route)	UPL (km route)	TOT AL (km route)	OPL (km route)	UPL (km route)	TOT AL (km route)	OPL (km route)	UPL (km route)	TOT AL (km route)
1	HV (110 kV)	922	242	1164	891	247	1137	891	252	1143	891	262	1153
2	MV (35/20/10/ 6 kV)	265 5	870 0	1135 5	264 3	879 1	1143 4	260 8	883 3	1144 1	256 2	900 9	1157 2
3	LV (0.4 kV)	848 5	142 23	2270 8	849 3	142 90	2278 3	850 1	144 49	2295 0	849 3	145 45	2303 8
4	Connections	570 0	549 6	1119 6	571 0	562 3	1133 3	572 1	578 8	1150 9	572 4	598 5	1171 0

**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017/2018**

A more detailed analysis of the network indicates that a large part of the 110 kV lines were put into operation before 2000 (93 %). Regarding the MV and LV lines, about 19 % and 29 % respectively have been put into operation during the last 17 years.

Table 9 – Length of power distribution lines depending on the time of their commissioning

N o.	Categor y	Total overhead+under ground power lines (km route)	OPL		UPL		Total overhead+under ground power lines (km)	% of total category
			Commissi oned	Length (km route )	Commissi oned	Length (km route )		
1	HV (110 kV)	1,143	Before 1960	123.86	Before 1960	4.5	128.36	11.2
			1960-1979	589,571	1960-1979	113.18	702.799	61.5
			1980-1999	177.434	1980-1999	59.25	236.728	20.7
			2000-2018	-	2000-2018	85.15	85.15	7.4
2	MV	11,441	Before 1960	-	Before 1960	147.40	147.40	1.3
			1960-1979	1,566.02	1960-1979	4,890.21	6,446.23	56.3
			1980-1999	284.24	1980-1999	2,362.01	2,646.25	23.1
			2000-2018	779.55	2000-2018	1739.89	2519.44	21.8
3	LV	22,950	Before 1960	-	Before 1960	23.42	23.42	0.1
			1960-1979	1,356	1960-1979	6,224.62	7,580.62	33.3
			1980-1999	3,004	1980-1999	6,056.61	9,060.69	39.8
			2000-2018	4352.54	2000-2018	2301.7	6654.23	28.9
4	Connecti ons	11,509	Before 1960	-	Before 1960	12.90	12.90	0.1
			1960-1979	907.29	1960-1979	2,451.17	3,358.46	29.2
			1980-1999	2,010.02	1980-1999	2,386.27	4,396.29	38.2
			2000-2018	2948.98	2000-2017	1178.11	4127.1	35.2

Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017/2018

Compared to 2017, at the level of the distribution operator E-Distribuție Muntenia, the total length of overhead and underground power lines increased by 1084.41 km.

At the level of Bucharest there are 262 km of HV lines, 7200 km of MV lines (7190 UPL and 10 km OPL) and 20296 km of LV lines (15743 UPL and 4553 OPL), representing a total of 27758 km of power lines in E-Distribuție Muntenia.

The number of 110 kV electrical substations has remained constant (67) in the recent years, the number of supply points has decreased slightly, while the number of transformer substations, as well as their capacity, has steadily increased, as a result of the investments made by the operator from own funds.

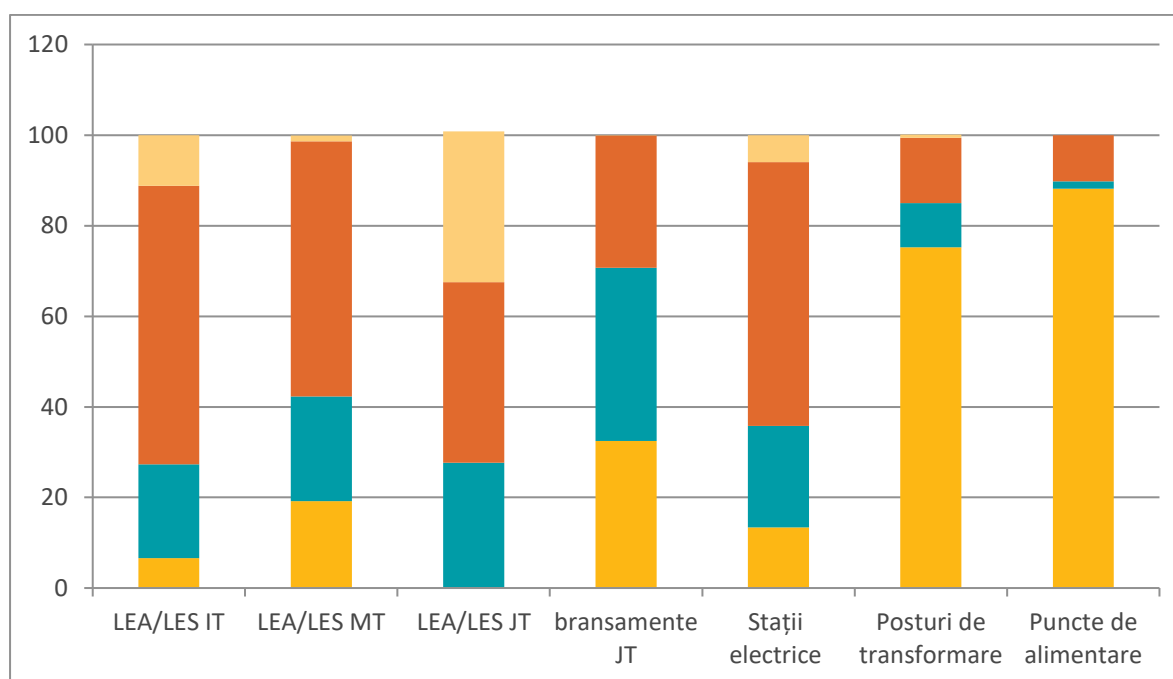
Table 10- Electrical substations, transformer substations and supply points

No.	Category	2015		2016		2017		2018
		Quantity (pcs)	Total: (MW)	Quantity (pcs)	Total: (MW)	Quantity (pcs)	Total: (MW)	Quantity (pcs)
1	Electrical substations (of switching and/or distribution) 110 kV	67	4,613	67	4,512	67	4,596	67
2	Transformer substations	7,957	3,486	8,153	3,687	8,275	3,767	8432
3	Supply points	189	-	188	-	187	-	190

**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017/2018**

In the period 2000-2018, 9 transformer stations have been commissioned (13.4 % of the total number), 6445 transformer substations (76.4 % of the total number), respectively 170 supply points (89.5 % of the total number).

**Figure 20 - Electrical substations, transformer substations and supply points, according to the time of commissioning**



**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017/2018**

In the period 2015-2018, about 1191 km of power lines were refurbished, and 201 km of lines were replaced.

Table 11 - New and refurbished power distribution lines in the period 2015-2018

Category		2015			2016			2017			2018		
		Length of lines (km route)	Length of upgraded lines (km route)	Length of new lines (km route)	Length of lines (km route)	Length of upgraded lines (km route)	Length of new lines (km route)	Length of lines (km route)	Length of upgraded lines (km route)	Length of new lines (km route)	Length of lines (km route)	Length of upgraded lines (km route)	Length of new lines (km route)
HV (110 kV)	OP	922	8	-	891	89.5	891	891		-	891	93	-
	UP	242	3	13	247	0.5	247	252	52	5.48	262	-	10.25
MV	OP	2655	91	9	2643	52.2	2643	2608	31.85	8.45	2562	11	-
	UP	8700	57	78	8791	51.4	8791	8833	78.82	79.28	9009	117.3	77.61
LV (exclusively connections)	OP	8485	117	7	8493	128.9	8493	8501	103	19.95	8493	218	23.83
	UP	14223	125	35	14290	18.5	14290	14449	26.25	83.48	14545	61	89.92
TOTAL		35227	401	142	35355	341	35355	35534		196.64	35762	383	201.61

**Source: [data processing "Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical state of electricity transmission and distribution networks for 2017/2018"]**

At the same time, over 400 transformer substations and 2 electrical substations were built, while 22 electrical substations, 336 transformer substations and 78 supply points were refurbished.

Table 12- Electrical substations, transformer substations and supply points, in the period 2015-2018

Category	2015			2016			2017			2018		
	Total electric power capacities (pieces)	Refurbished electric power capacities (pieces)	New built electric power capacities (pcs)	Total electric power capacities (pieces)	Refurbished electric power capacities (pieces)	New built electric power capacities (pcs)	Total electric power capacities (pieces)	Refurbished electric power capacities (pieces)	New built electric power capacities (pcs)	Total electric power capacities (pieces)	Refurbished electric power capacities (pieces)	New built electric power capacities (pcs)
Electrical substations	67	8	1	67	14	1	67	-	-	67	-	-
Transformer substations (PT)	7957	84	206	8153	110	188	8275	70	127	8432	72	204
Supply points (PA)	189	13	-	188	15	-	187	32	-	190	18	-

Source: ["Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical state of electricity transmission and distribution networks for 2017/2018"]

In accordance with the “ETN Development Plan for the period 2018-2027”, the following works were carried out in Bucharest in 2018, in order to consolidate the electric power system:

- 110/20 kV Parcul Drumul Taberei electric substation , 2x25 MVA, connected in input-output system on
- 110 kV UPL Salaj - Drumul Taberei 2;
- 110/20 kV Academia Militară electric substation, 2x25 MVA, connected in input-output system on
- 110 kV UPL Panduri - Răzoare;
- 110/20 kV Park Lake electric substation, 2x16 MVA, connected in input-output system on
- 110 kV UPL Dudești - Balta Albă:
- new 110 kV UPL Dudești - Park Lake, Al 630 mm<sup>2</sup>;
- new 110 kV UPL Balta Albă - Park Lake, Al 630 mm<sup>2</sup>;
- new 110 kV UPL Fundeni - București Nord, Al 1600 mm<sup>2</sup>;
- 110 kV UPL Fundeni - Obor, Al 1600 mm<sup>2</sup>, rewiring

In accordance with the address 1196/30.05.2019, a series of works to consolidate the electricity network presented in Annex 1 are provided for in Bucharest.

The maintenance program at DO level was achieved at a level of 95.62 % of the programmed value. The preventive maintenance works represent 47.9 % of the completed works, and 52.1 % represent corrective maintenance works.

Table 13 - Degree of achievement of the maintenance program, by categories of works

Maintenance program		Program achievement in 2016 (%)	Program achievement in 2017 (%)	Program achievement in 2018 (%)
WL1:	Operational works	51.12	96.27	68.69
	Periodic inspection	69.61	66.16	87.21
WL2:	Technical overhaul	40.82	37.07	32.23
	Accidental interventions	-	-	-
WL3:	1st degree repairs	129.43	111.17	77.88
	Accidental repairs	86.81	100.05	133.88
WL4:	2nd degree repairs	-	-	-
TOTAL		80.29	95.62	98.2

Source ["Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical state of electricity transmission and distribution networks for 2017/2018"]

Table 14- Degree of achievement of the maintenance program, by types of installations<sup>2</sup>

Category of works		WL1:		WL2:		WL3:		WL4:
		Operational works (%)	Periodic inspection (%)	Technical overhaul (%)	Accidental interventions (%)	1st degree repairs (%)	Accidental repairs (%)	2nd degree repairs (%)
OPL	HV	-	158	-	-	107	50	-
	MV	100	10	31	-	129	61	-
	LV	-	74	30	-	74	98	-
UPL	HV	-	128	-	-	126	92	-
	MV	145	-	-	-	33	174	-
	LV	-	23	1	-	49	148	-
Transformer substations (PT)	MV/LV	-	193	36	-	297	71	-
Supply points (PA)	MV	-	97	6	-	113	149	-
Electrical substations	HV/MV	80	113	54	-	61	165	-
Other installations	HV	-	-	-	-	-	-	-
	MV	122	-	20	-	-	4	-
	LV	32	-	-	-	-	-	-

Source: ENEL

In 2019, E-Distribuție Muntenia carried out investments from its own funds for the transition to 20 kV of the 6 kV and 10 kV network in the areas Bucharest South - Jilava (in stages), Drumul Taberei (in stages), Cotroceni (in stages) and Floreasca - which serves about 34,500 consumers. Such investments are needed to meet the consumption needs of those areas, to connect new customers and to increase operational safety. Also, more than 120 transformer substations and a series of transformer points throughout the city have been modernized, including them in a remote control and automation system, which allows remote operation and isolation of faulty areas. Other projects aim at modernizing the underground power networks in the areas of Domenii - Aviatorilor - Mărăști, Olteniței

<sup>2</sup> Works executed in house and with third-parties were included

Other installations include: meters, measuring and control devices (MCD), electricity remote transmission/management equipment

MV and LV

"Other maintenance and repair work" does not include: Machinery, Tools, devices, test equipment and tools used for maintenance work, Administrative buildings, Electrical/thermal facilities in administrative buildings, Computers, Furniture, Telephony, Other

- Văcărești - Iriceanu, Prelungirea Ghencea, Toamnei - Eminescu, Calea Griviței - serving a total of 95,000 customers. The CHP Sud-Dudești HV line (110 kV) was also updated, the Nord-Grozăvești and Nord-Centru HV lines were replaced, increasing the transmission capacity to 180 MVA, and a new underground HV line (Fundeni-București Nord) was built. At the level of Bucharest City the following generation capacities are installed and available:

Tabel 15- Generation capacities installed and available

Name of power plant	Distribution Unit (DU) name	Inst. cap. (MW)	Net cap. (MW)	Avlb.cap. (MW)	Manager	Notes
BUCURESTI SUD	BUCURESTI SUD 1	50	0	0	ELECTROCENTRALE BUCURESTI	Withdrawn from operation C1TA1.
BUCURESTI SUD	BUCURESTI SUD 2	50	0	0	ELECTROCENTRALE BUCURESTI	Withdrawn from operation TA2.
BUCURESTI SUD	BUCURESTI SUD 3	100	84	100	ELECTROCENTRALE BUCURESTI	
BUCURESTI SUD	BUCURESTI SUD 4	100	84	100	ELECTROCENTRALE BUCURESTI	
BUCURESTI SUD	BUCURESTI SUD 5	125	102	115	ELECTROCENTRALE BUCURESTI	
BUCURESTI SUD	BUCURESTI SUD 6	125	0	0	ELECTROCENTRALE BUCURESTI	Withdrawn from operation.
BUCURESTI VEST	BUCURESTI VEST 1	125	0	0	ELECTROCENTRALE BUCURESTI	Withdrawn from operation.
BUCURESTI VEST	BUCURESTI VEST 2	125	0	0	ELECTROCENTRALE BUCURESTI	Withdrawn from operation.
BUCURESTI VEST	BUCURESTI VEST C.C. 3+4	195	171	195	ELECTROCENTRALE BUCURESTI	
GROZAVESTI	GROZAVESTI 1	50	41	48	ELECTROCENTRALE BUCURESTI	
GROZAVESTI	GROZAVESTI 2	50	41	48	ELECTROCENTRALE BUCURESTI	
PROGRESU	PROGRESU 1	50	0	0	ELECTROCENTRALE BUCURESTI	Withdrawn from operation C1TA1.
PROGRESU	PROGRESU 2	50	0	0	ELECTROCENTRALE BUCURESTI	Defective turbine rotor

### 3.3. Analysis of power supply service

The indicators for evaluating the performance of the electricity supply service must provide information both at the system level and at the level of end users and represent an important tool in making decisions for the management and development of electricity transmission and distribution networks, in order to ensure:

- increased reliability of energy installations,
- improved power supply service for the users.

Information on the quality of the supply service and the decisions needed to improve it are transmitted and adopted at different levels of the process management (figure 3) [1].

The system operators set the general conditions regarding the continuity in the power supply, which reflect in the users' profit levels. Compliance with energy continuity regulations is an important strategic criterion for network operators, authorities and regulators. Obtaining a required level of profit is an important criterion for running a business, so high security in power supply is a basic requirement for users.

In a liberalized energy market, the performances regarding electric power quality need to be reflected separately for electricity generation operators, transmission operators, distribution operators and end-users. Thus, an interruption at the level of the transmission operator or at the level of the distribution operator may not be reflected to the level of the end-user, due to the intervention of other operators. However, each of the operators must take into account the events in its own system, in order to evaluate the performance of the power supply service. In this regard, continuity indicators in the electric power supply are widely used in the practical activity of energy systems [1]:

- as basic elements for the adoption of measures regarding the development of the supply system;
- to identify best practices in the field;
- as elements of the electricity supply contracts;
- for the realistic evaluation of normed values by the regulators;
- for evaluating the quality of the activity of energy operators.

In practical cases, a wide variety of indicators are used that provide specific information needed to evaluate the power supply service. The indicators used must meet the following minimum conditions:

- to be correctly defined, without ambiguities;
- to provide useful information for users;
- to be easy to understand and determine;
- to allow evaluations over significant periods;
- to ensure the comparability of information obtained with similar information from other systems.

The following indicators are used to evaluate the quality of the power supply service in the electricity distribution networks:

1. *System Average Interruption Duration Index (SAIDI)* for one year, calculated as the ratio between the total interruption time for all interrupted users and the total number of users connected to the analyzed system

$$SAIDI = \frac{\sum_{s=1}^n (N_s \cdot D_s)}{N_t} , \quad (1)$$

where  $N_s$  is the number of users interrupted for more than 3 minutes during the interruption  $s$ ,  $n$  – the total number of interruptions,  $N_t$  - the total number of users in the analyzed system,  $D_s$  – the duration of the interruption of users (minutes) during the interruption  $s$ .

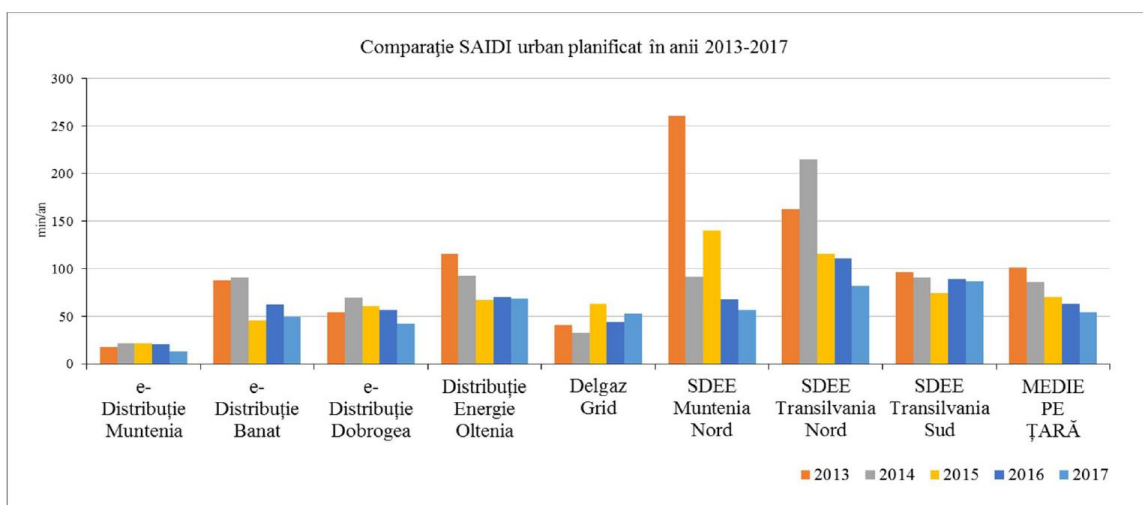
The *SAIDI* indicator provides an average value of the duration in which a user is interrupted over a one year period. It is measured in minutes of interruptions/user and year. The sum in the relation is made for all incidents and for the voltage levels taken into account. Note that the duration of the interruption may be different for different groups of users, for the same event. In this case, the sum must be extended for each of the user groups that experienced the same duration of the interruption.

The analysis of the *SAIDI* indicator must take into account that it is an average value, which may include very long interruptions and some of short duration. Areas with long-term interruption must be carefully analyzed, in order to establish solutions to increase the network performance.

The aggregate values for urban *SAIDI*, *planned interruptions*, are 13.11 min/year for E-Distribuție Muntenia, well below the national average of 54.27 min/year for 2017. The value of the *SAIDI* indicator for planned interruptions is determined by the level of intervention of the E-Distribution Muntenia staff and by the need to comply with the legislation in force.

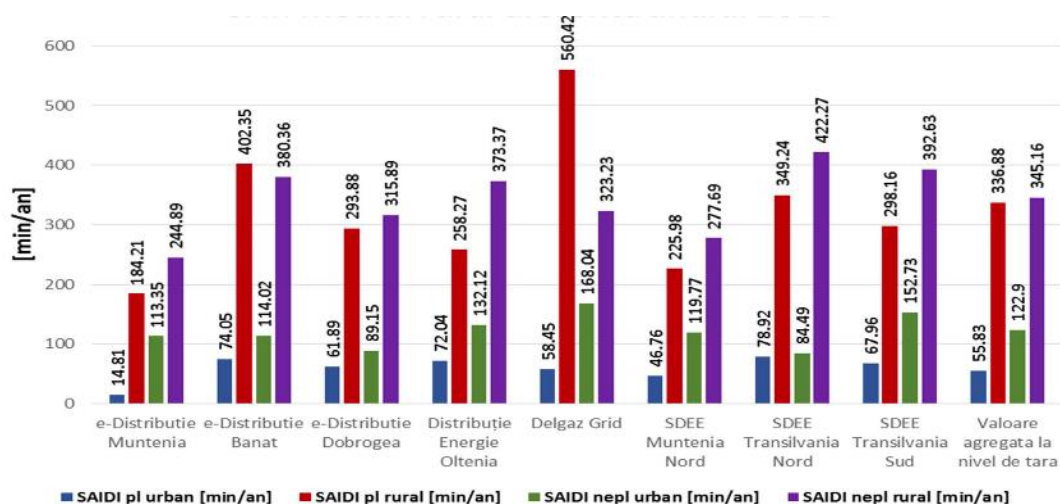
In 2018, the value of the average duration of network interruptions (*SAIDI*) index related to the DO is 14.81 min/year for *SAIDI* planned in urban areas and 113.35 min/year for *SAIDI* planned in urban areas. It can be seen that the average duration of interruptions in 2018 in the case of unplanned SAID is much higher than for planned interruptions. This can be largely caused by the influence of weather conditions on the distribution network, as well as by the increase of consumption in certain areas/periods. It can be considered to increase the share of underground cable lines compared to overhead lines, along with the necessary investment in cable laying works and the reactive power balance.

**Figure 7 - Planned urban SAIDI at the level of electricity distribution companies in Romania, in the period 2013-2017**



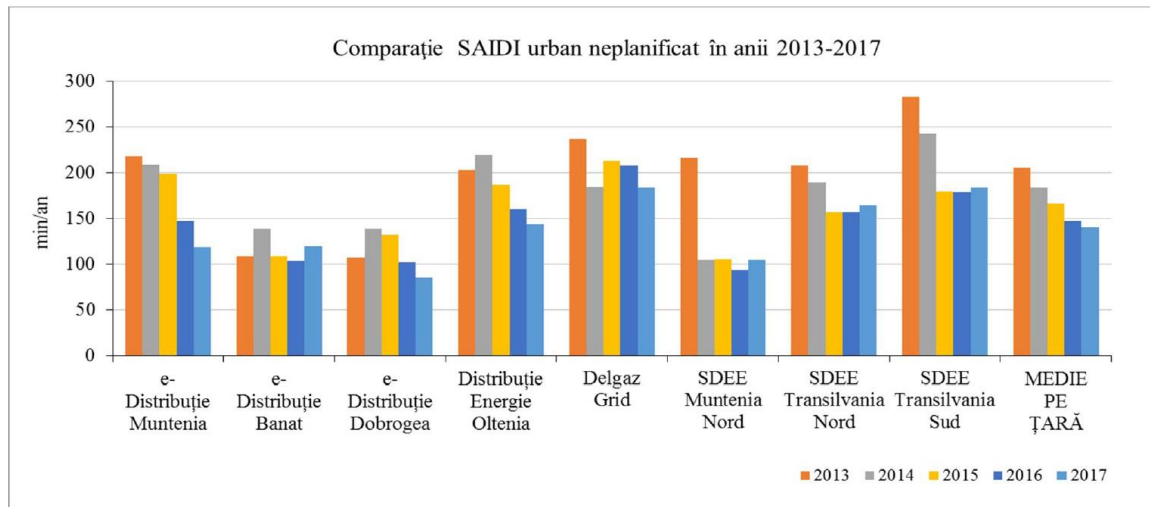
**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017**

**Figure 9 - Planned urban SAIDI at the level of electricity distribution companies in Romania, in 2018**



**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2018**

**Figure 10 - Unplanned urban SAIDI at the level of electricity distribution companies in Romania, in the period 2013-2017**



**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017**

The SAIDI values for the *unplanned interruptions caused by special weather conditions* registered values of 70 min/year for E-Distribuție Muntenia, registering an average value at country level of 652.65 min/year.

2. *System Average Interruption Frequency Index (SAIFI)*, calculated as the ratio between the total number of interrupted users in a year during each of the long-term interruptions  $s$  and the total number of users connected to the analyzed system

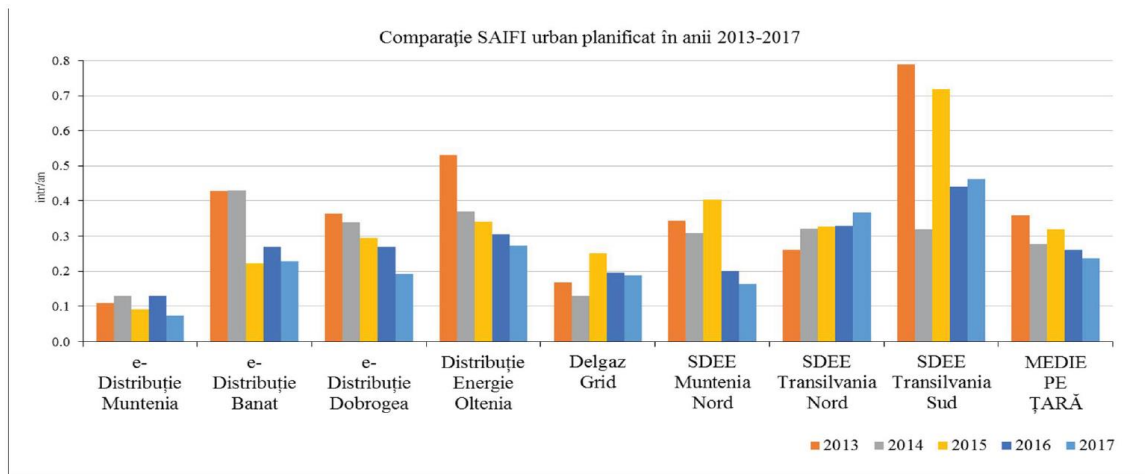
$$SAIFI = \frac{\sum_{s=1}^n N_s}{N_t} \quad (2)$$

where  $N_s$  is the number of users interrupted for more than 3 minutes during the interruption  $s$ ,  $n$  – the total number of interruptions,  $N_t$  – the total number of users served.

The SAIFI indicator defines the average number of interruptions per year that a user goes through. It is measured in number of interruptions/user and year. It is calculated taking into account the structure and the technical characteristics of the network.

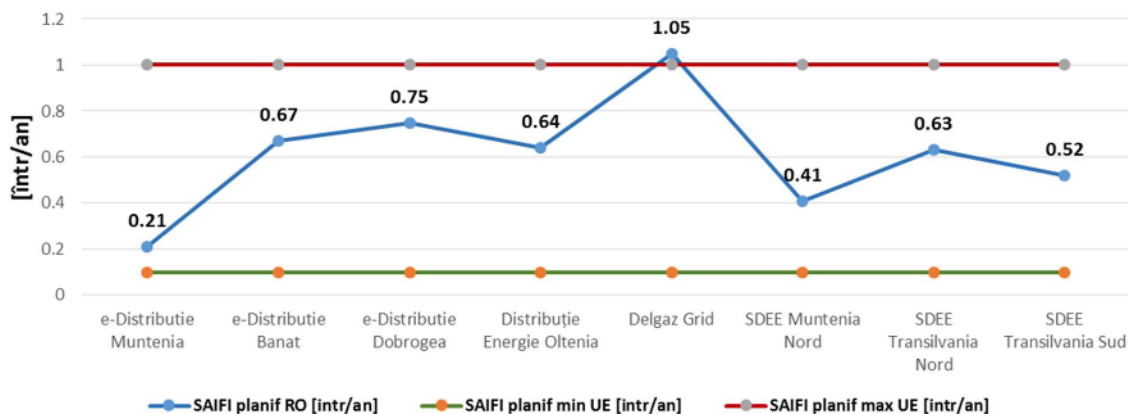
The aggregate values for urban SAIFI, on all voltage levels, *planned interruptions*, reach 0.07 interruptions/year for E-Distribuție Muntenia, below the national value of 0.24 interruptions/year in 2017. In 2018, the value of SAIFI for planned interruptions [measured in interruptions/year] was 0.21 int/year, below the national average of 0.61 [int/ year], the minimum value of this indicator being registered for E-Distribuție Muntenia.

**Figure 21 - Planned urban SAIFI at the level of electricity distribution companies in Romania, in the period 2013-2017**



**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017**

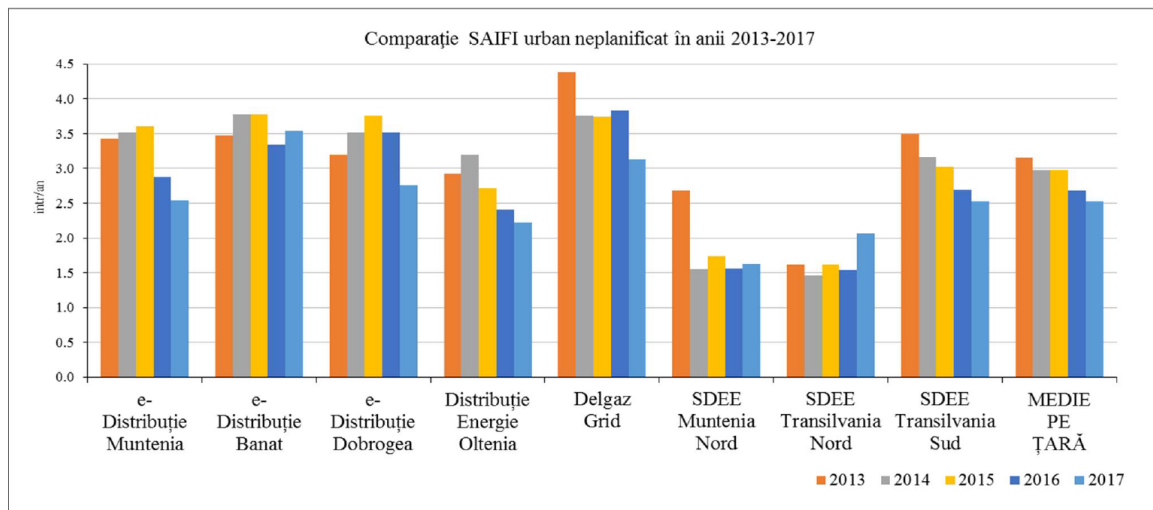
**Figure 12 - Planned urban SAIFI at the level of electricity distribution companies in Romania, in 2018**



**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2018**

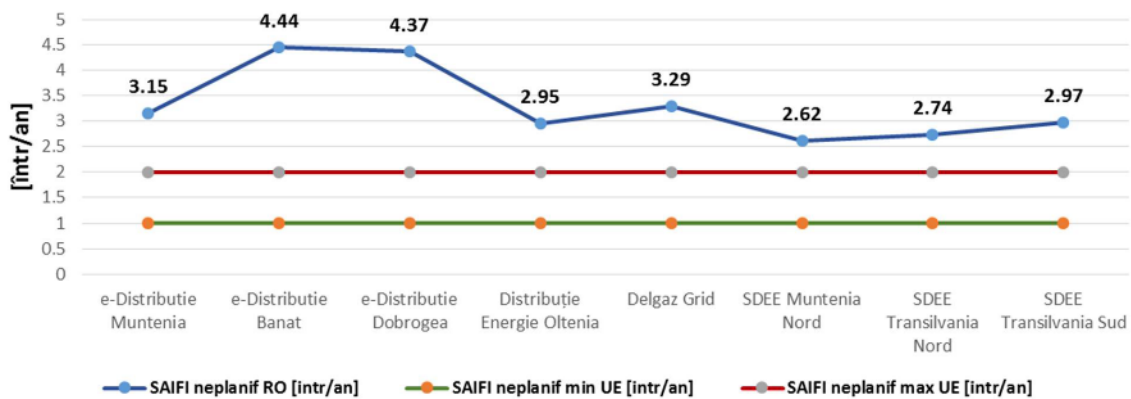
Unplanned SAIFI has average values in the national context, but with a declining trend. The value of SAIFI for unplanned interruptions is 3.15 [in/year] at the level of E-Distribution Muntenia, close to the average value at country level of 3.2 [in/year], still far from the average value of about 1-2 in/year in advanced European countries.

**Figure 22 - Unplanned urban SAIFI at the level of electricity distribution companies in Romania, in the period 2013-2017**



**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017**

**Figure 14 - Unplanned urban SAIFI at the level of electricity distribution companies in Romania, in 2018**



**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2018**

3. *Customer Average Interruption Duration Index (CAIDI)* calculated as the ratio between the total duration of interruptions in a year, for all interrupted users, and the total number of interrupted users during each of the long interruptions:

$$CAIDI = \frac{\sum_{s=1}^n (N_s \cdot D_s)}{\sum_{s=1}^n N_s} = \frac{SAIDI}{SAIFI} \quad (3)$$

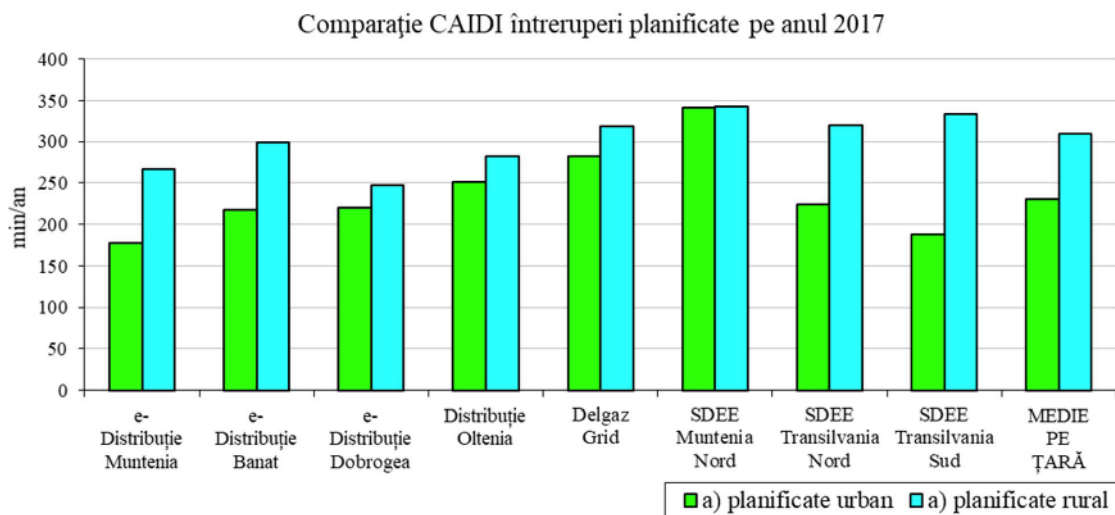
where  $N_s$  is the number of users interrupted for more than 3 minutes during the interruption  $s$ ,  $n$  – the total number of interruptions,  $D_s$  – the duration of the interruption of users (minutes) during the interruption  $s$ .

The *CAIDI* index indicates the average duration of an interruption for a user and is measured in minutes/interruption and year. It can be calculated as the ratio between *SAIDI* and *SAIFI* indicators.

The aggregate values for urban *CAIDI* in 2017, planned interruptions, are 239.29 min/interruption at E-Distribuție Muntenia, lower than the national average value of 293 min/year. The aggregate values for urban *CAIDI*, unplanned interruptions, are 45.76 min/interruption at E-Distribuție Muntenia, lower than the national average value of 80 min/year. This demonstrates that the number of users actually interrupted in the case of a system maneuver is lower than the number of connected consumers.

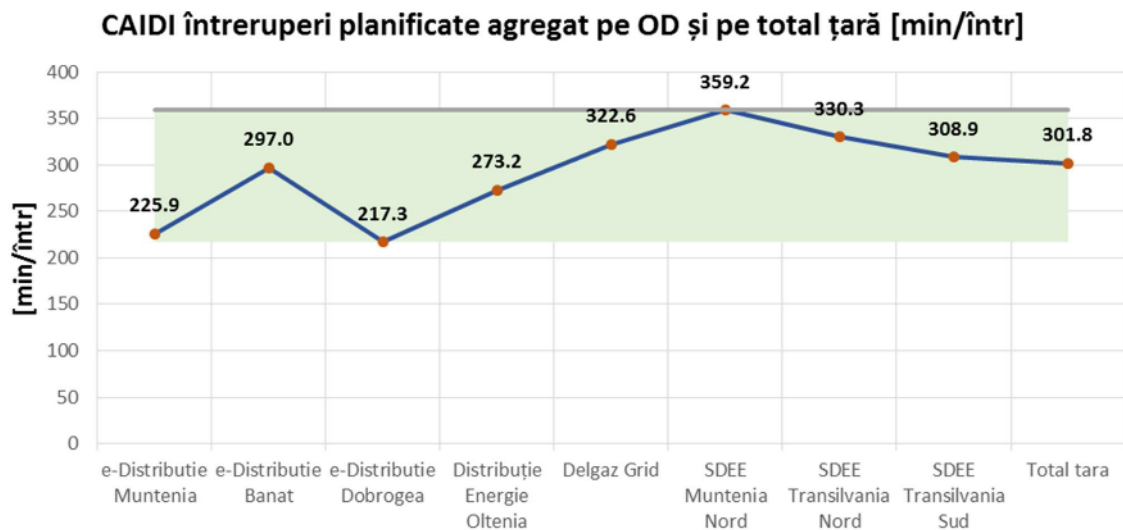
Aggregate values for *CAIDI* – the duration needed to restore the service in case of planned interruptions in 2018, for E-Distribuție Muntenia, is 226 min/int., below the national average of 302 min/int.

**Figure 15 – Planned urban CAIDI at the level of electricity distribution companies in Romania, in 2017**



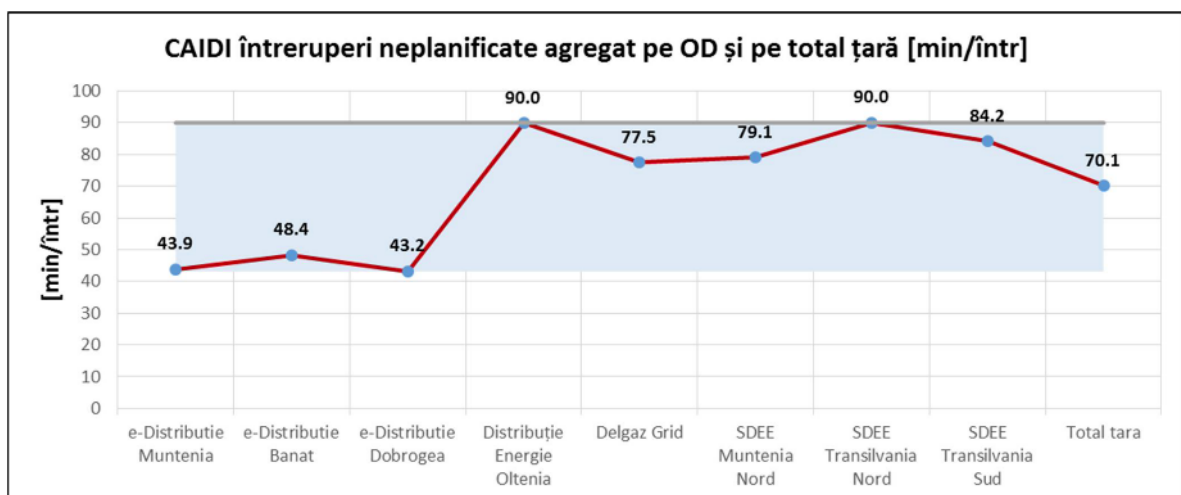
**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017**

Figure 16 – Planned urban CAIDI at the level of electricity distribution companies in Romania, in 2018



Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2018

Figure 17 - Unplanned urban CAIDI at the level of electricity distribution companies in Romania, in 2018

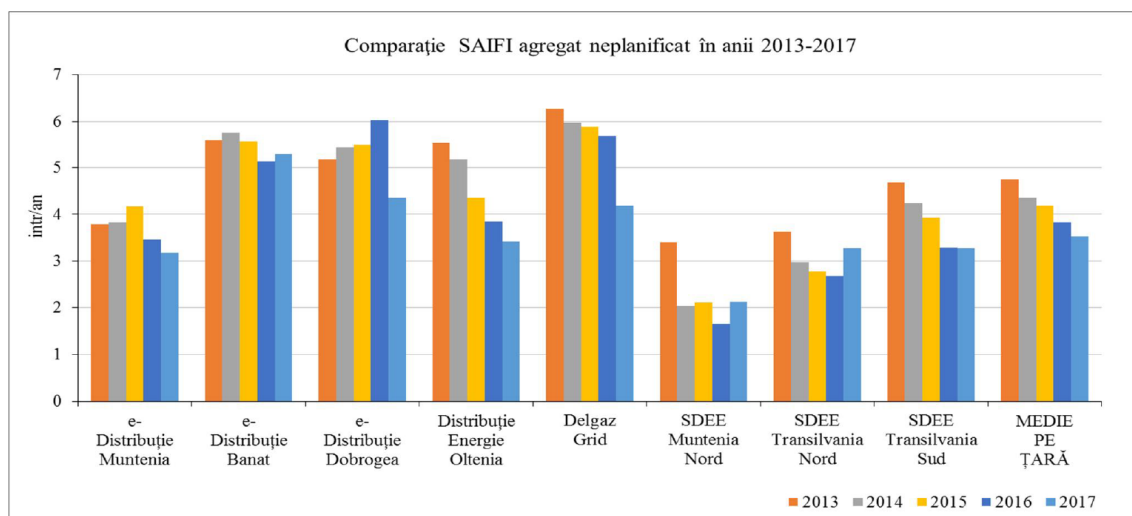


Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2018

The overall value for SAIFI, *planned interruptions*, at the level of E-Distribution Muntenia in 2017 was 0.19 int./year, compared with an average value of about 0.1-1 int./year in advanced European countries. In 2018, the overall value for SAIFI planned interruptions was 0.21 int./year, representing the minimum value.

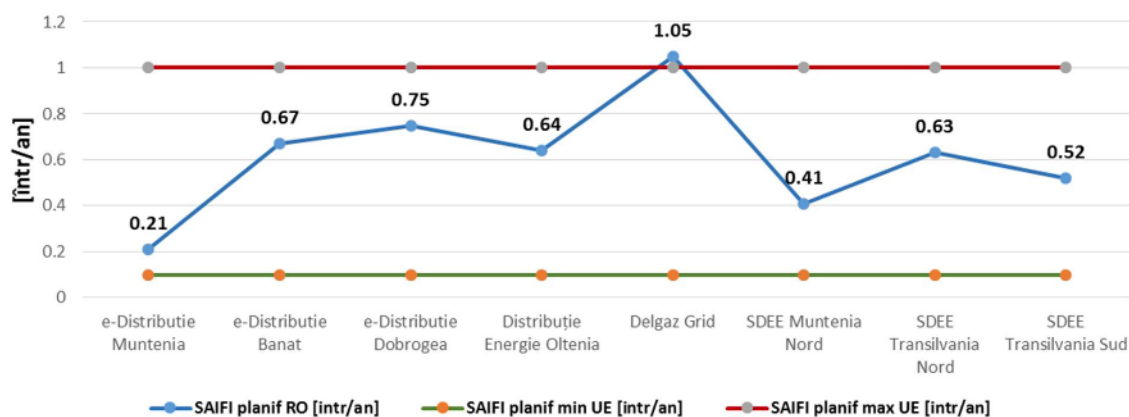
It should be mentioned that, in accordance with the *Performance Standard*, all long interruptions are recorded, respectively those with a duration over 3 minutes (in accordance with the European standard EN 50160, adapted in the Romanian standard SR-EN 50160).

**Figure 18 – SAIFI aggregated at the level of electricity distribution companies in Romania, in the period 2013-2017**



**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017**

**Figure 19 – SAIFI aggregated at the level of electricity distribution companies in Romania, in 2018**



**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2018**

Tabel 16 SAIFI - planned and unplanned interruptions at the level of E-Distribuție Muntenia (including Bucharest), in 2018

DO	e-Distribuție Muntenia
Planned interruptions SAIFI (interr./year)	0.08
Unplanned interruptions SAIFI (interr./year)	2.54
Total SAIFI (interr./year)	3.35

**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2018**

The table above shows the values for SAIFI, planned and unplanned interruptions. The total value of SAIFI is also presented, although it is rarely used in comparisons, because of the completely different, controllable, respectively uncontrollable character of the two categories of interruptions.

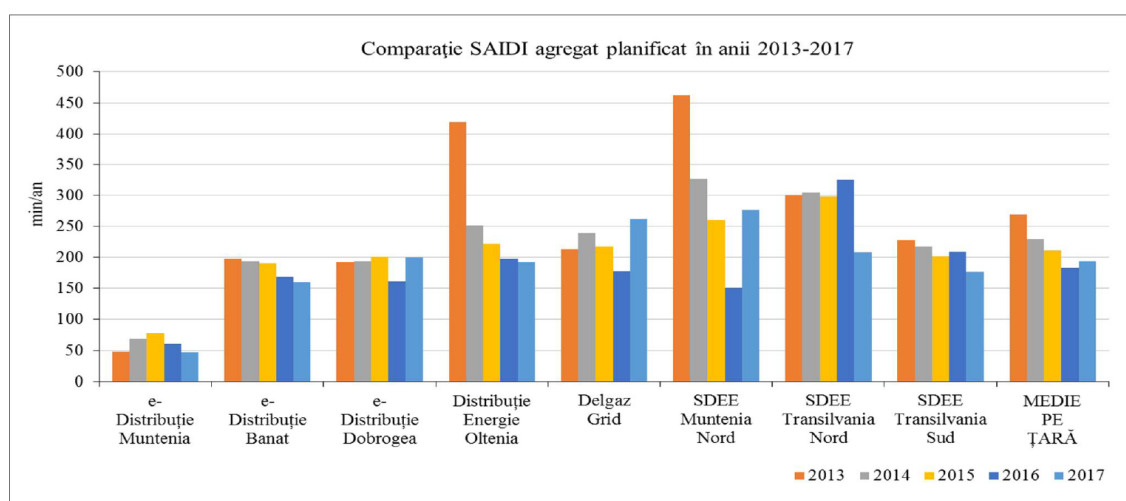
In the urban area, planned SAIFI, as an average value per country, was 0.21 int./year in 2018, while at the level of E-Distribution Muntenia in the urban area it was 0.08 in/year. In 2017, the planned urban SAIFI at the level of E-Distribuție Muntenia was 0.07 int./year; the difference could be caused by the development works (refurbishment) of the electricity network.

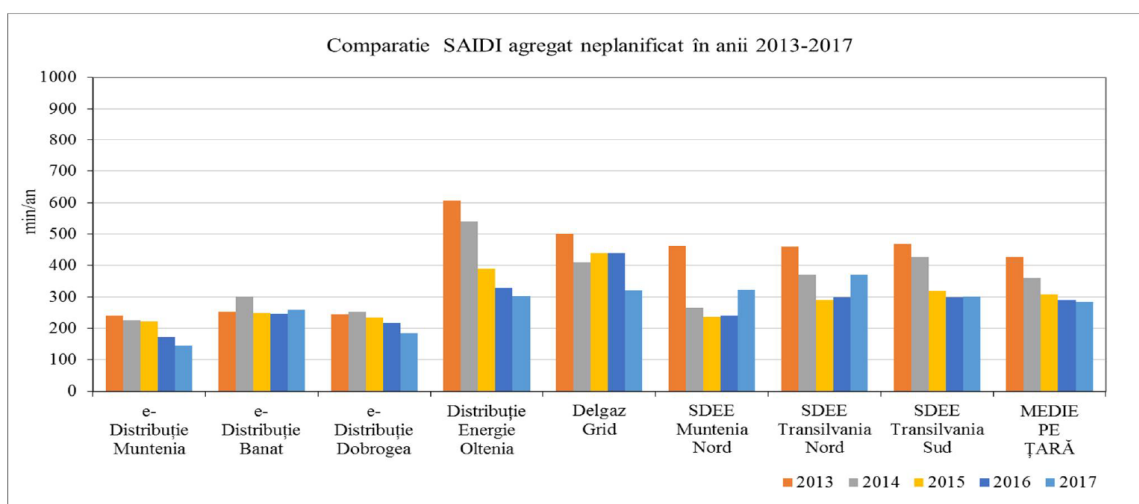
In 2018, unplanned urban SAIFI was, as an average value per country, of 2.4 int. /year, and at the level of E-Distribution Muntenia in the urban area it was 2.54 int./year. This situation could have several causes: the increase of consumption in Bucharest, the infrastructure works carried out, the aging of the electrical networks, the meteorological phenomena that affect the overhead power lines.

The overall aggregate value for SAIDI, *planned interruptions*, is 46.57 min/year for E-Distribuție Muntenia, 4 times lower than the national average of 183.58 min/year, and in line with the values of about 40-150 min/year registered in advanced European countries.

The overall aggregate value for SAIDI, *unplanned interruptions*, is 138.03 min/year for E-Distribuție Muntenia, almost half compared to the national average of 224.14 min/year, but still above the average value of about 20-100 min /year registered in advanced European countries.

**Figure 20 – SAIFI aggregated values – planned and unplanned – at the level of electricity distribution companies in Romania, in the period 2013-2017**





**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017**

One can also note that, as a rule, SAIDI has a higher value for unplanned interruptions than for planned interruptions. The main performance indicator for continuity of user supply is SAIDI for unplanned interruptions on account of the distribution operator, without unplanned interruptions caused by particular weather events, respectively by users and third parties.

The table below shows the SAIDI values for planned interruptions, respectively for unplanned interruptions. In 2018, for the planned interruptions, the maximum performances were set by E-Distribuție Muntenia. In urban areas, the planned SAIDI is well below the national average of 55.83 min/year, a value that shows that the distribution operator has taken the necessary measures to reduce the downtime of users in the case of maintenance operations.

Table 17 SAIDI – planned and unplanned interruptions, at the level of E-Distribuție Muntenia (including Bucharest), in 2017

DO	e-Distribuție Muntenia
Planned urban SAIDI (min/year)	14.81
Unplanned urban SAIDI (min/year)	113.35

**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2018**

The aggregate values for CAIDI are shown in the table below. The aggregate values for the case of planned interruptions for E-Distribuție Muntenia, below the national average value of 301.78 (min/year). Through the planning measures taken, this indicator can be reduced, as it is registered at E-Distribuție Muntenia, where the minimum duration of an interruption (power recovery time) was short. This indicator is quantified for users actually affected by a network event.

**Table 17 CAIDI – planned and unplanned interruptions at the level of E-Distributie Muntenia (including Bucharest), in 2018**

DO	e-Distribuție Muntenia
Planned interruptions CAIDI (min/year)	225.9
Unplanned interruptions CAIDI (min/year)	43.96

**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2018**

In the case of transmission networks, the interruptions are defined by the period of time during which a node in the system (user node or interface node with the distribution network) is not powered. The impact on users of the distribution network is not taken into account, as the transmission operator has no control over them.

Three interruption parameters are taken into account:

- frequency of interruptions (number of events);
- duration of interruptions;
- the extent of the interrupted load.

In the electricity transmission network, the indicators presented for the electricity distribution networks may be used for users directly connected to the corresponding voltage levels of the transmission network, including the interface points with the distribution network, considered as a network user. In addition, a number of specific indicators can be used to quantify the performance of the electricity transmission network, in terms of continuity in power supply.

- *Average Interruption Time (AIT)* defines the period of time when the power supply is interrupted

$$AIT = \frac{60 \cdot \sum_{s=1}^n ENS_s}{PM} = \frac{8760 \cdot 60 \cdot \sum_{s=1}^n ENS_s}{AD} \quad (4)$$

where *ENS (energy not Supplied)* is the energy not delivered during the interruption *s*, *PM* – the average power supplied from the system, *AD (annual demand)* – the total annual net energy supplied to users in a year (without the system's own technological consumption)

The *AIT* indicator is measured in minutes/year. In 2018, the values registered at the level of E-Distributie Muntenia were well below the national average values of 333.47 MWh, respectively 33.92 min/year.

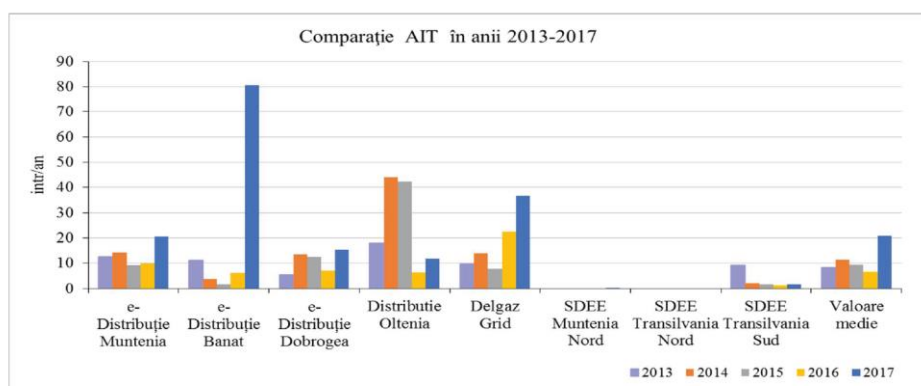
**Table 18 - AIT indicators at HV at the level of E-Distributie Muntenia (including Bucharest), in 2018**

	e-Distribuție Muntenia
ENS (MWh)	156.44
AIT (min/year)	8.75

**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2018**

Below is the evolution of the average AIT interruption time in the period 2013-2017. E-Distribuție Muntenia registers a limit value in a national context.

**Figure 21 – AIT dynamics at the level of distribution companies, in the period 2013-2017**



**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2017**

**Table 19 – The main technical parameters of electricity quality at the level of E-Distribution Muntenia, in 2017<sup>3</sup>**

Point of analysis (electrical substation/ Voltage level)	Week Analysis	No. transit. interr.	No. short interruptions	No. long interruptions	Exceeding the normal voltage change limits (number of weeks)	Exceeding the normal flicker value in the long run (number of weeks)	Exceeding the harmonic distortion factor (number of weeks)	Exceeding the negative sequence asymmetry factor (number of weeks)
Balta Albă S1-10kV	17	0	17	25	-	-	-	-
Balta Albă S2-10kV	51				-	-	-	-
Băneasa S1-20kV	52	3	14	46	-	-	-	-
Băneasa S2-20kV	41				-	-	-	-
Crângași S1-10kV	51	1	18	29	-	-	-	-

<sup>3</sup> Exceedances of normal limits for rapid voltage changes (unconfigured RVC parameter) have not been monitored. The number of transient, short and long interruptions (recorded at medium voltage downstream of the electrical substation busbars) are reported throughout 2017. For the last 5 positions, the reduced analysis time was caused by the loss of data at the time of the equipment update.

Point of analysis (electrical substation/ Voltage level)	Week Analysis	No. transit. interr.	No. short interruptions	No. long interruptions	Exceeding the normal voltage change limits (number of weeks)	Exceeding the normal flicker value in the long run (number of weeks)	Exceeding the harmonic distortion factor (number of weeks)	Exceeding the negative sequence asymmetry factor (number of weeks)
Crângași S2-10kV	49				-	-	-	-
Dr.Morarilor S1B-10kV	52				-	-	-	-
Dr.Morarilor S2B-10kV	46	0	33	48	-	-	-	-
Dr.Morarilor S1A-10kV	47				-	-	-	-
Dr.Morarilor S2A-10kV	52				-	-	-	-
Dr.Taberei S1-10kV	40	0	33	35	-	-	-	-
Dr.Taberei S2-10kV	49				-	-	-	-
Laromet 20kV	47	0	1	0	-	-	-	-
Militari S1-10kV	52	0	50	62	-	-	-	-
Panduri S1-20kV	52	0	15	32	-	-	-	-
Panduri S2-20kV	51				-	-	-	-
Sălaj 20kV	52	0	25	52	-	-	-	-
Vulcan 10kV	51	0	7	12	-	-	-	-
Vulcan 20kV	40	0	17	58	-	-	-	-
Toporași S2-10kV	37				-	-	-	-
Toporași S3-10kV	35	0	25	27	-	-	-	-
Toporași S4-10kV	37				-	-	-	-

Point of analysis (electrical substation/ Voltage level)	Week Analysis	No. transit. interr.	No. short interruptions	No. long interruptions	Exceeding the normal voltage change limits (number of weeks)	Exceeding the normal flicker value in the long run (number of weeks)	Exceeding the harmonic distortion factor (number of weeks)	Exceeding the negative sequence asymmetry factor (number of weeks)
Afumați S1-20kV	50	24	24	93	-	-	-	-
Afumați S2-20kV	52				-	-	-	-
Chitila S1-20kV	52	83	75	180	-	-	-	-
Chitila S2-20kV	51				-	-	-	-
Tâncăbești S1-20kV	52	105	80	174	-	-	-	-
Tâncăbești S2-20kV	52				-	-	-	-
ICMUG S2-20kV	52	66	41	47	-	-	-	-
Izvorul 20kV	43	81	9	20	-	-	-	-
Popești B1-20kV	15	47	45	102	-	-	-	-
Popești B2-20kV	15				-	-	-	-
IFA B2 20kV	15	11	45	81	-	-	-	-
Giurgiu Nord B2 20kV	15	163	73	198	-	-	-	-
Giurgiu Vest B2 20kV	15	64	35	80	-	-	-	-

Source: ENEL

The centralization and classification of voltage dips is presented in Annex 2.

Table 19 – Classification of voltage spikes at the level of E-Distribution Muntenia, in 2017

Point of analysis (electrical substation/  Voltage level)	Voltage increases					
	Maximum voltage $u(\%) \geq 120$			Maximum voltage $120 > u(\%) > 110$		
	$10 \leq t \text{ (ms)} \leq 500$	$0,5 < t \text{ (s)} \leq 5$	$5 < t \text{ (s)} \leq 60$	$10 \leq t \text{ (ms)} \leq 500$	$0,5 < t \text{ (s)} \leq 5$	$5 < t \text{ (s)} \leq 60$
Laromet 20kV	-	-	-	2	-	-
Vulcan 10kV	-	-	-	2	-	-
Chitila S1-20kV	-	-	-	3	-	-
Chitila S2-20kV	-	-	-	2	-	-
Tâncăbești S1-20kV	-	-	-	2	1	3
Tâncăbești S2-20kV	-	-	-	-	1	1
ICMUG S2-20kV	-	-	-	7	-	-
Izvorul 20kV	-	-	-	2	-	-
Popești B2-20kV	-	-	-	3	-	-

*Note: In the case of the other analysis points, no voltage increases were registered.*

At E-Distribuție Muntenia, the main parameters of electricity quality were recorded in 45 electrical substations (Balta Albă, Băneasa, Crângași, Dr. Morarilor, Dr. Taberei, Laromet, Militari, Panduri, Sălaj, Axas, Vulcan, București Centru, Dudești, FCME, Increst, Iremoas, Jilava, Mașini Grele, Mega Mall, Mihai Bravu, Pipera, Solex, Titan, Văcărești, Clejani, Colibași, Giurgiu Nord, Giurgiu Vest, ICMUG, Izvoru, Cucuruzu, Marsa, Pietrișu, Prundu, Uzunu, Afumați, Chitila, IFA Măgurele, Popești-Leordeni, Tâncăbești, Arcuda, Buftea, Căciulați, Copăceni, Glina), in 92 analysis points, for an average annual duration of 28 weeks. In 2018, there were 2530 transient interruptions, 1600 short interruptions and 2858 long interruptions.

Other indicators would be:

- The total number of connection complaints/ TCA appeals in 2018 was 2800, the maximum number being recorded at e-Distribuție Muntenia (1299 complaints).
- *The average response time to connection complaints/ TCA appeals* was 12 days at LV and 19 days at MV, values close to the national average.
- *The number of complaints regarding the quality of the voltage curve*, for all consumers, was 4170 on average per country, of which 986 complaints in E-Distribuție Muntenia (962 at LV and 24 at MV), with a slight increase compared to 2017.
- *The average response time to complaints regarding the quality of the voltage curve* was 9.69 days at LV and 13.54 days at MV, at LV being recorded the minimum values at country level and the maximum term of 20 days, set in the Standard.

- The *number of written applications/suggestions/complaints or requests on other topics than those explicitly referred to in the Standard* was 85694 throughout the country (compared to 78055 in 2017 and 58526 in 2016). The maximum number was registered at E-Distribuție Muntenia, of 33313, where the highest number of users in the urban area is recorded at country level.
- The *average response time to written applications/suggestions/complaints or requests on topics other than those explicitly referred to in the Standard* had a weighted average value of 15 days at LV, respectively 13 days at MV and HV, nationwide. At the level of E-Distribuție Muntenia there were 11 days at LV, 14 days at MV and 9 days at HV, the maximum term being 30 days at LV.

In the whole country, there were 1829 *written complaints on other topics than those explicitly referred to in the standard, that could not be resolved*, of which 95 at E-Distribuție Muntenia.

Tabel 20 – The main quality indicators of the E-Distribution Muntenia activity

		E-Distribuție Muntenia
Complaints related to measured data	LV	7360
	MV	114
	HV	-
Average response time to complaints related to measured data	LV	7
	MV	7
	HV	-

Number of users disconnected for non-payment	E-Distribuție Muntenia
LV	4004
MV	38
HV	-

Average reconnection time from the moment when the DO/user is notified about the payment (days)	E-Distribuție Muntenia
LV	2
MV	1
HV	-

DO	E-Distribuție Muntenia
Number of phone calls	751361
Number of answered calls	727417
Number of calls not answered within 60 s	25760
Percentage of calls not answered within 60 s	3.54%;
Average response time to phone calls (s)	22

**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2018**

### Compensation granted to users

Tabel 21- The value of the compensations granted to electricity users from Bucharest, in 2017

Performance indicators Unfulfilled		E-Distribuție Muntenia
Power supply continuity	No.	2282
	RON	122650
Technical quality of distributed electricity	No.	293
	RON	23445
Commercial quality of electricity distribution service	No.	11312
	RON	1018940
TOTAL Compensations	No.	13887
	RON	1165035

**Source: Report on the achievement of performance indicators for electricity transmission, system and distribution services and the technical condition of electricity transmission and distribution networks for 2018**

At the level of Bucharest City, in 2018 there were 22 incidents, representing 55 % of a total of 40 internal incidents in the network of the distribution operator E-Distribuție Muntenia. These incidents were caused by failures of the network elements (defective cables and cords, bypassed insulators, defective equipment in the electrical substations), being predominant the failures of the electric power lines in medium voltage cables. As a result of these incidents, which lead to interruptions in the supply of users and to the decrease of the continuity indicators of the electricity supply, corrective maintenance measures were necessary.

In 2018, at the level of E-Distribution Muntenia, 61.4 % of maintenance operations was represented by corrective maintenance, and 38.6 % by preventive maintenance. It is necessary to increase this percentage associated with preventive maintenance, by developing an elaborate plan for maintenance works, as well as by investing in network elements.

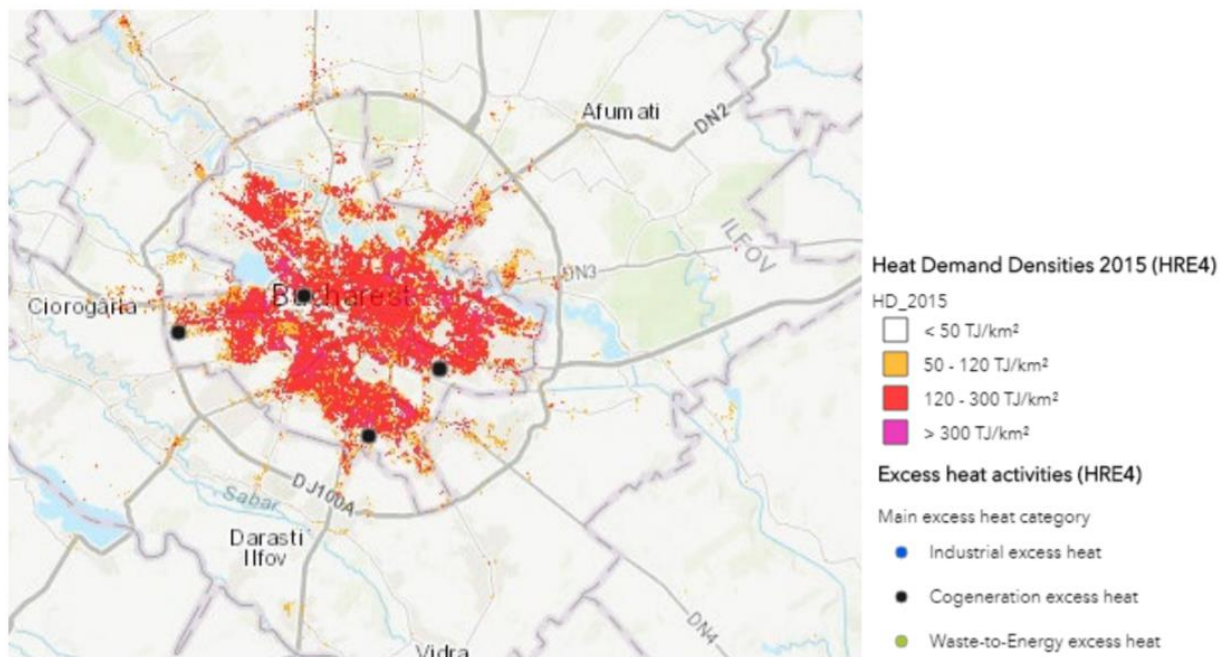
**Significant incidents at the level of the electricity distribution network are presented in Annex 3**

## 4. THERMAL ENERGY INFRASTRUCTURE

### 4.1. The thermal energy market in Bucharest

Bucharest has the largest district heating system in the country, with 561,213 apartments (approximately 1.2 million people) connected in 2018, representing about 50 % of the total heating consumers in centralized system in Romania. The system provides heat for 8,200 apartment blocks and 320 individual buildings, plus 5,400 non-residential consumers (public institutions, social entities, schools, hospitals, commercial buildings, industrial consumers, etc.). The district heating system in Bucharest concentrated in 2018 about 41 % of the total heat demand in Romania, respectively 48 % of the total connected households. In Bucharest, the district heating system currently covers 72 % of the total heat demand (residential and non-residential), of which the residential heating represents 88 %. The total demand amounts to 3.8 million GCal/year, a relatively stable value over the last 3 years, but by about a third lower than in 2004, due to the reduced demand for industrial heat, to the rising average temperatures, to energy efficiency measures in buildings (thermal insulation of blocks of flats) and to disconnections from the heating system. At the same time, the density of heat demand in Bucharest remains quite high, and the heat sources are relatively close to consumers compared to other cities, which makes the centralized system basically the most efficient heating solution for the city.

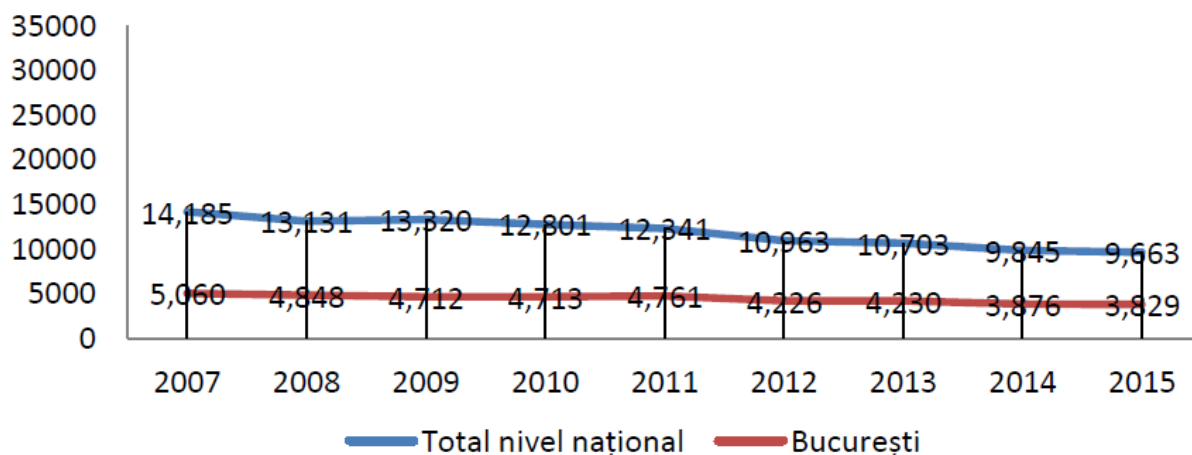
Figure 23 - Density of heat demand in Bucharest



Source: Romania Heat Roadmap, 2018<sup>4</sup>

<sup>4</sup> [https://vbn.aau.dk/ws/portalfiles/portal/288427732/Country\\_Roadmap\\_Romania\\_20181005.pdf](https://vbn.aau.dk/ws/portalfiles/portal/288427732/Country_Roadmap_Romania_20181005.pdf)

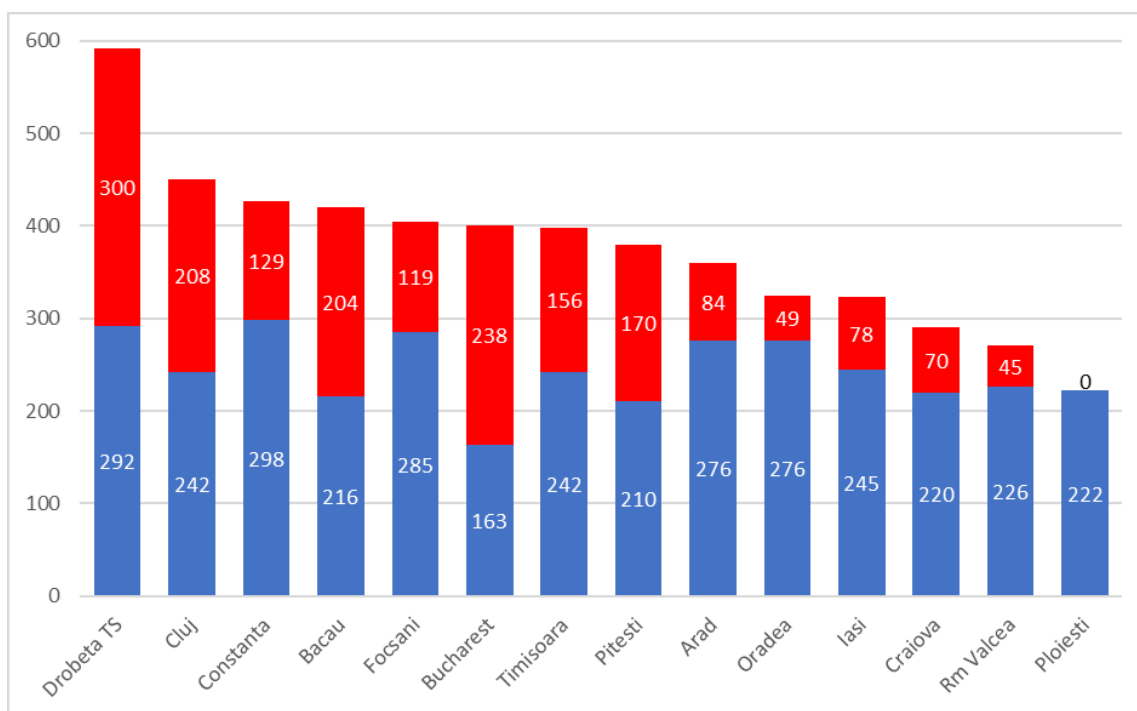
Figure 24 - Dynamics of thermal energy demand, Bucharest vs. national



Source: NIS The TEMPO Online database

Unlike the situation of district heating systems in most other cities, the number of official disconnections from the centralized heating system in Bucharest is low, about 1 % over the last 5 years (8 % since 1990) or less than 1,000 apartments per year. 99.7 % of the buildings have a meter for each block entrance and about half of the apartments are equipped with heat cost allocators. The rate of receipts from consumers is very good (over 97 %). However, the low disconnection rate is mainly due to the significant subsidy of the tariff to the final consumer, which is among the lowest in Romania. Consumers pay only about 40 % of the total cost recognized by ANRE (the National Energy Regulatory Authority) and approved by the General Council of Bucharest City.

Figure 25 – The tariff to the final consumer for thermal energy in district heating system, RON/GCal, at the end of 2018



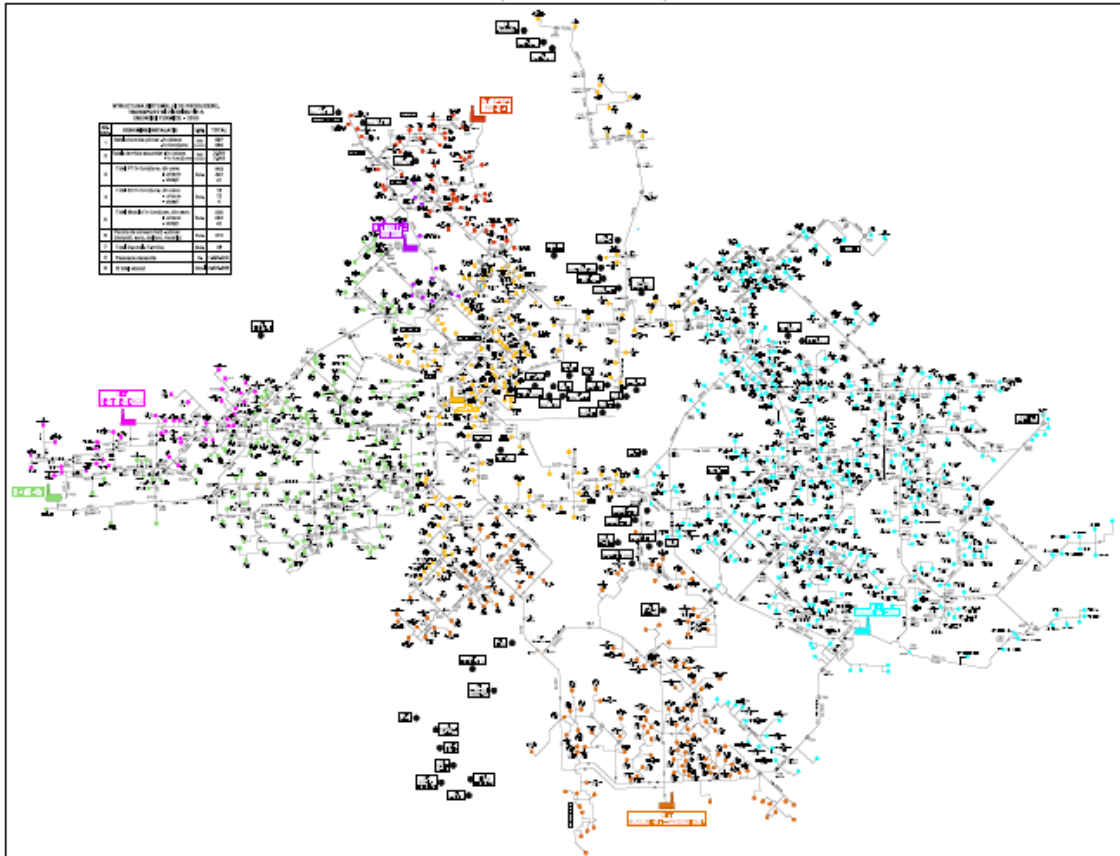
Source: ANRE report on SACET, 2018. Bucharest has the lowest tariff for end users among the cities with district heating systems and one of the highest subsidies, although it is the richest city in Romania.

**The officially recognized total cost for generation, transmission, distribution and supply is about RON 400 / Gcal, while the tariff for end users is RON 163 / Gcal.** The Municipality has the legal right to set a tariff for the end user below the approved costs, provided that it pays the difference (RON 237 / Gcal) as a direct subsidy to the district heating company. The regulated cost for heating (RON 400 / Gcal in 2018) is, actually, also an underestimation of the real costs incurred in the supply chain of the heating agent, as it is based on prices for natural gas and prices for CO<sub>2</sub> emissions that were valid in the previous year, without adjusting the tariff subsequently to the actual prices. The regulated cost, although calculated based on a methodology by ANRE (the regulatory authority), must obtain a political approval by a vote in the local council of Bucharest City, which tends to limit the increase of regulated costs. Therefore, the financial problems of the district heating system in Bucharest are caused by: delays in payment and partial payment of historical subsidies and of the ones for the current year, by PMB; the fact that regulated tariffs do not fully recognize real costs; and administrative problems, such as inconsistencies between payment terms - between consumers and RADET, between RADET and ELCEN, between them and the tax authorities - which generate additional penalties.

**The central heating system in Bucharest consists mainly of the supply and distribution network, owned by the municipality; and thermal energy generation capacities, owned by the central administration.**

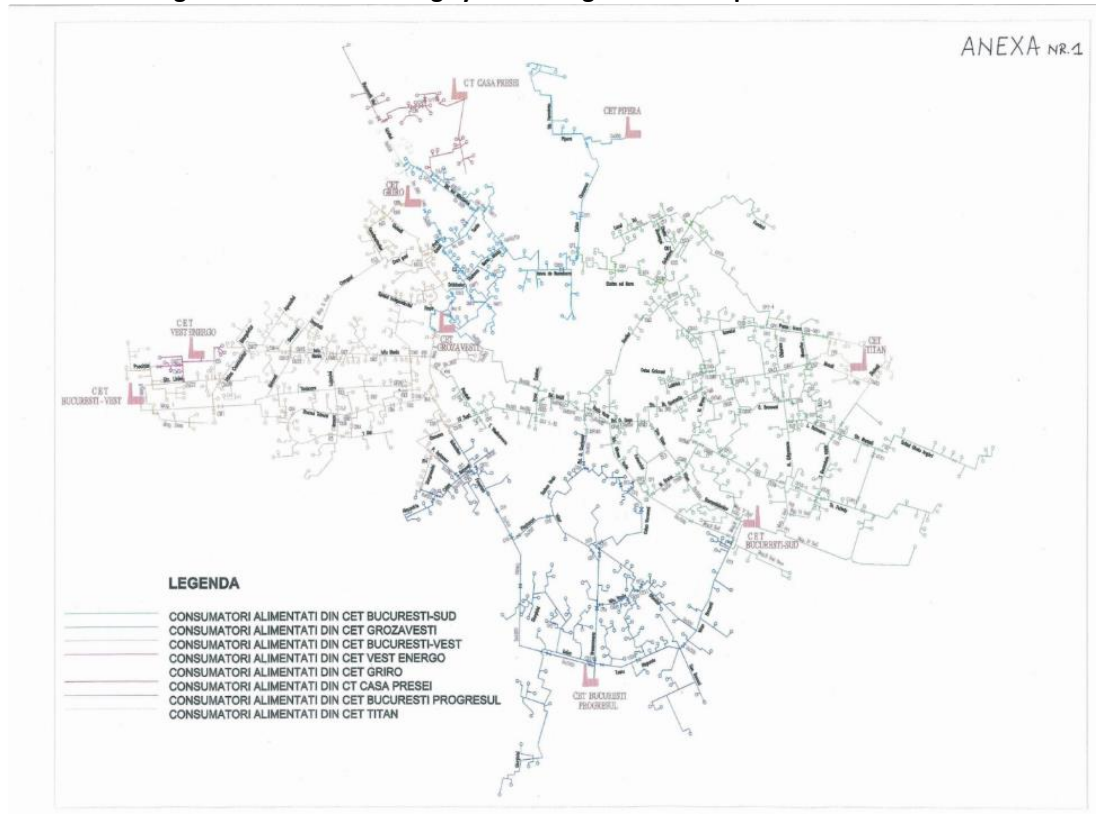
- the network (transmission, distribution, stations, small heat producers for reheating water after transport) was managed until November 2019 by RADET, a semi-commercial entity ("autonomous administration") subordinated to PMB. The network consists of 954 km of primary network and 2963 km of secondary pipelines. The primary network includes an inner ring, which basically allows all CHPs to supply heat in any part of the city. After RADET was declared bankrupt, the operation assets previously managed by this company was transferred, from December 1<sup>st</sup>, 2019, to the municipal company Termoenergetica, which has PMB as majority shareholder (99.9 % of the share capital), to which are added the commune Chiajna and the town Popești-Leordeni. The direct delegation of the service to this municipal company was made not by the Municipality, but by an intercommunity development association (ADI Termoenergetica Bucharest-Ilfov), to which the 3 above mentioned TAUs delegated their own attributions regarding the establishment, organization, regulation, financing, monitoring and joint operation of SACET, but also to jointly carry out investment projects. This model has been successfully applied in most Romanian counties for sewerage, sanitation or even public transport services, being an institutional model approved by the European Commission.
- Generation capacities: over 90 % of the heat in the district heating system is produced in 4 CHPs owned by ELCEN, a state-owned company whose shareholder is the central government (currently the Ministry of Economy, Energy and Business Environment). The rest of the thermal energy is produced in two small CHPs (one private – Vestenergo, and one owned by a sector municipality – CHP Grivița, sector 1), a small CHP owned by RADET (Casa Presei), plus 46 block plants owned by RADET.

Figure 26 – district heating network in Bucharest



Source: Bucharest City Hall

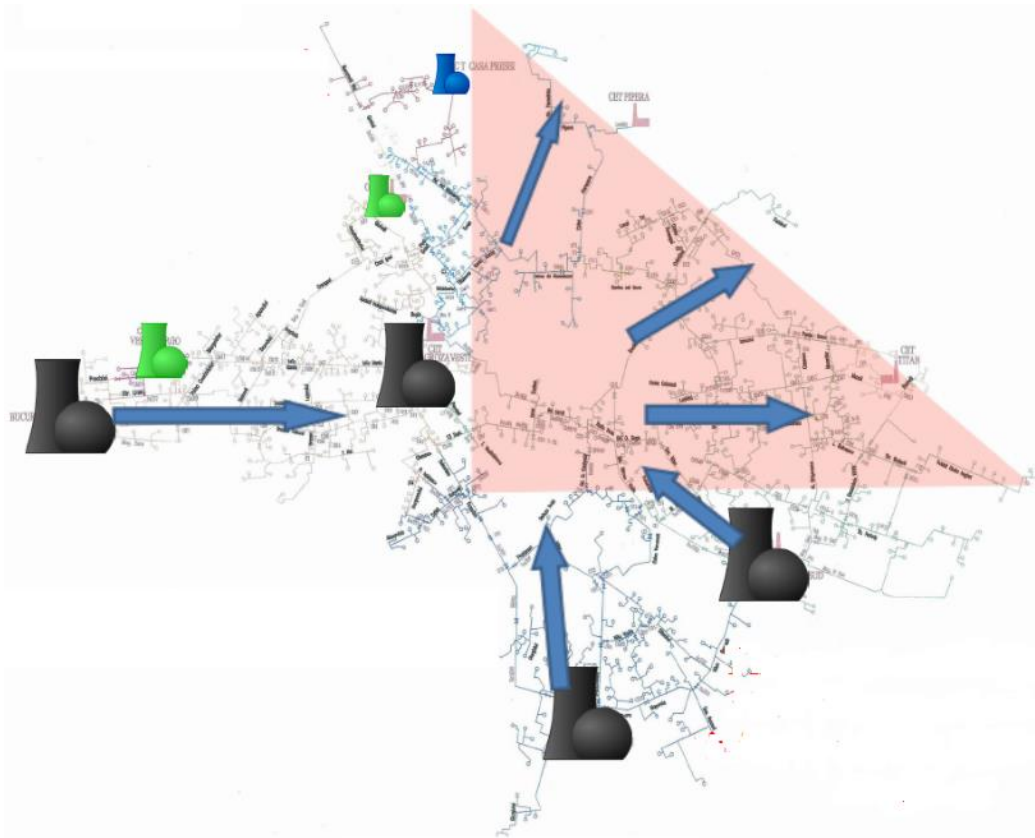
Figure 27 - district heating system and generation capacities before 2009



Source: Bucharest City Hall

The map illustrates the system as originally designed. In 2009-2014, CHP Titan and CHP Pipera were closed, currently the north and east of the Capital having no thermal energy source nearby. The two areas are fed mainly by CHP București Sud. The flow of thermal energy is currently illustrated below

**Figure 28 – Thermal energy supply at present**



Source: Gabriel Dumitrașcu, 2017

## 4.2. Quality of services and consumer satisfaction

The quality of the service has fallen substantially in recent years, as the system is morally and physically worn out and investments have been much delayed (see section below); this reduces consumer confidence in the viability of the district heating system. In recent years, no new connections have been registered to the district heating system, although the residential and commercial real estate sector in Bucharest has developed rapidly, because all real estate developers opt for gas heating plants, for apartments or blocks. For buildings already connected, the official low disconnection rate, compared to other cities, is caused by several factors:

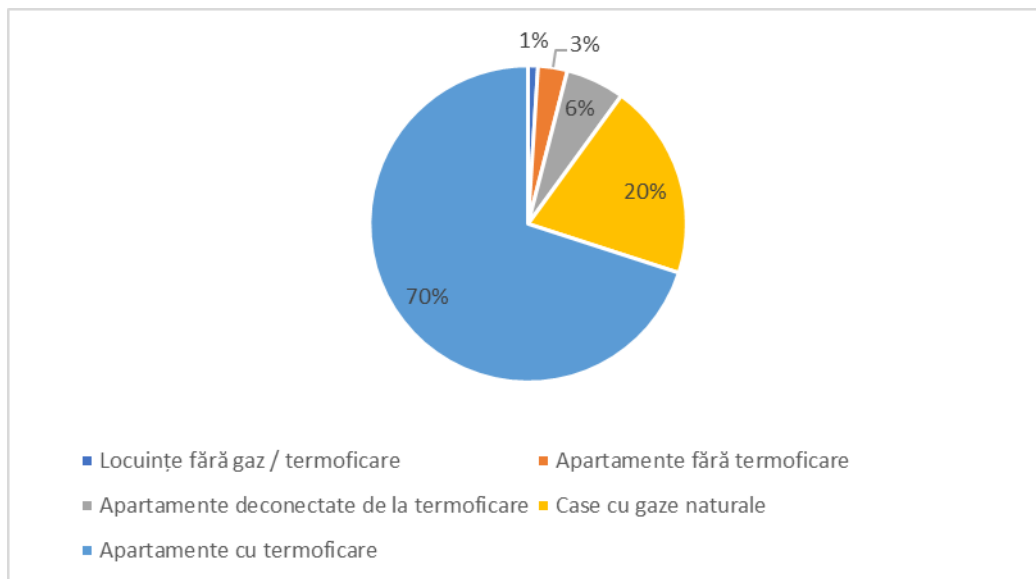
- low rates for the final consumer (practically the lowest price per gigacalorie in Romania);
- the absence of an intentional policy at municipality level to completely shut down the system (unlike cities like Galați, where the municipality started a subsidy program for apartment power plants and encouraged disconnections);
- quite difficult disconnection procedure (Law 325/2006 on central heating tries to discourage disconnections by imposing administrative barriers. However, the fact that many of the municipalities in the cities that still have district heating have adopted policies intended to close them has facilitated disconnections in these cities).

Although officially the disconnection rate is low, it is very likely that the number of commercial or unofficial disconnections will be much higher, although it is not known exactly. In the areas of

Bucharest where the quality of service is poor (no hot water or heating for several days/weeks), consumers are disconnected *de facto*. Most likely, in these areas consumers improvise ad-hoc alternatives, minimizing their consumption in the district heating system, more exactly they simply no longer rely on it for heating and hot water. However, such consumers will not appear in official disconnection statistics, as they are disconnected only from a commercial point of view, not physically. Still, the legal deterrence of disconnections makes has its logical motivation, with a view to maintain a certain level of demand in order to increase the economic viability of the centralized system, an objective which cannot be achieved if consumers disconnect commercially and the demand is low anyway.

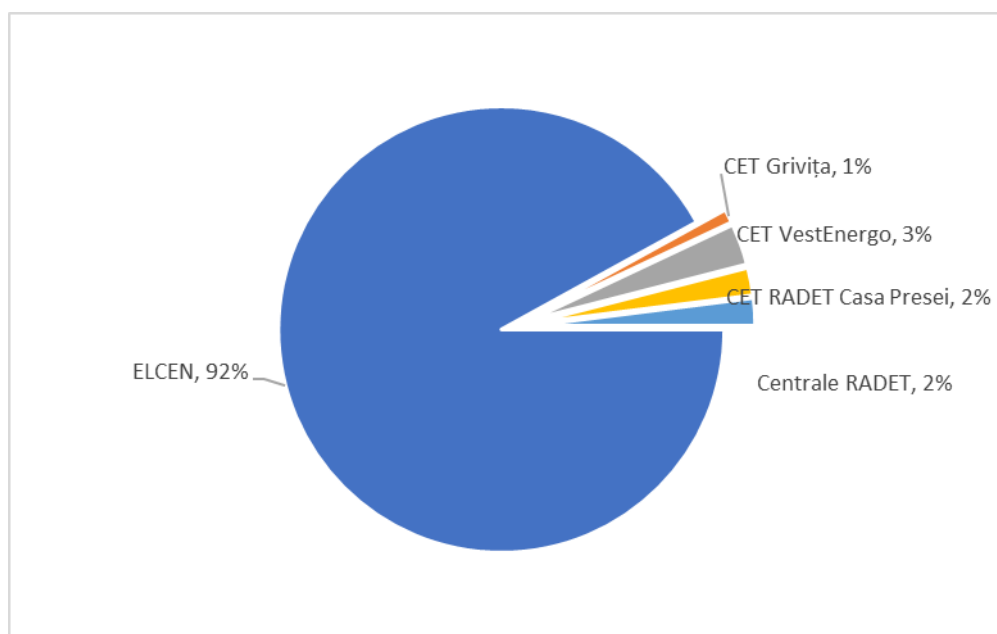
In the winter of 2018/2019, there have been officially 3,500 failures (interruptions or supply under normal parameters for heating and hot water) and failures are expected to be much more severe this year (larger areas affected, longer periods, both for heating and for hot water). In two neighborhoods of Bucharest (Aviation in Sector 1, Colentina in Sector 2) there have been hot water interruptions for several weeks since September. Shorter interruptions for both heat and hot water have occurred frequently since October in various parts of the city, although at least in some cases the number of failures has been officially reported lower. An accident at one of the CHP Grozăvești boilers in November 2019 caused a total interruption for one day in areas from two sectors until the boiler was repaired, because the RADET network could not take heat from other CHPs in compensation. Other major failures to sections of the transmission mains led to interruptions of several hours in various areas of the city, although the weather was not cold. The growing number of failures (total interruptions, supply under parameters) suggests that the Bucharest system risks to become physically inoperable in a few years, if quick solutions are not found for repairs and investments.

**Figure 29 - Heating sources in the residential sector of Bucharest, in 2018**



Source: JASPERS

Figure 30 - Sources of thermal agent in the district heating system, 2018



Source: JASPERS

#### 4.3. Moral and physical wear and tear of the system

The thermal energy distribution network, owned by the Capital, consisting of approx. 1000 km of transport pipelines and 3000 km of distribution pipelines, is very outdated, over 70-80 % being older than 25 years. As of 2017, the network is experiencing losses of 30 % (20 % in the transmission network and 10 % in the distribution network), mainly due to old, oversized pipelines and to the four-pipeline system. By 2018, only 13 % of the distribution network and 19 % of the transmission network had been replaced by pre-insulated pipes.

**Table 22 - Assets of the district heating system in Bucharest**

<b>Capacități de producție, inclusiv reîncălzire în T&amp;D</b>			
	MWe	MWt	Vechime
<b>ELCEN</b>			
București Sud	550	2262 (din care 1100 cogen)	Majoritatea 1965-1966
București Vest	250	1208 (din care 371 cogen)	Majoritatea 1972-1974
București Vest ciclu cor	186	198 (cogen)	2009
Grozăvești	100	912 (din care 215 cogen)	Majoritatea 1964-1966
Progresu	200	1054 (din care 684 cogen)	Majoritatea 1987-1992
<b>VestEnerg</b>	23	53 (din care 22 cogen)	2011-2014
<b>Grivița</b>	11	59 (cogen)	1965 (50%), 2009 (50%)
<b>RADET</b>			
Casa Presei		100 (căldură)	1996
Centrale de cvartal		271 (căldură)	Majoritatea 1960-1975
<b>TOTAL</b>	<b>1320</b>	<b>6117</b>	
<b>Rețea</b>			
		Km	Vechime
Transport		987	81% înainte de 1995
Distribuție		2963	62% înainte de 1995
<b>TOTAL</b>		<b>3950</b>	

**Source: World Bank data, collected in 2018**

**The losses consist of heat losses in the transmission and distribution network; but also increasing water losses.** The centralized heating system was originally designed to operate at pressures of 13-15 bar at peak demand (mostly industrial) during the winter. In the late 1990s, after a large part of the industry was closed, pressures gradually dropped to 10 bar and now reaches only 3.5-4 bar, with return pressures of about 3 bar. Because of this, inefficiencies are accelerating: lower pressures lead to lower quality of service (lower temperatures for end users because the water flow is slower) and higher heat losses in the network. RADET, and from the winter 2019/2020 the new operator TERMOENERGETICA, requests from ELCEN lower pressures at the points of entry into the district heating network, because of the decrease of demand, but also because the pipes would be damaged at higher pressures, increasing water losses, a direct consequence of the lack of investments in the network. Additional water pumped into the system to compensate for physical water losses has doubled in the last decade and now reaches volumes of 2000 m<sup>3</sup>/h with peaks of up to 2600 m<sup>3</sup>/h; losses recorded at maximum demand can be physically borne by the district heating system for limited periods of time (several hours). It is estimated that about 10 % of the water in the district heating system is lost through damaged pipes. ELCEN's ability to process additional water pumped into the system is also limited; in certain periods, partially treated water is pumped into the pipes - demineralized to avoid sediments, but not degassed to avoid the formation of acids. In turn, this further corrodes the network and accelerates the deterioration of the entire system.

In May 2019, the General Council of Bucharest City (CGMB) approved the establishment of the Municipal Company ENERGETICA SERVICII. This company took over the projects for replacing 31.6 x 2 (63) km of thermal energy transmission pipelines (I, II, III South mains, II-III Grozăvești mains, I-III West mains, Progresul-Berceni mains, respectively Progresul-Ferentari mains), modernizing the Amzei block heating plant, building a new cogeneration unit in one of the neighborhoods far from CHPs (e.g. Aviației, Colentina, Pantelimon, Balta Albă, Titan). To these are added preventive and corrective maintenance activities of the network.

Also in 2019, CGMB approved a rehabilitation project (resizing and replacement with pre-insulated steel pipes) of the district heating system in Bucharest, comprising 25 objectives, with a length of 106 x 2 (212) km of thermal energy transmission pipes, with a total value of the investment of RON 1,182 million. The project is estimated to be submitted in 2020 for financing from European funds, through LIOP 2014-2020. In case the financing will be approved, the value of the works will be settled only until December 31<sup>st</sup>, 2023. It is estimated that the project will lead to annual savings of RON 67 million, by reducing energy losses to 22.4 %. For the 2021-2027 programming period, PMB is preparing another project that should ensure the upgrade of another 240 km of district heating network, also with European funds, but the implementation horizon is longer (possibly until 2030). Therefore, in the medium term about 500 km of the heat transmission network could be upgraded.

**On the generation side, most of the capacities are physically and morally worn out and few new investments have been made over the last decade.** Only VestEnerg (private) and București Vest (combined cycle unit), plus some smaller capacities, have been upgraded. The combined cycle unit from București Vest power plant would need another capital investment program before 2030 to extend its life.

**If no investments are made in generation capacities (estimated at over EUR 500 million), ELCEN will have to shut down most boilers and cogeneration units by 2023, because they are not compliant with environmental standards and will be able to supply only about 20 % of today's heat generation.** Most existing generation capacities operate on the basis of temporary derogations from the NOx emission standards - 2 boilers from București Sud and Progresu power plants are authorized to operate until mid-2020, while another 11 boilers can operate until the end of 2023. The only capacities that will comply with environmental standards after the end of the derogation periods are the combined cycle capacity from București Vest power plant (which produces 170 GCal/h) and two boilers (100 GCal/h x 2), while the maximum demand is 1800 GCal/h. The financial situation of ELCEN, an insolvent company, which claims to have to collect from RADET (bankrupt company) about RON 4.8 billion, allows only to a very small extent to make these investments. Also, the insolvency status does not allow to attract European funds for this purpose.

However, ELCEN started several short-term investments to comply with environmental requirements, namely:

- refurbishment of two hot water boilers (HWB) with a capacity of 100 GCal/h - at CHP București Vest and CHP Grozăvești - completed in 2019;
- upgrade of the combustion system and of the process control system at the steam boilers 2,3,4 from CHP București Sud - estimated completion deadline June 30<sup>th</sup>, 2020;
- upgrade of the combustion system and the process control system at the steam boilers 2,3,4 from CHP Progresul - estimated deadline: quarter I 2020.

In this context, the new reorganization plan of ELCEN was approved in March 2020, and provided for the transfer of the business by the Romanian state to PMB or to an entity appointed by it, with a view to put in place an integrated centralized heating system, within 6 months. A second option is a partnership between the state and PMB to establish a new entity and to take over ELCEN's assets, possibly also those of TERMOENERGETICA, in order to make the integrated system functional. The third option would be for the Ministry of Economy, or an entity designated by it, to take over ELCEN's assets. If the Romanian state is not interested in this transaction, ELCEN's assets will be sold to any private investor who meets the business and legal requirements. In addition, the recovery of the claim held by ELCEN against RADET, estimated by the company at RON 4.8 billion, will be done in court, through demarches to incur liability on PMB.

**Despite the obsolescence and the delay of investments, there is practically no alternative to the district heating system in Bucharest, not only for the supply of heat, but also for electricity.** On the

one hand, the switch to alternative heating sources is limited in the short term - e.g. the 560,000 apartments could be connected to individual heating systems by the distribution operator in 10 years, at best, as the operator does not have the capacity to connect more than 50-60,000 apartments per year. There are also other significant risks and challenges regarding boilers or other individual heating solutions: increased pollution close to the consumer, health risks, risks of explosions from improvisations for heating, major accessibility problems for vulnerable consumers, “free-riding” behavior (full disconnection and heating from the neighbors, through the walls), security of supply – district heating works with reserve fuels, unlike apartment plants that require both gas and electricity. On the other hand, the total installed electricity capacity of cogeneration plants from ELCEN and smaller producers is about 600 MW, while the maximum consumption in Bucharest is about 7-800 MW (h/h). There is no other large capacity to produce electricity around Bucharest (the closest are in Ploiești and Giurgiu, about 50 km away); the electricity transmission network is quite outdated and congested around Bucharest, which limits the ability to bring electricity from elsewhere. At the same time, the demand for electricity in Bucharest will increase, considering the rapid development of the city. The possible closure of ELCEN, after the shutdown of the district heating system without replacing it with another solution, would affect the city's electricity supply. In other words, there is no alternative but urgent investment in restructuring and updating the system as a whole.

#### 4.4. Needs and upgrade plans

**Although all stakeholders agree that investment is urgent and that there is no viable alternative to district heating, a scenario has not yet been reached by all parties on how district heating should be restructured to meet current demand and upgraded to keep up with the developments in the city.** In order to summarize the various strategies, memoranda and documents on this topic, approved from 2009 to date, there are several visions on the future optimal structure of the district heating system. The diversity of options is partly caused by the institutional complications of all these options and the different agreements between the entities involved, on their role in the future system– ELCEN, RADET/Termoenergetica, Ministry of Energy, PMB, private and potential investors, etc. (see institutional chapter below).

Thus, some are considering the **merger of ELCEN and RADET/TERMOENERGETICA into a vertically integrated central heating system**, with a monopoly on the heat generation, transmission, distribution, supply, an option that has been considered also as a solution to erase the historical debts and to allow the owner (PMB) or a private concessionaire to take full responsibility for the city's heat supply service, while restructuring both the generation capacities and the network. This vision appears, for example, in the PMB strategy approved in 2017<sup>5</sup>. Others see the future of centralized heating as a system in which **the network is managed separately as a natural monopoly**. Several producers (ELCEN, VestEnerg, CHP Grivita and future investors) would have non-discriminatory access to the network and compete with each other to provide heat to end users, a solution that is possible considering the size and ring structure of the district heating network. Such a solution would be technically compatible with the existence of several producers, including renewable sources, heat storage, with producer-consumers (“prosumers”) and could foster innovation, so it is considered a more “progressive” approach. This was an option considered in a previous strategy, prepared by international consultants (Grontmij Carl Bro) and approved by PMB in 2009<sup>6</sup>.

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<sup>5</sup> [http://acteinterne.pmb.ro/legis/acteinterne/AtachInt/AnexaH260\\_17.pdf](http://acteinterne.pmb.ro/legis/acteinterne/AtachInt/AnexaH260_17.pdf)

<sup>6</sup> <http://www.amrsp.com.ro/index.php/analize-studii-rapoarte-elaborate-de-amrsp/strategia-energetica-a-municipiului-bucuresti-carl-bro-ath-energ>

Despite the new strategy of 2017, which goes for the option of vertical integration, the idea of a competitive heat market with non-discriminatory third party access is still *de facto* supported by various actors, including (or especially) by independent producers. It is likely that this second option will reappear on the agenda once the municipality begins to seek, in an active way, investors in generation capacities for the north and east of the city<sup>7</sup>, where ELCEN CHPs had been closed years ago, where currently the biggest problems with heat supply appear, and where there are no new investment plans from current operators.

Although both strategies (2009, 2017) were officially approved, neither was implemented after adoption. There are multiple solutions for each option (for example, *monopoly* - the merger of RADET and ELCEN by taking over RADET by ELCEN, including the transmission network, to settle historical debts, 2011; the transfer of ELCEN to Bucharest Municipality, 2013; acquisition of ELCEN by the Municipality, 2016; establishing a new municipal company, 2016-2019, etc.; *competitive market*: the "single buyer" model; the idea to build 5-7 new medium-sized generation capacities, with a total of about 300 MW in cogeneration; the transformation of the 46 decentralized units owned by RADET in neighborhood power plants, mainly only boilers for heat generation and with small cogeneration capacities, etc.). Each of these solutions has its merits and disadvantages, but a decision must be taken once and for all and it has to be implemented systematically for at least a decade with consistent investments and works, if we want the district heating system to become sustainable. In Annex 1 we summarized the main "scenarios" regarding the heating system in Bucharest.

**Unfortunately, none of the above visions seems to take into account the need to involve the consumer in an active manner in the reform of the district heating system.** For example, an alarm signal is the fact that none of the developers of Bucharest's new residential complexes is considering to connect to the central heating system (unlike the connection to any other utility). It should be noted instead that real estate developers in other cities, such as Iași or Oradea, connect the new apartment blocks to centralized heating systems, because there the district heating works well and consumers have confidence in the future of the system. The problems that Bucharest faced in the last years regarding the heat supply have activated social networks groups, where consumers with financial capacity and resources to disconnect and install their own apartment plants share their experiences, offer legal solutions for disconnection and analyze the most effective solutions. Even if "disconnection activists" are not necessarily a majority or statistically relevant, the reform of the system will need consumers with this profile: good payers, active, with

enough financial resources to support the increase of the investment tariff and the elimination of subsidies (painful measures, necessary for the reform), but they are also quite visible in consumer communities<sup>8</sup>.

**The network needs to be resized to meet the current demand and has to be completely upgraded, but most of the work undertaken so far has been to replace the pipe segments in case of major failures, with water and heat losses.** The commercial density of the thermal agent is 1.5 MW of heat

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<sup>7</sup> In November 2019, the municipality approved a project that allows RADET to launch a tender for the purchase of thermal energy in the north and east of Bucharest -

[http://www4.pmb.ro/wwwt/institutii/CGMB/sedinte/ordinea\\_de\\_zi/db/02\\_20191114.pdf](http://www4.pmb.ro/wwwt/institutii/CGMB/sedinte/ordinea_de_zi/db/02_20191114.pdf). This project is, in fact, compatible only with the principles of non-discriminatory third party access and a competitive heating market. The idea would be in contradiction with the philosophy of the strategy adopted in 2017 and with the fact that Termoenergetica should have, according its Articles of Association, (in the future) a monopoly for the generation of thermal energy.

<sup>8</sup> ELCEN understood this risk and recently set up a Facebook page, COGEN Romania, through which it tries to inform the general public about the advantages of district heating, the technical solutions, etc.

per one meter of network, well below the minimum of 2 MW needed for a district heating system to be efficient, which suggests that the network is substantially oversized. Despite the need to restructure the network, most of the capital currently invested is used only to resolve quickly the critical failures. Starting with 2004, the investments amounted to RON 30-120 million/year (EUR 7-25 million/year), reaching a maximum level in 2007-2010. In the period 2017-2018, the average capital investments in the network reached only EUR 1 million/year; although the budget initially allocated was higher, the actual expenditures were lower (the money being reallocated towards the end of the year to other priorities, due to the planning and organization problems related to procurement and works).

Thus, in 2019, the investments budgeted for RADET were of RON 68 million (approximately EUR 14 million), but the actual expenditures until September were of only RON 5.2 million (EUR 1.1 million). As regards the distribution, only 180 km of pipeline have been replaced in the last 3 years (30 km in the primary network, 150 km in the secondary network); the plan is to replace another 64 km by the spring of 2020 (20 km in the primary network , 44 km in the secondary network). As these works consist of the simple replacement of the pipe segments with major cracks, they do not contribute to the upgrade and to the necessary reduction of the pipe size, which means that these investments will be lost if a major renovation program begins. A note, replacing the entire network every 30 years would mean at least 33 km/year for the transmission network and 100 km/year for the distribution network – disregarding the urgent need now for investments to reduce losses.

**Table 23 - Investments in the district heating system (transmission and distribution networks), PMB budget, million RON**

	Sume bugetate	Sume cheltuite	
2014	50	50	
2015	55	25	
2016	40	40	
2017	86	7.5	
2018	76	9.7	
2019	68	5.2	Sep 2019

**Source: Own calculations based on the annual financial statements published by PMB**

*Note: these amounts allocated to capital expenditure are not investments for the system upgrade, but especially for the replacement of severely damaged pipes.*

**Table 24 - Situation of price subsidies granted by PMB for thermal energy**

SITUATIE DIFERENTA DE PRET LA ENERGIA TERMICA (2007-2019)							
An	Contravaloare deconturi aferente ian-dec	Sume incasate ian-dec	din care: avans pentru an urmator	decont acoperit din avans an precedent	incasare aferenta sold an precedent	diferenta neincasata aferenta ian-dec	lei (cu tva)
0	1	2	3	4	5=6-7	6=1-(2-3-5)-4	Observatii
							7
2007	286,021,057	185,041,200				100,979,857	100,979,857 neachitati
2008	596,071,268	480,535,733				115,535,535	72,685,640 neachitati
2009	676,257,364	529,660,422			42,849,895	189,446,837	145,789,267 neachitati
2010	775,539,270	402,576,430			43,657,570	372,962,840	228,632,883 neachitati
2011	747,528,813	623,150,000			144,329,957	268,708,770	167,265,118 neachitati
2012	589,701,786	526,869,219			101,443,652	164,276,219	incasat pana la 20,03,2013
2013	625,048,233	487,000,000			164,276,219	302,324,452	incasat pana la 13,08,2014
2014	598,005,056	552,000,000			302,324,452	348,329,508	incasat pana la 07,08,2015
2015	628,495,646	850,868,501			348,329,508	125,956,653	incasat pana la 18,01,2016
2016	608,140,975	820,105,606	108,856,117		125,956,653	22,848,139	incasat pana la 30,01,2017
2017	694,427,006	719,147,514	125,801,735	108,856,117	22,848,139	15,073,249	incasat pana la 01,02,2018
2018	766,370,606	507,183,607		125,801,735	15,073,249	148,458,513	incasat pana la 13,03,2019
2018 (acoperire pierderi)	165,574,997	165,574,994					incasat cf HCGMB 556 si 822/2018
2019 (ian-oct efectiv) + nov estimat (110 mil lei)	723,162,036	764,620,550			148,458,514	107,000,000	decont aferent noiembrie 2019

**Source: Own calculations based on the annual financial statements published by PMB**

*Note: some of the late payments derive from the way the budget is constructed, on an annual basis, with a winter season overlapping the corresponding budgets for two years.*

**A program to upgrade the district heating network would require around EUR 800-900 million for either option; it should be noted that the investment plan of the former RADET operator reflects its view that the thermal energy will be generated mostly in the 46 block plants (decentralized units), which would be transformed into neighborhood plants.** In other words, there is a clear mismatch in the RADET and ELCEN plans with regard to the model of the district heating system. EUR 8-900 million is an approximate figure, presented by various experts, and includes resizing the system with smaller diameter pipes, network adjustments to meet the current level of demand and the integration of distributed, next generation capacities and network digitization. Basically, the upgrade of the district heating system by designing and installing pre-insulated transport pipes with modern valves and pumps, together with a modern fully automated compact station for each building and the option of heat regulation at the building level could drastically reduce heat losses to only 5-8 %, according to Western standards. However, considering that there is no agreed scenario for restructuring the system, some consider a solution with a district heating network roughly on the current structure, but with smaller diameter pipes (as demand is smaller); others consider a district heating network structured around distributed generation (neighborhood units), with more limited interconnections with other areas of the city. The RADET plan with 46 district heating plants is the most decentralized option (distributed generation). In short, RADET's latest investment plan for 2017 (retrospective, unrealistic) consisted of<sup>9</sup>:

- upgrade of 250 km (x 2) of the transmission network in 2018-2022 and of the rest of the transmission network in 2023-2024
- high efficiency cogeneration unit to replace the boiler at Casa Presei in the period 2018-2020
- modern district heating dispatcher in the period 2019-2021
- installation of high efficiency thermal boilers in neighborhood power plants with an efficiency of over 91 % and automation until 2028
- installation of pre-insulated distribution pipes and station metering and automation in the period 2025-2028.

This plan also assumed that CHP Grozăvești and CHP București Sud would be modernized in 2018-2020 and CHP București Vest and CHP Progresu in 2021-2023.

For the implementation of the above-mentioned strategy, RADET considered to attract funds from the EIB, EBRD and other donors, financing from PMB plus approximately EUR 180 million from EU funds under LIOP 2014-2020. Until bankruptcy, at the end of 2019, RADET failed to attract external funds.

**The 250 km (x 2) of primary network in critical areas, which were highlighted as a priority in the RADET plans for 2018-2022, were to be replaced initially from the EU/LOIP funds for 2014-2020;** however, the EU funds will cover at best 200 km, will probably be lost at least partially and it would certainly not be possible to rehabilitate 500 km over the next two to three years. Currently, the plan would be to rehabilitate in 2020-2023 about 210 km of the network from European money, to finance 60 km from the Municipality own sources in the same period, and to finance another approximately 240 km from European funds in the next planning cycle. However, funding from European money and investments depend on the system's financial viability and on the demonstrated capacity to manage and execute works of a larger scale than replacing existing pipelines with similar ones. RADET entered the insolvency proceedings in the spring of 2016 and went bankrupt in November 2019; from the beginning of December 2019, its attributions were taken over by Termoenergetica (for operation) and by Energetica Servicii (for investments). However, Termoenergetica is not currently a viable entity eligible for EU funding and has little chance of demonstrating financial capacity in a timely manner; and Energetica Servicii is not yet operational. Thus, for Termoenergetica, the initial capital of RON 650

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<sup>9</sup> <http://www.amrsp.com.ro/images/ANALIZA%20INSTITUTIONALA.%20modificari%20%20PMB%20-%202018.05.2017.pdf>

million was only partially transferred, and PMB had not signed the advance payment agreement for gas until the end of February 2020, a necessary condition to avoid the accumulation of more debts, which was the main cause of RADET's bankruptcy.

The institutional situation and the solutions for reorganization of the district heating system in Bucharest were carefully analyzed by JASPERS in the previous years; the emphasis was on the financial viability of the system before the project could be discussed with the EC. In these conditions, it is unlikely that the EC will agree to transfer funds for the district heating system in Bucharest without any firm guarantees that PMB will pay the subsidy from now on and that Termoenergetica will not go bankrupt during the period when the project is financed with European money. The risk of operator's bankruptcy also affects the prospects of Energetica Servicii, even if it (and not Termoenergetica) would be the entity in charge of investments, because in any case the EC will be interested in the sustainable operation of the district heating system *after* ending the project. In December 2019, the General Council of Bucharest City adopted several decisions, including some related to the LIOP project: approval of technical and economic indicators and of the project itself, a project sent to Brussels before the end of the year to avoid reallocation of money<sup>10</sup>.

**In terms of generation capacity, ELCEN's plans for 2020-2030 amount to EUR 520 million and reflect ELCEN's views that thermal and electricity generation capacity will be located as in the current situation, in CHP Grozăvești, Sud, Vest and Progresul.** This plan is consistent with the paradigm of keeping ELCEN and TERMOENEGETICA as separate entities, and to have ELCEN competing with other companies, with the risk of incompatibility with the plan for a vertically integrated district heating system, which implies a lower need for thermal capacity in existing CHPs and more decentralized generation capacities. In short, the main investment needs proposed by ELCEN by 2030 would require around EUR 520 million, and consist of<sup>11</sup>:

- a) CHP București Sud:
  - refurbishing HWB 1 and 2, for which the derogation regarding the number of operating hours will expire in 2020, in order to be able to operate at least until 2023 (2x100 GCal/h);
  - upgrade/replacement of HWB 5 and 6 for recommissioning – hot water boilers that have been withdrawn from operation in 2016 (2x100 GCal/h);
  - maintenance of steam turbines 3 and 4 in order to ensure operation after 2020.
- b) CHP Grozăvești:
  - upgrade of the combustion system at the steam boiler 1, for which the derogation regarding the number of operating hours will expire in 2020, in order to be able to operate at least until 2023;
  - refurbishment/replacement of HWB 3 in order to be able to operate after 2020 (capacity 100 GCal/h);
  - implementation of a combined cycle power capacity of 50 MWe/35 GCal/hour;
- c) CHP București Vest:
  - refurbishment/replacement and return to operation of HWB 2-3-4-5 to ensure the necessary thermal energy after 2020, units that have been withdrawn from operation in 2016 (capacity 100 GCal/h);

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<sup>10</sup> It should be noted that in the initial version of the LIOP, 500 km (250x2) of the transmission network were to be rehabilitated by 2023; then the program was adjusted in January 2019 to include only 200 km (100x2), in the same amount. Even so, it is unclear whether 200 km of the network can be completed by the end of 2023, given the current pace of work, and so far there is no phasing plan to avoid the risk of total decommitment of funds if the works cannot be completed on time. At the same time, there are not enough own funds to carry out the rest of the works provided in the RADET plans and to attract loans.

<sup>11</sup> 2017 strategy and ELCEN investment plans

- maintenance (capital repair) of HWB 6 and 7, to ensure continuous operation until 2023, when the derogation expires;
- upgrade of automation systems in the combined cycle power plant;
- d) CHP Progresul:
  - maintenance of HWB 1-2-3 for keeping them in operation until 2023, when the derogation expires; refurbishment/replacement of these units in order to ensure operation after 2023 (2x100 GCal/h);
  - maintenance for keeping in operation the steam turbines 2,3,4.

In the medium term (post 2020), ELCEN's investment plan also provides for the development of two cogeneration groups in combined cycle, with a capacity of 200 MWe/170 GCal/h at CHP Progresul and CHP București-Sud, and for the rehabilitation of the combined cycle of CHP București Vest and its extension with a new unit.

Funding is available for (co) generation investments, provided that these investments contribute to reducing emissions (through the EU-ETS GHG trading scheme, in accordance with Directive 2018/410). The list sent by the Ministry of Energy to the European Commission in July 2019 includes the construction of three cogeneration plants by the private producer VEST ENERGO, in the Băneasa, Faur and Preciziei neighborhoods, respectively the refurbishment/construction of ELCEN's top thermal energy generation capacities, located at CHP Grozăvești, București Vest and București Sud. These would bring an additional generation capacity of about 434 GCal, involving total investments of EUR 52 million. The chances to finance these projects are debatable, at least in the case of ELCEN, which is a company in insolvency.

Another possible source of funding could be a new cogeneration bonus scheme (a mechanism for collecting a contribution from electricity consumers to support high-efficiency cogeneration); the current scheme expires in 2023 and no new investment has been encouraged through this mechanism of 2016. Renewables could also be supported by a new mechanism, after the completion of the current 2020 green certificate scheme.

#### 4.5. Institutional roles and challenges

**The current institutional configuration has been complicated by successive failed attempts to solve the problem of historical debts, without taking responsibility for difficult decisions such as adjusting tariffs, attracting investments, clarifying responsibilities and reforming the district heating system.** The table below summarizes the key developments in terms of property rights, the legal and institutional configuration since the first debts began to accumulate since the late 2000s. The roles of the main players in the system are as follows:

- **The Municipality of Bucharest (PMB):** owns the network and transferred to RADET, then to TERMOENERGETICA (via ADI TERMOENERGETICA București-Ilfov) the operation of transmission, distribution and supply of thermal energy. For district heating, PMB includes in its own budget amounts for tariff subsidies and investments. However, for more than a decade, subsidies have been paid only partially, generating arrears and penalties; and real investments have been substantially lower than what was initially budgeted, especially after 2016. The problem is also complicated by the manner in which the PMB annual budget is constructed (the heating seasons overlap with the end of a fiscal year and the beginning of the following year, which means that, in order to minimize the deficit at the end of the budget execution, some expenses are postponed until the next budget year); and different payment terms (45 days for payments from consumers to TERMOENERGETICA, 60 days for payments between TERMOENERGETICA/ELCEN/ROMGAZ, etc.).
- **AMRSP:** a local regulator for municipal utilities in Bucharest, established in 2009; the idea of a local regulator was born in the late 1990s, after the concession of the water and sewerage

service. Although it is declared an autonomous regulator, AMRSP operates under the coordination of the General Mayor and largely monitors the utility contracts between the municipality and the local utilities providers (water/wastewater and sewerage, waste, public lighting, local public transport, street signage). Periodically AMRSP issues reports on the supply of district heating services and performs quality checks or controls the execution of works; being under the coordination of PMB, it cannot be a regulator in the true sense of the word, i.e. independent.

- **ANRE:** the regulator of the energy sector, it took over the attributions regarding the district heating from the municipal utilities regulator (ANRSC) in 2016. It grants licenses for the thermal energy operators. The operators submit requests to increase tariffs, ANRE examines the application and proposes a tariff that is politically approved, by vote in the local councils of the local authorities. There is no standard tariff methodology as in the case of electricity and gas, and tariffs are set only according to the "cost plus" method. For example, in the meeting of December 18<sup>th</sup> CGMB sets its own methodology for determining the tariffs for thermal energy in Bucharest. In addition, there may be differences between the ANRE tariffs and the tariffs applied locally to the end user, while the municipalities are committing to pay a price subsidy.
- **RADET:** the operator of the transmission and distribution network, holds the monopoly of the supply, transmission and distribution of thermal energy in Bucharest. As of November 2019, RADET is bankrupt. From 2016 until December 2019, RADET went into insolvency and carried out its activity under the supervision of a judicial administrator (Rominsolv) and of a special administrator; from December 2019, the judicial administrator was replaced at the request of the creditors, and the special administrator became the director of Termoenergetica. Insolvency and bankruptcy were mainly caused by failure to pay the subsidy on time. When the insolvency was declared, the debts between RADET and ELCEN amounted to EUR 850 million (of which about 25 % represented the principal debt, and the rest were penalties), while ELCEN owed EUR 400 million to gas suppliers. (For comparison, PMB's total budget for 2019 was around EUR 1.4 billion).
- **Termoenergetica,** a company owned by ADI Termoenergetica, took over the RADET activity from December 1, 2019, respectively the transmission, distribution and supply of thermal energy. There are some problems in the articles of association of Termoenergetica, which might disrupt its future activity. The risk areas are: the establishment of Termoenergetica by dividing a company that is contested in court; The articles of incorporation contain provisions taken from the articles of incorporation of Energetica, through which the company was to have a monopoly for the generation of thermal energy (which means ELCEN or Vest Energo could face in the future the problem of legality for thermal energy supply); the rapid granting of the ANRE license in the current form of the company, although the licensing conditions are not adequately met (because it was not actually adequately capitalized for the purchase of thermal energy for the current heating season); taking over completely all RADET contracts, not only the operation of the district heating service, considering that it is possible that these contracts have RADET assets, as works in progress, in which the RADET creditors have priority; most likely, there was not enough time to complete an adequate inventory for this transfer to avoid these risks. All these issues, as well as the quick elaboration of the project with European money so as not to risk disengagement of funds, were hastily approved, in order to avoid the risk of interruption of heat supply in the winter season and loss of investment money. However, the approved documents contain many inaccuracies that could lead to lawsuits, legal blockages, appeals and, implicitly, delays in carrying out reforms.
- **ELCEN:** the largest producer of thermal energy for Bucharest, its main shareholder is the Ministry of Economy, Energy and Business Environment. The company has been insolvent since 2016, due to arrears from RADET caused by the accumulation of debts regarding the PMB subsidy. In addition, it owes money to its suppliers (mainly the gas producer Romgaz,

who has as majority shareholder the Ministry of Economy, Energy and Business Environment, but has an important minority shareholder - Fondul Proprietatea/Templeton – and is listed on the Bucharest and London Stock Exchanges). Both RADET and ELCEN owe money to the tax authorities (ANAF). ELCEN has a special administrator, and the main decisions are taken by the General Assembly of Creditors.

- **The Ministry of Economy, Energy and Business Environment:** majority shareholder in ELCEN and Romgaz. Dividing responsibilities for the central heating service between PMB and the ministry discourages overcoming the current deadlock regarding system financing and debt cancellation, a situation aggravated by the fact that the two entities are led by representatives of opposite political parties, and 2020 is an election year, with local elections in spring and general elections in autumn.
- **ADI Termoenergetica:** The Association for Intercommunity Development for district heating was created at the beginning of 2018 by the municipalities of Bucharest, Popești-Leordeni and Chiajna (the last two being two small TAUs, close to Bucharest). In the long run, ADI would make sense if the district heating system in Bucharest will work so well as to realistically consider the extension to other localities where new residential complexes are being developed, but this is not the case currently. Now, the creation of ADI will only cause delays in all matters previously related only to CGMB, because all decisions (e.g. approval of local tariffs, investment plans, etc.) must be taken in all 3 local councils – Bucharest, Popești-Leordeni and Chiajna. The delegation of the contract to Termoenergetica in November, for example, had to be approved in all 3 TAUs. An ADI is organized as a voluntary association of TAUs (communes, cities, municipalities, counties) that provide together a public utility (for example, water or waste management); legally it is an NGO of public interest without real authority, all its decisions require prior agreement in all local member councils of ADI.

## 4.6. Scenarios regarding the supply of heat and hot water in Bucharest

The analysis below contains very rough estimates regarding the two scenarios proposed for restructuring the system (merger vs competitive market) and for the case where a short-term decision is not taken regarding the district heating in Bucharest.

**1. Integrated SACET model** (fusion of generation capacities with the network). This scenario would involve maintaining the current generation capacity (upgrading capacities, but maintaining the current location of CHPs); investments from the ELCEN plan for the upgrade of the 4 CHPs and boilers; investments in two CHPs in the northern and eastern area, to compensate for the closure of CHP Palas and CHP Titan and to extend the system in the area where Bucharest expands with new residential complexes. The transmission and distribution network is maintained, while replacing the old pipes with pre-insulated pipes of smaller sizes. The territorial distribution of today's system is preserved and can later be extended to the areas where apartment blocks are built.

Investment needs: - about EUR 1.5 billion (without extension)

- Current ELCEN program (EUR 520 million)
- 2 new CHPs to compensate for the closure of the Titan and Pipera CHPs (50 MWe + 50 MWt, x 2), approx. EUR 100 million<sup>12</sup>
- Rehabilitation of the transmission and distribution network on the existing structure - RADET's current plan without significant investments in neighborhood power plants - EUR 900 million (500 million for the transmission network, 400 million for distribution and thermal stations; replacing the current vertical distribution system in apartment blocks with horizontal distribution is also an option taken into consideration, to reduce losses and to allow the customer a better control over their own consumption)

**Disadvantage:** The new CHPs must be built from the integrated operator's own funds, it would be difficult to attract private investors because they cannot compete with today's players, or they will ask for a supply contract with fixed price for heat, sold "at the plant's gate", based on a long-term binding agreement. The system is not flexible, there will be a monopoly price (unique for the city) and relatively few incentives for innovation, integration of new producers, prosumers, new technology.

**Advantage:** A single player would be responsible for the entire district heating service, without fragmenting the decision. One option may be to lease the system to a private company (one of the major international players in the energy sector). In 2013-2014 there were potential investors interested in the concession of the entire system and the simultaneous restructuring of generation capacities and network. The regulatory capacity at municipality level (AMRSP) will have to be strengthened for the monopoly.

**2. The competitive market model:** THERMOENERGETICA network remains under the administration of the municipality, at a regulated tariff. The transport network (today's transport ring) is strongly strengthened. Investments are being made in the 46 neighborhood power plants and some thermal points are being transformed into zonal power plants. The CHPs are kept, being in competition with each other, but the capacity to generate thermal energy in boilers is substantially reduced, their capacity being taken over by the neighborhood or zonal power plants. Thermal energy producers (zonal, CHPs, etc.) can be in public (e.g. sector municipalities) or private ownership; they must be separated from Termoenergetica and will have non-discriminatory, regulated access to the grid. CHPs

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<sup>12</sup> Note: the current location for the proposed waste incineration plant is too far away from the areas most affected by the failures of the centralized system, i.e. the north and east of the capital, and we did not take it into account in any of the scenarios.

will compete across the city with each other and with small area producers. The market is liberalized, consumers conclude contracts with the chosen supplier; the only regulated component remains the network tariff.

Investment Needs: - approx. EUR 1.5 billion

- ELCEN program for CHPs, without heat boilers - about EUR 300 million
- New CHPs in the northern and eastern areas - EUR 100 million
- Rehabilitation of the network, whose size needs to be reduced more than in scenario 1 because there will also be decentralized generation, closer to the consumer, but additional amounts will be invested in zonal power plants and thermal points. The distribution network is also being rehabilitated; as above, an attempt is also made to replace the current system of vertical distribution in apartment blocks with a horizontal distribution system, in order to reduce losses and to allow the consumer to have a better control over their own consumption - EUR 950 million
- Private or sector investments in new capacities (small CHPs, boilers in congested areas) - EUR 150 million

Disadvantage: requires to reconsider the system and the responsibilities of the municipality and of the AMRSP regulator; it is the only city in Romania with such a system and there are no similar experiences, but the model would be suitable for a system the size of Bucharest. The model is close to the Western developments (e.g. Copenhagen).

Advantages: it allows the evolution of the system depending on the dynamics of city development. Part of the investments (new CHPs, boilers) can be made by private individuals, provided that the return on investment is safe (elimination of subsidies). Prosumers, thermal energy storage capacities, renewable energy in the northern part of the city (geothermal), etc. can be integrated in the system. The total amounts are close to the investments required in scenario 1, but can be made to a greater extent by private players. Consumers have the freedom to choose between several competing suppliers. The transmission network could be resized with less surface work (new, smaller pipes can be inserted directly inside the existing heating pipes and canals).

3. Abandonment of the centralized heating system (the de facto option for the scenario in which no decision is made in the immediate future). The district heating system can no longer cope in a few years due to accelerated losses, and consumers disconnect (commercially or physically).

Consequences: only a part of the consumers can afford their own apartment plants, and the connection rate reaches the maximum capacity (50-60,000 individual plants per year, compared to 560,000 apartments currently connected to district heating); investments in heating systems can be exclusively private, but only a part of consumers can afford the investment, and they have to wait a while "in line", without any heating, until the gas operator can make the connection. Consumers who cannot afford their own modern power plant and a variable price of gas give up the access to heating or make improvisations, with increased risks of accidents and higher pollution<sup>13</sup>. In the event that the municipality will want to reduce social pressures (a large number of consumers who cannot afford an individual plant) or will want to decrease the risks caused by dangerous improvisations, it will have to grant subsidies for the purchase of plants – for example, in Galați all consumers could request a subsidy of about RON 3,000 per apartment; in Bucharest, the full subsidy for all households, on the

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<sup>13</sup> There is no estimate regarding the pollution that would be produced by the individual solutions; in the 2017 strategy, a score is given to this scenario for this criterion, showing that the pollution estimate is very high.

same pattern, would require EUR 360 million (the amount could be reduced if subsidies were granted only to consumers who have an income per capita below a certain amount).

In order to maintain the level of electricity generation, ELCEN should give up CHPs and boilers and replace the existing cogeneration capacities with electricity generation capacities - at an average cost of EUR 0.7 million/MW; the total replacement of today's electricity capacity, without taking into account the increasing trend of consumption in Bucharest (600 MW) would imply a total cost of EUR 420 million. Unlike cogeneration capacities, for which there support schemes are possible (10c, 10d, cogeneration bonus), these should be financed entirely from own funds. There would be private interest in investing in electricity capacities, but in recent years, because of legislative ambiguities, private interest in investing in the electricity sector has diminished (for example, in 2019 no private investment was made, despite a deficit of capacity).

## 5. TELECOMMUNICATIONS INFRASTRUCTURE

Eurostat and INS data on the use of information and communication technology show, in the case of Romania, a significant increase in the percentage of households with Internet access, from 38 % in 2009 to 81 % in 2018. The Bucharest-Ilfov region was ranked first in Romania from this point of view, with 96 % of households with Internet access, but also with a percentage of 89 % of those who had internet connection at home (35 % with narrowband connections, 14 % with mobile broadband connections, 17 % with fixed broadband connections). According to Eurostat data, 94 % of households in the region have broadband Internet access (which places the Bucharest-Ilfov region in Europe's top 30 in this respect).

Regarding the share of internet users in the total population, 94 % of the inhabitants of Bucharest-Ilfov region have used or are using the Internet – also the highest percentage of the Romanian regions, of which 88 % in the last 3 months, 10 % in the last year and 2 % more than a year ago. Most of them (94 %) used mobile devices (phone / smart phone) to make the connection, while 71 % (also) used a PC, 48 % a laptop, and 36 % a tablet. About 86 % of respondents use the Internet daily, and 12 % at least once a week, the maximum frequency of use being recorded, for both sexes, in the 16-34 years age group. On the other hand, if 97 % of students use the Internet daily or almost daily, the percentage drops to only 49 % for retirees.

Most of those interviewed by the INS indicated that they use the Internet for socializing (86 % of the total), for finding information about goods and services (59 %), and for email correspondence (59 %). These goals vary with age. Thus, if 95 % of pupils and students use the Internet for social media, in the case of retirees the percentage reaches only 70 %. In contrast, 56 % of retirees search for health information on the internet, compared to 20 % of young people, while the share of those who inquire about goods and services does not vary significantly depending on age and occupation. Email communication is used mainly by pupils and students (76 %), respectively by employees (66 %), the percentages being double compared to the one for retirees (37 %). On a different note, young people intensively use the online environment to listen to music (77 %), to play games (62 %) and to watch movies (30%). It is also worth noting that the unemployed record very high frequencies in the case of social media (92 %), of listening to music (65 %), playing games (45 %) and watching movies/shows (20 %), well above the percentages of employees who use the Internet for such purposes.

Among the internet users, only 12% used the online environment to interact with authorities or public services for personal reasons, a lower percentage than in the Central and South-Muntenia regions. They searched mainly for information on the institutions' websites (86 %), they downloaded official forms (61 %), and sent them (52 %). Therefore, correlating the data, only 6 % of citizens submit forms online. Those who did not use this feature invoked as reasons the lack of skills or knowledge in using the sites, namely the fact that someone else sent these documents on their behalf.

An interesting aspect is the continuous increase in the number of internet users who buy products and services online, reaching 53 % in 2018, far above other regions in the country. This phenomenon is more frequent in the case of people under 35 years of age, employed and with higher education. In the top of purchases are sports clothing and equipment (73 % of all those who made purchases), books/magazines/newspapers (25 %) and household products (23 %). The share of Bucharest residents who used identification procedures for online services for personal purposes was 83 % in 2018, more than double compared to other regions in the country, which indicates the fact that they paid increased attention to safety in use.

The share of those who access the internet at work is 57 % in the Bucharest-Ilfov region, the highest in the country. The purpose of use is related to sending emails or entering data into databases (87 %), creating or modifying documents in electronic format (60 %) and using programs specific to the field of activity (51 %). However, over 43 % also use the Internet for social media (Google, Facebook,

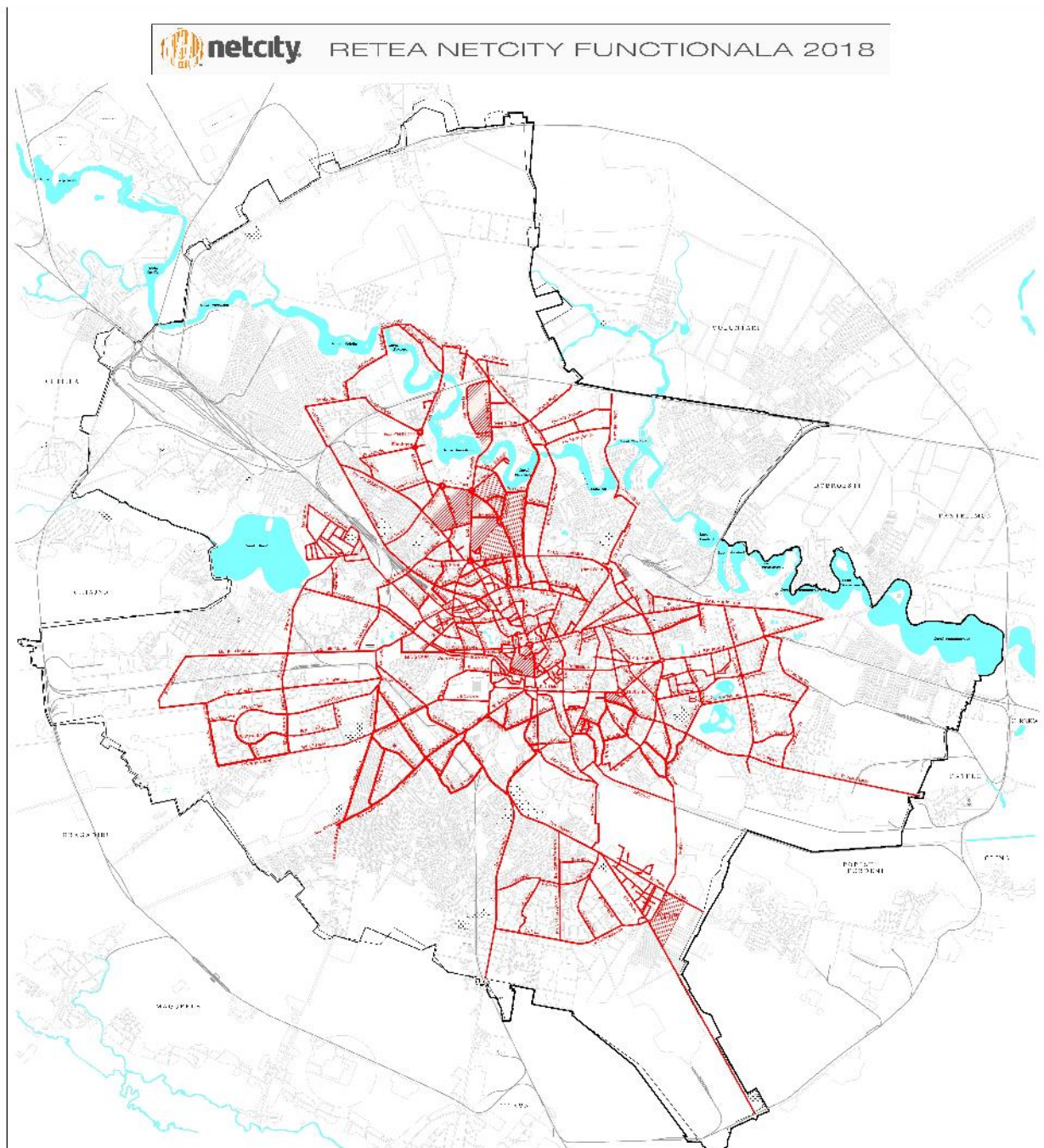
LinkedIn, etc.). Interestingly, 10 % of Bucharest residents use the Internet to operate computerized machines and equipment, a percentage similar to that of the North-West and Central regions. 25 % of employees indicated that they would need continuous training in the field of internet use to cope with the specific tasks of the job, a higher percentage in the case of people with basic education (who use the internet in a proportion of only 2 % at work) and of those over 55 years old. More than half of the respondents stated that the introduction of internet use at work did not bring significant benefits in terms of time spent on repetitive tasks, independence in organizing work tasks, performance monitoring, time spent acquiring new skills, number of extra hours. On the other hand, 46 % of them believe that using the online environment has facilitated collaboration with colleagues and collaborators.

Regarding the development of skills for using the internet, 76 % of users developed them through individual study or free online training, 28 % (also) received on-the-job training, 17 % followed courses paid by employers, 9 % were trained from public funds, and 4 % paid the training from own funds. Most of them have improved their skills in the field of social media use, data analysis and database management, and IT security.

Bucharest has an important competitive advantage in terms of broadband internet speed (fixed connections), ranking in April 2015 on the 7<sup>th</sup> place globally in Ookla Net Index, with a download speed of 95.18 Mbps. Although there is no more recent information on the position of Bucharest in the global hierarchy, the data available at national level suggest that this competitive advantage is maintained: in August 2019, when Romania ranked on the 4<sup>th</sup> place globally (after Singapore, Hong Kong and South Korea) in terms of broadband internet speed (fixed connection) – 131.22 Mbps (according to speedtest.net data). The same source places Romania on the 39<sup>th</sup> place in terms of the speed of the mobile internet connection (35.40 Mbps), but the adoption of 5G technology could determine the country's rise even in this ranking.



Figure 32: NetCity telecommunication network – 2018



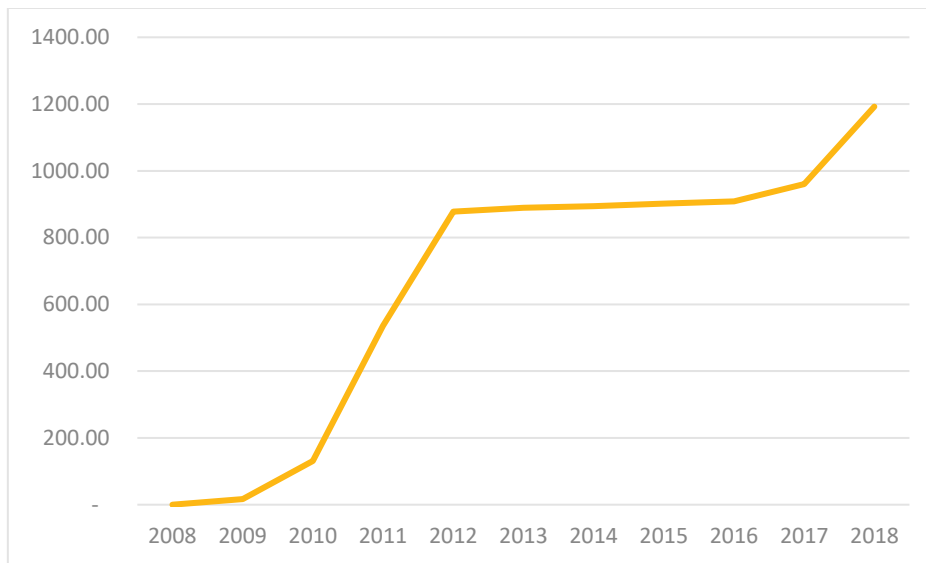
Source: NetCity Telecom SRL

The map above shows the underground telecommunications network (fiber optic cables) in Bucharest – a network managed by SC NetCity Telecom SRL. The network is present on most main arteries, but there are neighborhoods/areas not yet served: Ferentari, Andronache, Tei, Doamna Ghica, Șos. Chitilei - Bucureștii Noi, Giulești neighborhoods, the northern area of the Militari neighborhood or Cotroceni neighborhood.

The graphs below illustrate the significant evolution of the underground fiber optic network in Bucharest – from 0 km in 2008, the network reached 1,192.4 km in December 2018, with a significant increase (about 24 % – over 130 km) only in 2018. The number of connected properties experienced

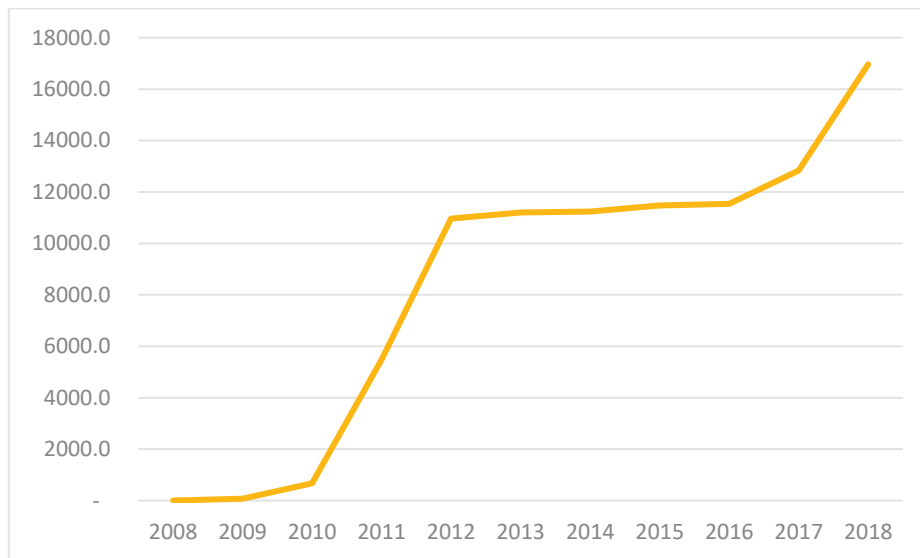
a similar evolution - 16,965 properties were connected in December 2018, an increase of about 32 % (over 4,000 properties) compared to December 2017.

**Figure 33: Evolution of the length of the optical fiber network (km, 2008-2018)**



Source: Data NetCity Telecom SRL

**Figure 34: Evolution of the number of buildings connected to the optical fiber network (2008-2018)**



Source: Data NetCity Telecom SRL

An improvement in the coverage of Bucharest City is expected following the investments made by NetCity Telecom for expanding the network in 2019. The expansion plan includes 537 streets, which would cover most of the areas still not served: Șos. Fundeni, Șos. Andronache, Șos. Gherase (for the northeast area), Șos. Chitilei, B-dul Bucureștii Noi, Șos. București-Târgoviște, Șos. Ionescu-Șisești (for the northern area), Bd. Lacu Tei and Bd. Ghica Tei (for the Tei neighborhood), Bd. Pieptănari, Bd. Uverturii, Bd. Eroilor and Bd. Dr. George Marinescu (for the Cotroceni neighborhood).

The Bucharest's optical fiber network is subject of the concession contract concluded in 2008 for the investment objective "Metropolitan optical fiber network of Bucharest City for telecommunications -

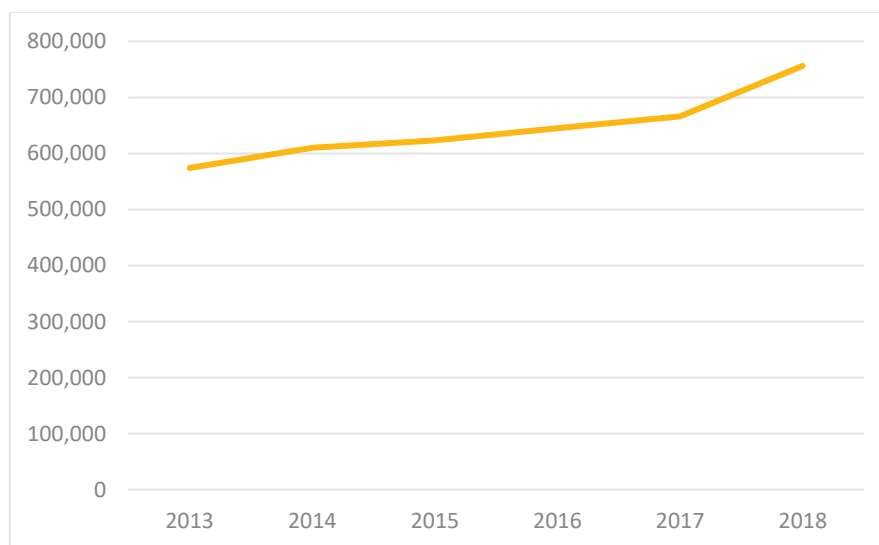
NETCITY" - contract concluded between the Municipality of Bucharest (concession provider) and S.C. UTI SYSTEMS S.A. and its affiliate S.C. NETCITY TELECOM S.R.L. (concessionaire). The object of the contract is the works for the realization and administration of the optical fiber network, respectively:

- Financing the entire project by the concessionaire from own and/or attracted funds;
- Design and execution of works on the "Netcity" network, taking into account, as far as possible, the coordination with the ongoing projects of the Municipality of Bucharest (e.g.: modernization and rehabilitation of streets).
- Supply of optical fiber equipment. Equipping with active equipment to facilitate the subsequent provision of telecommunications services at a transfer rate of at least 1 Gbps at the beneficiary;
- Operation, management and maintenance of the NetCity Network.

Through this contract, the Municipality of Bucharest grants S.C. NETCITY TELECOM S.R.L. the exclusive and unrestricted right to manage the network over the entire concession period (49 years), in accordance with the legal provisions. The royalty is 12 % of the annual income collected. During this period, the concessionaire undertakes to complete the Netcity network in 3 stages:

- Stage I – execution of the main network of Netcity and the construction of a pilot area (Historic Center of Bucharest) – completed.
- Stage II – execution of the distribution network and connections on the entire territory of Bucharest.
- Stage III – execution of the network on the entire metropolitan area, in the area of local competence of the concession provider, depending on the preferences of the concessionaire and on the future changes in Bucharest's territorial limits.

**Figure 35: Evolution of the number of fixed internet access connections (2013-2018)**



Source: ANCOM data

The analysis of the evolution of the number of fixed point internet access (data provided by ANCOM) also illustrates a significant increase, from 529,488 connections in 2008 to 756,301 connections in 2018 (increase of about 42 % – see chart below). For the number of fixed access telephone lines, data were collected only for 2009 and 2011, with a significant decrease (about 32 % in just one and a half years): from 1,162,168 access lines on July 31<sup>st</sup> 2009 to only 790,723 access lines as of December 31<sup>st</sup>, 2011. Considering the development of the optical fiber network as well as the evolution of mobile telephony since 2011, it is very likely that the number of fixed telephony access lines has continued the same downward trend so far.

Despite the very good situation in terms of internet connection speed, currently the possibility of free/open access to WiFi connections is reduced in public spaces of Bucharest. The administration of Sector 1 made in 2018 a project for the execution of a high speed wireless network, with free access, for 23 parks located in Sector 1 (over 10 ha covered with WiFi signal at Gigabit speed). In 2017, there was free WiFi internet access in Alexandru Ioan Cuza and Titan parks in Sector 3, as well as in Tineretului Park in Sector 4. In February 2019, the Municipality of Bucharest obtained funds amounting to EUR 15,000, through the WiFi4EU European initiative, for installing a WiFi network in public spaces, with free access, in a period of 18 months from the date of signing the financing agreement.

The sociological questionnaire applied to substantiate this strategy also indicates a high share of households with internet access in Bucharest (81.1 % - a lower share than in Eurostat data), as well as a very high share of homes with mobile phones (96.2 % – 2.20 mobile phones per family, on average).

## 6. PUBLIC LIGHTING

### 6.1. Introduction

From a historical perspective, in the middle of the 18<sup>th</sup> century, the first street lamps with lamp oil for public lighting were installed in Bucharest. In 1871, the Filaret Gas Plant was opened, producing oil, and in the same year, there were 785 street lamps with lamp oil in Bucharest. In 1901, Bucharest had 3,060 street lamps with oil, 990 - with mineral oil, 4,000 - with aerial gas, and 200 with arc lamps (electric light bulbs).

In 1885, the electric lighting was turned on at the National Theater. Until then, aerial gas lamps were the basis. As for street lighting, in 1890 the first two street lamps were turned on in Piața Palatului. Also in 1890, electric lighting was introduced in Cișmigiu Garden and on Șos. Kiseleff.

A census drawn up in 1923 showed that Bucharest had 2,398 streets, of which 1,873 were illuminated with aerial gas, 123 streets with oil, 24 streets had electric lighting, another 5 streets had both gas lanterns and electric energy, and 370 did not have any lighting.

From 1999 to 2019, the public lighting service was under the delegated administration of S.C Luxten Lighting Company S.A – according to the contract for delegation of the public lighting service no. 206/29.12.1997. Starting with January 2020, the Municipal Public Lighting Company took over the service, by direct delegation. These services include:

- Architectural lighting
- Lighting of parks, leisure spaces, markets and fairs
- Festive lighting
- Street and pedestrian paths lighting.

### 6.2. Organization and operation of the public lighting service in Bucharest

#### PRIMARY LEGISLATION

- Law no. 51/2006 on the community services of public utilities, republished, with the subsequent amendments and completions - general law (which also includes the amendments and completions brought by Law no. 225/2016 for the amendment and completion of the Law of community services of public utilities no. 51/2006 )
- Law no. 230/2006 on the public lighting service – special law
- Government Emergency Ordinance no. 57 of 03 July 2019 on the Administrative Code;
- Government Decision no. 246/2006 for the approval of the National Strategy on accelerating the development of community services of public utilities;
- Law no. 213/1998 regarding the public property and its legal status, as subsequently amended and supplemented;
- Law no. 273/2006 on local public finances, as subsequently amended and supplemented;
- Government Decision no. 246/2006 approving the Strategy on accelerating the development of community services of public utilities;

#### SECONDARY LEGISLATION

- Government Decision no. 745/2007 approving the Regulation regarding granting licenses in the area of community services of public utilities, as subsequently amended and supplemented;
- ANRSC Order no. 77/2007 on the approval of the Methodological Norms for establishing, adjusting or modifying the value of activities of the public lighting service;

- ANRSC Order no. 88/2007 on the approval of the Framework Regulation of the public lighting service;
- ANRSC Order no. 87/2007 regarding the approval of the Framework Specifications of the public lighting service.

## TECHNICAL STANDARDS

- SR 6646-1. Artificial lighting. Technical conditions for interior lighting and indoor lighting of building complexes;
- SR 8313. Civil, industrial and agro-zootechnical constructions. Lighting in buildings and outdoor spaces. Method of measuring illuminance and determining average illuminance level;
- SR 13433. Lighting of thoroughfares. Lighting conditions for thoroughfares meant for car traffic, pedestrians and/or bicycles and tunnels/underground passages;
- SR EN 40-1. Poles for public lighting. Part 1: Definitions and terms;
- SR EN 40-2. Poles for public lighting. Part 2: General requirements and sizes;
- SR EN 40-3-1. Poles for public lighting. Part 3-1: Design and verification. Specifications for the specific load;
- SR EN 40-3-2. Poles for public lighting. Part 3-2: Design and verification. Verification by tests;
- SR EN 40-3-3. Poles for public lighting. Part 3-3: Design and verification. Verification by calculation;
- SR EN 40-4 + AC:2007 - *correction announcement*. Poles for public lighting. Part 4: Requirements for reinforced and prestressed concrete lighting poles;
- SR EN 40-5. Poles for public lighting. Part 5: Requirements for steel poles;
- SR EN 40-6. Poles for public lighting. Part 6: Requirements for aluminum lighting poles;
- SR EN 40-7. Poles for public lighting. Part 7: Requirements for lighting poles made of composite materials based on polymers reinforced with fibers;
- SR EN 1838. Applications of lighting. Safety lighting;
- SR EN 12665. Light and lighting. Basic terms and criteria for specifying the lighting requirements;
- SR EN 13032-1 + A1 - *correction announcement*. Light and lighting. Measurement and presentation of photometric results for lamps and lighting devices. Part 1: Data measurement and presentation;
- SR EN/TR 13201-1. Public lighting. Part 1: Selecting the lighting classes; technical regulation;
- SR EN 13201-2. Public lighting. Part 2: Performance requirements;
- SR EN 13201-3. Public lighting. Part 3: Performance calculation;
- SR EN 13201-4. Public lighting. Part 4: Methods for measuring the photometric performance;
- SR EN 15193 + AC:2011 - *correction announcement*. Energy Performance Of Buildings. Energy requirements for lighting;
- CEN technical reports no. 88/1990 and no. 115/1995 – issued by the International Commission on Illumination.

## REGULATION OF THE PUBLIC LIGHTING SERVICE IN BUCHAREST

In 2007, the National Regulation Authority for Communal Household Services issued the Framework Regulation for the public lighting service. The framework regulation established the unitary legal framework regarding the operation of the public lighting service, defining the modalities and framework conditions that must be met for the provision of this service, the performance indicators, technical conditions, relations between operator and user in communes, cities and municipalities. It applies to the design, execution and maintenance of public lighting system components.

In 2020, by decision of the General Council of Bucharest City, the new Regulation of the Public Lighting Service in Bucharest was approved, replacing the one from 2015. As one of the performance indicators, the lighting level is established in accordance with SR 13433/1999 and the provisions of CIE Standard 115/95.

The opportunity study regarding the management of the public lighting service of Bucharest City, approved by the Decision of the General Council of Bucharest City No 23/29.01.2020 provides the activities that make up the public lighting service and the specific performance indicators. The Public Service of Bucharest City must ensure that certain requirements and needs of public utility are met, as follows:

- increasing the level of civilization, comfort and quality of life;
- increasing the level of individual and collective security, as well as the degree of traffic safety on public roads, for vehicles and pedestrians;
- highlighting, through adequate lighting, the architectural and landscape elements, as well as marking festive events and legal or religious holidays;
- supporting and stimulating the economic and social development of the Bucharest; safe functioning and operation of the service infrastructure.

The public lighting service is provided, on public roads, alleys and pedestrian areas, in gardens, parks but also for highlighting monuments, statues, architectural ensembles, buildings and constructions and/or public spaces of monumental value and of patrimony interest located in Bucharest, respecting the principles that govern the organization and functioning of the community services of public utilities.

The activities included in the service can be classified into two main levels:

- main activities performed within the public service
- support activities that ensure the good operation of the public service.

## Road lighting

A high level of luminance and the use of high luminous flow luminaires are required for road lighting. The lighting parameter represented by the color rendering is not very important compared to the lighting of pedestrian areas.

For the purpose of the European Union criteria, the public street lighting is defined as: „*A fixed lighting installation intended to provide good visibility to users of outdoor public traffic areas during the hours of darkness to support traffic safety, traffic flow and public security.*

This definition is derived from standard EN 13201 and does not cover tunnel lighting fixtures, private car park lighting fixtures, commercial and industrial outdoor lighting fixtures, sports ground lighting fixtures or spotlights (e.g. lighting for monuments, buildings or trees).

**For road traffic**, the lighting classes are marked with the letter M (M1-M5) and are intended for drivers of motor vehicles on traffic routes, and in some countries – on roads in residential areas that allow traffic speeds from medium to high speed. The lighting class M is determined by the weight of the various parameters that characterize the motorized traffic. The traffic recommendations, presented in classes M1-M6, depend on the geometry of the corresponding area, on traffic and weather-related circumstances and can be determined from CIE 115/953.

The luminance level corresponding to the class is shown below, with the following road traffic classes:

**Table 25 - Lighting classes related to road traffic<sup>14</sup>**

Road description	Illuminance class
High-speed road with separate lanes without intersections (e.g. highways)  Traffic density:  high  medium  low	   M1:  M2:  M3:
Road with high speed traffic, without sideways (e.g. national road, county road)  Traffic control (note 2) and separation (note 3) between different types of road passengers (note 4):  poor  good	   M1:  M2:
Important urban roads, ring roads or city streets.  Traffic control and separation of different types of passengers:  poor  good	   M2:  M3:
Less important connection streets in cities, in residential areas, local rural streets, access roads to streets, important roads.  Traffic control and separation of different types of passengers	   M4:  M5:

<sup>14</sup> Note 1. Traffic complexity refers to infrastructure, travel conditions and visibility.

The factors to be considered are the following:

- Number of lanes, curves and slope difficulty, as well as their density,
- Traffic signs, road signs.

Note 2. Traffic control refers to the presence of light signs and indicators, namely the existence of traffic control means.

The control methods are:

- Light signals,
- Priority rules,
- Road signs,
- Direction signs,
- Road markings.

Where these are missing or have a low density, the control is considered weak. Note 3. Separation of traffic refers to the existence of a separate driving lane. Dedicated to different types of traffic or where there are traffic restrictions.

Separation is good on roads with a good signal system.

Note 4. The different types of passengers are, for example, drivers, transport vehicles, low-speed vehicles, buses, cyclists and pedestrians.

Road description	Illuminance class
poor	
good	

Source: Opportunity study on the management of the public lighting service in Bucharest-2019

Values of the lighting parameters corresponding to the illuminance classes M1-M5:

Table 26 - Lighting parameters corresponding to the illuminance classes

Lighting class	L <sub>med</sub> [cd/m <sup>2</sup> ]	U <sub>0</sub>	TI [%]	U <sub>1</sub>
M1	2	0.4	10	0.7
M2	1.5	0.4	10	0.7
M3	1	0.4	10	0.5
M4	0.75	0.4	15	NR
M5	0.5	0.4	15	NR

Source: Opportunity study on the management of the public lighting service in Bucharest-2019

Legend:

- L<sub>med</sub> - average luminance on the computing area,
- U<sub>0</sub> - general lighting uniformity,
- TI - threshold index, increase of the visual perception threshold,
- U<sub>1</sub> - longitudinal lighting uniformity.

For conflict zones, classes are marked with the letter C and occur when the vehicle flows are intersecting in places frequently used by pedestrians, cyclists, or other road users, or when there are changes in the road geometry, such as reducing the lanes or the width of the carriageway. In these areas there is an increased potential for collision between vehicles, between vehicles and pedestrians, cyclists and other road users, or between vehicles and fixed objects.

The lighting levels for the conflict areas (Class C) are shown in Table 3.

Table 27 - Lighting classes related to conflict areas

Lighting class C	The average illuminance level over the entire surface used E, in lx	Lighting uniformity U <sub>0</sub> (E)	Increase threshold (threshold index, in %)	
			High and moderate speed	Low and very low speed
C0	50	0.40	10	15
C1	30	0.40	10	15
C2	20	0.40	10	20

Lighting class C	The average illuminance level over the entire surface used E, in lx	Lighting uniformity U <sub>o</sub> (E)	Increase threshold (threshold index, in %)	
			High and moderate speed	Low and very low speed
C3	15	0.40	10	20
C4	10	0.40	15	25
C5	7.5	0.40	15	25

Source: Opportunity study on the management of the public lighting service in Bucharest-2019

### Lighting of pedestrian and residential areas

The main objective of the lighting of pedestrian and residential areas is to ensure the visibility of citizens for orientation, to help distinguish obstacles or other dangers on the road and to identify other nearby pedestrians. Both horizontal and vertical lighting are important. An important aspect is the facial recognition, so additional requirements such as minimum vertical lighting and minimum semi-circular lighting must be met.

The visual needs of the pedestrian differ from those of the driver and are determined by CIE I36: 2000. The illuminance levels for lighting classes P (pedestrian traffic) are determined similarly to the ones for motorized traffic in CIE 115/95 (see table below).

Values of lighting parameters for pedestrian areas and for cyclists:

Table 28 - Lighting classes related to pedestrian areas

Lighting class	Horizontal lighting on the entire pedestrian area	
	E <sub>med</sub> (lx)	E <sub>min</sub> (lx)
P1	20	7.5
P2	10	3
P3	7.5	1.5
P4	5	1
P5	3	0.6
P6	1.5	0.2
P7	NR	NR

Source: Opportunity study on the management of the public lighting service in Bucharest-2019

### Lighting of parks, gardens and cultural monuments - architectural lighting

Architectural lighting has the role of highlighting at night historical and art monuments that have a special architecture, statues, representative buildings, green areas, fountains and creating a proper environment during the hours without natural light.

Architectural lighting is one of the quality criteria of modern civilization. The main functions of architectural lighting are:

- lighting of fountains;
- lighting of promenade areas;
- lighting of parks and gardens;
- lighting of buildings and monuments.

Architectural lighting must meet the conditions laid down in the lighting, physiological, traffic safety and architectural aesthetics rules, under the following conditions:

- rational use of electricity;
- recovery of the cost of investments in a period considered as short as possible;
- reduction of the annual operating expenses of the component elements related to the lighting installation.

## Festive lighting

The theme of festive lighting took into account various specific events and festivities in Romania (the Centennial, Romania joining NATO and the European Union).

The festive lighting in Bucharest was carried out both by the Municipality of Bucharest and by the sector municipalities, in the parks managed by the latter. The Municipality of Bucharest creates the festive lighting every year by placing decorative light elements in the area of Bucharest's access streets and on the axis formed by the streets starting from Miorita Fountain to Piata Unirii, respectively Sos. Bucuresti-Ploiesti-Sos. Kiseleff- Bd. Lascăr Catargiu- Bd. Nicolae Bălcescu-Bd. Ion C. Brătianu. The decorative light elements have been using LED technology in recent years and are generally switched on around December 1<sup>st</sup> and switched off after January 7<sup>th</sup>. In 2016, the installed capacity of the festive lighting system was approximately 350 kW, resulting in a consumption of 155.4 MWh in the specified period.

## Support activities that ensure the good operation of the Public Service

The support activities support the Public System and help creating the necessary framework for the provision of the Public Service in conditions of efficiency, effectiveness and economy.

The support activities provided within the Public Service are:

- maintenance of the Public System;
- ensuring the supply of electricity to the Public System;
- using the integrated remote control management of the Public System;

## OPERATION (MAINTENANCE) OF THE PUBLIC SYSTEM

The operation of the Public System involves a set of activities, performed periodically, scheduled or unscheduled, in order to maintain in proper technical condition the various components of the Public System.

Operations mainly include:

- **operational works** - the set of operations and activities of permanent supervision of installations and the execution of scheduled or unscheduled works for solving certain dysfunctions of the Public System;
- **technical overhauls** - the set of operations and small-scale activities that are performed periodically to verify the installations and to eliminate the failures found, in order to ensure the functioning of the Public System until the next planned work.
- **current repairs** - the set of operations performed periodically, within programs, to restore all elements of the Public System to the designed parameters, by repairing all malfunctions and replacing parts of the installation that no longer meet adequate operating parameters.

Types of operative works executed:

- interventions to fix accidental disorders at lighting fixtures and accessories;
- maneuvers to disconnect and reconnect the various parts of the lighting installation, in order to carry out the necessary works;
- maneuvers to modify the operating schemes in case of disorders;
- reception of new installations put into operation in accordance with the regulations in force;
- analysis of the technical condition of the installations;
- identification of failures in the electrical conductors that supply the lighting installations;
- monitoring the vegetation clearing and removing any objects that fell on the line;
- control of installations that have been under special weather conditions, such as: strong wind, heavy rain, snow storm, frost formation;
- actions for the preparation of lighting installations on the occasion of festive or special events;
- dismantling or demolition of elements of the Public System;
- interventions after complaints from citizens.

The following specific operations are performed during technical overhauls and current repairs:

- overhaul and repair of lighting fixtures;
- overhaul and repair of switchboards and connection points.

## ENSURING THE POWER SUPPLY FOR THE SYSTEM

The electricity market for the provision of the Public Service is competitive. The tariffs in force for the transmission service, the system service, the tariff for the services provided by the centralized market operator are those approved by the ANRE Order no 19/2011. The main distribution operator for Bucharest is S.C. E -Distribuție Muntenia S.A. The electricity distribution tariff used for billing is calculated by summing the specific tariffs for the electricity distribution service, depending on the voltage level at the network's delimitation point with the consumer, set according to the electricity distribution contract.

Characteristic for the operation of an integrated public lighting service is the continuity in electricity supply, which is ensured by a correct operation and maintenance of the components of the lighting system.

## USING THE INTEGRATED REMOTE CONTROL MANAGEMENT OF THE PUBLIC LIGHTING SYSTEM

So far, an integrated remote control management system has been implemented in the Dorobanți area, as well as on Splaiul Independenței, but there is a proposal to develop this remote control management system for the entire lighting system in Bucharest.

The remote control management system performs the following functions:

**a) The management - dispatching function, involving:**

- managing the owners/inventory/lifespan/warranties infrastructure;
- electricity consumption management on hourly intervals, by types of consumers;
- managing in real time the deficiencies in the operation of the public lighting system (PLS);
- identification of PLS non-functional areas as soon as possible;
- real-time identification of electrical illegal connections and thefts;
- managing the execution schedule for PLS maintenance works (monthly/daily);
- managing the active/reactive energy consumption for each phase and generating consumption graphs;
- instantaneous reading of the electricity consumption data on phases, from the command and control module;
- alert in case of malfunction of PLS components;
- prioritizing alerts and failures;
- preset commands through which the system will react to different events: exceeding consumption, voltage variations, short circuits on the network, etc.

**b) The Monitoring -Control- Diagnosis function, involving:**

- monitoring PLS elements/structure: network-pole-luminaire-console-ignition point;
- monitoring the total PLS switch on/off;
- monitoring, at the level of the measuring unit and with the ignition point, the functional and technical parameters of the infrastructure of the public lighting system: voltage, frequency, active energy, reactive energy;
- inventory evidence of PLS by components, as they are defined by art. L of Law 230/2006;
- monitoring the schedule of PLS works and interventions;
- generating reports for the analysis of electricity savings;
- generation of daily/weekly/monthly reports on electricity consumption;
- generating alerts for operation outside the voltage technical parameters in public power supply networks, regulated by SEEN 50160 standard and ANRE regulations in force;

**c) The function of geospatial representation of the components of the infrastructure, involving:**

- GPS positioning of elements of the PLS
- infrastructure - luminaires, poles, network;
- registration and visualization on the cartographic platform, for any area of the locality, of each component of the infrastructure of the public lighting system and assigning an identification number to each component;
- integration with other applications of utility managers.

### 6.3. The evolution of public lighting system over the last 20 years

Once the contract for the delegation of the public lighting service in Bucharest has started, an extensive process of development and extension of the public lighting system on the streets that were non-illuminated or non-compliant with the standards also began.

According to the Energy Strategy of the Municipality of Bucharest made by Grontmij, Carl Bro and ATHenerg, at the level of 2007, the installed capacity of the public lighting system was 13 MW (0.9 % of the total consumption in Bucharest). The annual amount of electricity used by the public lighting system for 2007 represented 57 GWh/year (1.1 % of the total consumption in Bucharest). The strategy estimated that the energy efficiency of the electricity distribution system for public lighting was 83 % in 2007.

The public lighting system in Bucharest consists of the following assets:

- low voltage power lines, underground or overhead;
- luminaires, consoles and accessories;
- ignition points, distribution boxes, passage boxes;
- control, automation and measurement equipment used in public lighting;
- foundations, poles, line support elements, earthing installations, conductors, insulators, clamps, fittings, used for public lighting.

The assets used for the provision of the Public Service are not the exclusive property of the Municipality of Bucharest, some of them being owned or managed by other public service operators, as follows:

- The Public Service Operator (for light points<sup>1</sup>, consoles, poles, distribution network, ignition points and measurement points);
- S.C. E - Distribuție Muntenia S.A. (for poles, distribution network<sup>2</sup> and measurement points);
- Bucharest (for light points, consoles, poles, distribution network and ignition points);
- R.A.T.B. (for poles);
- Telekom (for poles);

The ownership pattern for the assets used for the provision of the Public Service results from the Report of evaluation at fair value of the fixed assets to be handed over to the Municipality of Bucharest, prepared by SC INTERPROIECT CONSULTING SRL, as well as from the Minute no. 1/25.10.2018 and Minute no. 2/09.07.2019, both regarding the inventory of the public lighting system in Bucharest.

From a technological point of view, the state of the Public System in Bucharest can be summarized as follows:

- Regardless of the owner of the assets/components through which the Public Service is provided in Bucharest, the current infrastructure of the Public System is technologically and morally obsolete.
- The year 2014 is a milestone for the last upgrade of the Public System.
- The trend of development and expansion of Bucharest's infrastructure did not take into account the need to optimize the technical and functional parameters of the Public System and its upgrade needs.
- The performance of the Public System is limited to the following: maintaining its infrastructure in working order; response times to citizens' complaints for putting in safety mode the system's failures; ensuring the system's safe and secure operation.

- The rate of resolving failures is lower than the one for new failures. The electricity losses and thefts from the network are over 10-15 %, due to the wear and tear of the power networks.

From the perspective of the upgrade stage of the Bucharest's Public System infrastructure, the situation is as follows:

- the light points which have reached the maximum permitted service life must be replaced by LED or high energy efficiency lamps;
- the electricity distribution networks require rehabilitation for 60 % of its assets;
- 40 % of the poles must be replaced;
- 15 % of BMPIP (measurement and protection unit for public lighting system) must be replaced; 90 % of the distribution boxes must be replaced; transformer substations do not require upgrade.

The quantitative situation of PLS components in 2016 is as follows:

- Light points – 125,513 pcs;
- Consoles – 84,292 pcs;
- Poles – 101,829 pcs;
- Distribution network – 5,013 Km;
- Overhead network – 1,466 Km;
- Mixed network – 837 Km;
- Underground network – 2710 Km;
- Ignition points – 584 pcs;
- Measurement points – 1,053 pcs.

The technological evolution of the public lighting system in Bucharest between 2010-2016 is presented in the table below:

**Table 29 - Technological evolution of the public lighting system in Bucharest, in the period 2010-2016**

Year	Number of light spots	Technology	PLS installed capacity (kW)	PLS annual consumption (kW/year)
2010	115,176	Sodium, Mercury, Halogen, LED	14,445	61,969,608
2011	116,000	Sodium, Mercury, Halogen, LED	15,124	64,880,066
2012	117,437	Sodium, Mercury, Halogen, LED	14,166	59,568,382
2013	112,015	Sodium, Mercury, Halogen, LED	14,249	59,918,056
2014	114,613	Sodium, Mercury, Halogen, LED	14,102	59,299,066
2015	115,522	Sodium, Mercury, Halogen, LED	N/A	59,448,437

Year	Number of light spots	Technology	PLS installed capacity (kW)	PLS annual consumption (kW/year)
2016	125,513	Sodium, Mercury, Halogen, LED	14,501 ( plus 350 kW festive lighting)	62,682,539

Source: Opportunity study on the management of the public lighting service in Bucharest-2019

As the table points out, between 2010-2016, although the number of luminaires increased by about 10 %, the total installed capacity remained approximately the same. This is also due to the fact that, in addition to expanding the public lighting system, works have been carried out to upgrade and make improvements on the consumer side by replacing the mercury, sodium or halogen luminaires with ones that use LED technology.

According to the findings of AMRSP on the performance of the Public System in Bucharest, formulated at the end of 2015, the following conclusion result:

- in 2015, there have been 7,980 cases of solved malfunctions, an increasing trend compared to the number of solved cases in 2014 (5,470), but there are still 429 pending unresolved cases in the records of the operator;
- Among the malfunctions of the Public System with implications in the provision of a continuous and quality service, there are also cases of vandalism. These cases have an increasing trend from one year to another, with 1,325 such cases registered in 2015 , compared to only 771 registered in 2014. The resolution times for these cases are usually longer than in other situations, due to the verification and decision-making procedures on how to resolve them.
- at the level of 2014 and 2015, the analysis of the suggestions from customers led to the following conclusions:
  - in 2014, the daily average number of suggestions and complaints regarding the operation of public lighting was 23 cases;
  - in 2015, the daily average number of suggestions and complaints regarding the operation of public lighting was 25 cases.
- it was found that both in 2014 and in 2015 over half of the reported cases were resolved within 5 days of their occurrence, the rest being resolved within a period of up to 30 days. These aspects are not consistent with the provisions of the contract for the management of the public lighting service in Bucharest and with the operator's obligation to ensure the continuity of the public service (these cases should have been resolved quickly);
- 15 % of the annual suggestions and complaints refer to the lack of public lighting because of the distribution network of E - Distribuție Muntenia S.A. The main causes were: no voltage in the network, damage and high degree of physical and moral wear of the supply networks, insufficient interventions, the existence of areas with damaged, worn or non-compliant poles, owned by E - Distribuție Muntenia S.A., on which no action is taken;
- in 2015 there were 537 suggestions and complaints that were resolved by E - Distribuție Muntenia S.A. in a period of more than 30 days, compared to 2014 when there were only 266 such cases.

A major weak point of the Public Service in Bucharest, in terms of quality of services, is the existence of several entities that have a right of possession over some components through which the Public Service is provided. This factual situation leads to a lack of coherence in ensuring the quality parameters of the service and to a lack of a unified and integrated vision on the development of the service.

The summary of public lighting activities in 2016 is the following:

**a. Public System Maintenance**

Interventions in case of malfunction:

- lighting below the illuminance level - interventions to 17,470 luminaires;
- patrimony damage - replacement of 1,428 stolen or vandalized luminaires. Of these, 1,153 were fitted from the stock in custody and 275 were new.

Preventive maintenance activities on lighting supports - verification of 2,958 supports and 6,884 consoles.

**b. Maintaining the Public System**

- installation of LED technology luminaires - 481 pcs;
- mounting LED projectors - 283 pcs;
- installation of classic luminaires - 269 pcs;
- mounting Avangarde luminaires - 2 pcs;
- mounting Retro luminaires - 99 pcs;
- mounting poles - 1,113 pcs;
- mounting UPL network - 43.52 km;
- mounting OPL network - 43.52 km;

**c. Development and upgrade**

Based on the provisions of the Addendum no. 30/2016 to the contract for the delegation of the public lighting service, the number of lighting assets installed was:

- 975 LED luminaires;
- 7.02 km of underground network;
- 173 lighting poles.

The situation of financing from the PMB budget in the period 2013-2016, according to the activities included in the contract no. 206/1997, are presented in the following table:

**Table 30 - The situation of financing from the PMB budget in the period 2013-2016**

Year	Maintenance (RON/year)	Extensions (RON/year)	Electricity (RON/year)	Rehabilitation rate (RON/year)	Total value (RON/year)
2013	49,629,017	0	26,617,805	15,549,740	91,796,562
2014	64,991,130	0	23,644,905	14,480,795	103,116,830
2015	47,710,352	0	26,467,168	16,966,899	91,144,419
2016	43,083,396	0	21,607,756	18,297,389	82,988,541
Total (RON)	155,784,878	0	71,719,829	49,745,083	277,249,790

**Source: Opportunity study on the management of the public lighting service in Bucharest-2019**

The investments made in the Bucharest's Public System are presented in the following table:

**Table 7 - Investments made in the public lighting system**

Implementation area	Project/Source of funds	Characteristics
Calea Dorobanți and neighboring area	<p><b>Year 2014</b></p> <p>Integrated concept for energy efficiency by optimizing the technical and functional parameters and highlighting the cultural heritage in a European capital.</p> <p>Funded by the EBRD through the MFFEE (Financing Facility for Energy Efficiency Granted to Municipalities)</p>	<p>Duration of execution: 3 months</p> <p>EBRD consultant certification report, Project qualification for PMB to receive a grant of EUR 738,000.</p>
<p>Bd. Aviatorilor, Bd. Ghe. Magheru, Bd. Nicolae Bălcescu and Bd. I. C. Brătianu.</p> <p>Bd. Unirii, between Piața Alba lulia and Str. Mircea Vodă, Piața Unirii, on Bd. lului Maniu, Splaiul Independenței, between Calea Victoriei and Str. Halelor, and Splaiul Unirii, up to Pasajul Mărășești</p>	<p><b>Year 2011</b></p> <p>Local Budget</p>	<p>Upgrade works: Changing the lighting poles and rehabilitation of their power supply network</p>

Source: Opportunity study on the management of the public lighting service in Bucharest-2019

The investments financed by the Municipality of Bucharest in the period 2009-2014 are presented in summary in table 8, which shows that the implementation of investment projects carried out until 2014 has the effect of reducing the annual electricity consumption by 0.22 %/year.

**Table 8 - MEASURES AND EFFECTS OF PLS MODERNIZATION BETWEEN 2009-2014**

Measures	Results
<p><b>2009-2011</b></p> <ul style="list-style-type: none"> <li>- replacement of energy intensive luminaires (with incandescent sources) with LED luminaires;</li> <li>- control and monitoring of the operation schedule for the public lighting system;</li> <li>- replacement of lighting sources at the expiration of their lifespan with lighting sources with a longer lifespan - (28,000 operating hours);</li> <li>- application of dimming programs on certain time intervals.</li> <li>- replacement of physically and morally worn electrical network.</li> </ul>	<p><i>Reduction of annual electricity consumption:</i></p> <ul style="list-style-type: none"> <li>• 25-40 % by using LED technology;</li> <li>• 5-20 % by using electronic ballast, 5 % by monitoring the operation schedule of public lighting;</li> <li>• 7 % by reducing network losses.</li> </ul>

Measures	Results
<b>2012-2014</b>  Implementation: <ul style="list-style-type: none"> <li>- pilot projects for monitoring and controlling the technical and functional parameters of the public lighting system</li> <li>- installation of energy saving devices in the public lighting system.</li> <li>- replacement of magnetic ballast type accessories for luminaires with electronic ballast type equipment.</li> </ul>	<i>Reducing the operational costs of the public lighting system:</i> <ul style="list-style-type: none"> <li>• annual consumption reduction 0.22 %/year,</li> </ul>

**Source: Opportunity study on the management of the public lighting service in Bucharest-2019**

From the perspective of upgrading the light points of the Bucharest PLS, table 9 shows their technological evolution. It can be seen that the number of light points has increased, but in terms of technology, in 2014 luminaires equipped with mercury vapor lamps are still used.

In 2017, public lighting in Bucharest is provided with LED, sodium, metal-halide lamps, equipped with ballast/igniter equipment. Of the total luminaires (125,513 pcs.), the share of LED technology is very low, up to 10 % (12,416 pcs.); these have been installed in March and December 2012 and replaced in September 2013 and July 2014. According to the same annex, since 2014 there have been no lamp replacements.

The technological evolution of the lighting equipment between 2010 and 2014 is presented in the table below.

**Table 9 - Technological evolution of lighting equipment**

Year	Number of light spots	Technological	PLS installed capacity (kW)	Consumption/PLS/year (kWh)	tCO2
2010	115,176	Sodium, Mercury, Halogen, LED	14,445	61,969,008	43,440.3
2011	116,000	Sodium, Mercury, Halogen, LED	15,124	64,880,066	45,480.9
2012	117,437	Sodium, Mercury, Halogen, LED	14,166	59,568,382	41,757.4
2013	112,015	Sodium, Mercury, Halogen, LED	14,249	59,918,056	42,002.6
2014	114,613	Sodium, Mercury, Halogen, LED	14,102	59,299,066 <sup>1'</sup>	41,568.6

**Source: Opportunity study on the management of the public lighting service in Bucharest-2019**

The following table shows that, although the evolution of the average installed capacity of a light spot has an inconsistent trend, due to the reduction of the average tariff for 1 kWh, the cost of electricity for a bright spot has a sharp downward trend since 2013.

The evolution of electricity consumption and related costs of the public lighting system in Bucharest between 2012-2016 is presented in the following table:

**Table 10- Evolution of electricity consumption and costs related to the public lighting system in Bucharest, in the period 2012-2016**

Year	Medium power/light spot (kWh)	Cost of electricity/light spot (RON)	Medium electricity tariff (RON/kWh)
2012	507.23	181.27	0.3573
2013	496.80	196.41	0.3953
2014	481.30	185.39	0.3851
2015	491.36	181.88	0.3701
2016	490.93	164.10	0.3342

**Source: Opportunity study on the management of the public lighting service in Bucharest-2019**

## THE COMPOSITION OF THE PUBLIC LIGHTING SYSTEM IN BUCHAREST IN 2017

### a) Luminaires

The public lighting system in Bucharest on 28.07.2017 consisted of 121,838 public lighting fixtures, representing approximately 10.6 % of the total luminaires in Romania.

At the beginning of the concession contract for the public lighting service in Bucharest, luminaires using sodium vapor lamps and metal halide were installed.

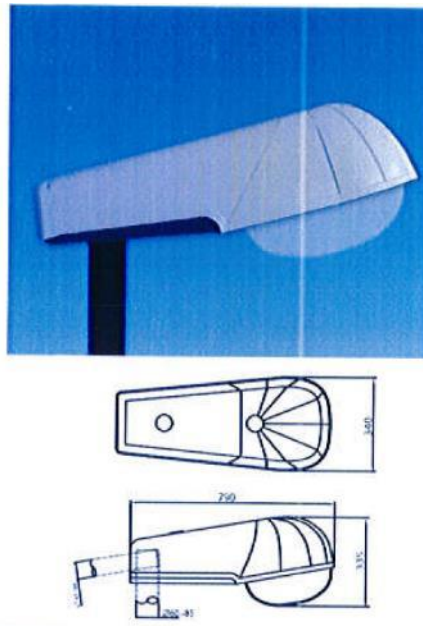
#### *For road lighting*

Timlux S/21 and Timlux S/22 type luminaires, with the possibility of being equipped with 70/100/150/250/400 W sodium vapor lamps, 80/125/250 W mercury lamps, 250 W metal iodide lamps.

Technical characteristics of Timlux S/21 and Timlux S/22 luminaires:

- Degree of protection of optical compartment IP66;
- Degree of protection of electrical accessories compartment IP44;
- Degree of protection against mechanical impact IK10;
- UV resistant polypropylene cover;
- Aluminum body;
- Anodized reflector with 99.8 % purity;
- Neoprene rubber gasket,
- UV-resistant clear polycarbonate diffuser;
- Porcelain socket with adjustable positioning;
- Device for interrupting the power supply when opening the body;
- Bronze anti-condensation filter.

**Fig.1. Timlux type luminaire S/21.**



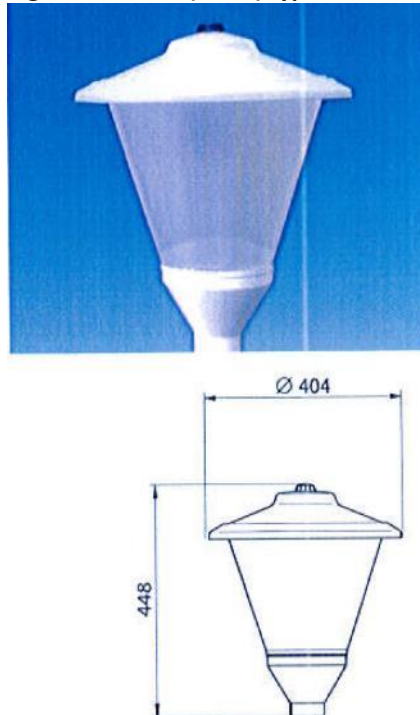
*For lighting pedestrian and residential areas*

Timlux P1 (Selux) type luminaires specially designed for the lighting of pedestrian and residential areas, with the possibility of being equipped with 70/100 W sodium vapor lamps, 80/125 W mercury lamps.

Technical characteristics of Timlux P1 luminaires:

- Degree of protection of optical compartment IP65;
- Degree of protection against mechanical impact IK10;
- UV ray resistant clear polycarbonate prismatic diffuser;
- Electrostatically painted aluminum body;
- E27 socket;

**Fig.2. Timlux P1 (Selux) type luminaire.**



### *For architectural lighting*

Depending on the distribution of the luminous flux, the projectors for architectural lighting used since 1997 had an asymmetric, symmetrical or circular type of luminous flux distribution. One of the types of projectors used was the JET 7 range.

**Fig.3 Jet 7 projector.**



The JET 7 projector has the following technical characteristics:

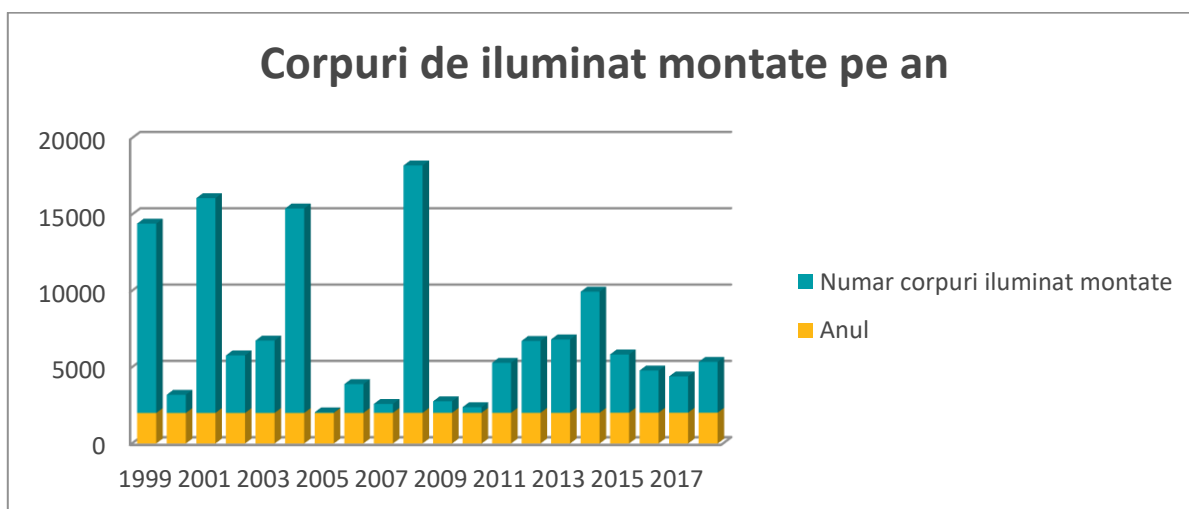
- The optical compartment of the proposed projector is dustproof and protected against water jets,
- Sudden temperature variations between  $-40^{\circ}\text{C}$  and  $+40^{\circ}\text{C}$  do not affect the projector's safety and operation,
- Aluminum body, spray-coated with black, white or silver polyester,
- Heat-resistant front protective glass,
- Silicone rubber gasket,
- High purity (99.8 %) anodized aluminum reflector,
- The minimum power factor is 0.95.

The estimated breakdown of Annex luminaires, by function and by the type of lighting served, is as follows:

- For road lighting: sodium luminaires with lamps of 70/100/150/250/400 W; 52/55/60/70/80/83/90/91/100/104/110/120/148/150/178/185/225 W LED luminaires
- For lighting pedestrian and residential areas: LED luminaires with lamps of 36/40/48/50/W,
- For architectural lighting: metal halide luminaires with lamps of 20/36/50/70/100/125/150/250/400/1000 W; LED luminaires with lamps of 5/8/9/15/18/24/25/30/35 W.

The number of luminaires installed annually in Bucharest between 1999-2018 is presented below:

**Figure 36 - Number of luminaires installed annually between 1999-2018**



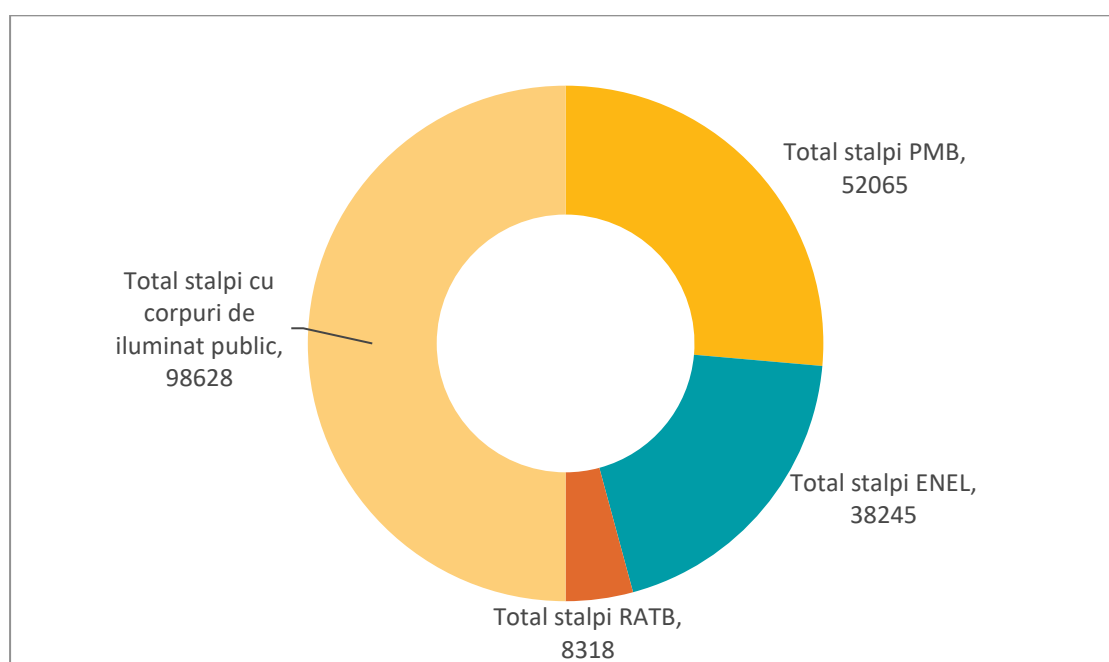
**Source: Opportunity study on the management of the public lighting service in Bucharest-2019**

Most luminaires (82.9 %) of the total are with 70/150/250/400 W sodium lamps, which means that there is a great opportunity to increase energy efficiency in this area by replacing them with efficient LED solutions. Of the total number of public lighting fixtures, approximately 15 % use LED technology and have been installed since 2009 until present day. Existing luminaires with LED technology are in a very high power range, from 5 W to 225 W (30 different power levels).

#### **b) Poles**

52.7 % of the poles related to the public lighting system are owned by the Municipality of Bucharest, while the rest belong to ENEL or STB companies.

**Figure 37 - The poles used by the public lighting system in Bucharest, by owners**



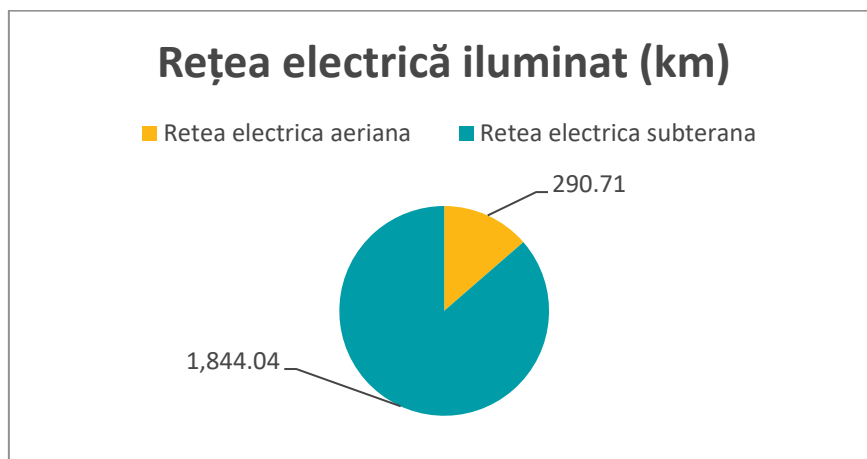
**Source: Opportunity study on the management of the public lighting service in Bucharest-2019**

The public lighting system in Bucharest consists of octagonal or conical metal poles with flange or buried, with heights between 2-14 m, decorative metal poles with a height of less than 5 m, centrifuged poles with metal reinforcement. For road lighting, octagonal or conical metal poles with flange or buried were used, with heights of 6-14 m, as well as centrifuged poles with metal reinforcement, while for the lighting of pedestrian and residential areas metal poles of 2-5 m and decorative metal poles with a height of less than 5 m were used.

**c) Power network**

Currently, 86 % of the network for the public lighting system is underground.

**Figure 38 - The electrical network used by the public lighting system in Bucharest, on type of lines**



**Source: Opportunity study on the management of the public lighting service in Bucharest-2019**

Since the start of the delegated concession contract for the public lighting system in Bucharest, the upgrade works have included the undergrounding of the power supply network for the public lighting system and the creation of its own electricity network.

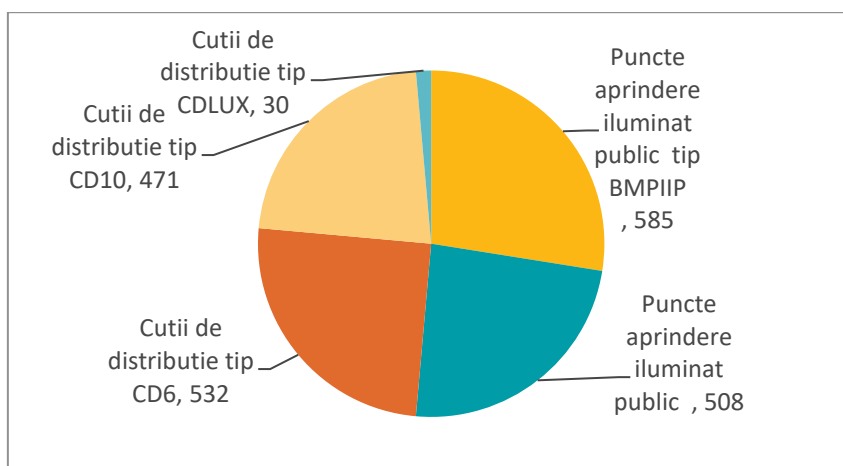
The underground electrical network consists of ACYABY type electric cables (4x16 mm<sup>2</sup>, 3x25+16 mm<sup>2</sup>, 3x35+16 mm<sup>2</sup>, ACYABY 3x70+35 mm<sup>2</sup>, ACYABY 3x150+70 mm<sup>2</sup>, ACYABY 3x120+70 mm<sup>2</sup>).

The underground electrical network consists of TYIR type (3x35 mm<sup>2</sup>) and TYIR type (3x50 OIAI 3x50 mm<sup>2</sup>) cables.

**d) Ignition points and distribution boxes**

The on and off switching of the public lighting system in București is also achieved through the 585 measurement and protection units for public lighting system (BMPIIP) located near the 20/04.kV transformer substations.

**Figure 39 - Ignition points and distribution boxes used by the public lighting system in Bucharest, according to their type**



**Source: Opportunity study on the management of the public lighting service in Bucharest-2019**

Starting with 1999, 585 points for turning on the public lighting were installed, of BMPIIP type (measurement and protection unit for the public lighting system), distributed according to the table:

**Table 11 - Number of ignition points and distribution boxes installed at the level of the public lighting system in Bucharest, during 1999-2017**

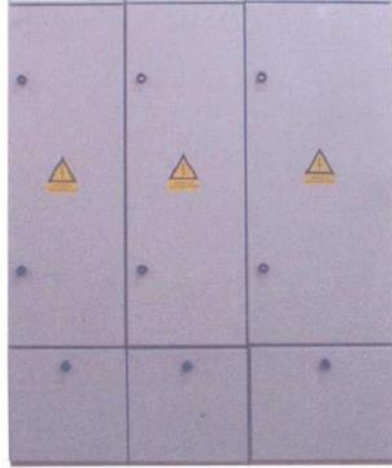
Year	Number of BMPIIP mounted
1999	4
2002	5
2003	4
2004	50
2005	4
2007	222
2008	219
2009	10
2011	6
2012	9
2013	8
2014	24
2015	7
2016	6
2017	7

**Source: Opportunity study on the management of the public lighting service in Bucharest-2019**

### ***Technical specifications of measurement and protection units for public lighting system (BMPIIP)***

BMPIIP is an assembly consisting of three modules: the supply module with the input circuits, the metering and control module, the distribution module with the output circuits.

**Figure 40 - The typical BMPIIP model related to the public lighting system in Bucharest**



**Source:** <https://www.scribd.com/doc/306417473/Manual-de-Instalare-Si-Eploatare-BMPIIP>

Technical characteristics:

- made of tin,
- protection degree IP54,
- rated operating voltage 400/230 V alternating current,
- frequency of supply voltage 50 Hz,
- controlled rated current 100 A,
- operating ambient temperature -33 ... + 50°C,
- measuring the electrical parameters and transmitting them remotely to the dispatcher via a GPS modem,
- storage and processing of the measured parameters at the dispatcher's office,
- the possibility to modify the operating program as well as the remote control of the power supply or the interruption of the power supply of the metered facility,
- automatic system for electrical management, of ARGUS type.

#### **e) Management, monitoring, command and control system for public lighting**

The Light Smart System application had the following functions:

- street lighting management,
- data acquisition linked to a geographically represented patrimony data platform (Google Maps),
- adaptability to the existing public lighting systems
- customization according to the particularities of the components of the public lighting system,
- system open to data acquisition.

The Public Lighting Measurement and Control Module (MMC-SIP) has the following components:

- internal microcontroller: CPU-700 MHz; RAM 512 MB; non-volatile memory 8/16/32 GB,
- internal storage capacity: max 45 (90) days,
- electronic measuring and control unit,
- automation-control system, configurable.

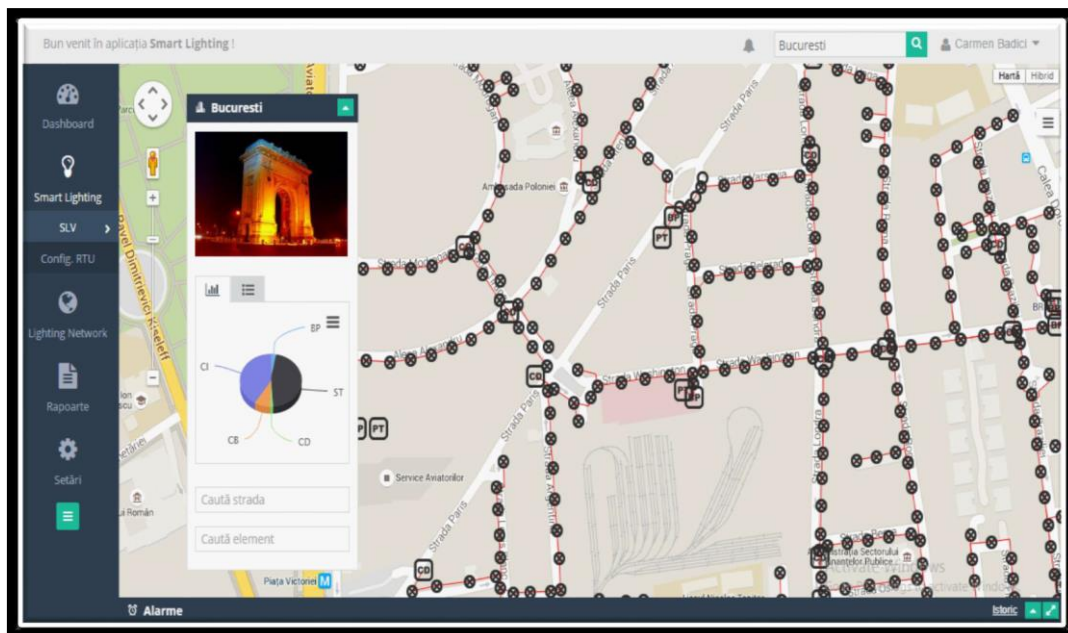
**Figure 41 - Public Lighting Measurement and Control Module (MMC-SIP) used by the public lighting system in Bucharest**



Source: <http://romaniasmartcities.ro/wp-content/uploads/2017/02/2015-20.pdf>

The Google Maps-enabled interface allows to view and locate quickly the public lighting ignition points, network and luminaires, and to send alarms and instant alerts via Google Maps.

**Figure 42 - Model of public lighting system interface in Bucharest**



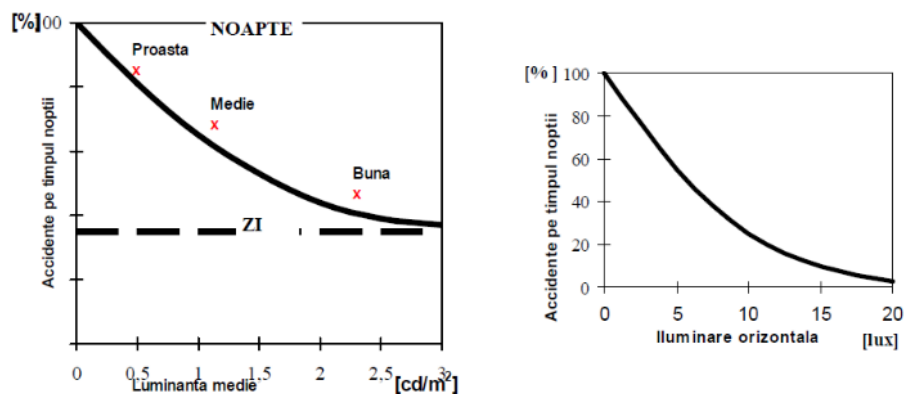
Source: <http://romaniasmartcities.ro/wp-content/uploads/2017/02/2015-20.pdf>

## 6.4. Solutions regarding the increase of the energy efficiency of the public system in Bucharest

Street lighting is an important public service provided by local public authorities. Quality lighting is essential for road safety, personal safety and for the urban environment. It provides visibility for motorists, cyclists and pedestrians, thus reducing the number of road accidents.

A study by P. Lemaigre Voreaux shows that the number of accidents during the night increases with the decrease of luminance level of the light source. When switching from an unsuitable lighting fixture to a good one, the number of accidents is reduced by about 40 %.

Figure 43 - Number of accidents related to the average luminance on the street.



Source: <http://romaniasmartcities.ro/wp-content/uploads/2017/02/2015-20.pdf>

Globally, public lighting is beginning to become an important element of the Smart City concept. In addition to significantly reducing electricity consumption, the use of the latest technologies in this field also brings extra benefits associated with the elimination of environmentally harmful technologies, reducing maintenance costs and achieving a much better overall control of the street lighting environment.

The increase of energy efficiency for the public lighting system in Bucharest must be achieved in the area of road lighting, of pedestrian and residential areas lighting, as well as for architectural lighting.

Any technical solution that aims to increase the energy efficiency of the public lighting system in Bucharest must comply primarily with the requirements of the regulations in force on the performance criteria of public lighting.

Increasing the energy efficiency of the lighting system can be achieved by continuing to replace the sodium and metal-halide luminaires with LED ones, as well as by using dimming solutions on certain streets during periods of low traffic.

The investments made in the Bucharest's Public System are presented in the following table:

In 2017, in Bucharest, public lighting is provided with LED, sodium lamps. Investments in luminaires in Bucharest:

**Table 12 - Type and number of luminaires existing in Bucharest in 2017**

No.	Name	MU	Quantities
1	Luminaire S 30 W	pcs.	8
2	Luminaire S 70 W	pcs.	66,623
3	Luminaire S 100 W	pcs.	1,799
4	Luminaire, S 150 W	pcs.	20,181
5	Luminaire S 250 W	pcs.	20,160
6	Luminaire S400W	pcs.	2,900
7	LED projector 10 W	pcs.	581
8	LED projector 20W	pcs.	25
9	LED projector 225W	pcs.	9
10	LED luminaire 30 W	pcs.	1,115
11	LED luminaire 40 W	pcs.	419
12	LED luminaire 50 W	pcs.	231
13	LED luminaire 60 W	pcs.	4.164
14	LED luminaire 80 W	pcs.	851
15	LED luminaire 90 W	pcs.	2,996
16	LED luminaire 100 W	pcs.	255
17	LED luminaire 120 W	pcs.	1,044
18	LED luminaire 185 W	pcs.	713
19	LED luminaire 225 W	pcs.	13
20	Ornamental projectors IHLUX	pcs.	47
21	Luminaire H 70 W	pcs.	29
22	Luminaire H 150W	pcs.	66
23	Luminaire H 250W	pcs.	433
24	Luminaire H 400W	pcs.	546
25	Luminaire M 125 W	pcs.	246
26	Luminaire M 80 W	pcs.	67
27	<b>Total number of luminaires</b>	<b>pcs.</b>	<b>125,513</b>
28	Simple extension, A1 type	pcs.	16,315
29	Double extension, A2 type	pcs.	5,254 y
30	Double extension, A3 type	pcs.	227
31	Four arm extension, A5 type	pcs.	32
32	Simple pipe type arm	pcs.	14,226
33	"Heavy traffic" type extension	pcs.	47,423
34	TGZ type extension	pcs.	815
35	<b>Total extensions</b>	<b>pcs.</b>	<b>84,292</b>
36	Metallic pole with h= [5...10] m	pcs.	7,679
37	Decorative metallic pole with h<5 m	pcs.	31,501
38	Metallic pole with h=10 m	pcs.	232
39	Mounting non-ferrous metal pole min. 8 m	pcs.	584
40	Mounting centrifuged pole with metal reinforcement	pcs.	922
41	Metallic pole 6-8 m	pcs.	3,418
42	Metallic pole 8.1-10 m	pcs.	1,478
43	Metallic pole 4.1-6 m	pcs.	634
44	Metallic pole 10.1-12 m	pcs.	434
45	Metallic pole 12.1-14 m	pcs.	20
46	Metallic pole 2-4 m	pcs.	284

No.	Name	MU	Quantities
47	<b>Total number of poles</b>	pcs.	<b>47,186</b>
48	Lighting cable ACYABY 3x35+16	km	703.717
49	Lighting cable ACYABY 3x70+35	km	11.542
50	Lighting cable ACYABY 3x150+70	km	2.687
51	Lighting cable ACYABY 3x120+70	km	1.721
52	Mounting underground cable	km	1,785
53	Mounting overhead cable	km	363
54	Lighting cable TYIR 3x35	km	159.350
55	Lighting cable TYIR 3x50, OIAI, 3x50	km	3.890
56	Lighting cable 3x1,5; 2x2,5 etc.	km	5.844
57	<b>Total cables</b>	<b>km</b>	<b>2.14738</b>

Source: Opportunity study on the management of the public lighting service in Bucharest-2019

## 6.5. Investments for providing the public lighting service in Bucharest

The payments made by the Municipality of Bucharest between 2015 and 30.09.2017 for providing the public lighting service are presented in the following table

**Table 13 - INVESTMENTS MADE BY THE MUNICIPALITY OF BUCHAREST BETWEEN 2015 AND 30.09.2017**

Year	Upgrade works (RON)	Electricity consumption (RON)	Maintenance (RON)	Optimization works (RON)	Festive lighting (RON)
2015	20,417,415	36,817,488	48,579,405	734,509	
2016	2,044,330	44,350,209	62,466,212		3,025,193
2017-until 30.09.2017	25,468,828		52,194,328		3,458,459

Source: Opportunity study on the management of the public lighting service in Bucharest-2019

In order to improve the Public System and to make more efficient the consumption of electricity, the following are necessary:

- replacement of used and inefficient lighting sources with new ones that provide adequate lighting, including by using high-performance lamps in the process of rehabilitating lighting fixtures;
- replacement of defective equipment such as electronic ballasts, igniters, reflectors;
- replacement of broken, rusty, damaged consoles;
- replacement of distribution boxes in order to ensure security conditions;
- making automation panels related to the ignition point, to ensure centralized lighting control in the central dispatcher (equipped with programmable controllers, GPRS PLC routers, which will allow further developments, network analyzers, etc.);
- compensation of the reactive power factor with the help of compensation batteries, in order to reduce the reactive power factor, which will lead to a significant reduction of the value of electricity bills;
- setting a dispatcher for the command and monitoring of lighting, as well as for the centralization and processing of all data; negotiation of electricity tariffs taking into account the night time consumption (low load section of the electricity supplier load curve).

## 7. WASTE MANAGEMENT

### 7.1. Legal and normative framework. Institutional aspects

In Romania, the waste management sector is regulated by two categories of acts at national level: those resulting from the transposition of the *acquis communautaire* (the European policy on waste management) and legislation related to public services (concerning the localities' sanitation service). The following normative acts affect waste management at the level of Bucharest City:

- The European waste legislation, transposed at national level, provides for a number of obligations of the territorial-administrative units (TAUs) regarding waste management. Of interest here are also the changes proposed with the adoption, in June 2018, of the package of measures aimed at stimulating Europe's transition to a circular economy.
  - Directive 2008/98/EC on waste and repealing certain directives (Waste Framework Directive) – transposed by Law no. 211/2011 on waste regime (as subsequently amended and supplemented)
  - Regulation 1013/2006 on shipments of waste – see, at national level, Government Directive no. 788/2007 on the establishment of measures for the application of the regulation (amended by GD no. 1435/2008 and GD no. 1168/2013).
  - Decision 2000/532/EC on the European list of wastes, transposed at national level by GD no. 856/2002 on waste management record keeping and for the approval of the list of wastes, including hazardous waste, as subsequently amended and supplemented.
  - Directive 1999/31/EC of 26 April 1999 on the landfill of waste – see, at national level, GD no. 349/2005 on the landfill of waste, as subsequently amended and supplemented.
  - Directive 2010/75/EU on industrial emissions – Law no. 278/2013 on industrial emissions).
  - Directive 94/62/EC on packaging and packaging waste – transposed by Law no. 249/2015 on the management method for packaging and packaging waste, as subsequently amended and supplemented.
- The legislation of the environmental fund (GEO no. 196/2005), stipulating, at national level, the landfill tax and the contributions due by TAUs that do not meet the annual objectives of reducing the quantities of landfilled waste.
- Legislation on sanitation services:
  - Law no. 51/2006 on public utilities community services, republished, as subsequently amended and supplemented.
  - Law no. 101/2006 on the urban sanitation service, republished, as subsequently amended and supplemented.

In addition to this general legal framework, strategic planning documents in the area of waste management have been developed at national level. Based on the 2014-2020 National Waste Management Strategy (NWMS) (approved by GD no. 870/2013), in December 2017 the National Waste Management Plan (NWMP) revised for the planning period 2018 - 2025 was approved, also including the first National Waste Generation Prevention Plan. According to Law no. 211/2011 on the waste regime, in addition to the plan at national level, waste management plans are developed at county level and in Bucharest.

For Bucharest City there is no updated version of the Waste Management Plan, the 2014 revised waste management plan has not been approved so far. However, according to the NWMP approved in December 2018, there are two major categories of investments in Bucharest City:

- Anaerobic digestion plant for separately collected biowaste (estimated capacity – 191,000 tons/year) – commissioned in 2020.
- Waste-to-energy incineration plant (estimated capacity of 173,000 tons/year) – commissioned in 2024.

In addition to these investments, the 2017-2046 Integrated Waste Management Master Plan, approved by the General Council of Bucharest in August 2019, also proposes the construction of biological waste treatment facilities and the implementation of a selective waste collection system for the whole city.

Aside from the waste management legislation and planning documents, according to Law no. 101/2006 on the urban sanitation service, the local public administration authorities elaborate, approve and control the application of the local strategies regarding the medium and long term development and functioning of the sanitation service. The following Decisions of the General Council of Bucharest City (DCGMB) were adopted.

- DCGMB no. 82/2015 on the approval of the Strategy for the medium and long term development and functioning of the public sanitation service in Bucharest City;
- DCGMB no. 119/2010 on the approval of the Rules governing the organization and functioning of public sanitation services in Bucharest City;
- DCGMB no. 109/2012 on the separate collection of waste by individuals and associations of tenants/owners in Bucharest City, which stipulates the obligation to collect household waste separately on two components – the recyclable component (paper-cardboard, plastic, PET, glass, aluminum cans) and the residual component.
- DCGMB no. 108/2012 on achieving the reduction targets for municipal waste landfilling in Bucharest City, which aims to reduce the quantities of landfilled biodegradable waste.

According to the Strategy for the medium and long term development and functioning of the public sanitation service in Bucharest City (SMLTDFPSSBC), approved by DCGMB no. 82/28.04.2015, the coordination, monitoring and control of the Public Sanitation Service in Bucharest is ensured by the General Council of Bucharest – any normative act issued by the sector municipalities must also be presented to the Municipality of Bucharest (MB), and these normative acts must not be contrary to the provisions of the strategy.

Thus, Bucharest City is the owner of the municipal waste and similar waste stored in containers located in Bucharest City. According to the Rules governing the organization and functioning of public sanitation services in Bucharest City, the domestic and street sanitation programs and the winter service are approved by the sector municipalities and endorsed by the Municipality of Bucharest; the public sanitation service provides the following activities:

- **The street sanitation activity:** maintaining cleanliness on public roads, as well as the collection, transport, sorting, recovery and disposal of street waste.
- **The winter activity:** cleaning and transporting snow from public roads and keeping the road and sidewalk in operation by combating ice and frost. The snow removal and anti-icing programs (prepared by the sanitation operators) are approved by the sector municipalities, and then sent to the Municipality of Bucharest.
- **The domestic sanitation activity:** the separate collection and transport of municipal and similar waste (including household waste, generated by interior and/or exterior refurbishment and rehabilitation activities). The municipalities of sectors 1-6 will draw up databases on the management of all waste by components produced in the respective sector (based on information received from sanitation service operators); these data are then reported to the Public Utilities Directorate of the Municipality of Bucharest at the beginning of each month.

- **Integrated waste management:** the operation or administration of transfer stations for municipal and similar waste, sorting in sorting units, the organization of the mechanical and biological treatment, the management of landfills and/or disposal facilities, as well as the organization of the processing, neutralization and material and energy recovery of the waste.

Based on the Framework Regulation adopted at the level of the Municipality of Bucharest, each sector municipality has adopted its own Rules governing the organization and operation of the public sanitation service.

**Table 31: Minimum frequencies for the execution of sanitation activities**

Activity	Operation	Frequency
Street cleaning	Manual sweeping	1 pass/day (boulevards, main streets)
		1 pass/2-3 days (side streets)
		2 passes/day (crowded areas)
	Mechanized sweeping	1 pass/day (boulevards, main streets, crowded areas)
		1 pass/2-3 days (side streets)
	Street and sidewalk cleaning maintenance	1 pass/day (boulevards) 3 passes/day (crowded areas)
Scraping off gutters	once/month (boulevards)	
	once/3 months (main streets)	
	once/6 months (side streets)	
Wetting	6 passes/24 hours (boulevards)	
	4 passes/24 hours (main streets)	
	1 pass/24 hours (side streets)	
Jet washing	2 passes/week (boulevards)	
	1 pass/week (main streets, crowded areas)	
	1 pass/2 weeks (side streets)	
Winter activity	Snow removal and anti-icing programs	Completion within a maximum of 4 hours from the cessation of specific meteorological phenomena
	Preventive anti-icing treatments	Applied in maximum 2 hours after the meteorological warning
	Snow loading, transport, unloading and storage	Completion within a maximum of 8 hours from the cessation of specific meteorological phenomena

Activity	Operation	Frequency
Domestic waste collection	Domestic waste collection – warm season (April 1 – October 1)	Daily from the central areas and from the public alimentation units, the sanitary units with beds, kindergartens and nurseries;  Every 2 days, at most, from the other areas.
	Domestic waste collection – cold season (October 1 – April 1)	Every 3 days, at most, from all areas.

- **Source: Processing according to the SMLTDFPSSBC and the Rules governing the organization and operation of the public sanitation services in the Municipality of Bucharest.**

The table above indicates the minimum frequencies for the performance of sanitation activities, as they are mentioned in the Strategy on the public sanitation service and in the Rules governing the organization and operation of the public sanitation services in Bucharest City. For road sanitation activities, it is recommended to replace the brooms/brushes with suction equipment and to prohibit the use of air blowers in order to reduce particulate matter air pollution. Regarding winter activities, in each sector, the arrangement of at least one location for snow storage will be considered, which will be included in the snow removal and anti-icing program.

The perception of cleanliness in Bucharest (and, implicitly, of the quality of sanitation services) is a negative one. Thus, the sociological questionnaires applied to substantiate the strategy indicate that 56% of high school students believe that the quality of sanitation services in Bucharest should be improved (and 46% believe that sanitation services should be improved in the neighborhood where they live). In the general questionnaire (for the entire population), the street sanitation services received a score of 6.50 out of 10 from the respondents, occupying an average position among the issues assessed by the respondents, and for the quality of street sanitation there was a score of 7.16.

According to the strategy for the sanitation service, the service delegates and sanitation operators are responsible for organizing the collection of domestic waste and have the obligation of differentiated waste collection. Thus, until 2025, the Strategy for the medium and long term development and functioning of the public sanitation service in Bucharest City stipulates the obligation to stop using the garbage storage rooms inside the blocks, as well as to build separate waste collection “islands” within the neighborhoods (with platforms on which to place the containers and measures to make them accessible only to those served).

Therefore, to carry out the domestic sanitation service, the strategy for the sanitation service proposes the following interventions:

- Implementing a modern municipal waste collection system, which will contain surface containers, buried or semi-buried, allowing for the elimination of the related odors and visual discomfort.
- Implementing an integrated collection and transport system based on at least 4 containers: biodegradable waste, paper-cardboard waste, plastic waste and glass/metal waste.

**Table 32: Fees applied to individuals or legal entities in Bucharest in 2018**

Sector	Monthly fee for individuals	Monthly fee for economic agents and public institutions
Sector 1	There are no fees for the population	RON 80.77 / m <sup>3</sup> (excluding VAT)
Sector 2	RON 8.46 / person (including VAT)	RON 60 / m <sup>3</sup> (excluding VAT)
Sector 3	There are no fees for the population	EUR 5-16 / sqm (depending on the quantity collected)
Sector 4	RON 6.0 / individual – individuals whose income is below RON 2,000 / month	RON 80 / m <sup>3</sup>
	RON 9.6 / individual per year – individuals whose income is over RON 2,000 / month	RON 40 / m <sup>3</sup> for newly established companies
Sector 5	RON 8.46 / individual/month (including VAT)	Separate fees depending on the economic operator providing the service
Sector 6	RON 8.46 / individual/month (including VAT)	EUR 7 / m <sup>3</sup>

**Source: Integrated Waste Management Master Plan (Ramboll, 2018)**

The level of the fee applied to individuals or legal entities by the delegatee of the domestic sanitation service must be sent to the Municipality of Bucharest to be correlated with the costs generated by the systems and technologies applied for waste treatment, neutralization and controlled disposal. Thus, the operators of the sanitation service conclude management delegation contracts with the local administrations (sector municipalities), the documentation is then submitted to the Municipality of Bucharest in order to obtain the authorization. The service delegates shall establish the measures for the sanctioning of the waste generators, as well as the conditions for their application.

The table above shows the situation of fees in Bucharest for different categories of consumers. The lack of fees or taxes for the population in sectors 1 and 3 does not comply with the European “polluter pays” principle, thus making it impossible to apply the Pay As You Throw (PAYT) instrument. There are large differences in the taxation of businesses and public institutions – from RON 80 without VAT/m<sup>3</sup> in Sector 1 to only EUR 7 /m<sup>3</sup> in Sector 6. The main shortcomings are the lack of transparency regarding the level of the applicable fees, especially for the collection part, as there is a risk that these fees may not ensure a long-term sustainable development of integrated waste management systems.

Therefore, according to the legislation in force and the planning documents consulted, the General Council of Bucharest City ensures the implementation of the waste management obligations undertaken for Romania’s integration with the European Union, by coordinating the activity of the local councils of sector municipalities and developing the public sanitation strategy. The CGMB also has exclusive powers to organize the processing, neutralization and material and energy waste recovery, to organize the mechanical and biological treatment of municipal waste and similar waste and to manage landfills and/or disposal facilities. Disinfection, disinsectization and rodent control activities are also reserved for the CGMB.

On the other hand, the local councils of the sector municipalities are responsible for the separate collection and transport of municipal waste (including bulky waste and hazardous waste) and construction waste, as well as for the municipal waste sorting activity. Therefore, it is the responsibility of each municipality to determine how the selective collection of waste will be organized in that sector.

Also, the local councils of the sector municipalities have exclusive competences when it comes to street sanitation activities, and to winter activities, respectively.

The analysis of the contracts concluded by the operators for the procurement of sanitation services in the Capital's sectors reveals that the responsibilities for which the services are delegated are similar: the collection and transport of domestic waste (mentioning the need to collect recyclable waste), the equipping of customers with garbage cans, snow removal and anti-icing. For waste from parks and gardens, the management is performed by the Bucharest Lakes, Parks and Recreation Administration (BLPRA), and by the Public Domain Administrations within the sector municipalities, respectively.

Waste management in Bucharest is closely related to waste management in Ilfov County. In fact, as will be seen in the next chapter, most of the components of the waste management system serving Bucharest are located on the administrative territory of Ilfov County. In this respect, integrated waste planning would be needed (starting from the Regional Waste Management Plan, developed between 2007 and 2013), which would take into account the needs of both administrative entities. In 2019, there was an intention to set up a Bucharest-Ilfov Intercommunity Development Association for waste management, but this intention has not materialized so far. Moreover, (in March 2020) Ilfov County has developed and approved its own County Waste Management Plan.

## 7.2. The components of the municipal waste management system

Municipal waste in Bucharest is stored in three ecological landfills, two of which are located in Ilfov County (Glina – its integrated environmental permit expired in 2017 and Vidra – authorized with an annual visa in 2018) and one in Bucharest – IRIDEX landfill, located in Sector 1 of the Capital, on the Rudeni – Chitila road. According to data from the Ilfov Environmental Protection Agency, the Glina landfill has 32% of the 26 million m<sup>3</sup> capacity covered, while the Vidra landfill has 61% of the 11.5 million m<sup>3</sup> capacity covered.

The IRIDEX landfill has a capacity of 4,500,000 m<sup>3</sup>, and is operational since 2001 and currently having an integrated environmental permit issued in February 2018 (according to data received from the Bucharest Environmental Protection Agency). As of December 31, 2016, the landfill still had a disposable capacity of 1,229,000 m<sup>3</sup> (according to the Bucharest integrated waste management system Master Plan – Ramboll, 2018). The landfill was built in association with the Municipality of Bucharest, and the sanitation operators to whom the sanitation service for the territory of Bucharest was delegated have the obligation to ensure the transport of the average quantity of 225,000 tons/year of domestic waste and street waste.

The landfill in the village of Sinești, Vidra commune (administered by SC ECO SUD SA) was also built in association with the Municipality of Bucharest and put in service in 2001. In this case also, the sanitation operators have the obligation to ensure the transport of the average quantity of 225,000 tons/year of domestic waste and street waste. If the annual amount of waste exceeds 450,000 tons, the additional quantity may be disposed of in another environmentally friendly landfill that meets the legal requirements in force.

Several authorities and civic groups have complained in the past years about serious problems regarding the operation of the 3 above-mentioned landfills. They allege that, although they have an integrated environmental permit valid through 2028, Sector 1 and Vidra landfills have long exceeded their projected capacity. In March 2020, the National Environmental Guard inspected the two landfills, and thus this information was refuted, but other deficiencies were found, especially concerning the fact that the open surfaces of the cells are too large, generating olfactory pollution, the waste is temporarily stored outside the authorized areas, the sorting stations work at very low capacity, the access alleys are not treated and generate large amounts of dust in the atmosphere, etc. In the case of the Glina landfill, whose landfilling activity ceased in 2018, the problems are more serious – it is

almost impossible reauthorize it since the legally required minimum distance of 1000 m from the dwellings is not complied with.

In 2020 (March and July, respectively), the contracts concluded with the Municipality of Bucharest for the storage of waste at the landfills in Sector 1 (Iridex) and Vidra (Eco Sud) will expire, and the responsibility for concluding contracts with landfills will be transferred to the sector municipalities, to which the sanitation activity has been delegated since 2001.

**Table 33: Sorting stations that sort waste from Bucharest**

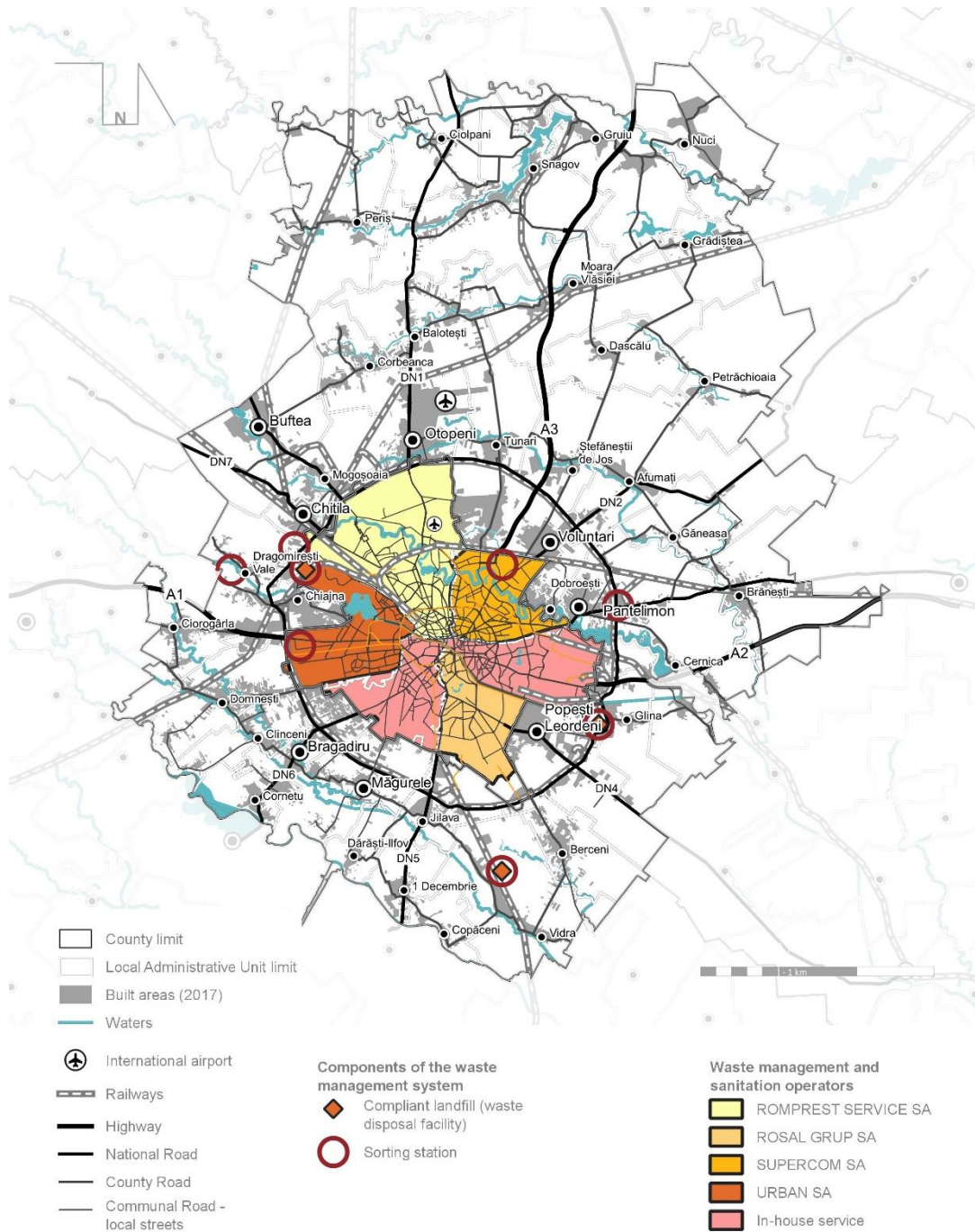
No.	Operator	Location	Capacity
1	SC URBAN RÂMNICU VÂLCEA SA	Militari neighborhood– Str. Preciziei, Sector 6	150,000 tons/year
2	SC SUPERCOM SA	Str. Gherghiței, Sector 2	120,000 tons/year
3	SC IRIDEX GROUP IMPORT-EXPORT SRL	Str. Drumul Poiana Trestiei, Sector 1	90,000 tons/year
4	SC 3R GREEN SRL	Chitila town, Rudeni neighborhood	90,000 tons/year
5	SC ROSAL GRUP SA	Șos. de Centură, Pantelimon town	55,000 tons/year
6	SC ROMWASTE SOLUTIONS SRL	Dragomirești-Vale commune	316,000 tons/year
7	SC ECOREC SA	Popești-Leordeni town – Glina landfill	46,000 tons/year
8	SC ECO SUD SA	Vidra commune – landfill	100,000 tons/year

**Source: Own processing according to the data from the Sanitation Service Strategy, the data provided by Bucharest EPA and Master Plan data**

According to the Master Plan data, the treatment of municipal waste in Bucharest is carried out in the following facilities (in addition to the 3 landfills):

- 7 sorting stations for mixed waste collected and separately collected recyclable waste, with a total capacity of about 871,000 tons/year (8 stations with the one at the Vidra landfill – see table above).

**Figure 44: Waste management system – Bucharest**



**Source: Own processing**

- two composting stations, with a total capacity of 2,400 tons/year: the operators are the BLPRA (Sector 5 – although it is declared to be a composting station, it only has one branch shredder with a maximum capacity of 60 tons/day, with no biological treatment facilities) and SC 3R GREEN SRL (green waste composting – 2,400 tons/year).
- a biological treatment facility, with a capacity of 40,600 tons/year (SC IRIDEX GROUP IMPORT EXPORT SRL).

Of all the facilities mentioned above, at the beginning of 2020 only 2 operators had contracts concluded with the Municipality of Bucharest: the compliant landfills operated by SC IRIDEX GRUP IMPORT EXPORT SA, and by SC ECOSUD SA, respectively. The operators of the sorting stations and of the composting installations have not concluded contracts with the sectors and with the Bucharest City. Also, the total used capacity of the sorting stations was about 300,000 tons (only 37% of the total capacity, according to the Master Plan). In addition, the two contracts will expire during 2020, so the decision to continue using them (or others) will be taken by the 6 sector municipalities.

The following components of the waste management system are located on the administrative territory of Bucharest (according to the data provided by the Bucharest Environmental Protection Agency):

- The sorting station operated by SC URBAN SA, located in Sector 6 of Bucharest (Str. Preciziei – industrial site) – a capacity of 150,000 tons/year, achieved in 2009. The station initially operated only by manual sorting, but since 2017 it has been automated.
- The sorting station operated by SC SUPERCOM SA, located in Sector 2 (Str. Gherghiței) with a capacity (function) of up to 7,120 tons/year, achieved in 2011.
- At the IRIDEX landfill, next to the sorting and mechanical treatment station for construction and demolition waste (located on the administrative territory of Chitila), there is a biological treatment plant with a capacity of 40,000 tons/year.

Recently, Sector 3 municipality started building its own sorting station in the village of Cățelu, but this activity has been suspended by the National Environmental Guard until the environmental permit is obtained. Sector 2 is also considering the development of a pre-sorting, sorting, mechanical-biological-thermal treatment and waste recovery plant by PPP, with a capacity of about 150,000 tons/year. However, the future of this partnership is uncertain.

In Bucharest, the sanitation services are managed, in each sector, by the following operators, and there is a 100% degree of connection to the sanitation services:

**Table 34: Sanitation operators who have concluded contracts with the sector municipalities in Bucharest**

Bucharest Sector	Operator name
Sector 1	SC Compania ROMPREST SERVICE SA
Sector 2	SC SUPERCOM SA
Sector 3	SC ROSAL GRUP SA until 2018, after that, the municipality's own service – Sector 3 General Directorate for Sanitation
Sector 4	SC ROSAL GRUP SA
Sector 5	SC Amenajare Edilitară și Salubritate SA, subordinated to Sector 5 Local Council (according to Local Council Decision no. 121/2019)
Sector 6	SC URBAN SA

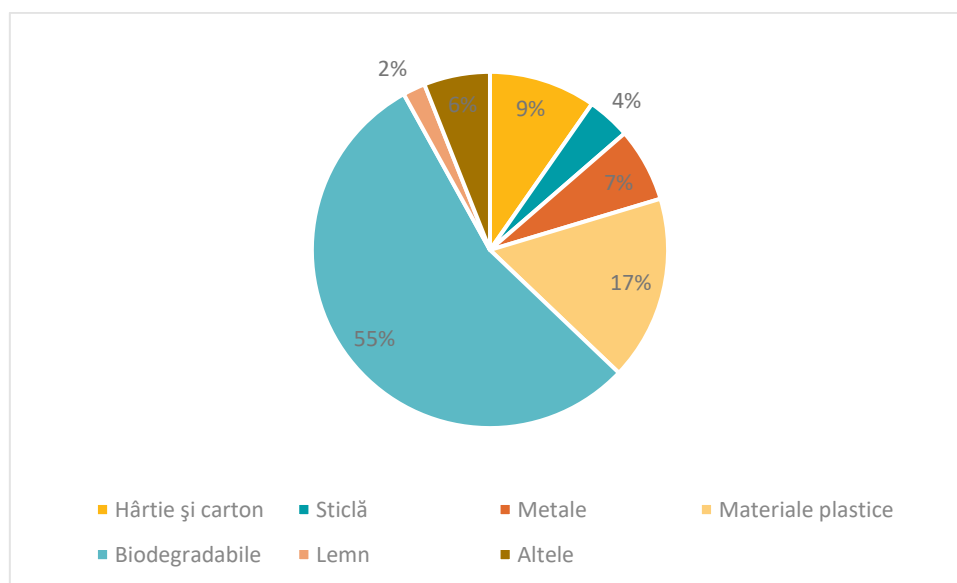
Source: Own processing

### 7.3. Municipal waste. Selective collection

According to the data presented in the Bucharest Integrated Waste Management System Master Plan (Ramboll, 2018), in Bucharest there were generated over one million tons of municipal waste in 2016 – about 20% of the total amount of waste generated at national level. The annual Environmental status report prepared by the Bucharest EPA indicates for 2017 a quantity of waste collected by the specialized operators and services of the municipalities of 914,538 tons (479,539 tons of waste generated by the population, 271,121 tons of similar waste, 163,848 tons of waste from public services). Thus, the municipal waste generation indicator was 500 kg per capita/year, above the EU average which is 476 kg per capita/year. The domestic waste generation indicator is about 1.05 kg per capita/day, significantly higher than the national average indicator for the urban environment (0.66 kg per capita/day).

The waste collected by the municipality includes domestic waste (698,466 tons in 2017 – 76%), municipal service waste (163,848 tons in 2017 – 18%) and construction and demolition waste (52,224 tons in 2017 – 6%). The composition of domestic and similar waste illustrates that the largest share (54%) is biodegradable waste – waste generated by economic operators, resulting from the preparation of food and expired food. Thus, it is possible to recover this waste in composting stations or for the production of biogas in anaerobic digestion plants. This would help meet the target of reducing the amount of biodegradable waste stored by 65% (a target undertaken at national level for 2017, according to the transposition into the Romanian legislation of European Union Directives in the field).

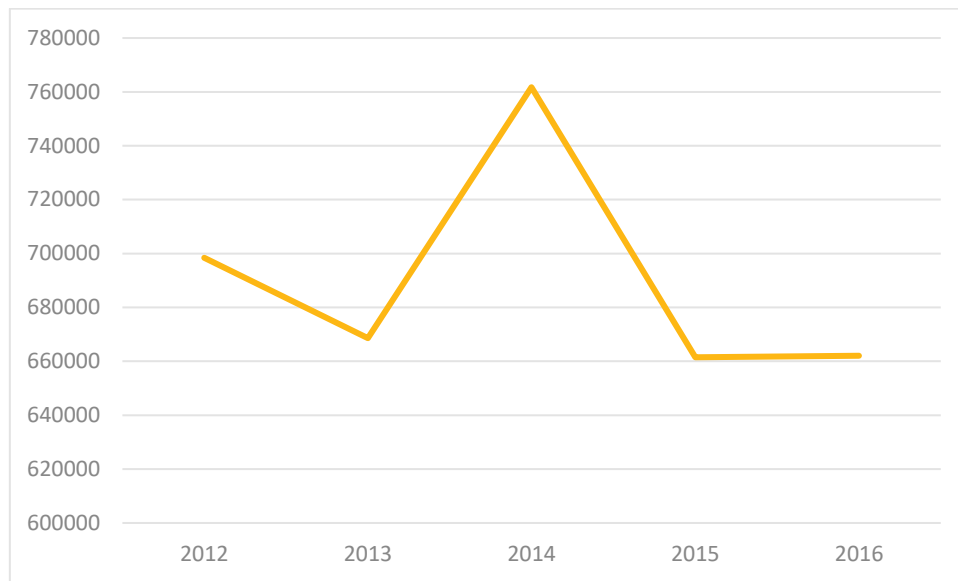
**Figure 45: The composition of domestic (and similar) waste – 2017**



**Source: 2017 Environmental status report, Bucharest EPA**

The evolution of the amount of municipal waste generated in Bucharest City (see figure below) indicates that, annually, according to data from the Municipality of Bucharest, the amount of waste is around 700,000 tons/year. For the year 2016, there is an increase by almost 70% (5,000 tons) in the amount of waste collected from gardens and parks (compared to 2015), possibly to be recovered following the separate collection of green waste. However, in 2016 the amount of composted waste from parks and gardens was only 1,100 tons.

**Figure 46:** The evolution of the amount of municipal waste generated in Bucharest between 2012 and 2016



**Source: Data from the Municipality of Bucharest, taken from the Master Plan (Ramboll, 2018)**

According to the Waste Master Plan, the collection of domestic waste in Bucharest is performed in collection points only for areas with low-rise blocks, and there were identified at least 3,200 above ground waste collection points, (data provided only for sectors 1, 3 and 5), to which 206 underground collection points in Sector 3 are added. In areas with individual dwellings and high-rise blocks of flats, the system implemented is “door to door”.

In terms of the collection infrastructure we can also discuss how separate waste collection is currently carried out. Thus, according to the Master Plan, the situation by sectors is as follows:

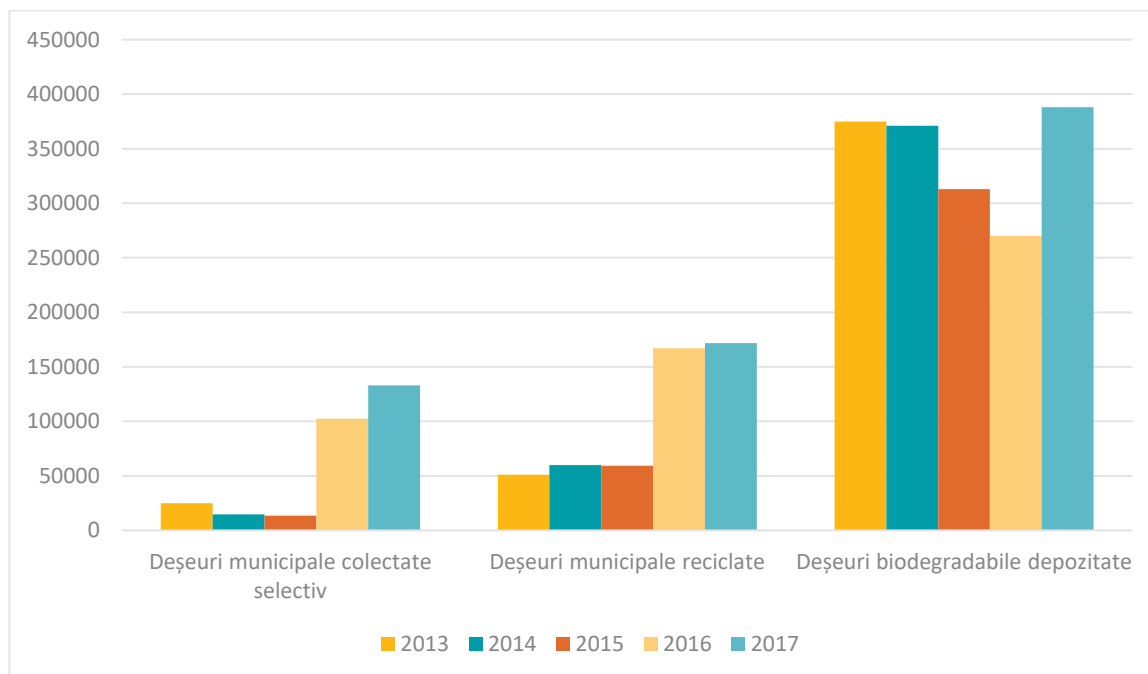
- **Sector 1** 313 above-ground points with containers of 2.5 m<sup>3</sup> and 1.1 m<sup>3</sup>. In 2018, the Local Council approved the construction of 1,973 underground collection points in blocks of flats and 20,000 mini composting stations for homeowners.
- **Sector 2** 31 above-ground points with 2.5 m<sup>3</sup> igloo-type containers.
- **Sector 3** 206 underground points with 1.1 m<sup>3</sup> containers and 14 above-ground points with bell-type containers (2.5 m<sup>3</sup>). In 2018, a new project for the development of underground containers was initiated, initially for 150 locations, later extended to 250 points, with an increased capacity (10 m<sup>3</sup>).
- **Sector 4** No data in the Master Plan. The strategy of the public sanitation service (2015) mentioned 26 points with 78 bell-type containers of 1.2 m<sup>3</sup>, plus the distribution of containers to owners' associations, economic agents, institutions, and schools.
- **Sector 5** 27 points with 61 containers of 2.5 m<sup>3</sup>.
- **Sector 6** 88 points with 248 igloo-type containers.

There is an unbalanced situation regarding the separate collection infrastructure in the sectors of Bucharest, especially in sectors 2 and 5 where the number of collection points is very low compared to the area and population. In general, the infrastructure is currently poorly developed and underused by (resident) waste generators.

Therefore, most of the waste is still mixed (only 27,000 tons of recyclable waste collected separately in 2016). Regarding the treatment of municipal waste, in 2017 about 23% of waste was recycled (117,821 tons of recyclable materials sorted, 21,402 tons of compost, 32,396 tons of co-incineration in cement plants, and 37,759 recovered in other ways), while about 77% (over 701,000 tons ) were landfilled (according to the EPA report). Considering the large amount of waste generated by the city

of Bucharest and the low rate of waste recycling/waste-to-energy in the rest of the country, it is apparent that 60% of the total amount of recycled waste and 80% of the total amount of waste-to-energy was generated on the Capital's territory.

**Figure 47 – Quantity of selectively collected, recycled and biodegradable municipal waste (tons) landfilled in Bucharest, between 2013 and 2017**



**Source: EPA. 2018 Environmental status report**

Despite the increase of more than 5 times in the quantity of selectively collected waste, and more than 3 times the amount of recycled waste, respectively, Bucharest City does not currently achieve the objectives set by the Waste Framework Directive, which requires preparation for the reuse and recycling of at least 50% of recyclable municipal waste (paper, metal, glass, plastic) by 2020, as well as preparation for the reuse and recycling of at least 70% of construction and disposal waste.

Most of the waste is currently stored in two landfills located in the area of Bucharest, whose capacity is limited and currently reaching its maximum. For about 4 years, the Municipality of Bucharest has been paying a tax of RON 50 / ton of landfilled waste over the limit imposed by the EC. Thus, without taking measures to rapidly reduce the amount of landfilled waste, the sector municipalities will be forced to resort to other landfills in the country and obviously bear the additional costs of transporting a very large quantity of waste collected daily.

The data provided by the Bucharest EPA indicate that there are 629 companies on the city territory that have received an environmental permit for waste collection. Most of them collect electrical and electronic equipment waste and have a small capacity. However, in the city there are also larger economic operators dealing with waste recycling and recovery – for example, for the recycling of glass waste the main economic operators are SC STIROM SA (35,000 tons/year) and SC TC ROM GLASS SRL (12,000 tons/year, with the possibility of expanding to 24,000 tons/year). Although there is a potential for higher recycling and recovery of domestic waste, the main obstacle is the lack of implementation of an efficient system of selective waste collection, coupled with the lack of sanctions for the violation of the relevant legislation by waste generators.

One of the questions of the sociological questionnaire applied to substantiate the strategy referred to the selective waste collection systems on the territory of Bucharest. Thus, 44.6% of the respondents state that they have access to such a system, but only 35.2% say that they also use this infrastructure. A positive aspect is the high willingness of respondents to selectively collect domestic waste in different bags or containers – 75.7% say they would certainly collect it, and 58.9% say they would certainly recover the sorted domestic waste.

Considering demographic and economic forecasts, the Bucharest integrated waste management system Master Plan presents projections of the amount of waste generated by 2046. The average scenario predicts a slight increase in the total amount of municipal waste by 2020 (from 1,040,900 tons in 2017 to 1,048,100 tons in 2020), but followed by a decrease of about 10% by 2025 (922,100 tons) and by almost 20% by 2046 (up to 836,100 tons). This projection translates into a decrease in the domestic waste generation indicator from 0.91 kg per capita in 2017 to 0.82 kg per capita in 2046.

In the light of the above, the Master Plan for 2046 proposes the implementation of an integrated waste management system in the Capital, whose main components are:

- a waste-to-energy incinerator with a capacity of about 235,000 tons, whose achievement deadline is 2023. Initially, the Municipality of Bucharest wanted it to be built in the vicinity of CET Progresul in Sector 4 (preferred against the RATB Titan base and CET Sud), but this was later abandoned due to the citizens' expressed dissatisfaction. At the moment, the Municipality of Bucharest is in the middle of a procedure for acquiring a private piece of land for the investment, but there is still the problem of financing the works estimated at about EUR 150 million, considering that the EC no longer finances such facilities, since 2019;
- the extension of the system for the selective collection of recyclable and biodegradable waste – from domestic, similar and market waste;
- the construction of an anaerobic digestion plant;
- the construction of a biological treatment plant for the waste from mixed waste sorting stations;
- the expansion of the storage capacity.

#### 7.4. Other categories of waste

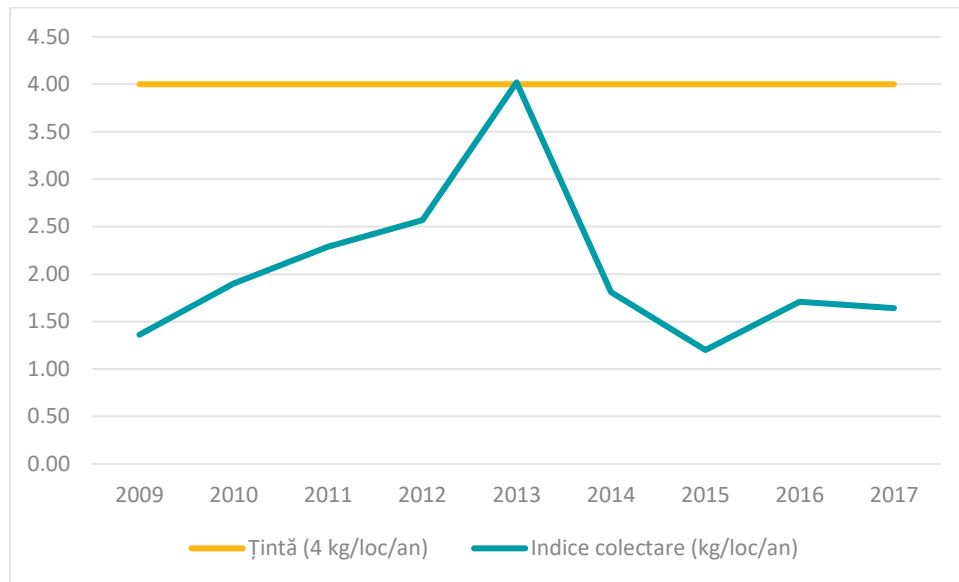
In 2017, 52,224 tons representing construction or demolition waste were collected in Bucharest (5.72% of the amount of waste collected in the Capital). The main dysfunction, in this case, is the lack of a construction and demolition waste treatment facility on the territory of the Bucharest-Ilfov region.

In Bucharest, the amount of non-hazardous waste generated by the main economic activities was 261,539 tons in 2017, of which 98,593 tons generated by the manufacturing industry, 5,055 tons generated by the energy sector (heat, electricity, gas), 5,406 tons by the water and sewerage services, and 152,485 tons by other economic activities. The amount of hazardous waste generated in the same year was 2,924 tons, the economic activities responsible for this being: the production of substances and chemicals (75 tons), metallurgy (100 tons), the machinery and equipment industry (31 tons), the transport means industry (184 tons), other activities (2,534 tons) – according to the Bucharest EPA Environmental status report. While economic agents are directly responsible for the management of the generated hazardous waste, at present in Bucharest there is no system implemented for the separate collection of domestic hazardous waste.

Regarding the management of waste electrical and electronic equipment (WEEE), it is noted that their collection index in Bucharest does not reach the target stipulated by the national legislation – 4 kg per capita/year; in 2017, only 2,997.32 tons were collected, which means a collection index of only 1.64 kg per capita/year.

Another special waste stream consists of end-of-life vehicles (ELVs). Between 2012 and 2017, the annual number of end-of-life vehicles (ELVs) collected and treated by authorized companies in Bucharest was around 4,000 units, with a minimum of 2,756 units of ELVs in 2017 – a significant decrease compared to the number of ELVs treated at the start of the “Rabla” program: the years 2010 (18,628) and 2011 – according to EPA data.

**Figure 48: Evolution of WEEE collection and treatment in Bucharest (2009-2017)**



**Source: Bucharest Environmental Protection Agency**

## 8. CONCLUSIONS, ISSUES AND TRENDS

Identified issues and needs	Proposals
<b>Drinking water supply infrastructure and services</b>	
Although in the Bucharest area lies the largest deposit of drinking water in the country, currently the underground catchment fronts are kept in conservation status due to some problems with the water quality.	Identification, evaluation and monitoring or closure of wells that collect water from the Frătești strata, existing on the territory of Bucharest City, in order to avoid groundwater contamination.
Currently, the water supply for Bucharest is ensured only from surface sources, which are vulnerable to pollution.	Development of a system that allows to capitalize on the strategic groundwater source, which should be activated in case of force majeure (e.g.: a major pollution on surface waters).  Building a pollution alert station upstream of the Arcuda treatment plant.
The water intakes Crivina (Argeș river) and Brezoale (Dâmbovița river) need rehabilitation.	Rehabilitation of the dam system at the Brezoale water intake and continuation of the rehabilitation program in the case of the Crivina intake.
Expansion of buildings in the lagoon area where the sludge from Roșu treatment plant is discharged.	Modernization of the sludge separation system at the Red treatment plant.
Low efficiency of the industrial water supply system, which operates at about 20% of capacity.	Use of the industrial water supply network to serve the south-eastern area (including neighboring localities: Popești-Leordeni, Jilava).
The existing city pumping stations are located only in the north, west and south areas of Bucharest. In the eastern area, consumers are only served by pumping stations.	Building a new pumping station in the eastern part of the city.
About 34 % of the drinking water distribution network consists of pipes over 50 years old, which should enter a rehabilitation program. In fact, about 54 % of the failures registered in the period 2015-2017 were on cast iron distribution pipes.	Resizing/replacing cast iron pipes more than 50 years old (526 km) which are located mainly in the central and northern part of the municipality.
About 80 % of failures on arterial mains (drinking water pipes) occurs on steel pipes.	Resizing the steel drinking water transport arterial mains, located in the Ring 1 area, Bd. Unirii, Splaiul Unirii, Calea 13 Septembrie, Vitan neighborhood, Bd. Pache Protopopescu, Șos. Ianului, Calea Griviței).
There are still areas in Bucharest not covered by the water supply network: in Sector 1 (Henri Coandă , Giulești-Sârbi neighborhoods), in Sector 3 (Luncilor and Gurilor areas), in Sector 4 (Progresul area), in Sector 5 (Prelungirea Ghencea) and in Sector 6 (Military - Roșu).	Extension of the water supply network in the areas located at the city's administrative limit, as well as in the areas of Gurilor, Luncilor, Dealurilor, Ghigideni.
There are still asbestos-cement pipes (66 km) in the area of Șos. Chitilei - Bucureștii Noi, but also in parts of Titan, Berceni or Militari neighborhoods.	Replacement of the remaining asbestos-cement pipes in Bucharest's water supply network.
There are high values of water age, over 12 hours in areas such as Bd. Theodor Pallady, Apărătorii Patriei or Timpuri Noi. The most affected area is the eastern area, as it is	Building a chlorination plant within the new pumping station proposed in the eastern part of Bucharest.

Identified issues and needs	Proposals
located furthest from the points where water chlorination is performed.	Study of water treatment methods in storage tanks.
The number of water facilities (fountains, drinking fountains, pumps) in the public space is low - only 115.	Extension of water facilities on the entire territory of Bucharest, in order to increase the thermal comfort in the summer season and to ensure an easy access to drinking water in the public space.
The negative perception of Bucharest's population regarding the quality of drinking water.	Carrying out extensive information campaigns on the quality of the drinking water in the system.
<b>Sewerage and wastewater treatment infrastructure and systems</b>	
The low drainage speed (below 0.7 m/s) does not ensure the minimum self-cleaning speed, in dry weather, for all collectors.	Identification of solutions for periodic hydraulic wash of collectors.
The sewerage network (including the size of the wastewater box culvert) is dimensioned in the 1980s, for a lower degree of waterproofing and a lower intensity of precipitation compared to current time.	Adaptation of the sewerage system to a calculation frequency, in case of rains, of 1:10.
Only 2 of the 68 wastewater pumping stations have a dual power supply.	Providing alternative power supplies for all wastewater pumping stations.
Almost 93 % of Bucharest's sewerage network operates in a unitary regime. Considering the increase of the waterproofing degree and the accentuation of extreme phenomena (heavy rains), this fact poses important problems in the operation of the network and treatment systems.	Realization of an integrated system for rainwater management, at municipal level: <ul style="list-style-type: none"> <li>- Extension of the separate rainwater collection network, directing them directly to the outflows after pre-treatment, where possible (for example, along the Colentina river valley).</li> <li>- Building retention basins and arrangement of green areas to allow rainwater storage.</li> </ul>
Frequency of flooding of underground infrastructure elements, in case of heavy rainfall.	Rehabilitation and upgrade of stormwater drainage facilities from the underground passages Mărășești, Lujerului, Jiului, Victoriei and Unirii
Over 50 % of the sewerage network is in an advanced state of degradation, requiring frequent interventions to remedy local problems.	Rehabilitation of 100 km of large sewer collectors, which need rehabilitation.  Resizing the sewerage network in the areas of Cotroceni, Regina Maria, Tineretului, and Slobozia street area.
Existence of areas not served by the sewerage network: the area in Sector 3 located north and south of Bd. Theodor Pallady (Gurilor and Luncilor area), but also in the northern area and in the Henri Coandă, Giulești-Sârbi neighborhoods or in the Prelungirea Ghencea area.	Extension of the sewerage network in the areas located at the administrative limit of the municipality, as well as in the areas Luncilor, Gurilor, Dealurilor, Giulești-Sârbi or Morii Lake.

Identified issues and needs	Proposals
<p>An average wastewater flow of about 3 m<sup>3</sup>/s (about 40 %) passes only through the primary treatment stage, generating important problems related to the quality of water in Dâmbovița River, downstream of Glina WWTP.</p>	<p>Completion of the second phase of the Glina Wastewater Treatment Plant project, which provides for the expansion of capacity to 2,500,000 l.e. and the possibility of biological treatment of a volume of wastewater of 8.3 m<sup>3</sup>/s.</p>
<p><b>Electricity</b></p>	
<p>The economic development of the city of Bucharest has led to an increase in electricity consumption higher than the national average, exceeding 1500 MW at peak load in winter 2017-2018. This represents approximately 65 % of the injection capacity from the electricity transmission network to the electricity distribution network in Bucharest and leads to reaching the limit value of injection capacity on each of the power supply areas inside Bucharest, the network not operating in loops. In the future, the forecast is that electricity consumption in Bucharest will increase, especially in the residential sector.</p>	<p>In the short term, the flexibility of the 220/110 kV Fundeni substation to increase the safety in supply of consumers in the north-east part of Bucharest and the installation of a new AT 220/110 kV 200 MVA, the installation of a new 400/110 kV 250 MVA transformer in the Substation Bucharest South.</p> <p>In the medium term, in the Bucharest area (Grozăvești) it would be opportune to build a 400/110 kV substation in the central area, connected by two underground 400 kV power lines with the Domnești substation, respectively București Sud.</p> <p>In the long term, considering the continuous increase of consumption, it would be necessary to build new 400 kV or 220 kV electrical substations and to build a 400 kV overhead/underground power line from the București Sud transmission substation to the Domnești substation, including the construction of a new 400/110 kV transmission substation in the northeastern area of Bucharest, in one of the localities Otopeni, Tunari, Voluntari, connected by the 400 kV UPL with the București Sud 400 kV substation and by the 400 kV OPL with the Brazi Vest 400 kV substation.</p>
<p>Considering the increase of consumption in Bucharest, the development of electricity supply infrastructure must take into account the lack and cost of land available for development works, the existence of users with a high degree of susceptibility to the quality of electricity supplied, the high number of cable supply lines, the decommissioning of generating sets in Bucharest, the increase of the power transit through Transelectrica substations in Bucharest coming from the Dobrogea area and supplying other areas of the country, the need to build charging stations for low/high capacity electric vehicles. The security of consumers' supply decreases in summer because this is when the total shutdowns for annual overhauls take place in the CHPs that supply electricity and heat to the Capital.</p>	<p>Installation of power plants with the possibility of energy storage leading to increased energy efficiency and flexibility of operation.</p> <p>Installation of renewable energy sources (photovoltaic panels) on the roofs of buildings so as to have neighborhoods/areas with excess of energy (local annual production higher than consumption in the area).</p> <p>Arrangement of electric charging stations for e-bikes/e-scooters and for electric vehicles and electric buses on the main traffic arteries.</p>

Identified issues and needs	Proposals
<p>Simultaneously with the increase in electricity consumption, in recent years there has been a decrease in thermal energy consumption, an increase in the number of disconnections from the centralized system, and uncertainty in ensuring the security of ELCEN revenues.</p>	<p>Cogeneration bonus scheme - the cost coverage scheme, started in 2011, must be extended from 2020. It is predicted that in 2025-2026 new capacities can be put into operation. RADET &amp; ELCEN integration and new power plants can be built in Titan, Aviației, Colentina, Casa Presei areas.</p> <p>Correlation between the city development and the energy development</p>
<p>Technical depreciation of materials, under standard conditions or at the end of assets life in electricity networks; most network elements older than 35 years; a small part of the total energy capacity has been rehabilitated or modernized; significant corrective maintenance</p>	<p>-preventive maintenance program developed and investments in network elements to reduce the number of interruptions;</p> <p>-significant increase in the number of upgrades of network elements;</p> <p>-upgrade of facilities for increasing the quality of the electricity supply service;</p> <p>-replacement of 110 kV UPL with increased capacity cables, such as the route București Nord-Centru, Militari-Răzoare, Militari-Grozăvești, Răzoare-Grozăvești. etc.</p> <p>-new 110 kV/MV electrical substations in the Drumul Taberei area, Băneasa</p>
<b>Thermal energy</b>	
<p>The central heating system in Bucharest is oversized (low pressure in documents), physically and morally worn out, most of the production capacities and networks being from 1960-1989, with about 30 % losses in networks , both for heat and water. The 4 big public CHPs that serve the Capital operate based on derogations with deadlines in 2020 and 2023, conditioned by investments in compliance with environmental requirements, and it is not clear if they can be achieved on time, especially in the conditions of the 2020 pandemic.</p> <p>district heating in Bucharest is currently in a state of accelerated degradation, with failures of increasing duration and size of the affected areas and, in the absence of clear political commitments from all decision makers, the system may become inoperable in the next few years. However, abandoning the centralized district heating system can be difficult in terms of ensuring the energy needs of Bucharest, given that they are based on integrated electricity and heat power plants. In addition, the number of customers connected to this system is more than half of the total city's population.</p>	<p>Preparation and submission for financing, from the existing European programs in the programming period 2014-2020, respectively 2021-2027, of the projects for rehabilitation and upgrade of the thermal energy distribution network (about 500 km in total).</p> <p>Providing financial resources from the PMB budget for continuing the network replacement works (other than those covered by European funding) and upgrade of block plants carried out by the operator under its subordination.</p> <p>Completion of compliance investment works initiated by ELCEN at the level of CHPs, and implementation (total or partial) of its investment plan, including after the transfer of its assets to another entity.</p>
<p>Lack of a scenario agreed by all actors involved about how the system should look in 10 years: vertically integrated</p>	<p>Making an urgent decision on the scenario for the district heating system, especially considering the</p>

Identified issues and needs	Proposals
<p>monopoly or competitive market with non-discriminatory access to a network regulated as a natural monopoly. This lack of vision means that the operators in the area of energy generation and distribution, the first being subordinated to a ministry, and the second to the General Council, have uncorrelated investment plans. In addition, the scenarios proposed so far have rarely been discussed with final consumers (captives, considering the complicated disconnection procedures) and have not taken into account their needs, leading to the situation in which they have less and less confidence in the future of the system.</p>	<p>approval of ELCEN's restructuring plan, which provides the transfer of the producer's assets by the end of 2020, either by the municipality or by the Ministry of Economy in the form of a new entity, or to any private investor.</p>
<p>The encumbrance of the district heating system by the PMB arrears on the payment of the subsidy to the district heating operator, respectively by it to ELCEN, including penalties, which amount to RON 3.8 billion (approximately EUR 850 million). Also, the municipality did not pay in full the subsidy for the winter 2019/2020. All these arrears led to the bankruptcy of RADET and the insolvency of the main producer, ELCEN.</p>	<p>The gradual settlement of PMB's debts to ELCEN (either by mutual agreement or following a lawsuit), so that the energy producer in turn honors its outstanding payment obligations to suppliers, creditors, etc.</p>
<p>The very high expenses of PMB with the subsidy for 60 % of the regulated cost of thermal energy generation (which is also lower than the real one) for all the inhabitants of the Capital, regardless of the amount of their incomes.</p>	<p>Reform of the PMB thermal energy subsidy system, adapted to the real resources available to the Municipality and aligning the percentage of the price borne by the final consumer at least to the level of other cities in Romania (with a much lower standard of living).</p>
<b>Telecommunications</b>	
<p>Although it has adopted 5G technology quite quickly, in Bucharest the 5G telecommunication services are provided by only two operators, and the coverage is limited to several areas in the center of the capital.</p>	<p>Extension of 5G coverage to the entire territory of Bucharest.</p>
<p>There are still areas/neighborhoods not served by the Bucharest's underground telecommunications network (optical fiber cables): Ferentari, Andronache, Tei, Doamna Ghica neighborhoods, Șos. Chitilei - Bucureștii Noi, Giulești neighborhood, the northern part of the Militari neighborhood or Cotroceni neighborhood</p>	<p>Achieving the objectives from the expansion plan of the NetCity Telecom network.</p>
<p>Reduced access to free WiFi connections in public spaces of Bucharest.</p>	<p>Installation of a WiFi network in public spaces (parks, markets), with free/open access for users.</p>
<b>Public lighting</b>	
<p>Currently only about 15 % of all public lighting fixtures use LED technology with powers from 5 W to 225 W</p>	<p>Replacement of all existing sodium or metal-halide luminaires with LED technology, which will result in an increase in energy efficiency.</p> <p>The implementation of dimming solutions at night in areas with low traffic over certain periods of time, in compliance with the standard lighting requirements,</p>

Identified issues and needs	Proposals
	<p>may lead to a reduction in the amount of electricity used by the luminaires by more than 15 %.</p> <p>Compensation of the reactive power factor with the help of compensation batteries, in order to reduce the reactive power factor (contractual obligation of the operator).</p>
<p>Switching on and off the lighting fixtures in Bucharest is done through almost 600 ignition points, most of them over 10 years old. Only 53 % of the poles related to the public lighting system in Bucharest belong to PMB, while the rest are owned by the electricity distribution and public transport operators.</p>	<p>A remote control management system ensures the individual control of each street lighting luminaire, so that the condition of each equipment (operation/non-operation) can be checked in due time, as well as the operation time or the electricity used.</p> <p>Establishing a dispatcher for the control and monitoring of lighting and creation of automation panels related to the ignition point to ensure the centralized control of lighting in the central dispatcher (contractual obligation of the operator).</p>
<p>In some areas of the Capital there is an increased potential for collisions between vehicles, between vehicles and pedestrians, cyclists and other road users, or between vehicles and immobile objects due to low illuminance levels.</p>	<p>Building a lighting system for the pedestrian crossing area that involves the increase of the illuminance level by at least 50 % compared to the rest of the road, which would lead to a decrease in the number of accidents.</p>
<p>The consumption and cost of electricity per light point has decreased slowly in recent years, but remains high because of the high share of luminaires based on sodium vapor, generating over 1 % of the total energy consumption in Bucharest.</p>	<p>The use of photovoltaic lighting systems in parks and parking lots, which would lead to a decrease in the total electricity consumption of the public lighting system of Bucharest.</p>
<b>Waste Management</b>	
<p>Street sweeping and equipment currently used for street cleaning contribute to high concentrations of dust in suspension in Bucharest.</p>	<p>Replacing brooms/brushes with vacuum equipment and banning the use of air blowers to reduce air pollution with suspended particles.</p>
<p>The perception on cleanliness in Bucharest is a negative one.</p>	<p>Increasing the frequency of street sanitation activities in areas with shortcomings.</p> <p>Fines applied to residents who do not comply with the rules in force.</p>
<p>The manner in which waste is currently collected in collective housing does not encourage selective collection.</p>	<p>Removal of the garbage storage rooms inside the blocks and the creation, inside the neighborhoods, of "islands" for the separate collection of waste.</p>
<p>The current pricing for sanitation services is not a transparent one, and in some cases the European "polluter pays" principle is not observed.</p>	<p>Increasing the degree of transparency in setting tariffs for sanitation services and applying a PAYT - Pay As You Throw system.</p>
<p>Lack of integrated waste management planning in Bucharest and Ilfov County, given that a large part of the system components (warehouses, sorting stations)</p>	<p>Cooperation between the two administrative entities, by setting up an Intercommunity Development Association for the integrated waste management.</p>

Identified issues and needs	Proposals
serving Bucharest are located in the administrative territory of Ilfov County.	
Sector municipalities have not concluded contracts with the sorting station operators, and they currently operate at less than 40 % of the total capacity.	Clarification of the contractual and institutional aspects regarding the waste sorting method, in order to increase the quantity of recovered waste.
The ALPAB composting station actually has only one branch shredder.	Construction of a composting station for the recovery of waste from parks and gardens
Although about 5 % of the collected household waste is biodegradable, the degree of recovery for it (as well as for waste from gardens and parks) remains very low. For this reason, the target of reducing the amount of biodegradable waste landfilled by 65 % until 2017 is not met.	Development of facilities for the recovery of biodegradable waste (including composting stations - anaerobic digestion plants).
The separate waste collection infrastructure is poorly developed and little used by waste generators (residents). Only 27,000 tons of recyclable waste were collected separately in 2016 and only 19.15 % of municipal waste collected was recycled - well below the 50 % target imposed by the Waste Framework Directive by 2020.	<p>Implementation of a selective waste collection system in Bucharest, with at least 4 fractions (biodegradable waste, paper-cardboard, plastics, glass/metal), (preferably) collected using buried or semi-buried containers.</p> <p>Carrying out information and awareness campaigns in schools and at the level of owners' associations.</p> <p>Implementing a mixed system of fines and facilities to encourage a change in the behavior of citizens regarding the selective collection of waste.</p>
Lack of a waste treatment plant for waste from construction and demolition on the territory of the Bucharest-Ilfov region.	Making such an infrastructure in Bucharest or on the territory of Ilfov county.
Lack of a system implemented for the separate collection of domestic hazardous waste.	Implementing such a system and informing the population on how to manage domestic hazardous waste.
Low index of WEEE collection on the territory of the city (1.2 kg/inhabitant/year, compared to the target provided by the national legislation of 4 kg/inhabitant/year).	Increasing the frequency of WEEE collection and more effective promotion of collection campaigns at the level of residents.

## ANNEX 1. WORKS FOR CONSOLIDATING THE ELECTRIC POWER SYSTEM IN BUCHAREST

Position in ANRE plan	Name of the investment objective/work/fixed asset
A1-009	Refurbishment and remote control of Cotroceni 110/20 kV substation
A1-010	Refurbishment of Nord 110/20/10 kV substation
A1-011	Refurbishment and remote control of Pajura 110/20 kV substation
A1-012	Increasing the operation safety level in the Solex substation
A1-013	Upgrade of supply points (PA) in Bucharest North area – PA1970, PA1380, PA1260, PA980, PA455, PA930, PA703, PA2420, PA2425, PA920, PA620
A1-014	Upgrade of supply points in Bucharest East area – PA 1520, PA3030, PA1580, PA1750, PA1455, PA2650, PA2570, PA2495, PA2550, PA2240, PA 2250, PA1990, PA1910, PA2440, PA2260, PA2505, PA3940
A1-015	Upgrade of supply points in Bucharest West area – PA759, PA2400, PA2490, PA2670, PA2690, PA2774,PA2800
A1-016	Upgrade of supply points in Bucharest South area – PA2120, PA1350, PA2500, PA2300, PA2210, PA2630, PA2270, PA210
A1-017	Upgrade of supply point in Bucharest South area – PA1930
A1-018	Upgrade of supply point in Bucharest South area – PA1790
A2-001	Relocation of medium voltage cables for Dudești substation that are crossing private properties
A2-002	Upgrade of 110 KV TRAFU 1+2 bays in the Mihai Bravu substation
A2-004	Upgrade of Obor substation – replacement of transformers T5, T6,T7,T8 110/10 kV in the 110/20/10 kV Substation
A2-005	Replacement of 110 kV UPL NORD – GROZAVESTI
A2-007	Replacement of 110 kV UPL NORD – CENTRU
A2-008	Relocation MV cables of CHP SUD substation, from the old connection room to the new one
B2-001	Upgrade of medium and low voltage network and transition to 20 kV distribution Floreasca area
B2-002	Transition to 20 kV distribution Dudesti - Ozana Policolor area
B2-003	Transition to 20 kV of T586, T786, T272, T2558 si T1631, upgrade and relocation of PTM 272 Antiaeriana
B2-004	Transition to 20 kV Bucharest, Cotroceni area
B2-005	Transition to 20 kV Bucharest, Drumul Taberei area
B2-006	Transition to 20 kV Bucharest, Pajura area

Position in ANRE plan	Name of the investment objective/work/fixed asset
B2-007	Improvement of voltage level in Jilava and transition to 20 kV Bucharest South area
B2-008	Upgrade of low voltage UPL in Domenii area, related to PT 10412, PT400, PT 4746, PT 156, PT 4657, PT 536, on Str. Stefan Sanatescu, Alexandru Constantinescu, Av. Petre Cretu, Av. Mircea Zorileanu, Constantin Sandu Aldea, Capitan Nicolae Drossu, Gheorghe Stalpeanu, Av. Ion Marasescu, Bd. Marasti, Bucharest City
B2-014	Centralization of measuring on Calea Victoriei, no. 128A
B2-016	Centralization of measuring in Lacul Tei area, no. 71, 73, 75, 126-128, Bucharest City
B2-022	Centralization of measuring in ANTIAERIANA area, Str. Manea Serban, Nedelcu Ilie, Valea Hartibaciului, Fratii Buzesti, Delureni, Luca Craioveanu, Ion Porumbaru, Corbita, Rombului, Suzana, Petre Gadescu, Elena si Vasile Cojocar, Ion Coman, Banu Maracine, Docolina, Iliada
B2-023	Centralization of measuring in ANTIAERIANA area, Str. Dorului, Mizileni, Recrutului, Mos Adam, Creata, Panterei, Tamasoia
B2-024	Centralization of measuring in Lamotesti area - Str. Lamotesti, Huedin, Izvorul Crisului, Izvorul Muresului, Izvorul Oltului, Izvorul Rece, Izvorul Trotusului, Resita
B2-025	Centralization of measuring in TURDA area, Str. Grivitei
B2-026	Centralization of measuring in CRANGASI area, Str. Zboina Neagra
B2-040	Amplification in Răzoare 110/20 kV substation, from 1x40+1x25 MVA to 2x40 MVA
B2-041	Centralization of measuring on Str. Cetatea de Balta No. 112-114, block 7
B2-042	Centralization of measuring on Sos. Nicolae Titulescu, Str. Maresal Averescu, PT 1975, PT 2468, PT 1107, PT 212, PT 1036 ,Turda area
B2-043	Making the MV connection between the Centru substation and the Nord substation and transition to 20 kV of the transformer points in the area
B2-046	Centralization of measuring on Aleea Parva, No. 8, Block A35, entrances A-D
B2-047	Centralization of measuring on Str. Vladeasa, No. 7, Block C34
B2-048	Centralization of measuring on Str. Pascani, No. 5, Block D7, entrances A-D
B2-049	Centralization of measuring on Aleea Baiut, No. 5, Block C36, entrances 1-5
B2-050	Centralization of measuring on Str. Topolovat, No 12, Block TD 22
B2-051	Centralization of measuring on Str. Soldat Zambila Ionita, No 1, 3, Bucharest East area
B3-001	Installing analyzers for electricity quality on the MV busbars of Cotroceni substation (4 pcs)
B3-002	Installing analyzers for electricity quality on the MV busbars of Filaret substation (6 pcs)
B3-003	Installing analyzers for electricity quality on the MV busbars of Nord substation (6 pcs)

Position in ANRE plan	Name of the investment objective/work/fixed asset
B3-004	Installing analyzers for electricity quality on the MV busbars of Obor substation (6 pcs)
B3-005	Installing analyzers for electricity quality on the MV busbars of Pajura substation (4 pcs)
B3-006	Installing analyzers for electricity quality on the MV busbars of Radu Zane substation (2 pcs)
B3-007	Installing analyzers for electricity quality on the MV busbars of Razoare substation (2 pcs)
B3-008	Installing analyzers for electricity quality on the MV busbars of Timpuri Noi substation (2 pcs)
B3-014	Installing analyzers for electricity quality on the MV busbars of Metrou substations (4 pcs)
B3-015	Installing analyzers for electricity quality on the MV busbars of Dudesti substation (2 pcs)
B3-016	Installing analyzers for electricity quality on the MV busbars of Jilava substation (2 pcs)
B3-017	Installing analyzers for electricity quality on the MV busbars of Solex substation (1 pcs)
B3-020	Installing analyzers for electricity quality on the MV busbars of IMGB substation (2 pcs)
B3-021	Installing analyzers for electricity quality on the MV busbars of Liviu Rebreanu substation (1 pcs)
B3-022	Increasing the electricity supply safety level in the Masini Grele 110 kV substation
B3-023	Upgrade of LV underground power lines on Sos. Oltenitei - DD Vacaresti Iriceanu
B3-024	Upgrade of LV UPL in Prelungirea Ghencea area
B3-025	Upgrade of MV cables in Filaret Distributie Brancoveanu 20 kV UPL and introducing the transformer points of this network in the remote control system
B3-026	Upgrade of MV cable with high failure frequency of PA 1480 bay 4 PT1329-PT1483
B3-027	Upgrade of MV cable of CET SUD 10 kV UPL bay 12: PT2824 - PA 1730 - PT 4006
B3-028	Upgrade of MV cable of 10 kV UPL PA 484 10 kV bay 12: PT 1633 - PT 3598 - PT 13 - PT 1685
B3-029	Upgrade of MV cables with high failure frequency in the area of Salaj substation (Salaj substation - T3227 and T3116-T3142) Bucharest City
B3-030	Upgrade of PA1 and PA2 for the Parliament building
B3-031	Upgrade of transformer substations (PT) in the northern part of Bucharest: PT 3977, PT 3979, PT 1113, PT 1114, PT 240, PT 2528, PT 545, PT 53, PT 112, PT 1654, PT 1664, PT 3646, PT 256, PT 382, PT 1283, PT 216, PT 2489, PT 46, PT 868, PT 2724, PT 924, PT 981, PT 1427, PT 1624, PT 1739

Position in ANRE plan	Name of the investment objective/work/fixed asset
B3-032	Upgrade and remote control for PT Bucuresti Vest :1383, 656, 1065, 152, 120, 986, 897, 265, 977, 1935, 2132, 661, 1963, 1275, 121, 2225, 3129, 1851, 2899, 449, 1327, 1492, 451, 1458
B3-033	Upgrade of transformer substations in the western part of Bucharest: PT 3169, PT 1018, PT 2519, PT, 1854,PT 2593, PT 2597, PT 2671, PT 2747, PT 2836, PT 2915, PT 2923, PT 3042, PT 3067, PT 3287, PT 3511, PT 1852, PT 3188
B3-034	Upgrade of transformer substations in the southern part of Bucharest: PT 279, PT 351, PT 1747, PT 3269, PT 2931, PT 2479, PT 2035, PT 1913, PT 1863
B3-036	Upgrade of transformer substations in the eastern part of Ilfov County: PT 3422, PT 3286, PT 3060, PT 3512, PT 3252, PT 3061 PT 3952
B3-051	Upgrade of LV UPL in the area of Toamnei neighborhood, Str. Mihai Eminescu, Bucharest City
B3-052	Upgrade of LV UPL in the area of Calea Grivitei neighborhood, PT 250, PT 319, PT 2487 Bucharest City
B3-054	Upgrade of LV network PA 1340
B3-060	Introducing remote control in transformer points with upgraded bays
B3-065	Upgrade of PT 1084, 1521, 1832, 2154, 2475, 2543, 2718, 2862
B3-066	Upgrade of PTA 218 with PTAB
B3-067	Upgrade of transformer substations in the western part of Bucharest: PT 2018, PT 1591, PT 718, PT 1971, PT 3254, PT 2230, PT 3946, PT 2132, PT 2162, PT 1935, PT 986, PT 897, PT 2021, PT 1577, PT 726, PT 1065, PT1352, PT1824, PT2346, PT 1997, PT 866, PT3425, PT 2975
B3-069	Introducing the LV network for PT 1822, PT 1806, PT 189, PT 589 in remote control system, in the southern part of Bucharest
B3-070	Introducing the LV network for PT 1082 in remote control system, in the northern part of Bucharest
B3-071	Introducing the LV network for PT 2937, PT 819 in remote control system, in the eastern part of Bucharest
B4-002	Improving the transmission capacity in Fundeni-Otopeni and Otopeni-Timpuri Noi and Timpuri Noi-Pajura 10 kV UPL
B6-004	Improving the level of safety in operation for Carne 1 20 kV power line and Porcine 2 20 kV power line, by discharging the load on a new 20 kV power line from PT 4350, connected directly in the Masini Grele 110 kV substation
B6-005	Increasing the safety level for the consumers in Metalurgiei and Popesti Leordeni areas, by making a new connection from Masini Grele substation and transition to 20 kV PT 1621

Source: ENEL

## ANNEX 2. CLASSIFICATION OF VOLTAGE DIPS ACCORDING TO DURATION AND RESIDUAL VOLTAGE LEVEL AT E-DISTRIBUTIE MUNTENIA

	10 ≤ t ≤ 200					200 < t ≤ 500					500 < t ≤ 1000					1000 < t ≤ 5000					5000 < t ≤ 6000					
Point of analysis (electrical substation/ Voltage level)	0,8 U <sub>c</sub> < u < 0,9 U <sub>c</sub>	0,7 U <sub>c</sub> < u < 0,8 U <sub>c</sub>	0,4 U <sub>c</sub> < u < 0,7 U <sub>c</sub>	0,05 U <sub>c</sub> < u < 0,4 U <sub>c</sub>	u < 0,05 U <sub>c</sub>	0,8 U <sub>c</sub> < u < 0,9 U <sub>c</sub>	0,7 U <sub>c</sub> < u < 0,8 U <sub>c</sub>	0,4 U <sub>c</sub> < u < 0,7 U <sub>c</sub>	0,05 U <sub>c</sub> < u < 0,4 U <sub>c</sub>	u < 0,05 U <sub>c</sub>	0,8 U <sub>c</sub> < u < 0,9 U <sub>c</sub>	0,7 U <sub>c</sub> < u < 0,8 U <sub>c</sub>	0,4 U <sub>c</sub> < u < 0,7 U <sub>c</sub>	0,05 U <sub>c</sub> < u < 0,4 U <sub>c</sub>	u < 0,05 U <sub>c</sub>	0,8 U <sub>c</sub> < u < 0,9 U <sub>c</sub>	0,7 U <sub>c</sub> < u < 0,8 U <sub>c</sub>	0,4 U <sub>c</sub> < u < 0,7 U <sub>c</sub>	0,05 U <sub>c</sub> < u < 0,4 U <sub>c</sub>	u < 0,05 U <sub>c</sub>	0,8 U <sub>c</sub> < u < 0,9 U <sub>c</sub>	0,7 U <sub>c</sub> < u < 0,8 U <sub>c</sub>	0,4 U <sub>c</sub> < u < 0,7 U <sub>c</sub>	0,05 U <sub>c</sub> < u < 0,4 U <sub>c</sub>	u < 0,05 U <sub>c</sub>	
Balta Albă S1-10 kV	22	7	8	2	-	2	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Balta Albă S2-10 kV	73	26	5	-	-	7	2	3	1	-	-	-	1	2	-	-	-	-	-	-	-	27	2	-	-	-
Băneasa S1-20 kV	69	13	8	1	-	11	4	4	3	-	8	-	1	2	-	-	-	-	-	-	-	13	1	1	-	-
Băneasa S2-20 kV	49	5	6	-	-	9	1	4	2	-	6	-	2	2	-	-	-	-	-	-	-	7	3	1	-	-
Crângăși S1-10 kV	51	24	13	1	-	2	-	1	-	-	-	-	-	3	-	-	-	-	-	-	-	9	1	-	-	-

	10 ≤ t ≤ 200					200 < t ≤ 500					500 < t ≤ 1000					1000 < t ≤ 5000					5000 < t ≤ 6000				
Crângeș i S2- 10 kV	79	24	28	-	-	2	-	-	-	-	-	-	-	1	-	-	-	-	-	-	2	3	1	-	-
Dr. Mor arilor S1B- 10 kV	73	28	9	1	-	3	4	7	5	-	1	1	6	1	-	-	-	-	-	-	15	2	-	-	-
Dr. Mor arilor S2B- 10 kV	84	25	13	1	-	2	2	10	6	-	-	1	4	1	-	-	-	-	-	-	12	4	1	-	-
Dr. Mor arilor S1A- 10 kV	60	22	16	-	-	2	3	8	2	-	-	4	5	1	-	-	-	-	-	-	9	1	-	-	-
Dr. Mor arilor S2A- 10 kV	83	26	19	1	-	3	7	14	4	-	-	3	6	1	-	-	-	-	-	-	14	3	-	-	-
Dr. Tabe rei S1- 10 kV	43	15	10	-	-	1	-	-	6	-	-	-	-	-	-	-	-	-	-	-	10	-	1	-	-
Dr. Tabe rei S2- 10 kV	47	17	17	-	-	-	-	1	1	-	-	1	1	-	-	-	-	-	-	-	13	-	1	-	-
Laromet 20 kV	24	7	13	6	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	1	-	-	-

	10 ≤ t ≤ 200					200 < t ≤ 500					500 < t ≤ 1000					1000 < t ≤ 5000					5000 < t ≤ 6000				
Militari S1-10 kV	51	17	16	1	-	2	-	3	-	-	-	-	1	1	-	-	-	-	-	-	15	2	1	-	-
Panduri S1-20 kV	71	19	9	-	-	6	1	2	-	-	-	-	-	-	-	-	-	-	-	-	14	1	-	-	-
Panduri S2-20 kV	76	24	3	-	-	7	1	4	-	-	1	-	-	-	-	-	-	-	-	-	14	1	-	-	-
Sălaj 20 kV	54	14	16	-	-	3	-	1	2	-	-	-	1	-	-	-	-	-	-	-	8	1	1	-	-
Vulcan 10 kV	51	13	4	-	-	5	1	3	-	-	-	-	-	-	-	-	-	-	-	-	19	1	-	-	-
Vulcan 20 kV	116	27	4	1	-	21	1	2	2	-	5	2	-	-	-	-	-	-	-	-	20	-	-	-	-
Toporașii S2-10 kV	68	26	15	-	-	4	3	3	-	-	-	1	-	-	-	-	-	-	-	-	5	-	-	-	-
Toporașii S3-10 kV	65	16	24	-	-	8	3	2	-	-	-	-	1	-	-	-	-	-	-	-	2	1	-	-	-
Toporașii S4-10 kV	67	25	13	-	-	4	3	4	-	-	-	1	-	-	-	-	-	-	-	-	3	-	-	-	-

	10 ≤ t ≤ 200					200 < t ≤ 500					500 < t ≤ 1000					1000 < t ≤ 5000					5000 < t ≤ 6000				
Afumați S1-20 kV	31	5	9	-	-	2	5	4	3	-	-	-	1	-	-	-	-	-	-	-	4	-	-	-	-
Afumați S2-20 kV	33	6	7	-	-	15	5	2	2	-	-	-	1	-	-	-	-	-	-	-	14	-	-	-	-
Chitila S1-20 kV	29	15	22	3	-	5	11	4	-	-	14	20	2	1	-	-	-	-	-	-	15	3	1	-	-
Chitila S2-20 kV	20	10	15	1	-	2	1	8	1	-	1	3	2	2	-	-	-	-	2	-	9	3	-	-	-
Tâncăbești S1-20 kV	102	19	25	24	-	43	30	21	15	-	30	51	31	7	-	-	-	6	2	-	48	9	11	5	-
Tâncăbești S2-20 kV	139	94	69	27	-	44	32	19	15	-	31	54	30	5	-	-	-	6	2	-	63	6	11	2	-
ICMUG S2-20 kV	108	13	154	1	-	25	7	149	1	-	4	-	-	-	-	-	3	-	-	-	783	5	-	-	-
Izvorul 20 kV	245	113	71	3	-	29	9	16	5	1	17	11	15	-	-	-	-	-	3	13	42	6	3	-	2
Popești B1-20 kV	7	1	-	-	-	4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	10 ≤ t ≤ 200					200 < t ≤ 500					500 < t ≤ 1000					1000 < t ≤ 5000					5000 < t ≤ 6000				
Popești B2- 20 kV	8	1	-	2	4	4	3	2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IFA B2 20 kV	14	1	3	-	-	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Giurgiu Nord B2 20 kV	17	1	-	1	-	1	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Giurgiu Vest B2 20 kV	18	5	14	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: ENEL

## ANNEX 3. SIGNIFICANT INCIDENTS IN THE POWER DISTRIBUTION NETWORK MANAGED BY E-DISTRIBUTIE MUNTENIA IN 2018

Substation	Equipment	Date/hour		Duration (mins)	No. of clients	Interrupted power [MW]	Localities	Cause	Notes
Fundeni 110/20 KV	OPL + UPL 110 KV Pipera 1	10.01.2018	14:31	20	27.265	83	Pipera neighborhood, partially Baneasa	cord for T phase cut in the connection point from the descent from OPL to the line separator, Fundeni-Pipera 1 110 kV OPL+UPL	Fixed on 10.01.2018. At 19:26 hours the switch has been made to the normal scheme with the Fundeni-Pipera 1 110 kV line
Centru 110/10 KV	Trafo 1 110/10kV	19.02.2018	03:32	5	14005	15	Bucharest, central area	110 kV cable, Centru substation-PA 1450	Automatic switch on to reserve power supply worked at PA2710, PA596, PA1670, PA703, automatic restoration of supply for 34 PTs/2400 customers. At 03:37, Trafo 1 110/10 kV restored, fully supplied.
Arcuda 110/20 KV	Pompe (CMU) 20 kV line – switched off by timed homopolar current protection	01.04.2018	15:48	150	5998	4	Bolintin-Deal, Gradinari, Bolintin- Vale, Ogrezeni, Joita GR, Sabareni	Defective 20 kV separator at S1013	Fixed on 03.04.2018 - for replacement
Arcuda 110/20 KV	POMPE(CMU) 20 kV LINE- switched off by timed homopolar	01.04.2018	09:43	254	5998	4	Bolintin-Deal, Gradinari, Bolintin- Vale, Ogrezeni. Joita	Broken 20 kV isolator - between S1199-S1660	Fixed on 01.04.2018 - ISNS isolator replaced;

Substation	Equipment	Date/hour		Duration (mins)	No. of clients	Interrupted power [MW]	Localities	Cause	Notes
Drumul Taberei 110/10 kV	Trafo 2 110/10 KV	03.05.2018	04:13	11	18717	6	Dr. Taberei neighborhood, partially	Main cause: Defective 10 kV cable Dr. Taberei substation – Metrou Lujerului 1A; associated with: defective protection relay DV901 Metrou Lujerului 1 bay;	Restored supply for 10,072 customers by action of the automatic switch to reserve power supply. Supply fully restored after 11 minutes. Replaced defective DV901 relay: 03.05.2018; fixed defective cable: 07.05.2018
Pipera 110 20/10 kV	10 kV LINE PA2425R – switched off by timed homopolar current protection	09.05.2018	14:38	102	3 MV/ 7682 LV	3	Bucharest – Lacul Tei area	<b>Main cause:</b> 10 kV cable between PA2425 - T2575, associated to the primary cause, refuse of switching off in bay T 2575, bays 3380 si 2865B from PA 2425.	<b>In:</b> 26 minutes the power supply was restored for 2882 customers , in 52 minutes for 2346 customers, in 78 minutes for 1272 customers, and in 102 minutes for 1185 customers; <b>Fixing cable and bay revision: 11.05.2018</b>
CHP BUCURESTI SUD 220/110/10 kV	10 kV LINE PC4150B1+PA2535 R switched off by timed homopolar current protection	14.06.2018	10:02	55	2 MV/ 5323 LV	1	Bucharest, Baba Novac - IOR area, Oltenitei	Defective 10 kV cable between PA1450 - PA2535	In 35 minutes the power supply was restored for 1304 customers , in 48 minutes for 1956 customers, and in 55 minutes for 2065 customers; <b>Fixed:</b> 17.06.2018

CHP BUCURESTI SUD 220/110/10 kV	10 kV OPL PA 1910R switched off by timed homopolar current protection	18.06.2018	10:07	62	1 MV/ 6956 LV	1.55	Bucharest, Ozana - Pallady and Titan - Grigorescu area	<b>Primary cause:</b> short circuit caused by a rat in bay T1156 from PA1910; - 10 kV Circuit breaker T1156 from PA1910; - Defective 10 kV cable between PA1910 - T1156.	<b>The network was operating with deviation from the normal scheme:</b> T1521, T5127, T1514, T1512, T4231 - taken over from PA 1580; <b>Fixed:</b> 21.06.2018
ARCUDA 110/20 kV	POMPE 20 kV LINE - switched off by timed homopolar current protection	21.06.2018	18:25	404	8 MV/ 5917 LV	4	Bolintin-Deal, Gradinari, Bolintin- Vale, OGREZENI, JOITA GR, Sabareni	Cut off cord at S 1150	In: 55 minutes the power supply was restored for 610 customers , in 86 minutes for 3363 customers, in 102 minutes for 1207 customers, and in 153 minutes for 744 customers and in 404 minutes for 1 customer; <b>Special weather conditions:</b> thunderstorm.
OBOR 110/20/10 kV	10 kV UPL PA197+PA2350 - switched off by timed homopolar current protection	08.07.2018	08:00	16	4 MV/ 6085 LV	2.1	Bucharest - sector 2 partially	Defective 10 kV cable between substation - PA197	Power supply was restored for 1105 customers by the action of automatic switch to reserve power supply and in 16 minutes supply was restored for 4891 customers; <b>Fixed:</b> 11.07.2018
SALAJ 110/20/10 kV substation	Trafo 2 110/20 kV - switched off by homopolar voltage protection	29/08/2018	13:56	12	10 MV/ 18870 LV	9.8	Bucharest, Salaj, Rahova neighborhood	10 kV feeder PA1470R, defective cables A and B	In 3 mins, power supply was restored for 1 MV and 4342 LV customers ; in 12 mins – 9 MV and 14528 LV customers. Defective 10 kV relay in 10 kV bay in PA1470R, which led to switch off of Trafo 2; action of automatic switch to reserve power supply in PA1930 and automatically power supply restored for 4343 customers; <b>Fixed:</b> 29.08.2018
CHP BUCURES TI SUD 220/110/10 kV substation	10 kV line, PA2120B2 - - switched off by timed homopolar current protection	02.10.2018	11:27	5	5442 LV	1	Bucharest City: Berceni neighborhood, partially	-10 kV cable- (A) - CHP SUD - PA2120 - (B2) -10 kV cable- (B) - CHP SUD - PA2120 - (B2)	The 10 kV automatic switch to reserve power supply in PA 2120 did not work – fixed on 03.10.2018. 10 kV cable fixed on 05.10.2018

Balta Alba 110/10 kV substation	10 kV OPL PA 1910B - - switched off by timed homopolar current protection	09.10.2018	17:56	33	1 MV/ 7784 LV	2	Bucharest City - partially Balta Alba neighborhood, sector 2	~ 10 kV cable - (A) - BALTA ALBA - PA1910 - (B) ~ 10 kV cable - (B) - BALTA ALBA - PA1910 - (B)	In 7 mins, 1179 LV customers were supplied; in 10 mins – 953 LV; in 14 mins – 1186 LV; in 17 mins - 606 LV; in 24 min - 830 LV; in 29 mins - 1 MV and 1586 LV; in 33 mins - 1444 LV. At PA 1910, the action of the automatic switch to reserve power supply was incomplete. Fixed: 16.10.2018
OBOR 110/20/10 kV substation	10 kV UPL PA197+PA2350 - switched off by timed maximal current protection	13.10.2018	06:36	13	4 MV/ 6085 LV	0.9	Bucharest City: sector 2 partially - Doamna Ghica neighborhood, Vatra Luminoasa, National Stadium, Fundeni.	• 10 kV cable - (B) - OBOR - PA197 • 10 kV cable - (A) - OBOR - PA197	In 1 min, power supply was restored for 344 LV customers ; in 2 mins – 1 MV and 4639 LV customers; in 13 mins - 3 MV and 1102 LV. Automatic switch to reserve power supply cancelled in PA 2350 (defective 10 kV cable on Fundeni substation - PA 1750 (R)). The 10 kV automatic switch to reserve power supply in PA 197 did not work. The 10 kV cable A and B was fixed and put into operation on 15.10.2018.
MILITARI 110/20/10 kV substation	TRAF0 3/20 kV - switched off by homopolar voltage protection	17.10.2018	18:14	76	37 MV/ 20194 LV	9.7	Bucharest City: neighborhoods Militari, Dr. Taberei, Valea Cascadelor, Bdul Timișoara	Defective cable on the 10 kV feeder - MILITARI - RGAB DR.TABEREI 2	In 2 min, power supply was restored for 18 MV customers and 2235 LV customers ; in 13 mins – 9 MV and 6225 LV customers; in 1 hour 16 mins - 10 MV and 11734 LV customers. 10 kV cable Dr. Taberei-RGAB Dr Taberei 2 hit on str. Brașov by a third party company (RGAB). Automatic switch on to reserve power supply worked at PA3770 and PA962, restoring supply for 2253 customers. Initially, the 10 kV bay RGAB Dr. Taberei 2 did not switch off. After supply of busbar in no-load conditions



CHP București SUD 220/110/10 kV substation	10 kV line, CHP SUD R - disconnected in failure prevention	18.10.2018	21:00	4	5722 LV	2	Bucharest City - partially Balta Alba neighborhood	Defective 10 kV circuit breaker - busbar coupling in PA2535	Interruption maneuver for isolation of defective element in PA2535. <b>Fixed:</b> 22.10.2018
Drumul Taberei 110/10 kV substation	10 kV line, PA1880B - switched off by timed homopolar current protection	30/10/2018	02:41	1.2	2 MV/ 6685 LV	1.2	Bucharest City: Drumul Taberei neighborhood, partially	Defective 10 kV cable - (A) - Drumul Taberei - PA1880 - (B) Defective 10 kV cable (B) - Drumul Taberei - PA1880 - (B)	The 10 kV automatic switch to reserve power supply in PA 1880 did not work – <b>Fixed:</b> 02.11.2018
TOPORA SI 110/20/10 kV substation	10 kV UPL, PA1350 - switched off by timed maximal current protection	23.11.2018	18:27	3	1 MV/ 5675 LV	3	Bucharest City: Berceni neighborhood, partially	CABLE - 10kV - (A) - TOPORASI - PA1350 - (B) CABLE - 10kV - (B) - TOPORASI - PA1350 - (B)	In 19 mins, power supply was restored for 2 LV customers ; in 57 mins – 1 MV and 5673 LV customers. <b>Fixed:</b> 29.11.2018

TITAN 110/10/6 kV substation	TRAFO 1 /110/10 kV – switched off by homopolar voltage protection	27.11.2018	21:23	13	29 MV/7918 LV	12	Bucharest: 23 August neighborhood, Calea Ducești-Pantelimon, National Stadium, partially Pantelimon neighborhood	10 kV cable Titan substation - T495; homopolar voltage loop interrupted in the secondary circuits CM - 10 kV, which led to the malfunction of the protection in 10 kV bay T495 and switch off of Trafo 1.	Affected -10 kV A and B busbar sections, 6 kV A and B busbar sections; <b>Fixing:</b> On 28.11.2018, at 11:57, the homopolar voltage loop for 10 KV section B was fixed. Fixing and return to operation of 10 kV cable Titan-T495 on 03.12.2018.
INCREST 110/20/6 kV substation	TRAFO 3 /110/20 kV – switched off by homopolar voltage protection	15.12.2018	05:47	38	14741 LV	2.1	Localities Chitila (partially) and Chiajna, Bd. Iuliu Maniu (exit to A1)	UPL 20 kV T 5139 bay - 20 kV protection relay	<b>FIXED: 15.12.2018</b>
TOPORASI 110/20/10 kV substation	PA 2300 Berceni - UPL 10 kV T2802 - switched off by timed homopolar current protection	16.12.2018	21:28	58	5370 LV	2.9	Bucharest: Constantin Brancoveanu, Drumul Gazarului, Huedin, Izvorul Muresului area	Defective 10 kV cable: PA 2300-T2802	10 kV bay T2802 from PA 2300 IO 10 kV did not switch off, incomplete operation of 10 kV automatic switch on to reserve power supply. <b>Fixed:</b> 18.12.2018

FUNDENI 220/110/10 kV substation - managed by ST Bucuresti/TRANS ELECTRICA	PA 1750R - switched off by timed maximal current protection	18.12.2018	21:53	21	3 MV/ 8060 LV	5	Bucharest City: Pipera neighborhood, partially Baneasa	Defective 10 kV cable B Fundeni – PA175 Orez	<b>Fixed: 21.12.2018</b>
SALAJ 110/20/10 kV substation	T5160 (IV) - switched off by timed maximal current protection	29.12.2018	12:20	264	7665 LV	2.2	Bucharest City: Rahova neighborhood and partially Ferentari neighborhood	Defective 20 kV cable between T3353-T4983	<b>In 4 mins, 420 LV customers were supplied; in 7 mins – 4699 LV; in 12 mins – 339 LV; in 49 mins – 261 LV; in 50 mins – 668 LV; in 4:24:00 – 1258 LV. Fixed: 29.12.2018.</b> The network was operating with deviation from the normal scheme (fault in Salaj 20 kV UPL – T4994)