Energy Technology and Governance Program:

South East European Distribution System Operators Benchmarking Study – 2nd edition (2008 – 2015)

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Authors:
Danko Vidović, Energy Institute Hrvoje Požar (EIHP), Croatia
M.Sc. Kristina Perić, Energy Institute Hrvoje Požar (EIHP), Croatia
Ph.D. Goran Majstrović, Energy Institute Hrvoje Požar (EIHP), Croatia
Tomislav Baričević, Energy Institute Hrvoje Požar (EIHP), Croatia
Ph.D. Minea Skok, Energy Institute Hrvoje Požar (EIHP), Croatia
Ph.D. Jurica Brajković, Energy Institute Hrvoje Požar (EIHP), Croatia

United States Energy Association
1300 Pennsylvania Avenue, NW
Suite 550, Mailbox 142
Washington, DC 20004
+1 202 312-1230 (USA)

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1 TERMS OF REFERENCE

Weather change induced and manmade outages occurring in the distribution system networks in Southeast Europe threaten the security of the electricity supply for end-use consumers and disrupt economic activity. To assist distribution system operators in Southeast Europe to reduce the breadth and scope of outages in their networks, USAID, together with the United States Energy Association, has establish a Southeast Europe Distribution System Operator (DSO) Security of Supply Working Group. Working Group members currently include representatives from the DSOs of:

Albania,
Bosnia and Herzegovina,
Croatia,
Macedonia,
Kosovo,
Montenegro and
Serbia

Representatives from the regulatory agencies (RAs) in these countries serve as observers to the Working Group.

Modelled after the Southeast Europe Cooperation Initiative (SECI) Transmission System Planning Project, the activities of the DSO Security of Supply Working Group will be demand driven to respond to the needs of the distribution companies in the region, with an emphasis on the following deliverables:

- **Business continuity plans** to help electric companies plan for all scenarios such as severe weather events that may impact their ability to provide reliable electric power to consumers;
- **Mutual assistance plans** to encourage distribution companies to share staff and materials necessary for fast restoration of service after a significant outage;
- **Maintaining and sharing critical inventory** to ensure adequate supply of spare parts necessary to respond to outage events;
- **Emergency procurement systems** to allow for rapid procurement of essential equipment in emergency situations;
- **Asset management programs** to optimize the life of distribution network infrastructure; and
- **Benchmarking of best practices**.

These deliverables will assist the SEE DSOs harden their distribution systems, thereby mitigating potential system outages induced by weather related events. It will also assist them to adapt to climate induced outages by improving their ability to restore service in an efficient and timely manner as a result of weather related system disturbances.

Though it is widely accepted that distribution system outages continue to plague Southeast European electric power systems, the exact number, frequency, duration and the scope of outages in terms of the number of customers effected is not quantified.

1.1 Scope of Work

Starting in 2013, the Consultant prepared the 1st SEE DSO Benchmarking Study that covered large set of benchmarking indicators in the period 2008 - 2012. These data were compiled and used for a comparative analysis to benchmark the performance of the DSOs in the region against one another. A similar comparative analysis was prepared to benchmark the performance of the DSOs in Southeast Europe against a utility(ies) in North America.

Results from the 1st Benchmarking Study provide the DSOs, regulators, donors, consumer groups and other interested parties a set of region-wide metrics on the extent to which distribution system outages threaten security of supply, an understanding of their route causes, and a comparison of the performance within the region and with other regions in their prevention and restoration of service.

Based on the results of the Benchmarking Study, the Consultant developed a set of recommendations to improve system outage data acquisition and analysis as well as to provide preliminary indications of areas in which the Working Group should engage to improve outage mitigation and service restoration. After successful completion of the 1st SEE DSO Benchmarking Report it was decided to proceed with the benchmarking process and to prepare new 2nd edition of the SEE DSO Benchmarking Study covering the period 2013 – 2015. That will result with quite long benchmarked period (2008-2015), with clear trends and achievements in SEE DSO. It will be the most comprehensive benchmarking analysis of the power sector in the SEE region.

In preparing the Benchmarking Study, the Consultant will perform the following tasks:

TASK ONE: Select the Set of DSO Outage Benchmark Metrics to be Applied to the Benchmarking Study. In doing so, the Consultant will take into account the quality of data available from the DSOs by preparing a questionnaire to be distributed as a result of and following the initial Working Group meeting and previous project phase. Data returned in the questionnaire will be used to select the metrics used for the Benchmarking Study, based on the availability of data reported by the DSOs. A second questionnaire requesting data specific to those metrics selected by the Consultant for this Benchmarking Study will be issued to each DSO. With assistance from USEA, the Consultant will be responsible for collecting the responses to the first and second questionnaires.

An initial list of metrics are proposed by the Consultant and agreed to by the Working Group members during the July 16-17 meeting, 2013.

TASK TWO: **Compile and Benchmark System Outage Data within Southeast Europe and against a European or North American DSO.** The Consultant will prepare a profile report for each member of the Working Group that contains a physical and technical description of the network; information on commercial performance including losses, etc.; and other non-outage related information. This profile will provide a context in which outage data may be examined. The Consultant will then compile outage indices to report on the selected metrics for each Working Group member. The indices will provide the basis for two benchmarking studies enabling Working Group members and their regulators to: 1) assess an individual company's performance against another in the region and; 2) against a DSO in Europe or North America selected by the Consultant.

TASK THREE: **Develop Recommendations** on: 1) Improving Data Acquisition and 2) Areas in Which the Working Group Should Focus on Mitigating Outages and Improving Service Restoration. It is expected that data acquisition will be among the foremost difficulties in preparing the Benchmarking Study. Based on the results of the Benchmarking Study, the Consultant will prepare a set of suggestions to the Working Group for areas of future collaboration on mitigating outages and improving service restoration in line with the deliverables detailed on page one above.

TASK FOUR: Improve the capacity of distribution system operators to monitor and report system outages using harmonized definitions across the region. The Consultant will coordinate the meetings to introduce counterpart DSOs to best practices of defining outage frequency and duration, restoration time, unserved load and other metrics by which the Working Group will benchmark their performance. After two editions of the Benchmarking Study, the Consultant will support SEE DSOs to promote common reliability definitions throughout Southeast Europe.

2 EXECUTIVE SUMMARY

INTRODUCTORY REMARKS

Within this study South East European DSOs were analyzed, including Croatia, Bosnia and Herzegovina, Serbia, Kosovo, Macedonia, Montenegro and Albania, as shown on the following Figure. In this region electricity distribution system is operated by 10 DSOs:

1. HEP ODS (Croatia) - *HEP – Operator distribucijskog sustava d.o.o.*,
2. EPBiH (BiH) - *JP Elektroprivreda BiH*,
3. EPHZHB (BiH) - *JP Elektroprivreda Hrvatske Zajednice Herceg-Bosne*,
4. ERS (BiH) - *JP Elektroprivreda Republike Srpske*,
5. EDB (BiH) - *JP Komunalno Brcko*,
6. EPS (Serbia) - *Elektroprivreda Srbije*,
7. KEDS (Kosovo) - *Kosovo Electricity Distribution and Supply*,
8. EVNM (Macedonia) - *EVN Macedonia,*
9. OSHEE (Albania) - *OSHEE Operatori i Shpërndarjes së Energjisë Elektrike sh.a,*
10. CEDIS (Montenegro) – *Crnogorski elektrodistributivni system d.o.o.*

Figure 2.1 Geographical area analyzed in this study

At the beginning, it is important to note that this benchmarking study is the continuation of the first common benchmarking analysis prepared in this region after more than 25 years. Actually, from 1991 to 2004 the SEE power system was not connected in unified synchronous operation and there was no mutual cooperation. Prior to 1991 there were two separate power systems in the Balkans region: the Union for the Coordination and Transport of Electricity (UCTE), comprised of the western European and western Balkans power systems of Yugoslavia, Albania and Greece and the eastern system comprised of Hungary, Romania, Bulgaria and Soviet system. These asynchronous systems were connected through several direct current DC links.

Following the regional conflict, in October 2004 the systems were reconnected in synchronous operation under UCTE (now ENTSO-E). For the first time in history all continental Europe (with the exception of Former Soviet countries and Turkey) operated as a single synchronous electricity area comprised of a population of 450 million and annual electricity consumption of 2 300 TWh. The synchronous power system of SEE was further enlarged in September 2010, when after 10 years of detailed preparations the Turkish power system connected to ENTSO-E via three 400 kV interconnections with Bulgaria and Greece. With its current 44 000 MW of installed generation capacity and 30 000 MW of peak load the Turkish power system effectively doubles the size of the SEE electrical area. SEE population is around 52 million. After the UCTE reconnection strong mutual cooperation of the regional TSOs was re-established again. But, due to its responsibility to operate and control local distribution networks, the DSOs did not have the strong need to re-established its regional cooperation yet.

Till 1991 all analyzed DSOs, except Albanian one, were part of common ex-Yugoslavian power system. The organizational and ownership structure of the DSOs was different, but the coordination was strong. They were having common meetings on the regular basis within Yugoslavian CIGRE committee where different benchmarking indicators and experiences were developed and exchanged. Unfortunately, when the war conflict started in 1991 this cooperation was completely abandoned and this USAID SEE DSO project is the first action to re-establish regional DSO cooperation on the regular basis again.

SCOPE

This Benchmarking Study consists of 19 Chapters on 381 pages, including 406 figures. The Study is based on the large set of input data delivered by the DSOs through three benchmarking questionnaires developed and collected in the period 2013 –2016. Even though there is a still space for improvement of input data collection and benchmarking analysis, this study is valuable input both internally for the SEE DSO working group to determine the most important topics of common interest to be addressed in the future work, as well as to all relevant decision makers in the region.

Terms of Reference is given in the Chapter 1 and Executive Summary in Chapter 2. In Chapter 3 basic information of 10 SEE DSOs are given, including total number of metering points, electricity delivered, distribution network length, network age, number of feeders, substations and transformers, supply area size, number of employees and distributed generation installed capacity. After introductory part, in this Chapter all above mentioned values are compared among the DSOs. In Chapters 4, 5 and 6 relevant benchmarking indicators are analyzed, including continuity of supply and electricity losses. The Chapter 7 and 8 extensively cover the topic of metering (with a special emphasis on smart meters and advanced metering infrastructure (AMI)) and metering effectiveness. Chapter 9 deals with the basic legal, technical and economic issues of disconnection and reconnection/resupply, while Chapter 10 shows the details on the electricity billing process. Chapter 11 deals with revenue collection issues, followed by competitiveness analysis given in the Chapter 12. Customer service issues are presented in the Chapter 13. Chapter 14 and 15, respectively, give comparison analyses to the EU and US DSOs. Finally, recommendations are given in the Chapter 16. List of figures, tables and appendix are given in the Chapters 17 – 19.

GENERAL CHARACTERISTICS OF SEE DSOS

Total number of metering points in this region is 10,44 million. There is a large difference between the smallest one – EDB, BiH with just around 35.000 metering points to the largest one EPS, Serbia and its 3,6 million metering points. EPS is holding 35 % of all metering points in this region. About the same relations are found in the number of customers and supply area size. It is interesting that in the period 2008 – 2015 the increase of total number of metering points in the region was 6,42%, assuming annual increase of about 1,26%, which is quite low and probably mainly determined by the economic crisis.

The number of low voltage (LV) - households metering points is by far the largest for every SEE DSO regarding division by consumer categories. Out of total 10,440 mils. metering points in the region in 2015, there is 9,330 mils. (or 89,4%) metering points on the low voltage – household consumer category. Low voltage – commercial category is covered by 1,094 million metering points. Number of metering points on the medium voltage in the region is very low – just 16.722 and it significantly decreased by 31% compared to 2012. Number of metering points on high voltage level in the whole region is just 17.

The total amount of electricity delivered to final consumers in the region in 2015 was 64,629 TWh. It is 0,39% lower than in 2008 and higher for 1,7% than in 2012. It clearly indicates how deep economic crisis was and that the recovery goes quite slow.

As expected, more than half of electricity was delivered to the household consumers (52,6%), and this share remains almost the same (increased by 0,3% in 2015 compared to 2012). Electricity delivered to HV consumers in the period 2012 – 2015 dropped for 3,8%, while electricity delivered to MV consumers increased for 2,4%.

Distribution network length in the region in 2015 was 475.038 km and it has growth by 7,6% compared to 2011[1]. Cable network share in total network length in the region in 2015 was 20,34%, while in 2011 it was 17,84%. The largest growth in the period 2011 – 2015 is found in Kosovo (+34,1%), while the average growth in the region is 4,51%. The exceptions with total network length decrease are OSHEE (-10,3%) and HEP (-2,1%).
The MV network length share is in the range 24 – 42%, with the regional average of 33%. The share of a cable network in total distribution network length is in the range of 9 – 33%, with the largest values in HEP (33%), EVNM (24%) and ERS (22%) and the lowest found in OSHEE (9%).

Average distribution network age in SEE DSOs is in the range 18 – 39 years. Looking per each DSO, the oldest distribution network can still be found in Albania (OSHEE) with the average age of 39 years and Serbia (EPS) 32 years, with the trend of fall in EPS (in 2012 it was 33 years) but not in OSHEE (2012 it was 37 years). The lowest distribution network age is in KEDS (18 years).

In SEE distribution network there are 132.956 substations, most of it in Serbia (26%), Croatia (23%) and Albania (19%). Total sum of all distribution transformers capacity in the region is 71.053 MVA or 0,6 MVA (600 kVA) per substation.

These 10 regional DSOs cover the area of 266.687 km^2, about the size of United Kingdom or Nevada (USA). The largest area portions are covered by Serbian EPS (31%) and Croatian HEP (22%).

[1] These data are available for the period 2011 - 2015.

In ten regional DSOs in 2015, there were 37.732 employees, with the decrease of 1,2% compared to 2012. But, 25.364 employees (67,2%) are dealing purely with network business. Remaining 7.041 employees (18,7%) are engaged in supply business, while 3.829 (10,2%) employees are shared between network and supply business.

In line with EU energy policy targets, as well as national energy strategies, there has been a lot of distributed generation projects in SEE under development in the last decade. At the end of 2015, there were 800 of distributed generation installed capacity in the region and that is an increase of 77,3% compared to 2012. Most of it is installed in Albania (211,8 MW), BiH (total of 180 MW, with the largest contribution of EPBiH (113,3 MW)) and Croatia (153,7 MW). In Croatia was the highest increase in this value in 2015 compared to 2012: by 157,6%. All DSOs, except KEDS and EDB, reported a large increase of this values compared to 2012.

GENERAL BENCHMARKING INDICATORS

One of the most important DSO benchmarking indicators is electricity delivered per each metering point. In the first edition of SEE DSO Benchmarking Study (2008 – 2012) there was an indicator on electricity delivered per each consumer, but in the most DSOs number of consumers was not available.

In 2015, this indicator was between 3,68 MWh/metering point in OSHEE and 7,17 MWh/metering point in EPS. The average electricity delivered per each metering point in the region in 2015 was 6,19 MWh/metering point. Compared to 2008, it dropped by 11,06%, but in 2014/2015 it began to grow again in the most of SEE DSOs.

Total electricity delivered per each employee in all SEE DSOs in the period 2008 – 2015 are having two trends: in the period 2008 – 2011 there was a strong increase, followed by the decrease in 2012-2015. The trends are different among the DSOs, while the values in 2015 are in the range from 661 MWh/employee in EPHZHB to 2745 MWh/employee in HEP, in average 1671 MWh/employee (in 2008 it was 1810 MWh/employee).

Electricity delivered per km of distribution network (including all voltage levels) strongly depends on the distribution area shape and size, as well as geographical dispersion of consumers. That’s why there is a large variety of values, between 73 MWh/km in ERS and 190 GWh/km in EVNM. The average value in the region is 136 MWh/km and it decreased by 21,4% in 2015 compared to 2008.

It has always been a question for power system planners how to optimize number of transformations and its loading in the system. In that sense, it is interesting to measure the level of transformers loadings, in other words electricity delivered per transformer installed capacity or installed capacity usage (hours per year). The value of usage of X/MV transformer installed capacities in the region in 2015 varies significantly in the range between 1.947 h/year (HEP) and 3385 h/year (OSHEE). The trend of usage of X/MV transformer installed capacities in most of SEE DSOs in the period 2012 – 2015 is falling. For MV/LV substations this indicator also varies significantly, as shown on the following Figure. In 2015, it is between 964 h/year (OSHEE) and 1.726 h/year (EPS). The average value is 1.278 h/year, with mainly falling trend in the period 2012 – 2015.

SEE DSOs had the average capacity of X/MV substations in the range between 10,9 MVA (CEDIS) and 21,2 MVA (EVNM) with the average of 16,1 MVA, while the average capacity of X/MV transformers is in the range between 8 MVA (EDB and OSHEE) and 11,2 MVA (EPHZHB) with the average of 9,6 MVA. The average capacity of MV/LV substations in the region is 320 kVA and it is in the range between 208 kVA (OSHEE) and 416 kVA (EVNM). The average capacity of MV/LV transformers in the region are like for the substations: the average value is 327 kVA and it is in the range between 209 kVA (OSHEE) and 401 kVA (EVNM).

The range of average 20 kV feeder length is between 74,6 km (EVNM) and 6,9 km (HEP). Average value of 10 kV feeder length in the region is 7,3 km with the values between 2,3 km (EDB) and 13,1 km (ERS).

Average number of 20 kV feeders per substation is in the range between 0,7 in EPHZHB and 13,8 in OSHEE, with the average of 11,9 for 7 DSOs. Average number of 10 kV feeders per substation is in the range between 2,5 in EDB and 15 in KEDS, with the average of 5,7 for 9 DSOs. Average number of 6 kV feeders per substation is 5,0 for 4 DSOs, in the range between 0,1 in EPS and 6,8 in OSHEE.

Average number of LV feeders per MV/LV substation is between 2,4 in HEP and 5,5 in EDB, with an average of 2,6 for 7 DSOs.

Regional DSOs operate at the different supply area size and shape. Due to its very small size, EBD is having the largest electricity delivered per supply area size in 2015 – 460 MWh/km^2. The regional average is almost twice lower, around 256 MWh/km^2, while the lowest level of electricity delivered per supply area size is in EPHZHB, around 110 MWh/km^2. Accordingly, the ratio between the lowest and the highest level of electricity delivered per supply area size is more than 4 times. In SEE DSO the average network length per supply area size is 1,9 km/km^2. Network length per supply area size ranges from 1,06 km/km^2 in EVNM to 4,3 km/km^2 in EDB.

CONTINUITY OF SUPPLY

SAIDI for unplanned interruptions on all voltage levels, for all events in distribution network generally shows a smooth trend change, decreasing (EPBiH) or being constant in given timeframe (HEP, ERS, EPHZHB). It is important to keep in mind that all DSOs didn't provide the same set of input data (for example, some data for interruptions on LV are missing). There are no available input data on continuity of supply for EVNM, Macedonia.

Over the period 2008-2015, SAIDI in the SEE DSOs have had very wide range, between 270 and 6.849 minutes/year. The largest SAIDI was recorded in OSHEE (in average 6366 min/year) and the second largest in ERS (in average 1579 min/year). All other DSOs have SAIDI lower than 900 min/year in whole observed period. The lowest SAID values were found in HEP (in average 310 min/year).

Based on available data it can be concluded that only in KEDS smooth increase of SAIDI value is found in the period 2008 – 2012. SAIDI range for unplanned interruptions in SEE is between 245 – 6.849 minutes. The largest level of SAIDI is found in OSHEE, Albania (up to 6.849 min) and it is significantly higher than in other DSOs (all up to 1.589 min). The lowest SAIDI is in HEP (Croatia). The level of SAIDI on medium voltage network is not significantly lower than on the system level and it is between 256 (HEP, Croatia) and 6.008 minutes (OSHEE, Albania).

SAIFI of unplanned interruptions was in the range between 2 interruptions/year (KEDS, 2009) and 49 interruptions/year (OSHEE, 2013). For planned interruptions, SAIFI was in the range 0,2 interruptions/year (KEDS, 2012) to 9,7 interruptions/year (ERS, 2009).

Duration of planned interruptions relates to supply interruptions experienced by the network users after they receive prior notice of planned electricity interruption. SAIDI of planned interruptions was in the range between 25 minutes (KEDS, 2012) and 1045 minutes (OSHEE, 2014). Country data show (more or less) slightly decreasing trend (ERS, EPBiH, EPHZHB, KEDS, EPS). The only outlier in respect of planned SAIDI is Croatian HEP which has almost persistent values over observed period.

The highest value of CAIDI for unplanned interruptions in given timeframe (2008 - 2015) was 237 minutes (KEDS, 2009), and for planned interruptions it was 184 minutes (OSHEE, 2015). Except for KEDS, in general, all other DSOs have had higher CAIDI for planned than unplanned interruptions. The difference between planned and unplanned CAIDI was in range -94% (KEDS, 2011) and 154% (EPBiH, 2010).

The data for electricity not supplied (ENS) to final consumers on all voltage levels due to unplanned interruption in the distribution network were available only for 4 DSOs (HEP, EPS, EDB and KEDS). ENS for unplanned interruptions in the distribution network was the highest in KEDS (155,4 GWh in 2011), or 4,38% of the total delivered electricity to final consumers in 2011. Except for KEDS, ENS in other available DSOs has not been higher than 0,2% of total delivered electricity to final consumers.

The share of unplanned interruptions in total number of interruptions has also been calculated. This share was in the range between 33 % (HEP, 2011) and 98 % (KEDS, 2012). 8 of 9 DSOs that provided data had over 50 % share of unplanned interruptions in the total number of interruptions.

For unplanned interruptions ENS due to interruptions in TSO network is 6 to 30 times lower than ENS due to interruptions in DSO network, and 6 to 48 times lower for planned interruptions. The highest yearly ENS due to interruptions in the TSO network relative to total delivered electricity to final consumers was 0,036% (EPHZHB, 2012) for unplanned interruptions and 0,031% (EPHZHB, 2013) for planned interruptions.

ELECTRICITY LOSSES

The share of total losses in total electricity received in the whole distribution network of SEE (treated as one single system) in the period 2008 – 2015 was between 15% and 17,6%, with decreasing trend in the last three years. At the individual DSO level, share of total losses was in the range between 7,2% (HEP) and 45,7% (OSHEE). Besides OSHEE and HEP, all other DSOs had mainly decreasing trend of total losses in given timeframe.

Within the period 2008 – 2015, for available input data unit cost of total losses was in the range between 23,2 €/MWh (KEDS, 2014) and 83,1 €/MWh (EPHZHB, 2012). At the same time, relative standard deviation was in the range between 2,7% (EPHZHB) and 18,8% (EVNM).

Data on estimated technical losses were available just for 6 DSOs: EPHZHB, EPS, ERS, HEP, KEDS and OSHEE. Share of estimated technical losses in total losses in the period 2008-2015 ranged between 32,8% (OSHEE, 2012) and 70% (HEP, 2013-2015). In OSHEE, level of estimated technical losses increased for 65% in 2014 compared to 2013, which is very unusual and should be double-checked.

Network losses approved by the regulator relative to the total losses were between 47,9% (CEDIS, 2015) and 110% (ERS,2015). This value has mainly decreasing trend (EPS, KEDS, OSHEE) in given timeframe. In OSHEE and EPS in the observed period level of approved losses was exactly the same as realized total losses (technical + commercial).

METERS

Comprehensive set of input data of the meters used in SEE DSO has been analyzed in this study. Some of the main findings are given here, while the rest of the results can be found in the Chapter 7.

In some countries around world there are specific customer classes allowed to be connected without meters. In this region, this was applied in OSHEE until 2012 for 3 LV consumption categories: households, commercial customers without peak power registration and public lighting. Their shares in total number of customers were almost negligible. But, since 2013 it is not allowed any more.

On LV level the share of electromechanical meters is 62,3%, electronic (digital) meters is 30,6% and smart meters 7,1%. At the household level electromechanical meters prevail, with the exception of CEDIS with dominant smart meters.

On MV level the share of electromechanical meters is 5,9%, electronic (digital) meters is 46,9% and smart meters 47,2%. In EPS and OSHEE on MV automatic reading using the terminal prevails, while in CEDIS and EDB manual reading is dominant.

PLC type of communication is used in 3 DSOs: CEDIS, EDB, and EPHZHB, GPRS type of communication are used in other 3 DSOs: EPBiH, EPS, and KEDS, while GSM type is used in EVNM and OSHEE.

On the MV level average age of electromechanical meters is 22,6 years, while on LV level it is 27,9 years. Electronic (digital) meters in average are 6,9 years old on MV level and 11,8 years on LV level. Finally, in average smart meters on MV level are 5,4 years old, while smart meters on LV level are 4,7 years old in average.

For LV customers in SEE DSOs, the EVNM has the youngest average age of meters – 6,2 years and EPS has the oldest – 28,4 years.

Remote meter reading is considered the most important reason for the roll out of smart meters. DSOs shall take a central role in the roll-out of smart meters. In line with the provision of the EU Third Energy Package it is suggested here to prepare Cost Benefit Analysis on electricity smart metering roll-out on the national (or DSO) level. The main reasons for the roll-out are:

- efficient remote meter reading,
- reducing electricity losses,
- reducing fraud,
- improving responses to delayed or lack of payment by consumers;
- many new services, including energy efficiency services, for customers (however, to realize potential feedback-induced savings, advanced meters (smart meters) must be used in conjunction with in-home (or on-line) displays and well-designed programs that successfully inform, engage, empower and motivate people.).

By examining countries cases (forerunners in the roll-out of the Smart Grid or countries that have applied a distinctive approach to the roll-out and/or to the management of the meter data, e.g. Sweden, Italy, Denmark, France, the UK, Texas in the USA), lessons can be learned on successful market models in support of a large scale roll-outs and on potential pitfalls and challenges.

In the observed region, unauthorized connection points (connections without metering) and unauthorized use of meters (e.g. tempered meters, tempered time switch, broken seal) are still serious issue for the DSOs. Estimated share of unauthorized connections at LV level (given as a portion of total number of connection points) goes up to 6,5 % on the regional level. At HV and MV level estimation of unauthorized connections were not available or were equal to zero. Conducted yearly inspections of connection points support this thesis because yearly detected unauthorized connections (without metering or with tampered meters) are mainly in LV distribution network.

In the given timeframe, share of yearly detected unauthorized connections (without metering or with tampered meters) was below 2% of total number of connection points. The highest share of yearly detected connections without metering were found in KEDS (1,54%), but the warring thing about KEDS is recorded increasing trend of this share in all LV consumption categories. All other DSOs in the given timeframe had this share below 1%. From the other side, shares of yearly detected connections with tampered meters greater than 1% were only found in EDB (1,68%) and EPS (1,45%) in 2008 and 2012, respectively.

Although these shares of yearly detected irregularities weren't high, it is worrying thing that in some DSOs share of detected irregularities in total number of conducted inspection was very high. The highest shares were detected in households category, up to 20,5 % (EDB, 2008). In other words, in average every fifth controlled household connection in EDB in 2008 was irregular. The good thing about EDB is decreasing trend of this share over observed period, and this share was reduced to below 1% in 2015. From the other side, in KEDS (second DSO with the highest share) this share in the last three years of the observed period was also very high (17,54% in average), and compared to 2012 it was 9 times increased. Except EPS which had this share up to 10,5%, all other SEE DSOs had this share below 4% in all consumer categories. Therefore, to detect unauthorized connections and lower losses caused by them in the system, customer connections and meters should be frequently inspected.

Monthly readings of almost all electricity meters in the SEE DSOs are required which is very valuable initial position for market activities and management of distribution system (exceptions are households in HEP that should be read only twice a year and households in OSHEE that should be read just once a year). Because of ordinary monthly readings all DSOs are exhibiting relatively low shares of meters without any reading during a year. Exceptions are households in OSHEE (14,5% in 2011) and HEP (8% in 2014). These two DSOs also had the highest shares of connection points with readings not in line with the prescribed number of readings per year. The highest irregularities were also recorded in households category (OSHEE and HEP had this share in average 6 and 6,5% of total connection points, respectively).

Croatia is the only country with self-reading for households envisaged by the law. Self-reading shall be strongly encouraged for customers that are not read monthly.

DISCONNECTION AND RECONNECTION / RE-SUPPLY

In almost all DSOs Supply Rules and Distribution Grid Code propose unauthorized connection and use of electricity, legal conditions for disconnection, fines and penalties envisaged and, also, methodology for estimating unauthorized electricity consumption. Failure to pay a bill owed to the supplier/DSO results in electricity supply suspension until payment of overdue amounts or agreement on payment schedule is reached.

General prohibition to disconnect customers does not exists in SEE DSO (the same applies to European DSOs). Most SEE DSOs have specific measures available to prevent or at least to delay customer disconnection. Groups that benefit from a general prohibition of disconnection are people with life threatening illnesses, hospitals or other specific population groups that are deemed particularly vulnerable.

In all consumption categories in the SEE DSOs were recorded very high rates of disconnections/supply suspensions. The only exception was HV consumer category where disconnections weren't recorded in the observed period. Disconnection rates below 100% of total number of connection points were recorded in MV consumer category (up to 24%, OSHEE in 2012) and public lighting category (up to 61%, KEDS in 2013). In households and both LV-commercial categories disconnection rates recorded in some DSOs were above 100%, which is extremely high. Three SEE DSOs that were the most faced with disconnection rates in the observed period are EDB, KEDS and OSHEE.

Prescribed dates for reconnection/resupply upon disconnections due to non-payment were in the range between one and three working days. In all DSOs realized time periods have been within prescribed intervals.

Unlike other SEE DSOs, EPS and OSHEE have higher prescribed time periods for reconnection/resupply upon disconnections due to unauthorized consumption (theft) than for those disconnections due to non-payment (15 and 10-14 days, respectively). As for non-payment reasons, for unauthorized consumption (theft) all realized time periods for reconnection/resupply were within prescribed intervals.

KEDS and OSHEE don't have any reconnection/resupply charge, while all other SEE DSOs have reconnection/resupply charges (one-time payments) that differ upon reasons of disconnection (non-payment and theft). Furthermore, some DSOs (EPHZHB, EVNM and HEP) have several different charges, mostly one charge for prompt reconnection/resupply (within 24 hours including non-working days) and one for ordinary reconnections/resupplies (within prescribed time period).

BILLING

Besides the primary function of charging the customers for the network and other power system services, usually including energy supply, the bill is also important as a comprehensive information to customers on energy consumption, prices, opportunities for savings and efficiency. Therefore, billing the customers for the service of electricity distribution should be based on accurate periodical meter readings and bills issued on a monthly basis. Thus, provisional billing should be avoided as much as possible.

In the DSOs with monthly readings, provisional billing has been used only exceptionally, when reading couldn't be conducted. In the SEE DSOs shares of provisional billing were up to 17%, depending on consumer category. Significant shares of provisional billings are recorded in EVNM, HEP, KEDS and OSHEE. For HV and MV consumers provisional billing was not an issue in any DSO.

Bill processing time is time interval between meter reading and bill dispatch. In the SEE DSOs it was in the range between 1 and 17 days, depending on the consumer category. The highest values are recorded in OSHEE in almost all consumer categories (only exception was households category when EDB had the highest bill processing time in the observed period).

Majority of billing errors should be detected and corrected before sending the bill to consumer. Frequency of billing errors corrected before sending the bill for HV and MV consumers was negligible. In other consumer categories, these errors were registered only by EDB, EPS and OSHEE, with the highest value below 1%. The internal DSO procedures for billing control has been contributing to the trend of billing errors reduction.

In all consumer categories, the highest shares of corrected billing errors after sending the bills to consumers were recorded in HEP and KEDS. Relatively high shares existed in households category, up to 5%, and in LV-commercial without peak power registration category, up to 2%. In the other categories, this share was below 1,2%.

REVENUE COLLECTION

The maturity of bill payment is usually about 2-3 weeks of issue. ERS and OSHEE had problems with bill collection at HV consumer category over the observed period, in average 250 days (about 8 months) and 152 days (about 5 months), respectively. OSHEE also had bill collection problems in all other categories, ranged between 143 days (about 5 months) to 206 days (about 7 months), depending on consumer category. In other DSOs, HEP in given timeframe had in average about 2 months' time period of bill payment in commercial category, and EVNM had also in average bill payment time period of 2 months for all consumer category.

As expected, having in mind length of bill collection time period, in all consumer categories OSHEE had the lowest ratio of collected and issued bills. Only exception was HV consumer category where EPHZHB had the lowest percentage of collected bills (in average only 84%, with highly decreasing trend in the observed period). OSHEE had average share of collected in issued bills above 90% only in HV and MV consumer categories. Other DSOs that submitted data had average achievement of bill collection higher than 90% in all consumer categories, except KEDS in households category (in average 83%).

Cumulative costumer's arrears for electricity in some DSOs were very high. Comparing to DSOs total yearly income, in EPS cumulative customer's arrears were 1,8 times higher (in 2015) than total yearly income, while in ERS average cumulative customer's arrears were at level of 80% of total yearly income. In other DSOs that submitted data, cumulative customer's arrears were below 25% of DSOs total yearly income.

The SEE DSOs have restricted resource for non-payment or delayed payment, e.g. limited legal recourse to recover unpaid bills, inability to write-down bad customer debts or negotiate payments, effective inability to disconnect non-paying customers (e.g. for political or social reasons) etc. Hence, DSOs collection performance is complicated and complex process.

COMPETITIVENESS ANALYSIS

Distribution and retail business is relatively labor intensive, implying companies should strive for efficient level of staffing and staffing cost. The lowest average costs per MWh of distributed energy (delivered electricity + electricity losses) are observed in OSHEE, EVNM and EPS respectively with costs below 5 €/MWh. In the observed period EDB, EPHZHB and ERS recorded increasing trend, while EPBiH and EVNM recorded decreasing trend. The rest of the DSOs exhibit costs in the range of 10-

15 €/MWh, with the exception of EDB where in period 2010-2015 this cost were in the range of 17-21 €/MWh.

Slightly different results of labor costs are obtained when delivered energy to final consumers was analyzed (without energy losses in the network). OSHEE had the greatest impact of losses on this cost, increase of 56% when energy losses are excluded. In other DSOs, this growth was in the range between 9% (HEP) and 21% (EVNM).

With regard to labor cost per metering point, the similar pattern is observed. The lowest values are observed at OSHEE, EVNM and EPS respectively with average values below 38 €/MWh, whilst the reaming DSOs had values in the range of 71 €/MWh (EPBIH) to 126 €/MWh (EDB).

Comparing employment level per number of metering points and labor cost per employee in the observed period it is recognized relation between these two variables. Thus, in observed period EDB increased number of employees on expense of decreasing labor cost per employee, while opposite situation was detected in HEP where decreasing number of employees was accompanied with increasing labor cost per employee. EPBiH and EVNM decreased number of employees to maintain labor cost per employee about the same level. EPHZHB, EPS (without 2015) and ERS during the observed period increased labor cost per employee, while OSHEE maintain almost the same level of labor cost per employee in the observed period even the number of employees recorded big changes (drop in 2012 by 36% since 2008, and recovering after 2012).

It is important to indicate potential *limitations* of this analysis. In particular, we were not able to identify to what degree did the DSOs outsource services. Thus, to get the complete picture of employment efficiency this issue deserves further investigation.

Most of the DSOs exhibit values of ratio of depreciation to book value of property plant and equipment below or around 8 %, except KEDS and OSHEE (12,1% and 9,9% in 2015, respectively). Values of around 8 % are to be expected as this value is commensurate with average distribution asset life.

In the most DSOs investments in 2014 and 2015 were higher than in 2013 since in 2014 those DSOs suffered extensive damage due to the floods that hit the area in which they operate.

In order to compare the values of investment and depreciation to book value more easily, their difference was observed. Positive values imply that the ratio of investment to book value is greater than depreciation to book value, hence the DSO is investing more than it is depreciating. Blank cells determine unavailable data. Taking the average value for the eight years' period, three DSOs (EPBiH, EPHZHB and EVNM) have on average invested more than what has been written off, whilst four DSOs (EDB, EPS, HEP and KEDS) have invested less than what was written off in the period 2008 – 2015.

High maintenance costs recorded in EDB can be justified by the fact that EDB is owner only part of the network and it is responsible for maintenance of the entire network. Except maintenance costs in EPS in the period 2008-2012, that should be double checked, average maintenance costs to book value of assets in other DSOs in the observed period was up to 6%.

In general, while analyzing the received data, we observed the lack of standardization regarding the reported data. Having identified some of the issues we propose more detailed data collection exercise is carried out with the following emphasis:

- revenues from distribution and / or retail services should be clearly identified. It is important to distinguish revenue from sale of electricity and revenue from use of distribution network,

- pass through costs should be clearly identified and not taken into account (e.g. transmission costs),
- all data should then be adjusted to reflect purchasing power differences among countries.

CUSTOMER SERVICE

Customer rights in SEE DSOs are definitely lagging behind in comparison to customer rights in the EU DSOs. On the other hand, DSOs customer service may be a DSO's principal means to establish/improve public image (especially when increasing tariffs).

The main finding on this topic is that the DSOs haven't been recording complaints as envisaged in the study questionnaire and, what is even more important, scope of complaints observed by the DSO differs considerably (some DSOs were focused on several technical and nontechnical services, while others were focused only to one or two technical). Therefore, data provided here are not the good starting point for mutual comparison. In future reports, more efforts should be devoted to the development of clear definitions and understanding of indicators and to the harmonization of data collection procedures in SEE DSOs.

As observed in 6th CEER Benchmarking Report on the Quality of Electricity Supply, no adequate statistical data exists for most commercial quality indicators. In SEE DSOs commercial quality is largely enforced by standards that in essence are not guaranteed to the customers because there is no compensation for individual customers and often there is no penalty defined. For most of these standards, penalties are based either on vague and imprecise general penal provisions or simply do not exists (even if required by primary legislation).

Therefore, further development of the legislation and practice to accommodate even basic service quality regulation is needed. Standards for technical services (and the legal framework governing the supplier business) must be developed to accommodate scenarios where customers contact the DSO directly or their supplier for technical services. In complaint procedures and afterward benchmarking, precise definitions of triggers and time intervals are crucial, as well as defining the entity on which a certain trigger/event/process applies to since it is different if the customer calls his supplier in comparison to the scenario where the customer calls to the DSO directly. This is important to differentiate because of better and faster resolving of some problems, and for the better benchmarking results with the aim of creating new commercial quality standards.

Most of the observed DSOs are only in a very early stages of developing service quality regulation. This report suggests DSOs to follow with:

- the establishment of legal framework,
- usage of standards and guidelines of good practice (e.g. definitions should be developed in order to allow monitoring and acquisition of data, standards should be based on specific and precise definitions),
- the implementation of the monitoring system,
- quality standards and incentive schemes.

COMPARISON TO THE EU AND US DSOs INDICATORS

One of the tasks to be realized in this study is to benchmark SEE DSOs with DSOs from the western countries. Comparison is made with EU and US DSOs. Last available Eurelectric report on Power distribution in Europe, 2013[2], is used to compare SEE DSOs and respective national indicators to the EU DSOs and national indicators. It should be noted that SEE DSOs indicators are related to 2015, while data for the other EU DSOs are mainly for 2013. For comparison with US DSOs American Electric Power with its 7 subsidiaries are chosen since American Electric Power (AEP) is a major investor-owned of electric utility in the United States. These 7 AEP companies and total of AEP are having similar level of electricity delivered per consumer (27 – 31 MWh/year in 2015). It is much higher than in DSOs in SEE where values for 2015 range from 3.679 kWh/consumer (OSHEE) to 7.934 kWh/consumer (HEP), with an average of 6.229 kWh/consumer. Comparing this average value for SEE DSOs in 2015 and 2012 to the values that AEP had in the same years, it is observed that this ratio slightly increased (AEP had 4,6 times in 2012 to 4,7 times in 2015 higher delivered electricity per consumer than SEE DSOs). This clearly shows different level of economic development and/or small to medium industrial activity.

Similar to that, US companies are also having much higher level of electricity delivered per employee (28 – 36 GWh/employee in 2015). It is much higher than in SEE DSOs where average electricity delivered per employee in 2015 was 1,567 GWh/employee (on average 20 times lower in 2015, compared to 2012 this difference increased for 25%). When evaluating this indicator, several facts should be taken into account, e.g. whether DSO is bundled with supply business, and/or with other parts of vertically integrated company, level of outsourcing of its tasks, etc. At first, it can be assumed with great certainty that US companies are significantly more efficient. Accordingly, average number of customers per employee in SEE DSOs in 2015 was 247 (2% higher than 2012), while in the US DSOs in 2015 it was 1102 (33% higher than 2012), i.e. this ratio in 2015 in US DSOs was 4,5 times higher than in SEE DSOs (31% higher than in 2012).

US companies are having significantly higher values of electricity delivered per network length than those from the SEE. In 2015 in the SEE DSOs average value was 123 MWh/km (5% lower than 2012), while in the US DSOs this value was 466 MWh/km (8% higher than 2012). This suggests that the distribution network infrastructure in US AEP is about four times more efficiently used than in SEE.

SAIDI indicator for unplanned interruptions at all voltage levels in US AEP was lower than in any SEE DSOs in 2015, especially compared to OSHEE which had much higher value than any other SEE DSO. Similarly, SAIFI indicator for unplanned interruptions at all voltage levels shows large differences between SEE and US DSOs. In given US DSOs SAIFI for unplanned interruptions was below 3 interruptions/year in 2015, while in SEE DSOs it was in the range between 2,5 interruptions/year (HEP) and 44,9 interruptions/year (OSHEE). On the other side, for planned interruptions at all voltage levels SAIDI indicators in the US companies are practically equal to zero. In other words, network maintenance and other planned activities in the US cause almost no supply interruptions, mostly due to “live working” (work without disconnection) or different maintenance practice. In the SEE DSOs, SAIDI for planned interruptions ranged between 25 minutes (KEDS, 2012) and 1045 minutes (OSHEE, 2014), while SAIFI for planned interruptions ranged between 0,22 interruptions/year (KEDS, 2012) to 9,69 interruptions/year (ERS, 2009).

[2] http://www.eurelectric.org/media/113155/dso_report-web_final-2013-030-0764-01-e.pdf

Total number of long unplanned interruptions is significantly lower in SEE than in the US DSOs, as expected due to network size. With exception of AEP (which is the sum of all other US DSOs), the other US DSOs in 2015 were all below 39.000 long unplanned interruptions. On the other side, total numbers of long planned interruptions are showing large variations between different DSOs, starting from KEDS and EPS in SEE and AEP-OH and AEP-TX in the US. In general, it can be concluded that there are no regional specificities that would explain differences in number of long planned interruptions in SEE and the US. It is known that cable network experience much lower power interruptions, and it should be noted that SEE DSOs and US DSOs in average have similar ratios of aerial and cable networks.

In SEE DSOs average share of planned in total number of interruptions in 2015 (for those DSOs which submitted the data) was 38%, while in US AEP this value was 17% (lower more than double). These values again prove that the maintenance and other planned interruptions are performed in different way in the US and SEE DSOs. Differences mainly refer to “live working” (i.e. work on the equipment without its disconnection). This could be one of the areas in which SEE DSOs could analyze and take over US practice and experience in order to reduce number and duration of planned interruptions.

RECOMMENDATIONS

Based on tremendous amount of data analyzed in this report and taking into account best practices and relevant case studies, the final chapter presents the recommendations for improvement of DSOs performance divided in three groups:

- organizational recommendations,
- data harmonization and
- share of best practices in distribution business.

It is also suggested here to continue with the DSO benchmarking reporting in this region. The feedback and experience with the first edition of this study was very positive and the authors strongly believe that this valuable data set will help the DSOs, network users and regulatory authorities to further improve their system operation.

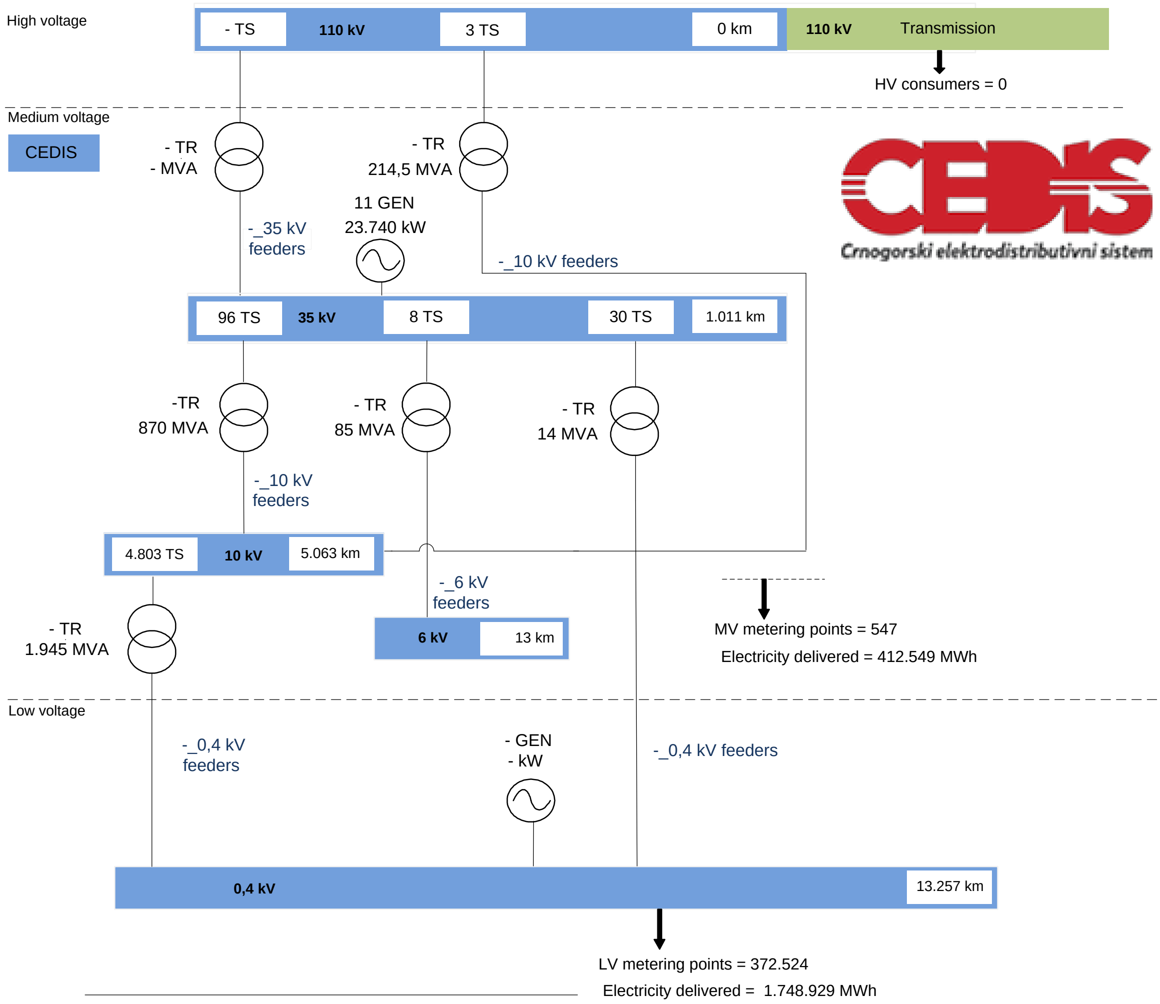
3 GENERAL CHARACTERISTICS OF SEE DSO

As an introduction to the benchmarking analysis, in this Chapter basic information of ten Southeast European distribution system operators (SEE DSO) are given. All basic data in subchapter 2.1 are referring to 2015. After set of basic information, 13 different benchmarks are given (number of metering points, number of customers, electricity delivered, distribution network length, distribution network age, number of substations, number of transformers, supply area size, transformer capacity, number of feeders, distribution network not operated and owned by the DSO, number of employees and distributed generation data).

3.1 BASIC INFORMATION ABOUT SEE DSO

CEDIS – MONTENEGRO

Crnogorski elektrodistributivni sistem (CEDIS) is limited liability company. The founder of the company is power utility EPCG with 100 % of CEDIS shares. EPCG is listed at Montenegro Stock Exchange with majority of shares owned by the Government of Montenegro. The second largest shareholder is Italian utility A2A with 43,7% of shares. CEDIS operates within Montenegrin power system and it is the only licensee for electricity distribution in the country. The following figure shows available basic data of CEDIS in 2015.



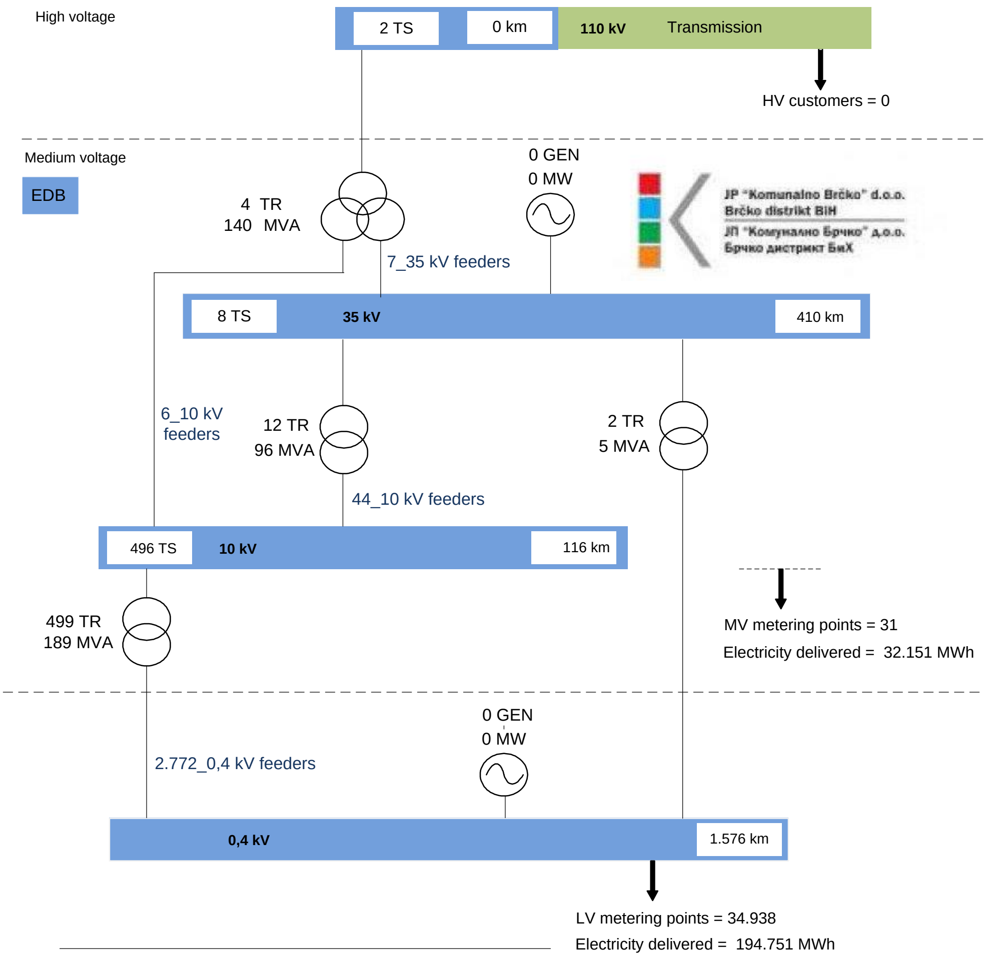
Total number of metering points	373.017 (-0,8 %)
Electricity delivered to final customers	2.161.477 MWh (5,2 %)
Total losses	446.111 MWh (-17,6 %)
Total lenght of distribution network	19.344 km (2,2 %)

Value in brackets represent the relative change of value in 2015. compared to 2012. year

Figure 3.1 General data of CEDIS in 2015

EDB - BOSNIA AND HERZEGOVINA

Bosnia and Herzegovina is politically organized in two entities (Federation BiH and Republika Srpska) and one district (Brčko). In Federation BiH, there are two DSOs (EPBiH and EPHZHB), in Republika Srpska there is one DSO (ERS) and in Brčko District there is also one DSO (EDB). *JP Komunalno Brcko (EDB)* in Brčko District in Bosnia and Herzegovina operates the local distribution network and provides electricity supply to the customers in the District. EDB is 100% owned by Brčko District.



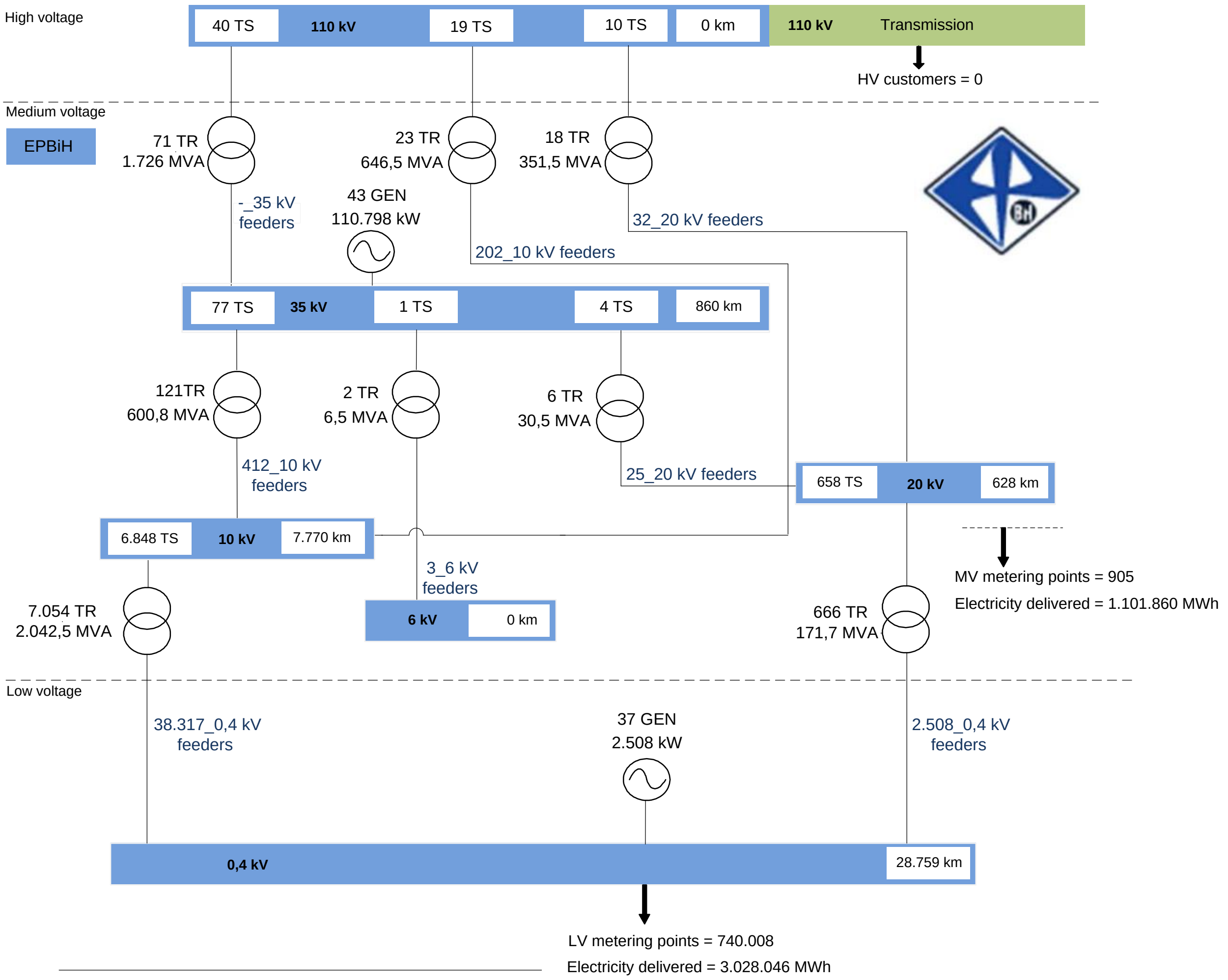
Total number of metering points	34.969 (-2,8 %)
Electricity delivered to final customers	226.902 MWh (1,1 %)
Total losses	34.684 MWh (-7,0 %)
Total lenght of distribution network	2.102 km (1,4 %)

Value in brackets represent the relative change of value in 2015. compared to 2012. year

Figure 3.2 General data of EDB in 2015

EPBIH - BOSNIA AND HERZEGOVINA

Elektroprivreda Bosne i Hercegovine (EPBiH) is 90,4% owned by the Federation BiH. The remaining shares are owned by 9 private investors. On its territory EPBiH is serving as distribution system operator, also having dominant position in electricity generation and electricity supply. The company operates as a public enterprise.



Total number of metering points	740.913 (3,6 %)
Electricity delivered to final customers	4.129.906 MWh (5,0 %)
Total losses	408.652 MWh (0,6 %)
Total lenght of distribution network	38.017 km (12,3 %)

Value in brackets represent the relative change of value in 2015. compared to 2012. year

Figure 3.3 General data of EPBiH in 2015

EPHZHB - BOSNIA AND HERZEGOVINA

Similarly, to EPBiH, *Elektroprivreda Hrvatske Zajednice Herceg-Bosne (EPHZHB) is* also 90% owned by the Federation BiH. The remaining shares are owned by 5 private investors. On its territory EPHZHB is serving as distribution system operator, having dominant position in electricity generation and electricity supply. This company also operates as a public enterprise.

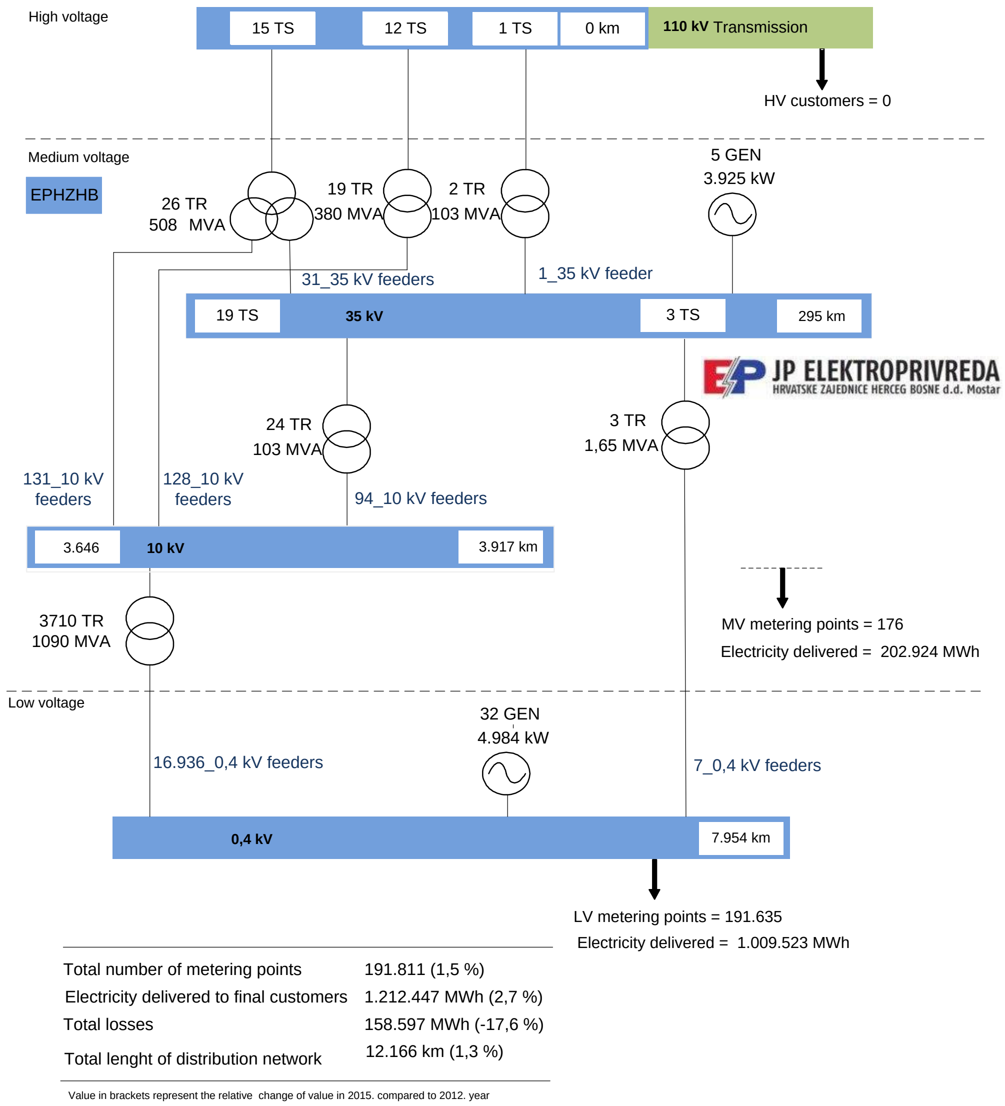
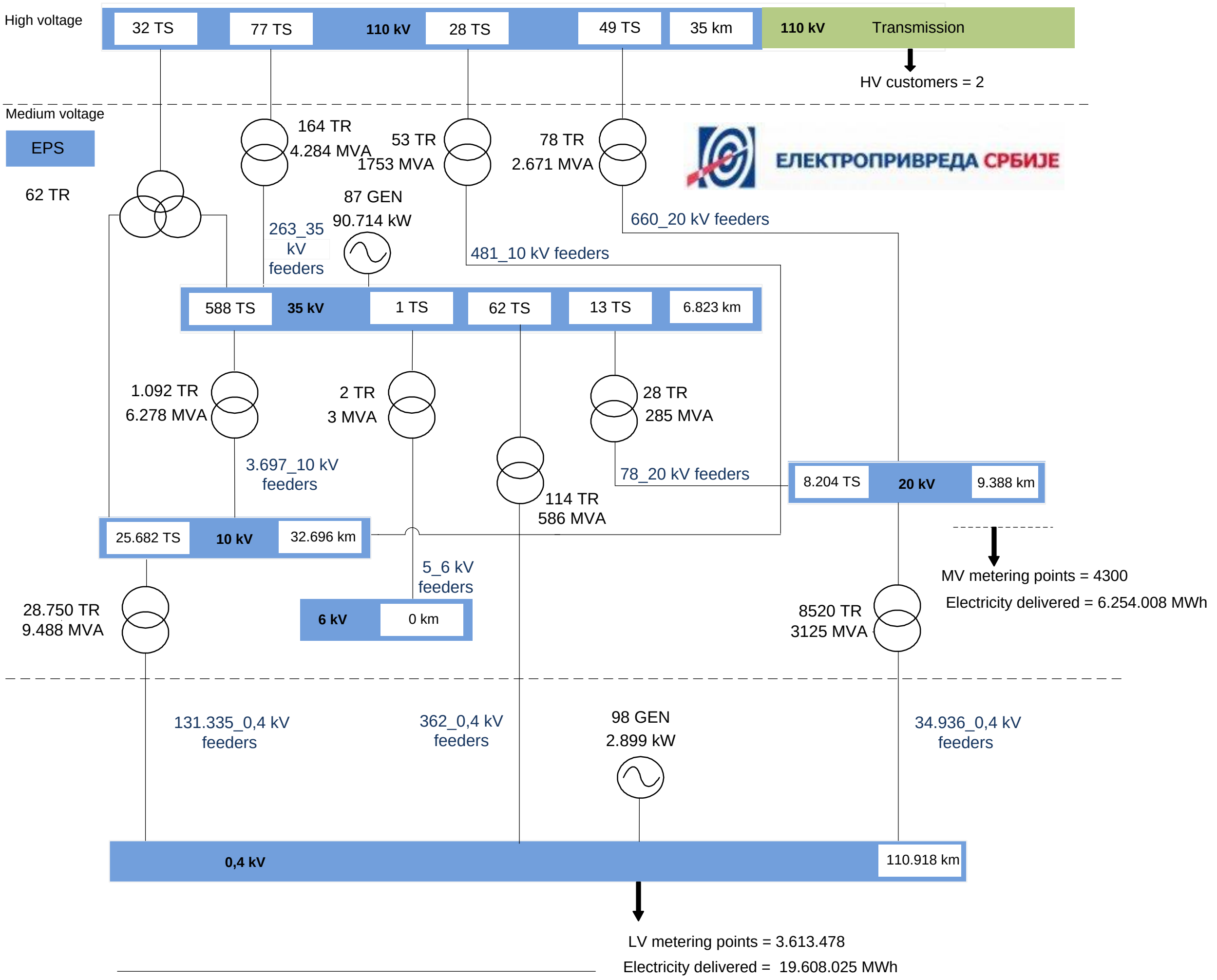


Figure 3.4 General data of EPHZHB in 2015

EPS - SERBIA

The main electricity undertaking in Serbia EPS is 100% state owned. The public enterprise *Elektroprivreda Srbije (EPS)* is a vertically integrated holding encompassing a total of thirteen legal entities for electricity generation, distribution, supply, and mining. Till recently five undertakings within *EPS* performed activities in electricity distribution and distribution system operation, but today EPS is in the process of restructuring, forming one DSO covering the whole territory of Serbia.



Total number of metering points	3.617.780 (1,8 %)
Electricity delivered to final customers	25.947.522 MWh (-6,8 %)
Total losses	4.236.876 MWh (-7,6 %)
Total lenght of distribution network	159.860 km (6,0 %)

Value in brackets represent the relative change of value in 2015. compared to 2012. year

Figure 3.5 General data of EPS in 2015

ERS - BOSNIA AND HERZEGOVINA

In BiH entity - Republika Srpska there is one DSO. The holding company *Elektroprivreda Republike Srpske (ERS)* is 100% owned by the entity. At the same time, ERS holding is the owner of 65% of shares in all its subsidiaries (5 for electricity generation and 5 for distribution and supply). The Holding Company also operates as a public enterprise.

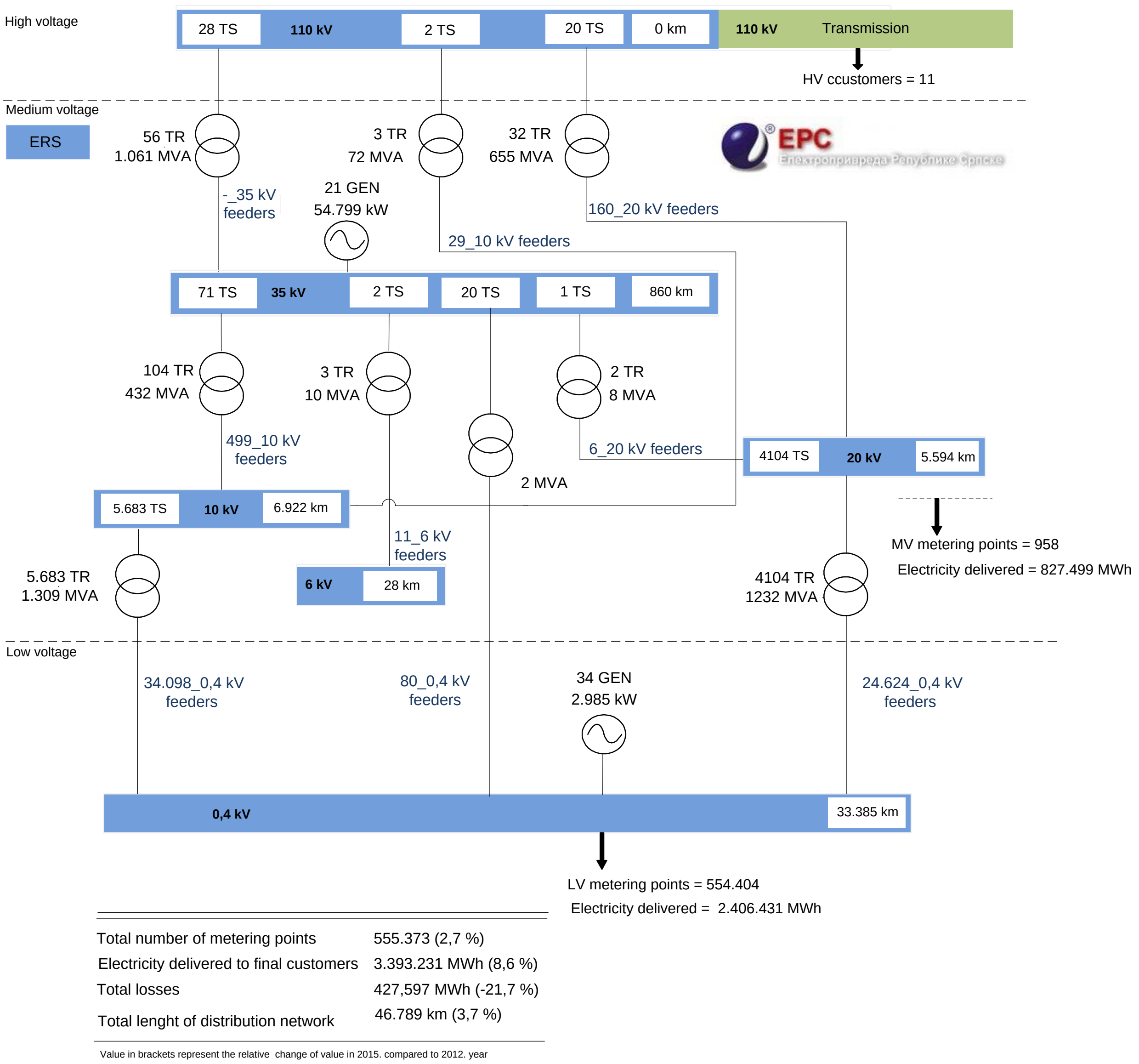
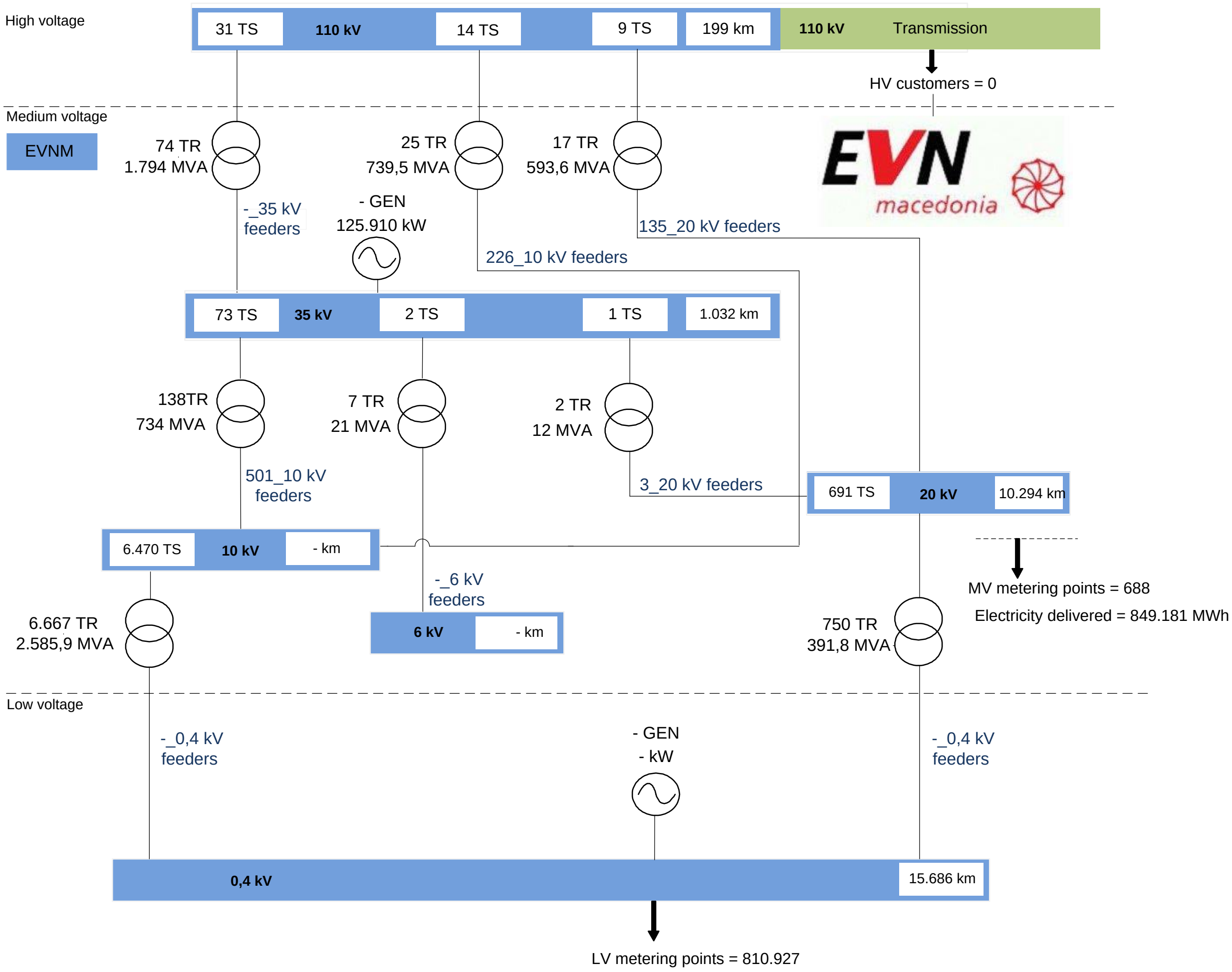


Figure 3.6 General data of ERS in 2015

EVN - MACEDONIA

EVN Makedonija is Macedonian distribution system operator. Austrian utility *EVN* holds 90% of shares in *EVN Makedonija*, which is also supplying 98% of all customers in the country.



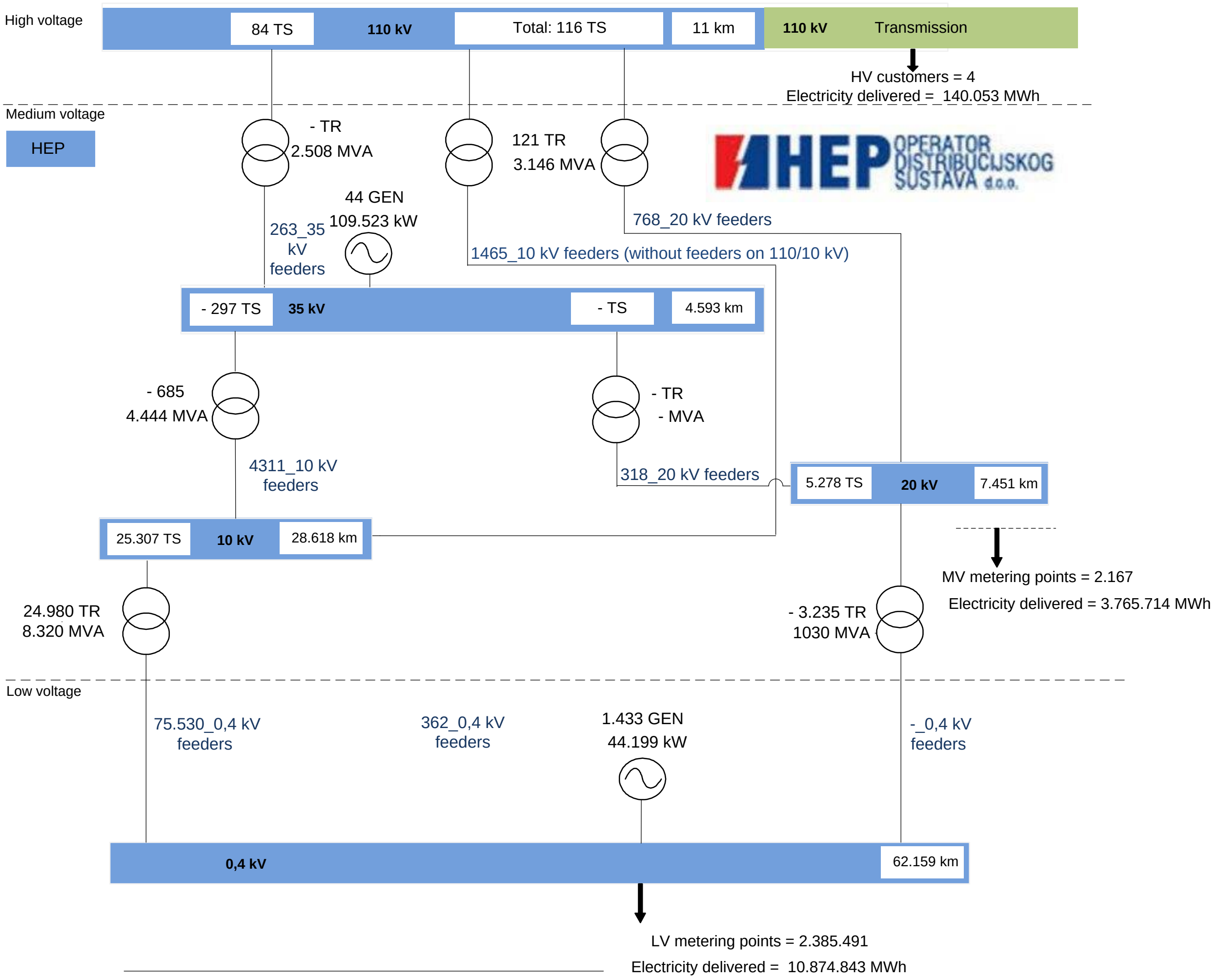
Total number of metering points	811.615 (-1,9 %)
Electricity delivered to final customers	5.181.937 MWh (-1,3 %)
Total losses	902.830 MWh (-18,5 %)
Total lenght of distribution network	27.211 km (4,7 %)

Value in brackets represent the relative change of value in 2015. compared to 2012. year

Figure 3.7 General data of EVNM in 2015

HEP ODS - CROATIA

Electricity distribution and public supply activities in Croatia were performed by the distribution system operator *HEP-Operator distribucijskog sustava d.o.o. (HEP ODS)*. HEP ODS is 100% state owned and it is part of HEP Group. Recently, public supplier HEP Elektra has been unbundled as a separate company from HEP ODS, so today HEP ODS is acting only as a distribution system operator.



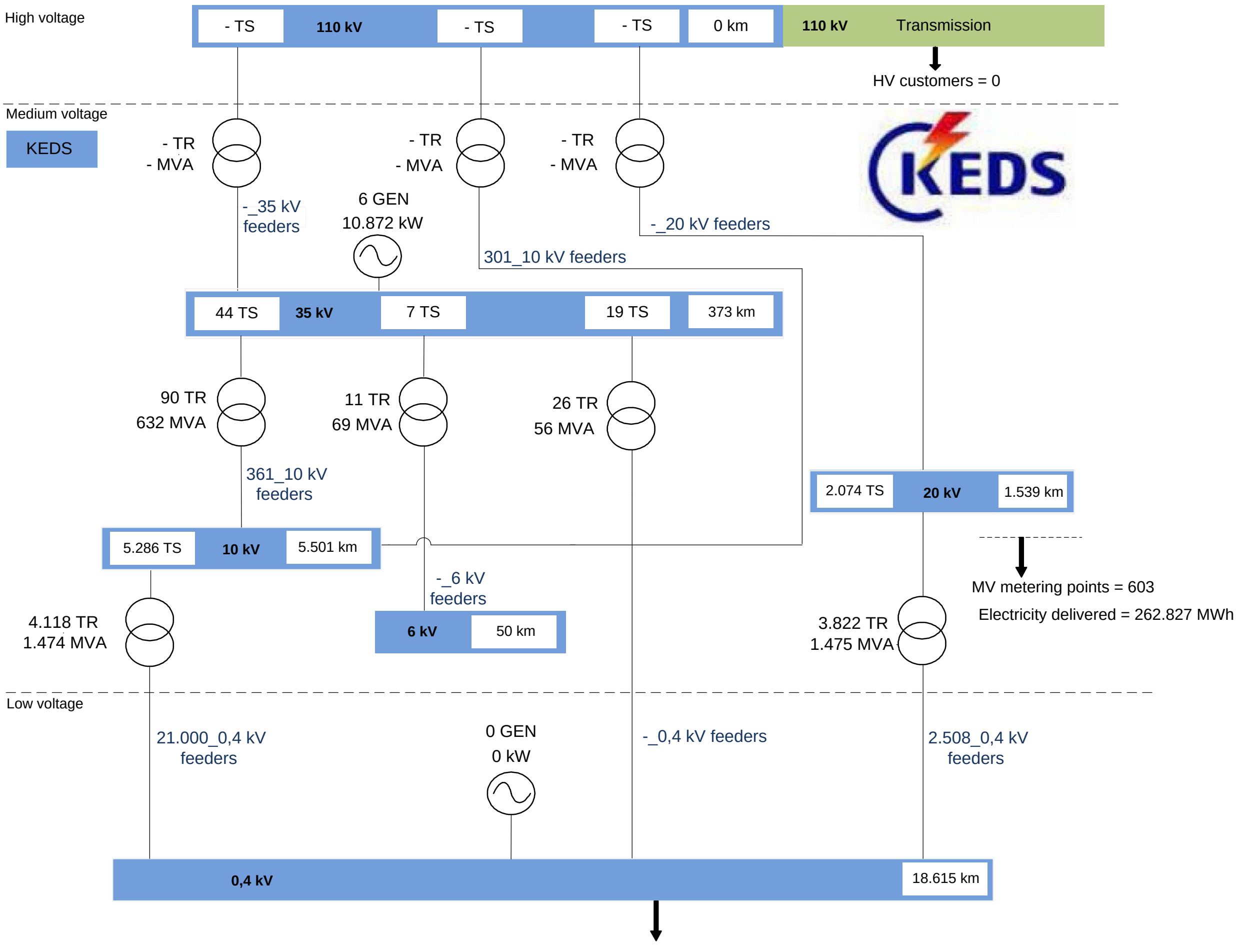
Total number of metering points	2.387.662 (1,6 %)
Electricity delivered to final customers	14.780.610 MWh (0,2 %)
Total losses	1.294.847 MWh (-7,7 %)
Total lenght of distribution network	102.868 km (-2,1 %)

Value in brackets represent the relative change of value in 2015. compared to 2012. year

Figure 3.8 General data of HEP in 2015

KEDS - KOSOVO

In 2013, the licenses and assets for distribution system operation and public supply in Kosovo were transferred from state – owned utility *KEK* to the joint-stock company *Kosovo Electricity Distribution and Supply (KEDS)*. Since then, following the signature of the share-purchase agreement between the Government of Kosovo and Turkish companies *Çalik Holding and Limak*, the latter owns and controls distribution system operation in Kosovo. After that, public supply has been further unbundled from the DSO in a separate supply company- KESCO.



Total number of metering points	514.799 (8,4 %)
Electricity delivered to final customers	3.135.292 MWh (-9,6 %)
Total losses	1.488.252 MWh (-14,9 %)
Total lenght of distribution network	26.078 km (34,1 %)

Value in brackets represent the relative change of value in 2015. compared to 2012. year

Figure 3.9 General data of KEDS in 2015

OSHEE - ALBANIA

In Albania, there is also only one DSO. It's been privatized in 2009 by Czech energy holding CEZ who entered Albanian market and bought 76% of the DSO shares. However, after several years of disputes in July 2014 Albanian Government re-nationalized all CEZ shares in OSHEE *Shpërndarje,* so today OSHEE is 100% state-owned company.

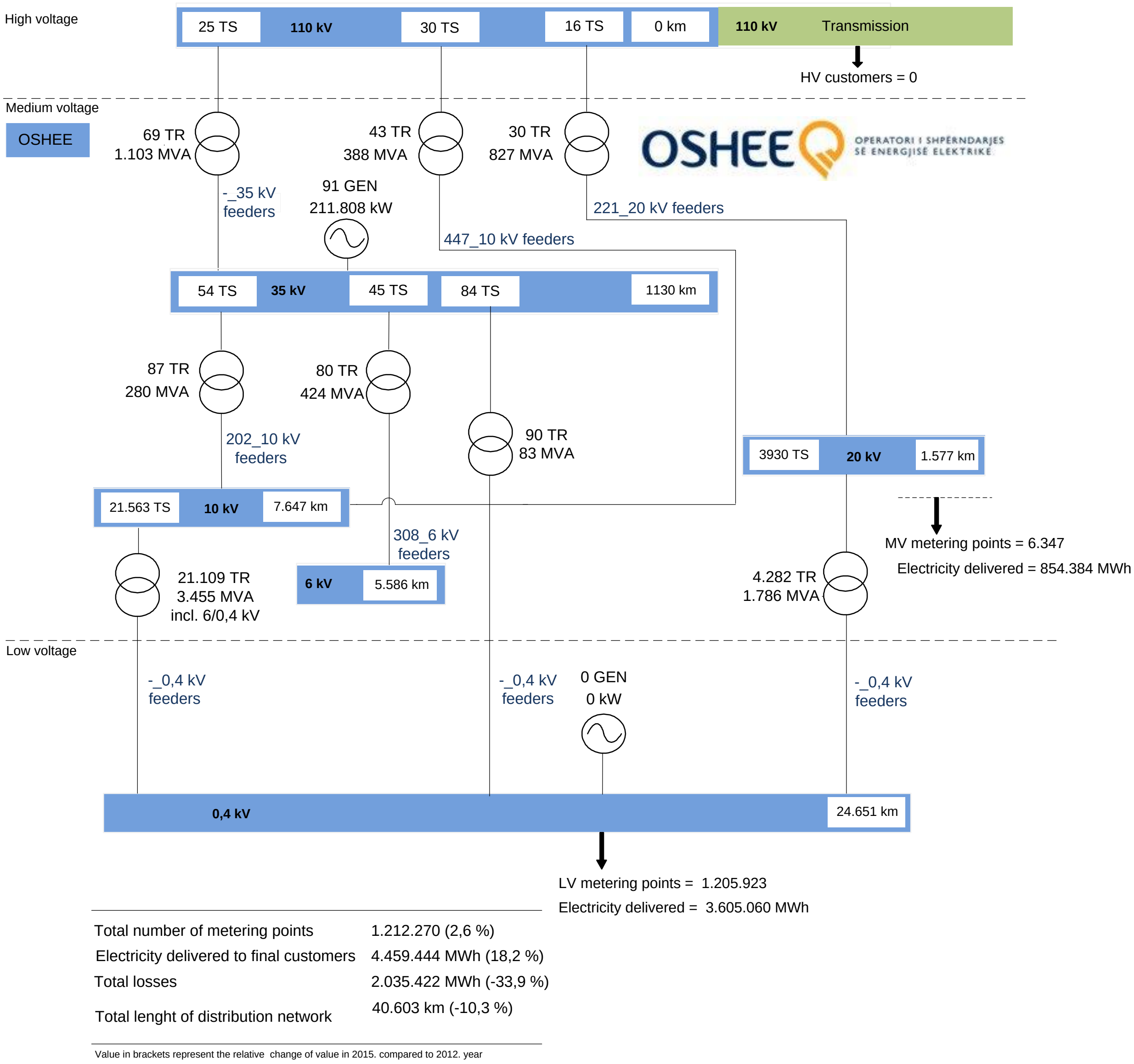


Figure 3.10 General data of OSHEE in 2015

3.2 NUMBER OF METERING POINTS

A total number of metering points in SEE is 10,440 million. Compared to the 1st edition of SEE DSO Benchmarking Study (2008 – 2012), new member CEDIS, Montenegro is added and will also be considered in this Study. A total number of the metering points in each SEE DSO in 2015 is shown in the following Figure. Values given in brackets represent the change of a total number of metering points in each DSO in 2015 compared to 2012. The highest increase of this value is found in Kosovo (KEDS) (+8,4 %), while the highest decrease is in District Brčko (EDB BiH) (-2,8%). Other DSOs, beside EVNM and CEDIS, recorded slight increase. Average value of a total number of metering points in all SEE DSOs in 2015 compared to 2012 has increased by 1,81%.

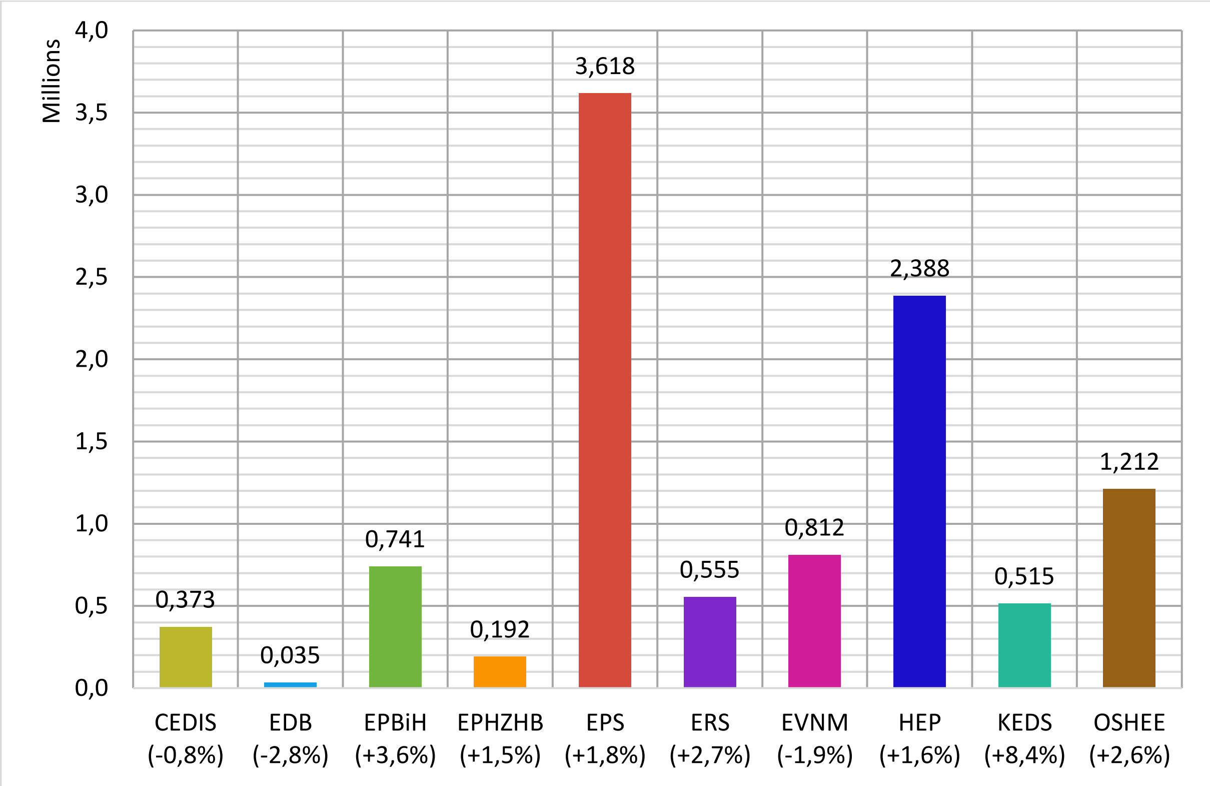


Figure 3.11 Total number of metering points in SEE DSOs in 2015[3]

Speaking of shares, EPS is holding 34,7% of all metering points in the region, with no change in this share in 2015 compared to 2012. The share of a total number of metering points in SEE DSOs is about in the same relation to the number of customers and supply area size. The highest increase of the regional share in 2015 compared to 2012 was in Kosovo (KEDS), for a 0,3%, while for the same amount EVNM had decreased, as shown in the following Figure.

[3]Number in brackets represents the share of given value in 2015 compared to 2012, and the same meaning will have on the following Figures.

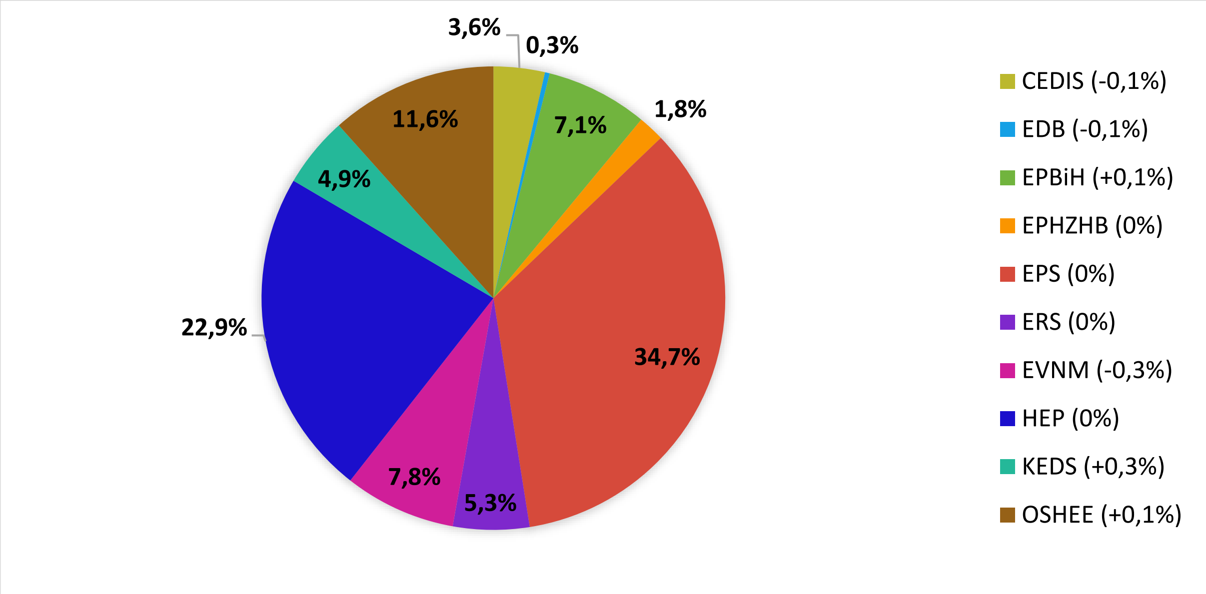


Figure 3.12 Share of total number of metering points in SEE DSOs in 2015

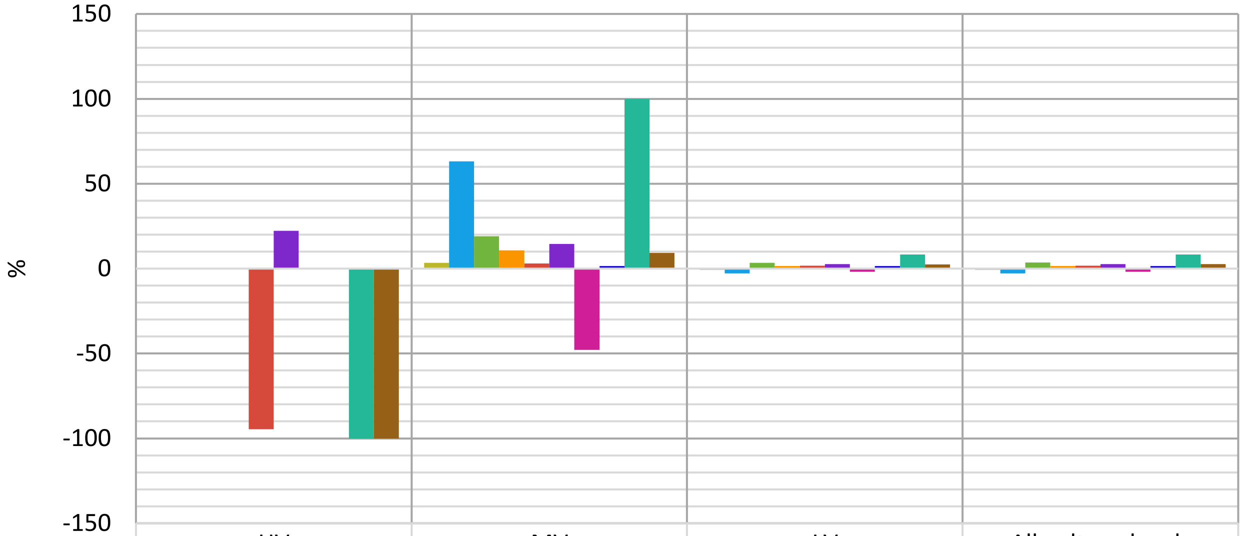
In the last four years (2012 – 2015) total number of metering points in this region increased by 1,81%, from 10,255 million to 10,440 million and in last eight years (2008 – 2015) total number of metering points increased 6,42%, from 9,327 million to 9,925 million (data for KEDS in 2008 were not available). It assumes average annual increase on the regional level of about 1,26%, which is quite low and probably mainly determined by the economic crises.

The number of low voltage (LV) - households metering points is by far the largest for every SEE DSO regarding division by consumer categories. Out of total 10,440 mils. metering points in the region in 2015, there is 9,330 mils. (or 89,4%) metering points on the low voltage – household consumer category. Low voltage – commercial category is covered by 1,094 million metering points. Number of metering points on the medium voltage in the region is very low – just 16.722 and it significantly decreased by 31% compared to 2012. Number of metering points on high voltage level in the whole region is just 17.

Average yearly changes of number of metering points in each SEE DSO per voltage levels are given in the following Figure. Just four DSOs provided data for number of metering points on the HV level. For 3 DSOs the number of HV metering points almost completely dropped to zero (EPS (-94,6%), KEDS and OSHEE (-100%)), meaning almost no metering points on HV level. Just one DSO (ERS) reported growth of the number of metering points on HV level.

The value of number of metering points on MV level for KEDS in 2012 is not available, that why the specified value of change in 2015 compared to 2012 is 100%. The highest change is reported in EDB (63,2%), while the smallest one is in HEP (1,5%). The only decrease in this value happened in EVNM (-47,9%). The average change in number of metering points on MV level in SEE in the period 2012 - 2015 is +17,7%.

On LV level, it also increased for 1,65% as well for all voltage levels for 1,67%. The highest increase on LV level is in KEDS (8,3%) as well for all voltage levels with the value of 8,4%. The highest decrease on LV level is in EDB (-2,8%) and for All voltage levels is also in EDB (-2,8%).



	HV	MV	LV	All voltage levels
CEDIS	0	3,4	-0,8	-0,8
EDB	0	63,2	-2,8	-2,8
EPBiH	0	19,1	3,5	3,6
EPHZHB	0	10,7	1,5	1,5
EPS	-94,6	3	1,8	1,8
ERS	22,2	14,6	2,7	2,7
EVNM	0	-47,9	-1,8	-1,9
HEP	0	1,5	1,6	1,6
KEDS	-100	100	8,3	8,4
OSHEE	-100	9,2	2,5	2,6

Figure 3.13 Number of metering points in SEE DSOs - change (%) in 2015 compared to 2012

3.3 ELECTRICITY DELIVERED TO FINAL CONSUMERS

The total amount of electricity delivered to final consumers in the region in 2015 was 64,629 TWh. It is 0,39% lower than in 2008 and higher for 1,7% than in 2012. Electricity delivered by each DSO in 2015 and its change compared to 2012 is shown in the following Figure. The growth of electricity delivered to final customers in 2015 compared to 2012 has been reported in 7 DSOs, in the range between 0,2% (HEP) and 18,2% (OSHEE). In the same period, the decrease of electricity delivered to final customers happened in KEDS, EPS, and EVNM, in the range between -1,3% (EVNM) and -9,6% (KEDS). Electricity delivery in each DSOs in the period 2008 – 2015 is given in Figure 3.15

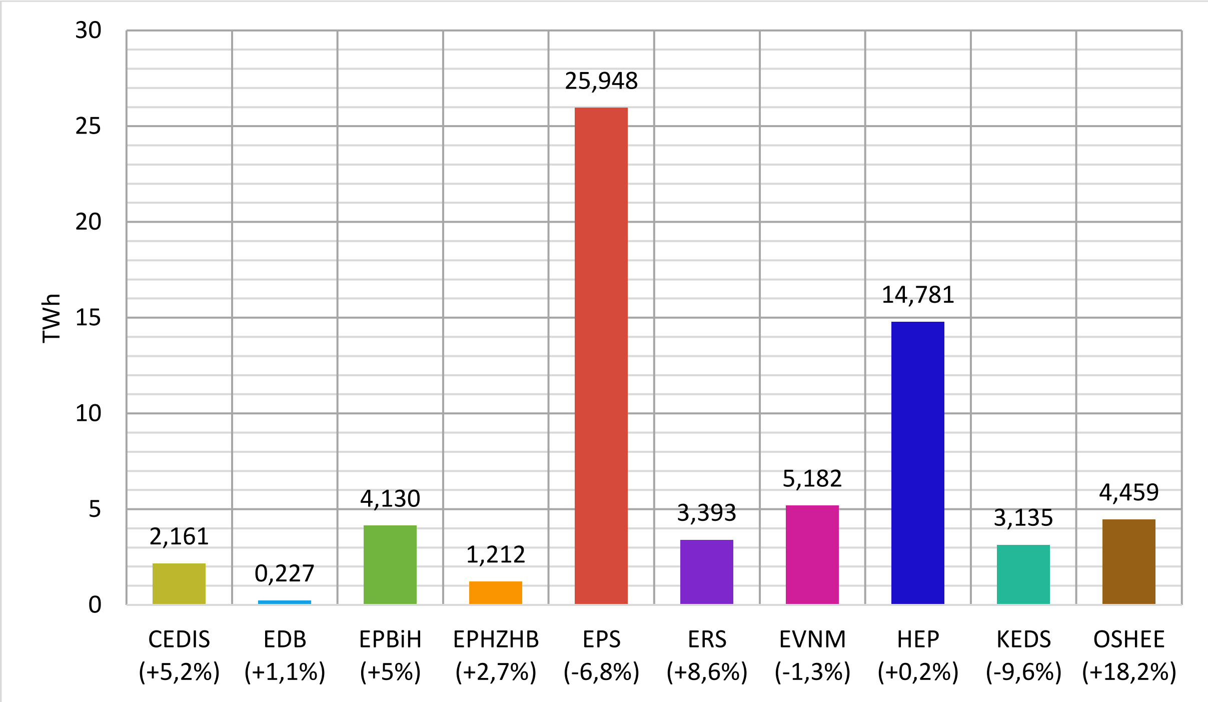
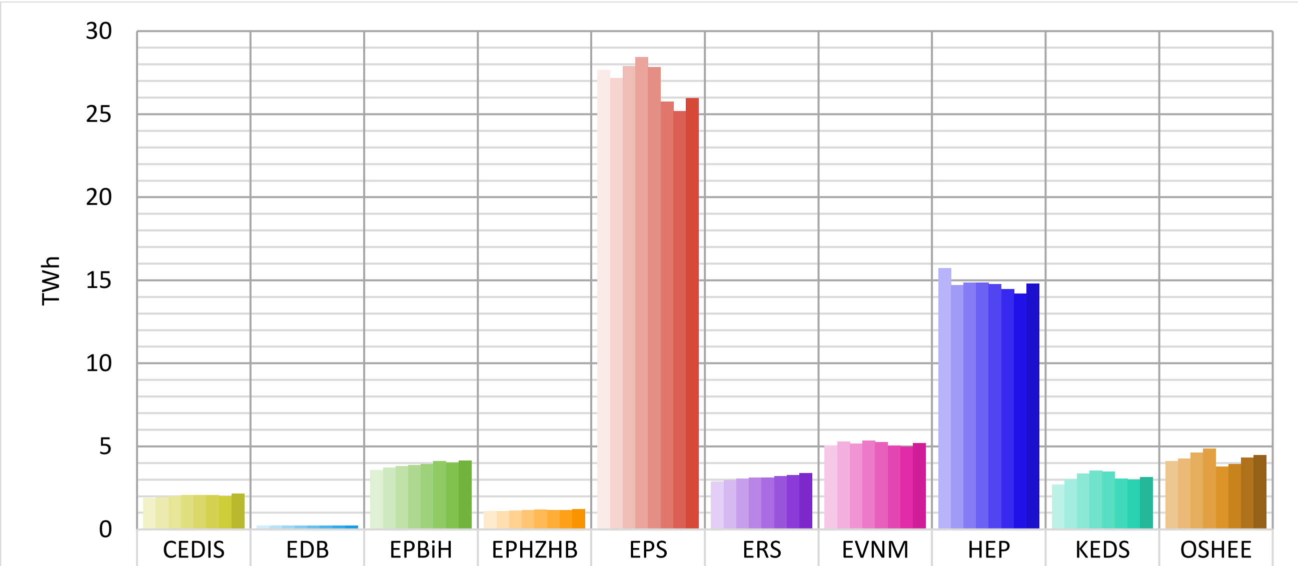


Figure 3.14 Electricity delivered to final consumers in SEE DSOs in 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	1,89	0,214	3,573	1,096	27,639	2,885	5,036	15,735	2,706	4,109
2009	1,931	0,227	3,728	1,108	27,158	2,978	5,282	14,701	3,038	4,264
2010	1,999	0,235	3,823	1,138	27,875	3,05	5,165	14,863	3,356	4,606
2011	2,058	0,232	3,878	1,161	28,438	3,104	5,358	14,851	3,549	4,875
2012	2,055	0,224	3,934	1,181	27,84	3,124	5,252	14,753	3,468	3,771
2013	2,051	0,224	4,104	1,168	25,759	3,22	5,028	14,466	3,069	3,927
2014	2,016	0,216	4,027	1,155	25,193	3,257	4,974	14,183	2,993	4,313
2015	2,161	0,227	4,13	1,212	25,948	3,393	5,182	14,781	3,135	4,459

Figure 3.15 Electricity delivered to final consumers in SEE DSOs in the period 2008 - 2015

DSO's shares in total delivery in the region are shown in the following Figure. Two largest DSOs remain Serbian EPS (40,1%) and Croatian HEP (22,9%), delivering almost 2/3 of total electricity delivered in the region.

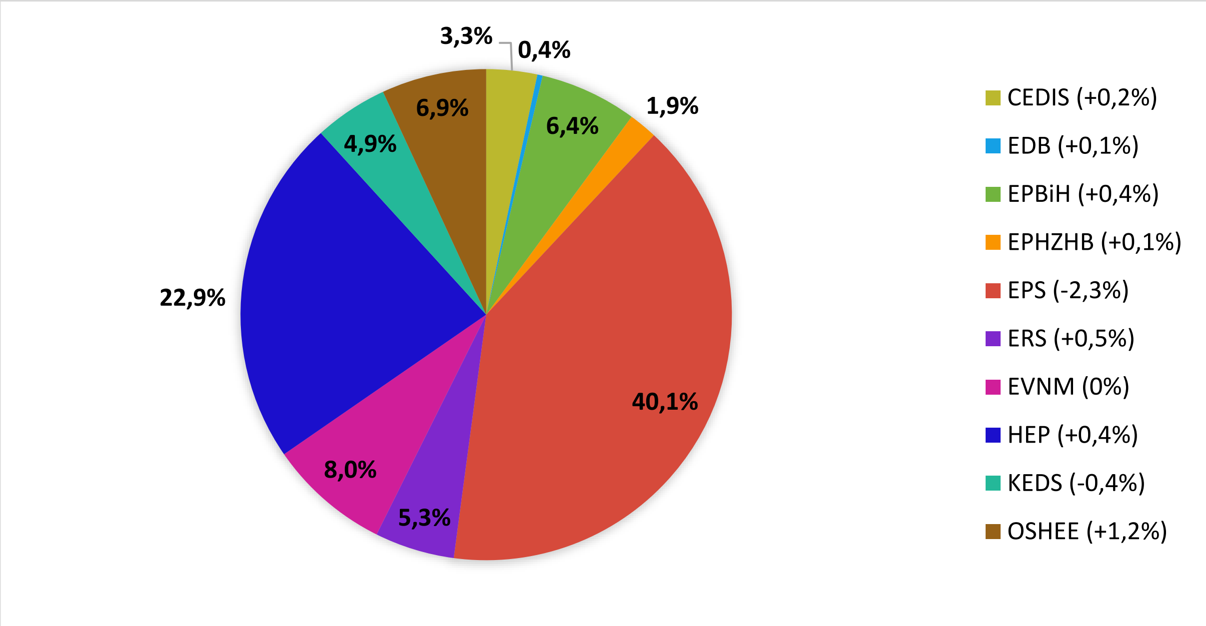


Figure 3.16 Share of electricity delivered to final consumers in different SEE DSOs in 2015

The following Figure depicts the electricity delivered to different consumer categories by SEE DSOs in 2015. As expected, more than half of electricity was delivered to the household consumers (52,6%), and this share remains almost the same (increased by 0,3% in 2015 compared to 2012). Electricity delivered to HV consumers in the period 2012 – 2015 dropped for 3,8%, while electricity delivered to MV consumers increased for 2,4%.

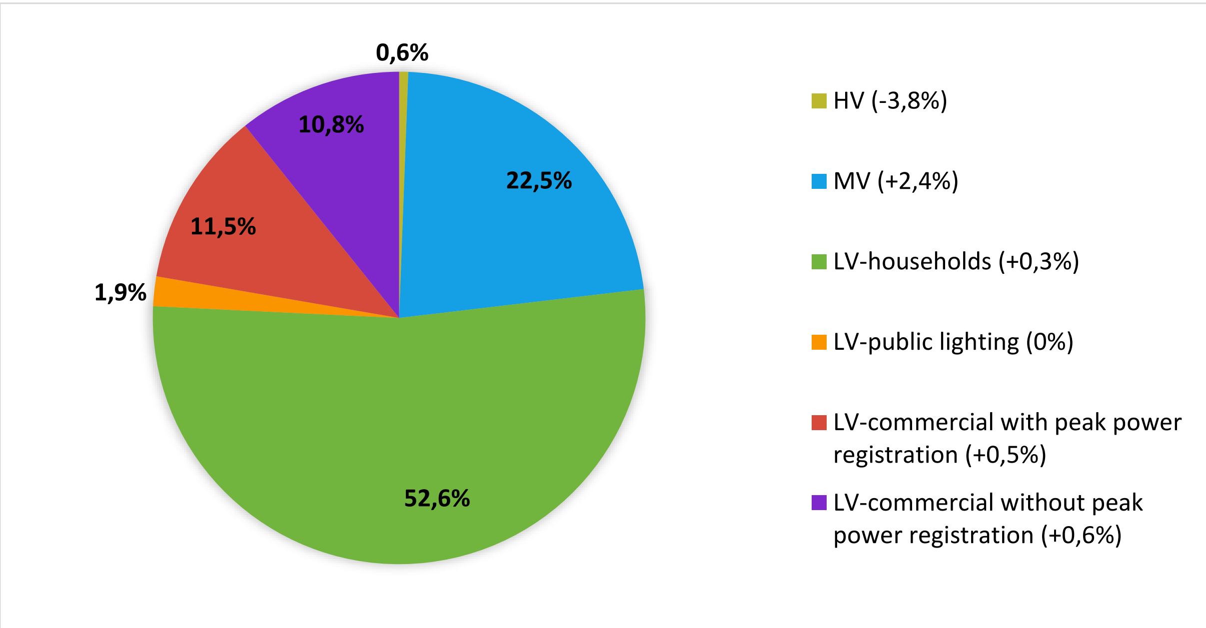
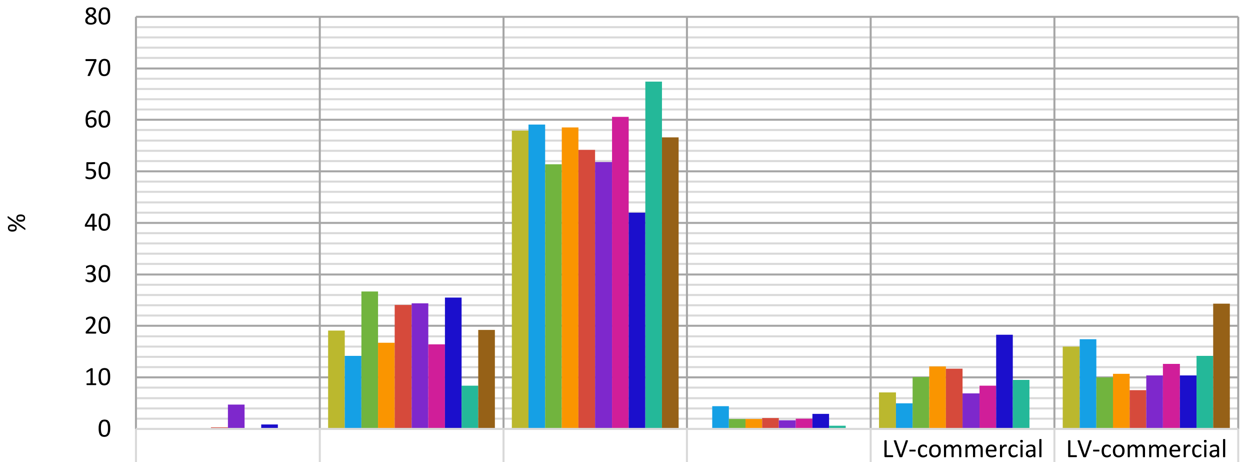


Figure 3.17 Share of electricity delivered per consumer categories in each SEE DSOs in 2015

In most of the SEE DSOs the share of electricity delivered to households in total delivered electricity is between 50 – 60%, while only Croatian HEP have a lower share of 42% and Kosovo KEDS greater share of 67,4%. Electricity delivered to MV customers is usually between 15 – 25% of total delivery, except in KEDS (8,4%), as shown in the following Figure.

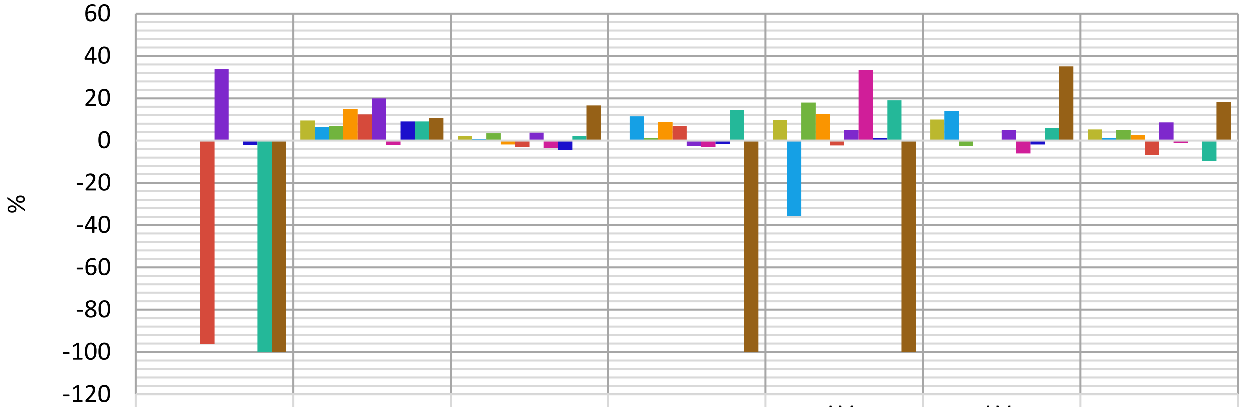


	HV	MV	LV-households	LV-public lighting	LV-commercial with peak power registration	LV-commercial without peak power registration
CEDIS	0	19,1	57,9	0	7,1	16
EDB	0	14,2	59,1	4,4	5	17,4
EPBiH	0	26,7	51,4	1,9	10,1	10
EPHZHB	0	16,7	58,5	1,9	12,1	10,7
EPS	0,3	24,1	54,2	2,1	11,7	7,5
ERS	4,7	24,4	51,8	1,7	6,9	10,4
EVNM	0	16,4	60,6	2	8,4	12,6
HEP	0,9	25,5	42	2,9	18,3	10,4
KEDS	0	8,4	67,4	0,6	9,5	14,2
OSHEE	0	19,2	56,6	0	0	24,3

Figure 3.18 Share of electricity delivered to different consumer categories in each SEE DSO in 2015

Change of electricity delivered to different consumer categories in the period 2012 - 2015 in SEE DSO is given in the following Figure. Delivery of electricity to consumers on HV fell in 2015 compared to 2012, due to a lower number of metering points. Electricity delivered on mid voltage in the region has grown by 9,69% with the range from -2,1% in EVNM to 19,9% in ERS. It has also grown for household consumers with the average value 1,6% in the range from -4,4% (HEP) to 16,6% (OSHEE).

For all other public lighting and LV-commercial consumer category, this trend is mainly positive, as shown in the following Figure. Please note that in the case of OSHEE electricity delivery for public lighting, LV- commercial with peak power registration and LV-commercial without peak power registration are summed in the electricity delivery to LV-commercial without peak power registration in 2015.



	HV	MV	LV-households	LV-public lighting	LV-commercial with peak power registration	LV-commercial without peak power registration	All categories
CEDIS	0	9,5	2,1	0	9,8	9,9	5,2
EDB	0	6,5	0,7	11,4	-35,7	14,1	1,1
EPBiH	0	6,9	3,5	1,3	17,9	-2,4	5
EPHZHB	0	15	-1,8	8,9	12,5	-0,2	2,7
EPS	-96,1	12,3	-3,1	6,9	-2,3	-0,1	-6,8
ERS	33,7	19,9	3,8	-2,5	5,1	5,1	8,6
EVNM	0	-2,1	-3,5	-3	33,2	-6,1	-1,3
HEP	-2	9,1	-4,4	-1,7	1,3	-1,8	0,2
KEDS	-100	9,1	2,1	14,3	19,1	6	-9,6
OSHEE	-100	10,7	16,6	-100	-100	35,1	18,2

Figure 3.19 Change of electricity delivered to different consumer categories in each SEE DSO in 2015 compared to 2012 [%]

More detailed data on the electricity delivery to different consumer categories in each DSO in the region are shown in the Figure 19.98 in the Appendix.

On the individual DSO level, there were two cases with significant electricity delivery variations in the last eight years (2008 – 2015). In Kosovo, there were the largest consumption fluctuations with the huge growth of 31% in the period 2008 - 2011, followed by 20% drop in the period 2011 - 2014, and again growth in 2015, resulting in overall growth of 16% in the period 2008 - 2015. Similar changes in consumption were recorded in Albania, with 19% growth in the period 2008 – 2011, followed by 23% drop 2011 – 2012 and then growth again resulting in total 9% increase in the period 2008 – 2015.

At the same time, Croatian HEP had a slight trend of decreasing by 10% until 2014 compared to 2008, but finally, they started with recovering and in 2015 consumption was 6% lower than in 2008. All DSOs in the region recorded electricity delivery growth in the period 2008 – 2015, except Croatian HEP and Serbian EPS with the delivery drop of 6% each.

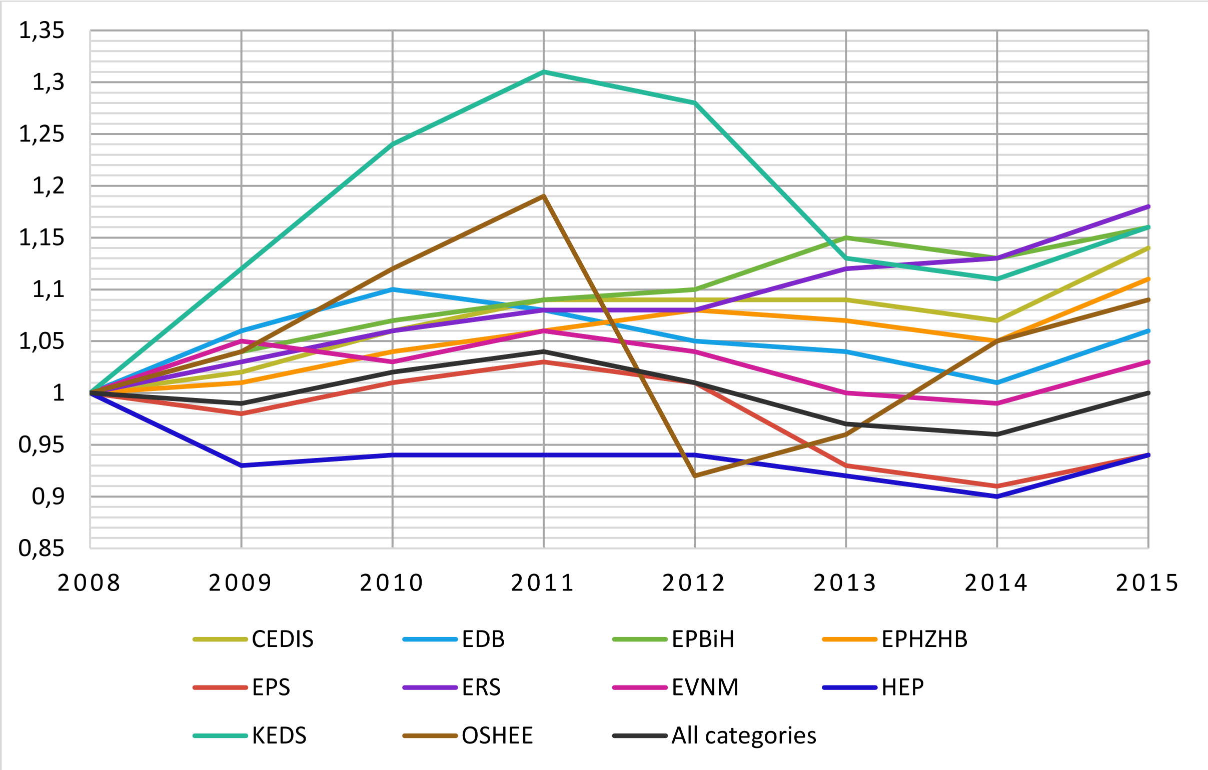


Figure 3.20 Change of electricity delivered to final consumers in SEE DSOs since 2008

Similar values are valid for the most dominant consumer category – households. It is interesting that none of the DSOs had constant household consumption growth during the whole period 2008 – 2015.

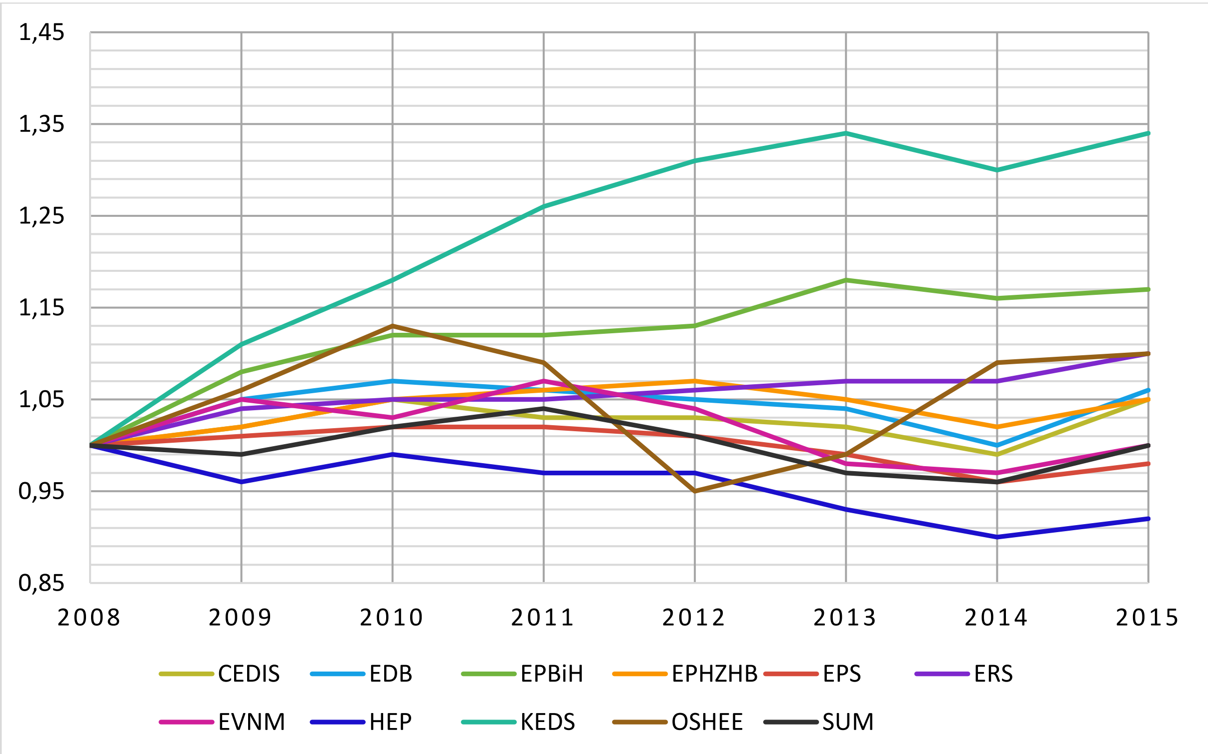


Figure 3.21 Change of electricity delivered to households since 2008

3.4 DISTRIBUTION NETWORK LENGTH

Distribution network length in the region in 2015 was 475.038 km and it has growth by 7,6% compared to 2011[4]. Cable network share in total network length in the region in 2015 was 20,34%, while in 2011 it was 17,84%.

Distribution network length in each SEE DSO is given in the following Figure. It shows that the largest growth in the period 2011 – 2015 is found in Kosovo (+34,1%), while the average growth in the region is 4,51%. The exceptions with total network length decrease are OSHEE (-10,3%) and HEP (-2,1%).

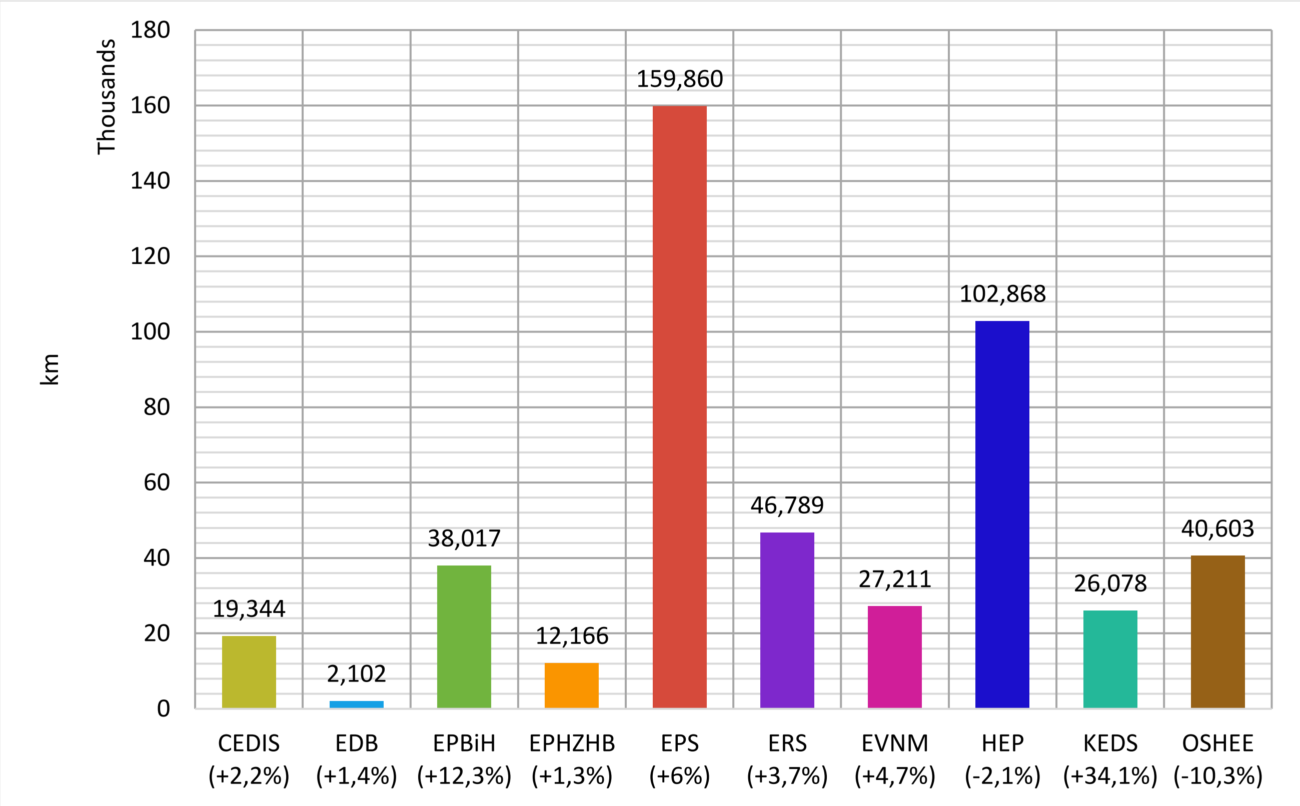


Figure 3.22 Length of distribution network owned by SEE DSOs in 2015

The following Figure shows the share of network length per different voltage levels in the region. 0,4 kV aerial network accounts for the largest share (55,3%). As expected, five-year changes are very small: 0,4 kV cable network length has increased by 1,9%, opposite to 0,4 kV aerial network that has fallen by 1,7%.

[4] These data are available for the period 2011 - 2015.

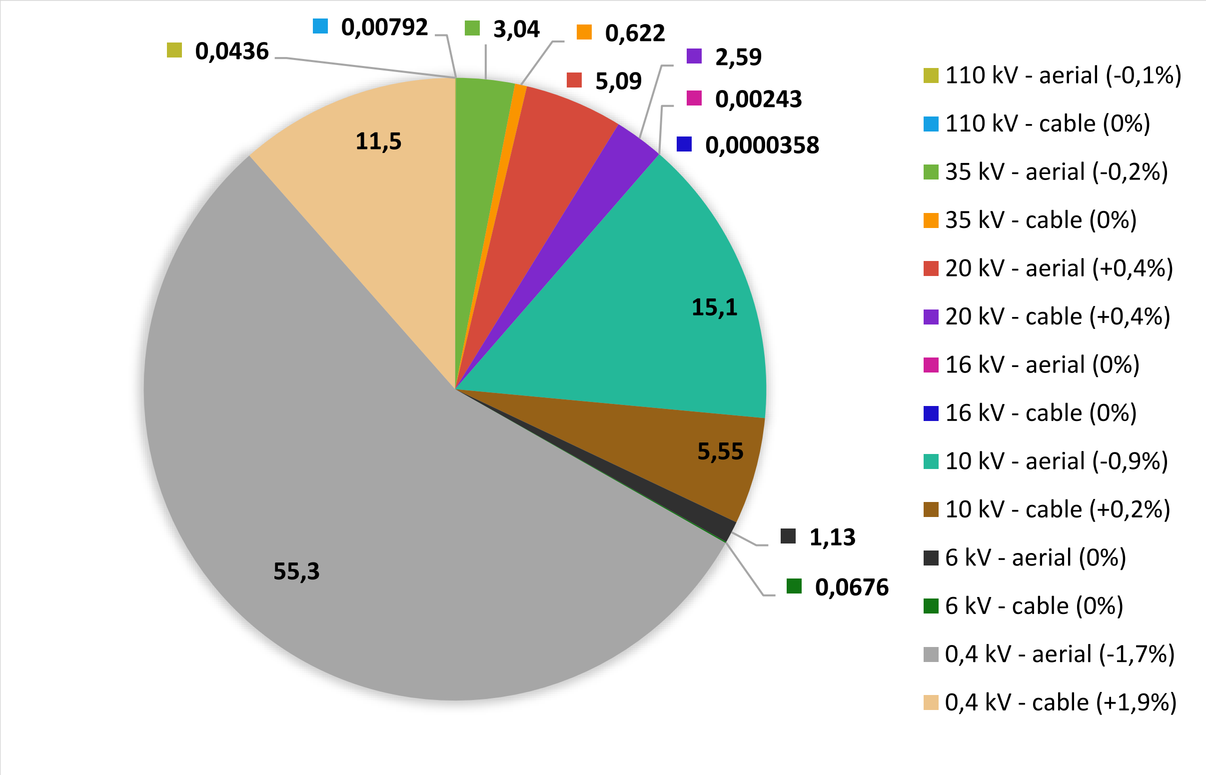


Figure 3.23 Share of total network length at different voltage levels in SEE DSO in 2015 [%]

The share of each DSO distribution network length in total distribution network in the region is shown in the following Figure and it is like the DSO's shares of number of metering points given in subchapter 2.2.

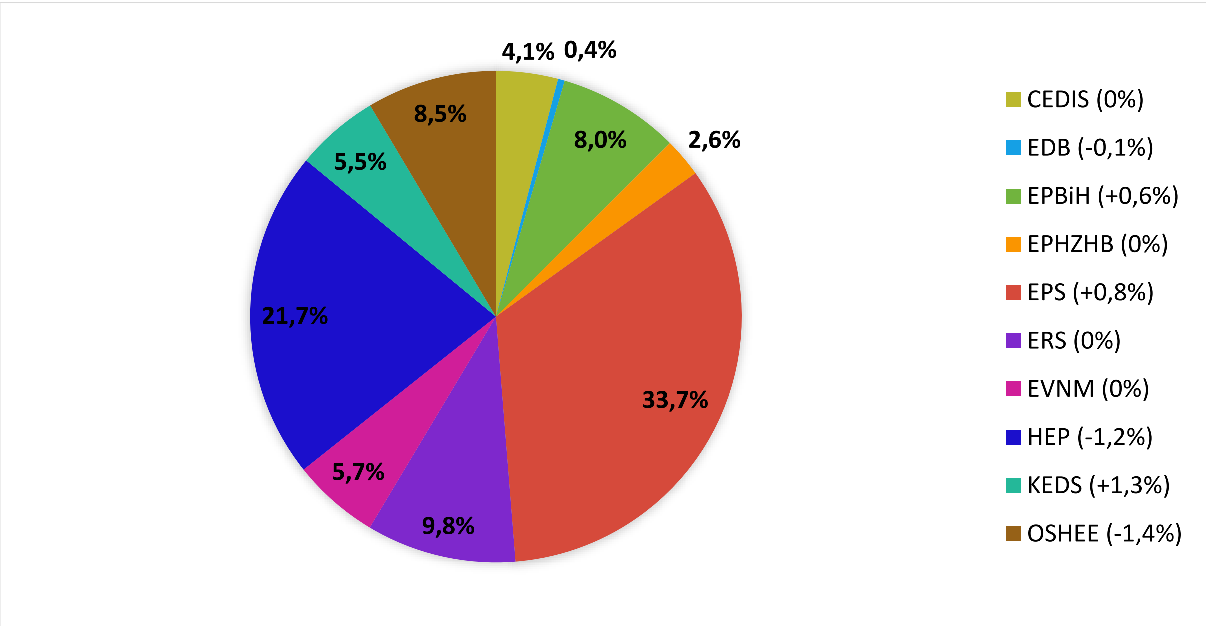


Figure 3.24 Share of distribution network length in SEE DSOs in 2015

SEE DSO's network are designed in the different ways, depending on the supply area size, terrain, population density, commercial activities, industrial developments etc., but also on the historical background. For example, cable network share is important indicator having a direct impact on the continuity of supply in the country. Figure 3.25 shows that the share of a cable network in total distribution network length is in the range of 9 – 33%, with the largest values in HEP (33%), EVNM (24%) and ERS (22%) and the lowest found in OSHEE (9%). The average regional share of a cable network in total network length is 20%. The details are given in the Figure 19.61 in the Appendix.

The shares of MV and LV network length in the region are shown in the Figure 3.26. The MV network length share is in the range 24 – 42%, with the regional average of 33%.

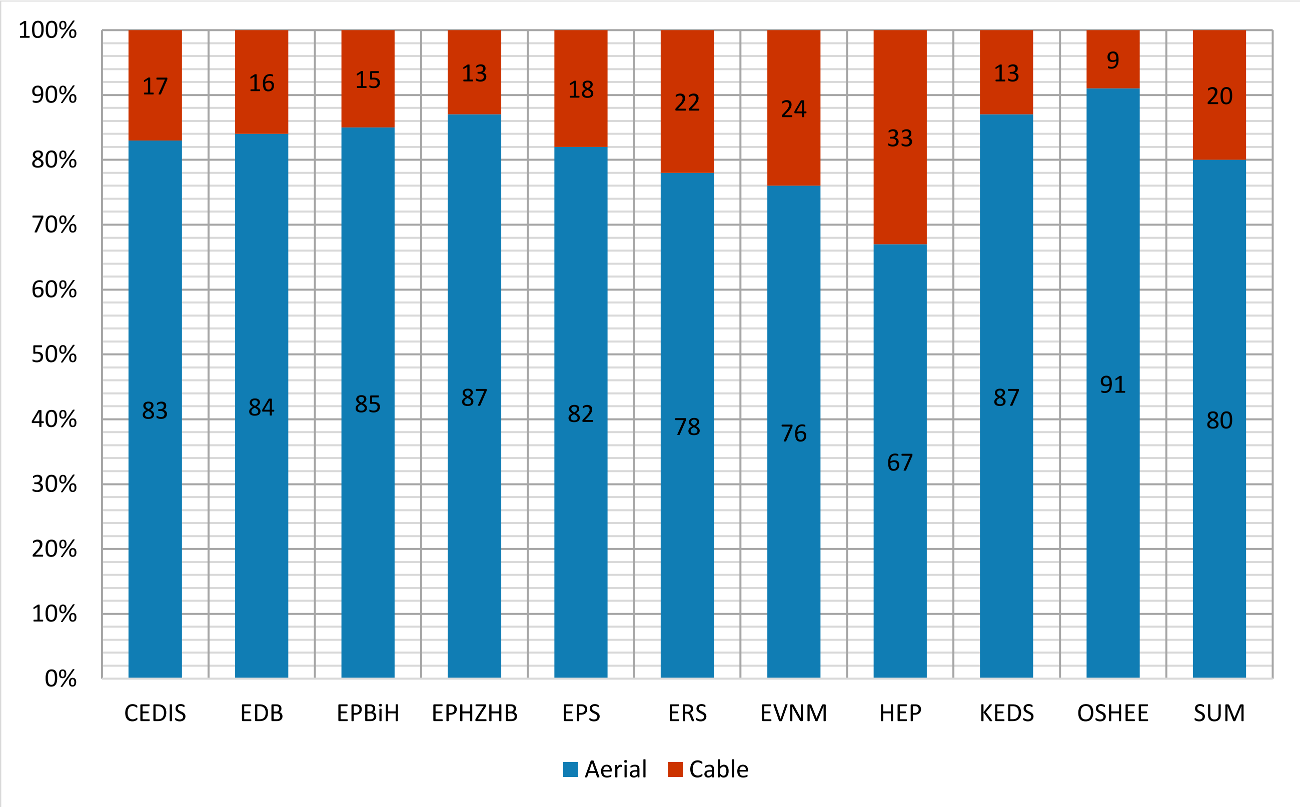


Figure 3.25 Share of aerial and cable network in SEE DSOs in 2015

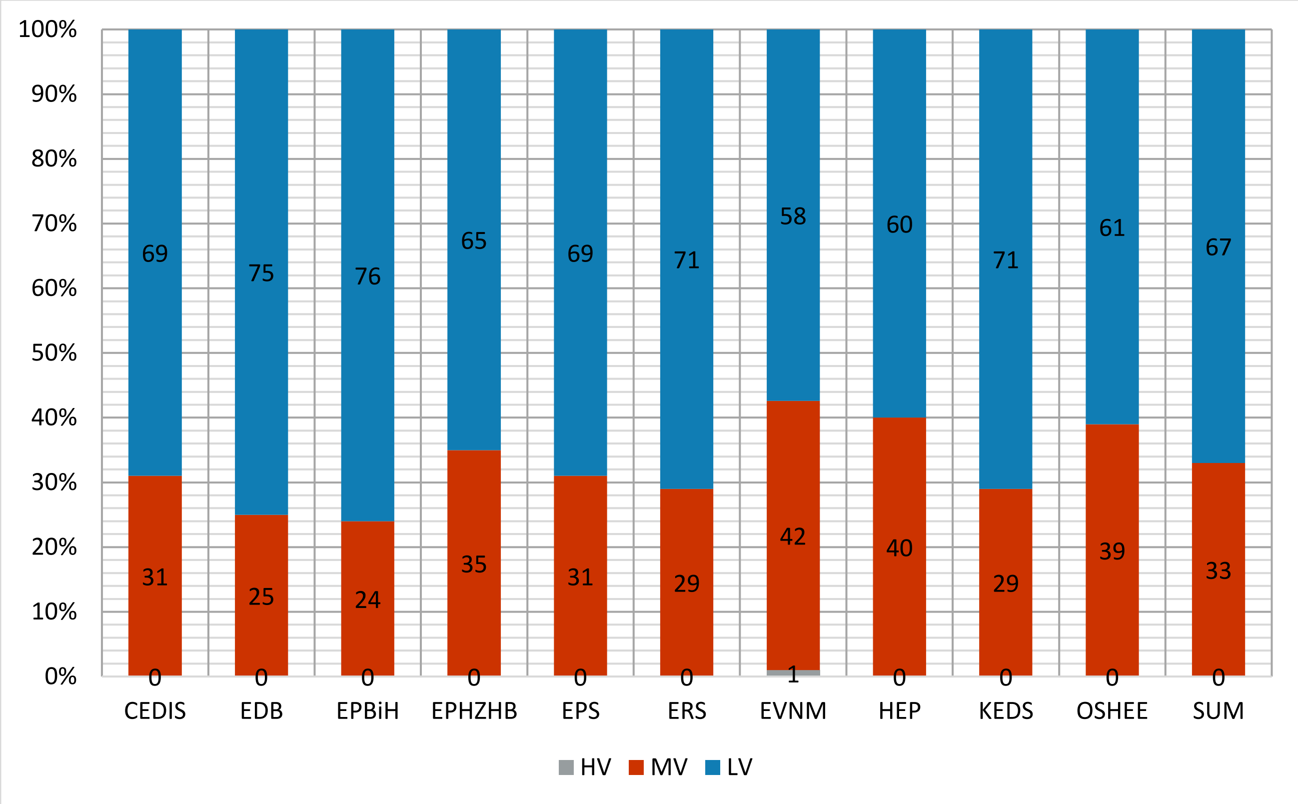


Figure 3.26 Share of HV, MV and LV in total network length in SEE DSOs in 2015

3.5 DISTRIBUTION NETWORK AGE

One of the most important data for estimation of distribution network reliability is distribution network age. Average distribution network age for each SEE DSOs is calculated and shown in the following Figure. The distribution network in most of SEE DSOs is getting older in the period 2012 – 2015 except in EPHZHB and EPS.

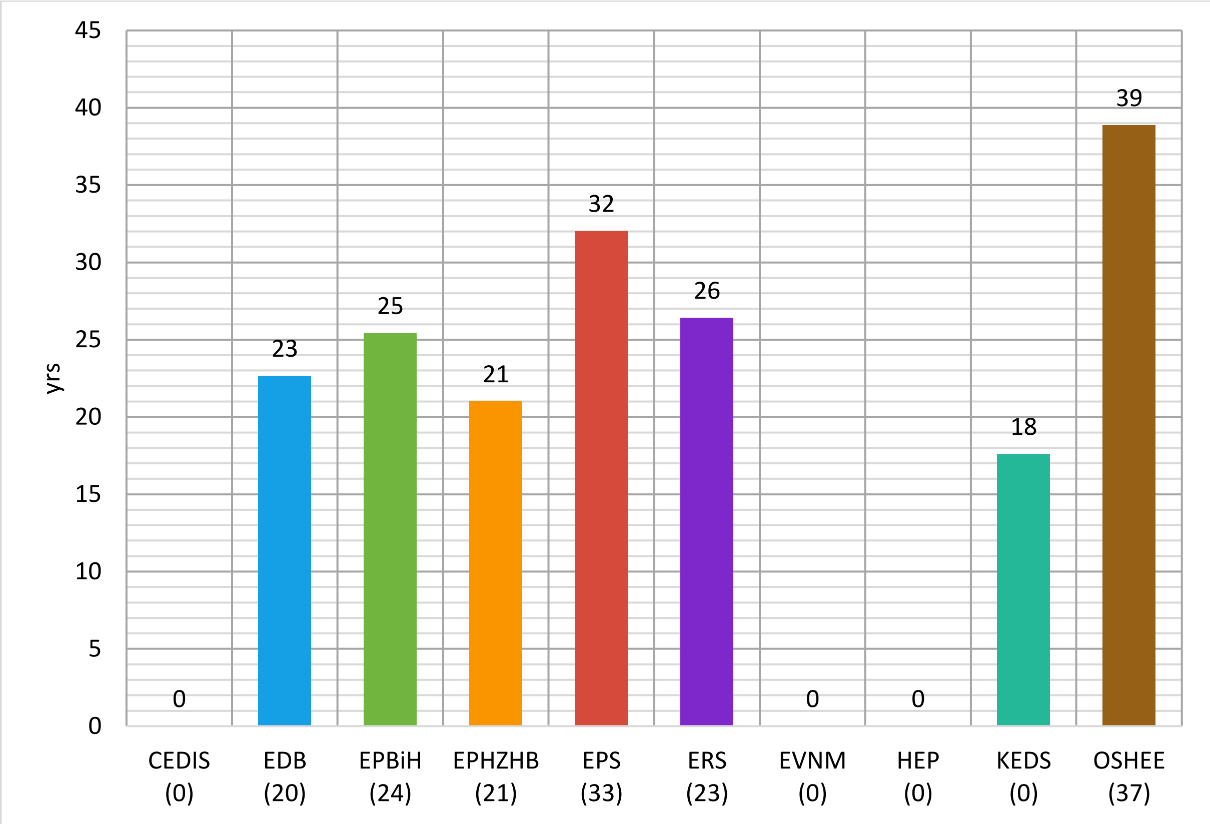


Figure 3.27 Calculated average distribution network age in SEE DSOs in 2015

The values are calculated as average age of the elements weighted per its length (for lines) or number of pieces (for transformers). The values given in brackets are referring to 2012 and in some cases the average distribution network age is increasing (EBD, ERS, OSHEE), while in some cases it is decreasing or keeping constant due to new investments in revitalization and new construction (EPHZHB, EPS). The oldest distribution network can be found in Albania (OSHEE) with the average age of 39 years and Serbia (EPS) 32 years, with the trend of fall in EPS (in 2012 it was 33 years) but not in OSHEE (2012 it was 37 years). The lowest distribution network age is in KEDS (18 years). The following Figure provides distribution network age per each type (cable/aerial) and voltage level in the region.

More details of the distribution network age in SEE DSOs in the period 2008 – 2015 are given in the Figure 19.84 in the Appendix.

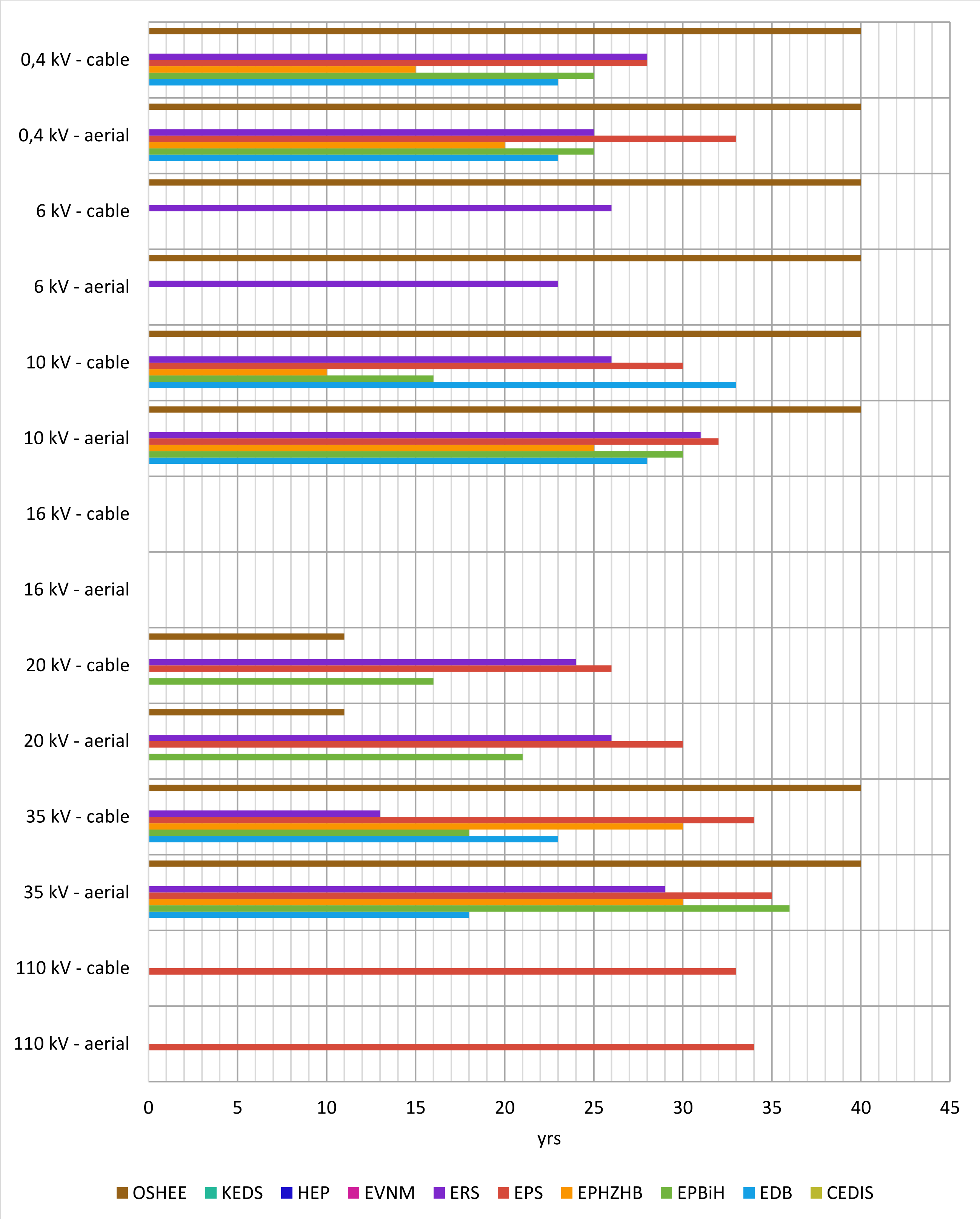


Figure 3.28 Distribution network age per type and voltage level in SEE DSOs in 2015

3.6 SUPPLY AREA SIZE

These 10 DSOs cover the area of 266.687 km^2 in 2015 and, as expected, there are no changes in supply area compared to 2012. The largest area portions are covered by Serbian EPS (31%) and Croatian HEP (22%).

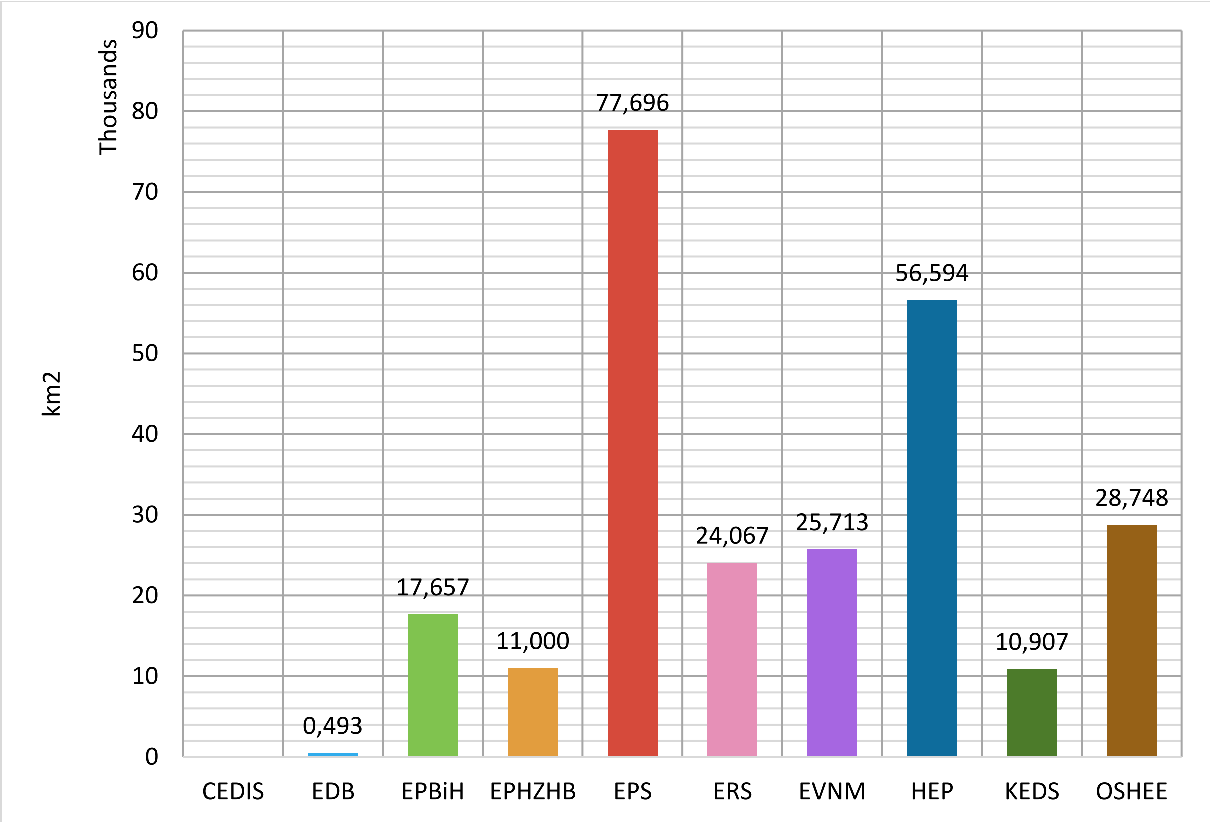


Figure 3.29 Supply area size in SEE DSOs in 2015

3.7 NUMBER OF SUBSTATIONS

In SEE distribution network there are 132.956 substations in 2015 with the growing trend of +2,95% comparing to 2012. Almost all DSOs have increased number of substations in the last 4 years and the highest growth is found in OSHEE (+7,8%), while only KEDS has had slight decrease (-0,1%). Most of the substations in the region are in EPS (26%), HEP (23%) and OSHEE (19%). For better understanding, rare types of substations are grouped and given in Appendix in Subchapter 19.2.

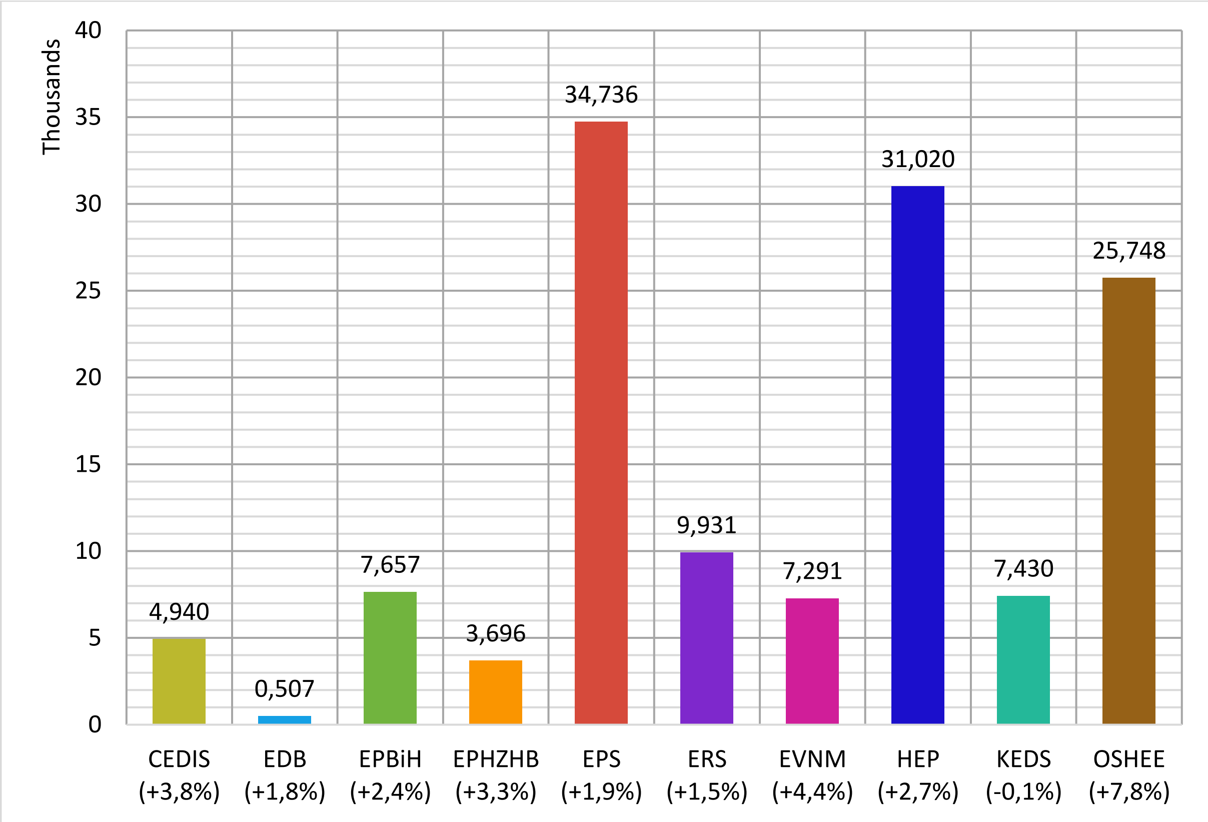


Figure 3.30 Number of substations in SEE DSOs in 2015

In addition to total number of substations given above, that have been divided into two groups, X/MV and MV/LV substations, the following two Figures give number of first X/MV group of substations (i.e. 110/35/10(20) kV; 110/20 kV; 110/10 kV; 110/10(20) kV; 35/20 kV; 35/10 kV; 35/6 kV) and second MV/LV group of substations (i.e. 35/0,4 kV; 20/0,4 kV; 10/0,4 kV). Overall regional growth in the period 2012 – 2015 was +2,82%.

The highest growth in 2015 compared to 2012 in the number of substations X/MV were found in HEP and EVNM, while all other SEE DSOs, except CEDIS, had a decrease of that type of substations (the highest decrease was in KEDS). Reason why was so high value of increase in the number of substations X/MV in HEP (+31,8%) is because the number of the TS 110/35 kV were first time given in 2015 and added to the number of the TS 110/10(20), without matter that they are only partly in jurisdiction of HEP and the same worth for the number of the TS 110/10 kV. Number of TS 35/3 kV in KEDS was only in 2012 added to the number of TS 35/6 kV, what is the one of the reasons of such high decrease (-17,7%) in the number of substation X/MV in given timeframe. There were no complete data for number of substations X/MV in EPHZHB in 2012, that why the increase in 2015 compared to 2012 is very large (+106,7%).

As expected, all regional DSOs reported a slight increase of number of MV/LV substations (0,1 – 7,8%).

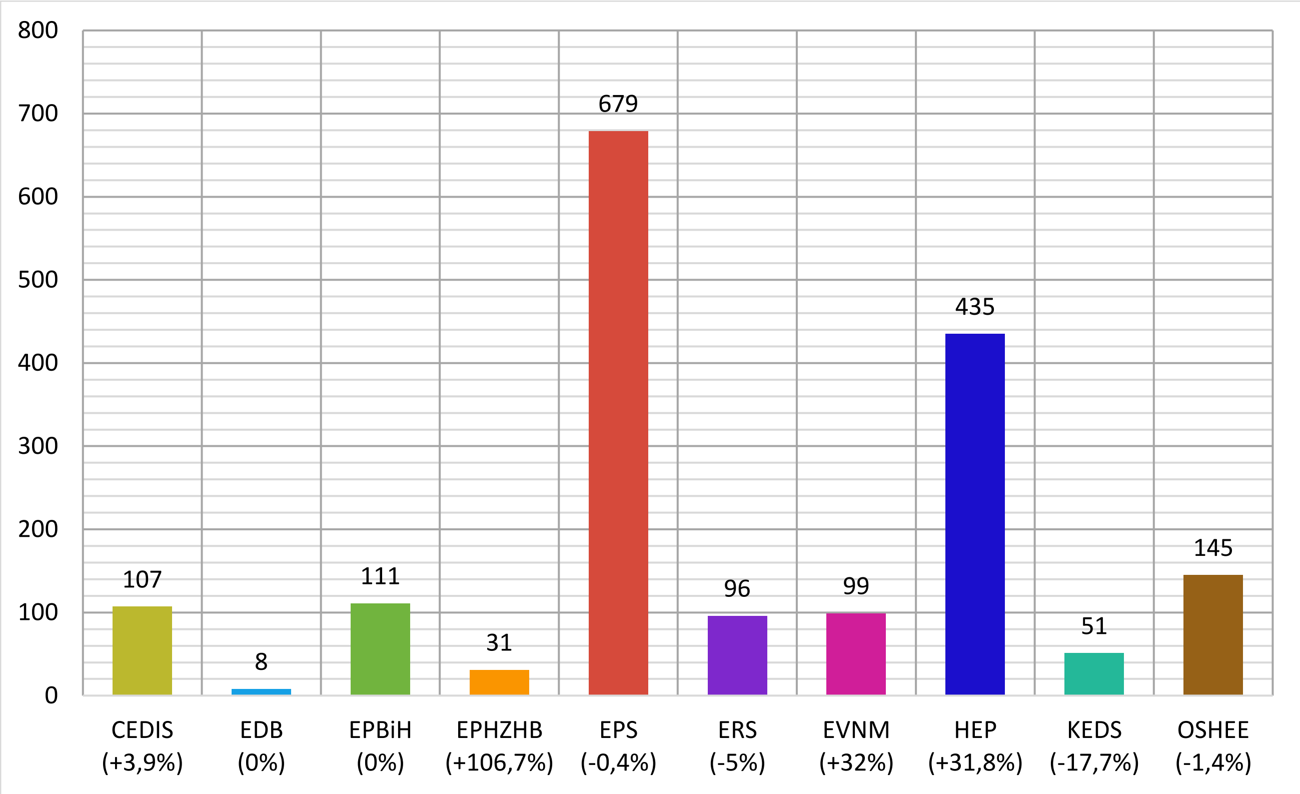


Figure 3.31 Number of X/MV substations in SEE DSOs in 2015

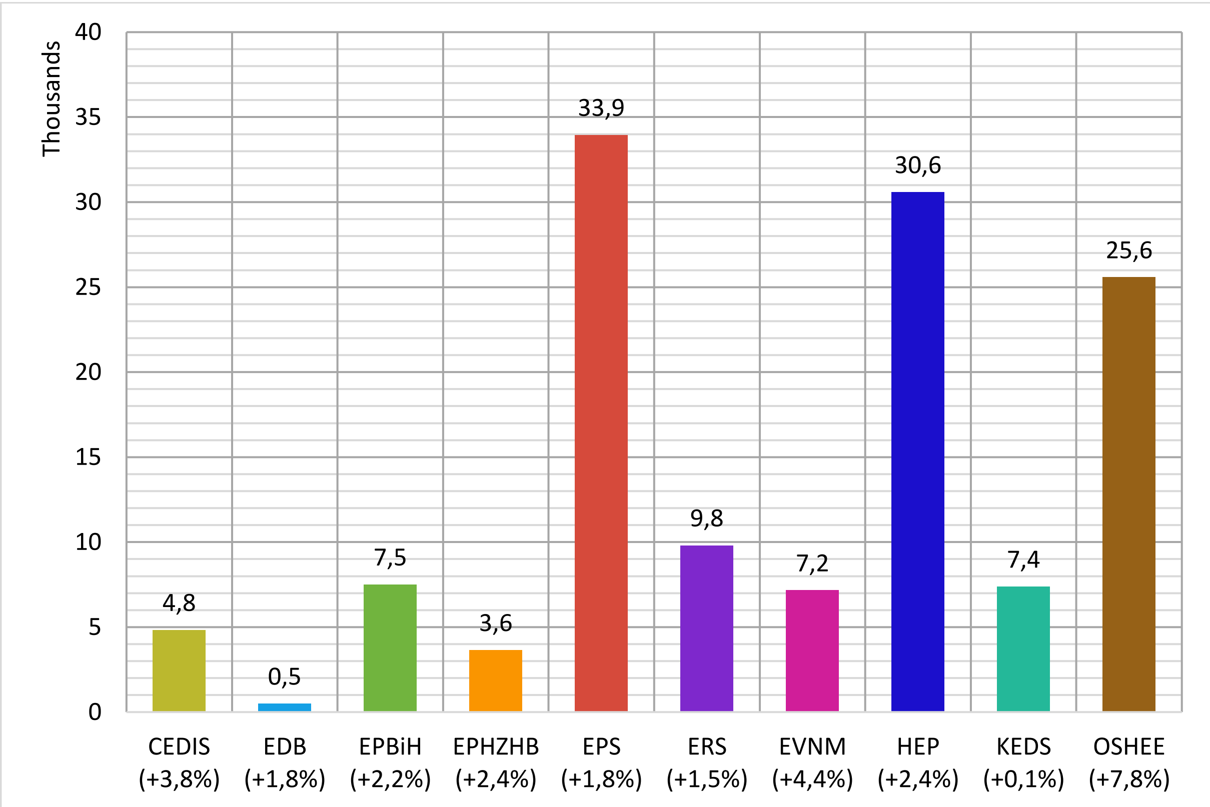


Figure 3.32 Number of MV/LV substations in SEE DSOs in 2015

3.8 NUMBER OF TRANSFORMERS

Altogether there were 131.670 distribution network transformers in the region in 2015 compared to the 129.719 substations in 2012, so it assumes slight increase by 1,5% in given timeframe. Data for EVNM in 2012 were not complete and that's the reason for significant drop reported in 2015: -29,6%.

Data for CEDIS were not available here.

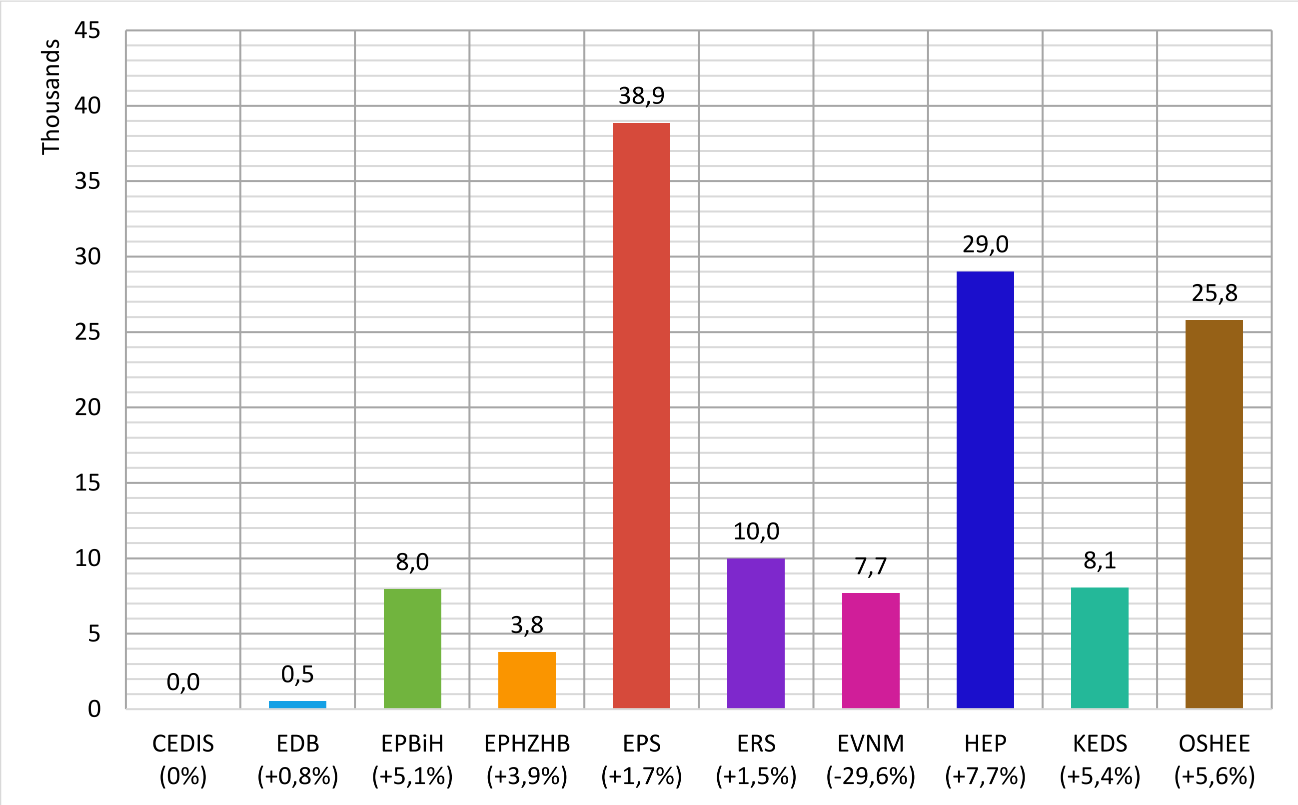


Figure 3.33 Number of transformers in SEE DSOs in 2015

In addition to total number of transformers given above, the following two Figures give number of X/MV transformers (i.e. 110/35/10(20) kV, 110/20 kV; 110/10 kV; 110/10(20) kV, 35/20 kV; 35/10 kV; 35/6 kV) and MV/LV substations (i.e. 35/0,4 kV; 20/0,4 kV; 10/0,4 kV).

Number of X/MV transformers in 2015 compared to 2012 increased in EPBiH and HEP, while it is decreased in KEDS, ERS, and EPS. The data for X/MV transformers in EPHZHB in 2012 were not completely available, and most of them are not in their jurisdiction.

Speaking of number of MV/LV transformers in the region, EVNM data should be rechecked since large deviations of number of transformers are found here.

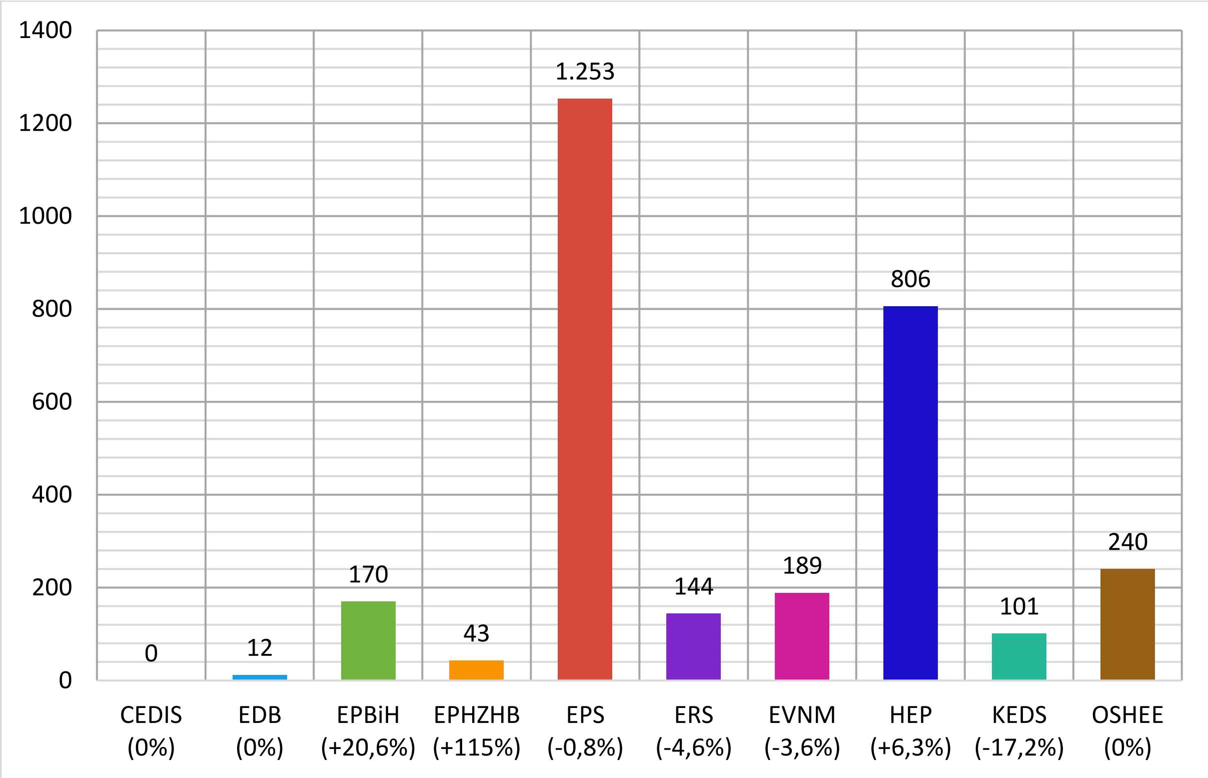


Figure 3.34 Number of X/MV transformers in SEE DSOs in 2015

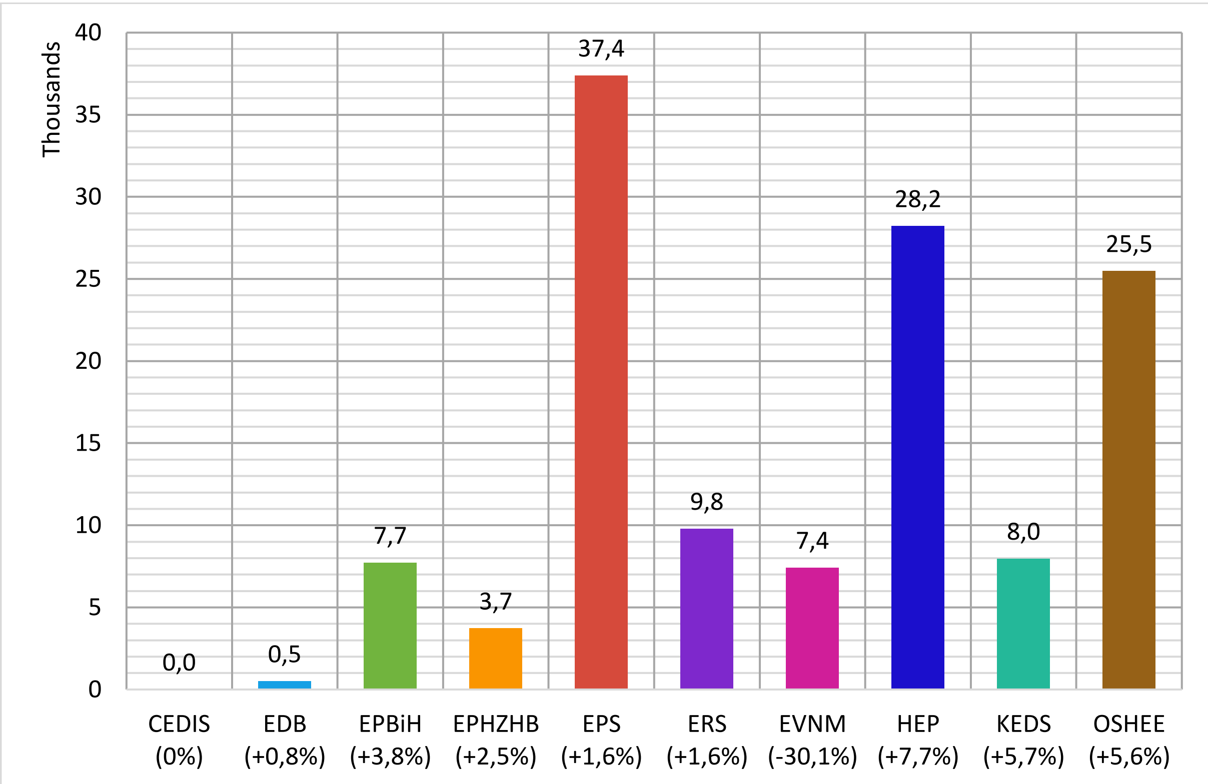


Figure 3.35 Number of MV/LV transformers in SEE DSOs in 2015

3.9 SUM CAPACITY OF TRANSFORMERS

As given above, in this region in 2015 there were 132.956 substations (without 110/MV substations in KEDS), with 131.670 distribution network transformer (data for number of transformers for CEDIS are not available). The total sum of its capacity was 82.776 MVA (110/MV transformers in KEDS not included), with an average capacity of 623 kVA per substation. In the period 2012 – 2015 it is increased by 3,8%. It increased in all SEE DSOs, especially in HEP (18,7%), but as was already mentioned, it is because the sum capacity of 110/35 kV transformers was first time given in 2015 and added to the sum capacity of 110/10(20) transformers, and the same goes for 110/10 kV transformers (data on transformer installed capacity drop in EVNM should be rechecked). The total capacity of 110/MV transformers in 2012 in EPHZHB was not available.

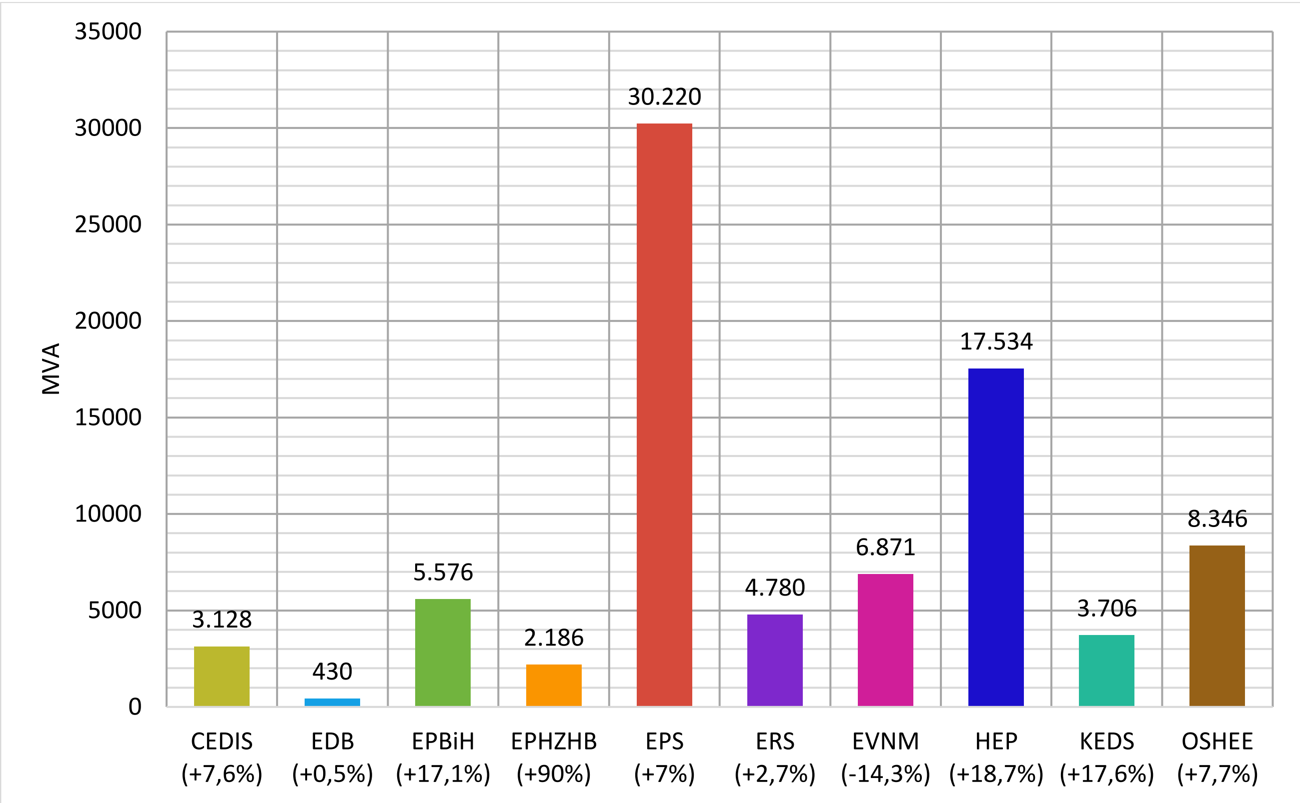


Figure 3.36 Sum capacity of transformers in SEE DSOs in 2015

The following two Figures show installed capacity of X/MV transformers (i.e. 110/35/10(20) kV; 110/20 kV; 110/10 kV; 110/10(20) kV; 35/20 kV; 35/10 kV; 35/6 kV) and MV/LV transformers (i.e. 35/0,4 kV; 20/0,4 kV; 10/0,4 kV).

67,4% of all installed capacities of transformers in the region are placed in Serbian EPS and Croatian HEP.

Please note that the data for EPHZHB in 2012 were incomplete. The share of MV/LV transformer capacity in total installed distribution transformer capacity in the region in 65,63%. More detailed values in the period 2008 - 2015 can be found on the Figure 19.31 and Figure 19.32 in the Appendix.

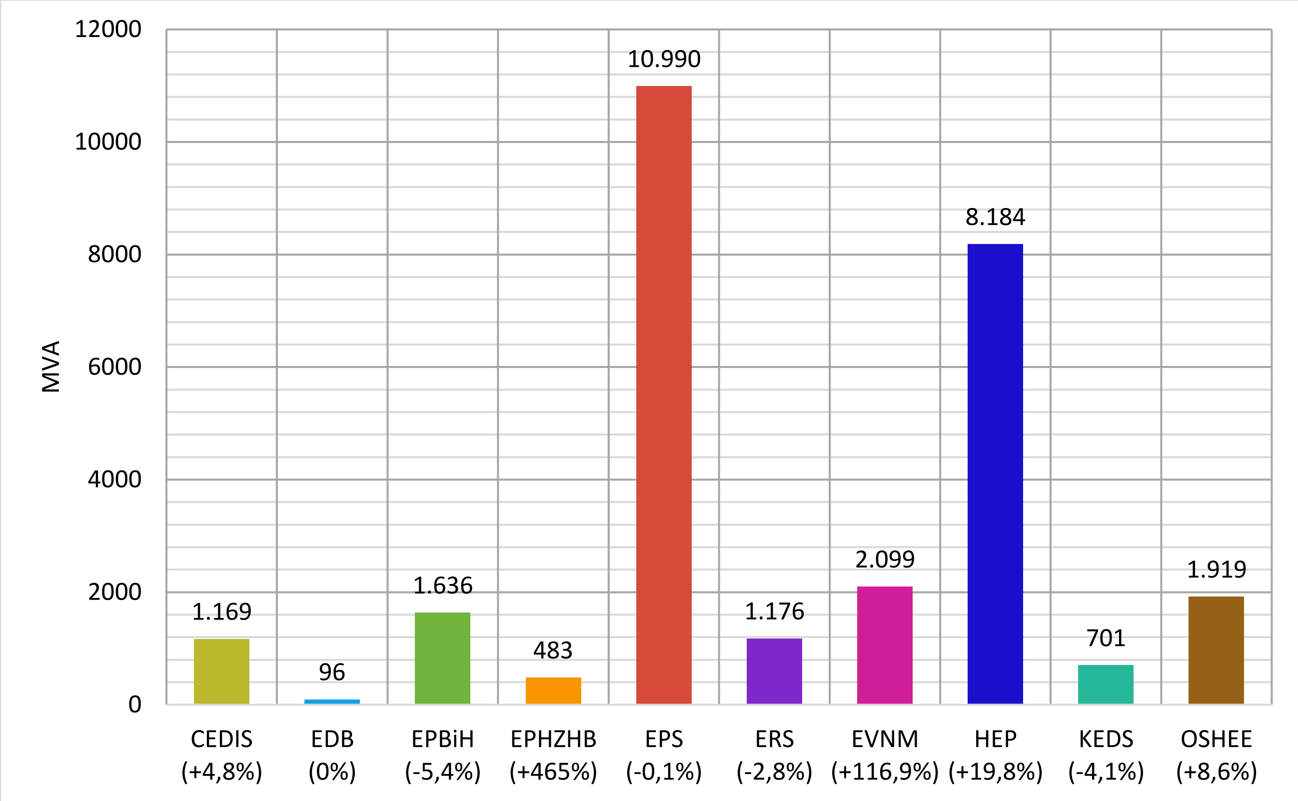


Figure 3.37 Installed capacity of X/MV transformers in SEE DSOs in 2015

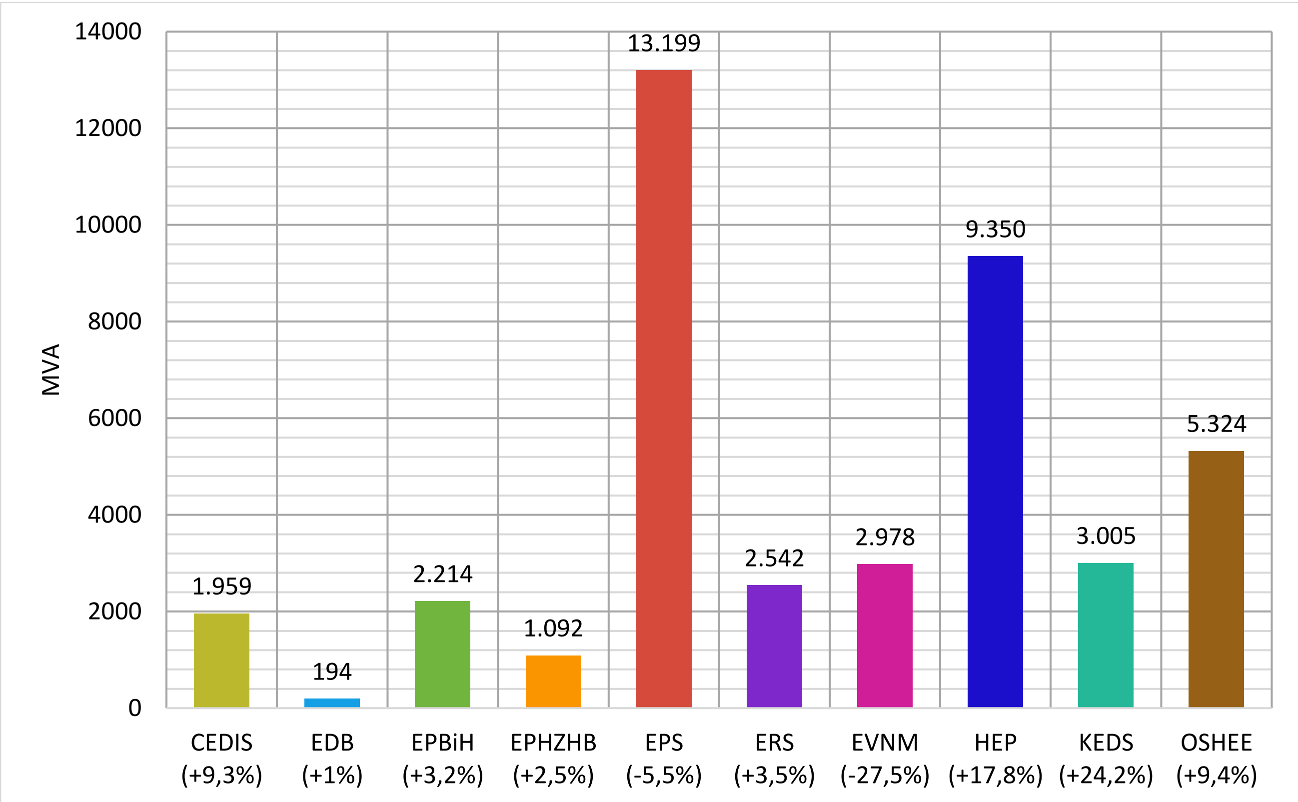
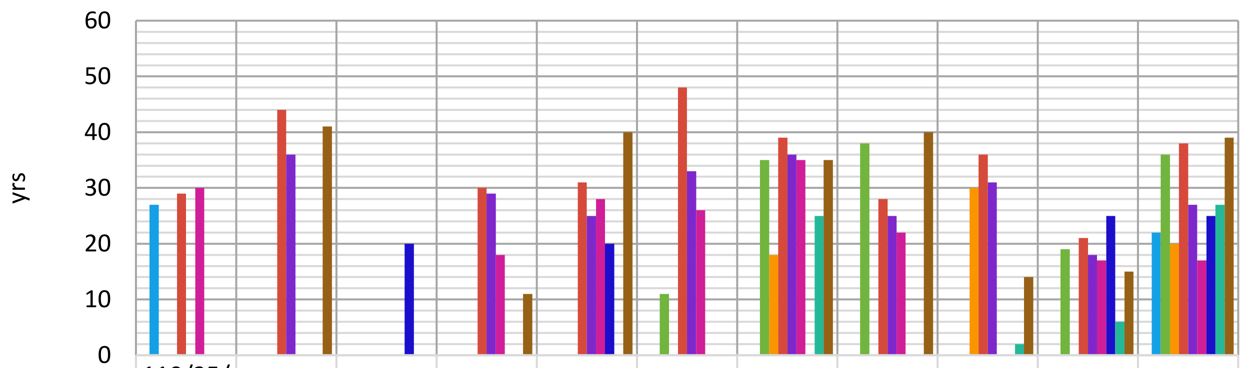


Figure 3.38 Installed capacity of MV/LV transformers in SEE DSOs in 2015

3.10 DISTRIBUTION TRANSFORMERS AGE

The average age of transformers per each type in SEE DSOs in 2015 is shown in the Figure 3.39. Average age of all transformers in the region, according the available data, in 2015 was 29,2 years (data for CEDIS were not included in this weighted calculation of average age, because the number of transformers in CEDIS were not available), while in 2012 was 30,4 years (data for CEDIS, EVNM, and HEP were not available), what points that the age of transformers in the region become younger, i.e. the oldest transformers are replacing with the new ones, and certainly, the completely new transformers are also installing in the distribution system, where they are needed. The change of average age of transformers in most of the SEE DSOs in the period 2008 - 2015, as can be seen in the Figure 19.30 in the Appendix, is in the slight growth or it is remaining the same over that time, what means that the new type of transformers has been installed but slowly. Only KEDS had a significant decrease of this value, for 4 years in the period 2012 – 2015 and ERS for 1 year. Figure 3.40 Calculated average distribution transformers age per type in SEE DSOs in 2015 shows the calculated average age of all transformers in each DSO. The oldest transformers in the region are found in OSHEE (35 years), EPBiH and EPS (34 years). In the rest of the region, it is in the range of 17 – 25 years. Please note that the values for KEDS, EPBiH, and EPHZHB are calculated based on 35/20 kV; 35/10 kV; 35/6 kV and lower level transformation data, since their distribution system does not comprise of the substations and transformers on HV/MV level.



	110/35/10(20) kV	110/35 kV	110/10(20) kV	110/20 kV	110/10 kV	35/20 kV	35/10 kV	35/6 kV	35/0,4 kV	20/0,4 kV	10/0,4 kV
CEDIS	0	0	0	0	0	0	0	0	0	0	0
EDB	27	0	0	0	0	0	0	0	0	0	22
EPBiH	0	0	0	0	0	11	35	38	0	19	36
EPHZHB	0	0	0	0	0	0	18	0	30	0	20
EPS	29	44	0	30	31	48	39	28	36	21	38
ERS	0	36	0	29	25	33	36	25	31	18	27
EVNM	30	0	0	18	28	26	35	22	0	17	17
HEP	0	0	20	0	20	0	0	0	0	25	25
KEDS	0	0	0	0	0	0	25	0	2	6	27
OSHEE	0	41	0	11	40	0	35	40	14	15	39

Figure 3.39 Average distribution transformers age per type in SEE DSOs in 2015

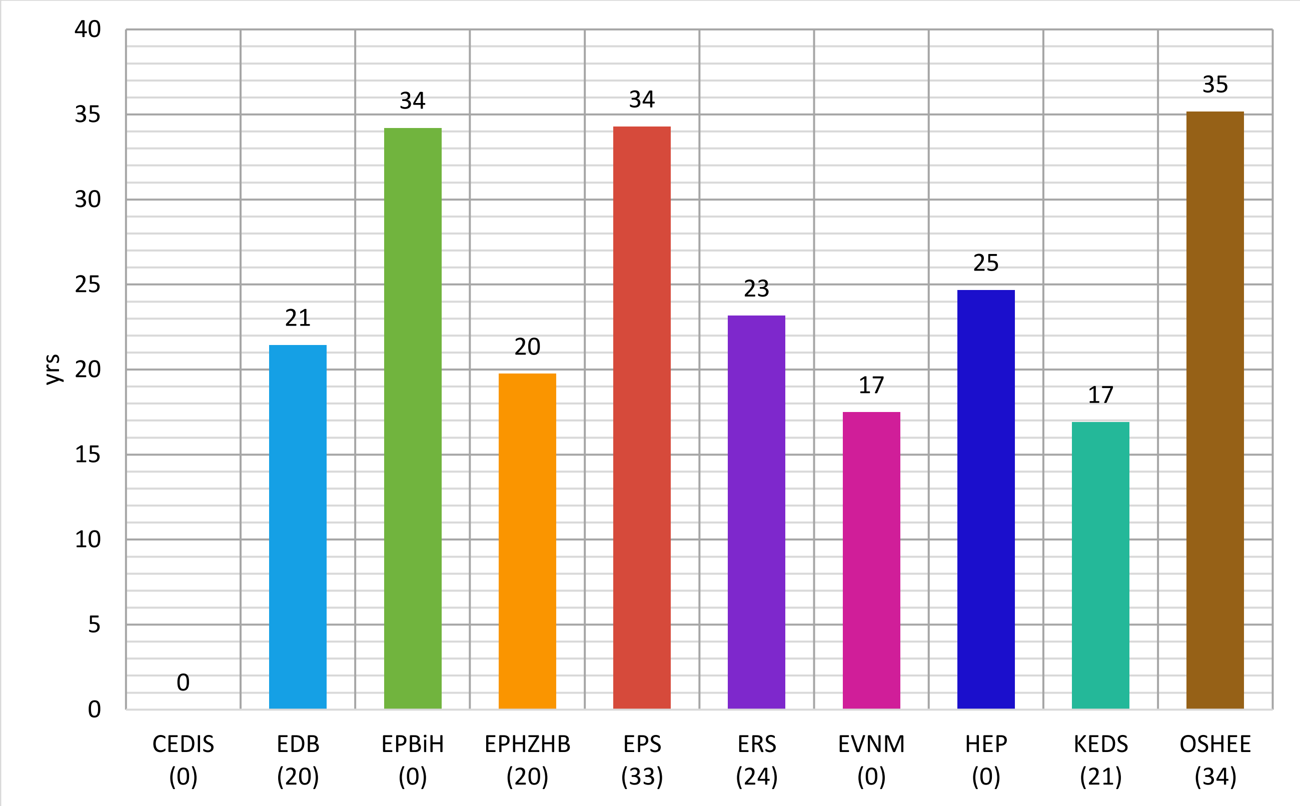


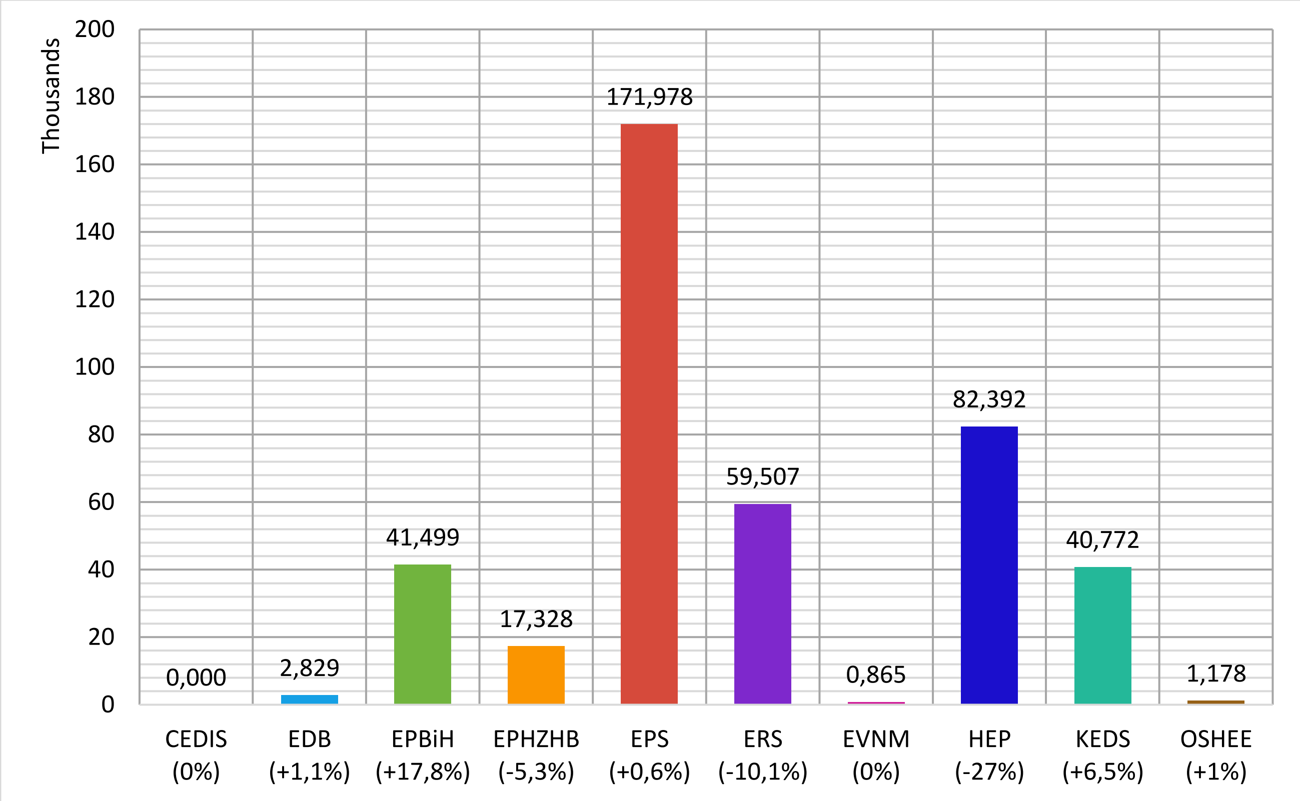
Figure 3.40 Calculated average distribution transformers age per type in SEE DSOs in 2015

3.11 NUMBER OF FEEDERS

One of the usual benchmarking indicators that characterize the network density is number of distribution feeders. In the region in 2015 in total (without CEDIS and LV feeders in EVNM - data are not available) there were 418.348 feeders. Compared to 2012 it decreased by 6,2%.

The highest growth in 2015 compared to 2012 is found in KEDS (+6,5%), while the highest drop is recorded in HEP (-27%) Clearly, data for 2015 should be rechecked. The data for 0,4 kV feeders in EPBiH in 2012 were not available.

More detailed data on the number of feeders per each type in SEE DSOs are given in Figures 19.46 - 19.50 in the Appendix.



*The main principles in data collection used in each DSO are given in the appendix.

Figure 3.41 Number of feeders in SEE DSOs in 2015

It is also interesting to analyze the total number and the change of MV and LV feeders in the region (Figure 19.44 and in the Appendix shows the trend of change of MV and respectively LV feeders in the region, in the period 2008 – 2015). Trend of change in the number of MV feeders in the period 2012 – 2015 in the region is slightly growing (except in EPS where the number of MV feeders wasn’t available until 2012 except for 20 kV feeders in TS 35/20 kV, and because of that, after 2012 was high growth). Data for EPBiH should be rechecked due to large fluctuations on yearly basis. Number of LV feeders in the region is also in slight increase with exception of DSOs with the uncomplete data (number of 0,4 kV feeders in TS 20/0,4 kV in HEP wasn’t available in 2015; data of number of 0,4 kV feeders in TS 20/0,4 kV in EPBiH wasn’t available in 2012; number of 0,4 kV feeders in the 20/0,4 kV in EPS wasn’t available until 2010 and number of 0,4 kV feeders in the 10/0,4 kV in EPS wasn’t available until 2012). In 2015, the largest number of MV feeders was in Croatia - 6.862 feeders (41% of regional total), with the growth of 4,1% compared to 2012.

Data shown in the following Figure represent a total number of MV feeders in 2015, regardless of its ownership.

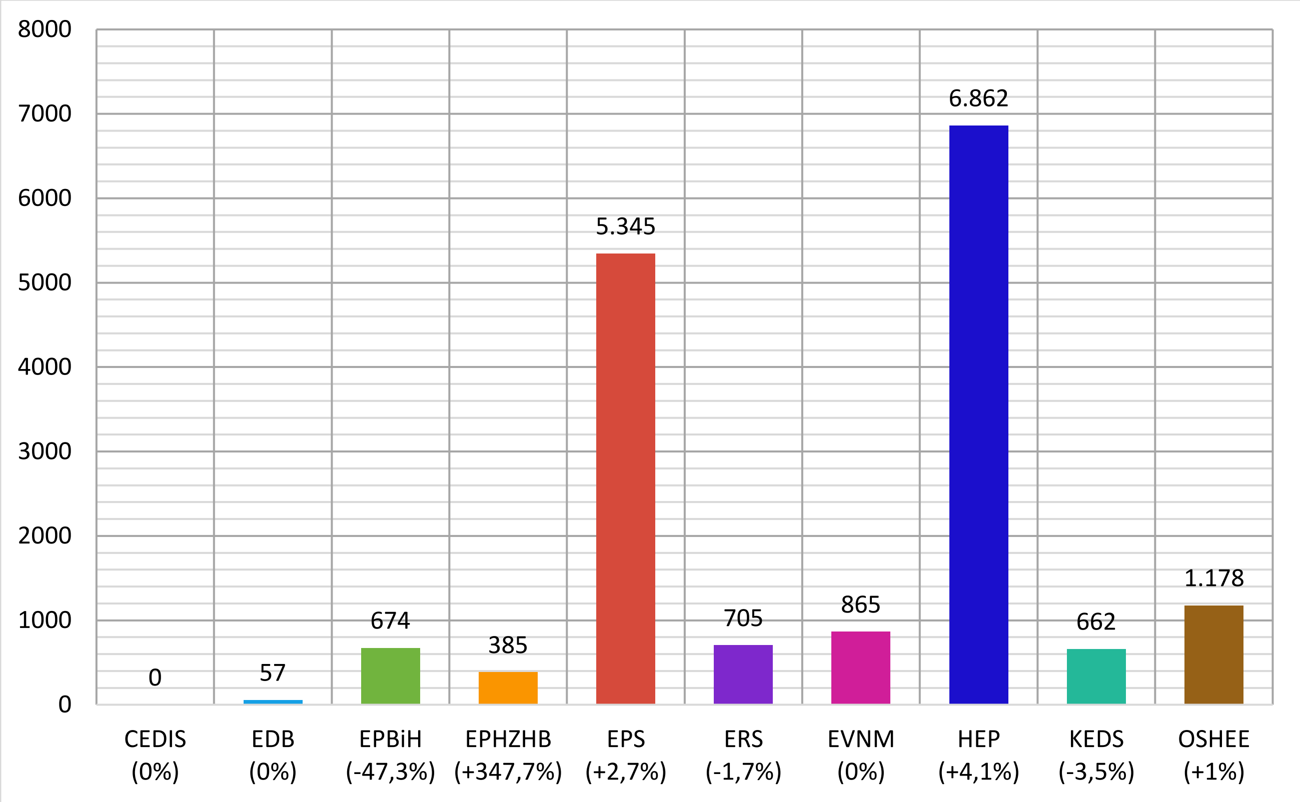


Figure 3.42 Number of MV feeders in SEE DSOs in 2015

The largest number of LV feeders in 2015 was in EPS 166.633 (41,5% of all collected data, where data for CEDIS, EVNM and OSHEE were not available). The largest growth of the number of LV feeders in the period 2012 - 2015 is found in EPBiH (+20,3%), such large number the mostly is because the data of number of 0,4 kV feeders in TS 20/0,4 kV wasn't available in 2012, and KEDS (+6,6%), while HEP lost significant portion of it LV feeders (-28,9%) because the data given in 2015 are not complete, as mentioned above, as well as ERS (-10,2%) and EPHZHB (-7%).

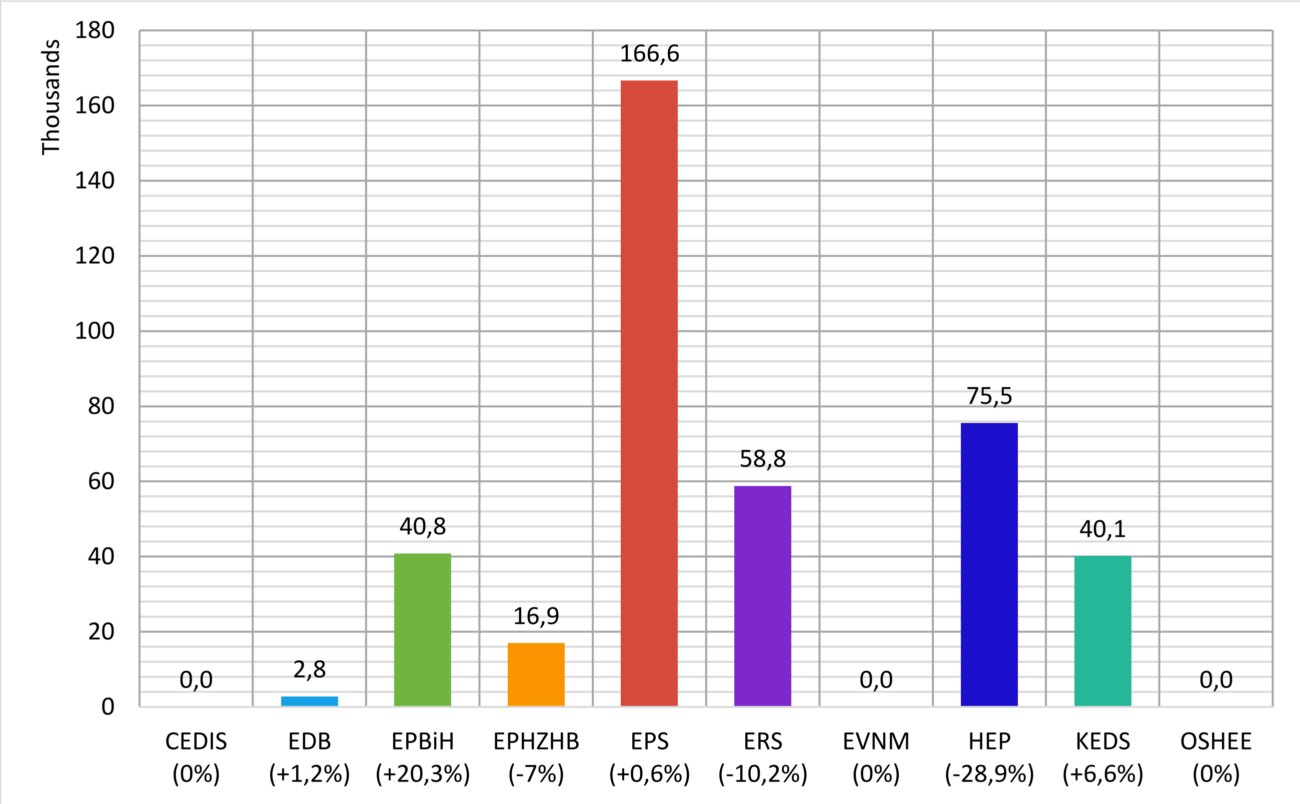


Figure 3.43 Number of LV feeders in SEE DSOs in 2015

3.12 DISTRIBUTION NETWORK OPERATED AND NOT OWNED BY DSO

In some cases, parts of the distribution network are not owned by the DSO, but some other entities (industrial customer, municipality, TSO, etc.). In these cases, DSO is obliged to operate and control (sometimes to maintain) this part of the distribution network to keep it reliable and harmonized with the remaining part of the system.

In the region in 2015, there was 5.666 km of distribution lines operated and not owned by the DSOs. Most of them are in EPS (58,5%), EVNM (17,8%), EDB (9,3%) and EPBiH (7,9%), as shown in the following Figure. Only in EPS and EDB length of this distribution lines have grown while in most of other DSOs have fallen in 2015 compared to 2012. In EVNM has been no change. The length of this network on LV level in ERS in 2015 compared to 2012 decreased by 90%, and together with the decrease in MV level gives the value of 85,2% decrease in ERS. The reason for such high decrease in network length operated but not owned by ERS, need to be checked. Such high value of a decrease of this network in EPHZHB (-25,6%) is because the length of this network on MV level is not available in 2015 regarding this values in 2012 that are given on both MV and LV level.

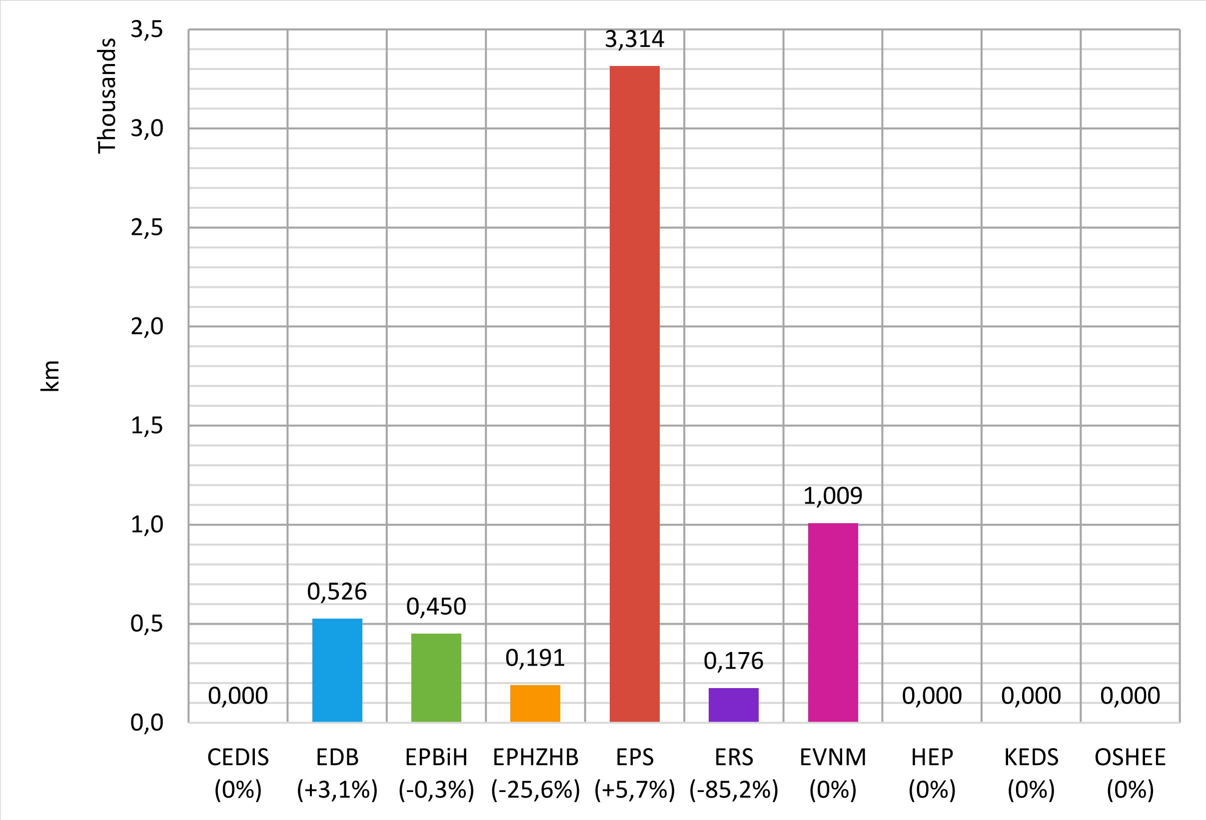


Figure 3.44 Distribution network length operated but not owned by SEE DSOs in 2015

3.13 NUMBER OF EMPLOYEES

One of the most usual benchmarking indicators for the company efficiency is number of employees per given service. In the DSO activity, it is quite specific, especially in SEE, since part of the staff is/was shared with supply business or eventually with other parts of the vertically integrated company. In most of the cases in SEE, supply business is not fully unbundled from network business, company restructuring is still underway with a lot of shared staff.

In ten regional DSOs in 2015, there were 37.732 employees, with the decrease of 1,2% compared to 2012. But, 25.364 employees (67,2%) are dealing purely with network business. Remaining 7.041 employees (18,7%) are engaged in supply business, while 3.829 (10,2%) employees are shared between network and supply business. EDB had 274 employees in other non – electricity services, but they didn't include in a total number of SEE DSOs employees.

Taking individually, as shown in the following Figure, the largest increase in the number of employees in 2015 compared to 2012 has happened in OSHEE (+43,1%), mostly because of high increase in the number of employees in the supply business (around 3,8 times), while the largest decrease was in HEP (-15,2%) then in EVNM (-14,8%) and KEDS (-7%). Data on number of employees in CEDIS in the period 2008 – 2015 were not available, but CEDIS submitted the data for 2016 which were then used for the whole period.

The trend of change in number of employees in SEE DSOs in the period 2008 – 2015 is shown in the Figure 19.7 in the Appendix.

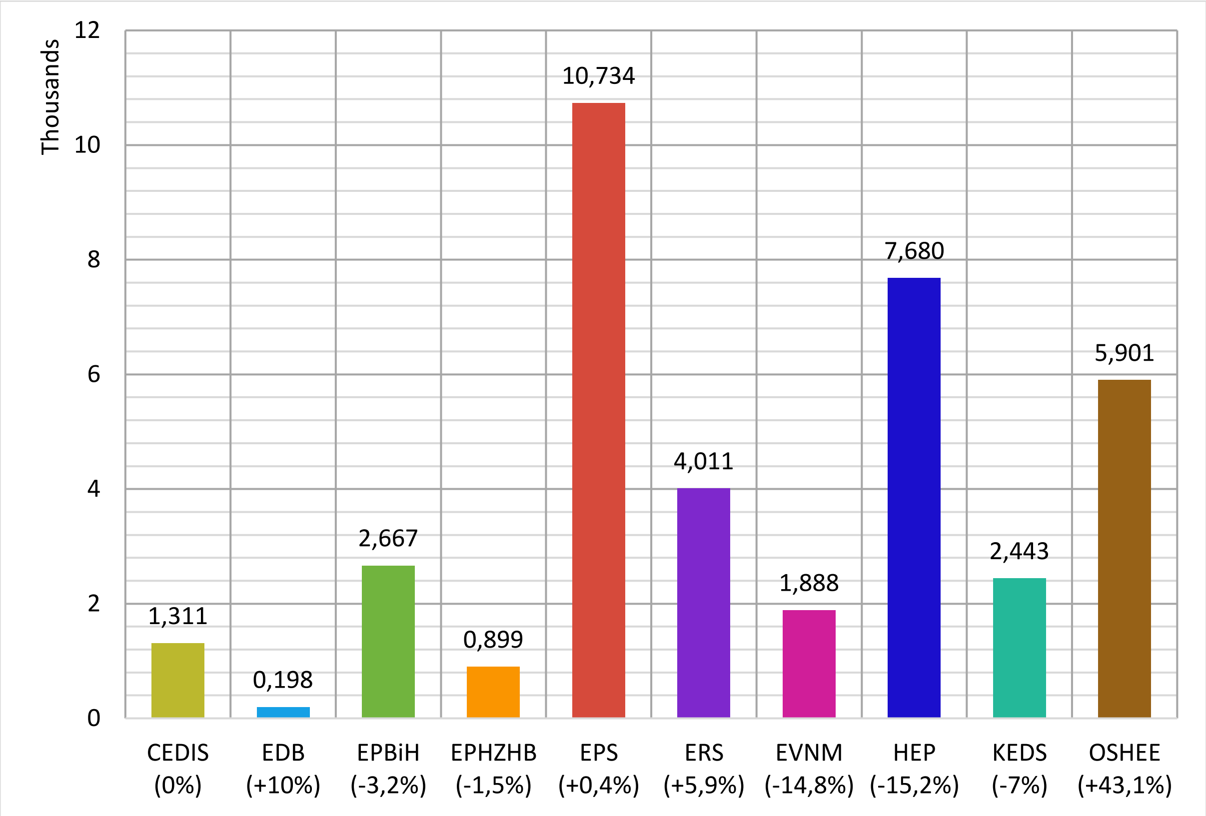


Figure 3.45 Number of employees in SEE DSOs in 2015

3.14 DISTRIBUTED GENERATION DATA

In line with EU energy policy targets, as well as national energy strategies, there has been a large increase in the number of distributed generation projects in SEE in the last few years, as shown in the following Figure. At the end of 2015, there were 799,629 MW of distributed generation installed capacity in the region and that is an increase of 77,3% compared to 2012. Most of it is installed in Albania (211,808 MW), BiH (total of 179,964 MW, with the largest contribution of EPBiH (113,305 MW)) and Croatia (153,722 MW). In Croatia was the highest increase in this value in 2015 compared to 2012: by 157,6%. All DSOs, except KEDS and EDB, reported a large increase of this values compared to 2012.

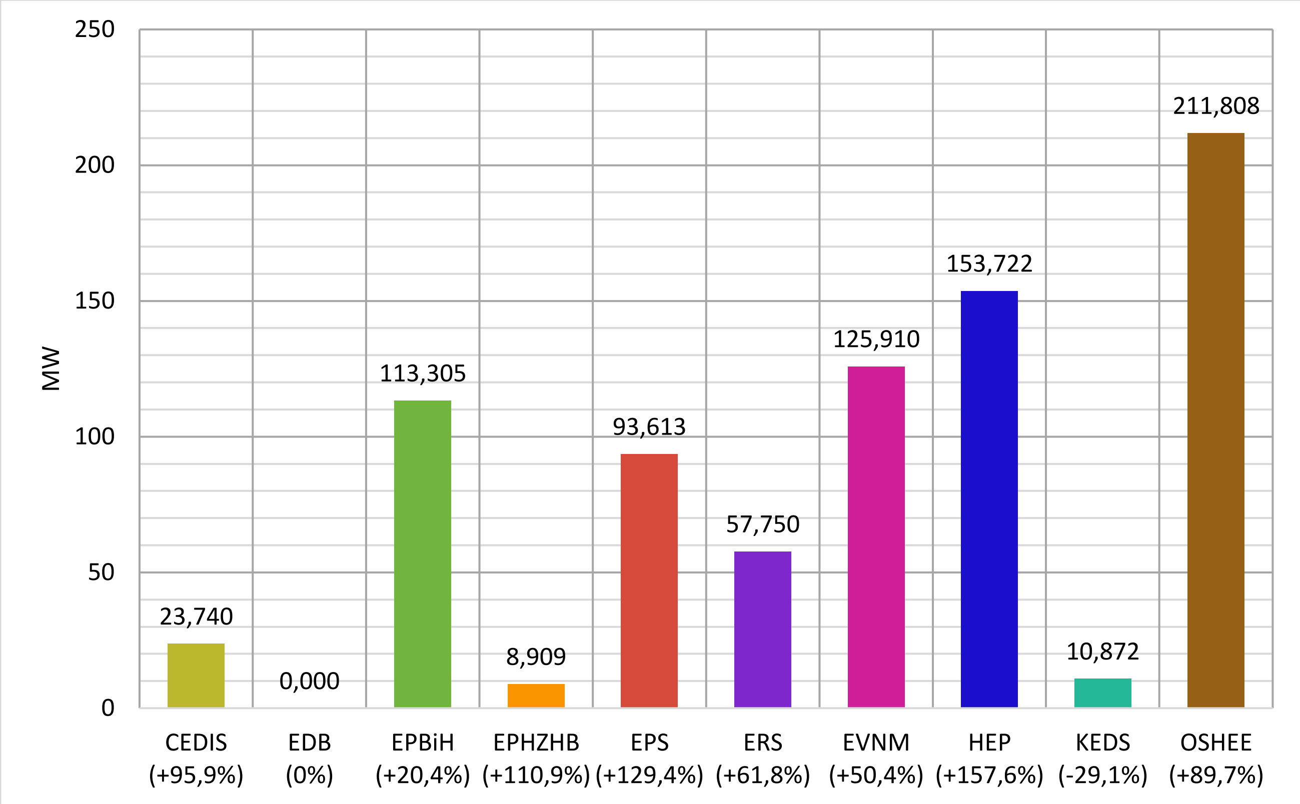


Figure 3.46 Distributed generation installed capacity in SEE DSOs in 2015

Figure 19.85 in the Appendix shows all collected data on the distributed generation installed capacity in SEE DSOs in the period 2008 – 2015.

The largest portion of distributed generation capacity was installed in hydropower plants (65,5%). Solar power plants came on the second place with the share of 10,5%, followed by the wind farms that are covering 5,7% of total installed distribution generation capacity in the region, as shown in the following Figure. The share of distributed generation capacity from biomass increased in 2015 compared to 2012 by 2,7%, with the share of 4,3% in 2015.

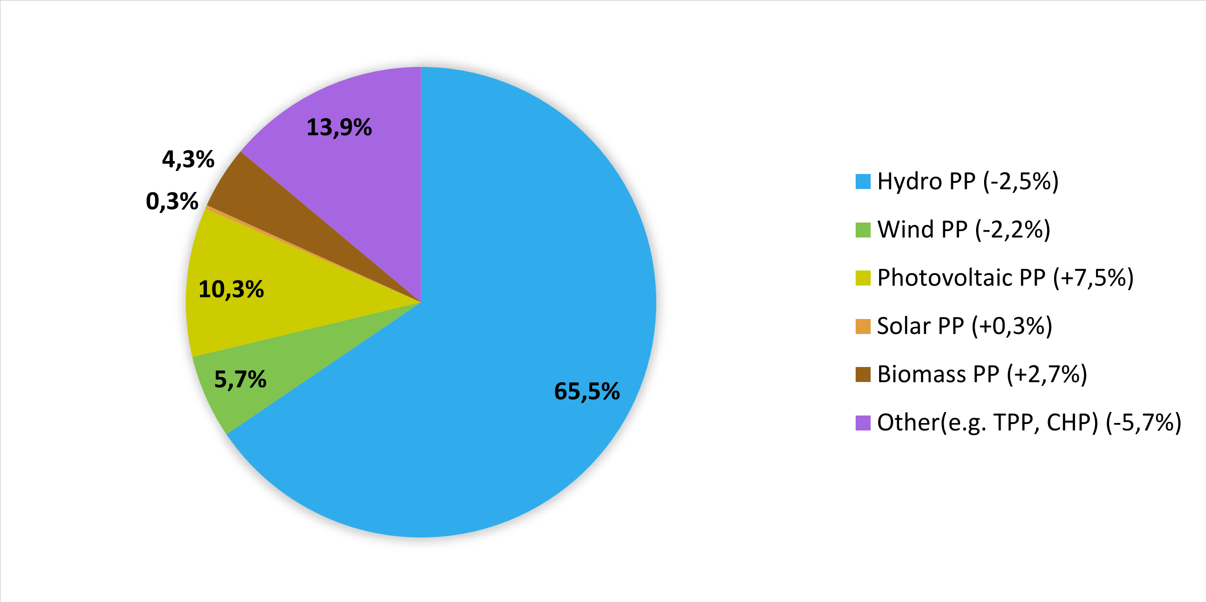


Figure 3.47 Installed capacity shares of each DG type in SEE DSOs in 2015

As shown in the following Figure, most of the distributed generation capacity in the region is connected to the medium voltage network (93%). Only Croatian HEP have significant distributed generation capacity (44,199 MW) connected to the low voltage network (with the large increase by 17,9 times in 2015 compared to 2012), which assumes 75,9% of all distributed generation capacities connected to the low voltage network in the region in 2015. This is due to the high increase of incentivized photovoltaic installations with the status of eligible producers (in the next 12 or even 14 years).

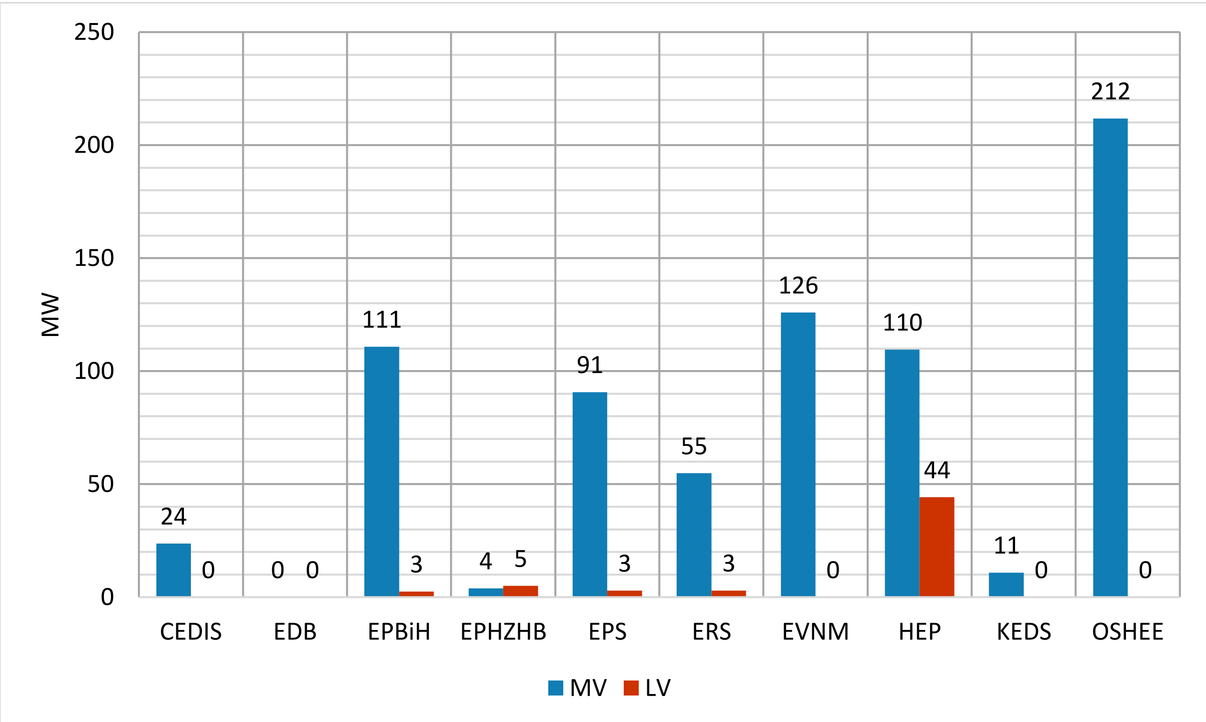


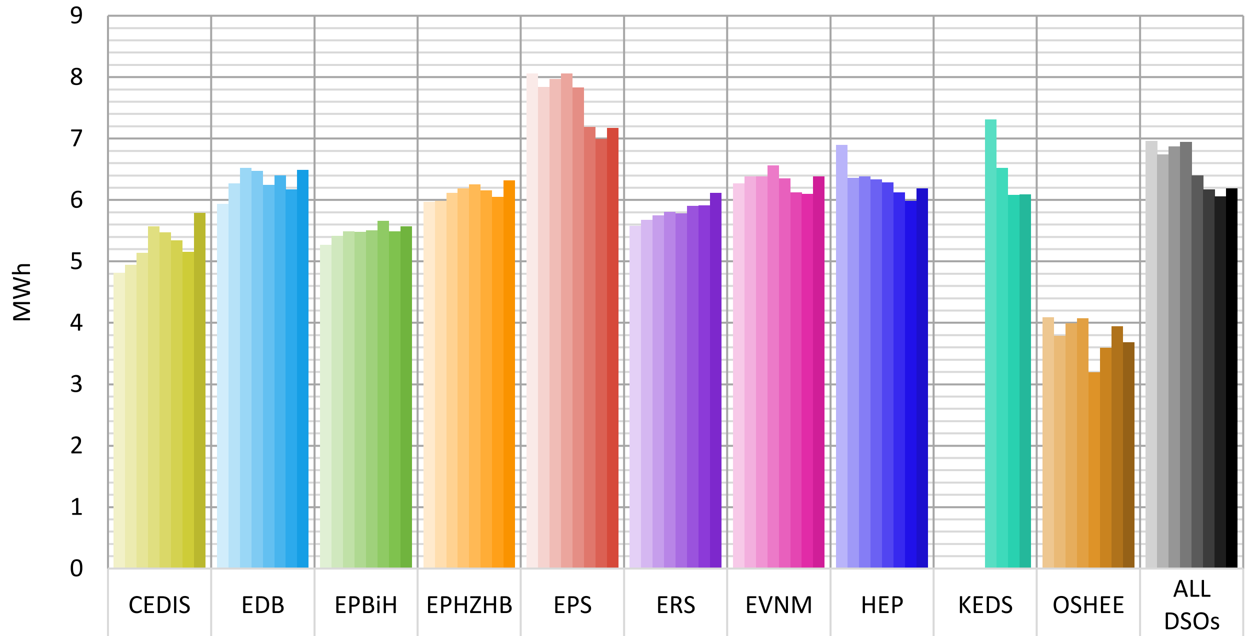
Figure 3.48 Capacity of distributed generation connected to MV and LV network in SEE DSOs in 2015

4 GENERAL BENCHMARKING INDICATORS

4.1 ELECTRICITY DELIVERED PER METERING POINT

One of the most important DSO benchmarking indicators is electricity delivered per each metering point. In the first edition of SEE DSO Benchmarking Study (2008 – 2012) there was an indicator on electricity delivered per each consumer, but in the most DSOs number of consumers was not available.

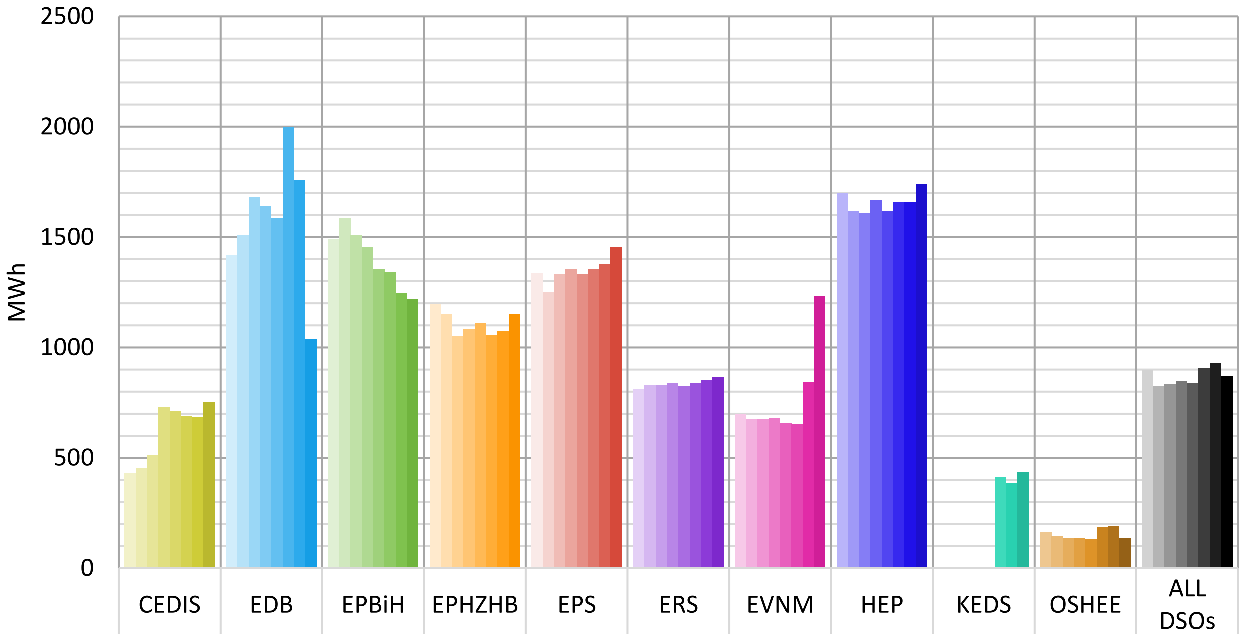
The following Figure shows that in the SEE DSOs in 2015 this indicator was between 3,68 MWh/metering point in OSHEE and 7,17 MWh/metering point in EPS. The average electricity delivered per each metering point in the region in 2015 was 6,19 MWh/metering point. Compared to 2008, it dropped by 11,06%, but in 2014/2015 it began to grow again in the most of SEE DSOs.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	4,81	5,93	5,27	5,97	8,06	5,58	6,27	6,89	0	4,09	6,96
2009	4,94	6,27	5,41	5,98	7,84	5,67	6,38	6,36	0	3,79	6,74
2010	5,14	6,52	5,49	6,11	7,97	5,75	6,38	6,38	0	3,99	6,87
2011	5,57	6,47	5,48	6,19	8,06	5,8	6,56	6,33	0	4,07	6,94
2012	5,47	6,24	5,5	6,25	7,83	5,78	6,35	6,28	7,31	3,19	6,4
2013	5,34	6,4	5,66	6,15	7,19	5,9	6,12	6,12	6,52	3,59	6,17
2014	5,15	6,17	5,49	6,05	6,99	5,91	6,1	5,98	6,08	3,94	6,06
2015	5,79	6,49	5,57	6,32	7,17	6,11	6,38	6,19	6,09	3,68	6,19

Figure 4.1 Electricity delivered per metering point in SEE DSOs in the period 2008 - 2015

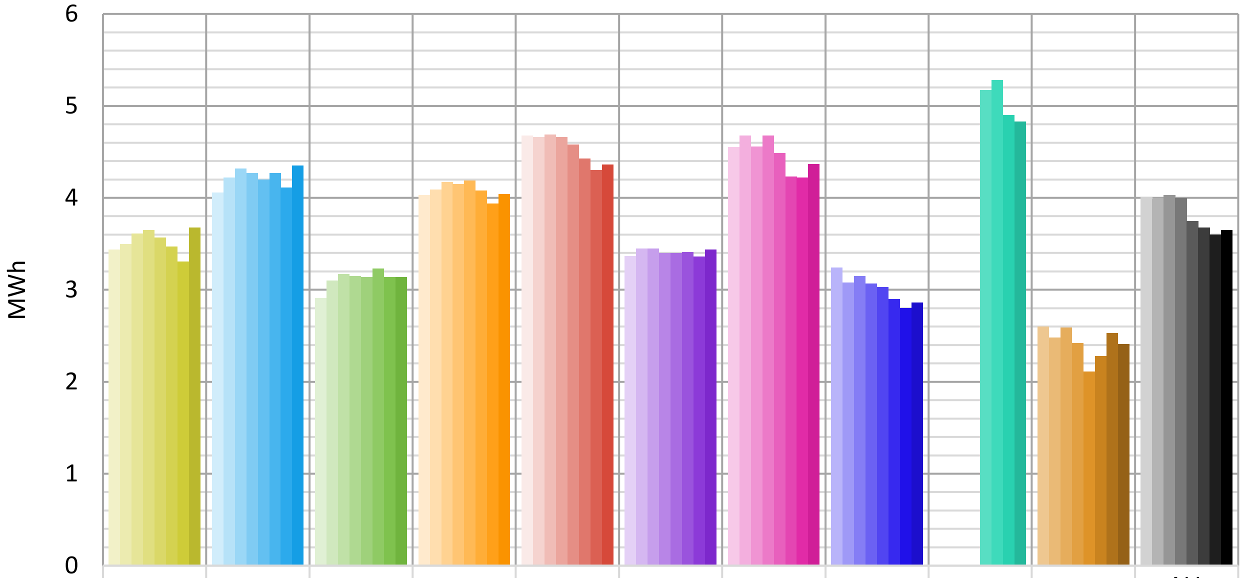
Industrial consumption category is mostly connected to the medium voltage. The following Figure shows that the average electricity delivered per metering point at the MV level in SEE in 2015 is 871 MWh, with the range from 135 MWh in KEDS to 1.738 MWh in HEP. It shows growing trend in most of SEE DSOs in the last few years, except in EDB, EPBiH, and OSHEE. At the same time, total amount of electricity delivered in all SEE DSOs is in decline.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	429	1420	1491	1198	1335	811	696	1699	0	165	897
2009	455	1511	1586	1150	1249	828	676	1616	0	145	824
2010	511	1679	1507	1050	1330	831	673	1610	0	137	833
2011	729	1641	1453	1081	1355	837	679	1667	0	135	846
2012	712	1588	1357	1110	1334	825	657	1616	0	133	838
2013	689	2000	1340	1057	1356	839	651	1659	413	187	907
2014	683	1757	1244	1076	1378	850	842	1660	386	191	929
2015	754	1037	1218	1153	1454	864	1234	1738	436	135	871

Figure 4.2 Electricity delivered per metering point at the medium voltage level in SEE DSOs in the period 2008 - 2015

The following Figure shows that the average electricity delivered to the household in SEE is 3.65 MWh/year, with the range from 2,41 MWh in OSHEE to 4,83 MWh in KEDS.

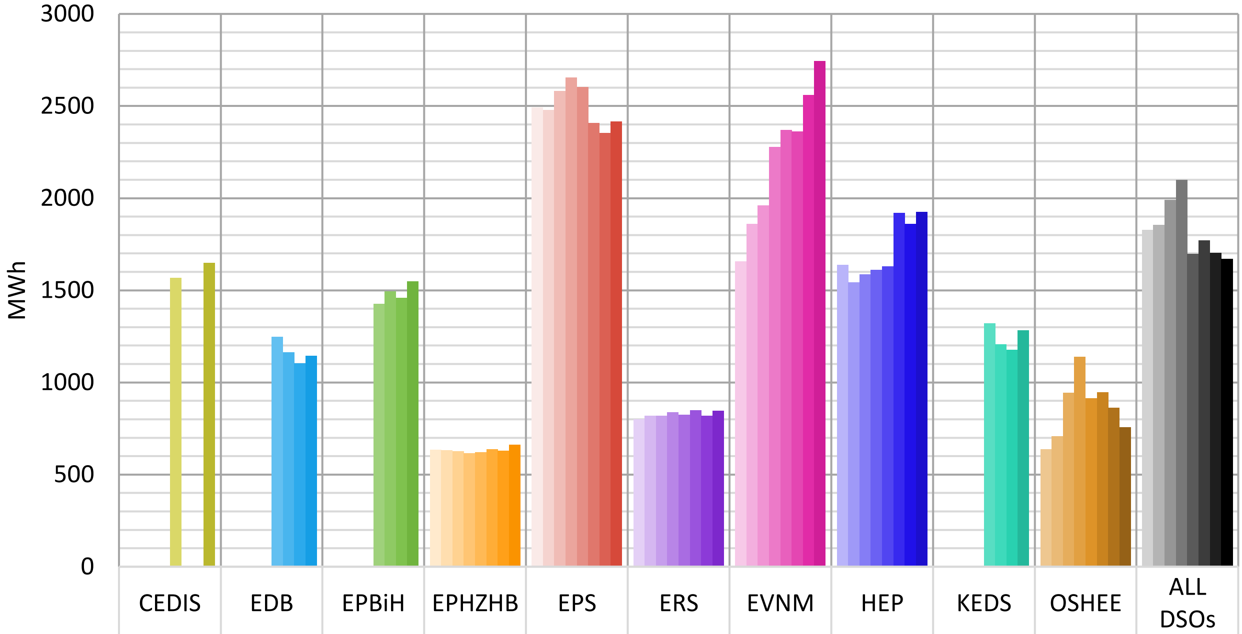


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	3,44	4,06	2,91	4,03	4,68	3,37	4,55	3,24	0	2,6	4,01
2009	3,5	4,22	3,1	4,09	4,66	3,45	4,68	3,08	0	2,48	3,99
2010	3,61	4,32	3,17	4,17	4,69	3,45	4,56	3,15	0	2,59	4,03
2011	3,65	4,27	3,15	4,15	4,66	3,4	4,68	3,07	0	2,42	4
2012	3,57	4,2	3,14	4,19	4,58	3,4	4,49	3,03	5,17	2,11	3,75
2013	3,47	4,27	3,23	4,08	4,43	3,41	4,23	2,9	5,28	2,28	3,68
2014	3,31	4,11	3,14	3,94	4,3	3,36	4,22	2,8	4,9	2,53	3,6
2015	3,68	4,35	3,14	4,04	4,36	3,44	4,37	2,86	4,83	2,41	3,65

Figure 4.3 Electricity delivered per household in SEE DSOs in the period 2008 – 2015

4.2 ELECTRICITY DELIVERED PER EMPLOYEE

The following Figure shows the electricity delivered per each employee in SEE DSO in the period 2008 – 2015. The trends are different among the DSOs, while the values in 2015 are in the range from 661 MWh/employee in EPHZHB to 2745 MWh/employee in HEP, in average 1671 MWh/employee. On the regional level, in the period 2008 – 2011 there was a strong increase, followed by the decrease in 2012-2015.

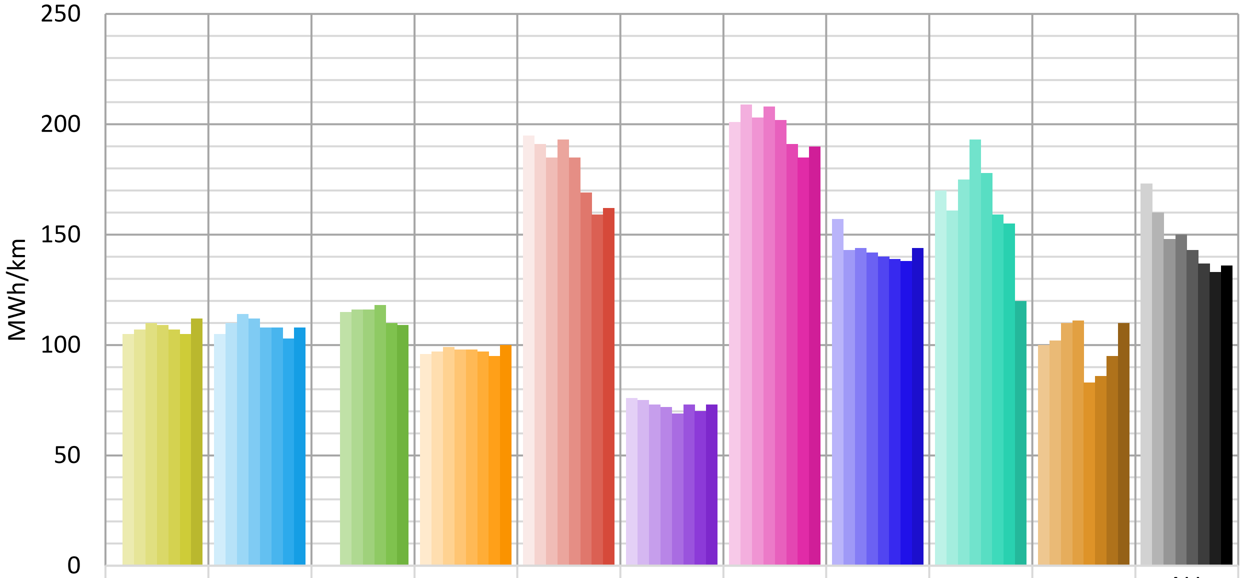


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	0	0	0	634	2492	799	1656	1639	0	639	1827
2009	0	0	0	632	2480	820	1861	1543	0	709	1856
2010	0	0	0	627	2581	819	1960	1586	0	945	1990
2011	0	0	0	617	2655	838	2279	1610	0	1140	2100
2012	1568	1247	1427	622	2604	825	2371	1630	1320	915	1698
2013	0	1165	1494	637	2407	850	2361	1921	1208	948	1770
2014	0	1103	1459	630	2354	818	2561	1860	1178	863	1704
2015	1649	1146	1549	661	2417	846	2745	1925	1283	756	1671

Figure 4.4 Electricity delivered per employee in SEE DSOs in period 2008 – 2015

4.3 ELECTRICITY DELIVERED PER NETWORK LENGTH

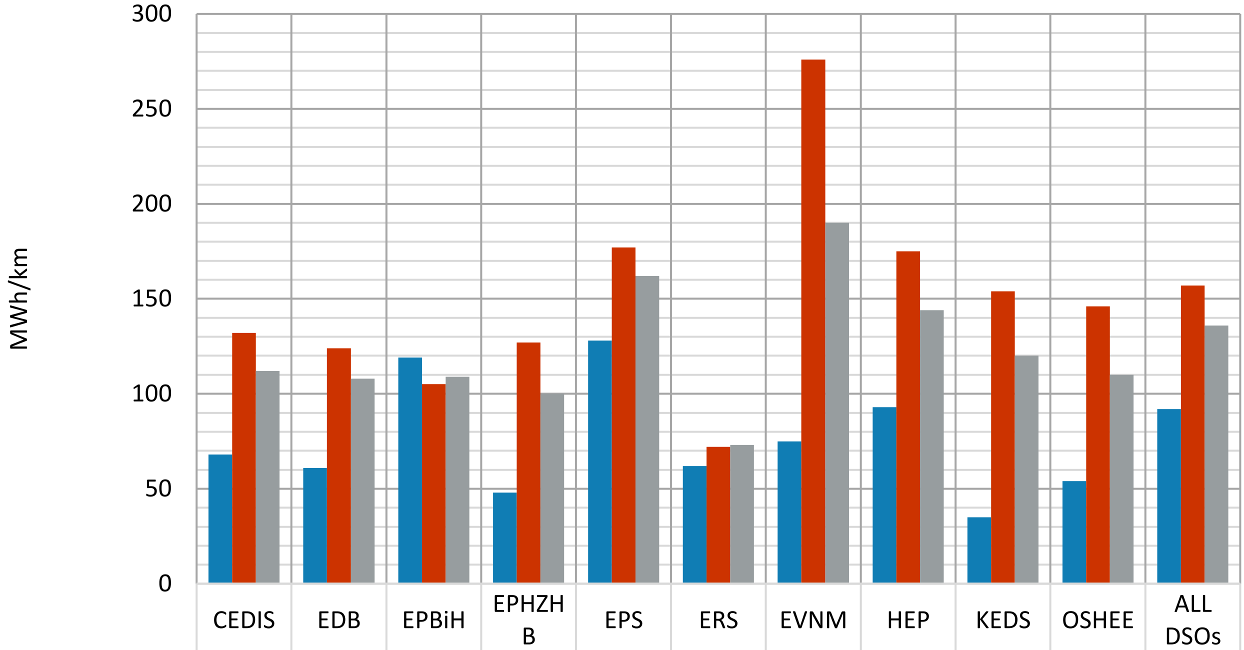
Electricity delivered per km of the distribution network (including all voltage levels) is shown in the following Figure. This indicator strongly depends on the distribution area shape and size, as well as geographical topology and disperse of the consumers. That’s why there is a large variety of values, between 73 MWh/km in ERS and 190 GWh/km in EVNM. The average value in the region is 136 MWh/km and it decreased by 21,4% in 2015 compared to 2008.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	0	105	0	96	195	76	201	157	170	100	173
2009	105	110	0	97	191	75	209	143	161	102	160
2010	107	114	115	99	185	73	203	144	175	110	148
2011	110	112	116	98	193	72	208	142	193	111	150
2012	109	108	116	98	185	69	202	140	178	83	143
2013	107	108	118	97	169	73	191	139	159	86	137
2014	105	103	110	95	159	70	185	138	155	95	133
2015	112	108	109	100	162	73	190	144	120	110	136

Figure 4.5 Electricity delivered per distribution network length at different voltage levels in SEE DSOs in the period 2008 - 2015

Electricity delivered per MV and per LV network length is notably different across the DSOs. Macedonian EVNM has higher values than the other DSOs. In average, electricity delivered per LV network length is 65 MWh/km higher than electricity delivered per MV network length, or 41,4%. The exception is found in EPBiH, where electricity delivered per MV network length is higher than per LV network length.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
MV	68	61	119	48	128	62	75	93	35	54	92
LV	132	124	105	127	177	72	276	175	154	146	157
All categories	112	108	109	100	162	73	190	144	120	110	136

Figure 4.6 Electricity delivered per distribution network length at different voltage levels in SEE DSOs in 2015

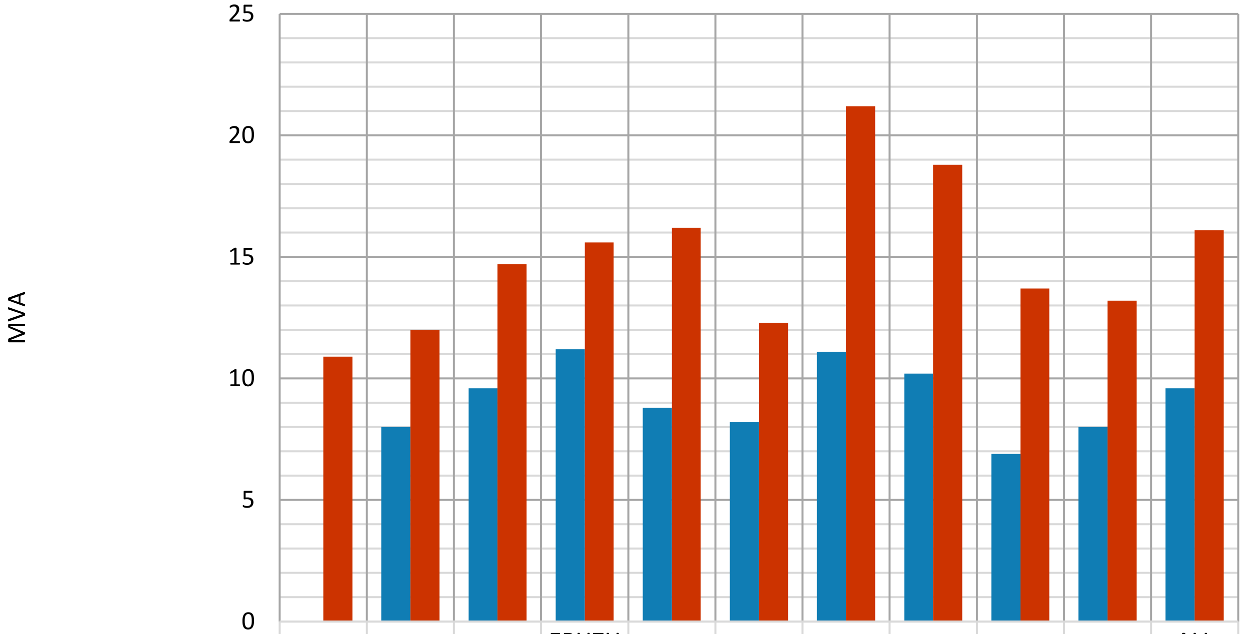
4.4 TRANSFORMER CAPACITY PER SUBSTATION

A total number of substations and transformers has been divided into two groups:

1. X/MV substations and transformers (i.e. 110/10(20) kV; 110/20 kV; 110/10 kV; 35/20 kV; 35/10 kV; 35/6 kV) and
2. MV/LV substations and transformers (i.e. 35/0,4 kV; 20/0,4 kV; 10/0,4 kV).

The following Figure shows the average capacity of X/MV substations and transformers in the region. KEDS values are calculated based on 35/10 kV and 35/6 kV data, since input data do not comprise of 110/10 kV and 110/20 kV substations and transformers, while the data for 35/20 kV were not available. Data for number of transformers in CEDIS were also not available.

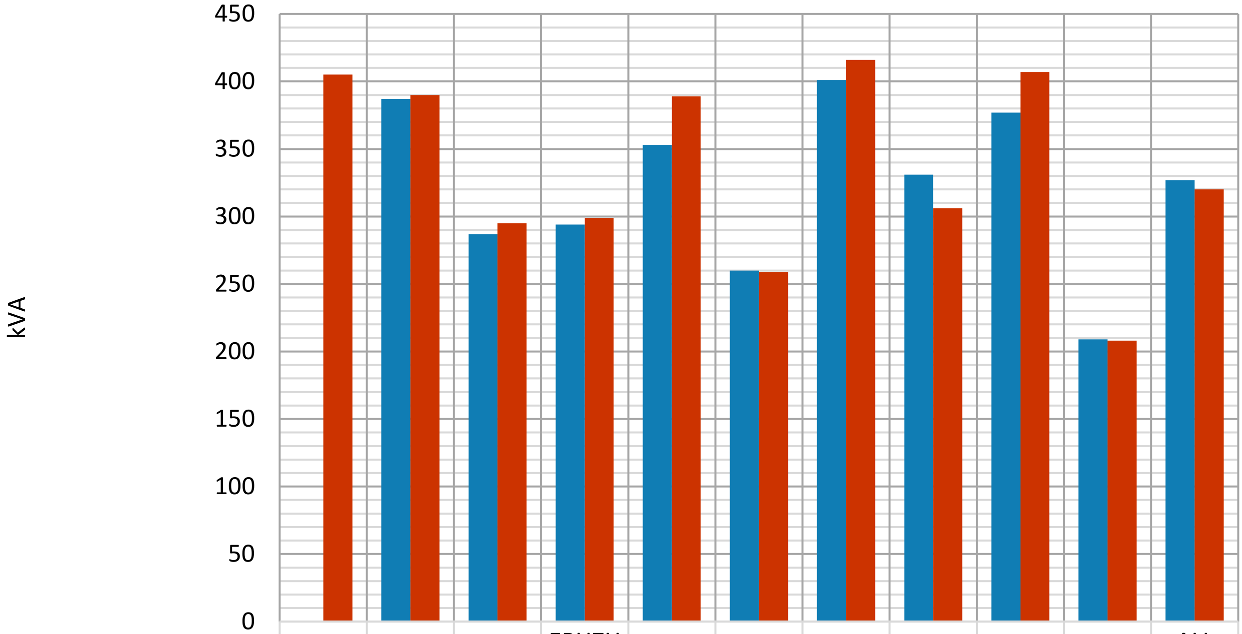
SEE DSOs had the average capacity of X/MV substations in the range between 10,9 MVA (CEDIS) and 21,2 MVA (EVNM) with the average of 16,1 MVA, while the average capacity of X/MV transformers is in the range between 8 MVA (EDB and OSHEE) and 11,2 MVA (EPHZHB) with the average of 9,6 MVA.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
MVA/TRANSFORMER	0	8	9,6	11,2	8,8	8,2	11,1	10,2	6,9	8	9,6
MVA/SUBSTATION	10,9	12	14,7	15,6	16,2	12,3	21,2	18,8	13,7	13,2	16,1

Figure 4.7 Average capacity of 110/10(20); 110/20 kV; 110/10 kV; 35/20 kV; 35/10 kV; 35/6 kV substations and transformers in SEE DSOs in 2015

The average capacity of MV/LV substations in the region, as can be seen in the following Figure, is 320 kVA and it is in the range between 208 kVA (OSHEE) and 416 kVA (EVNM). The average capacity of MV/LV transformers in the region are like for the substations: the average value is 327 kVA and it is in the range between 209 kVA (OSHEE) and 401 kVA (EVNM).



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
MVA/TRANSFORMER	0	387	287	294	353	260	401	331	377	209	327
MVA/SUBSTATION	405	390	295	299	389	259	416	306	407	208	320

Figure 4.8 Average capacity of MV/LV substations and transformers in SEE DSOs in 2015

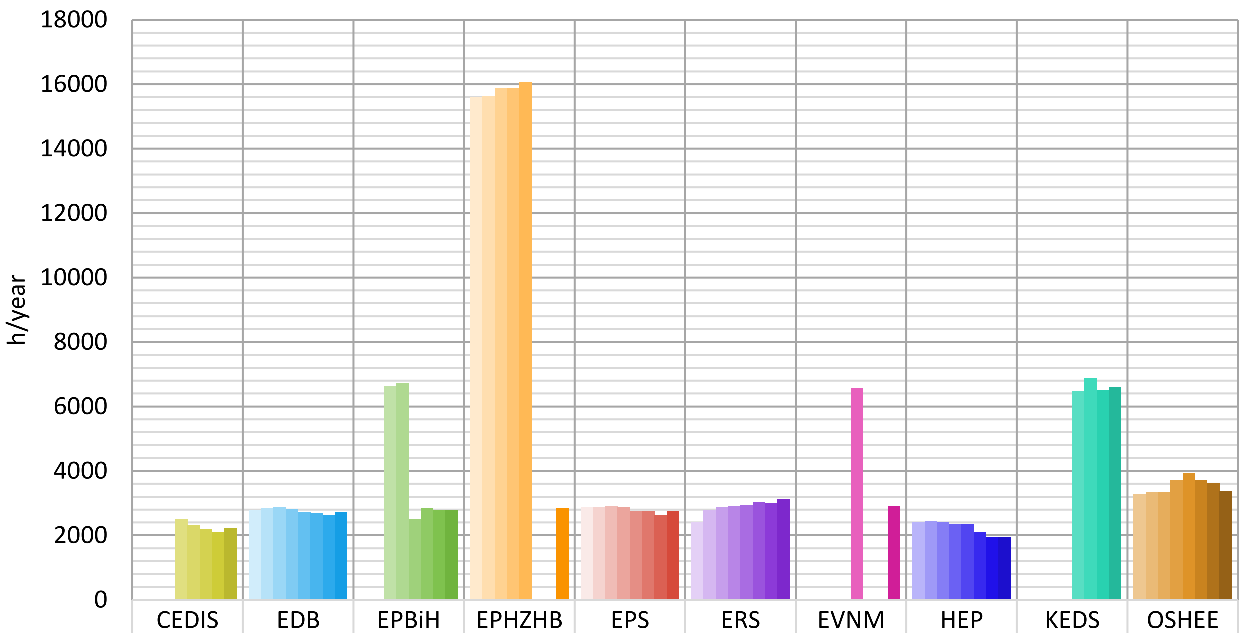
4.5 USAGE OF SUBSTATION INSTALLED CAPACITY

It has always been a question for power system planners how to optimize number of transformations and its loading in the system. In that sense, it is interesting to measure the level of transformers loadings (usage), in other words, the ratio between electricity delivered per transformer and its installed capacity.

In this report, the value of electricity delivered per X/MV transformer comprises electricity delivered to consumers at 35 kV. This is because 35 kV consumption has not been reckoned separately, instead this value is included in the value of electricity delivered to MV consumers (Figure 19.98).

In the calculation of indicator, it was assumed that all losses are passing through X/MVs substations, and technical and non-technical losses on HV and MV network (i.e. without MV/LV substations and LV network) equal 25% of total losses. An indicator of usage of MV/LV substations is equal to the ratio between the sum of total electricity delivered on LV and 75% of total losses and installed capacity of all MV/LV substations (i.e. TS 35/0,4 kV; TS 20/0,4 kV; TS 10/0,4 kV) in the distribution.

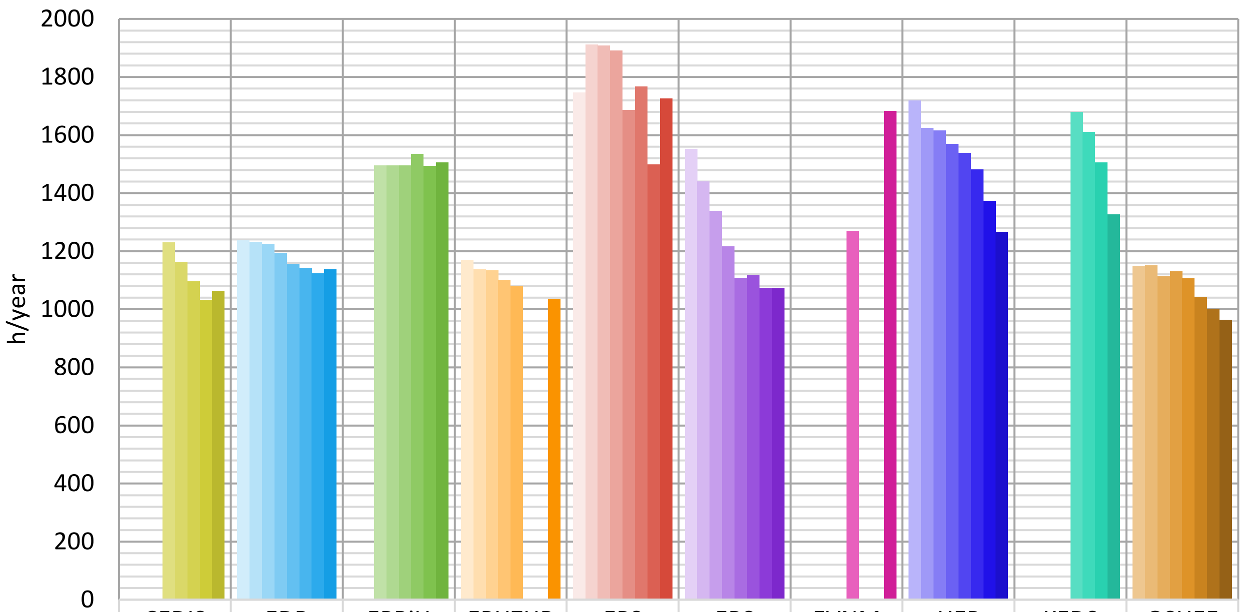
As shown on the following Figure, the value of usage of X/MV transformer installed capacities in the region in 2015 varies significantly in the range between 1.947 h/year (HEP) and 3385 h/year (OSHEE). The trend of usage of X/MV transformer installed capacities in most of SEE DSOs in the period 2012 – 2015 is falling. Values for KEDS are too high, because the data of installed capacity of X/MV transformers haven't been completely available (because it is TSO asset), but also for EPHZHB because the sum capacity of X/MV transformers haven't been completely available until 2015. From the same reason, the values for usage of X/MV transformer installed capacity in EVNM in 2012 were also too high.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	2789	0	15592	2881	2417	0	2411	0	3290
2009	0	2845	0	15643	2876	2779	0	2425	0	3328
2010	0	2889	6639	15886	2903	2875	0	2416	0	3338
2011	2516	2823	6719	15875	2867	2903	0	2341	0	3703
2012	2329	2726	2510	16065	2750	2934	6571	2345	6488	3931
2013	2189	2675	2840	0	2734	3033	0	2097	6867	3723
2014	2108	2617	2780	0	2636	2997	0	1946	6501	3614
2015	2231	2725	2775	2838	2739	3112	2898	1947	6596	3385

Figure 4.9 Usage of X/MV transformer installed capacity in SEE DSOs in the period 2008 - 2015

For MV/LV substations this indicator also varies significantly, as shown on the following Figure. In 2015, it is between 964 h/year (OSHEE) and 1.726 h/year (EPS). The average value is 1.278 h/year, with falling trend in the period 2012 – 2015, except in EPS (available data on transformer capacity in EPS need to be rechecked, regarding large changes from 2012 to 2015), and EVNM. In these two cases electricity delivered was growing slower than installed capacity of MV/LV transformers, as shown in the Figure 3.15 and Figure 19.32, respectively.



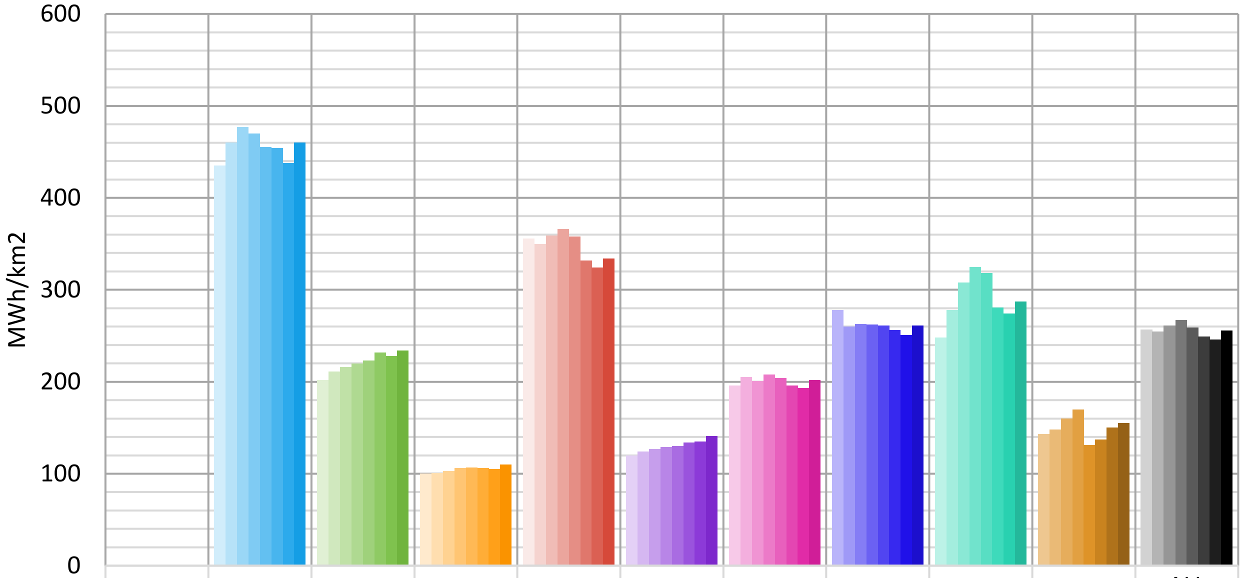
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	1237	0	1170	1746	1553	0	1719	0	1149
2009	0	1232	0	1137	1912	1440	0	1625	0	1152
2010	0	1226	1495	1134	1908	1338	0	1616	0	1114
2011	1230	1194	1496	1101	1891	1216	0	1570	0	1131
2012	1163	1157	1495	1079	1686	1109	1270	1538	1680	1106
2013	1097	1143	1535	0	1767	1118	0	1482	1611	1041
2014	1031	1123	1494	0	1498	1074	0	1374	1506	1001
2015	1064	1138	1506	1034	1726	1073	1683	1267	1327	964

Figure 4.10 Usage of MV/LV transformer installed capacity in SEE DSOs in the period 2008 - 2015

4.6 ELECTRICITY DELIVERED PER SUPPLY AREA SIZE

As described in Chapter 3, regional DSOs operate in different supply area sizes and shapes.

Due to its very small size, EBD is having the largest electricity delivered per supply area size in 2015 – 460 MWh/km^2. The regional average is almost twice lower, around 256 MWh/km^2, while the lowest level of electricity delivered per supply area size is in EPHZHB, around 110 MWh/km^2. Accordingly, the ratio between the lowest and the highest level of electricity delivered per supply area size is more than 4. The trend of electricity delivery per supply area size in the region in the period 2012 - 2015, as shown in the following Figure, has been falling slightly till 2014, but then it started to grow. Considering this value in each DSO, the growth of electricity delivered to final customers in 2015 compared to 2012 has been reported in 7 DSOs, in the range between 0,2% (HEP) and 18,2% (OSHEE). In the same period, the decrease of electricity delivered to the final customers happened in KEDS, EPS, and EVNM, in the range between -1,3% (EVNM) and -9,6% (KEDS). Electricity delivery in each DSOs in the period 2008 – 2015 is shown in Figure 3.15



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	0	435	202	100	356	120	196	278	248	143	257
2009	0	460	211	101	350	124	205	260	278	148	255
2010	0	477	216	103	359	127	201	263	308	160	261
2011	0	470	220	106	366	129	208	262	325	170	267
2012	0	455	223	107	358	130	204	261	318	131	259
2013	0	454	232	106	332	134	196	256	281	137	249
2014	0	438	228	105	324	135	193	251	274	150	246
2015	0	460	234	110	334	141	202	261	287	155	256

Figure 4.11 Electricity delivered per supply area size in SEE DSOs in the period 2008 - 2015

4.7 NETWORK LENGTH PER SUPPLY AREA SIZE

In addition to the previous indicator, it is interesting to measure the ratio between network length (owned by the DSO) and supply area size. In SEE DSO the average network length per supply area size is 1,9 km/km^2. Network length per supply area size ranges from 1,06 km/km^2 in EVNM to 4,3km/km^2 in EDB. Low value in EVNM is a consequence of its relatively low network length, while high value in EDB is a consequence of its small supply area size. The value in EDB is more than twice higher than average value in the region.

As expected, in most DSOs LV network length per supply area size is more than twice larger than MV network length per supply area size, except in EPHZHB, EVNM, HEP and OSHEE (Figure 4.13).

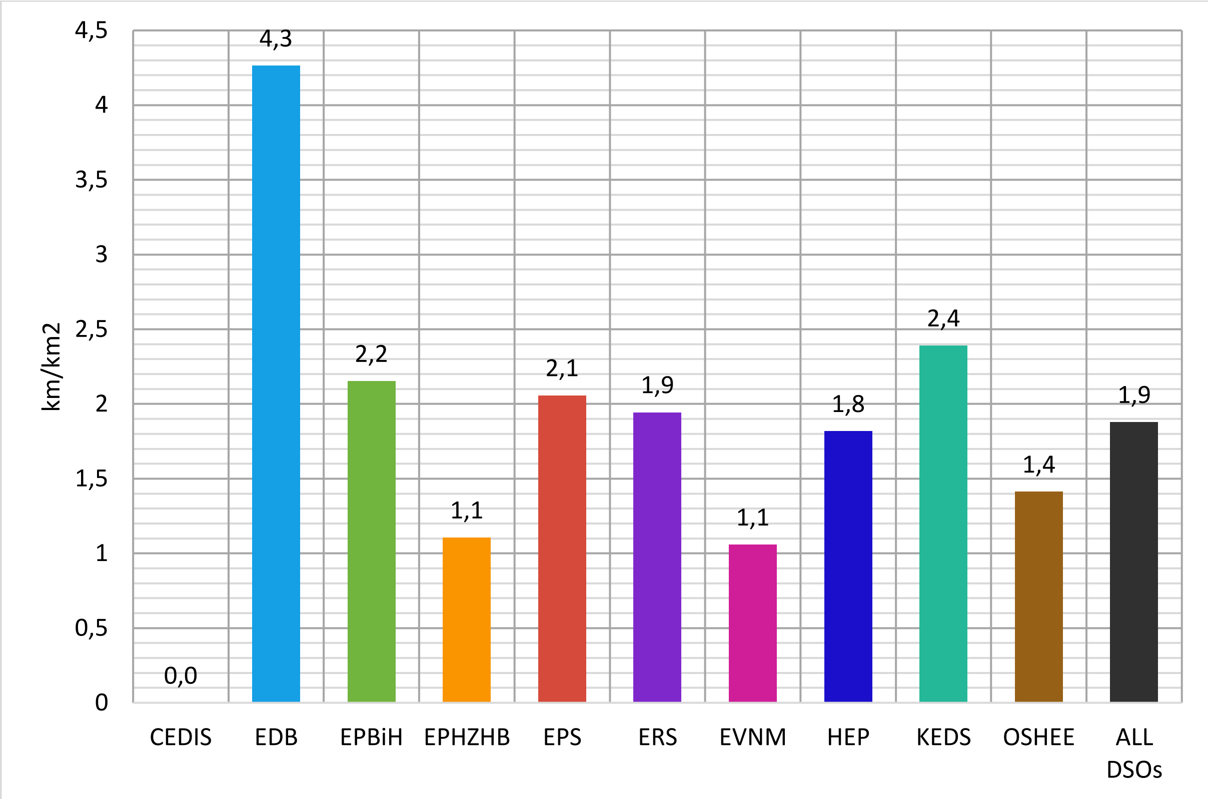


Figure 4.12 Distribution network length (owned by DSO) per supply area size in SEE DSOs in 2012

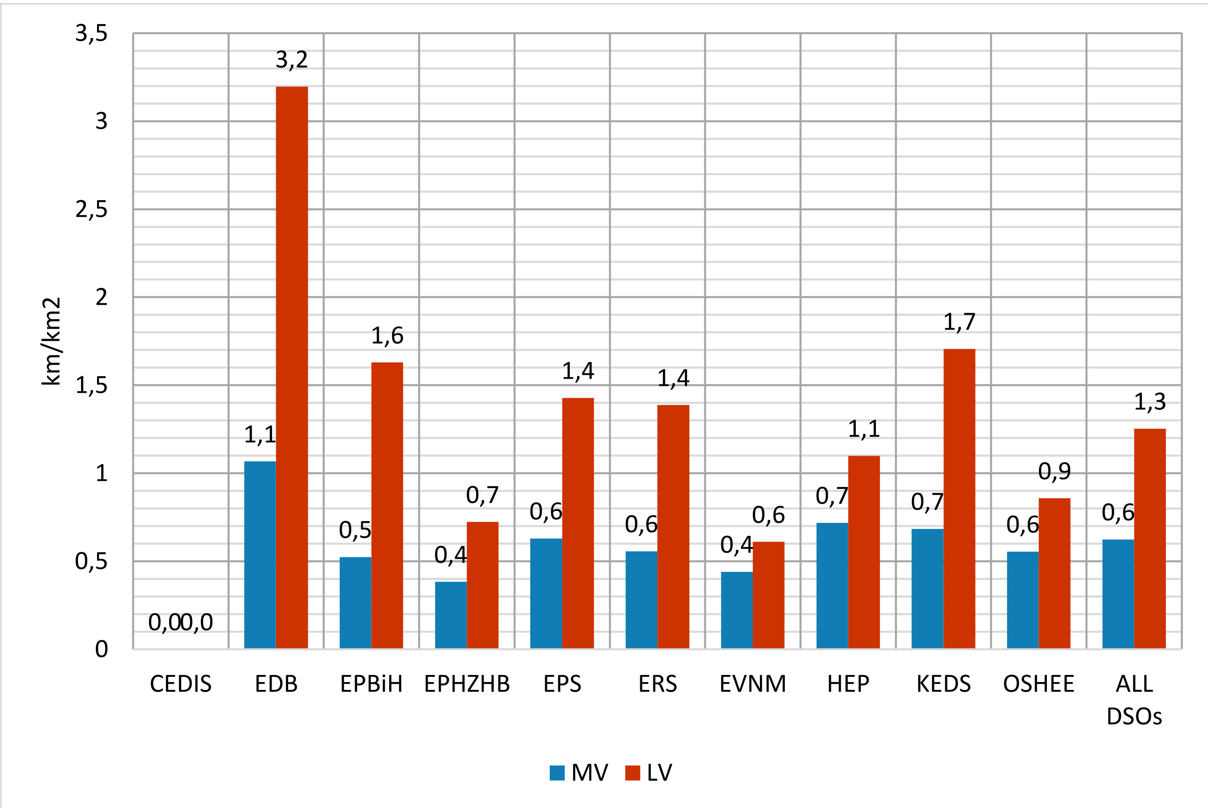
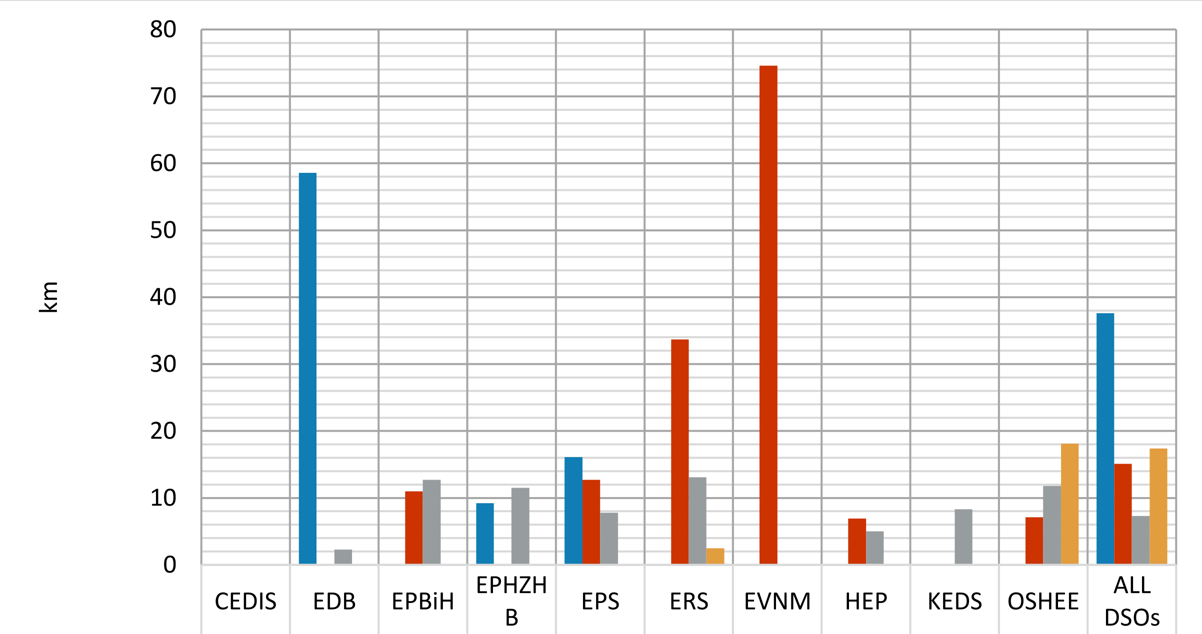


Figure 4.13 MV and LV network length per supply area size in SEE DSOs in 2012

4.8 AVERAGE FEEDER LENGTH

Most common types of MV feeders: 35 kV, 20 kV, 10 kV and 6 kV are shown on the following figure. The average length of 35 kV feeders in EDB is 58,6 km and it is by far the longest in the region. EPS has 16,1 km and EPHZHB 9,2 km, while other DSOs haven't provided data on number of 35 kV feeders.

The following Figure provides data on average MV feeders length in all DSOs except CEDIS (no data). EDB and KEDS values relate to 10 kV feeders only. In average, the longest (20 kV, 10 kV, and 6 kV) feeders in the region are found in EVNM (74,6 km – 20 kV) and in ERS (33,7 km – 20 kV). The range of average 20 kV feeder length is between 74,6 km (EVNM) and 6,9 km (HEP). Average value of 10 kV feeder length in the region is 7,3 km with the values between 2,3 km (EDB) and 13,1 km (ERS). EPBiH, EPS, ERS, and OSHEE have 6 kV feeders in their networks, but the length of 6 kV network in EPBiH and in EPS wasn't available (so, the average 6 kV feeders were set to zero in this report). On the other side, CEDIS reported the length of 6 kV network, but not the number of 6 kV feeders. Average 6 kV feeder length in ERS is 2,5 km and in OSHEE it is 18,1 km. Average values of each MV feeder length (35 kV, 20 kV, 10 kV and 6 kV) are given on the Figures 19.55 – 19.58 in the Appendix.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
MV (35 kV)	0	58,6	0	9,2	16,1	0	0	0	0	0	37,6
MV (20 kV)	0	0	11	0	12,7	33,7	74,6	6,9	0	7,1	15,1
MV (10 kV)	0	2,3	12,7	11,5	7,8	13,1	0	5	8,3	11,8	7,3
MV (6 kV)	0	0	0	0	0	2,5	0	0	0	18,1	17,4

Figure 4.14 Average MV feeder length in SEE DSOs in 2012

Average LV feeder length in 7 DSOs is 0,79 km with the longest LV feeders in HEP – 0,82 km on average. Average LV feeder length in the region in the period 2008 – 2015 is given on the 19.59 in the Appendix.

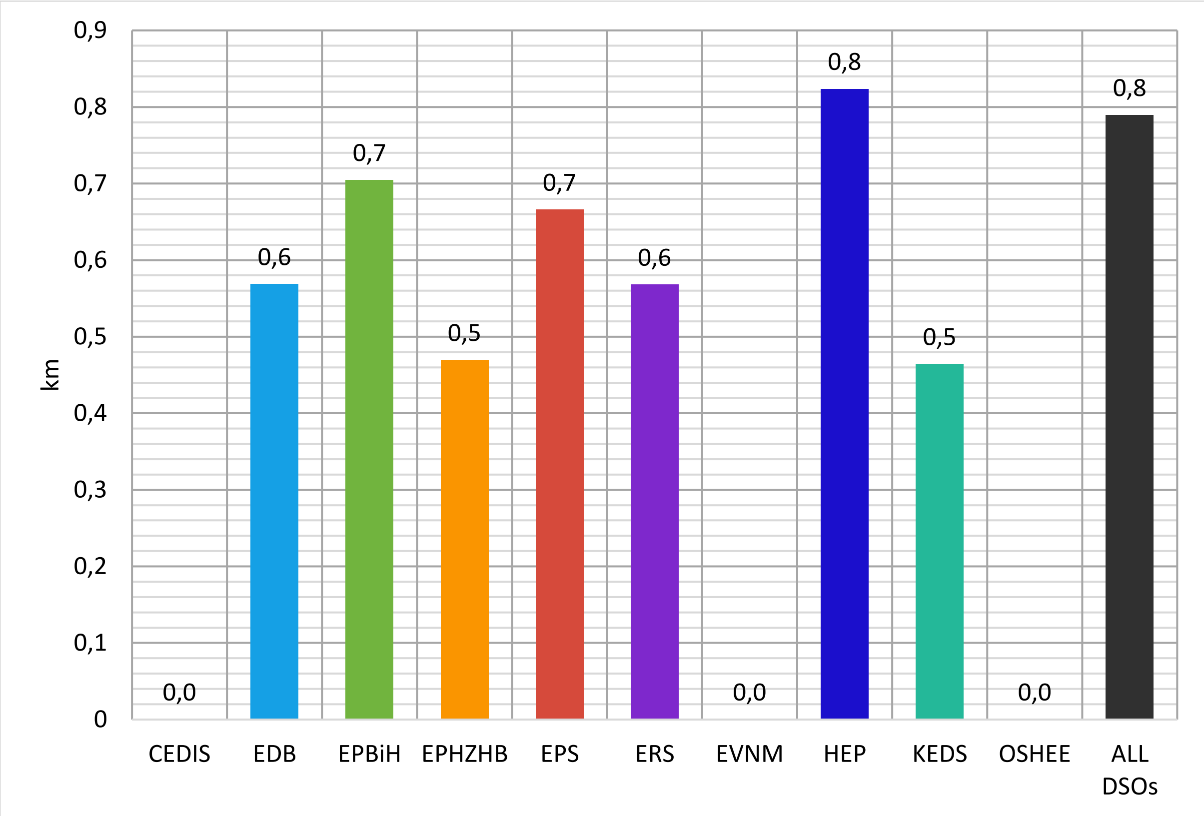


Figure 4.15 Average LV feeder length in SEE DSOs in 2012

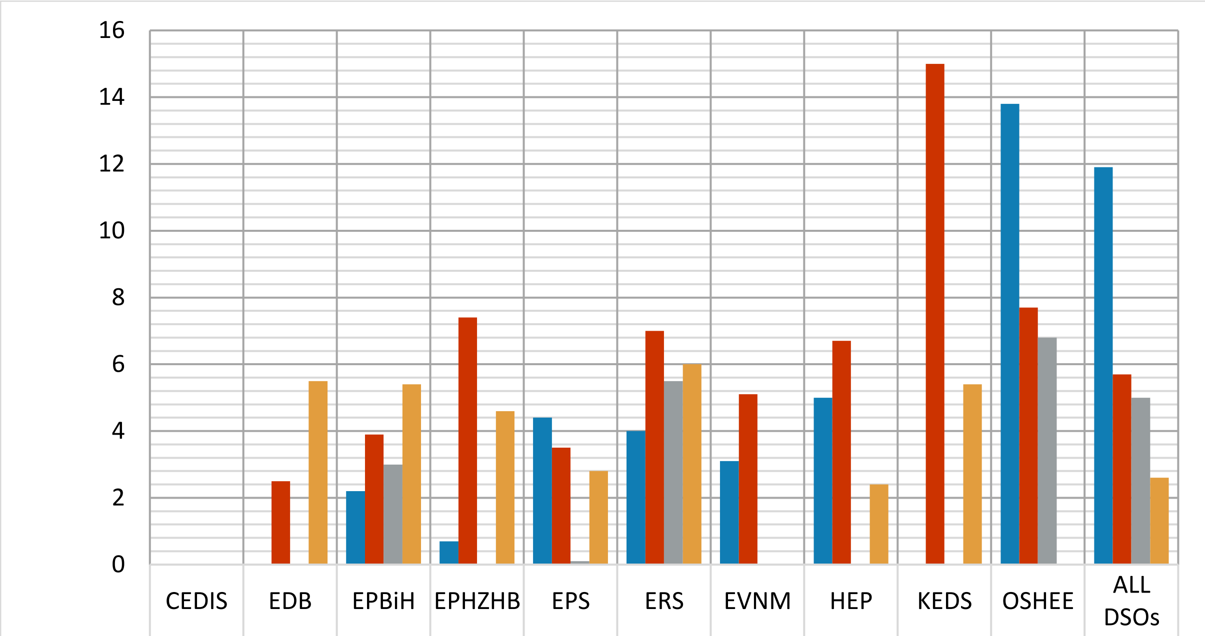
4.9 NUMBER OF FEEDERS PER SUBSTATIONS

Average number of each MV (20 kV, 10 kV and 6 kV) feeders per X/MV substation (i.e. 110/35/10(20), 110/20 kV, 110/10 kV, 110/10(20) kV, 35/20 kV, 35/10 kV, 35/6 kV) are calculated as a ratio between sum of all feeders at that voltage level and the number of each substation containing that feeder, as shown on the following Figure. Average number of LV (0,4 kV) feeders per MV/LV substation (i.e. 35/0,4 kV, 20/0,4 kV, 10/0,4 kV) in each SEE DSOs, is also shown on the following Figure.

Average number of 20 kV feeders per substation is in the range between 0,7 in EPHZHB and 13,8 in OSHEE, with the average of 11,9 for 7 DSOs. Average number of 10 kV feeders per substation is in the range between 2,5 in EDB and 15 in KEDS, with the average of 5,7 for 9 DSOs. Average number of 6 kV feeders per substation is 5,0 for 4 DSOs, in the range between 0,1 in EPS and 6,8 in OSHEE.

Average number of LV feeders per MV/LV substation is between 2,4 in HEP and 5,5 in EDB, with an average of 2,6 for 7 DSOs.

Average number of MV (20 kV, 10 kV, and 6 kV) feeders per X/MV substation and LV (0,4 kV) feeders per number of MV/LV substation in the period 2008 – 2015 are shown in the Appendix (Figure 19.51 - Figure 19.54).



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
20 kV	0	0	2,2	0,7	4,4	4	3,1	5	0	13,8	11,9
10 kV	0	2,5	3,9	7,4	3,5	7	5,1	6,7	15	7,7	5,7
6 kV	0	0	3	0	0,1	5,5	0	0	0	6,8	5
0,4 kV	0	5,5	5,4	4,6	2,8	6	0	2,4	5,4	0	2,6

Figure 4.16 Average number of MV (20 kV, 10 kV, and 6 kV) and LV (0,4 kV) feeders per X/MV and MV/LV substations respectively

5 CONTINUITY OF SUPPLY

Continuity of supply concerns interruptions in electricity supply. In other words, it focuses on the events during which the voltage at the supply terminals of a network user drops to zero or nearly (practically) zero. Various quality dimensions can describe continuity of supply. The ones most commonly used are the number of interruptions per year, unavailability (interrupted minutes per year) and energy not supplied per year.

Continuity of supply indicators are traditionally one of the important tools for making decisions in the management of distribution networks. According to the quality dimensions, regulatory instruments now mostly focus on accurately defined continuity of supply indicators of the frequency of interruptions, duration of interruptions and energy not supplied due to interruptions. These instruments normally complement incentive regulation, which (either in the form of price or revenue-cap mechanisms) is commonly used across Europe at present. Incentive regulation provides a motivation to increase economic efficiency over time. However, it also carries a risk that network operators could refrain from carrying out investments and proper operational arrangements for better continuity, in order to lower their costs and increase their efficiency. To account for this drawback in incentive regulation, many European regulators adopt regulatory instruments to maintain or improve the continuity of supply (6th CEER Benchmarking report on the quality of electricity and gas supply, 2016).

5.1 SAIDI, SAIFI, CAIDI, ENS

Within this subchapter four indicators are analyzed:

- SAIDI - System Average Interruption Duration Index - the average outage duration for each consumer supplied. SAIDI is measured in units of time, often minutes or hours. The values given here are divided into two groups: planned and unplanned interruptions. Also, SAIDI can be calculated per voltage level or at all voltage levels (the system as a whole). Here, SAIDI is calculated for unplanned and planned interruptions, both for all voltage levels and MV level. The definition of a planned interruption assumes the requirement for notice in advance that varies strongly between European countries (between 24 hours and 50 days). The definition of unplanned interruptions assumes all other interruptions.

- SAIFI - System Average Interruption Frequency Index - the average number of interruptions per consumer (the ratio between a total number of interruptions and a total number of consumers). Similarly to SAIDI indicator, in this report, SAIFI is given for unplanned and planned interruptions at all voltage levels and separately at MV level only.

- CAIDI - Customer Average Interruption Duration Index. CAIDI gives the average outage duration that any given consumer would experience. It is the ratio between SAIDI and SAIFI. CAIDI can also be viewed as the average restoration time. CAIDI is measured in units of time, often minutes or hours. For this benchmarking report, CAIDI is calculated for unplanned and planned interruptions at all voltage levels.

- ENS – Electricity not supplied is calculated for both unplanned and planned interruptions at all voltage levels, as well as for TSO and DSO network. ENS TSO assumes electricity not supplied to final consumers due to interruptions in the transmission network.

Table 5.1 shows which voltage levels are included in input data of continuity of supply. None of relevant input data from CEDIS and EVNM were not available. Data for EPS refer to the average level in the EPS Group. Only long interruptions (> 3 min) were taken into account when calculating SAIDI and SAIFI in EDB, EPS, EPBiH, EPHZHB, HEP, while for OSHEE this threshold was 10 min. ERS and KEDS delivered input data for all interruptions (including those with duration less than 3 min) when calculating SAIDI and SAIFI.

Table 5.1 Voltage levels included in the data on SAIDI, SAIFI and ENS

2015	CEDIS	EDB	EPBIH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
HV - TSO	n.a.	No	No	Yes	Yes	Yes	n.a.	Yes	No	Yes
HV - DSO	n.a.	No	No	No	Yes	No	n.a.	No	No	Yes
MV	n.a.	Yes	Yes	Yes	Yes	Yes	n.a.	Yes	Yes	Yes
LV	n.a.	Yes	Yes	No	Yes	Yes	n.a.	Yes	Yes	No

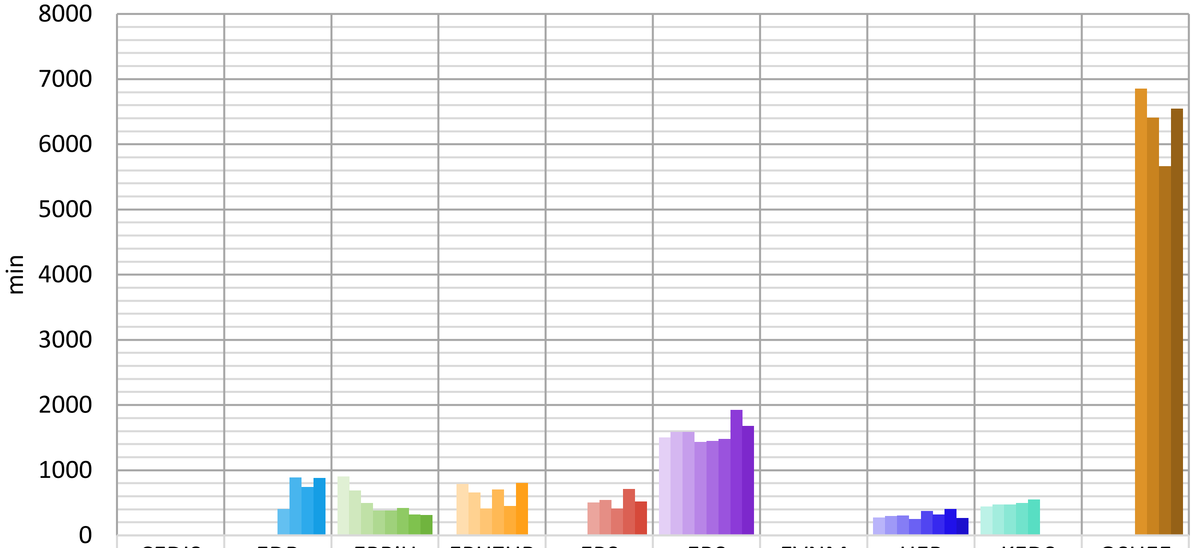
The following Figure shows SAIDI for unplanned interruptions at all voltage levels and for all events in the distribution networks in SEE. **Zeros in figure data table in this chapter mean that those data were not available.**

Over the period 2008-2015, SAIDI in the SEE DSOs have had very wide range, between 270 and 6.849 minutes/year. The largest SAIDI was recorded in OSHEE (in average 6366 min/year) and the second largest in ERS (in average 1579 min/year). All other DSOs have SAIDI lower than 900 min/year in whole observed period. The lowest SAID values were found in HEP (in average 310 min/year).

As shown on the Figure, data for EPBiH and KEDS show continuous trend during the whole period (decreasing and increasing, respectively), while all other DSOs have fluctuations. The highest yearly changes were equal to 121% (EDB, 2012/2013) and 79% (EPHZHB, 2013/2014).

In this chapter, standard deviation is calculated for those DSOs who collected input data for the whole 2008-2015 timeframe. For the DSOs with incomplete input data period, sample standard deviation is calculated. In the rest of this chapter, standard deviations of all DSOs are compared regardless of the calculation method. Standard deviation is a measure that is used to quantify the amount of variation or dispersion of a set of data values. A high standard deviation indicates that the data points are spread out over a wider range of values, while a low standard deviation indicates that the data points tend to be close to the mean (also called the expected value) of the set.

The highest standard deviations of this type of SAIDI were 504,4 minutes (OSHEE) and 227,4 minutes (EDB). Also, besides dispersion around the mean (standard deviation), to be able to benchmark DSOs it is important to calculate the dispersion relative to the mean value (relative standard deviation, also known as coefficient of variation) because a DSO with the highest standard deviation not necessary have the highest relative standard deviation in the observed period. The relative standard deviation tells us how much calculated standard deviation on some dataset values is big in relation to the level of that dataset values (to the mean of that dataset). The highest standard deviation in this case (OSHEE, 504,4 minutes) has the lowest relative standard deviation (8%). The highest relative standard deviation is found in EPBiH (40%).

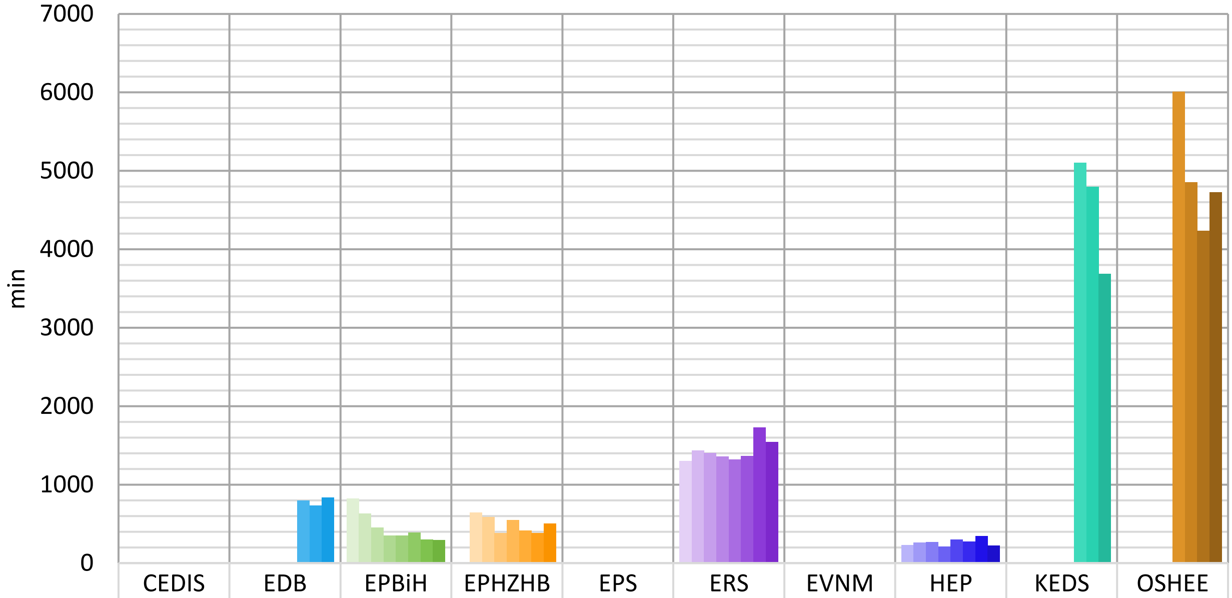


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	903	0	0	1501	0	270	445	0
2009	0	0	689	784	0	1589	0	296	471	0
2010	0	0	495	654	0	1582	0	307	476	0
2011	0	0	380	412	501	1434	0	251	494	0
2012	0	402	383	699	541	1444	0	372	548	6849
2013	0	890	415	448	409	1476	0	320	0	6407
2014	0	740	317	802	710	1925	0	402	0	5662
2015	0	878	312	0	522	1679	0	265	0	6547

Figure 5.1 SAIDI - unplanned interruptions at all voltage levels - all events in SEE DSOs in the period 2008 – 2015

SAIDI of unplanned interruptions for all events at MV level is shown below. The complete data were available just for 3 DSOs (ERS, EPBiH and HEP). KEDS's data for SAIDI – unplanned interruptions at all voltage levels and for all events are given for the period 2008-2012, while for the period 2013-2015 only those for MV level are given. Here we found that SAIDI on MV in the period 2013-2015 are about 10 times higher than SAIDI on all voltage levels in the period 2008-2012. It is recommended to double-check input data set and input data collection process for SAIDI in KEDS.

Besides that, level of SAIDI in MV network is not significantly lower than at the system level. It ranged between 210 (HEP, 2011) and 6.008 min/year (OSHEE, 2012).



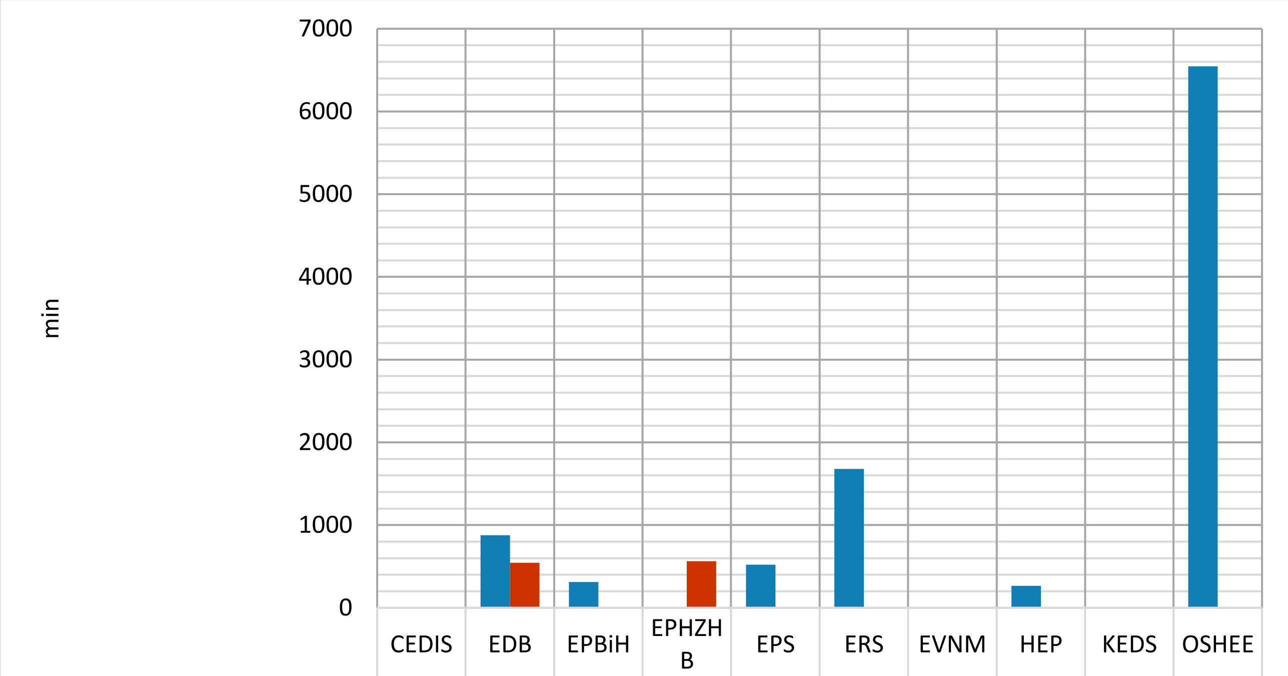
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	825	0	0	1300	0	228	0	0
2009	0	0	634	644	0	1434	0	260	0	0
2010	0	0	452	586	0	1402	0	267	0	0
2011	0	0	354	382	0	1356	0	210	0	0
2012	0	0	352	550	0	1323	0	302	0	6008
2013	0	800	389	412	0	1364	0	273	5100	4853
2014	0	736	298	383	0	1731	0	344	4800	4234
2015	0	835	291	502	0	1546	0	222	3687	4729

Figure 5.2 SAIDI - unplanned interruptions at MV level - all events in SEE DSOs in period 2008 – 2015

EDB delivered input data for all events and data without exceptional events in 2015, separately. The problem of consistency is found here since there are many different definitions of the exceptional events. In general, some countries have more statistical approach, while others focus their definition on the causes of exceptional events. Changes in number and duration of interruptions could be clearer if exceptional events are excluded from the data.

For example, exceptional weather conditions, natural disasters (earthquake, flood, lightning strike, storm, icing, etc.), epidemics, explosions, other than those caused by improper or careless handling, which are not foreseeable and are not due to wear and tear of materials or equipment, war, riot or sabotage and other exceptional circumstances can significantly affect the continuity of supply. Interruptions due to exceptional events, even if quite rare, are usually very long and/or affect a substantial number of consumers. It is important to note that in the last few years this region has suffered from the extreme weather conditions (floods, icing, storms etc.) which certainly affected continuity of supply indicators.

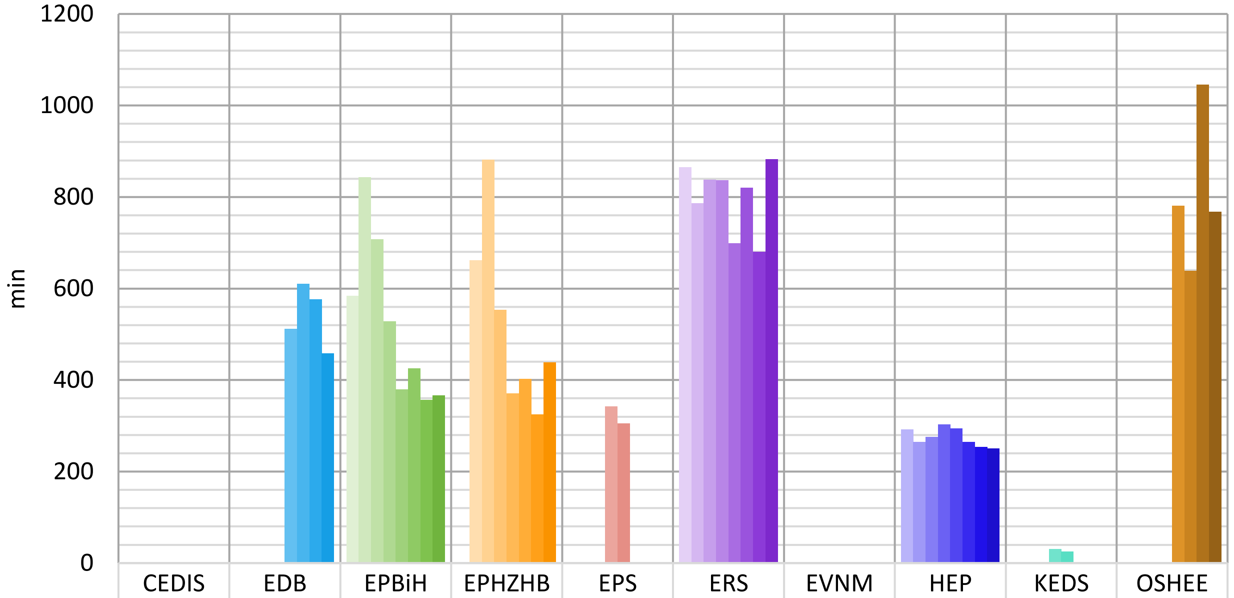
The following Figure shows SAIDI of unplanned interruptions with and without exceptional events. In BiH exceptional events (i.e. force majeure) are defined as all events which cause interruption of supply and are out of control of the DSO such as: natural disasters (earthquake, fire, flooding), extreme weather conditions (lightning, storm wind, excessive ice etc.), interruptions at the transmission voltage level, load shedding due to shortage of supply, under-frequency relief of load and orders of the respective authorities. It can be clearly seen that SAIDI in EDB is significantly lower (~ 40 %) when exceptional events are excluded from all events. For other SEE DSOs there are no available data.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
all events	0	878	312	0	522	1679	0	265	0	6547
without exceptional events	0	543	0	564	0	0	0	0	0	0

Figure 5.3 SAIDI - unplanned interruptions at all voltage levels with and without exceptional events in the period 2008 - 2015

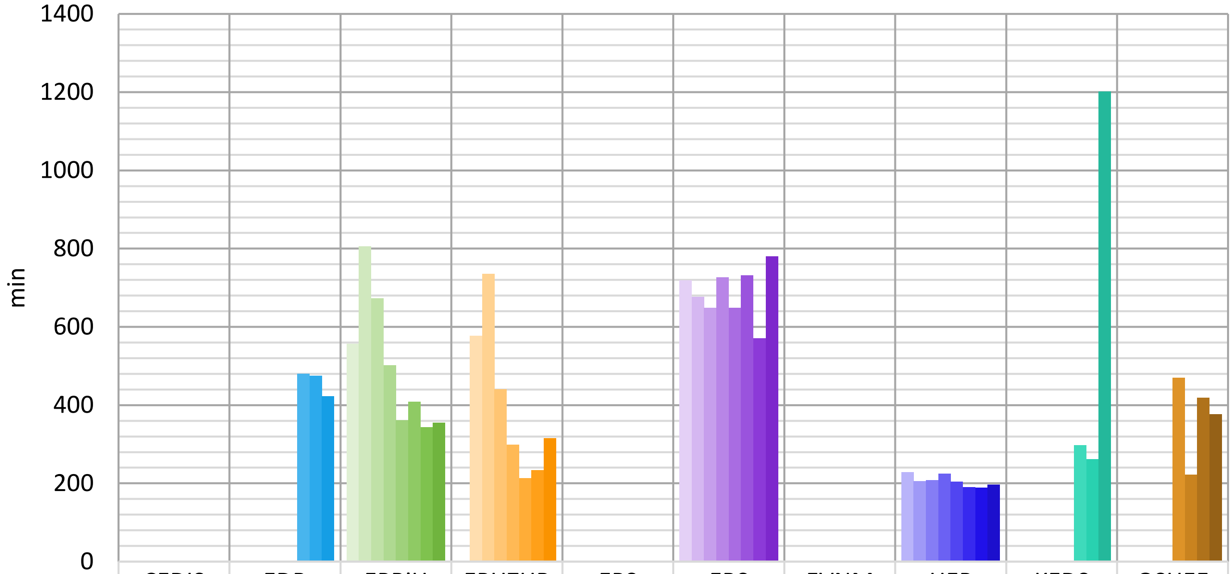
Duration of planned interruptions relates to supply interruptions experienced by the network users after they receive prior notice of planned electricity interruption. SAIDI of planned interruptions was in the range between 25 minutes (KEDS, 2012) and 1045 minutes (OSHEE, 2014), as shown on the Figure 5.4. The highest yearly changes were 64% (OSHEE, 2013/2014) and 44% (EPBiH, 2008/2009). The difference between two highest SAIDIs of planned interruptions of two different SEE DSOs was only 18% (compared to 360% for unplanned interruptions). The highest standard deviations were 196,8 minutes (EPHZHB) and 170,4 minutes (OSHEE), while the highest relative standard deviations were 38% (EPHZHB) and 32% (EPBiH). This mean that in EPHZHB and EPBiH were the highest dispersion of yearly SAIDIs relative to their mean. In this case, it is good thing because SAIDI of planned interruptions in EPHZHB and EPBiH shown downward trend in the observed period. KEDS and OSHEE had the largest ratio between SAIDI of unplanned and SAIDI of planned interruptions in corresponding year, 22 and 10, respectively. In other DSOs, this ratio wasn't higher than 2,83.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	584	0	0	865	0	292	0	0
2009	0	0	843	662	0	786	0	265	0	0
2010	0	0	708	881	0	838	0	276	0	0
2011	0	0	528	553	342	837	0	303	31	0
2012	0	512	380	371	305	699	0	294	25	781
2013	0	610	425	402	0	820	0	265	0	639
2014	0	576	357	325	0	680	0	254	0	1045
2015	0	458	366	438	0	882	0	251	0	768

Figure 5.4 SAIDI - planned interruptions at all voltage levels - all events in SEE DSOs in period 2008 - 2015

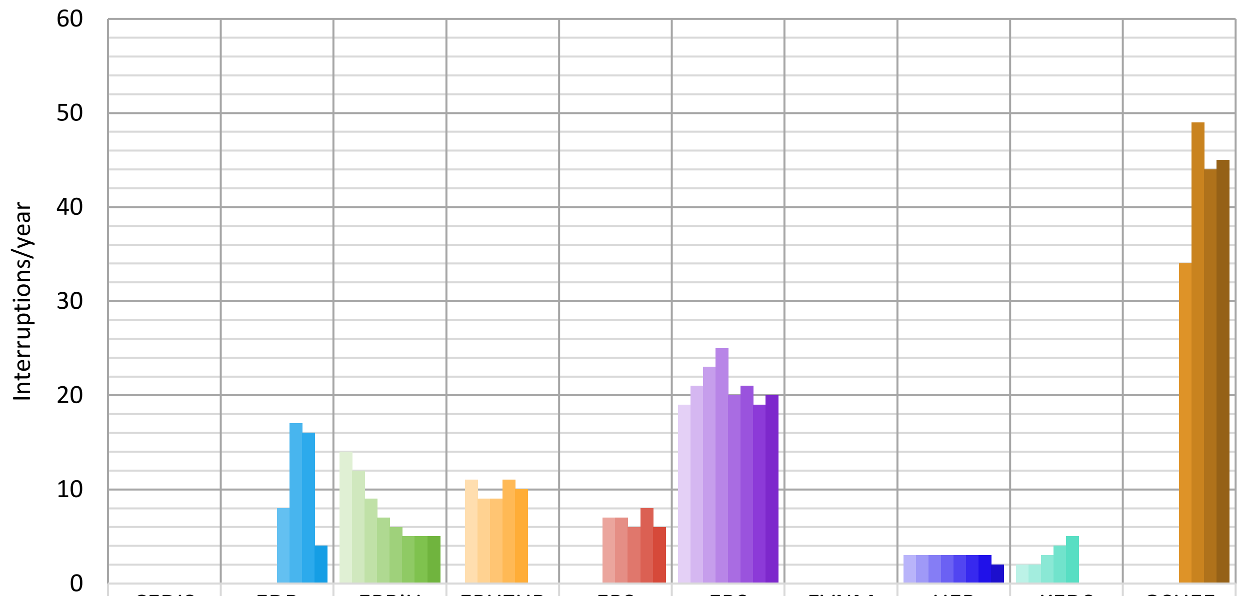
SAIDI of planned interruptions at MV level and all events are shown below. In this case the above mentioned remark on KEDS input data on SAIDI at MV level is also valid. In 2015 KEDS had the highest SAIDI (1201 minutes) and the highest yearly change of 358% (2014/2015).



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	557	0	0	719	0	228	0	0
2009	0	0	806	577	0	677	0	206	0	0
2010	0	0	673	735	0	648	0	208	0	0
2011	0	0	502	440	0	726	0	225	0	0
2012	0	0	361	299	0	649	0	204	0	470
2013	0	480	408	213	0	732	0	190	298	222
2014	0	475	343	233	0	571	0	189	262	419
2015	0	422	355	315	0	780	0	196	1201	376

Figure 5.5 SAIDI - planned interruptions at MV level - all events in SEE DSOs in period 2008 – 2015

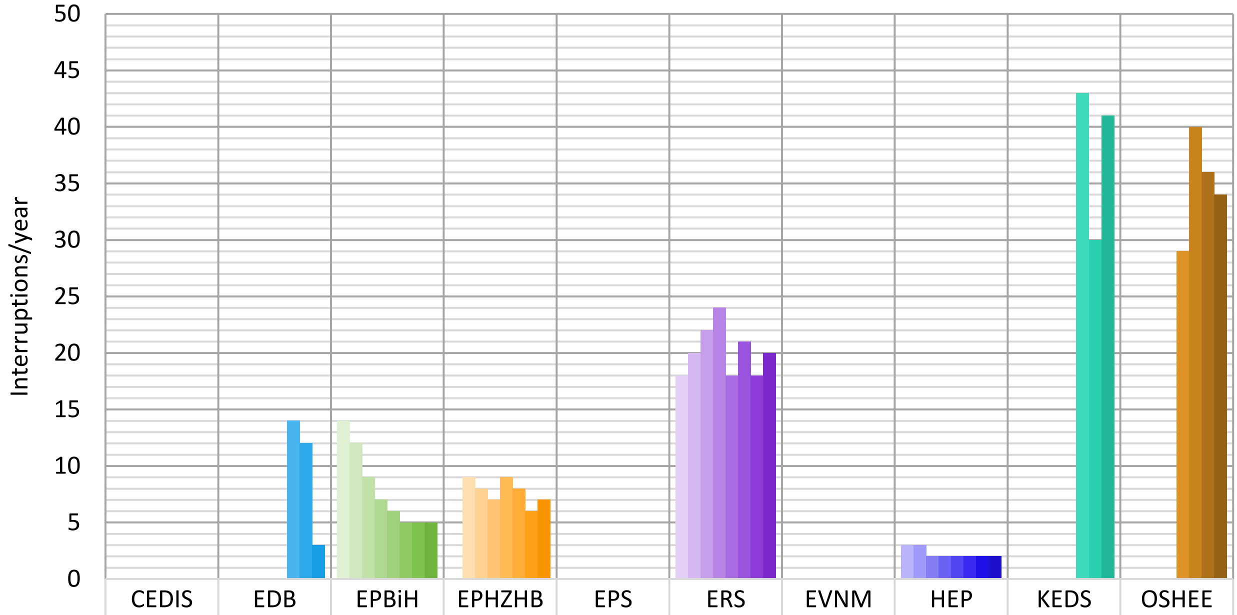
As for the SAIDI indicator, in this subchapter SAIFI is also given for unplanned and planned interruptions for all voltage levels and for MV level, as shown on the Figures 5.6 - 5.9. SAIFI of unplanned interruptions was in the range between 2 interruptions/year (KEDS, 2009) and 49 interruptions/year (OSHEE, 2013). The highest yearly changes were 100% and 75 % (EDB, 2012/2013 and 2014/2015, respectively). Even though there were extreme weather conditions in the region in 2014, SAIFI in 2014 is not found much more different than the other years. The difference between two SEE DSOs with the highest level of SAIFI of unplanned interruptions was 96%. The highest standard deviations were 6,3 interruptions/year (EDB, also with the highest relative standard deviation of 55%) and 6,2 interruptions/year (OSHEE).



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	14	0	0	19	0	3	2	0
2009	0	0	12	11	0	21	0	3	2	0
2010	0	0	9	9	0	23	0	3	3	0
2011	0	0	7	9	7	25	0	3	4	0
2012	0	8	6	11	7	20	0	3	5	34
2013	0	17	5	10	6	21	0	3	0	49
2014	0	16	5	0	8	19	0	3	0	44
2015	0	4	5	0	6	20	0	2	0	45

Figure 5.6 SAIFI - unplanned interruptions at all voltage levels - all events in SEE DSOs in period 2008 – 2015

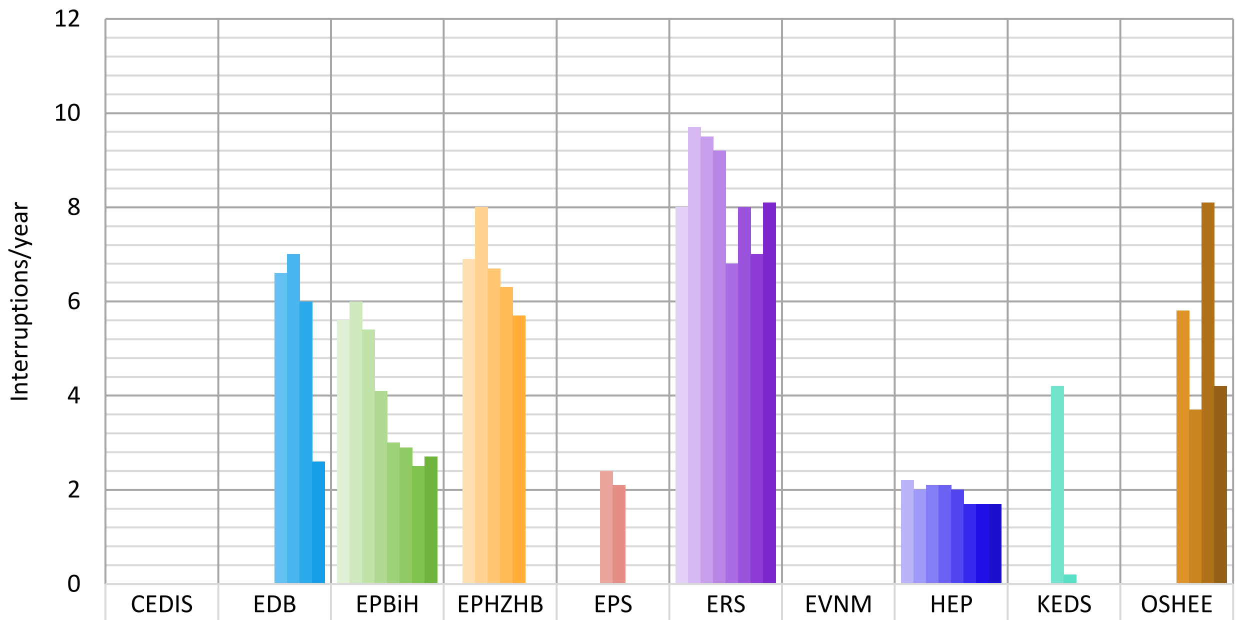
As for SAIDI, KEDS's data for SAIFI – unplanned interruptions at all voltage levels and for all events are given for the 2008-2012 timeframe, while for the 2013-2015 period only values on MV level are given. It is found very strange that SAIFI MV values in 2013-2015 are 10-20 times higher than SAIFI all voltage level values for 2008-2012, so we suggest to double-check these values. Except for KEDS, all other DSOs kept approximately the same SAIFI level, but in most cases with slightly lower values on MV level than at all voltage levels.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	14	0	0	18	0	3	0	0
2009	0	0	12	9	0	20	0	3	0	0
2010	0	0	9	8	0	22	0	2	0	0
2011	0	0	7	7	0	24	0	2	0	0
2012	0	0	6	9	0	18	0	2	0	29
2013	0	14	5	8	0	21	0	2	43	40
2014	0	12	5	6	0	18	0	2	30	36
2015	0	3	5	7	0	20	0	2	41	34

Figure 5.7 SAIFI - unplanned interruptions at MV level - all events in SEE DSOs in period 2008 – 2015

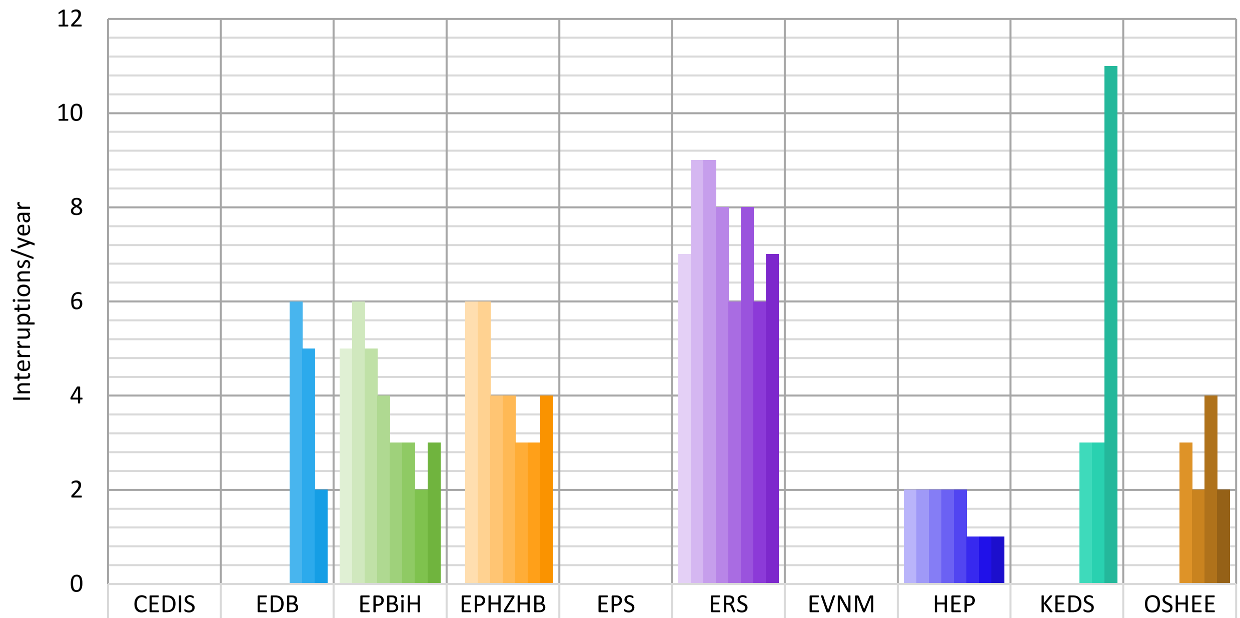
For planned interruptions, SAIFI was in the range 0,2 interruptions/year (KEDS, 2012) to 9,7 interruptions/year (ERS, 2009). As for SAIDI, compared to unplanned interruptions, planned interruptions also had much lower difference between the two SEE DSOs with the highest SAIFI at all voltage levels (only 20% i.e. almost 5 times lower). The highest yearly changes were 120% growth (OSHEE, 2013/2014) and 95% reduction (KEDS, 2011/2012), and the highest standard deviation was 2,8 interruptions/year (KEDS). In the relative, KEDS also had the highest standard deviation, 127%, which is almost 3,5 times higher than the second one (OSHEE, 37%).



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	5,6	0	0	8	0	2,2	0	0
2009	0	0	6	6,9	0	9,7	0	2	0	0
2010	0	0	5,4	8	0	9,5	0	2,1	0	0
2011	0	0	4,1	6,7	2,4	9,2	0	2,1	4,2	0
2012	0	6,6	3	6,3	2,1	6,8	0	2	0,2	5,8
2013	0	7	2,9	5,7	0	8	0	1,7	0	3,7
2014	0	6	2,5	0	0	7	0	1,7	0	8,1
2015	0	2,6	2,7	0	0	8,1	0	1,7	0	4,2

Figure 5.8 SAIFI - planned interruptions at all voltage levels - all events in SEE DSOs in period 2008 – 2012

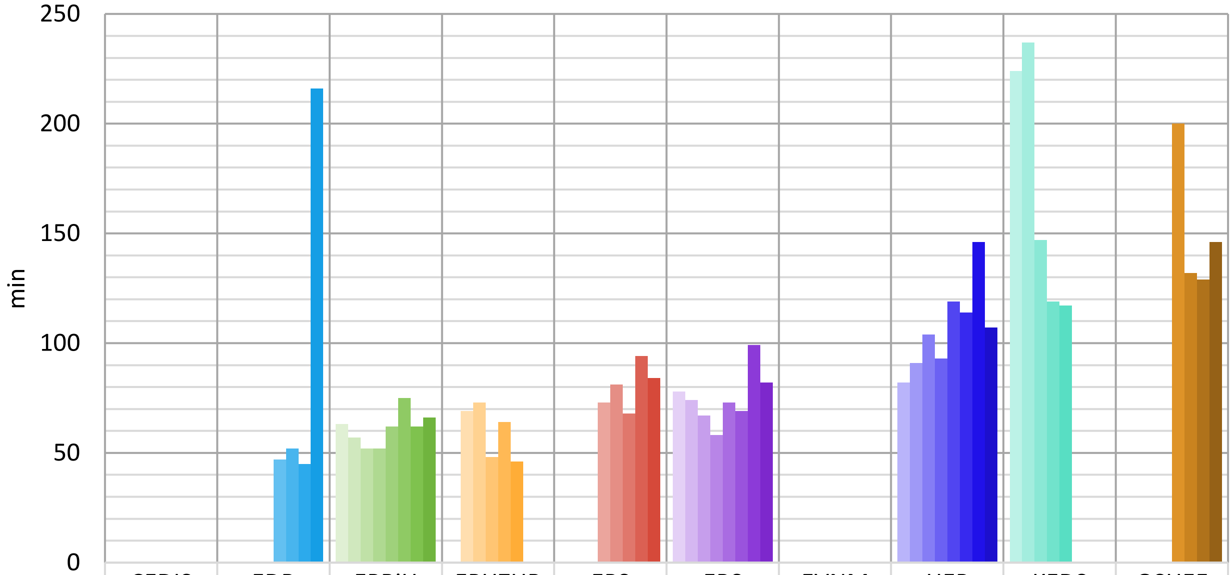
For planned interruptions, SAIFI also has a similar shape at MV level compared to SAIFI for all voltage levels. The only difference is again KEDS, as explained above.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	5	0	0	7	0	2	0	0
2009	0	0	6	6	0	9	0	2	0	0
2010	0	0	5	6	0	9	0	2	0	0
2011	0	0	4	4	0	8	0	2	0	0
2012	0	0	3	4	0	6	0	2	0	3
2013	0	6	3	3	0	8	0	1	3	2
2014	0	5	2	3	0	6	0	1	3	4
2015	0	2	3	4	0	7	0	1	11	2

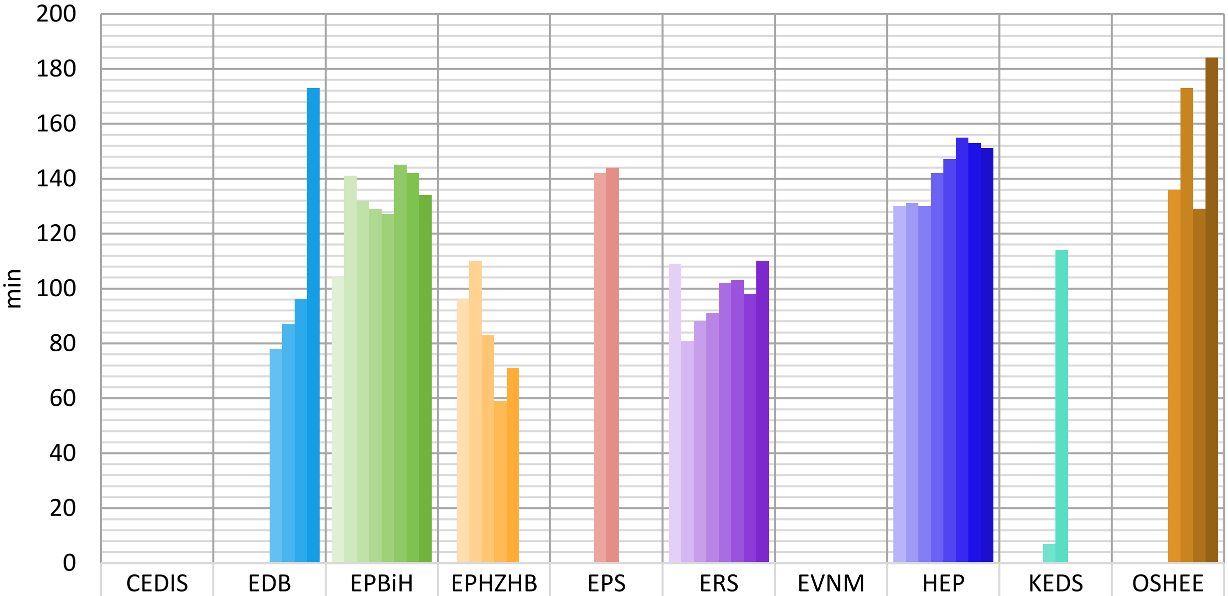
Figure 5.9 SAIFI - planned interruptions at MV level - all events in SEE DSOs in period 2008 – 2015

CAIDI indicator is also given for unplanned and planned interruptions at all voltage levels, as shown on following two figures. The highest value of CAIDI for unplanned interruptions in given timeframe was 237 minutes (KEDS, 2009), and for planned interruptions it was 184 minutes (OSHEE, 2015). Except for KEDS, in general, all other DSOs have had higher CAIDI for planned than unplanned interruptions. The difference between planned and unplanned CAIDI was in range -94% (KEDS, 2011) and 154% (EPBiH, 2010). The highest yearly change for unplanned interruptions was 380% (EDB, 2014/2015), and for planned interruptions (Figure 5.11) the largest yearly change was in KEDS (7 min in 2011, 114 min in 2012).



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	63	0	0	78	0	82	224	0
2009	0	0	57	69	0	74	0	91	237	0
2010	0	0	52	73	0	67	0	104	147	0
2011	0	0	52	48	73	58	0	93	119	0
2012	0	47	62	64	81	73	0	119	117	200
2013	0	52	75	46	68	69	0	114	0	132
2014	0	45	62	0	94	99	0	146	0	129
2015	0	216	66	0	84	82	0	107	0	146

Figure 5.10 CAIDI - unplanned interruptions at all voltage levels - all events in SEE DSOs in period 2008 – 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	104	0	0	109	0	130	0	0
2009	0	0	141	96	0	81	0	131	0	0
2010	0	0	132	110	0	88	0	130	0	0
2011	0	0	129	83	142	91	0	142	7	0
2012	0	78	127	59	144	102	0	147	114	136
2013	0	87	145	71	0	103	0	155	0	173
2014	0	96	142	0	0	98	0	153	0	129
2015	0	173	134	0	0	110	0	151	0	184

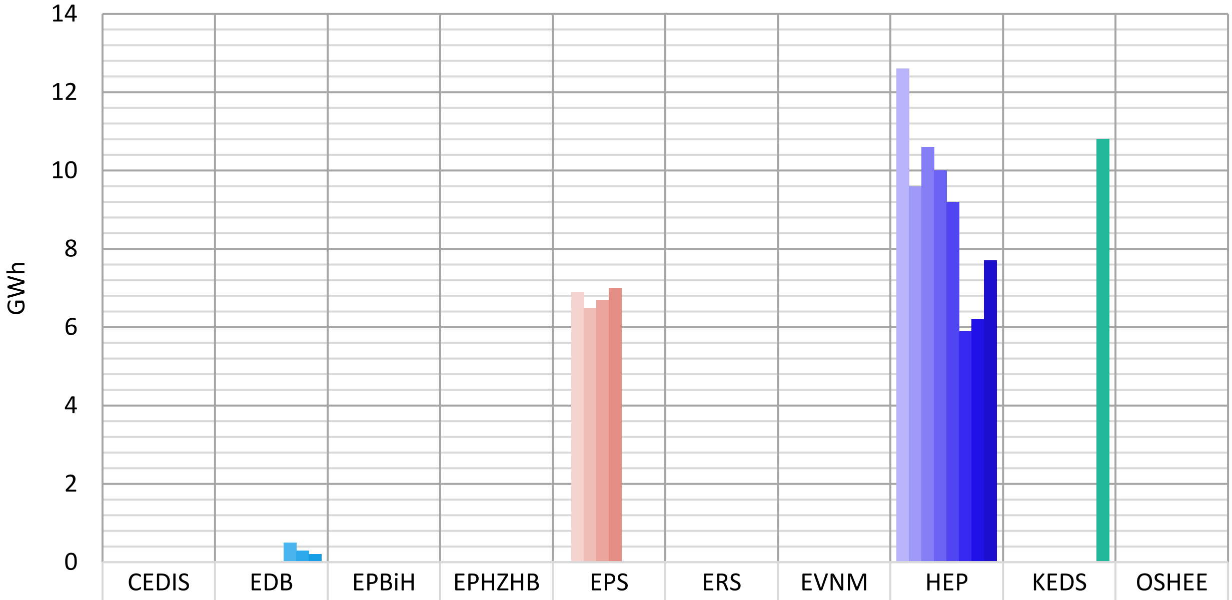
Figure 5.11 CAIDI - planned interruptions at all voltage levels - all events in SEE DSOs in period 2008 – 2015

Figures 5.12 - 5.15 refer to electricity not supplied (ENS) to final consumers due to unplanned and planned interruptions for all events in the distribution and transmission network. The data were available for only 4 DSOs. Please note that ENS data for EPS are given only for Distribution area 4, not for entire EPS territory. ENS for unplanned interruptions in the distribution network was the highest in KEDS (155,4 GWh in 2011), or 4,38% of the total delivered electricity to final consumers in 2011. Except for KEDS, ENS in other available DSOs has not been higher than 0,2% of total delivered electricity to final consumers.

	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	12,5	0	0
2009	0	0	0	0	4	0	0	7,8	0	0
2010	0	0	0	0	3,9	0	0	8,2	0	0
2011	0	0	0	0	2	0	0	6,2	155,4	0
2012	0	0	0	0	2,1	0	0	9,2	68,5	0
2013	0	0,4	0	0	0	0	0	7,7	51,6	0
2014	0	0,4	0	0	0	0	0	2,4	36	0
2015	0	0,5	0	0	0	0	0	8,4	36,3	0

Figure 5.12 ENS – at all voltage levels due to unplanned interruptions in DSO network- all events in SEE DSOs in period 2008 - 2015

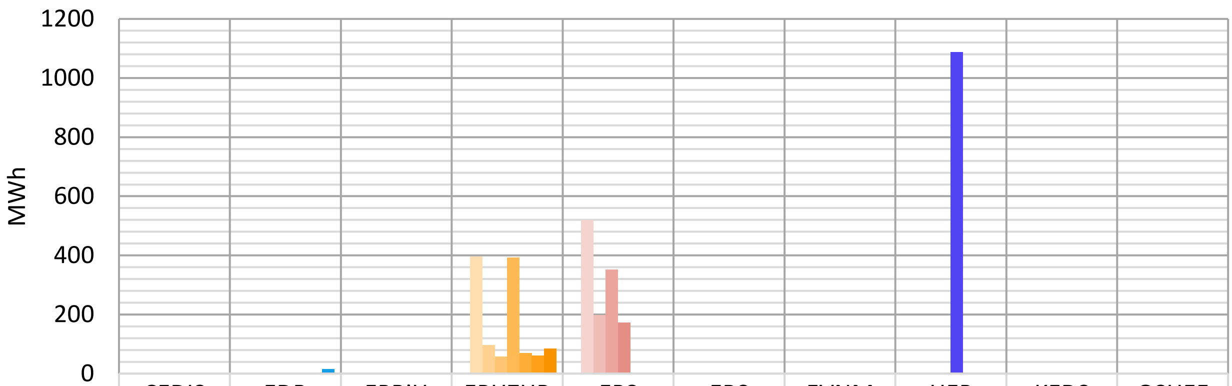
Although the highest ENS for planned interruptions in DSO network was in HEP (12,6 GWh in 2008), it is only 0,07% of total delivered electricity to final consumers. The highest ENS for planned interruptions relative to total delivered electricity to final consumers was found in KEDS in 2015, 0,34%.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	12,6	0	0
2009	0	0	0	0	6,9	0	0	9,6	0	0
2010	0	0	0	0	6,5	0	0	10,6	0	0
2011	0	0	0	0	6,7	0	0	10	0	0
2012	0	0	0	0	7	0	0	9,2	0	0
2013	0	0,5	0	0	0	0	0	5,9	0	0
2014	0	0,3	0	0	0	0	0	6,2	0	0
2015	0	0,2	0	0	0	0	0	7,7	10,8	0

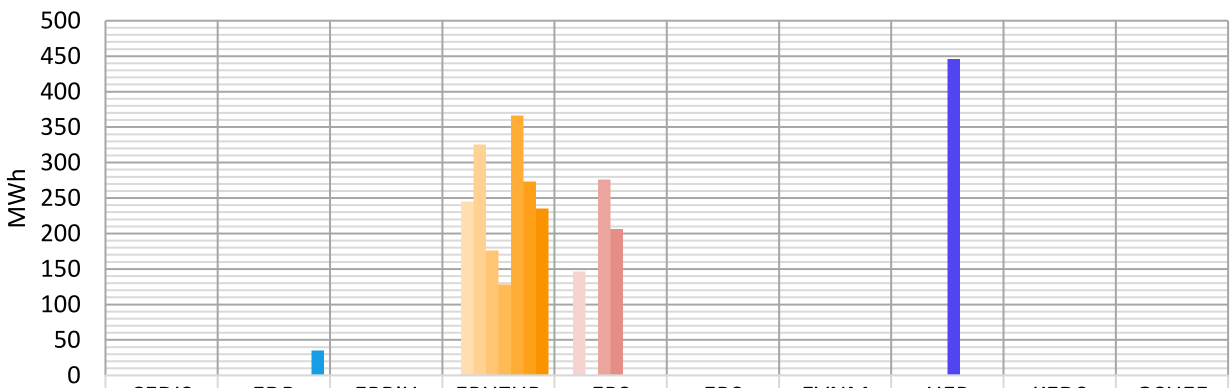
Figure 5.13 ENS - at all voltage levels due to planned interruptions in DSO network - all events in SEE DSOs in the period 2008 - 2015

For unplanned interruptions ENS due to interruptions in TSO network is 6 to 30 times lower than ENS due to interruptions in DSO network, and 6 to 48 times lower for planned interruptions. The highest yearly ENS due to interruptions in the TSO network relative to total delivered electricity to final consumers was 0,036% (EPHZHB, 2012) for unplanned interruptions and 0,031% (EPHZHB, 2013) for planned interruptions.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	396	519	0	0	0	0	0
2010	0	0	0	97	197	0	0	0	0	0
2011	0	0	0	57	351	0	0	0	0	0
2012	0	0	0	392	172	0	0	1087	0	0
2013	0	0	0	70	0	0	0	0	0	0
2014	0	0	0	61	0	0	0	0	0	0
2015	0	15	0	84	0	0	0	0	0	0

Figure 5.14 ENS – at all voltage levels due to unplanned interruptions in TSO network- all events in SEE DSOs in period 2008 - 2015

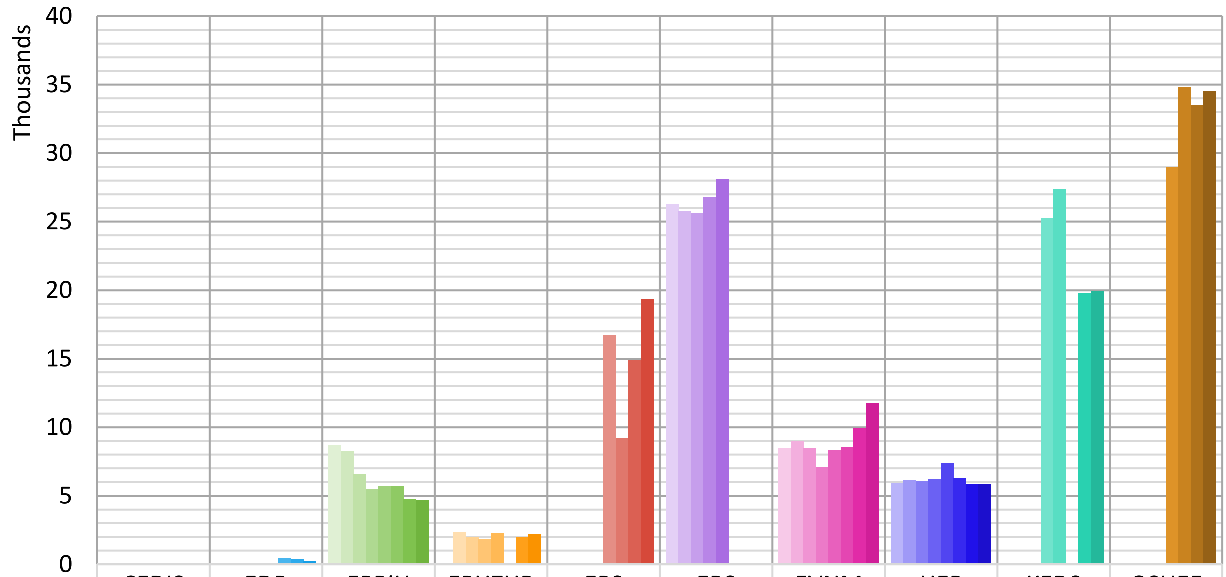


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	245	146	0	0	0	0	0
2010	0	0	0	325	0	0	0	0	0	0
2011	0	0	0	176	276	0	0	0	0	0
2012	0	0	0	128	206	0	0	446	0	0
2013	0	0	0	366	0	0	0	0	0	0
2014	0	0	0	273	0	0	0	0	0	0
2015	0	35	0	235	0	0	0	0	0	0

Figure 5.15 ENS - at all voltage levels due to planned interruptions in TSO network - all events in SEE DSOs in the period 2008 - 2015

5.2 SHARE OF UNPLANNED INTERRUPTIONS IN TOTAL NUMBER OF INTERRUPTIONS

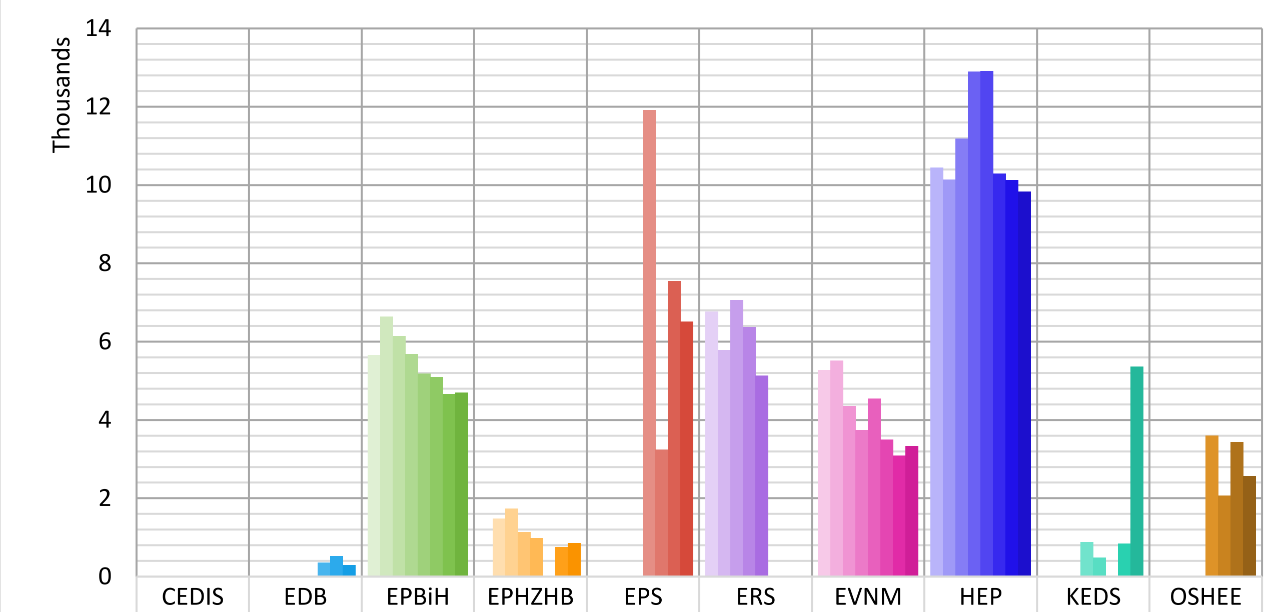
Total number of unplanned interruptions for each DSO is given on the following Figure. It was in the range between 241 interruptions/year (EDB, 2015) and 34810 interruptions/year (OSHEE, 2013). The highest yearly change was 62% (EPS, 2013/2014). EPS also had the highest relative standard deviation of 29% in this period.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	8706	0	0	26260	8470	5911	0	0
2009	0	0	8272	2356	0	25759	8965	6131	0	0
2010	0	0	6543	1999	0	25648	8484	6074	0	0
2011	0	0	5474	1816	0	26760	7096	6229	25226	0
2012	0	0	5686	2240	16683	28123	8322	7357	27390	28958
2013	0	425	5675	0	9208	0	8543	6319	0	34810
2014	0	375	4754	1966	14910	0	9906	5875	19819	33477
2015	0	241	4693	2189	19363	0	11729	5815	19961	34522

Figure 5.16 Total number of long unplanned interruption in SEE DSOs in the period 2008 - 2012

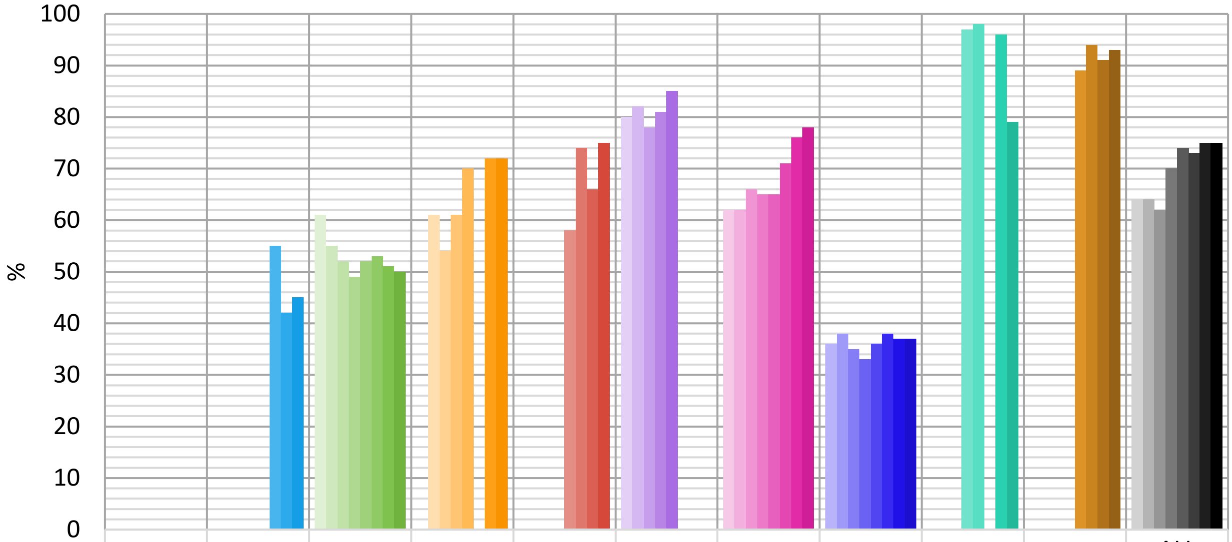
Figure 5.17 shows the total number of planned long interruptions in SEE DSOs which was up to 56 times lower (KEDS, 2012) compared to unplanned long interruptions.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	5650	0	0	6764	5279	10440	0	0
2009	0	0	6644	1483	0	5787	5511	10134	0	0
2010	0	0	6143	1735	0	7064	4350	11191	0	0
2011	0	0	5683	1137	0	6365	3741	12893	877	0
2012	0	0	5187	981	11915	5128	4547	12904	488	3595
2013	0	354	5091	0	3244	0	3500	10288	0	2067
2014	0	523	4655	758	7552	0	3093	10123	836	3434
2015	0	293	4702	850	6516	0	3335	9836	5358	2570

Figure 5.17 Total number of planned long interruptions in SEE DSOs in the period 2008 - 2012

Based on the previous two values (provided by the DSOs) share of unplanned interruptions in total number of interruptions has been calculated and given in the following Figure. This share was in the range between 33 % (HEP, 2011) and 98 % (KEDS, 2012). 8 of 9 DSOs that provided data had over 50 % share of unplanned interruptions in the total number of interruptions.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	0	0	61	0	0	80	62	36	0	0	64
2009	0	0	55	61	0	82	62	38	0	0	64
2010	0	0	52	54	0	78	66	35	0	0	62
2011	0	0	49	61	0	81	65	33	97	0	70
2012	0	0	52	70	58	85	65	36	98	89	74
2013	0	55	53	0	74	0	71	38	0	94	73
2014	0	42	51	72	66	0	76	37	96	91	75
2015	0	45	50	72	75	0	78	37	79	93	75

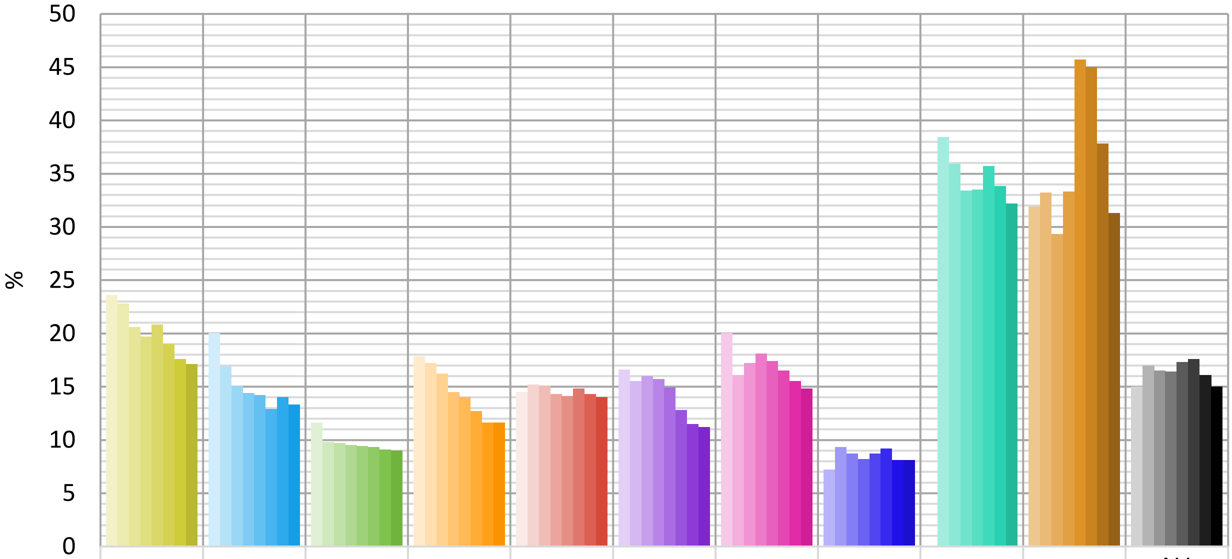
Figure 5.18 Share of unplanned interruptions in total number of interruptions in SEE DSOs in the period 2008 - 2012

6 ELECTRICITY LOSSES

Electricity losses are one of the most important indicators in DSO operational performance evaluation. In general, total losses in distribution network are calculated as the difference between electricity received in the distribution network (from transmission network and distributed generation) and electricity delivered to the final consumers. Relative total losses are calculated as the ratio between total losses and sum of total sale and total losses, i.e. total electricity received in the distribution network. It is important to note that total losses calculated in this way include both, technical and non-technical (commercial) losses. The technical losses are due to energy dissipated in distribution system equipment (overhead and cable lines, transformers and other auxiliary equipment) when electric current flows through the distribution system toward end user terminals. These losses are inherent to distribution of electricity and cannot be eliminated. There are two types of technical losses: permanent/fixed technical losses (do not vary with current changes) and variable technical losses (vary with the amount of distributed electricity). Between 1/4 and 1/3 of technical losses in distribution networks are fixed losses. Variable technical losses are in direct correlation with cross sections of lines and cables, so one of the ways to reduce these losses is to increase cross sections of lines and cables. Normally, this leads to a direct trade-off between cost of losses and cost of capital expenditure. One of the main reasons for technical losses is distributions lines length, inadequate size of distribution lines conductors, installation of distribution transformers away from the consumption centers, low power factor, low load factor, overloading of lines etc. Commercial losses are theft, non-payment by consumers, unmetered supply, errors in meter reading, etc.

6.1 VOLUME AND COST OF AGGREGATED TECHNICAL AND COMMERCIAL LOSSES

The last column on the following Figure shows that the share of total losses in total electricity received in the whole distribution network of SEE (treated as one single system) in the period 2008 – 2015 was between 15% and 17,6%. Total losses for KEDS in 2008 weren’t available, so total losses in the SEE in 2008 doesn’t include KEDS. At the individual DSO level, share of total losses was in the range between 7,2% (HEP) and 45,7% (OSHEE). Besides OSHEE and HEP, all other DSOs had mainly decreasing trend of total losses in given timeframe.

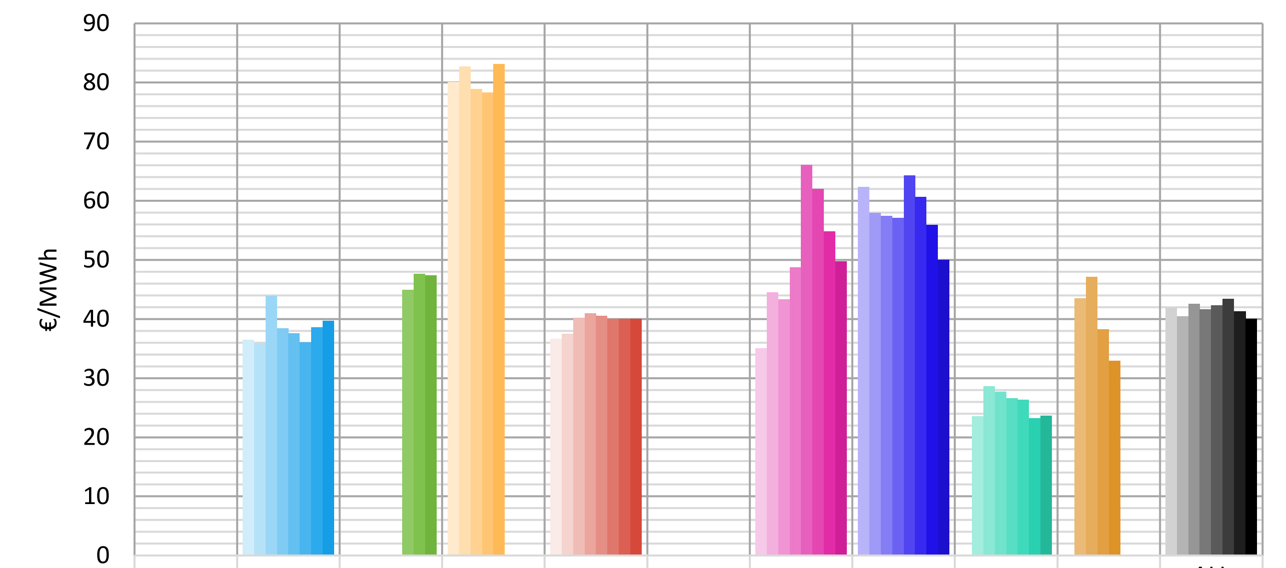


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	23,6	20	11,6	17,8	14,5	16,6	20	7,2	0	31,9	15
2009	22,8	16,9	9,8	17,2	15,2	15,5	16,1	9,3	38,4	33,2	17
2010	20,6	15,1	9,7	16,2	15,1	16	17,2	8,7	35,9	29,3	16,5
2011	19,7	14,4	9,5	14,5	14,3	15,7	18,1	8,2	33,4	33,3	16,4
2012	20,8	14,2	9,4	14	14,1	14,9	17,4	8,7	33,5	45,7	17,3
2013	19	12,9	9,3	12,7	14,8	12,8	16,5	9,2	35,7	45	17,6
2014	17,6	14	9,1	11,6	14,3	11,5	15,5	8,1	33,8	37,8	16,1
2015	17,1	13,3	9	11,6	14	11,2	14,8	8,1	32,2	31,3	15

Figure 6.1 Total losses relative to sale + total losses in SEE DSOs in the period 2008 - 2015

Unit costs of total losses were calculated as the ratio between cost of total losses (€) and total amount of losses (MWh) and it is given on the following Figure. It is defined as the unit cost paid annually for procuring 1 MWh to cover electricity losses. In some countries it is fully regulated, while in other it is linked to the market price. It is expected that in the future all network losses will be procured using market based methods.

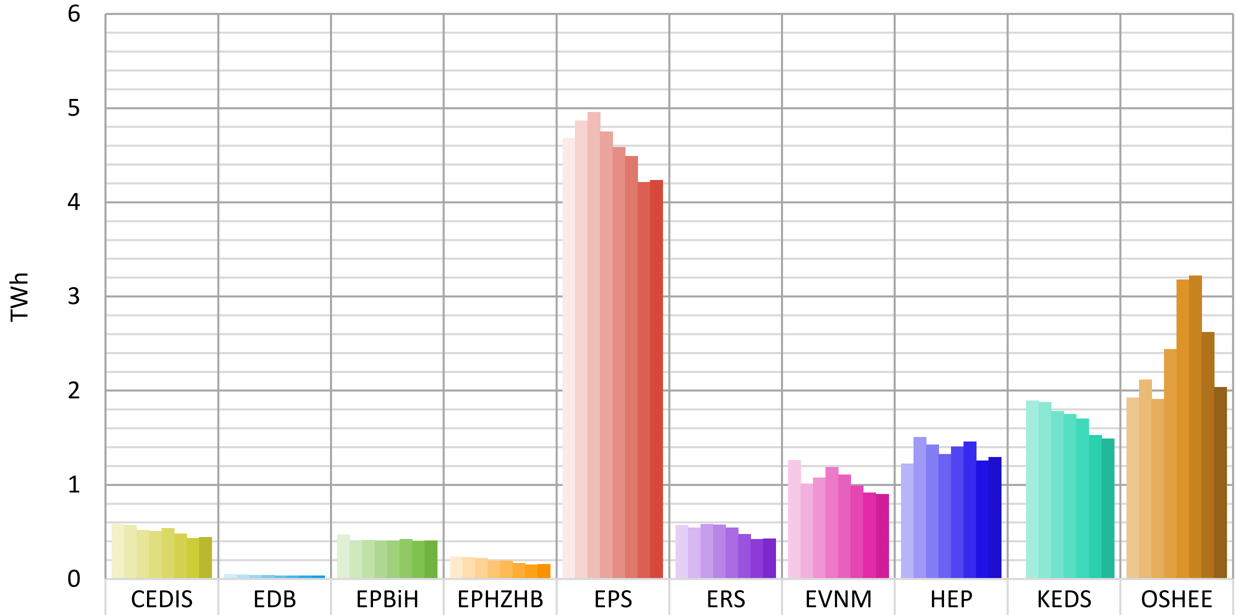
Within the period 2008 – 2015, for available input data (**zeros mean unavailable input data**), unit cost of total losses was in the range between 23,2 €/MWh (KEDS, 2014) and 83,1 €/MWh (EPHZHB, 2012). At the same time, relative standard deviation was in the range between 2,7% (EPHZHB) and 18,8% (EVNM).



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	0	36,5	0	80,1	36,6	0	35	62,3	0	0	41,9
2009	0	35,9	0	82,7	37,5	0	44,5	57,9	23,5	43,5	40,4
2010	0	43,9	0	78,9	40,2	0	43,3	57,4	28,6	47,1	42,6
2011	0	38,4	0	78,3	40,9	0	48,7	57,1	27,7	38,2	41,6
2012	0	37,6	0	83,1	40,5	0	66	64,3	26,6	32,9	42,3
2013	0	36	44,9	0	40	0	62	60,6	26,3	0	43,4
2014	0	38,6	47,6	0	40	0	54,8	55,9	23,2	0	41,3
2015	0	39,7	47,4	0	40	0	49,7	50	23,6	0	40

Figure 6.2 Unit cost of total losses in SEE DSOs in the period 2008 - 2015

As mentioned above, there are many influential factors on the level of network losses. Delivered electricity, line length and types (share of areal and cable lines, share of HV, MV and LV in total length per voltage levels, physical characteristics of lines), number and substation/transformer types (determine variable and fixed technical losses) should also be considered while evaluating technical losses. Non-technical (commercial) losses also depend on many different factors. The following Figure shows the volume of total losses in the period 2008 – 2015. As expected, the highest amount of the distribution network losses was in the largest DSO, EPS (up to 4,959 TWh/year), and it shown decreasing trend in the given timeframe (9,4% lower since 2008). The highest relative standard deviation was 21% (OSHEE). This mean that in OSHEE volume of total losses had the highest yearly oscillation during the observed period. In the most of the DSOs decreasing trend on volume of total losses was recorded.



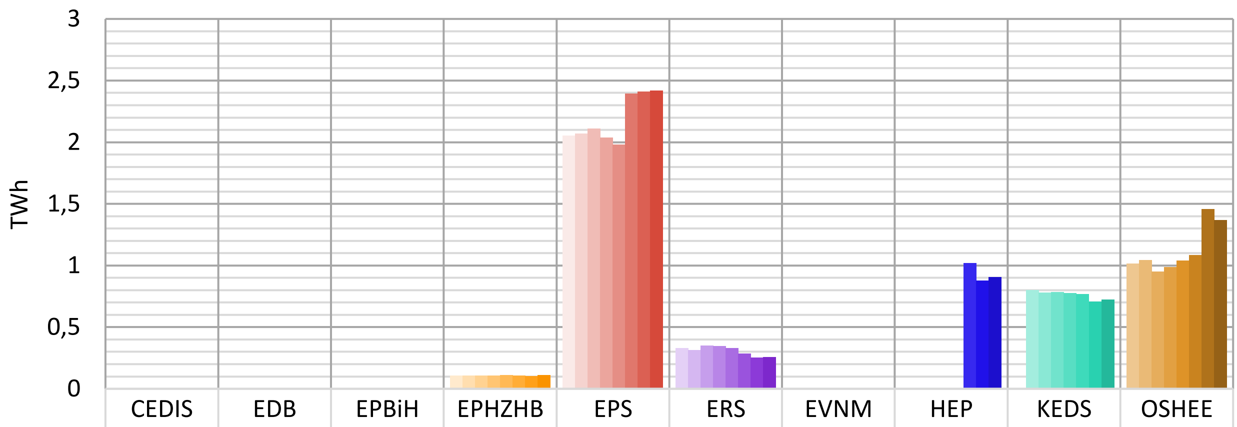
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0,583	0,053	0,471	0,237	4,679	0,572	1,261	1,223	0	1,927
2009	0,57	0,046	0,404	0,23	4,865	0,547	1,014	1,508	1,895	2,117
2010	0,518	0,042	0,41	0,221	4,959	0,582	1,075	1,424	1,879	1,911
2011	0,506	0,039	0,407	0,197	4,748	0,576	1,186	1,325	1,782	2,439
2012	0,541	0,037	0,406	0,192	4,586	0,546	1,107	1,403	1,749	3,178
2013	0,48	0,033	0,422	0,17	4,487	0,474	0,99	1,459	1,704	3,218
2014	0,432	0,035	0,402	0,151	4,215	0,425	0,914	1,257	1,526	2,622
2015	0,446	0,035	0,409	0,159	4,237	0,428	0,903	1,295	1,488	2,035

Figure 6.3 Volume of total losses in SEE DSOs in the period 2008 – 2015

6.2 ESTIMATED TECHNICAL LOSSES

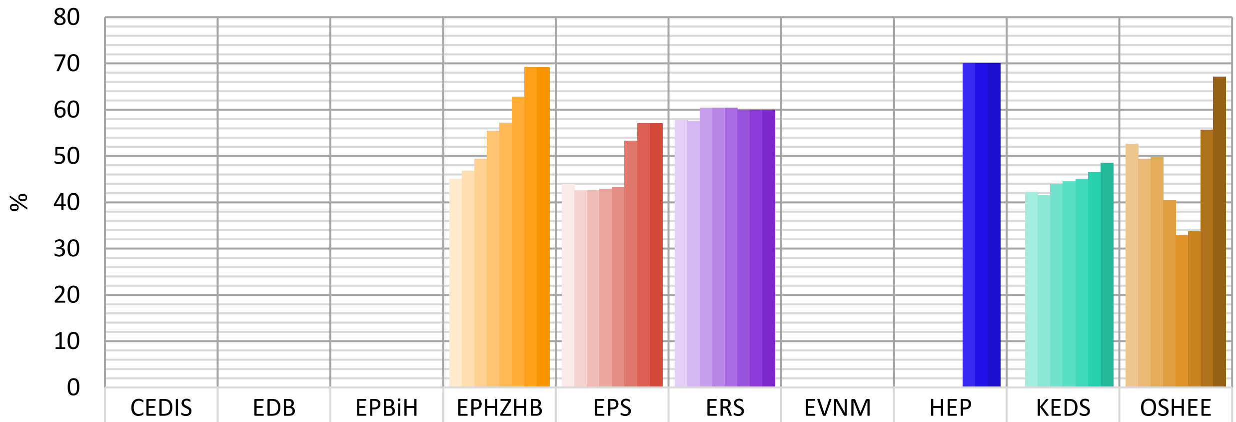
As stated above, total losses are divided into technical and commercial losses. Data on estimated technical losses were available just for 6 DSOs: EPHZHB, EPS, ERS, HEP, KEDS and OSHEE, as given on the following Figure. Share of estimated technical losses in total losses in the period 2008-2015 ranged between 32,8% (OSHEE, 2012) and 70% (HEP, 2013-2015), as shown on Figure 6.5.

In OSHEE, level of estimated technical losses increased for 65% in 2014 compared to 2013, which is very unusual and should be double-checked.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0,107	2,055	0,33	0	0	0	1,015
2009	0	0	0	0,107	2,071	0,315	0	0	0,799	1,046
2010	0	0	0	0,109	2,111	0,352	0	0	0,78	0,951
2011	0	0	0	0,109	2,036	0,348	0	0	0,785	0,986
2012	0	0	0	0,11	1,981	0,33	0	0	0,778	1,041
2013	0	0	0	0,107	2,393	0,284	0	1,021	0,767	1,086
2014	0	0	0	0,104	2,409	0,255	0	0,88	0,709	1,459
2015	0	0	0	0,11	2,421	0,257	0	0,906	0,722	1,367

Figure 6.4 Estimated volume of technical losses in SEE DSOs in the period 2008 – 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	45,1	43,9	57,7	0	0	0	52,6
2009	0	0	0	46,8	42,6	57,6	0	0	42,2	49,4
2010	0	0	0	49,4	42,6	60,4	0	0	41,5	49,7
2011	0	0	0	55,4	42,9	60,4	0	0	44	40,4
2012	0	0	0	57,2	43,2	60,4	0	0	44,5	32,8
2013	0	0	0	62,8	53,3	60	0	70	45	33,7
2014	0	0	0	69,2	57,1	60	0	70	46,5	55,7
2015	0	0	0	69,2	57,1	60	0	70	48,5	67,1

Figure 6.5 Estimated volume of technical losses relative to total losses in SEE DSOs in the period 2008 – 2015

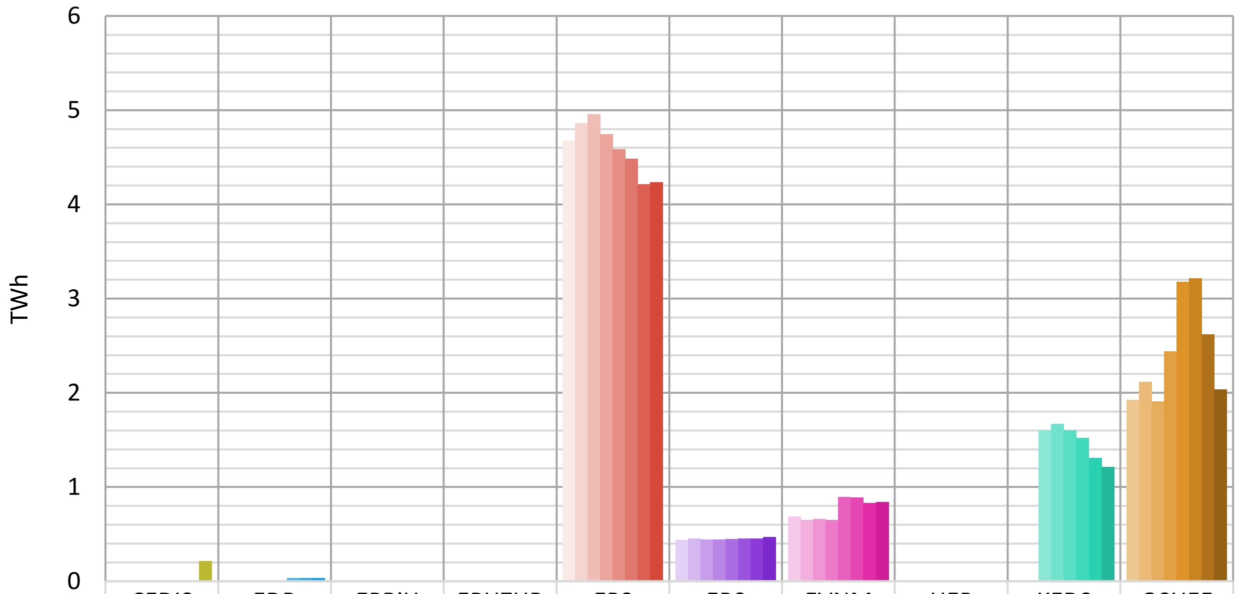
6.3 LEVEL OF LOSSES APPROVED BY THE REGULATOR

In the process of network tariff adoption, national energy regulatory agencies approve certain level of network losses that will be covered by the network charge. It is usually defined for regulatory period of several years in a descending order as incentive to the system operators to gradually decrease system losses. The losses higher than approved by the regulator are not covered by the network charge. This portion of the losses are to be covered from the DSOs' profit.

Total amounts of the network losses approved by the regulator are given on the following Figure. Data for EPBiH, EPHZHB and HEP were not available.

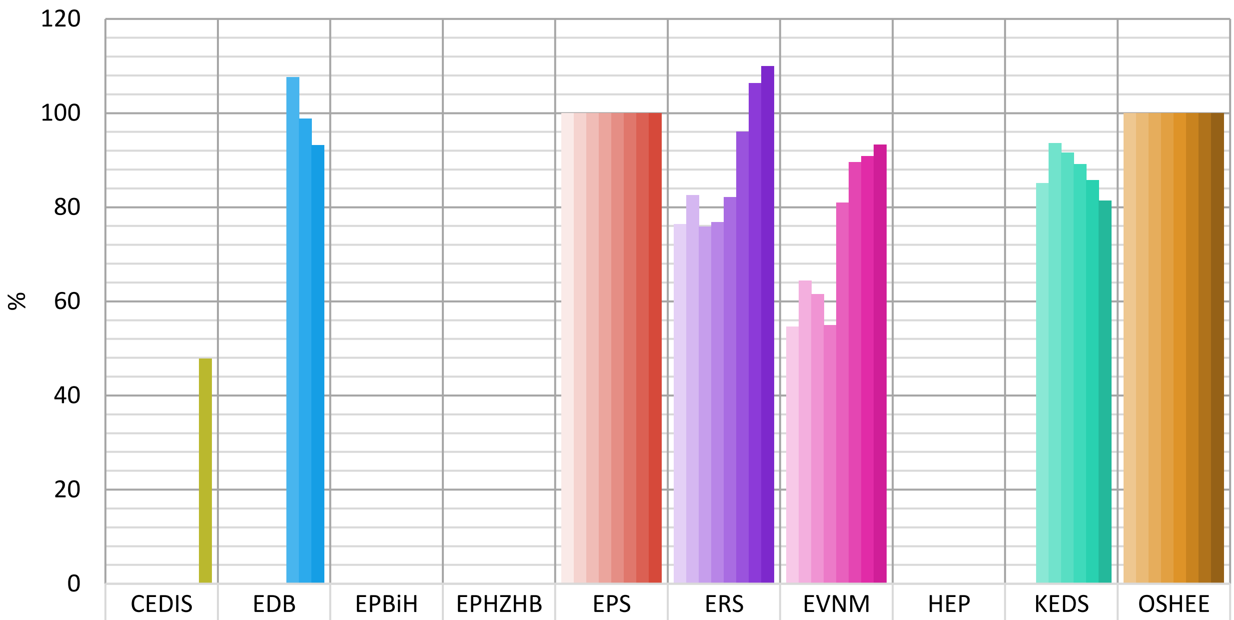
Figure 6.7 shows that the network losses approved by the regulator relative to the total losses were between 47,9% (CEDIS, 2015) and 110% (ERS,2015). In OSHEE and EPS in the observed period level of approved losses was exactly the same as realized total losses (technical + commercial).

Realized losses were higher than approved only in EDB (2013) and ERS (2014 and 2015). In all other cases the DSOs were more efficient than the regulator expected.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	4,679	0,437	0,69	0	0	1,927
2009	0	0	0	0	4,865	0,452	0,653	0	0	2,117
2010	0	0	0	0	4,959	0,442	0,662	0	1,599	1,911
2011	0	0	0	0	4,748	0,443	0,652	0	1,668	2,439
2012	0	0	0	0	4,586	0,449	0,897	0	1,603	3,178
2013	0	0,036	0	0	4,487	0,455	0,887	0	1,521	3,218
2014	0	0,035	0	0	4,215	0,452	0,831	0	1,309	2,622
2015	0,214	0,032	0	0	4,237	0,47	0,842	0	1,211	2,035

Figure 6.6 Level of losses approved by the regulator in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	100	76,4	54,7	0	0	100
2009	0	0	0	0	100	82,6	64,4	0	0	100
2010	0	0	0	0	100	75,9	61,6	0	85,1	100
2011	0	0	0	0	100	76,9	55	0	93,6	100
2012	0	0	0	0	100	82,2	81	0	91,6	100
2013	0	107,7	0	0	100	96,1	89,6	0	89,2	100
2014	0	98,8	0	0	100	106,4	90,9	0	85,8	100
2015	47,9	93,2	0	0	100	110	93,3	0	81,4	100

Figure 6.7 Level of losses approved by the regulator relative to total losses in SEE DSOs in the period 2008 - 2015

7 METERS

The customer meter is a critical resource for DSO as it enables both internal accounting of losses on the distribution system and proper accounting of sales to customers. Installation of meters at all customer sites is basic prerequisite for effective tariff development and progress toward financial sustainability for DSOs. Malfunctioning and tempered meters are also common problems that cause inaccurate sales recognition and insufficient revenue collection, but with the current trend, in accordance with the European regulations and recommendations (Directive 2009/72/EC of 13 July 2009 and Regulation (EU) No 347/2013 of 17 April 2013), of the installation of smart meters this problem can be reduced to minimum. Smart meter can help consumers to become better informed about their usage, to become prosumer at the same time and to optimize energy usage based on environmental and/or price preferences (demand response). It enables billing of real consumed energy. Increase in distributed generation capacities in SEE DSOs can be better supported with the increase of the number of smart meters and components of smart grid deployment, because of the easier integration and supervision of distributed generation in the network with smart grid components and DMS (Distributed Management System).

In some countries around world there are specific customer classes allowed to be connected without meters. In this region, this was applied in OSHEE until 2012 for 3 LV consumption categories: households, commercial customers without peak power registration and public lighting. Their shares in total number of customers were almost negligible. But, since 2013 it is not allowed any more.

The proposed benchmarking measures in this report are intended to evaluate issues of metering accuracy, precision, extent that different types of meters and reading tools are used to measure electricity consumption (i.e. smart meters, electronic/digital meters, electromechanical meters), type of communication used in smart meters, meters age, value of new meters installed, etc.

7.1 METER TYPES AND METER READING

This section grasps meter types (electromechanical, electronic and smart meter) and meter reading approaches (manual, automatic meter reading, remotely) applied in the observed DSOs. Smart meters with remotely meter reading use PLC, GPRS or GSM type of communication for data transfer between the meter and AMI (advance metering infrastructure) system. Data on the number of meters provided in this section are related to the current situation (first half of 2016) as well as the data from the second half of 2013. In this sense, it does not necessarily match the number of meters from the metering set of data. This difference is noticeable for EPBiH, EVNM, KEDS, OSHEE and CEDIS DSOs.

A smart meter is an electronic device that records consumption of electric energy in intervals of an hour or less (15 minutes) and communicates that information back to the utility for monitoring and billing purposes or to the consumer with the use of In home display (IHD) or with the web or mobile applications. Smart meters enable two-way communication between the meter and the central system what differs from traditional automatic meter reading (AMR) that enabled only one-way PLC malfunction, electricity theft or some other problem with two-way metering of active and reactive power, and at the same time ensure the security of data. Minimum requirements on the characteristics of smart meters need to be in accordance with the Commission Recommendations (2012/148/EU). Communication types between the smart meter and AMI system used in the region are:

- PLC (Power line communication)
- GPRS (General Packet Radio Service), and
- GSM (Global System for Mobile Communications).

PLC is techniques which enable telecommunication using the electricity distribution network as a communication channel. The range of PLC is limited by the fact that the data cannot be transferred through power transformation. To transfer data from the smart meter with PLC communication to remote AMI system, the use of data concentrator, with other communication channels, is required. GSM is a digital mobile telephone standard. GPRS stands is an extension technology to the existing GSM network, it is a packet oriented mobile data service on the 2G and 3G cellular communication systems.

It is important to note that the share of meters type and meter reading in CEDIS in 2012 were equal to those in 2015, as well as for values of share of meters type and meter reading is in EPS, where the values in 2015 were equal with those in 2012.

Type of meters in 2015 used for customers on HV level are reported in 3 DSOs: EPS the share of electric meters was 100%, while in HEP and KEDS the share of smart meters was 100%, with no change compared to 2012, as shown in the following figure. Data for ERS in 2015 were not available.

Figure 7.2 shows smart meters at HV customers with remotely reading use GPRS type of communication. Type of communication in HEP and KEDS used on HV is not available.

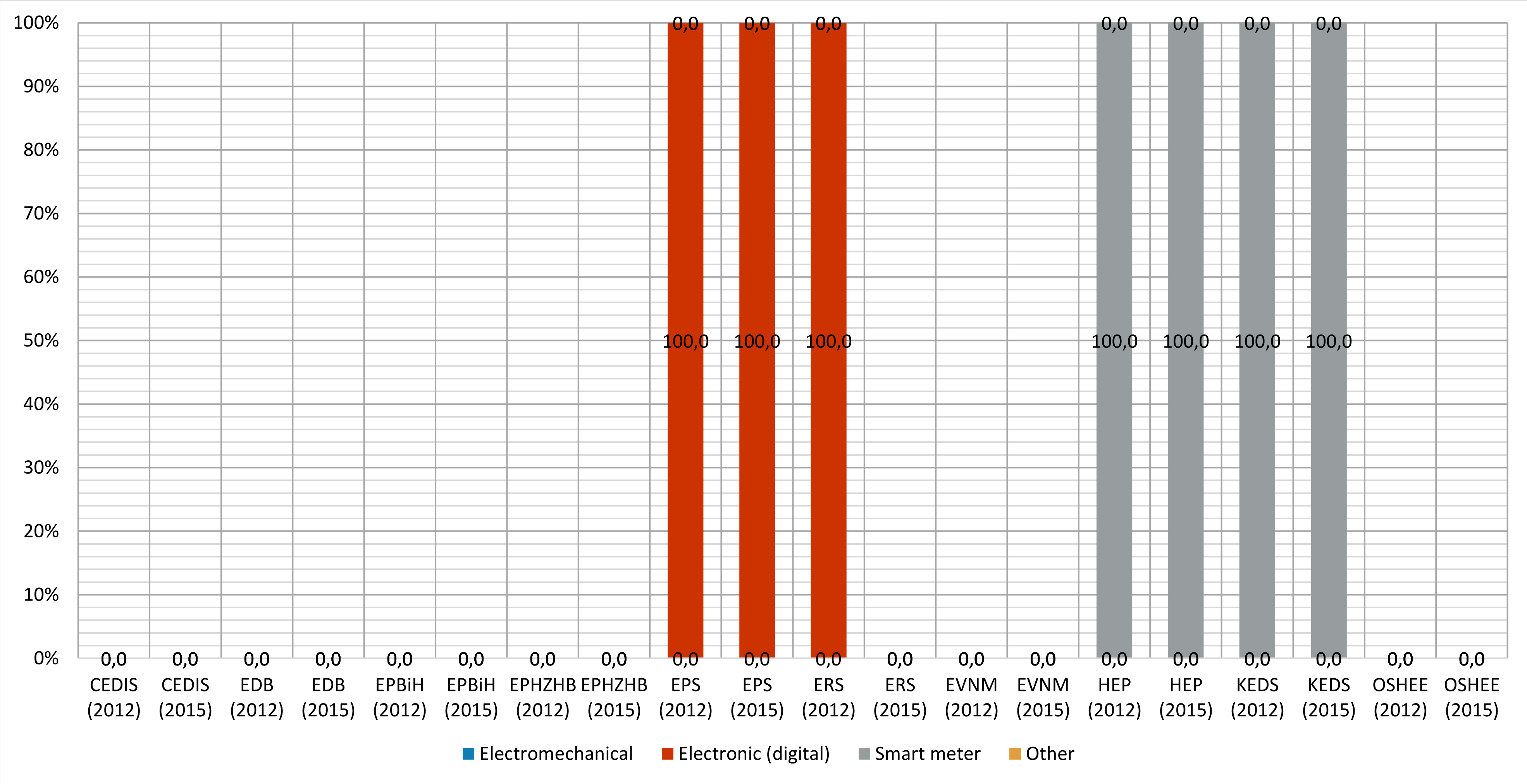


Figure 7.1 Share of different meter types - HV consumers (2012 and 2015)

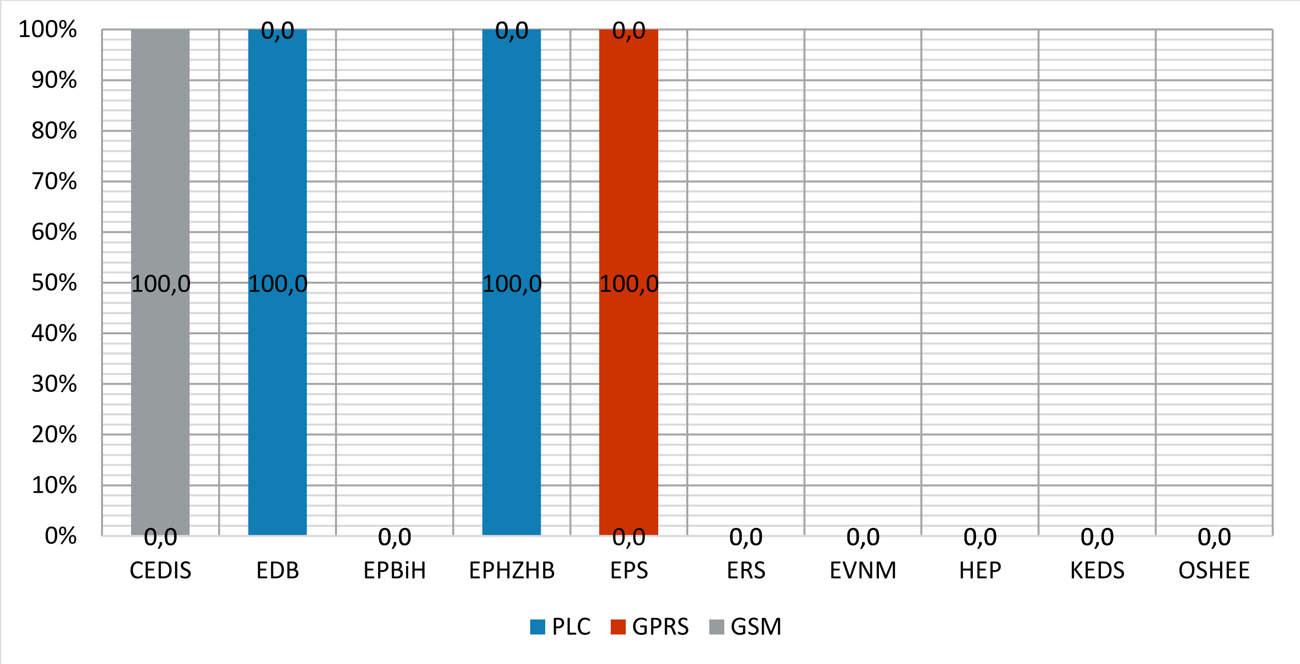


Figure 7.2 Share of communication types in smart meters with remotely reading - HV consumers (2015)

On MV (Figure 7.3) in 5 out of 10 DSOs (EPBIH, EPHZHB, EVNM, HEP, KEDS) the share of smart meters is 100% or almost 100%, and in EPS it is 64%. Some DSOs, like EDB, EPBiH, EPHZHB and KEDS had a trend of increase in the share of smart meters on MV, and increase the share of electronic meters (EDB) in 2015 comparing to 2012. Remote reading of MV customers prevails in 5 out of 10 DSOs: KEDS, HEP, EVNM, EPHZHB and EPBIH. In EPS and OSHEE on MV automatic reading using the terminal prevails, while in CEDIS and EDB manual reading is dominant (Figure 7.4). Data in ERS in 2015 were not available. The trend of slight increase in remotely and automatic meter reading using the terminal on MV is found in the region in the period 2012 – 2015.

Figure 7.5 shows the difference in communication types used in smart meters on MV with remotely reading. PLC type of communication is used in 3 DSOs: CEDIS, EDB, and EPHZHB, GPRS type of communication are used in other 3 DSOs: EPBiH, EPS, and KEDS, while GSM type is used in EVNM and OSHEE.

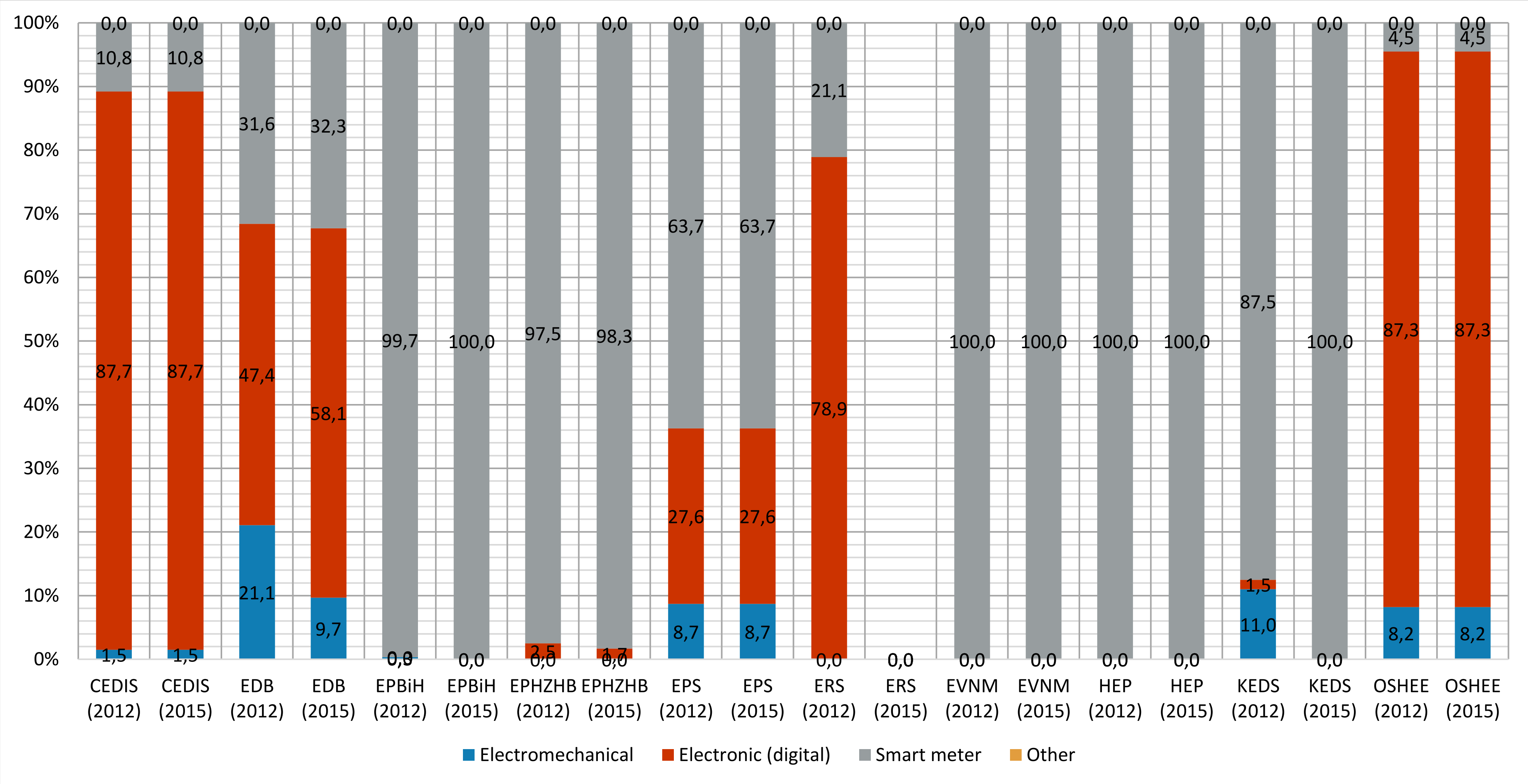


Figure 7.3 Share of different meter types - MV consumers (2012 and 2015)

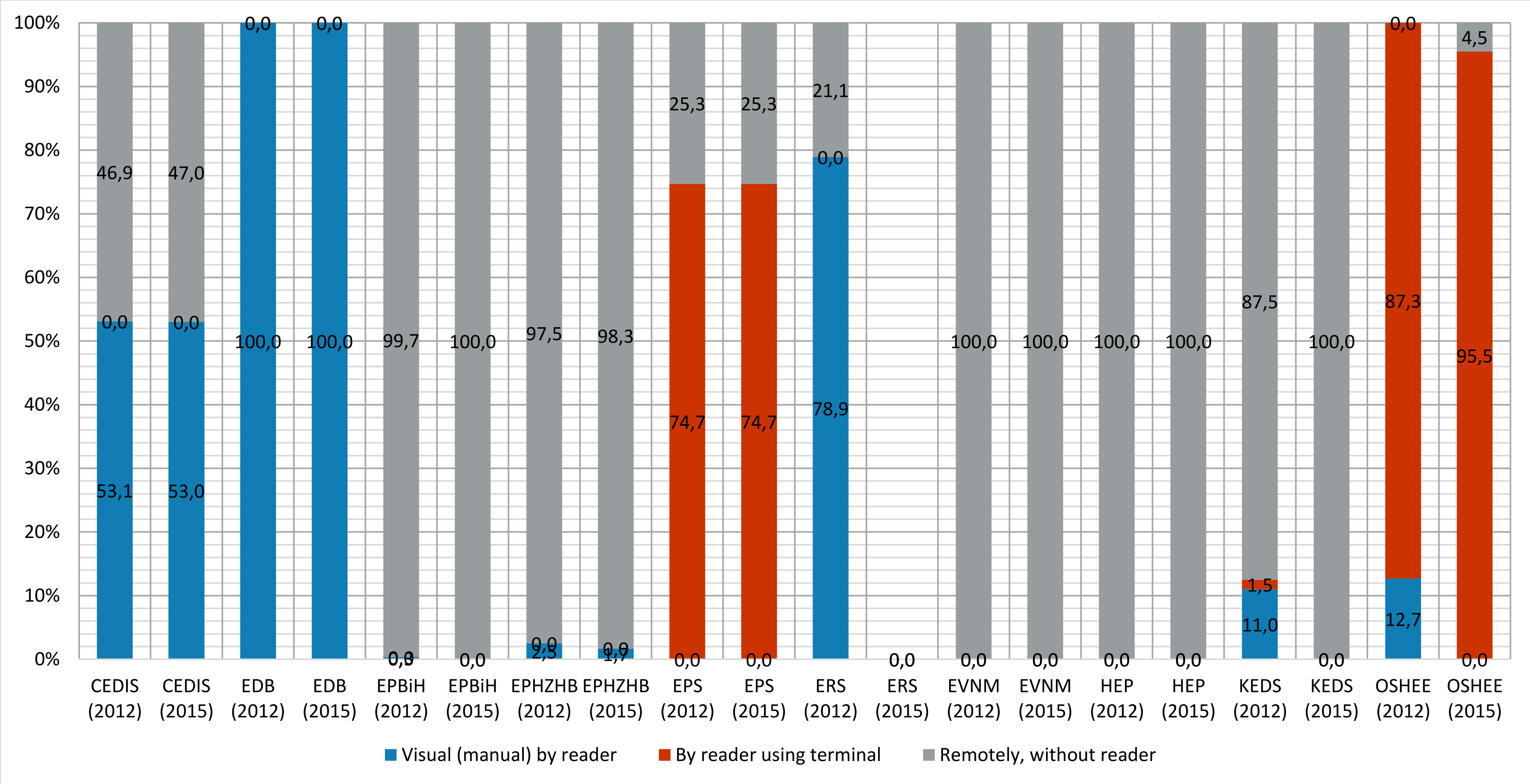


Figure 7.4 Share of different meter readings [%] - MV consumers (2012 and 2015)

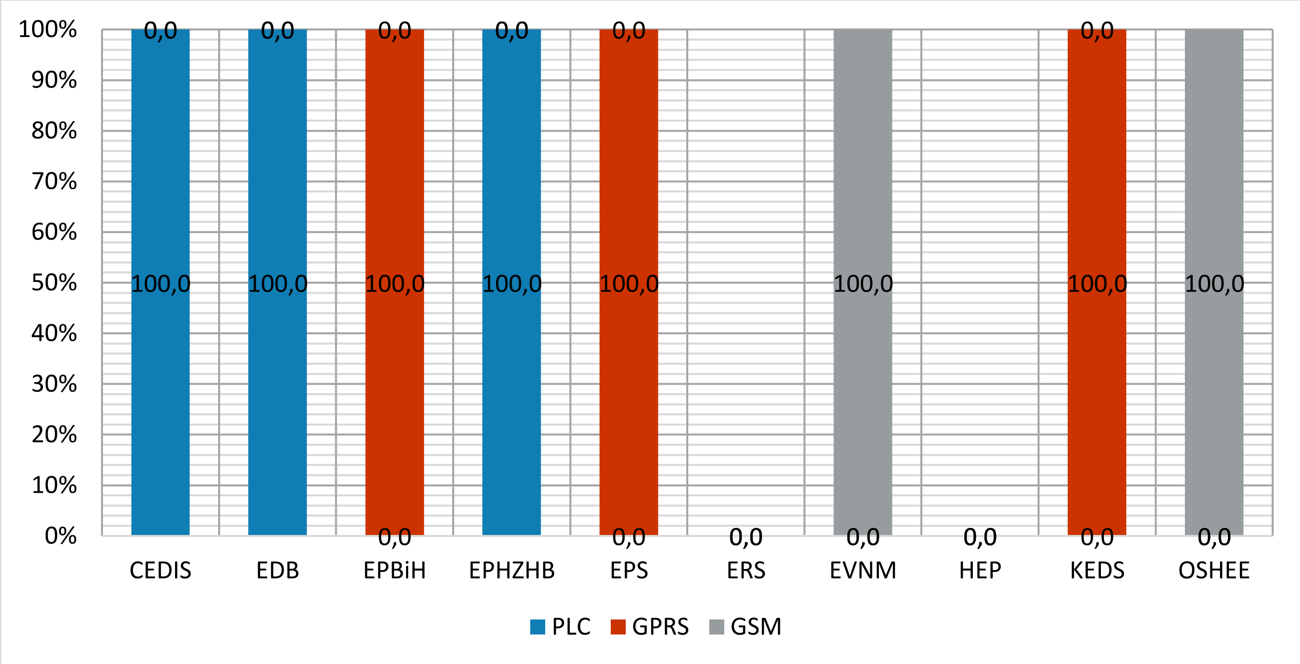


Figure 7.5 Share of different communication types in smart meters with remote reading [%] - MV consumers (2015)

At the household level (Figure 7.6) electromechanical meters prevail. The exception is found in CEDIS where smart meters prevail. In EDB electromechanical meters prevail, but in 2013 EDB started with the installation of the smart meters at household customers, reaching the share of smart meters of 11,4% in 2015. In EPBiH also electromechanical meters prevail, but they continued with the installation of electronic and smart meters, so the share of electronic meters increased from 0,1 to 0,6 %, while the share of smart meters increased from 10,1 to 14,9% in 2015 compared to 2012. In EVNM electronic meters prevail, and in the same period the share increased from 91 to 92,4%. In parallel, EVNM started with the installation of smart meters (4,4% in 2015). In KEDS electronic meters prevail and the share increased almost 3 times in the period 2012 - 2015. The decrease in the share of smart and electronic meters in EPHZHB in the same period is probably found due to decrease in the number of all types of meters at household customers in that period, probably because of emigration (number of LV customer in 2015 was for 6.685 less compared to that number in 2012). Manual reading prevails in EDB, EPBIH, and EPHZHB (Figure 7.7), automatic meter reading using terminal dominate in EPS, EVNM, KEDS, and OSHEE. Remotely meter reading on LV prevails only in CEDIS. The trend of slight increase in remotely meter reading (EDB, EPBiH, and EVNM) and high increase in automatic meter reading using the terminal (KEDS and OSHEE) is found in the region, while due to emigration, in EPHZHB the share of remotely meter reading is decreased.

The most common type of communication used in smart meters at household customers in the region is the PLC and is used in CEDIS, EDB, EPBiH, and EPHZHB, while in EVNM are nearly equally presented PLC and GSM types (Figure 7.8). In EPS and KEDS are used GPRS type of communication for smart meters, and in EPBiH, also GPRS, with the share of 15,8%, together with dominant PLC type of communication. GSM type of communication is dominant in OSHEE, while in EVNM GSM and PLC are nearly equally presented. Data for ERS and HEP weren't available.

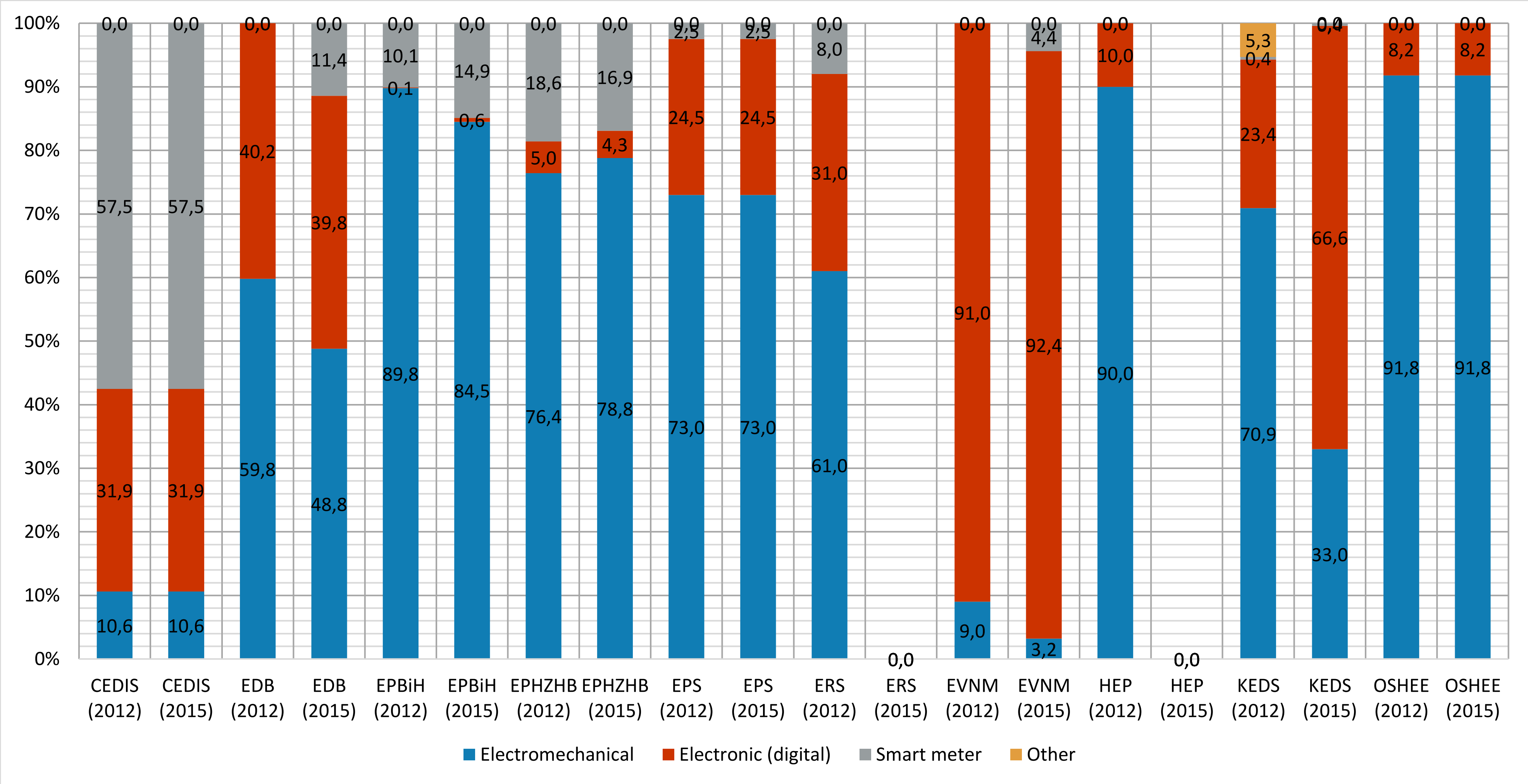


Figure 7.6 Share of different meter types in households consumer category (2012 and 2015)

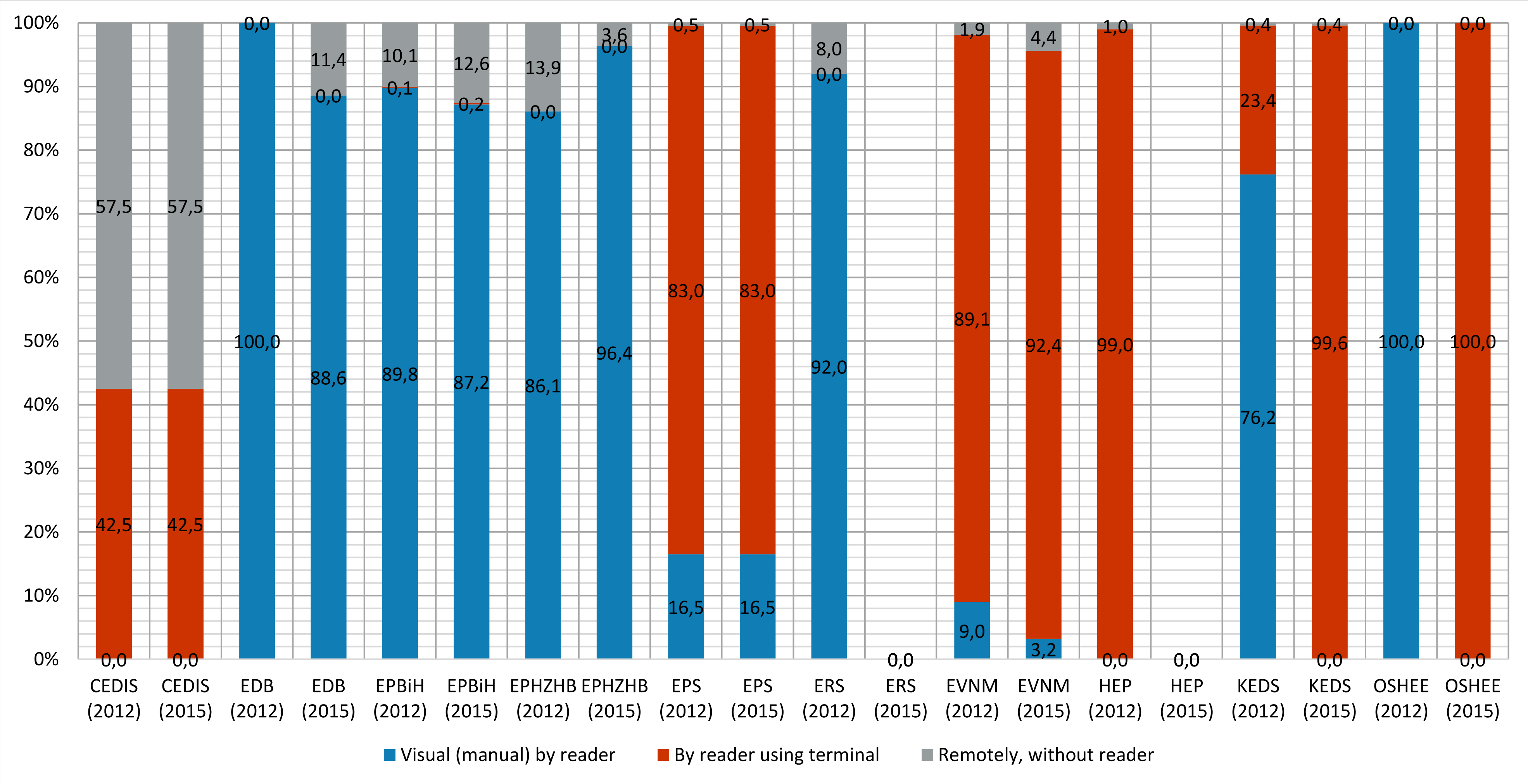


Figure 7.7 Share of different meter readings [%] in households consumer category (2012 and 2015)

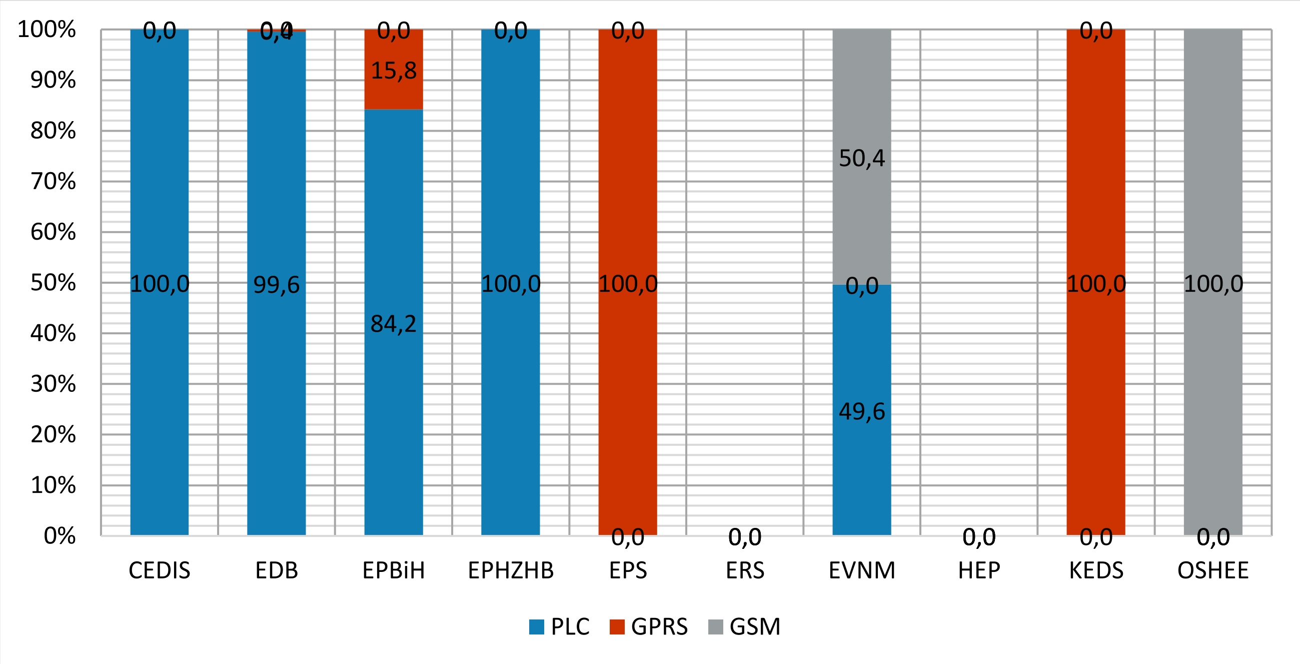


Figure 7.8 Share of different communication types in smart meters with remotely reading [%] in households consumer category (2015)

For public lighting (Figure 7.9) in 3 out of 6 DSOs the most common type of electricity meter is electromechanical: EDB, EPHZHB, and EPS. In EDB and KEDS electronic meters prevail, and only in EVNM smart meters dominate (58%), that were installed during the period 2012 - 2015. In the same period, slight increase in smart meters' use in found in EDB, EPBiH, EPHZHB, and already mentioned EVNM, while in KEDS the use of electronic meters increases more than 2 times but the use of smart meters decreased by 4,4%. Figure 7.10 shows meter reading approaches used for public lighting. In EDB, EPBiH, and EPHZHB manual readings prevail, while in EPS, and KEDS automatic readings using the terminal are more common. Only in EVNM remotely meter readings dominate, with the share of 58% in 2015, while in 2012 there was no data on public lighting meter reading. The trend of slight increase in remotely meter reading is found in EDB, EPBiH, and EVNM, in 2015 compared to 2012, while in the same period in KEDS all meters with visual meter reading were switched to with automatic meter reading with terminal because of the increase in the share of electronic meters for 35,9%. Share of remotely meter reading in KEDS decreased for 4,4%, according to the decrease of the smart meter share. Data in CEDIS, ERS, HEP and OSHEE were not available in 2015.

The dominant communication type in smart meters with remotely reading for public lighting category in the region is PLC in 4 DSOs: CEDIS, EPBiH, EPHZHB and EVNM, while in EDB is present with the share of 40,9% (Figure 7.11). GPRS communication prevails in EDB (59,1%), for all smart meters is used in EPS and KEDS, while in EPBiH is presented with 19,7%. GSM communication is only used in EPBiH with the share of 6%. Data for ERS, HEP, and OSHEE weren't available.

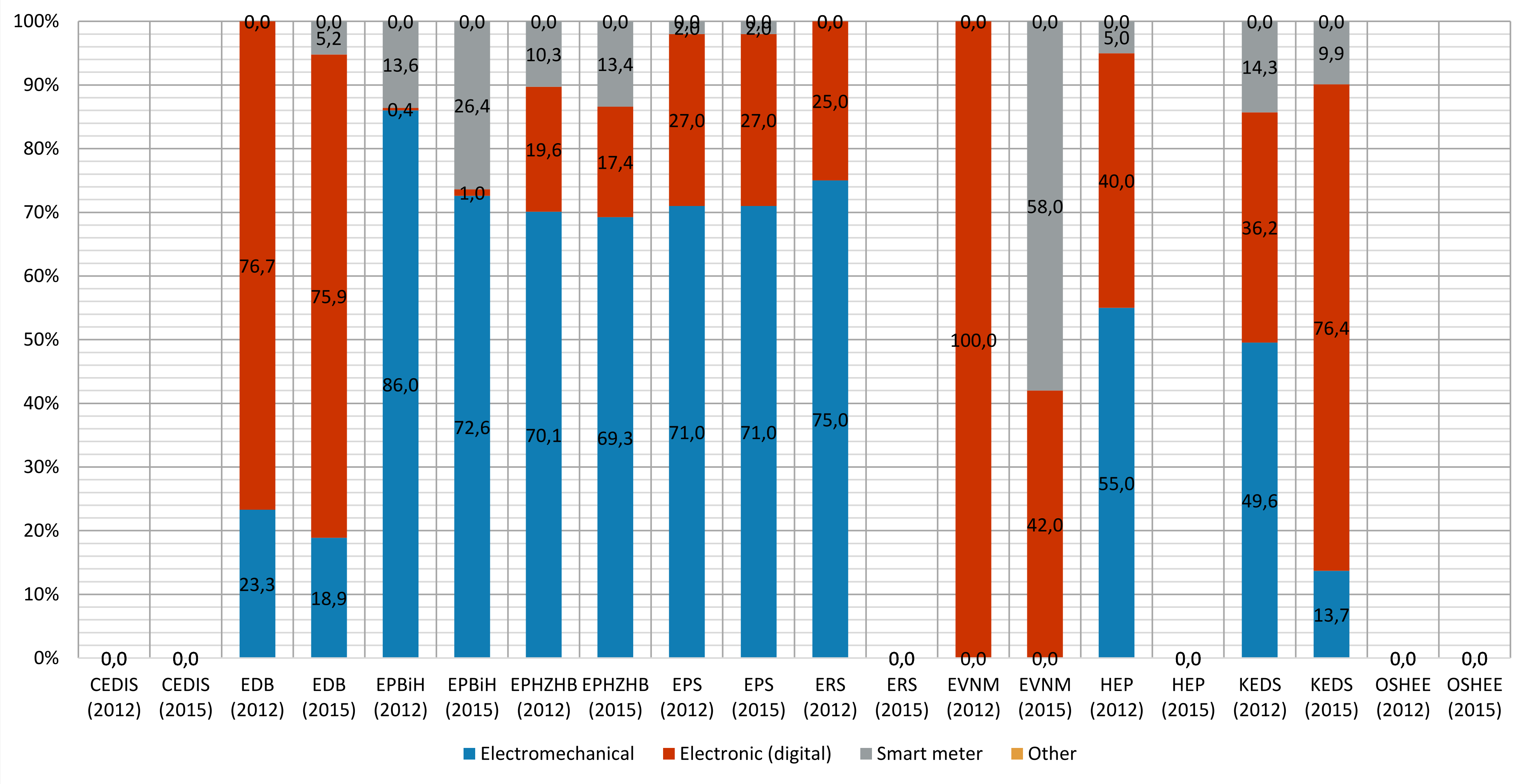


Figure 7.9 Share of different meter types in public lighting consumer category (2012 and 2015)

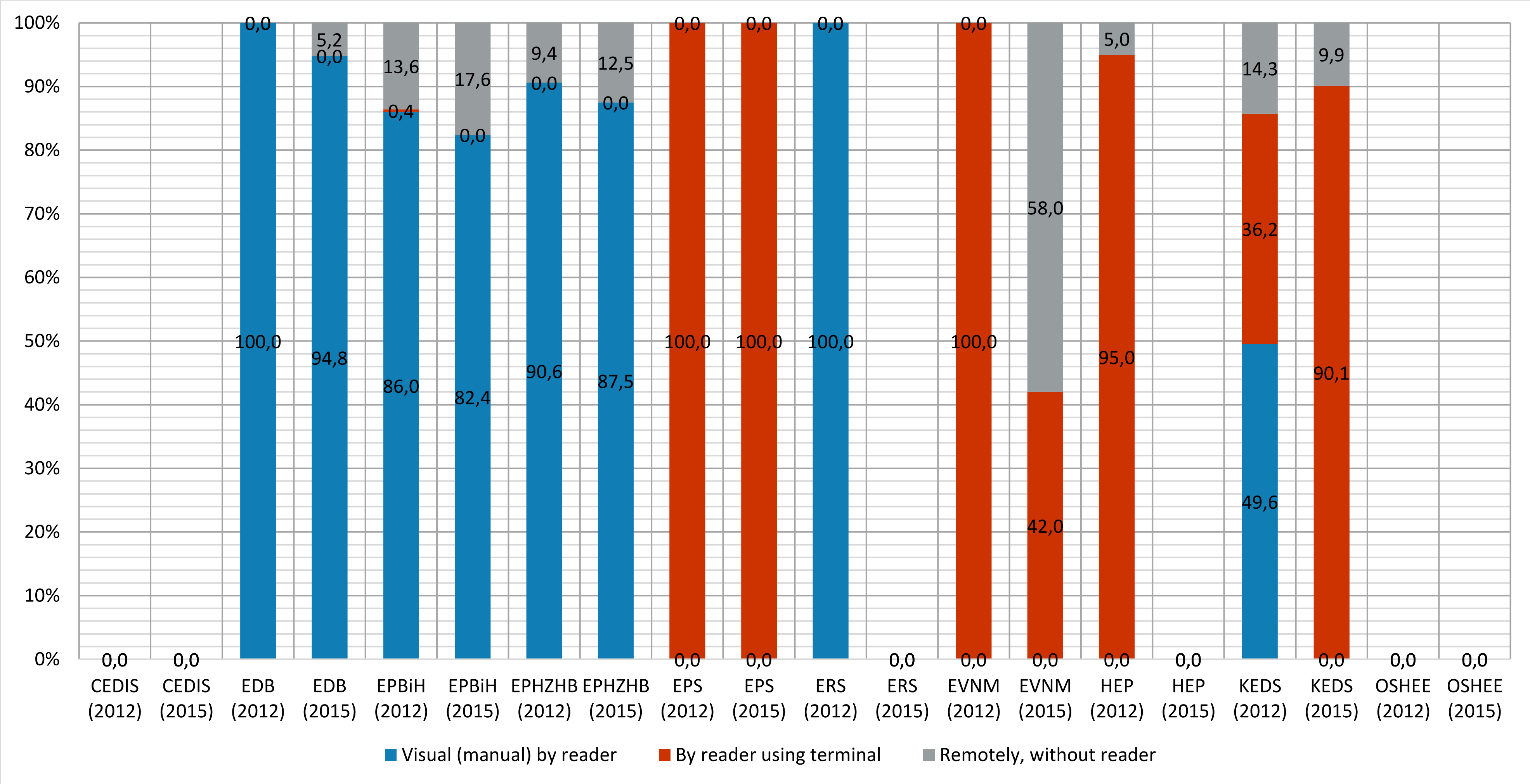


Figure 7.10 Share of different meter readings [%] in public lighting consumer category (2012 and 2015)

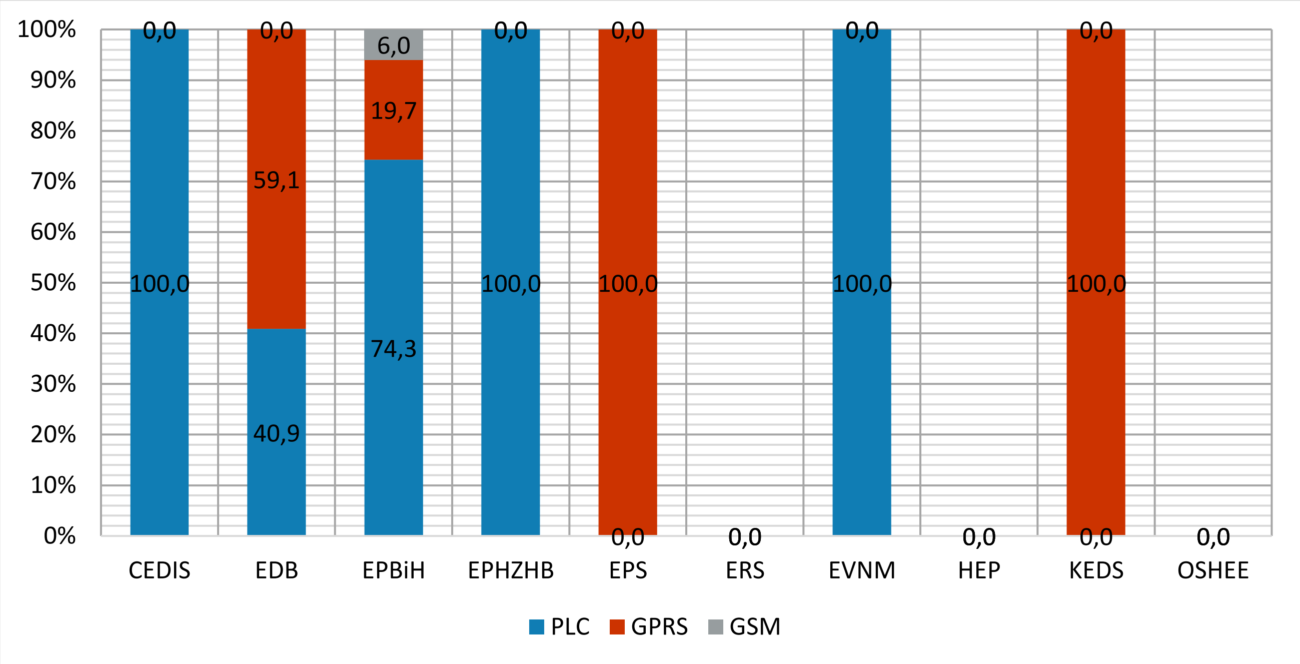


Figure 7.11 Share of different communication types in smart meters with remotely reading [%] in public lighting consumer category (2015)

For LV commercial customers with peak power (demand) registration common types of electricity meters are electronic and smart meters (Figure 7.12). In 5 DSOs the most common type of electricity meter is a smart meter (EPBIH, EPHZHB, EVNM, KEDS, and HEP – in 2012 share of smart meters was 100%). In other 4 DSOs it is the electronic meter: CEDIS, EDB, EPS, and OSHEE. The trend of slight increase in the share of smart meters in 2015 compared to 2012 is found in EDB, EPBiH, and KEDS, while in EVNM during that period all electronic meters are replaced with the smart meters. In the same period, the share and the number of smart meters in EPHZHB decreased for 11,4% and 214, respectively, while the share and the number of electronic meters increased for 11,4% and 140, respectively.

Figure 7.13 shows that the most of LV commercial customers with peak power (demand) registration were read remotely (in 5 DSOs: EPBiH, EPHZHB, EVNM, KEDS, and HEP - in 2012 share of smart meters was 100%). In CEDIS, EDB, and ERS (in 2012 was 98% meters with visual readings) visual (manual) readings prevail, while in EPS, and OSHEE automatic readings using terminals were dominant.

Figure 7.14 shows that 3 out of 7 DSOs use PLC communication in smart meters with remote reading at LV commercial customers with peak power registration: CEDIS, EDB, and EPHZHB, while in EPBiH, EPS, EVNM, and KEDS are used GPRS communication. Data for ERS, HEP, and OSHEE weren’t available.

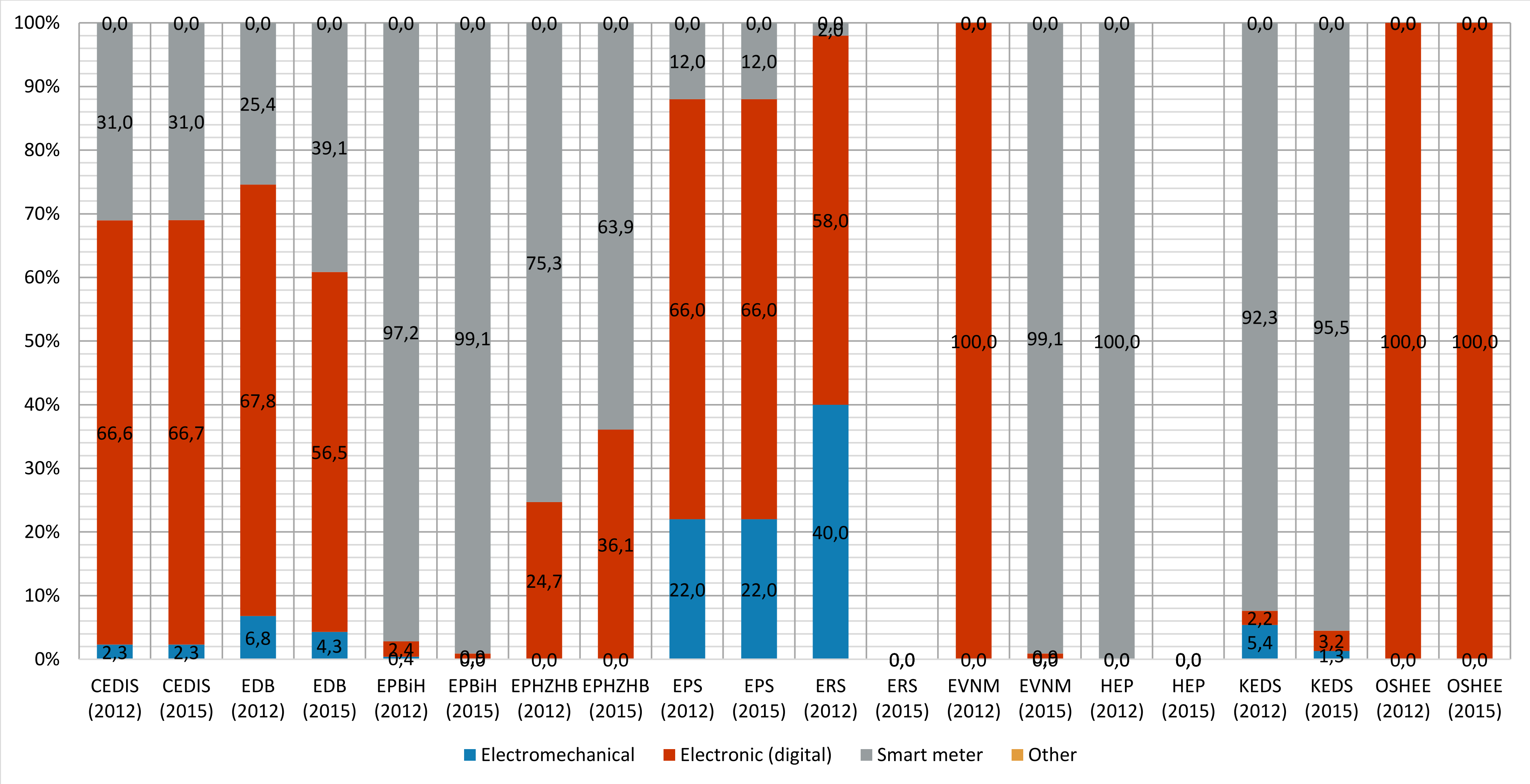


Figure 7.12 Share of different meter types in LV-commercial consumers with peak power registration consumer category (2012 and 2015)

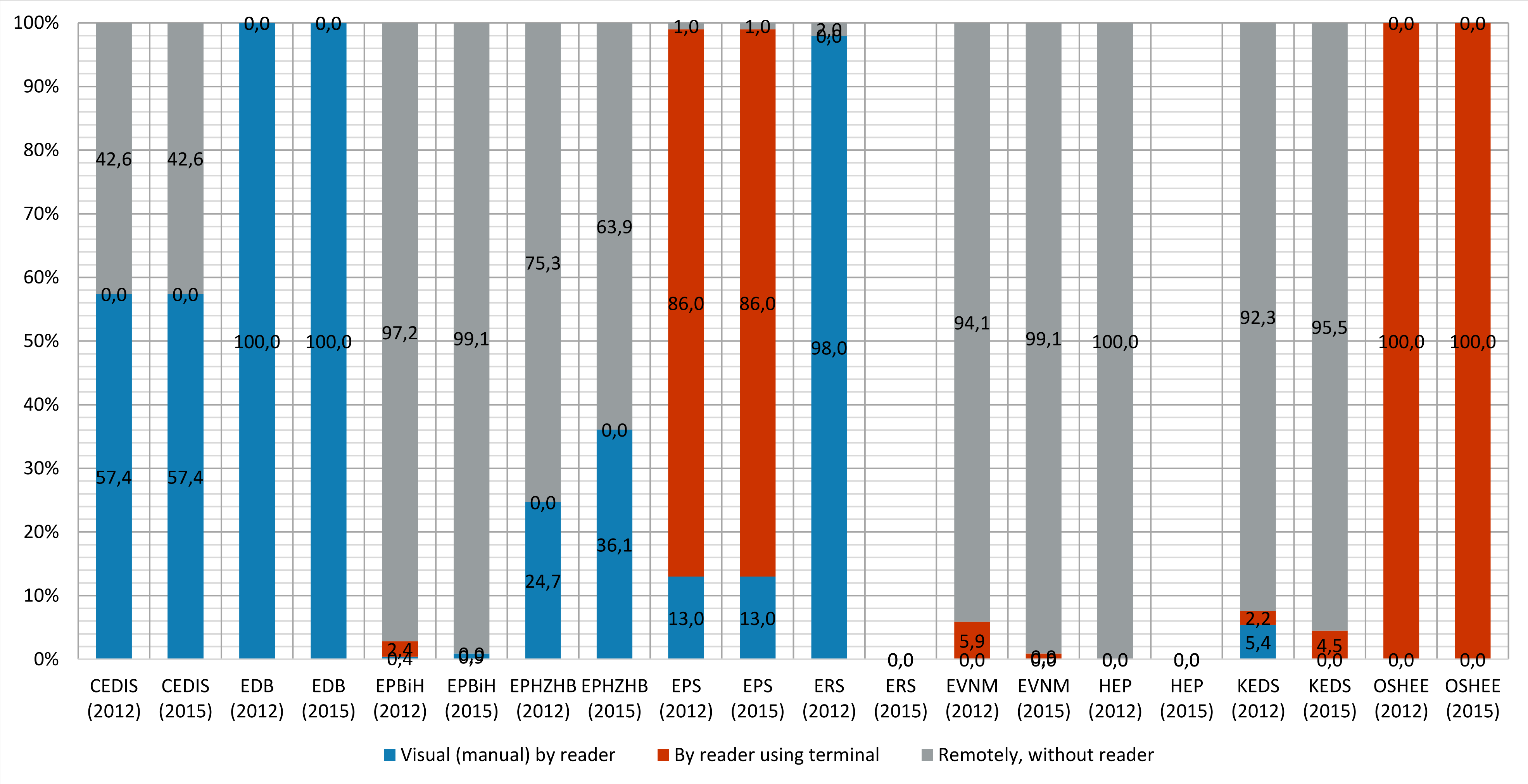


Figure 7.13 Share of different meter types and meter readings [%] in LV-commercial with peak power registration consumer category (2012 and 2015)

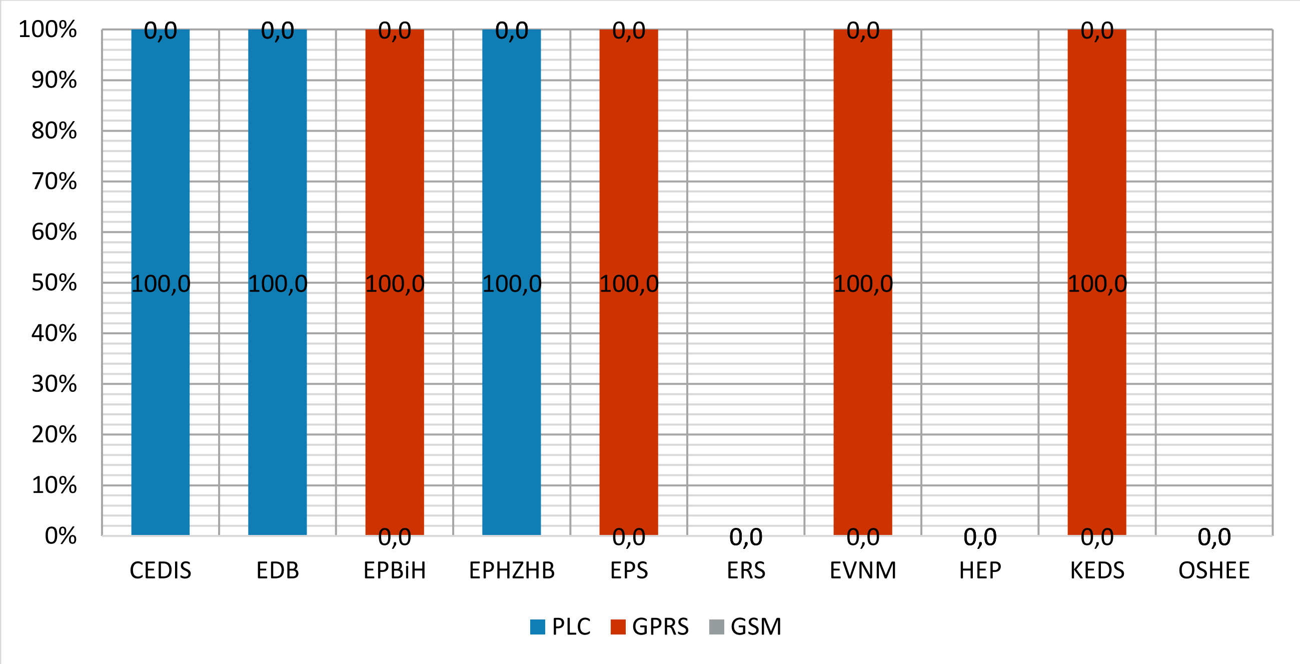


Figure 7.14 Share of different communication types in smart meters with remotely reading [%] in LV commercial with peak power registration consumer category (2015)

For LV commercial customers without peak power (demand) registration common types of electricity meters differ among the DSOs (Figure 7.15). Electromechanical meters prevail in 4 DSOs: EPBiH, EPHZHB, EPS, and OSHEE. Electronic meters are the most common in 4 other DSOs: EDB, ERS, EVNM, and KEDS, while smart meters dominate only in CEDIS. Smart meters are installed in 7 DSOs: CEDIS, EDB, EPBiH, EPHZHB, EPS, EVNM, and KEDS, but only in CEDIS they are having dominant role on LV commercial customers without peak power (demand) registration. In all of them the trend of slight increase in the share of smart meters is found in 2015 compared to 2012 with the significant increase of electronic meters in ERS and KEDS. In HEP the data weren't available for 2015.

The most LV commercial customers without peak power (demand) registration are read manually (in 4 DSOs: EDB, EPBIH, EPHZHB, and ERS (Figure 7.16). In other 4 DSOs: EPS, EVNM, KEDS and OSHEE automatic readings using terminals prevail. In CEDIS smart meters prevails and they are read remotely. In EPHZHB share of remotely read meters is 33,6%, while remotely read meters, with a smaller share, are present also in EDB, EPBiH, EVNM, and KEDS. The trend of increase of remotely read meters in the period 2012 - 2015 in the region is also presented here: in KEDS meters with automatic readings using terminals increased for more than 3 times, and their share in 2015 was 69,7%, while in OSHEE all meters were read visually until 2012, but since 2015 they are read automatically with the use of reading terminals.

Communication type that prevails in smart meters with remotely reading at LV commercial customers without peak power registration is PLC (Figure 7.17), especially in 4 DSOs: CEDIS, EDB, EPBiH, and EPHZHB, while in EVNM is equally presented with GSM communication type. In EPS and KEDS the GPRS communication is used only, while their share in EPBiH is 36,4%, and in EDB it is 8,3%.

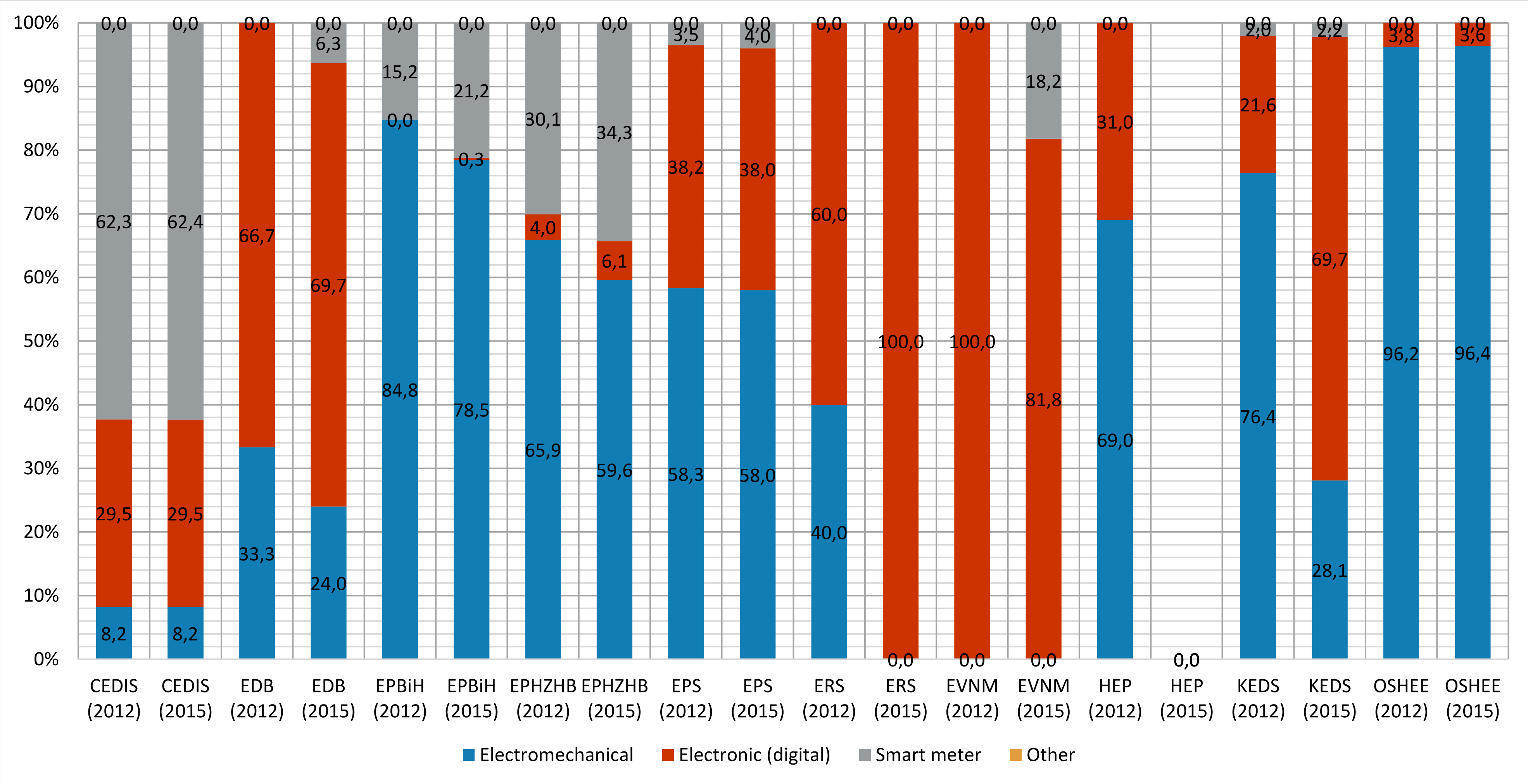


Figure 7.15 Share of different meter types in LV-commercial without peak power registration consumer category (2012 and 2015)

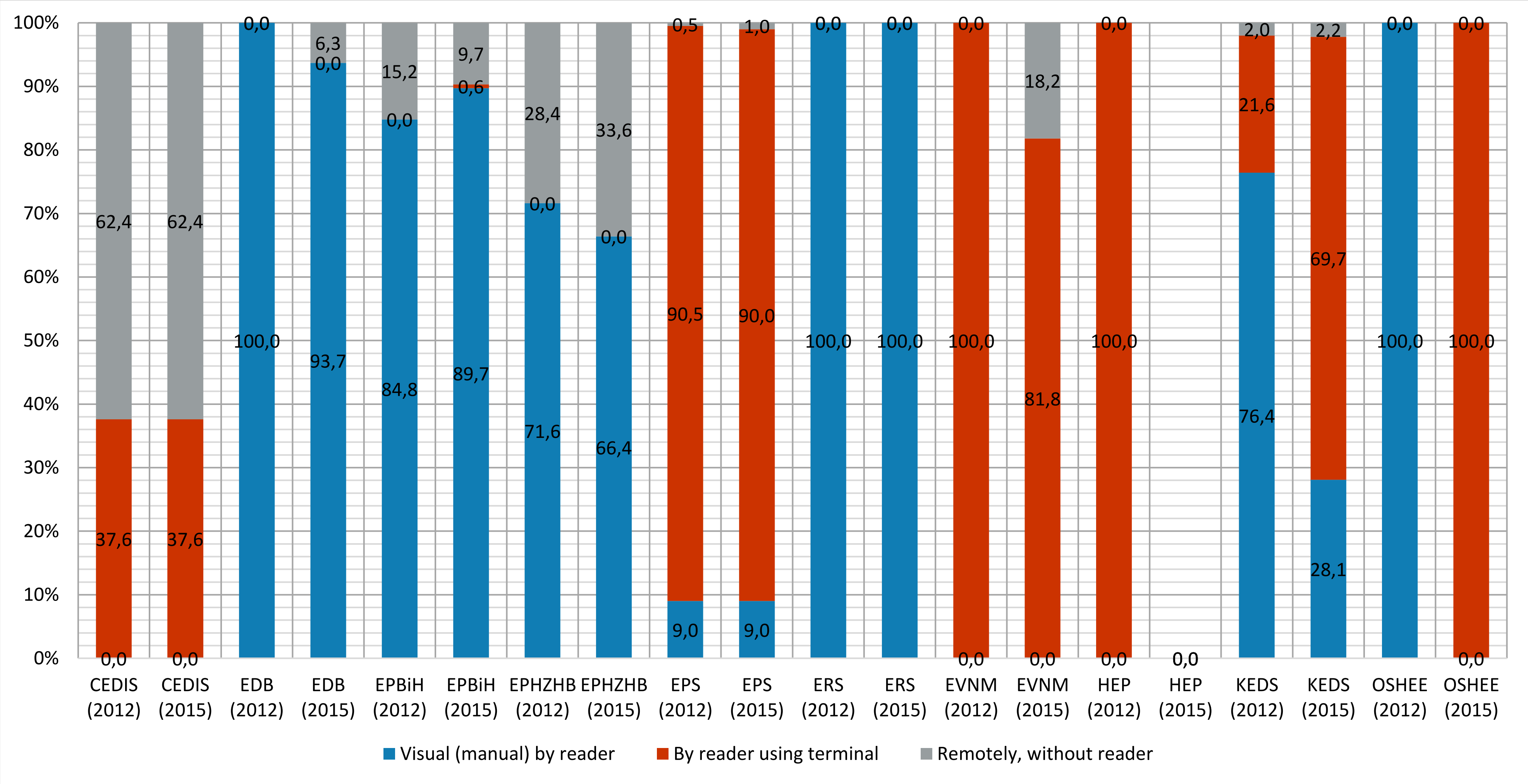


Figure 7.16 Share of different meter readings [%] in LV-commercial without peak power registration consumer category (2012 and 2015)

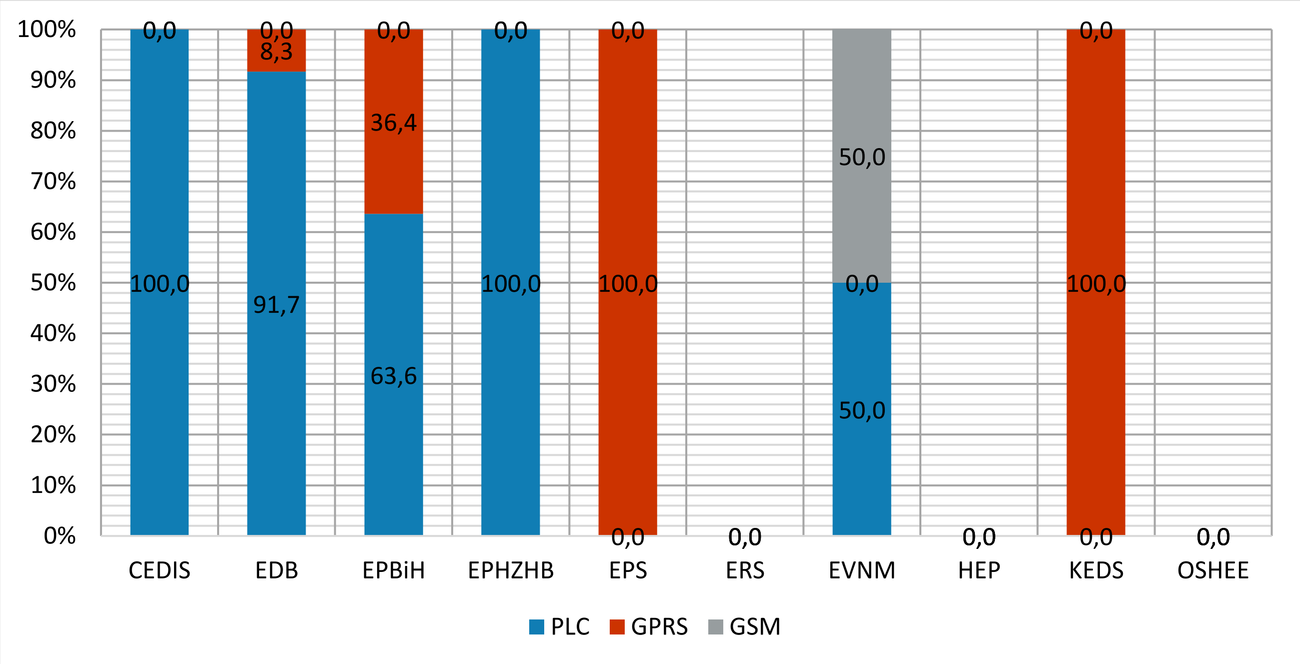


Figure 7.17 Share of different communication types in smart meters with remotely reading [%] in LV-commercial without peak power registration consumer category (2015)

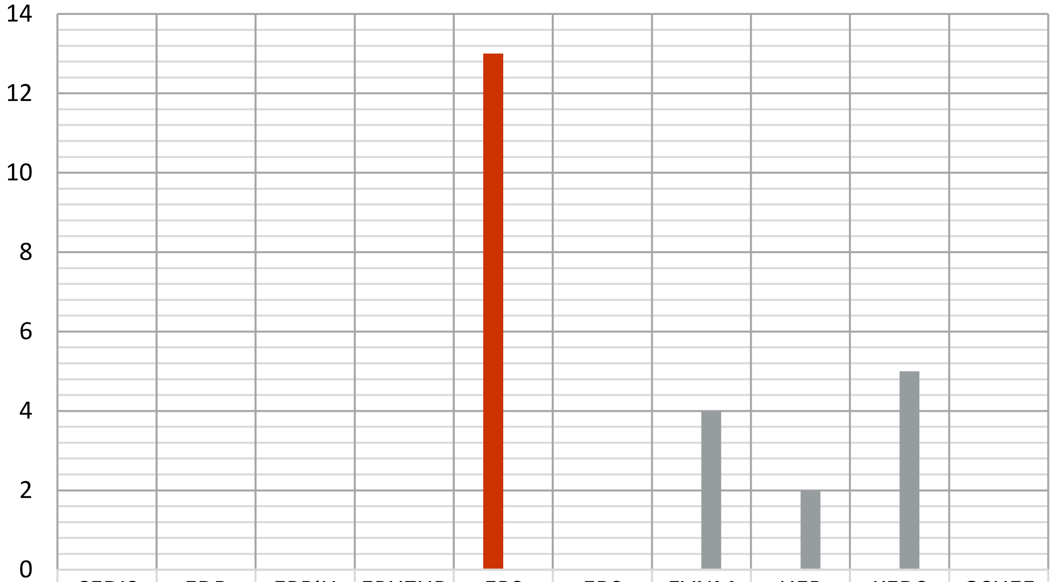
7.2 AVERAGE AGE OF METERS

The average age of meters is given here as an approximate indicator of meter accuracy and indicator of new meter installation activities of the distribution system in the period 2012 - 2015.

In this subchapter there is a lack of input data from ERS side (for all meters). Besides that, the report lacks the data on meters type used in HEP. KEDS also didn't provide the data for electromechanical meters for MV customers, while EPHZHB lacks the data for electronic meters also for MV customers. The data for the number of public lighting meters in CEDIS and OSHEE were not reported separately in the billing system, so their data on average age are also excluded from the calculation. This should be considered when evaluating data on average ages of MV and LV meters by type – for all DSOs (i.e. 22,6 yrs for electromechanical meters, and 6,9 yrs for electronic meters, Figure 7.24), and average age of meters by consumption category (for MV customers - 7,1 yrs).

Figure 7.18 shows the average age of meters by type for HV customers in 4 DSOs: EPS, EVNM, HEP, and KEDS, while the number of metering points on HV is given for 3 DSOs: EDB, OSHEE, and EVNM (Figure 19.1). The oldest meters are found in EPS – 13 years old, and that is 2,6 times older than the second oldest meters found in KEDS - 5 years old. The newest meters on HV level are found in HEP (2 years).

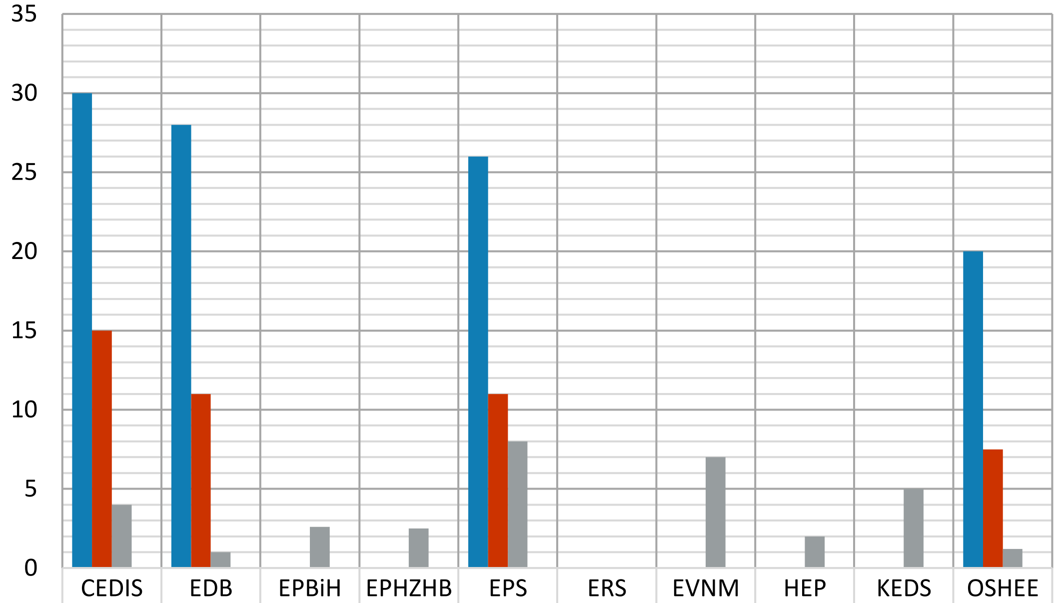
At MV level all DSOs with electromechanical meters: CEDIS, EDB, EPS, and OSHEE, are having the oldest meters (20-30 years old) (Figure 7.19). Electronic meters, in the same 4 DSOs, are aged between 7,5 (OSHEE) and 15 (CEDIS). Smart meters in 9 DSO, are the newest ones, with the age between 1 (EDB) and 8 (EPS) years.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	0	0	0	0	0	0	0	0	0
Electronic (digital)	0	0	0	0	13	0	0	0	0	0
Smart meter	0	0	0	0	0	0	4	2	5	0
Other	0	0	0	0	0	0	0	0	0	0

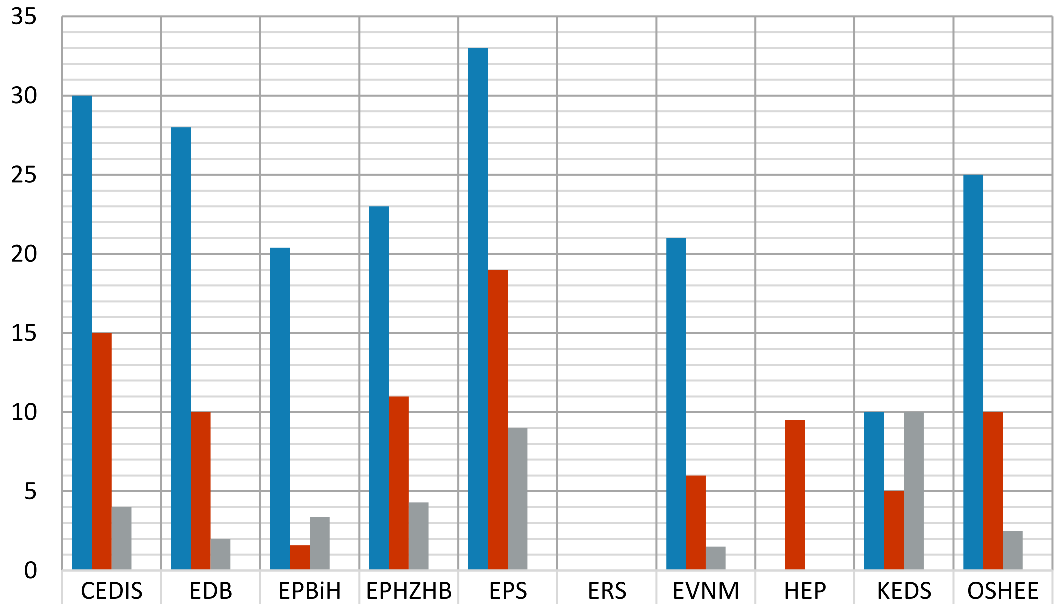
Figure 7.18 Average age by type of meter for HV consumers in SEE DSOs (2015)

Again, electromechanical meters at household customers are the oldest meter type in 7 DSOs in the region (in CEDIS, EDB, EPBiH, EPHZHB, EPS, EVNM, and OSHEE) between 20,4 (EPBiH) and 33 (EPS) years (Figure 7.20). The exception is found in KEDS, where they are as old as the smart meters, both are 10 years old. Also, there are the youngest electromechanical meters at household customers in the region. The oldest electronic meters are again in EPS, 19 years old, while the newest are in EPBiH, 1,6 years old. The average age of electronic meters at household customers for other 7 DSOs, is in the range from 5 to 15 years. Smart meters are by far the newest type of meters in most of the DSOs (in CEDIS, EDB, EPHZHB, EPS, EVNM, and OSHEE). In average, smart meters are about 3,6 times younger than electronic meters, and about 8,7 times younger than electromechanical meters. The oldest smart meters are in KEDS, 10 years, while the youngest are in EVNM, 1,5 years. In EPBiH and KEDS average age of smart meters are about 2 times older than electronic meters. The average age of electromechanical meters at household customers in HEP was not available.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	30	28	0	0	26	0	0	0	0	20
Electronic (digital)	15	11	0	0	11	0	0	0	0	7,5
Smart meter	4	1	2,6	2,5	8	0	7	2	5	1,2
Other	0	0	0	0	0	0	0	0	0	0

Figure 7.19 Average age by type of meter for MV consumers in SEE DSOs (2015)

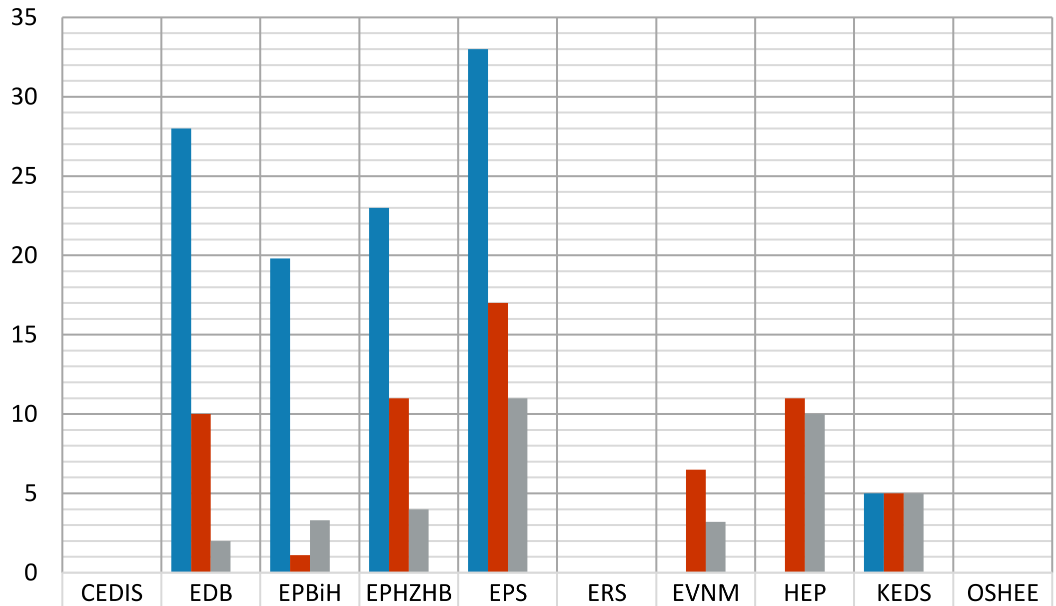


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	30	28	20,4	23	33	0	21	0	10	25
Electronic (digital)	15	10	1,6	11	19	0	6	9,5	5	10
Smart meter	4	2	3,4	4,3	9	0	1,5	0	10	2,5
Other	0	0	0	0	0	0	0	0	0	0

Figure 7.20 Average age by type of meter for households consumers in SEE DSOs (2015)

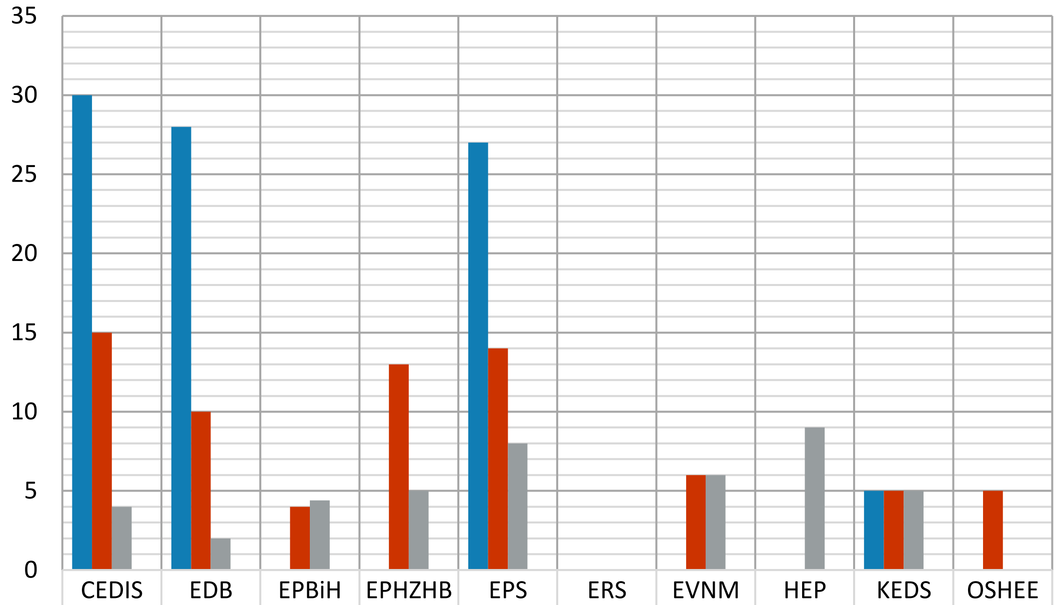
The oldest meters at public lighting customers are electromechanical meters; in 4 DSOs: EDB, EPBiH, EPHZHB, and EPS, with the average age in range from 19,8 years (EPBiH) to 33 years (EPS), except in KEDS, where all meter type (electromechanical, electronic, and smart meter) were 5 years old (Figure 7.21). EVNM doesn't have this type of meters at public lighting customers. The youngest meters' type in almost all DSOs, except EPBiH, and above mentioned KEDS, are smart meters: in EDB, EPHZHB, EPS, EVNM, and HEP, in the range from 2 years (EDB) to 11 years (EPS). Smart meters, for this type of customers, are about 2,2 times younger than electronic meters, and about 6 times younger than electromechanical meters. Electronic type of meters is the youngest in EPBiH, as mentioned before, younger than smart meters, 1,1 year, while for other 6 DSOs are between 5 years (KEDS) and 17 years (EPS). The average age of electromechanical meters at public lighting customers in HEP was not available.

Figure 7.22 shows that, again, the electromechanical meters at LV – commercial with peak power registration customers, are the oldest in 3 DSOs, where they are being used: in CEDIS, EDB, and EPS; from 27 years in EPS to 30 years in CEDIS, except in KEDS, were like at public lighting, the average age of all three types of meters is 5 years. The average age of electronic meters at this type of customers is between 4 years in EPBiH (younger than the age of smart meters), and 15 years in CEDIS. The age of smart meters compared to the age of another type of meters in each DSO differ, but generally, they are the youngest in most of the DSOs, in 4 DSOs: CEDIS, EDB, EPHZHB, and EPS, between 2 years in EDB, and 8 years in EPS. Smart meters in EVNM and KEDS are as old as the other type of meters presented at this type of customers. As mentioned before, smart meters in EPBiH are 2,2 years older than electronic meters.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	28	19,8	23	33	0	0	0	5	0
Electronic (digital)	0	10	1,1	11	17	0	6,5	11	5	0
Smart meter	0	2	3,3	4	11	0	3,2	10	5	0
Other	0	0	0	0	0	0	0	0	0	0

Figure 7.21 Average age by type of meter for public lighting consumers in SEE DSOs (2015)

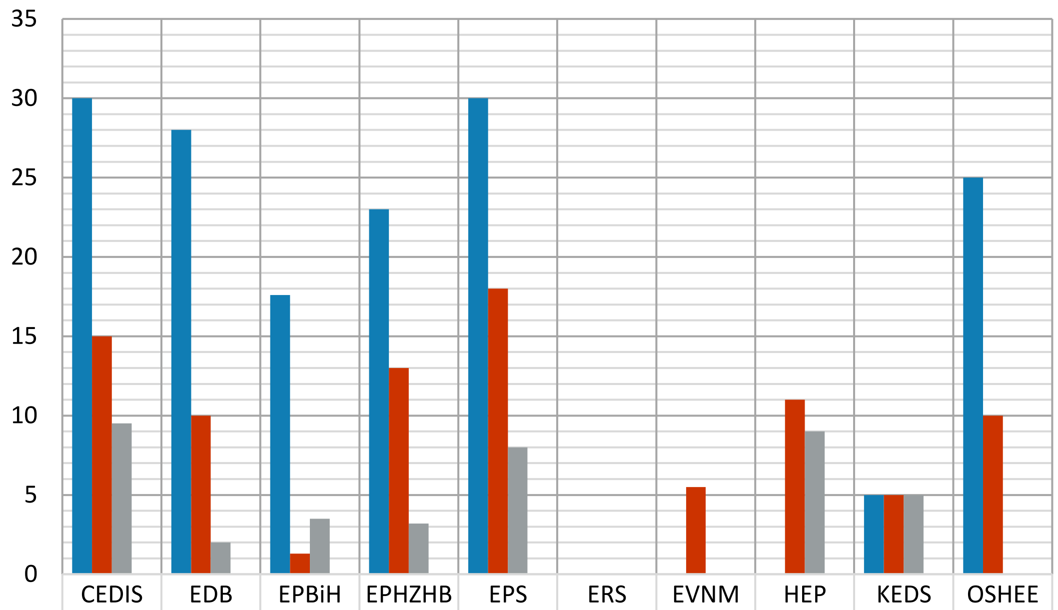


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	30	28	0	0	27	0	0	0	5	0
Electronic (digital)	15	10	4	13	14	0	6	0	5	5
Smart meter	4	2	4,4	5	8	0	6	9	5	0
Other	0	0	0	0	0	0	0	0	0	0

Figure 7.22 Average age by type of meter for LV-commercial with peak power registration consumers in SEE DSOs (2015)

Same as at all customer categories, the oldest type of meters at LV - commercial without peak power registration customers are the electromechanical meters, and that the case in 6 SEE DSOs, that had that type of meters: CEDIS, EDB, EPBiH, EPHZHB, EPS, and OSHEE, except in KEDS, where all three type of meters are the same age of 5 years (Figure 7.23). The average age of meters in other 6 DSOs are between 17,6 years in EPBiH, and 30 years in CEDIS and EPS. Electronic meters are the youngest type of meters in EPBiH (1,3 years), and they are 13,5 times younger than electromechanical meters, while in other DSOs they are from 1,7 times (EPS) to 2,8 times (EDB) younger than electromechanical meters (in KEDS this ratio is 1), between 5 years in KEDS and 18 years in EPS. Smart meters, as the latest type of meters, are generally the youngest type of meters in all DSOs, except in EPBiH at this type of consumers. Their average age is between 2 years in EDB and 9,5 years in CEDIS. The average age of smart type of meters in EVNM and electromechanical type of meters in HEP weren't available.

Figure 7.24 shows that the electromechanical meters are the oldest meters in the region on MV and LV. As expected, the smart meters are the youngest on all voltage levels. Smart meters on MV, with the average age of 5,4 years are 4,2 times younger than electromechanical meters, and 1,3 times than electronic meters. Smart meters on LV, with the average age of 4,7 years are 5,9 times younger than electromechanical meters, and 2,5 times than electronic meters. Electromechanical and electronic meters on MV in the region are younger than the same meters on LV, except the smart meters that are for 0,7 year older on MV.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	30	28	17,6	23	30	0	0	0	5	25
Electronic (digital)	15	10	1,3	13	18	0	5,5	11	5	10
Smart meter	9,5	2	3,5	3,2	8	0	0	9	5	0
Other	0	0	0	0	0	0	0	0	0	0

Figure 7.23 Average age by type of meter for LV-commercial without peak power registration consumers in SEE DSOs (2015)

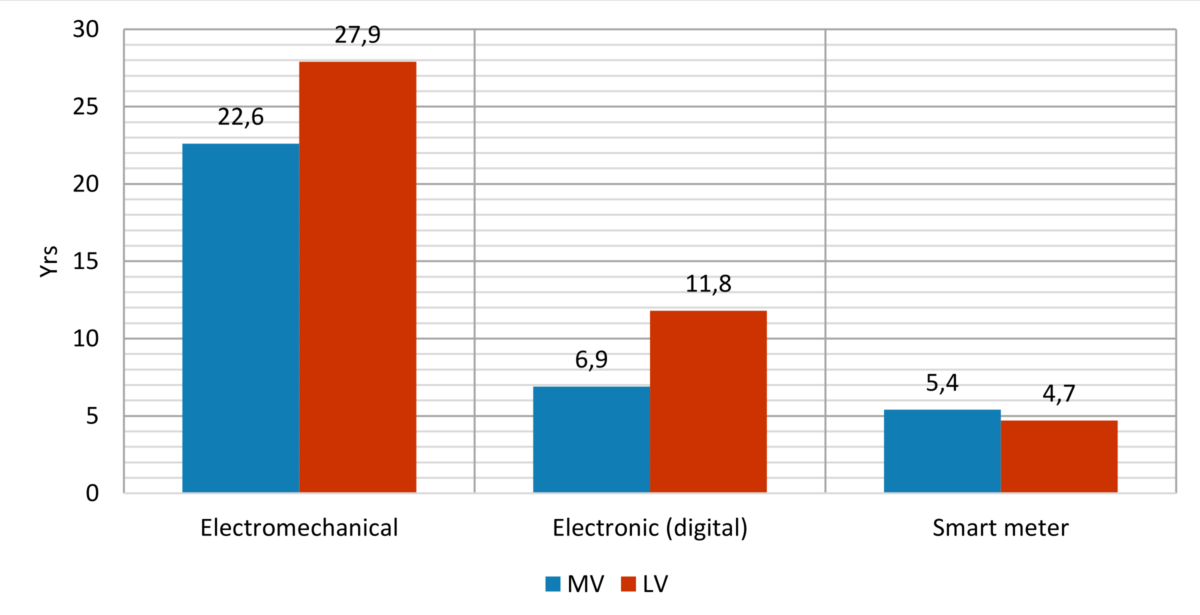


Figure 7.24 Average age of MV and LV meters by type – for all DSOs (2015)

For LV customers in SEE DSOs, the EVNM has the youngest average age of meters – 6,2 years and EPS has the oldest – 28,4 years. Figure 7.26 shows that the smart meters at LV customers in the region are the youngest type of meters in 6 out of 8 DSOs in the region: in CEDIS, EDB, EPHZHB, ERS, EVNM, and OSHEE, between 2 years in EDB and 8,8 years in EPS. In EPBiH and KEDS, the smart meters are older than electronic meters, for 1,6 years and 1,5 years respectively. The average age of the electronic meters on LV are in the range from 1,6 years in EPBiH and 18,7 years in EPS. As expected, the oldest meters at LV are the electromechanical meters with the average age between 9,4 years in KEDS, and 32,8 in EPS.

As expected, the newest meters in SEE DSOs by consumption categories are on HV and MV, with 5,1 and 7,1 years respectively, what is in line with their accuracy requirements, followed by LV – commercial with peak power generation with the age of 13,6 years. Then follows household with the age of 21,6 year, and the oldest meter category is public lighting with the age of 21,7 years.

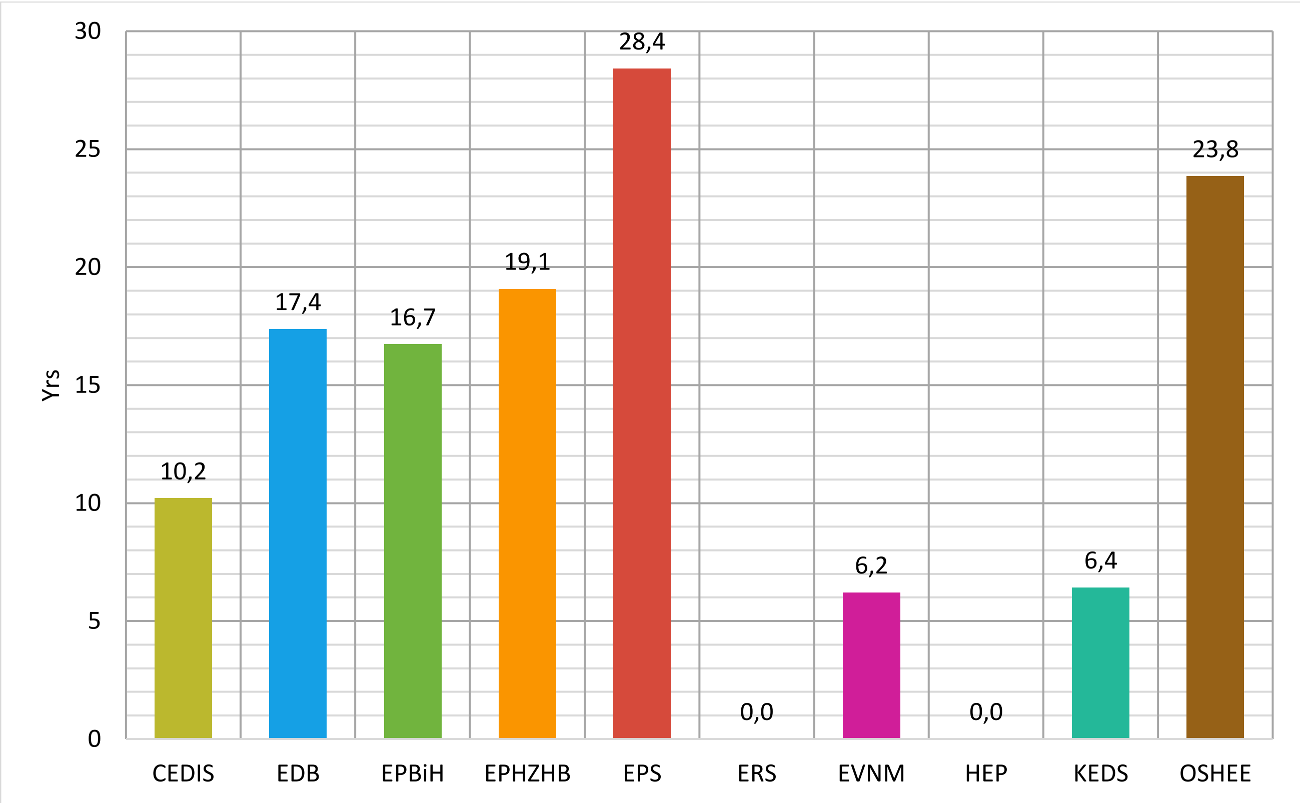
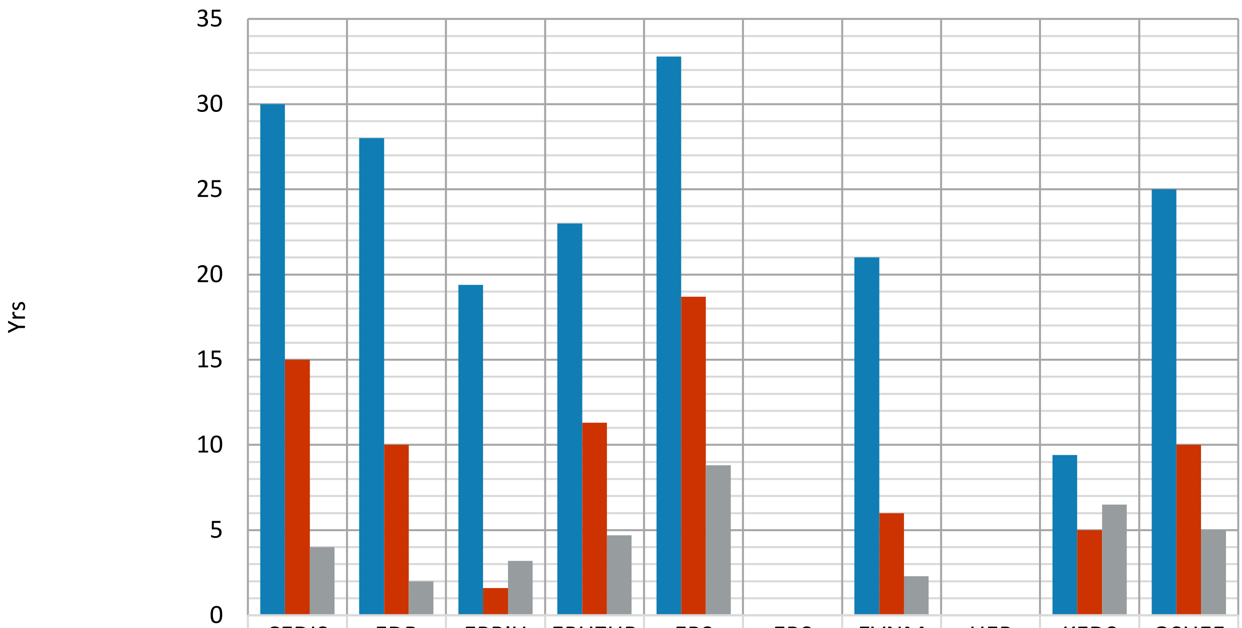


Figure 7.25 Average age of meters for LV consumers in SEE DSOs (2015)



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	30	28	19,4	23	32,8	0	21	0	9,4	25
Electronic (digital)	15	10	1,6	11,3	18,7	0	6	0	5	10
Smart meter	4	2	3,2	4,7	8,8	0	2,3	0	6,5	5

Figure 7.26 Average age of meters at LV consumers by type in SEE DSOs (2015)

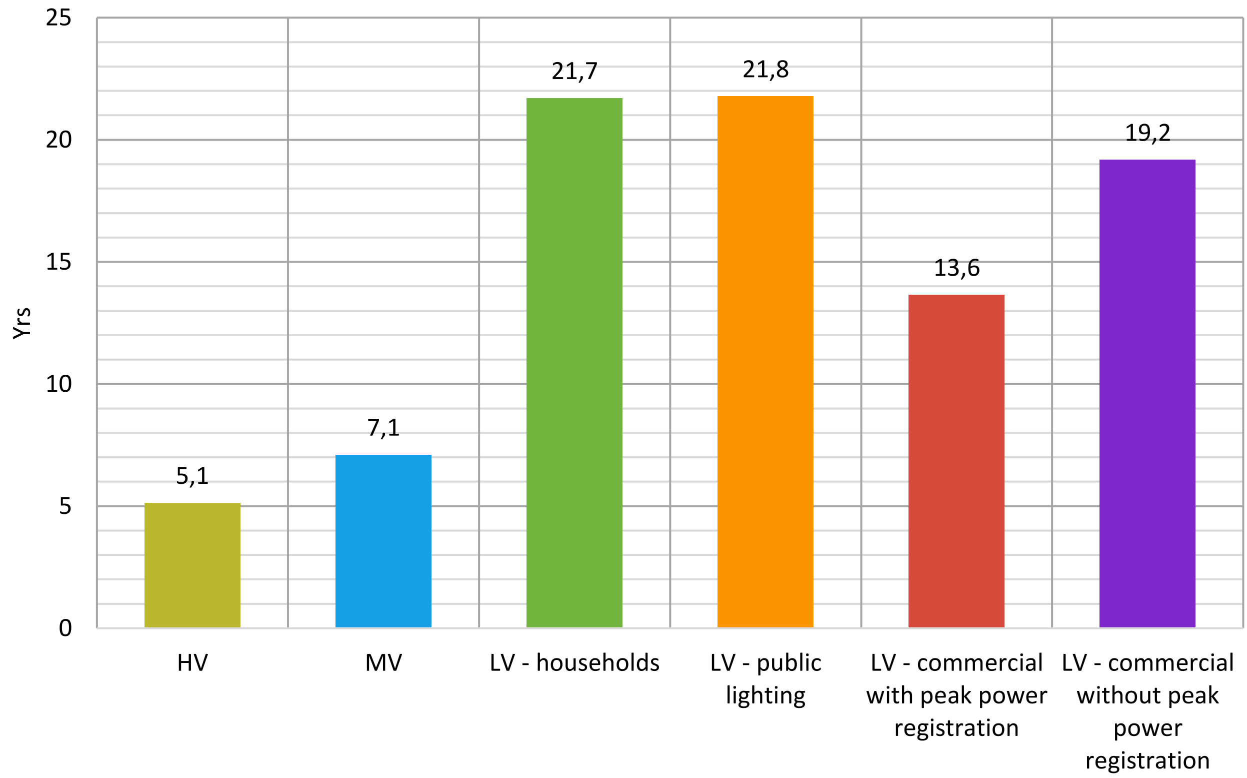


Figure 7.27 Average age of meters by consumption category in SEE DSOs (2015)

7.3 METER REPLACEMENT RATE

Meters with expired calibration need to be replaced with the new one. Meter replacement rate is presented as the number of meters replaced by a specific type of meters in a year as a portion of the total meters in service in some consumption category.

When analyzing meter replacement data, it should be considered that:

- data relates to the values in 2015,
- CEDIS provided lump sum data for electronic and smart meter type, and the rate was calculated as the number of meters replaced by a specific type of meters in a year as a portion of the total meters in service at all consumption categories (around 54.840 meters are replaced annually),
- EPBiH provided data only for meter replacement rate of electromechanical meters at LV - commercial without peak power registration,
- data on meter replacement rate in OSHEE were not available.

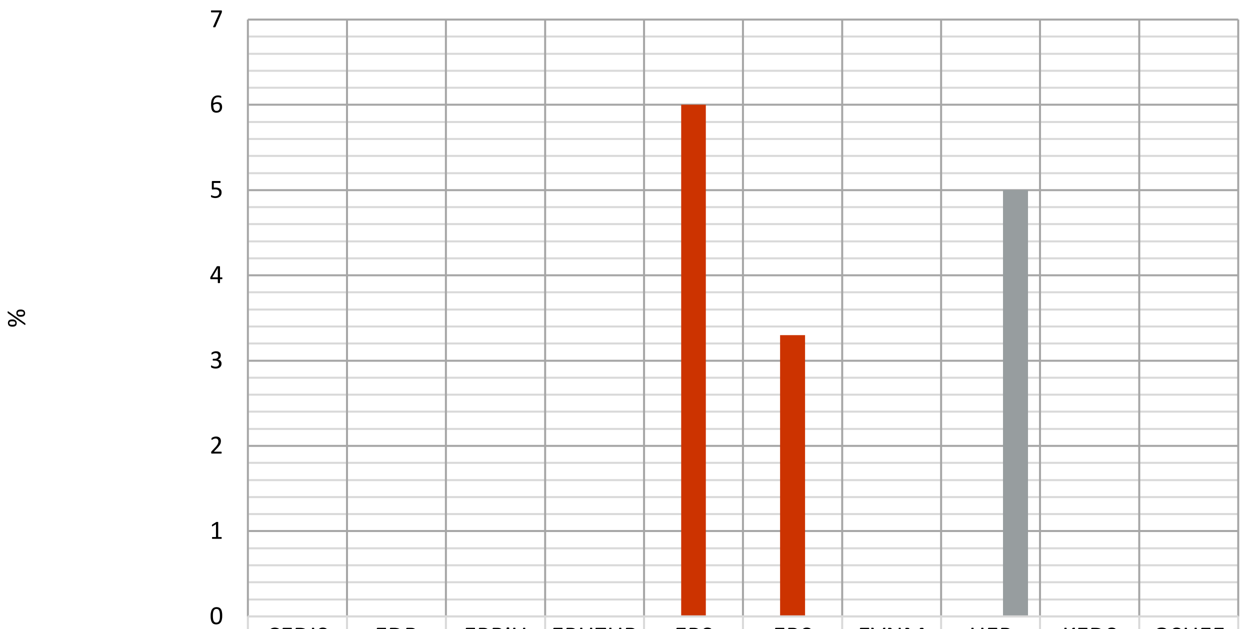
Usually, the electronic meters were used for LV customers with lower electricity consumption (e.g. households, commercial customers without peak power registration), whereas smart meters were used for MV and LV customers with higher yearly electricity consumption (e.g. commercial customers with peak power registration). But the data shows that this is not the case anymore in the region, and the meters are nowadays more and more electronic and smart meters at all customers categories.

Figure 7.28 shows that at HV customers, electronic and smart meters were used for meter replacement in ERS, EPS, and HEP. The largest replacement rate of the electromechanical meters with digital meters is reported in EPS (6%), in ERS (3,3%), while in HEP electromechanical meters were replaced with the smart meters with annual replacement rate of 5%.

The largest replacement rate of meters for MV customers was reported in KEDS, with the plan to equip more than half of their metering point with new smart meters in one year. In other 7 DSOs: CEDIS, EDB, EPHZHB, EPS, EVNM, HEP, and OSHEE at MV level the smart meters should be installed with planned replacement rate between 16% (EVNM) and 1% (EPS). Replacement rate for electronic meters in SEE DSOs is the largest in EDB (16,1%), and the smallest is in CEDIS – 1,7%, and also used in EPHZHB, EPS, and ERS. Replacement with electromechanical meters was used in EDB (3,2%) and EPS (5%).

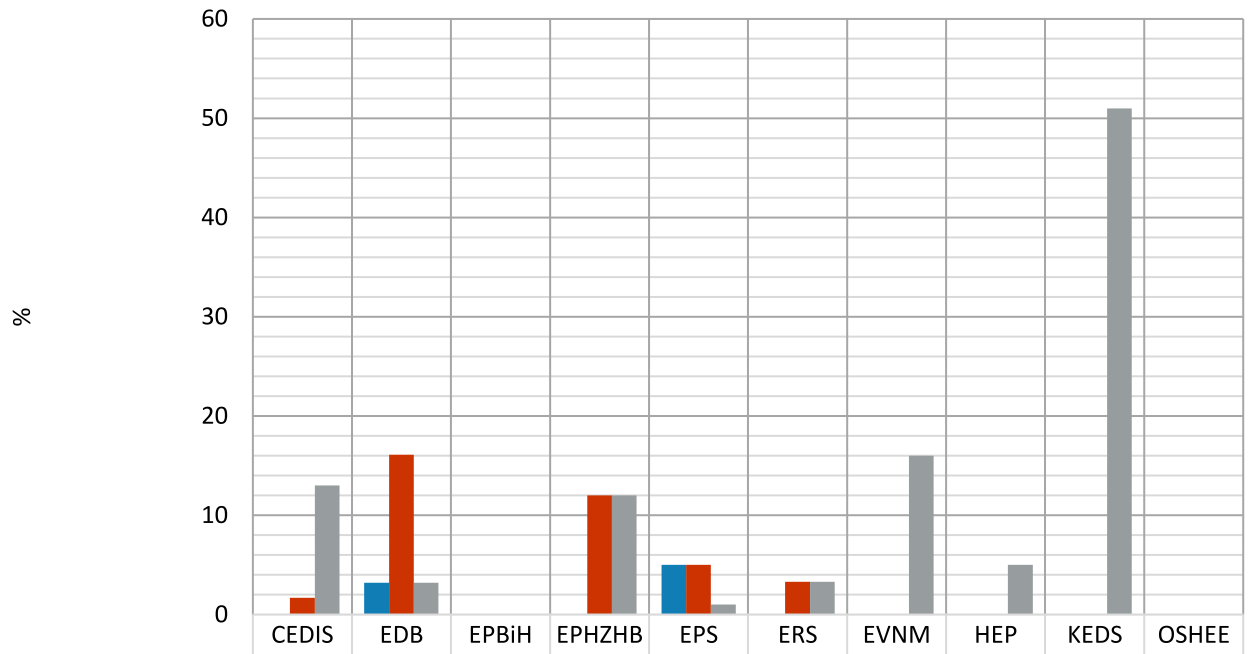
Figure 7.30 shows different type of meters used for replacement at household level. KEDS had the higher replacement rate of meters for household customers with the electronic meters – 15%, followed by EPHZHB with the rate of 7%, while the other 5 DSOs (CEDIS, EDB, EPS, ERS, and HEP) had the replacement rate in the range from 1,7% in CEDIS with the lump sum replacement rate, to 0,8% in HEP. Replacement of meters for household with the electromechanical meters is reported in EPHZHB (with the largest replacement rate of 8%), EDB, EPS, ERS, and HEP (with the lowest replacement rate of 0,7%). Replacement of meters for household customers with the smart meters prevails in CEDIS (but refers to the lump sum for all categories of the customer), and are also found in EPHZHB, EPS, ERS, EVNM, and KEDS. The lowest replacement rate is reported in EPS – 0,1%. The largest replacement rate with electromechanical meters is found in EPHZHB, then EPS, EDB, ERS, and HEP, in the range from 8% to 0,7%, respectively.

Although KEDS, EDB, and CEDIS reported high replacement rate of meters at MV and household customer categories, number of respective customers in KEDS, EDB and CEDIS is very low compared to the other DSOs (4,2% in KEDS, 0,33% in EDB, and 3,64% in CEDIS). Similar is for meter replacement rate at other LV customer categories for KEDS, EVNM (6,9% is number of meters at MV and household customer categories compared to total number of customers in SEE DSOs), EDB and CEDIS, as follows on the Figure 7.31 and Figure 7.33.Figure 7.30



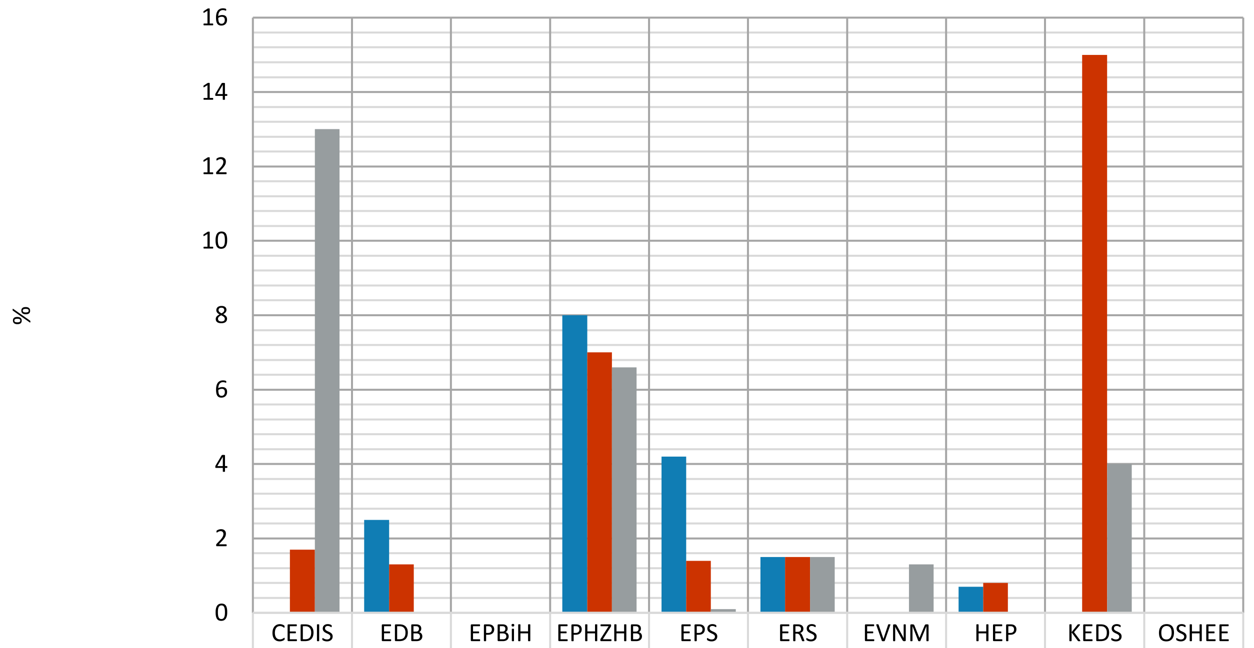
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	0	0	0	0	0	0	0	0	0
Electronic (digital)	0	0	0	0	6	3,3	0	0	0	0
Smart meter	0	0	0	0	0	0	0	5	0	0

Figure 7.28 Replacement rate by type of meters for HV consumers in SEE DSOs



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	3,2	0	0	5	0	0	0	0	0
Electronic (digital)	1,7	16,1	0	12	5	3,3	0	0	0	0
Smart meter	13	3,2	0	12	1	3,3	16	5	51	0

Figure 7.29 Replacement rate by type of meters for MV consumers in SEE DSOs



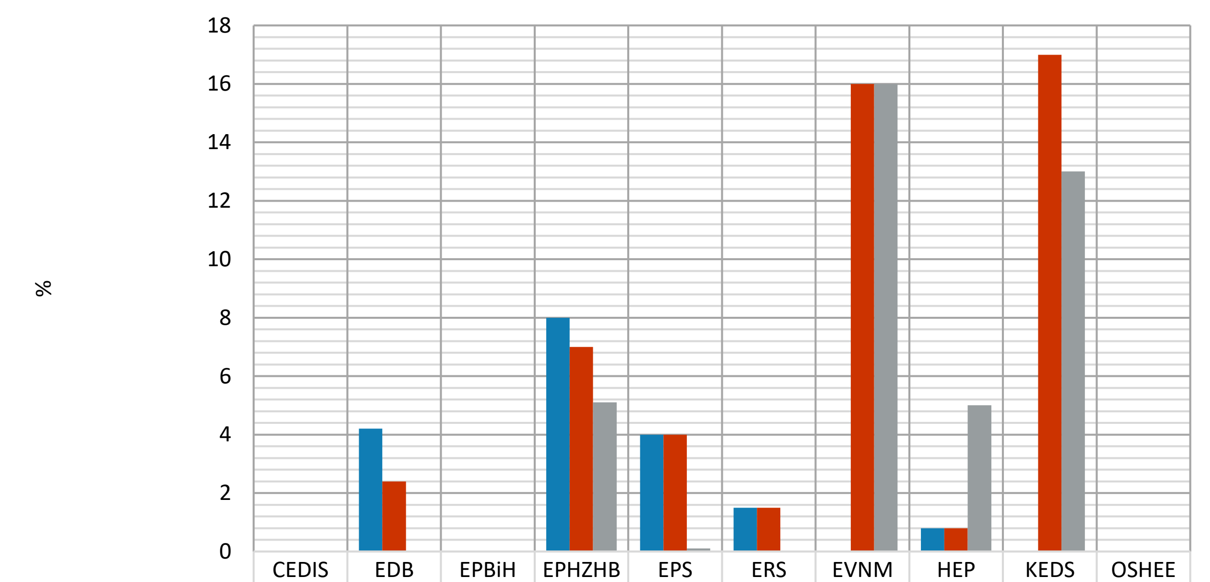
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	2,5	0	8	4,2	1,5	0	0,7	0	0
Electronic (digital)	1,7	1,3	0	7	1,4	1,5	0	0,8	15	0
Smart meter	13	0	0	6,6	0,1	1,5	1,3	0	4	0

Figure 7.30 Replacement rate by type of meters for households consumers in SEE DSOs

The largest replacement rate of meters at public lighting customers in the region is in KEDS with the electronic type of meters, being 17% (Figure 7.31). These meters were replaced with electronic meters also in EDB, EPHZHB, EPS, EVNM, and HEP, with the smallest replacement rate of 0,8% in HEP. The largest replacement rate with smart meters at public lighting customers was in EVNM – 16%, then in KEDS – 13%, in EPHZHB – 5,1%, in HEP – 5%, and the smallest was in EPS – 0,1%. Replacement with electromechanical meters was in EDB, EPHZHB, EPS, ERS, and HEP, in the range from 5% in EPHZHB to 0,8% in HEP.

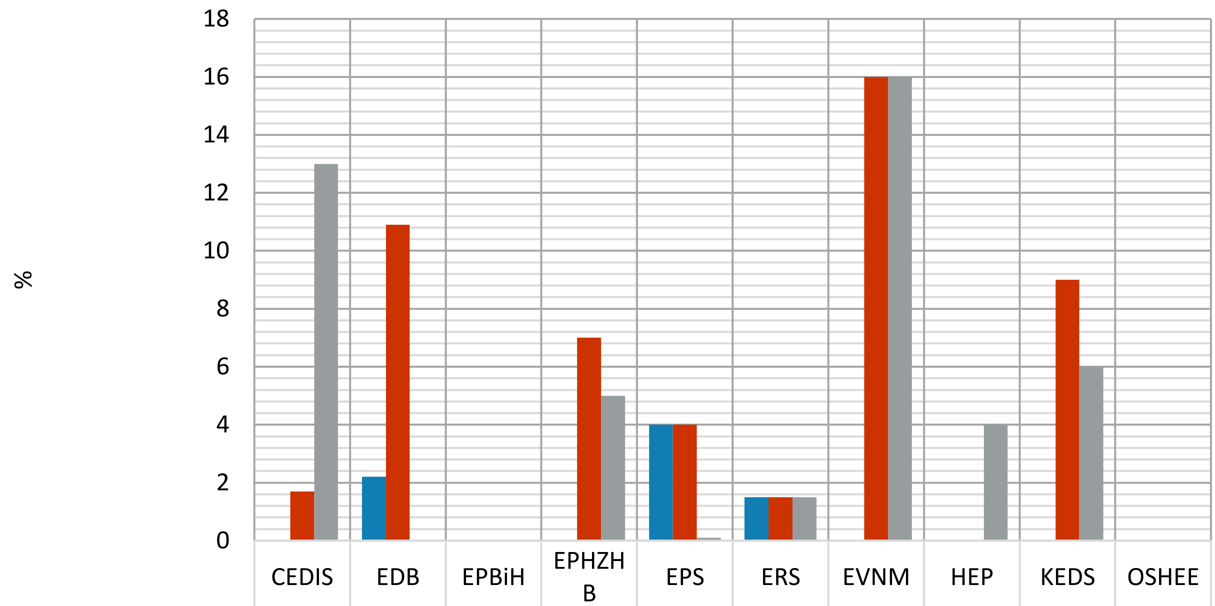
In the Figure 7.32 is shown that the largest replacement of meters at LV - commercial with peak power registration customers in SEE DSOs was in EVNM with the electronic and smart type of meters being the same value of 16%. Then followed replacement rate of smart meters in CEDIS by 13% (lump sum for all customer categories). Replacement with electronic meters is presented in most of the DSOs (7 of 9): in CEDIS, EDB, EPHZHB, EPS, ERS, EVNM, and KEDS, with the values between 1,5% in ERS, and mentioned EVNM with 16%. Replacement with the smart meters was in 7 DSOs: CEDIS, EPHZHB, EPS, ERS, EVNM, HEP, and KEDS, with the smallest rate in EPS – 0,1%, and the largest rate in EVNM – 16%. Replacement with electromechanical meters was also presented in EDB – 2,2%, EPS – 4%, and ERS – 1,5%. From the stated, it can be noticed, that the type of meters used for replacement at LV - commercial with peak power registration customers differ in the region, and the most common used were electronic and smart meters.

The most used type of meters for replacement at LV - commercial without peak power registration customers were electronic meters, in 9 DSOs except in EPBiH (Figure 6.33). Replacement rate was the largest in KEDS – 24%, and the lowest in HEP – 0,8%. The electromechanical meters for replacement were used in 5 DSOs: EDB, EPBiH, EPHZHB, EPS, and HEP, with the replacement rate of 0,5% in HEP, and 9% in EPS. In CEDIS, EPHZHB, EPS, HEP, and KEDS for replacement were also used smart meters. The smallest replacement rate is in EPS – 0,1% and the largest is in CEDIS – 13% (again, this represents the lump sum for all customer categories).



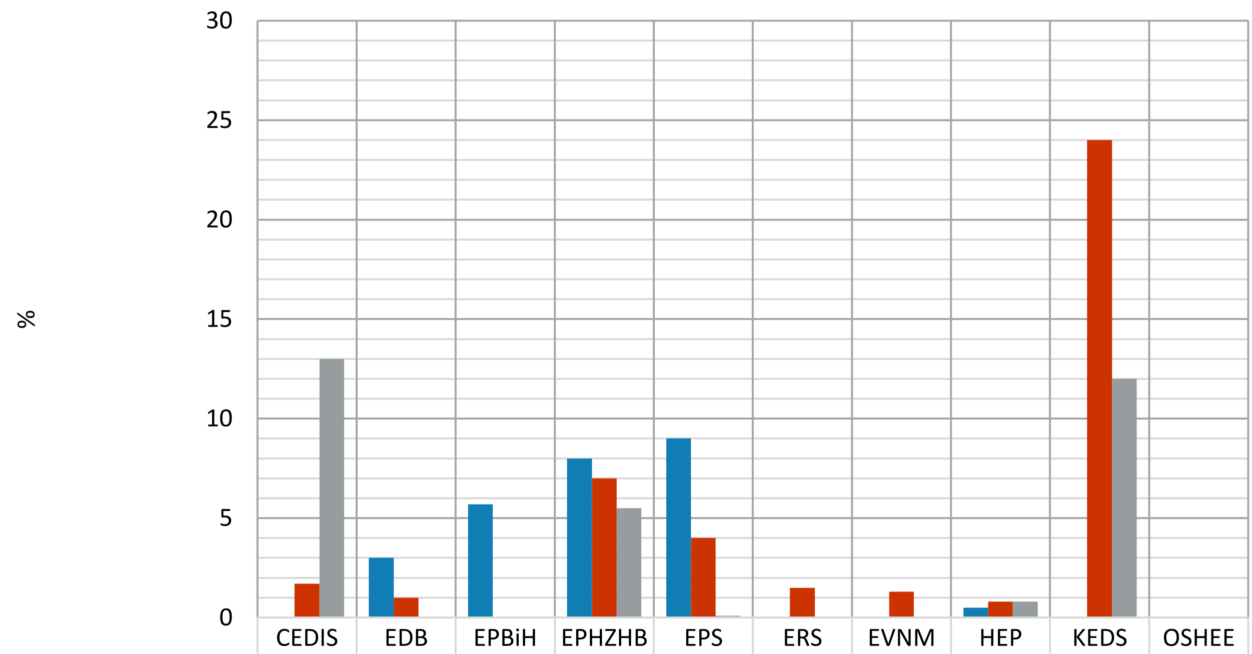
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	4,2	0	8	4	1,5	0	0,8	0	0
Electronic (digital)	0	2,4	0	7	4	1,5	16	0,8	17	0
Smart meter	0	0	0	5,1	0,1	0	16	5	13	0

Figure 7.31 Replacement rate by type of meters for public lighting consumers in SEE DSOs



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	2,2	0	0	4	1,5	0	0	0	0
Electronic (digital)	1,7	10,9	0	7	4	1,5	16	0	9	0
Smart meter	13	0	0	5	0,1	1,5	16	4	6	0

Figure 7.32 Replacement rate by type of meters for LV-commercial with peak power registration consumers in SEE DSOs



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	3	5,7	8	9	0	0	0,5	0	0
Electronic (digital)	1,7	1	0	7	4	1,5	1,3	0,8	24	0
Smart meter	13	0	0	5,5	0,1	0	0	0,8	12	0

Figure 7.33 Replacement rate by type of meters for LV-commercial without peak power registration consumers in SEE DSOs

7.4 INSTALLATION OF NEW METERS

Figure 7.34 shows the share of installation of new meters in SEE DSOs in 2012 and 2015, calculated as a share of number of installation of new meters in the total number of meters in each DSO.

DSO	Number of new meters in 2015	Type
CEDIS	6801	Electronic (digital) Smart meter with PLC type of communication
EDB	1,375	Electronic (digital)
EPBiH	433	Electronic (digital) - public lighting, LV - commercial customers without peak power registration Smart meter – MV, households, LV - commercial customers with peak power registration, LV - commercial customers without peak power registration
EPHZHB	1,871 – new customers 2,531 – existing customers	Smart meter
ERS	8,799	Electronic (digital) Smart meter
EPS	36,192	Electronic (digital) Smart meter
EVNM	25,200	Electronic (digital) Smart meter with PLC and GSM type of communication
HEP	7,146	Electronic (digital) – households, public lighting, LV commercial customers without peak power registration Smart meter – MV customers, LV commercial customers without peak power registration
KEDS	58,603	Electronic (digital) (95,4 %) Smart meter (4,6 %)
OSHEE	n/a	n/a

The previous table provides number of new meters installed in 2015, either at new customers' premises or by replacing meter at existing customers' premises. Clearly, DSOs are installing either electronic (digital) or smart meters. Only CEDIS and EVNM have reported the type of communication that were used in new smart meters.

Before analysis of this parameter, the number, and the share of new meters installed in CEDIS and EVNM in 2012, and in OSHEE in 2015 were not available. Data in EPBiH were incomplete, mainly based on the number of installation of new meters in distribution area (ED) of Mostar. Data on the number of installation of new meters in ED Zenica, ED, Sarajevo, ED Tuzla, and ED Bihać were also not available. Data given for HEP in 2015, are related to the data in 2014, which was previously submitted by HEP.

KEDS exhibited the highest installation of new meters in 2015: 12,3% of the total meters in service, but this is more than half lower than in 2012 (Figure 7.34). All other DSOs installed less than 4% of new meters. Also, the decreasing trend in the installation of new meters in most of SEE DSOs is found in 2015 compared to 2012, except in ERS. Decreasing rates are quite large, the largest decrease was in EPBiH (-92,9%), and HEP (-91,9%), while in EDB it was the lowest: -27,8%. Increase, by 45,5% in the installation of new meters was found only in ERS. This can be explained by the fact that in some DSOs cost-benefit analyses are in progress for a smart metering roll-out, in line with the requirements of Directives 2009/72/EC and 2009/73/EC, in accordance to the requirements by the national regulator. Based upon these studies the regulators will decide about the way of smart meters' installation. Another reason found in some DSOs is the cancellation of the meters procurement process.

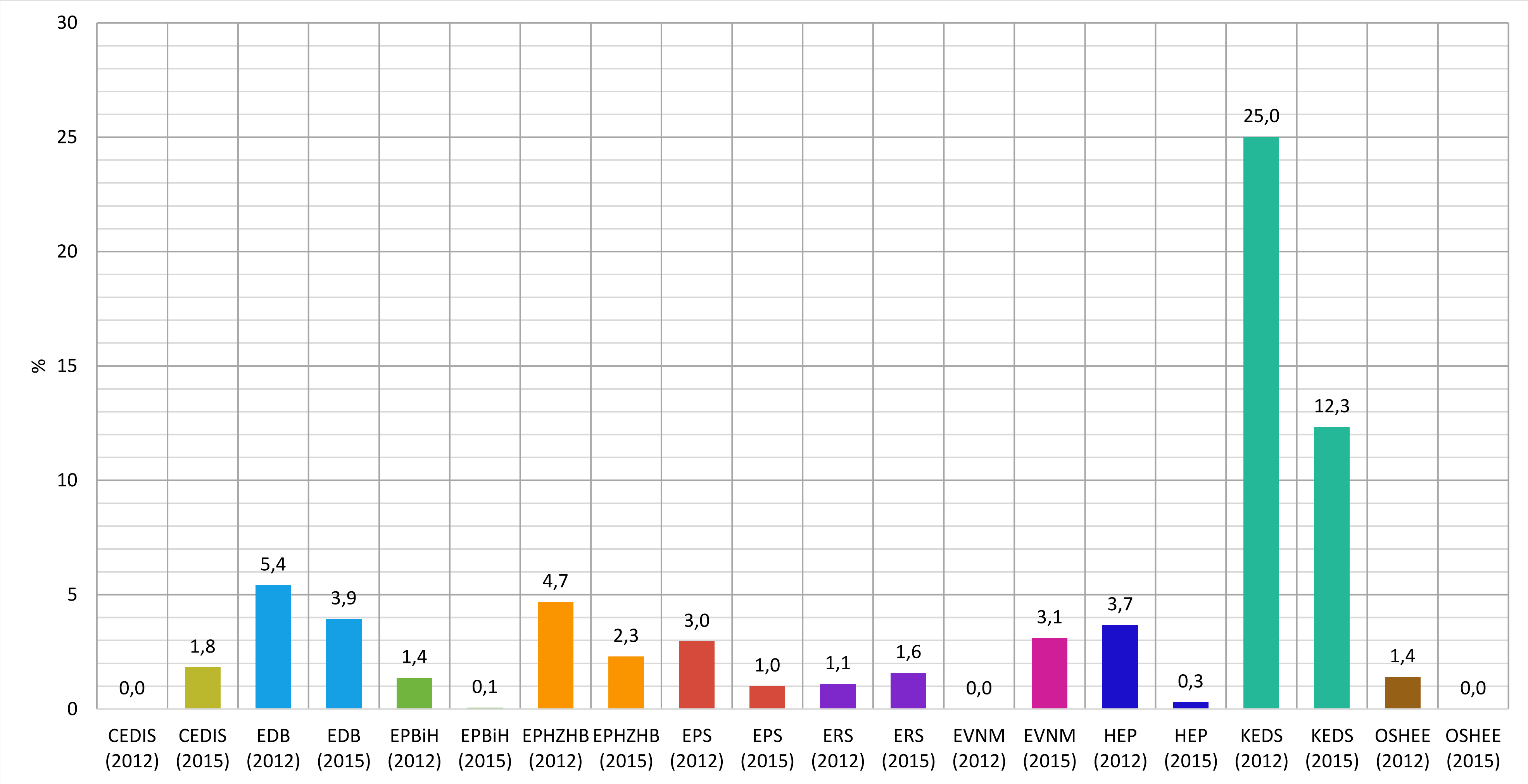


Figure 7.34 Share of new meters installed annually in total number of metering points in SEE DSOs (2012 and 2015)

Table 7.1 New meters installed in the distribution system (MV and LV) - meters installed at new consumers and old meters replaced at existing premises of consumers

DSO	Number of new meters in 2015	Type
CEDIS	6801	Electronic (digital) Smart meter with PLC type of communication
EDB	1,375	Electronic (digital)
EPBiH	433	Electronic (digital) - public lighting, LV - commercial customers without peak power registration Smart meter – MV, households, LV - commercial customers with peak power registration, LV - commercial customers without peak power registration
EPHZHB	1,871 – new customers 2,531 – existing customers	Smart meter
ERS	8,799	Electronic (digital) Smart meter
EPS	36,192	Electronic (digital) Smart meter
EVNM	25,200	Electronic (digital) Smart meter with PLC and GSM type of communication
HEP	7,146	Electronic (digital) – households, public lighting, LV commercial customers without peak power registration Smart meter – MV customers, LV commercial customers without peak power registration
KEDS	58,603	Electronic (digital) (95,4 %) Smart meter (4,6 %)
OSHEE	n/a	n/a

7.5 FREQUENCY OF METER CALIBRATION

The calibration assures that the measurement errors can be kept within the desired limits. In this report, the measure is developed as the number of calibrations performed in a year divided by the number of meters in service.

In this report, the following assumptions are made:

- input data refer to 2012, except in EPHZHB, ERS, and HEP,
- data on meters' calibration frequency are missing for CEDIS, and HEP for all customers,
- EDB provided lump sum data for all meters on MV level (i.e. 11% is frequency of meter calibration on MV level for all meter types),

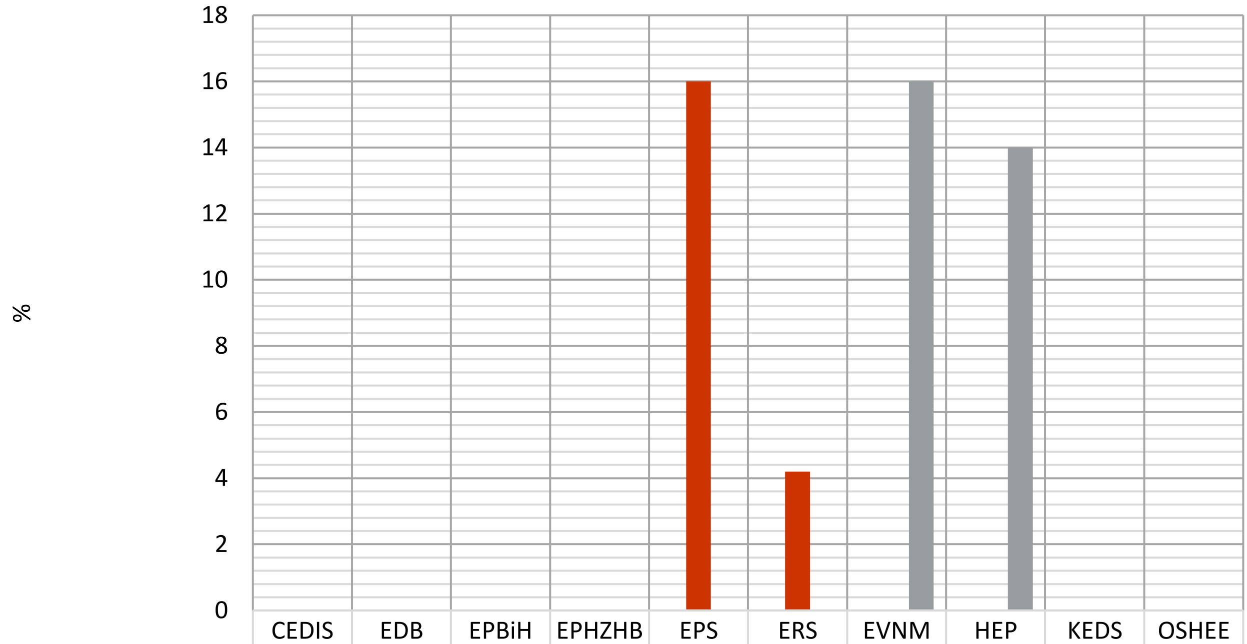
- EPBIH indicated that electronic and smart meters have not been calibrated in the observed year because these meters are relatively new (recently installed), so EPBIH provided only data on electromechanical meters,
- EPHZHB has not provided data for different meter types (i.e. electromechanical, electronic and smart meters) nor for different connection types (i.e. direct, semi-direct and indirect), calibration of the exact number of 7.686 directly connected meters and 345 semi-directly and indirectly connected meters were calibrated in 2015. Authors assumed that directly connected meters were used at household customers and public lighting, and the frequency of meters calibration for that type of customers is calculated as a percentage of number of directly connected meters in number of household and public lighting metering points, being 4,35%, while for semi-directly and indirectly connected meters assumed were used at HV, MV, LV – commercial customers with peak power registration and LV - commercial customers without peak power registration, being 2,31%.
- ERS has not provided data for different meter types (i.e. electromechanical, electronic and smart meters) nor for two different connection types (i.e. direct, semi-direct and indirect), calibration of the exact number of 50.195 directly connected meters and 1.650 semi-directly and indirectly connected meters were calibrated in 2015. Authors of the study assumed that directly connected meters were used at household customers public lighting, and the frequency of meters calibration for that type of customers is calculated as percentage of number of directly connected meters in number of household metering points and public lighting, being 9,73%, while for semi-directly and indirectly connected meters assumed were used at HV, MV, LV – commercial customers with peak power registration and LV - commercial customers without peak power registration, being 4,19%.
- EVNM has not provided data for household frequency of meter calibration, for all types of meters, and for electronic meters for LV - commercial customers without peak power registration.
- Data given for HEP in 2015 are equal to those given in 2014
- KEDS has provided only data for households electromechanical meters, i.e. 1,8%,
- OSHEE has provided lump sum data for all meters on MV and LV level, i.e. 10%, based on an approximate number of calibrated meters being 120.000.

Figure 7.35 shows that the frequencies of smart meters' calibration on HV level of electronic meters are the largest in EPS (16%), in ERS (4,2%), while the calibration of smart meters in EVNM is also high (16%, although EVNM didn't report the present of HV customers under their jurisdiction) and in HEP (14%).

Figure 7.36 shows frequencies of meter calibration on MV level. EVNM reported the highest frequency of calibration of smart meters, followed by HEP, while the lowest value is found in ERS. The frequency of electromechanical meter calibration is the largest in EDB, followed by OSHEE, although OSHEE provided lump sum data for all consumption categories. The lowest values were reported for electronic and smart meters in ERS. Data on frequency of electronic meter calibration were also given for EDB, EPHZHB, EPS, and OSHEE, while for smart meters were given also for EDB, EPHZHB, and OSHEE.

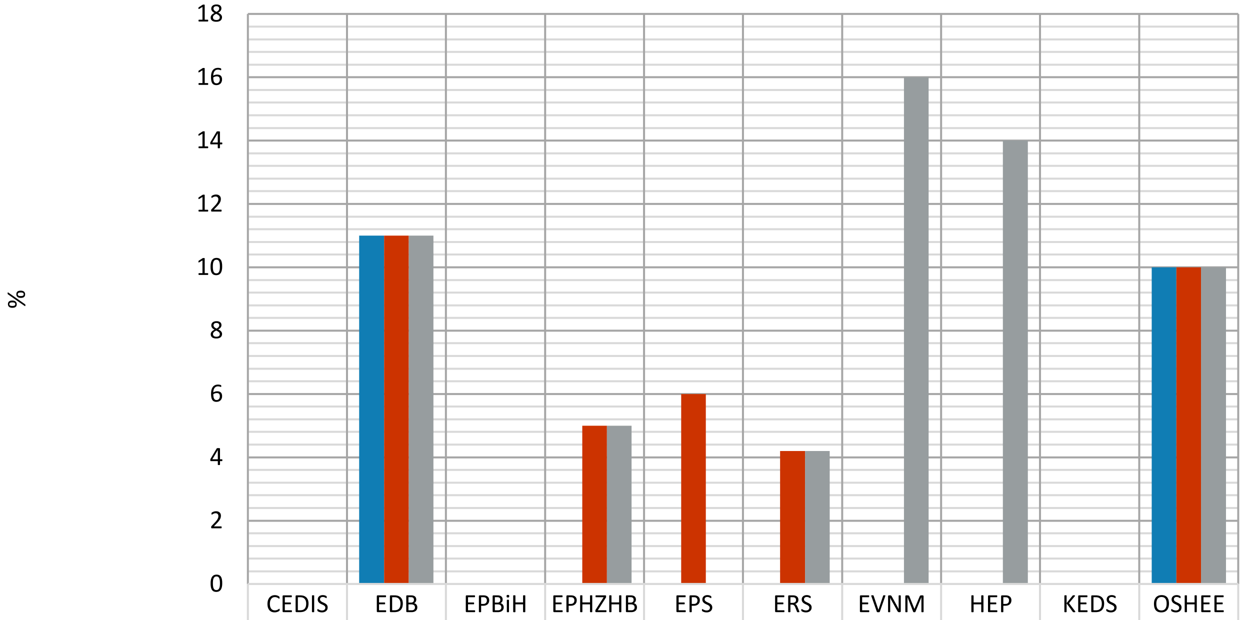
The frequency of meter calibration for household customers, all meter types was the largest in OSHEE and ERS with the almost same values, 10%, and 9,7%, respectively (Figure 7.37). The smallest frequency of meter calibration for electromechanical, electronic, and smart meters was in EDB, EPS, and again EPS, respectively.

Figure 7.38 shows that the largest frequency of meter calibration for the electronic type of meters was in EVNM of 16%. For the same type of meters, the smallest was found in EPS of 4,5%. The largest frequency of meter calibration for smart meters was in HEP of 9%, while the smallest was in EPS of 4,5%. The largest frequency of meter calibration for the electromechanical type of meters was in ERS of 9,7%, while the smallest was in EPS of 4,5%.



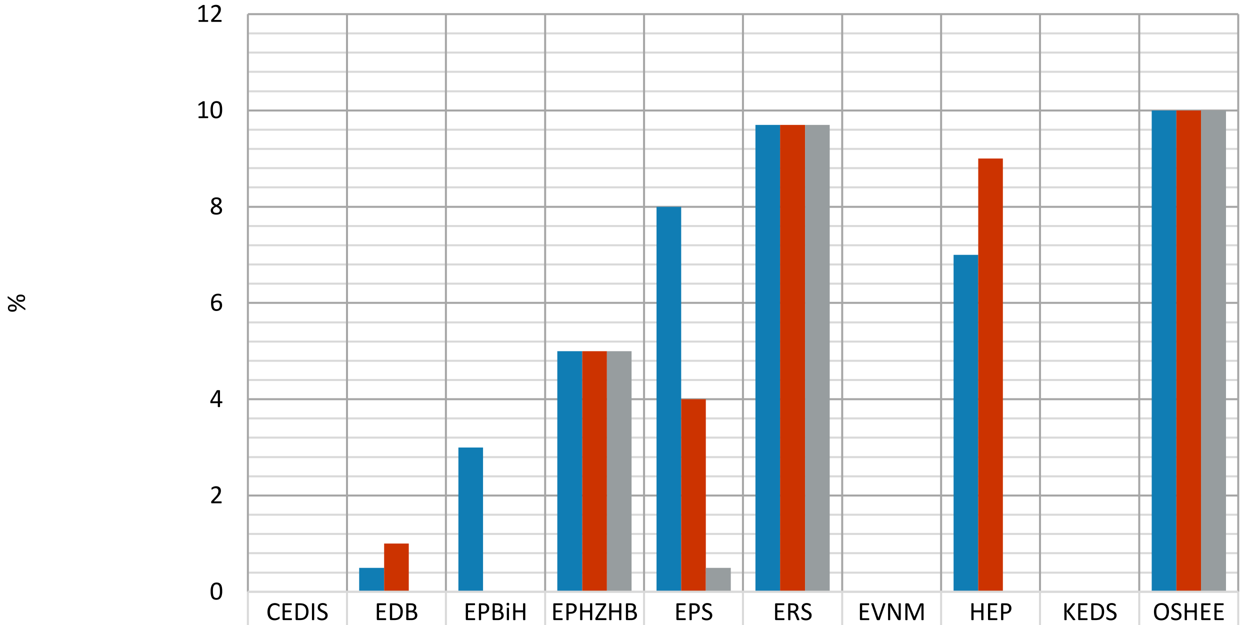
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	0	0	0	0	0	0	0	0	0
Electronic (digital)	0	0	0	0	16	4,2	0	0	0	0
Smart meter	0	0	0	0	0	0	16	14	0	0

Figure 7.35 Frequency of meter calibration by type of meter for HV consumers in SEE DSOs



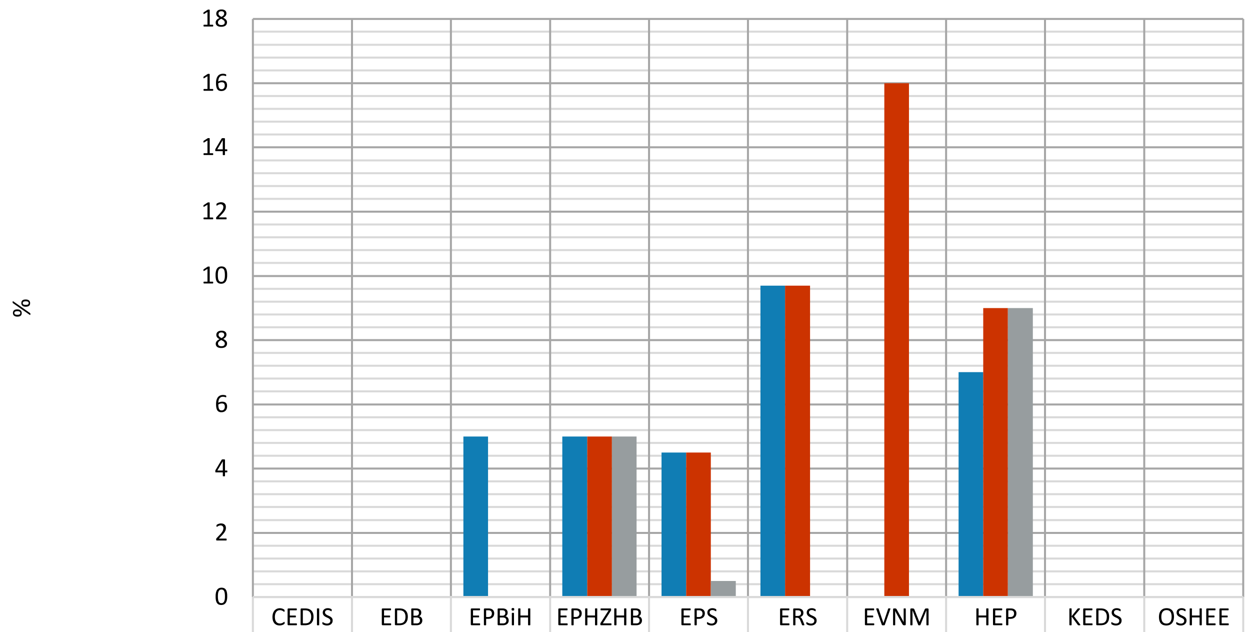
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	11	0	0	0	0	0	0	0	10
Electronic (digital)	0	11	0	5	6	4,2	0	0	0	10
Smart meter	0	11	0	5	0	4,2	16	14	0	10

Figure 7.36 Frequency of meter calibration by type of meter for MV consumers in SEE DSOs



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	0,5	3	5	8	9,7	0	7	0	10
Electronic (digital)	0	1	0	5	4	9,7	0	9	0	10
Smart meter	0	0	0	5	0,5	9,7	0	0	0	10

Figure 7.37 Frequency of meter calibration by type of meter for households consumers in SEE DSOs

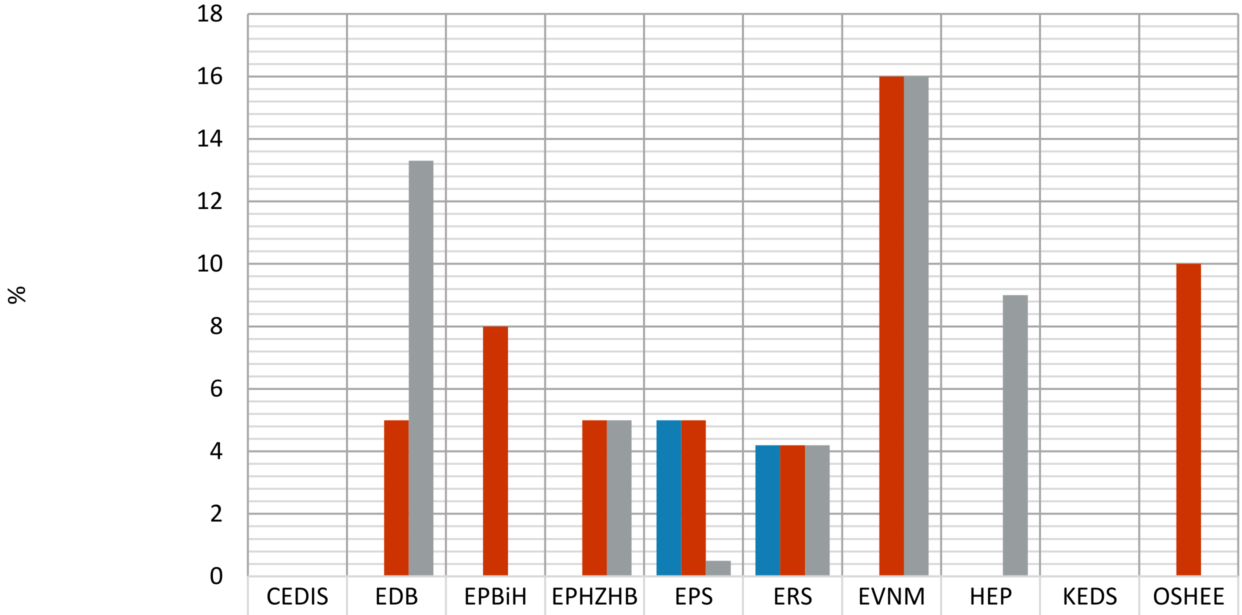


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	0	5	5	4,5	9,7	0	7	0	0
Electronic (digital)	0	0	0	5	4,5	9,7	16	9	0	0
Smart meter	0	0	0	5	0,5	0	0	9	0	0

Figure 7.38 Frequency of meter calibration by type of meter for public lighting consumers in SEE DSOs

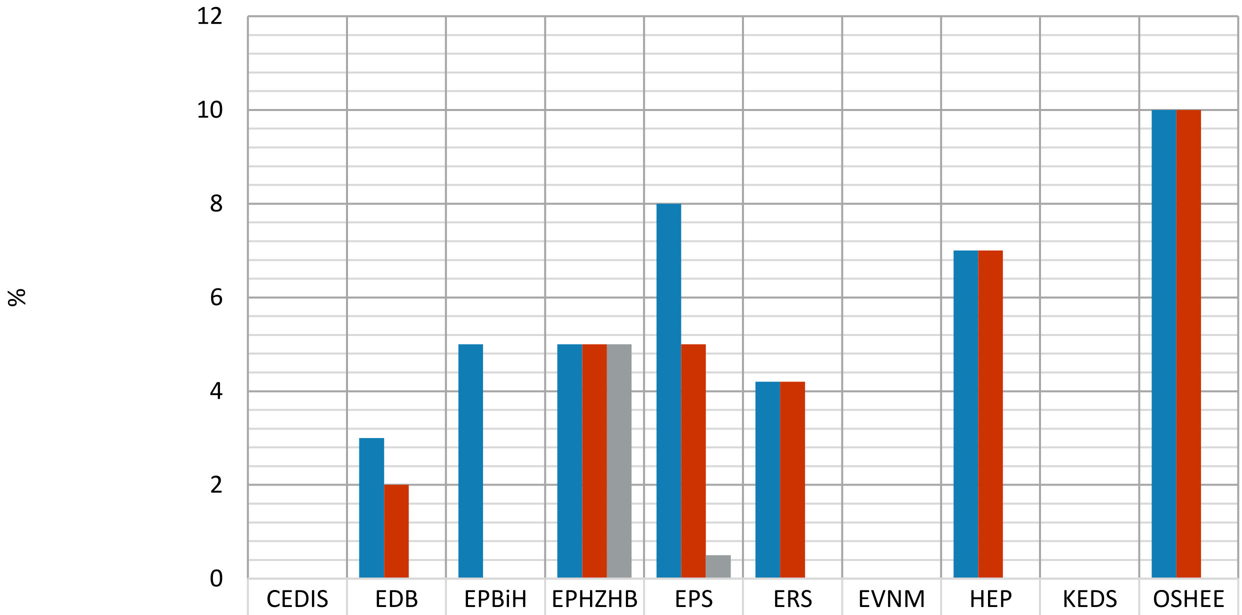
The largest frequency of meter calibration for LV – commercial with peak power registration consumers for the electronic and smart type of meters in SEE DSOs is in EVNM, being 16% (Figure 7.39). For the electronic type of meters is the smallest in ERS of 4,2%, while for smart meters is the smallest in EPS of 0,5% because they are still new. EPS and ERS reported almost the same values of frequency of meter calibration for the electromechanical type of meters, of 5% and 4,2%, respectively.

Figure 7.40 shows that the largest frequency of meter calibration for LV – commercial without peak power registration customers for electromechanical and electronic meters is in OSHEE of 10% (lump sum data for all consumption categories), the smallest for electromechanical meters is in EDB of 3%, and the smallest for electronic meters is in EDB of 2%. The frequency of meter calibration was recorded in EPHZHB of 5%, and EPS of 0,5%.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	0	0	0	5	4,2	0	0	0	0
Electronic (digital)	0	5	8	5	5	4,2	16	0	0	10
Smart meter	0	13,3	0	5	0,5	4,2	16	9	0	0

Figure 7.39 Frequency of meter calibration by type of meter for LV-commercial with peak power registration consumers in SEE DSOs



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	3	5	5	8	4,2	0	7	0	10
Electronic (digital)	0	2	0	5	5	4,2	0	7	0	10
Smart meter	0	0	0	5	0,5	0	0	0	0	0

Figure 7.40 Frequency of meter calibration by type of meter for LV-commercial without peak power registration consumers in SEE DSOs

In addition to the previous indicator (frequency of meter calibration), DSOs have delivered data on prescribed meter calibration intervals (subject to the national legislation). Data for this indicator in CEDIS and HEP were not available for all customer categories, while in OSHEE it was not available for HV, public lighting and LV – commercial with peak power registration customers.

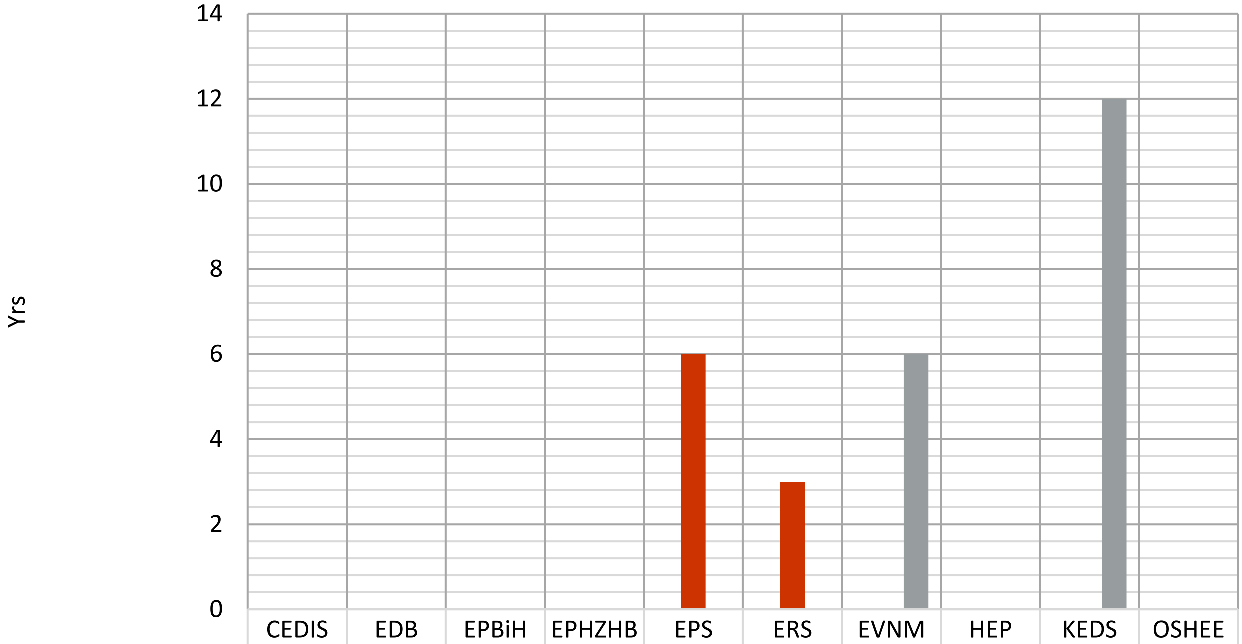
Figures from Figure 7.41 to Figure 7.46 give data on prescribed calibration intervals of all customer categories by meter type.

For meters on HV level (Figure 7.41) prescribed calibration interval for the electromechanical type of meters ranges from 3 (ERS) to 6 (EPS) years. Prescribed calibration interval for smart meters is between 6 and 12 years. In accordance with the regulations, the latter implies that frequency of electromechanical meters' calibration per year must be greater than 16,6% to 33,3%, while for smart meters between 8,3% to 16,67 in the region.

For meters on MV level, electromechanical meters prescribed calibration interval ranges from 5 to 12 years, for electronic meters from 3 to 6 years, while for smart meters is between 2 to 12 years (Figure 7.42). The latter implies that frequency of electromechanical meter calibration per year must be greater than 8,3% to 20%, electronic meters from 16,7% to 33,3%, while smart meters need to have from 8,3% to 33,3% frequency of meter calibration per year.

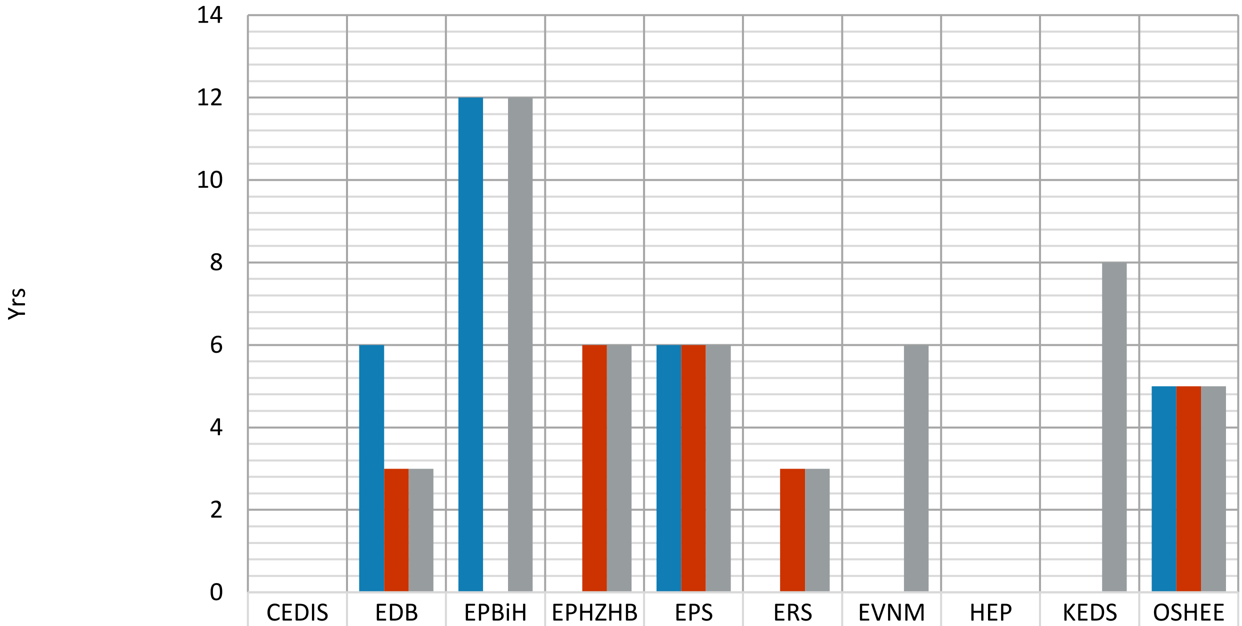
The largest prescribed meters calibration interval in the region is for electromechanical meters in KEDS for LV customers (from Figure 7.43 to Figure 7.46), being 16 years, what means that meters calibration per years is 6,25%.

On the Figure 7.43 it can be noticed that most of the DSOs (5 of 8. EDB, EPBiH, EPHZHB, EPS, and ERS) for household customers have 12 years prescribed meters' calibration interval for all type of meters. Just EDB doesn't have the smart meter type. OSHEE has the lowest values for all three-meter types - 5 years. Similar values are prescribed for meters' calibration interval for all type of meters for public lighting (Figure 7.44), with 12-year value for 5 of 7 DSOs: EDB, EPBiH, EPHZHB, EPS, and ERS, but EDB, EPBiH, and ERS don't have smart meter type. The lowest calibration interval for smart meters is reported in EVNM – 6 years, for electronic meters in KEDS – 8 years, while the largest prescribed meters' calibration interval for electromechanical meters is found in KEDS – 16 years.



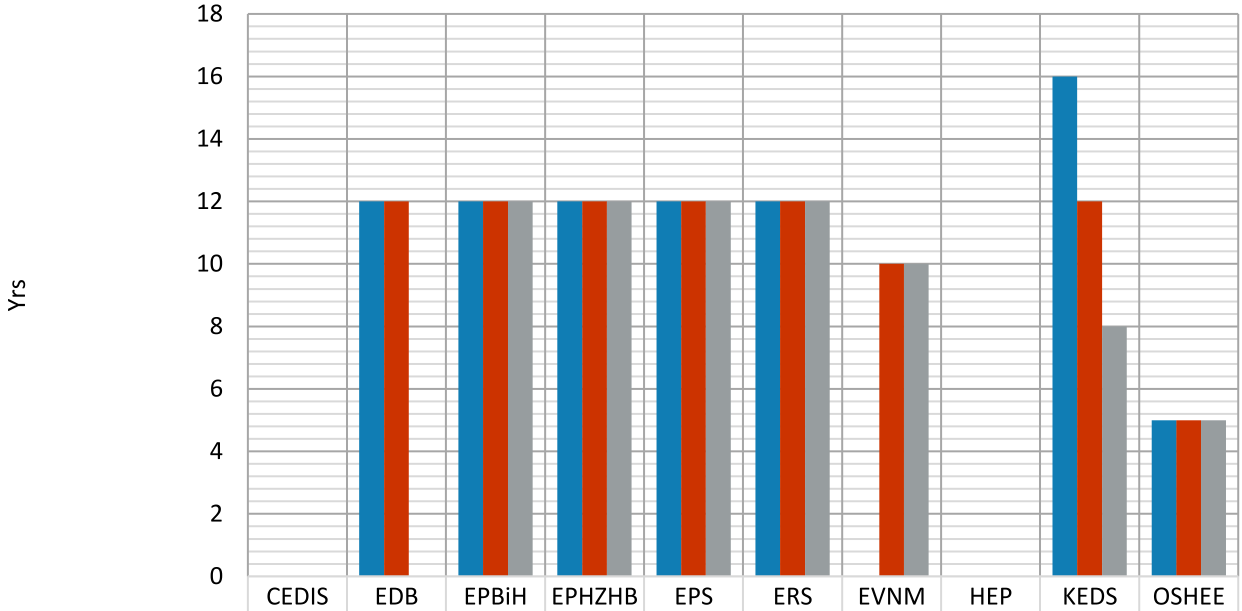
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	0	0	0	0	0	0	0	0	0
Electronic (digital)	0	0	0	0	6	3	0	0	0	0
Smart meter	0	0	0	0	0	0	6	0	12	0

Figure 7.41 Prescribed calibration interval by type of meter for HV consumers in SEE DSOs



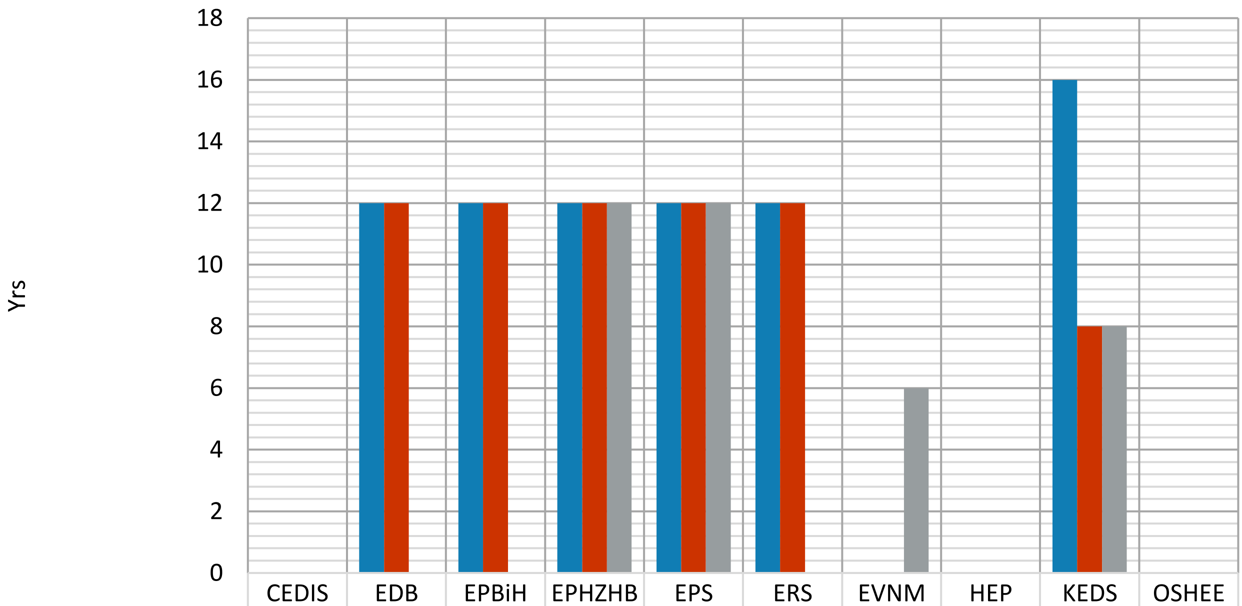
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	6	12	0	6	0	0	0	0	5
Electronic (digital)	0	3	0	6	6	3	0	0	0	5
Smart meter	0	3	12	6	6	3	6	0	8	5

Figure 7.42 Prescribed calibration interval by type of meter for MV consumers in SEE DSOs



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	12	12	12	12	12	0	0	16	5
Electronic (digital)	0	12	12	12	12	12	10	0	12	5
Smart meter	0	0	12	12	12	12	10	0	8	5

Figure 7.43 Prescribed calibration interval by type of meter for households consumers in SEE DSOs

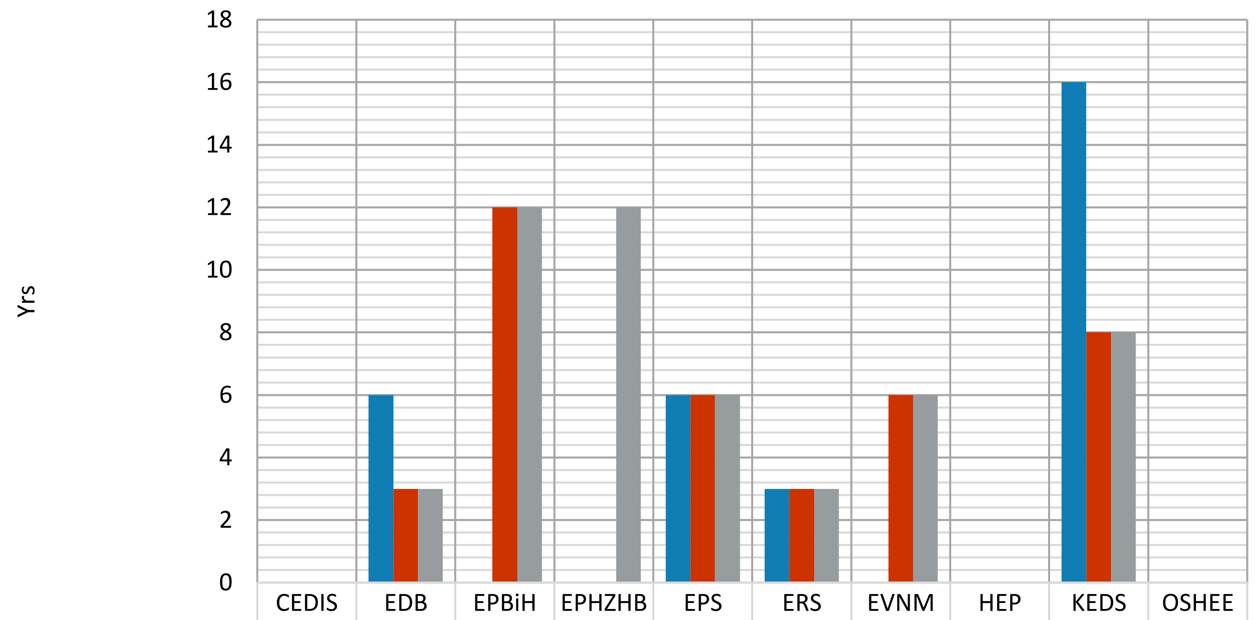


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	12	12	12	12	12	0	0	16	0
Electronic (digital)	0	12	12	12	12	12	0	0	8	0
Smart meter	0	0	0	12	12	0	6	0	8	0

Figure 7.44 Prescribed calibration interval by type of meter for public lighting consumers in SEE DSOs

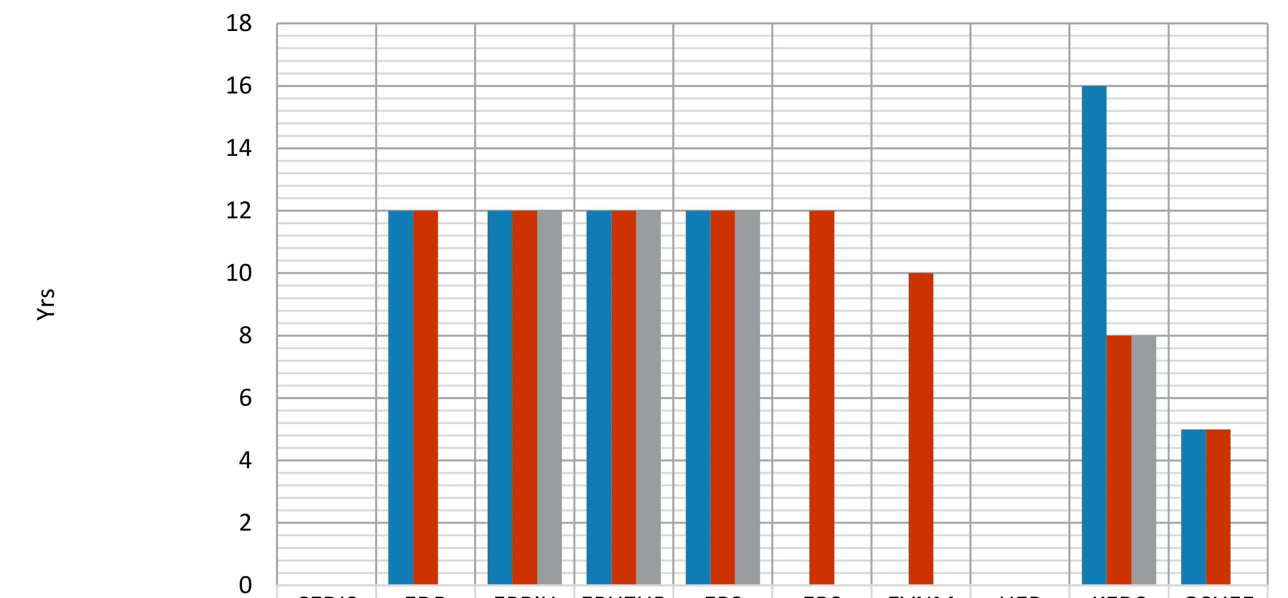
Prescribed calibration interval for all type of meters for LV – commercial with peak power registration differ among SEE DSOs (Figure 7.45). For electromechanical type of meters, presented in 4 DSOs: EDB, EPS, ERS, and KEDS; for electronic meters, presented in 6 DSOs: EDB, EPBiH, EPS, ERS, EVNM, and KEDS, and for smart meters presented in 7 DSOs: EDB, EPBiH, EPHZHB, EPS, ERS, EVNM, and KEDS it ranges from 3 to 16 years. The latter implies that frequency of all types of meter calibration per year must be between 6,3% to 3,33%.

Figure 7.46 shows that prescribed calibration interval for all type of meters for LV – commercial without peak power registration in most of the DSOs is 12 years: in EDB, EPBiH, EPHZHB, EPS, and ERS. EDB doesn't have the smart type of meters, and ERS have the only electronic type of meters. The lowest calibration interval is in KEDS – 8 years, electronic meters in OSHEE – 5 years, while the prescribed calibration interval for electromechanical meters ranges from 5 years in OSHEE to 16 years in KEDS.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	6	0	0	6	3	0	0	16	0
Electronic (digital)	0	3	12	0	6	3	6	0	8	0
Smart meter	0	3	12	12	6	3	6	0	8	0

Figure 7.45 Prescribed calibration interval by type of meter for LV-commercial with peak power registration consumers in SEE DSOs



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	12	12	12	12	0	0	0	16	5
Electronic (digital)	0	12	12	12	12	12	10	0	8	5
Smart meter	0	0	12	12	12	0	0	0	8	0

Figure 7.46 Prescribed calibration interval by type of meter for LV-commercial without peak power registration consumers in SEE DSOs

7.6 FREQUENCY OF METER AND SEAL INSPECTION

Inspections are important measure to assure meter accuracy and detect theft. Some DSOs assign this task to meter readers and they may claim that inspections of meters and seals thus occur on every site visit. In many cases, this belies the prevalence of broken seals and tampered meters. However, measures should focus on inspections by personnel independent of meter reading. With the trend of increase in the use of smart meters, warning about meter unauthorized attempt or state will be sent automatically from the smart meter to the AMI system. This can ensure benefits and save the costs for distribution utilities planned for meter and seal inspection, and decrease commercial losses, but also to all customers, because every customer will pay for the energy that is spent. In some DSOs, it is assumed that the smart meters have 100% frequency of meter and seal inspection.

For this report, the measure is developed from the number of yearly inspections of each consumption category as a portion of the number of meters in service of each consumption categories.

Here it must be noted that:

- EPHZHB provided lump sum data for different consumption categories,
- ERS has not provided data for different meter types (i.e. electromechanical, electronic and smart meters) nor for two different connection types (i.e. direct, semi-direct and indirect), 70.282 directly connected meters, and 2.444 semi-directly and indirectly connected meters were inspected in 2015. Authors assumed that directly connected meters were used at household customers and public lighting, and the frequency of meter and seal inspection

calibration for that type of customers is calculated as a portion of number of directly connected meters that have been inspected in total number of household metering points and public lighting, being 13,62%, while for semi-directly and indirectly connected meters was assumed that they were used at HV, MV, LV – commercial customers with peak power registration and LV - commercial customers without peak power registration, with the frequency of meter and seal inspection of 6,21%.

- EPS stated that the meter reader, during the meter reading need to recognize all unauthorized attempt and tamper on meter and seal, but also has delivered the table with the number of regular and additional controls per consumption category in 2015, from which the frequency of meter and seal inspection for each consumption category were calculated. The frequency of meter and seal inspection for HV customers is 100%.
- EVNM delivered data only for smart meters for HV, MV, and household customers,
- For HEP it is assumed that smart meters have 100% share of meter and seal inspection,
- for KEDS data are delivered only for smart meters for LV – commercial with peak power registration consumers, being 100%, i.e. all meters and seals for that customers were inspected,
- OSHEE has not delivered any data on the frequency of meter and seal inspections.

Figure 7.47 shows that the frequency of meter and seal inspection of most smart and electronic meter on HV were inspected at least once a year in DSOs that have HV customers. Exceptions were found in ERS and EVNM, with the 5,6% of inspection for electronic meters and 50% inspection of smart meters, respectively.

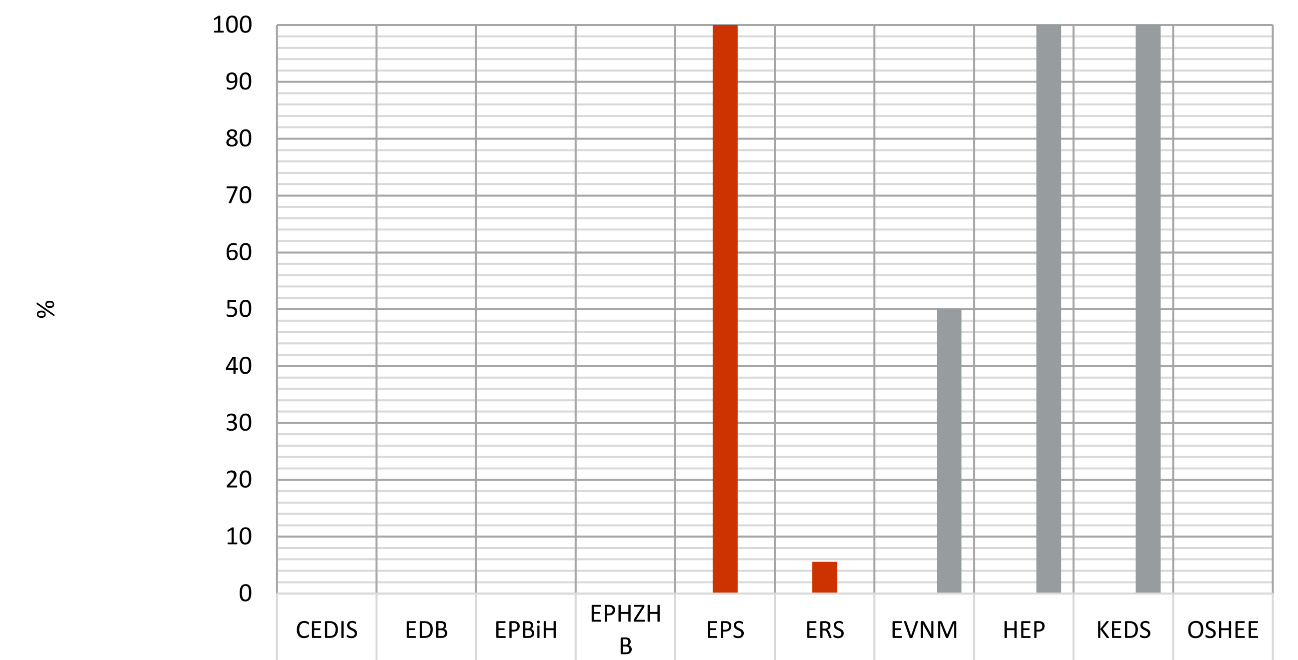
Similar situation is detected with the frequency of meter and seal inspection for MV customers, where most of the meters, of all type of meters, were inspected once a year, except in EDB, ERS, and EVNM (Figure 7.48).

In the Figure 7.49 it is shown that the largest frequency of meter and seal inspection of meters for households customers were for electronic meters in HEP, more than half of them once a year. For other DSOs, for all type of meters, it ranges from 0,3% for smart meters in EDB to 19,6% for electromechanical meters in EPBiH.

The largest frequency of meter and seal inspection of meters for public lighting customers were for smart meters in HEP, all of them once a year. For other DSOs, for all type of meters, it ranges from 0,6% for smart meters in EDB to 28,7% also for smart meters in EPBiH.

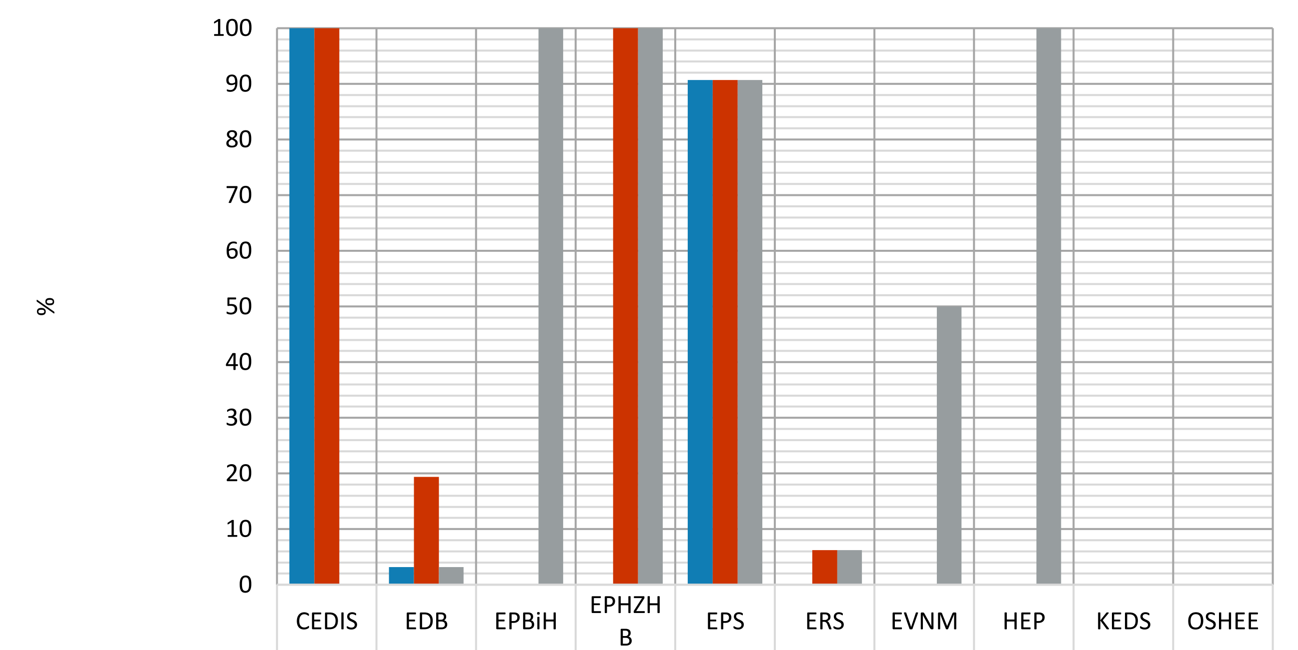
In 4 of 7 DSOs (in EPBiH, EPHZHB, HEP, and KEDS) for LV – commercial with peak power registration customers, the frequency of meter and seal inspection of all smart meters is almost once a year or exactly once a year. For all other DSOs, for all type of meters, it ranges from 6,2% in ERS to 31% in EPS (Figure 7.51).

Figure 7.52 shows that the largest frequency of meter and seal inspection of meters for LV – commercial without peak power registration customers were for smart meters in HEP. For other DSOs, for all type of meters, it ranges from 0,7% for electromechanical meters in EDB to 34,1% also for electromechanical meters in EPBiH.



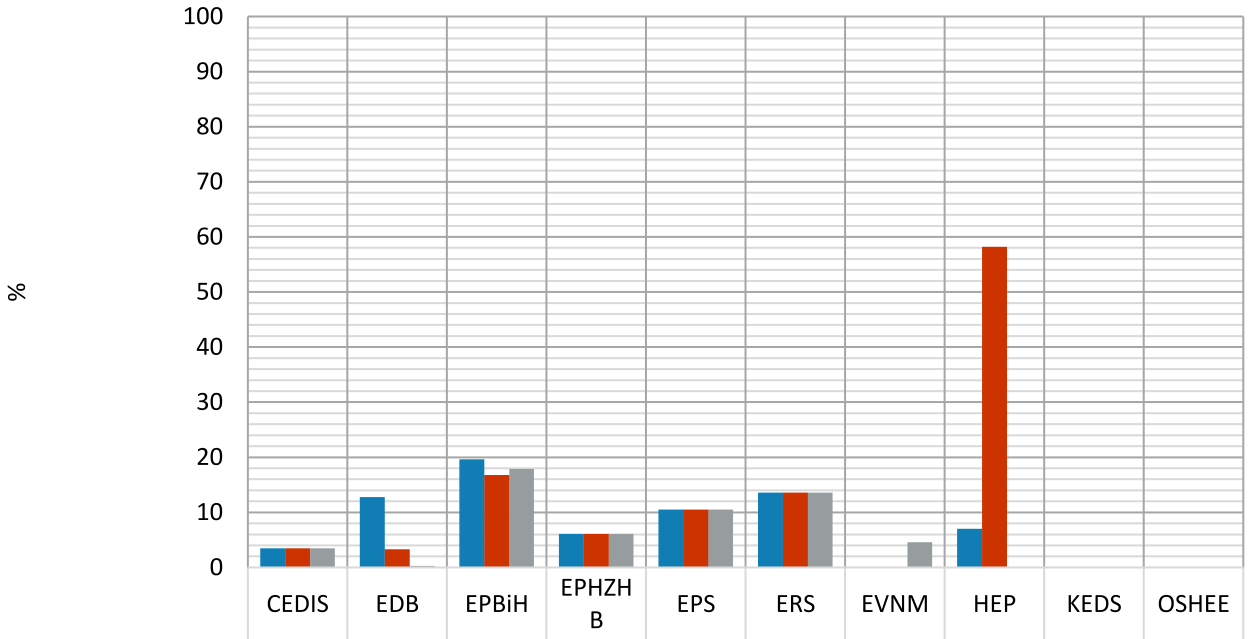
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	0	0	0	0	0	0	0	0	0
Electronic (digital)	0	0	0	0	100	5,6	0	0	0	0
Smart meter	0	0	0	0	0	0	50	100	100	0

Figure 7.47 Frequency of meter and seal inspection for HV consumers in SEE DSOs (2015)



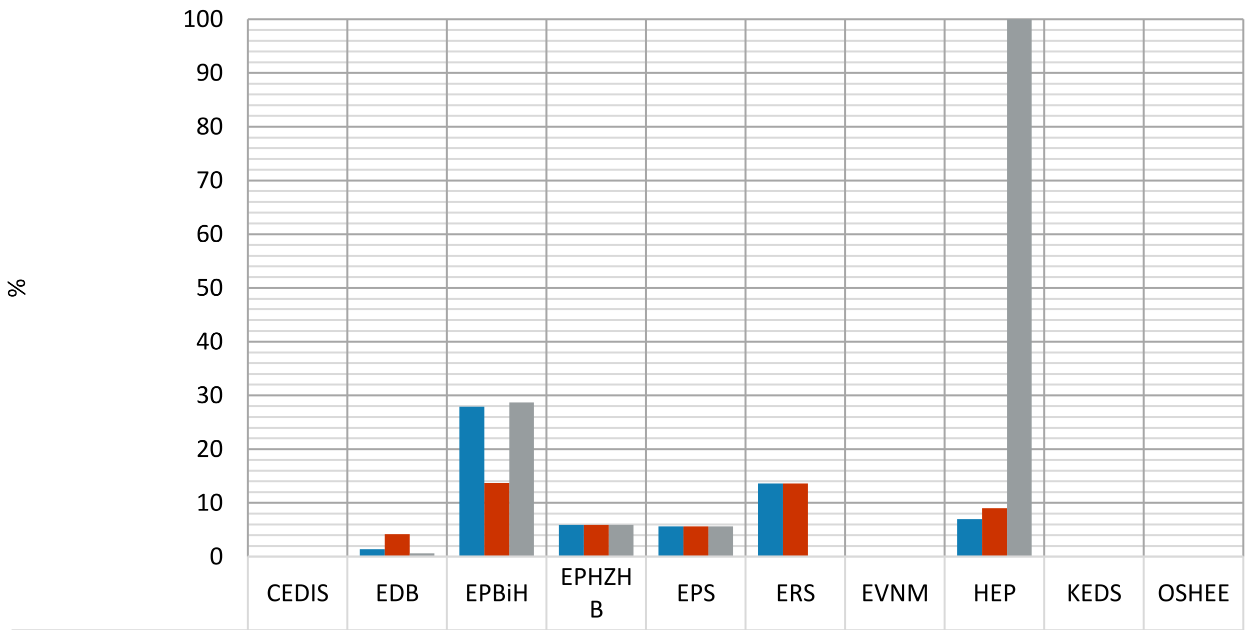
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	100	3,2	0	0	90,7	0	0	0	0	0
Electronic (digital)	100	19,4	0	100	90,7	6,2	0	0	0	0
Smart meter	0	3,2	100	100	90,7	6,2	50	100	0	0

Figure 7.48 Frequency of meter and seal inspection for MV consumers in SEE DSOs (2015)



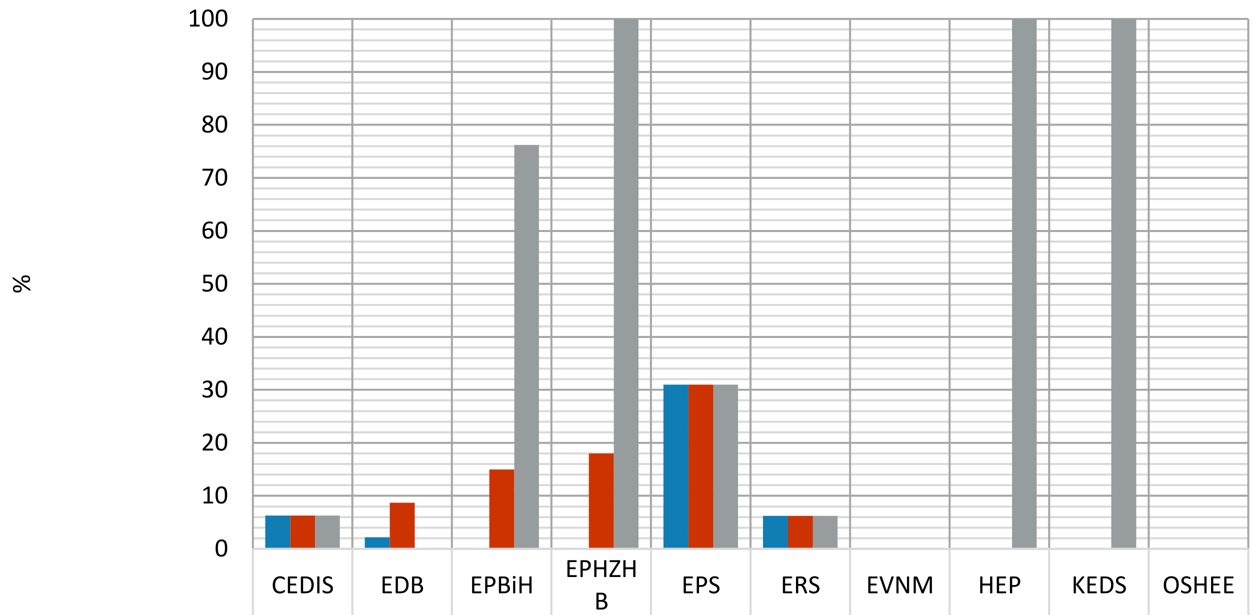
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	3,5	12,8	19,6	6,1	10,5	13,6	0	7	0	0
Electronic (digital)	3,5	3,3	16,8	6,1	10,5	13,6	0	58,2	0	0
Smart meter	3,5	0,3	17,9	6,1	10,5	13,6	4,6	0	0	0

Figure 7.49 Frequency of meter and seal inspection for households consumers in SEE DSOs (2015)



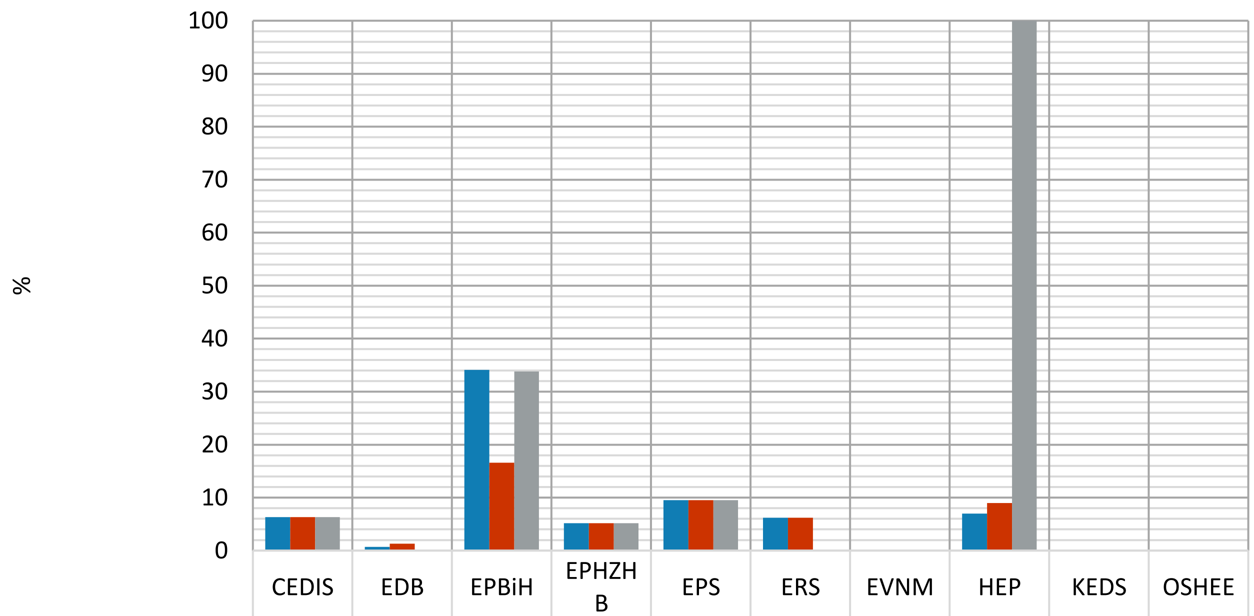
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	0	1,4	27,9	5,9	5,6	13,6	0	7	0	0
Electronic (digital)	0	4,2	13,7	5,9	5,6	13,6	0	9	0	0
Smart meter	0	0,6	28,7	5,9	5,6	0	0	100	0	0

Figure 7.50 Frequency of meter and seal inspection for public lighting consumers in SEE DSOs (2015)



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	6,3	2,2	0	0	31	6,2	0	0	0	0
Electronic (digital)	6,3	8,7	15	18	31	6,2	0	0	0	0
Smart meter	6,3	0	76,2	100	31	6,2	0	100	100	0

Figure 7.51 Frequency of meter and seal inspection for LV-commercial with peak power registration consumers in SEE DSOs (2015)



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Electromechanical	6,3	0,7	34,1	5,2	9,5	6,2	0	7	0	0
Electronic (digital)	6,3	1,3	16,6	5,2	9,5	6,2	0	9	0	0
Smart meter	6,3	0	33,8	5,2	9,5	0	0	100	0	0

Figure 7.52 Frequency of meter and seal inspection for LV-commercial without peak power registration consumers in SEE DSOs (2015)

7.7 FREQUENCY OF CONNECTION AND INSTALLATION INSPECTIONS (SERVICE INSPECTIONS)

To detect unauthorized connections, customer connections and installation should be inspected periodically. For this report, the measure is developed from the number of yearly service inspections as a portion of the number of meters in service of each consumption categories.

Here it must be noted that:

- EPHZHB, EPS, HEP, and OSHEE have not provided data on service inspections,
- in EDB there are some differences between frequencies of meters/seal and connection/installation inspections,
- EPBIH, EVNM (provided only data for HV, MV, and households customers for smart meters), and CEDIS provided the same data for connection and meter inspections (from Figure 7.47 to Figure 7.52),
- ERS provided data only for LV – commercial without peak power registration customers for electronic type of meters, being 20%,
- KEDS provided data for smart meters for HV and LV - commercial with peak power registration customers and from these data it is possible to conclude that all smart meter connections are inspected every year.

7.8 OBSERVATIONS/RECOMMENDATIONS

Comparing to the 1st SEE DSOs Benchmarking Study this edition considers the type of communication that is used in the remote type of reading of smart meters. All proposed indicators provide benchmarks for good meter maintenance practice, pointing to trends of different meter used in the region, regarding the type, way of reading and the type of communication that is used for remote reading of smart meters. It is important to stress out that none of the proposed metrics in this section measures meter accuracy directly.

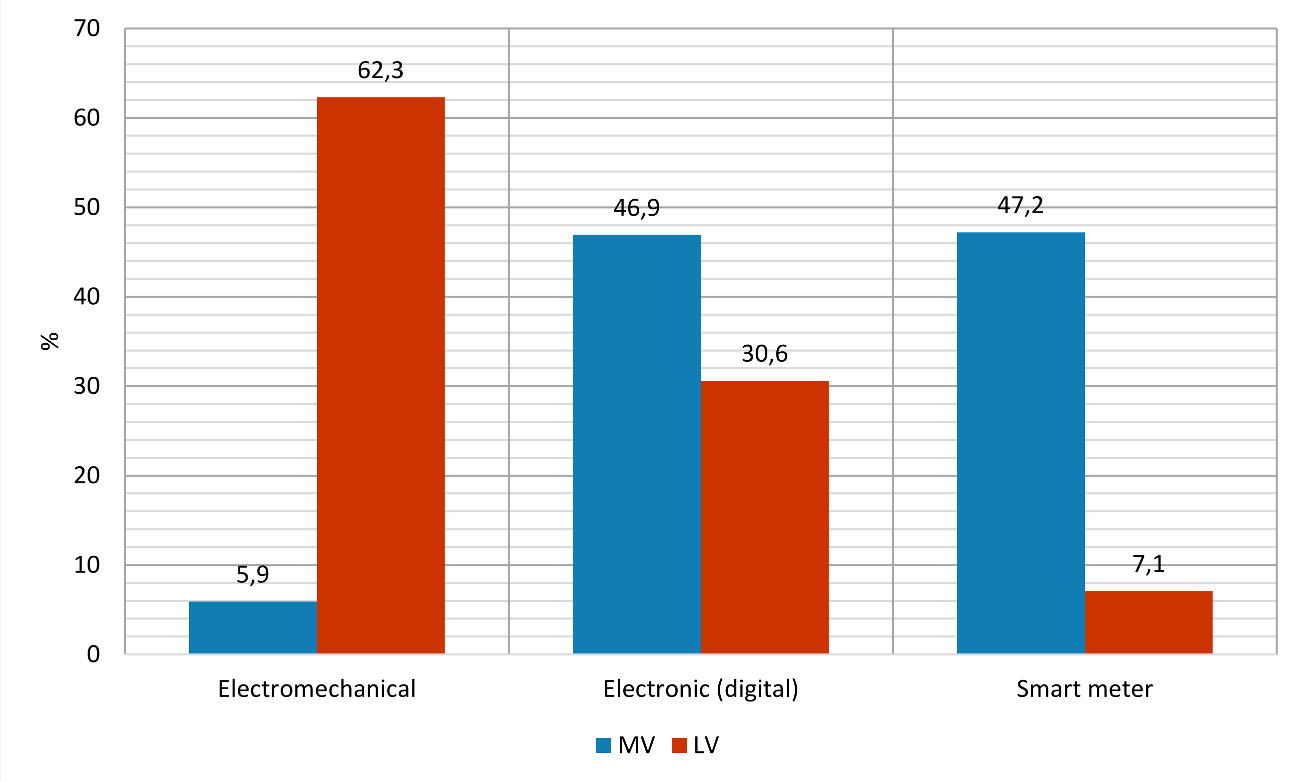


Figure 7.53 Share of different meter types in the observed region

Before final finding for customers on MV and LV need to be observed that the ERS and HEP have not delivered data for all LV customers except ERS for LV – commercial customers without peak power registration, and HEP for MV customers.

Regarding existing smart metering and trends, the main findings are given as follows:

- on the LV level, there are 7,1 % of smart meters (Figure 7.53), with the trend of increase in 2015 compared to 2012 in most of the DSOs for all LV consumption categories, the average age of this meters in the region is 4,7 years (Figure 6.24):
    - The largest share of smart meters for household customers is in CEDIS with the 57,5% (Figure 7.6), and all these meters have remotely way of reading, the only one in the region with the dominate PLC type of communication
    - The largest share of smart meters for public lighting meters was in EVNM with the 58% (Figure 6.9), also all with remotely way of reading (Figure 6.10), and PLC type of reading (Figure 6.11)
    - Almost 100% of smart meters for LV – commercial customers with peak power registration were in EPBiH, EVNM, and KEDS (Figure 6.12). All of them use remotely type of reading (HEP did not deliver that data) (Figure 6.13). In all of them is used GPRS type of communication, and that type of communication prevails for this type of customers (Figure 6.14).

  - Smart meters were used in most of SEE DSOs for LV - commercial customers without peak power registration, with the largest share in CEDIS of 62,4% with the trend of slight increase in 2015 compared to 2012 (Figure 6.15). Smart meters in CEDIS were read remotely, in EPHZHB 33,6% of the meters were read remotely. On the Figure 6.16 the trend of increase of remotely read meters in the period 2012 – 2015 is presented. The most common type of communication used for smart meters was PLC.

- only in OSHEE there are no smart meters on LV level in 2015, while in 2012 this was the case also in EDB and OSHEE,
- on the LV level, 62,3% are electromechanical meters (Figure 7.53); the oldest meters of this type are in EPS, 33 years old for households customers (Figure 7.20) and public lighting (Figure 7.21) with the average age of all electromechanical meters on LV, 27,9 years (Figure 7.24), (the reported lifespan of analog meters is 30-40 years)
- on the LV level, electronic meters were used with the share of 30,6% in the region (Figure 7.53). The average age of this meters is 11,8 years (Figure 7.24).
- the most common way of reading of meters for household customers was automatic meter reading that prevails in EPS, EVNM, KEDS, and OSHEE (Figure 6.7). In the region is present the trend of slight increase in remotely meter reading (EDB, EPBiH, and EVNM) and high increase in automatic meter reading using the terminal in EPS, EVNM, KEDS, and OSHEE.
- there is a great difference in the age of meters for LV customers, the oldest meters were in EPS, i.e. 28,4 years, while the youngest were in EVNM, i.e. 6,2 years (Figure 7.25),
- on MV level almost evenly prevails electronic and smart meters with the share of 46,9% and 47,2%, respectively (Figure 7.53). The average age of electronic meters is between 7,5 years in OSHEE, and 15 years in CEDIS (Figure 7.19). As expected, the average age of electromechanical meters is between 20 years in OSHEE, and 30 years in CEDIS. The oldest smart meters are in EPS, 8 years old,
- It can be noticed the trend of slight increase in remotely and automatic meter reading using the terminal on MV in the region in the period 2012 – 2015 (Figure 7.4). Remote reading of MV customers prevails in 5 out of 10 DSOs (PLC and GPRS type of communication prevail on MV level for smart meters, with the same number of DSOs at whom they are used Figure 7.5).

In accordance to the results of CBA for installation of smart meters, DSO should take a central role in the roll-out of smart meters. In line with the provision of the EU Third Energy Package, it is suggested here to prepare Cost-Benefit Analysis for each country (or DSO) level on electricity smart metering roll-out to be performed by the Regulatory Authority. The main reasons for the roll-out are:

- efficient remote meter reading,
- reducing outage time,
- reducing electricity losses,

- reducing fraud,
- improving responses to delayed or lack of payment by consumers,
- the rise of satisfaction of customers, because they will pay the exact amount of energy that they have been consumed,
- enable active participation of customers in energy efficient consumption and production,
- enable remote connection/disconnection of the customers, change in allowed peak demand,
- many new services, including energy efficiency services, for customers (however, to realize potential feedback-induced savings, advanced meters (smart meters) must be used in conjunction with in-home (or on-line) displays and well-designed programs that successfully inform, engage, empower and motivate people).

Based on the results of cost-benefit analysis for a roll-out of smart metering, several European countries have already decided for, and in a few cases against a roll-out of smart metering (e.g. Belgium, Czech Republic, Lithuania). In some countries, the decision for a roll-out of smart metering has been driven by the DSOs independently from the results of a CBA (e.g. in Italy or Sweden). By examining countries cases (forerunners in the roll-out of the Smart Grid or countries that have applied a distinctive approach to the roll-out and/or to the management of the meter data, e.g. Sweden, Italy, Denmark, France, the UK, Portugal, Slovenia, Texas in the USA), lessons can be learned on successful market models in support of a large-scale roll-outs and on potential pitfalls and challenges. Results of great number of smart grid pilot projects can help to overcome the possible obstacles in smart grid and distribution management system development, but at first about the decision for a roll-out of smart metering.

8 METERING EFFECTIVENESS

Billing and collection are based on the metering data, thus one of the main DSO objectives should be to measure the consumption accurately and to transmit metering data to the DSO billing system in a fast and secure way. In most of the SEE DSOs there is a space for improvement through equipment investments and changes in the working process.

8.1 ESTIMATED NUMBER OF UNAUTHORIZED CONNECTION POINTS

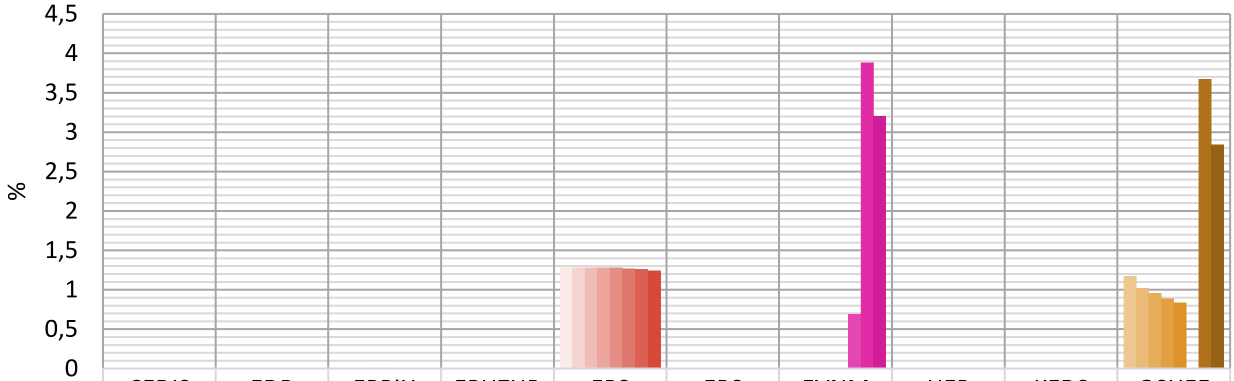
Regarding estimated number of unauthorized connection points (points without metering), 5 DSOs provided data: EPBIH, EPHZHB, EPS, EVNM and OSHEE. Data for EVNM in the period 2013-2015 were given as lump sums of all categories and it is shown within the largest category - households.

Data on number of connection points equipped with meters were not available for KEDS in the period 2008-2011 for all categories. Data on public lighting and commercial with peak power registration in OSHEE were not available in the period 2013-2015. CEDIS didn't provide the data for public lighting in the whole period, while ERS provided data only 2013 with lump sums data for both commercial categories (with and without power peak registration). Data for EPBiH were divided into 5 distribution areas[5].

Shares of estimated number of unauthorized connection points (without metering) in the total number of connection points equipped with meters per each consumer category at LV level were calculated and shown on the Figures 8.1 - 8.4. These shares at HV and MV level were not available or were equal to zero. As stated above, estimated number of unauthorized connection points for EVNM refers to all categories and on the following figure represent its share in the largest category – households.

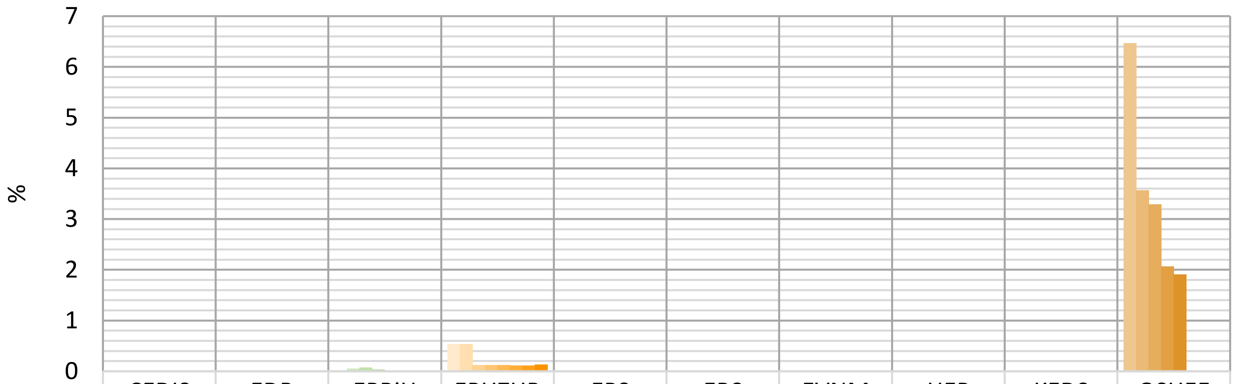
Data for OSHEE in all consumer categories in 2014 and 2015 are about 4 times higher than in 2012 and prior. Reason for this change in the share for LV-commercial connection points with peak power registration in EPS (Figure 8.3) was 47% drop of the number of connection points equipped with meters in 2013 relative to 2012. Share of estimated number of unauthorized connection points (without metering) wasn't higher than 6,47% in all LV consumer categories in the observed period.

[5] One correction was done in Distribution Area Sarajevo dataset: data for 2014 were used for 2013 since the data submitted for 2013 were relating to whole EPBiH



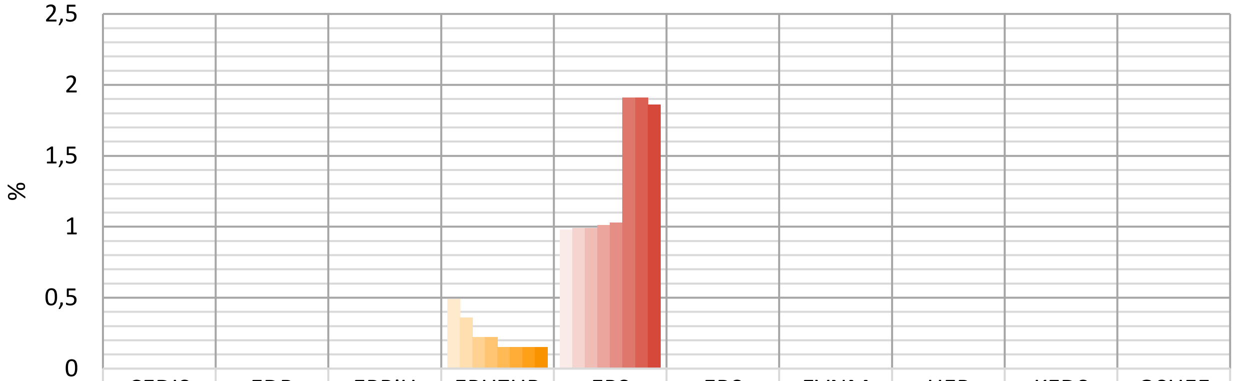
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0,01	0,01	1,28	0	0	0	0	1,17
2009	0	0	0,01	0,01	1,28	0	0	0	0	1,02
2010	0	0	0,01	0,01	1,28	0	0	0	0	0,96
2011	0	0	0,01	0	1,28	0	0	0	0	0,89
2012	0	0	0,01	0	1,28	0	0	0	0	0,84
2013	0	0	0	0	1,27	0	0,69	0	0	0
2014	0	0	0	0	1,26	0	3,88	0	0	3,67
2015	0	0	0	0	1,24	0	3,2	0	0	2,84

Figure 8.1 Estimated share of unauthorized households connection points in the period 2008-2015



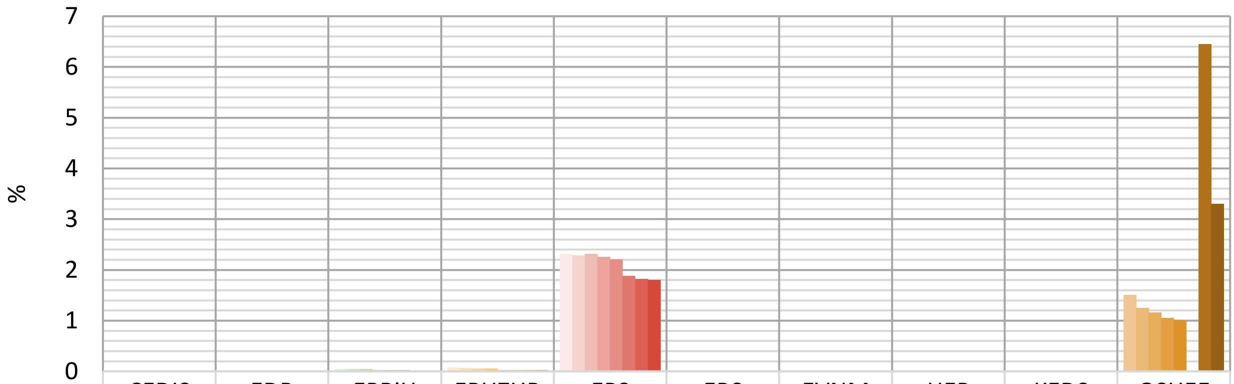
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0,54	0	0	0	0	0	6,47
2009	0	0	0,05	0,54	0	0	0	0	0	3,57
2010	0	0	0,07	0,12	0	0	0	0	0	3,29
2011	0	0	0,03	0,12	0	0	0	0	0	2,07
2012	0	0	0	0,12	0	0	0	0	0	1,91
2013	0	0	0	0,11	0	0	0	0	0	0
2014	0	0	0	0,11	0	0	0	0	0	0
2015	0	0	0	0,13	0	0	0	0	0	0

Figure 8.2 Estimated share of unauthorized public lighting connection points in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0,49	0,98	0	0	0	0	0
2009	0	0	0	0,36	0,99	0	0	0	0	0
2010	0	0	0	0,22	0,99	0	0	0	0	0
2011	0	0	0	0,22	1,01	0	0	0	0	0
2012	0	0	0	0,15	1,03	0	0	0	0	0
2013	0	0	0	0,15	1,91	0	0	0	0	0
2014	0	0	0	0,15	1,91	0	0	0	0	0
2015	0	0	0	0,15	1,86	0	0	0	0	0

Figure 8.3 Estimated share of unauthorized LV-commercial with peak power registration connection points in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0,04	0,07	2,31	0	0	0	0	1,5
2009	0	0	0,04	0,06	2,28	0	0	0	0	1,25
2010	0	0	0,04	0,05	2,31	0	0	0	0	1,16
2011	0	0	0,02	0,05	2,25	0	0	0	0	1,05
2012	0	0	0,02	0,02	2,21	0	0	0	0	1,01
2013	0	0	0,02	0,02	1,88	0	0	0	0	0
2014	0	0	0,01	0,02	1,82	0	0	0	0	6,45
2015	0	0	0,01	0,02	1,8	0	0	0	0	3,3

Figure 8.4 Estimated share of unauthorized LV-commercial without peak power registration connection points in the period 2008-2015

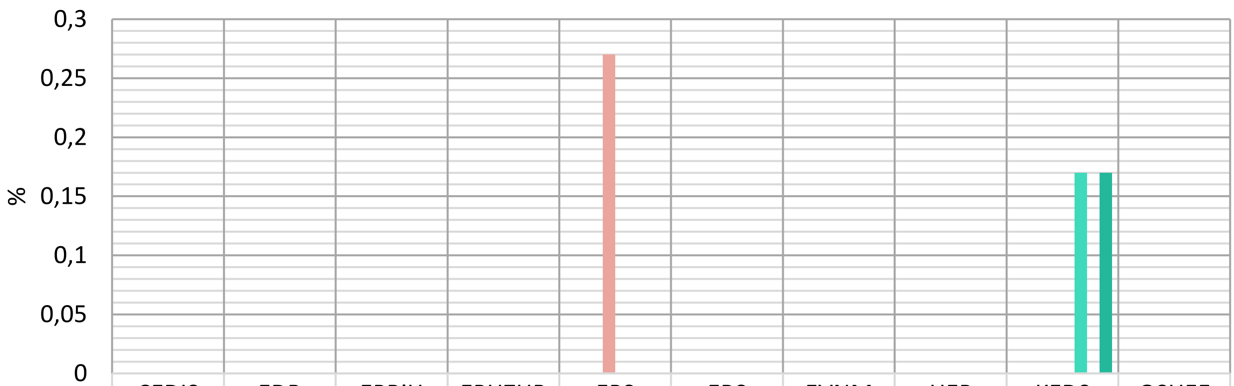
8.2 NUMBER OF YEARLY DETECTED UNAUTHORIZED CONNECTION POINTS (WITHOUT METERING)

Usually unauthorized connections are related to electricity meter deliberately omitted or bypassed, direct tapping from distribution line, reconnection without authority after disconnection for nonpayment or use of distribution network not in line with the network code etc.

Besides estimated number of unauthorized connection points (without metering) in DSOs supply areas (Figures 8.1 - 8.4), this section provides data on number of yearly detected unauthorized connection points (without metering). In Figures 8.5 - 8.9 these are given as a portion of the total number of connection points equipped with the meters. CEDIS and OSHEE haven't provided any input data on that, while EPHZHB, ERS, EVNM and partially KEDS have provided lump sum data. These data are then set within the household category as the largest category and shown on following figures. For KEDS, lump sum data in the period 2010 – 2012 were proportionally distributed per each consumer category that existed in 2013.

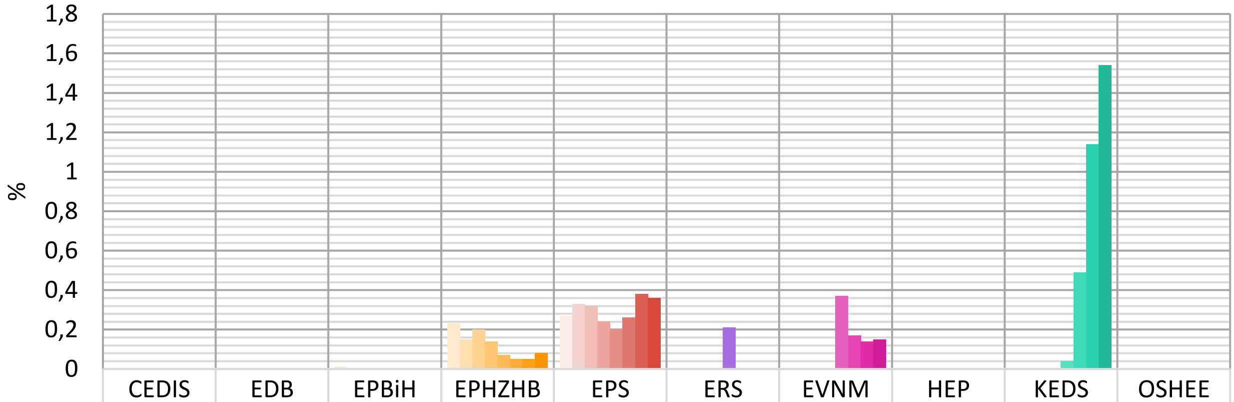
As expected, unauthorized connections are detected only in the LV distribution network (with very few exceptions at MV level in EPS in 2011, and KEDS in 2013 and 2015).

The highest share of detected unauthorized connections in 2015 is found in KEDS in all LV categories, up to 1,54%. In other DSOs, this share was below 0,4% in the whole monitored period of time.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0,27	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0,17	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0,17	0

Figure 8.5 Share of yearly detected unauthorized MV connection points (connections without metering) in the period 2008-2015

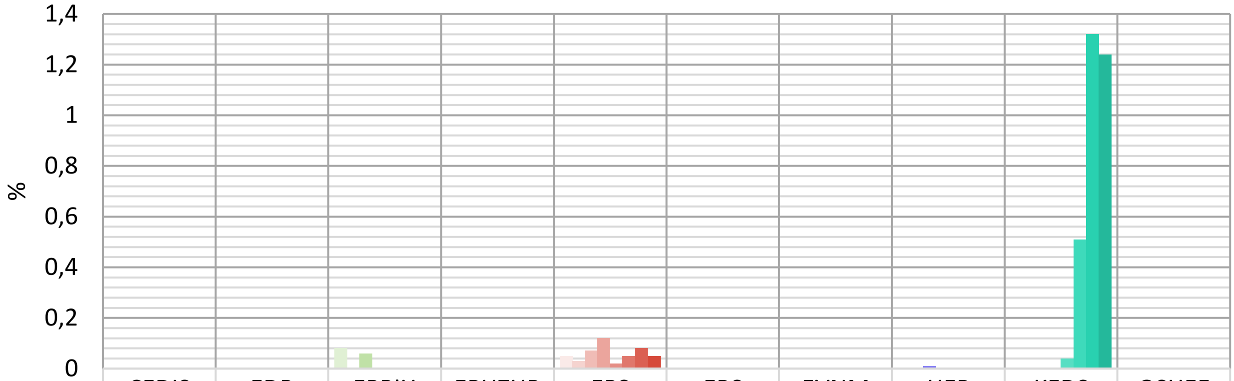


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0,01	0,23	0,27	0	0	0	0	0
2009	0	0	0	0,15	0,33	0	0	0	0	0
2010	0	0	0	0,2	0,32	0	0	0	0	0
2011	0	0	0	0,14	0,24	0	0	0	0	0
2012	0	0	0	0,07	0,2	0,21	0,37	0	0,04	0
2013	0	0	0	0,05	0,26	0	0,17	0	0,49	0
2014	0	0	0	0,05	0,38	0	0,14	0	1,14	0
2015	0	0	0	0,08	0,36	0	0,15	0	1,54	0

Figure 8.6 Share of yearly detected unauthorized households connection points (connections without metering) in the period 2008-2015

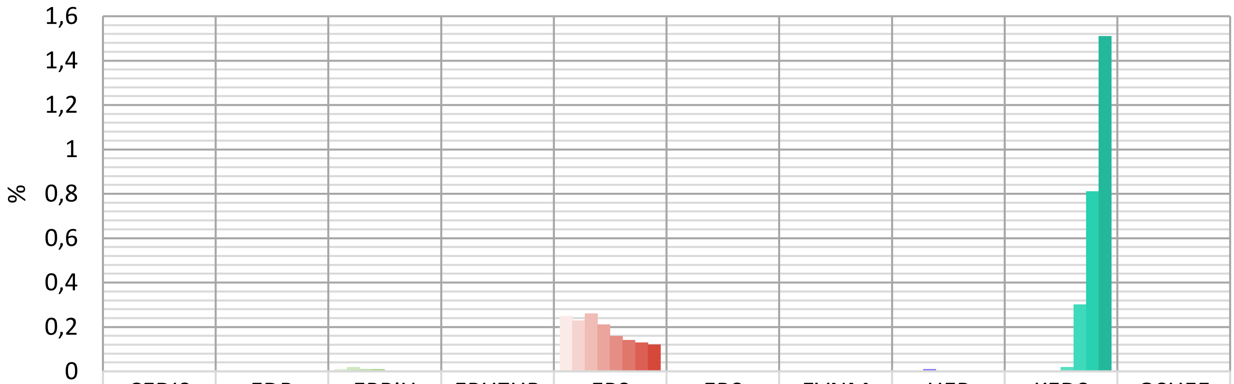
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0,05	0	0	0	0	0	0	0
2010	0	0	0,07	0	0,02	0	0	0,04	0	0
2011	0	0	0,03	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0,32	0
2015	0	0	0	0	0	0	0	0	0,93	0

Figure 8.7 Share of yearly detected unauthorized public lighting connection points (connections without metering) in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0,08	0	0,05	0	0	0	0	0
2009	0	0	0	0	0,03	0	0	0	0	0
2010	0	0	0,06	0	0,07	0	0	0,01	0	0
2011	0	0	0	0	0,12	0	0	0	0	0
2012	0	0	0	0	0,02	0	0	0	0,04	0
2013	0	0	0	0	0,05	0	0	0	0,51	0
2014	0	0	0	0	0,08	0	0	0	1,32	0
2015	0	0	0	0	0,05	0	0	0	1,24	0

Figure 8.8 Share of yearly detected unauthorized LV-commercial connection points with peak power registration (connections without metering) in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0,01	0	0,25	0	0	0	0	0
2009	0	0	0,02	0	0,23	0	0	0	0	0
2010	0	0	0,01	0	0,26	0	0	0,01	0	0
2011	0	0	0,01	0	0,21	0	0	0	0	0
2012	0	0	0	0	0,16	0	0	0	0,02	0
2013	0	0	0	0	0,14	0	0	0	0,3	0
2014	0	0	0	0	0,13	0	0	0	0,81	0
2015	0	0	0	0	0,12	0	0	0	1,51	0

Figure 8.9 Share of yearly detected unauthorized LV-commercial connection points without peak power registration (connections without metering) in the period 2008-2015

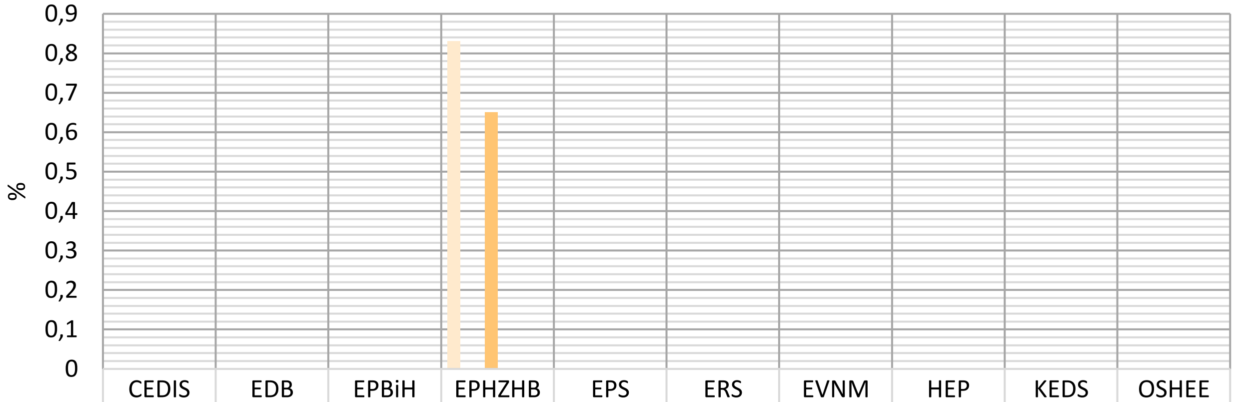
8.3 NUMBER OF YEARLY DETECTED CONNECTION POINTS WITH TAMPERED METERS

Unauthorized use of meters is usually related with tampered meter, tampered time switch, broken seal, unauthorized meter relocation/displacement, usage of electricity for unauthorized purposes (e.g. misrepresentation of consumption category to DSO) etc.

This section provides data on number of yearly detected connections with tampered meters. In Figures 8.10 - 8.14 these are given as a portion of total number of connection points equipped with meters. In this subchapter DSOs reported all connections with unauthorized use of meters detected by means of either planned inspections or inspections due to reported finding of irregularity/fraud.

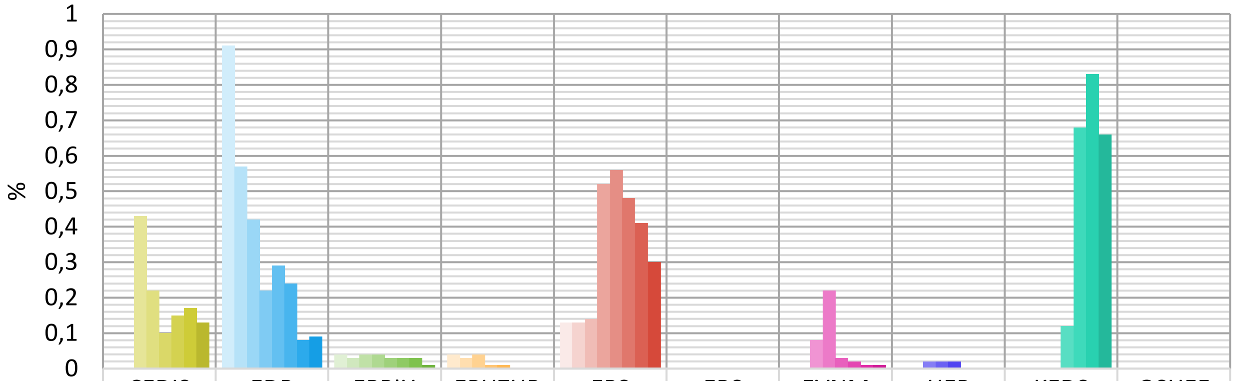
Two DSOs haven't provided any data: OSHEE and ERS. Three DSOs have provided partial inputs: HEP (2010-2012), KEDS, EVNM and CEDIS (all for 2010-2015). Therefore, EPHZHB, EVNM, CEDIS and partially KEDS provided lump sum data. In KEDS lump sum data in the period 2010-2012 were distributed proportionally to each consumer category in 2013, while in other DSOs lump sum data is presented in the largest category, i.e. household category.

Connections with tampered meters were detected only in LV network (except for EPHZHB at MV level in 2008 and 2011). The largest share of unauthorized use of meters was in LV category of commercial customers without peak power registration, i.e. 1,68 % (EDB, 2008), followed by 1,45 % (EPS, 2012). All other shares in given timeframe were below 1%.



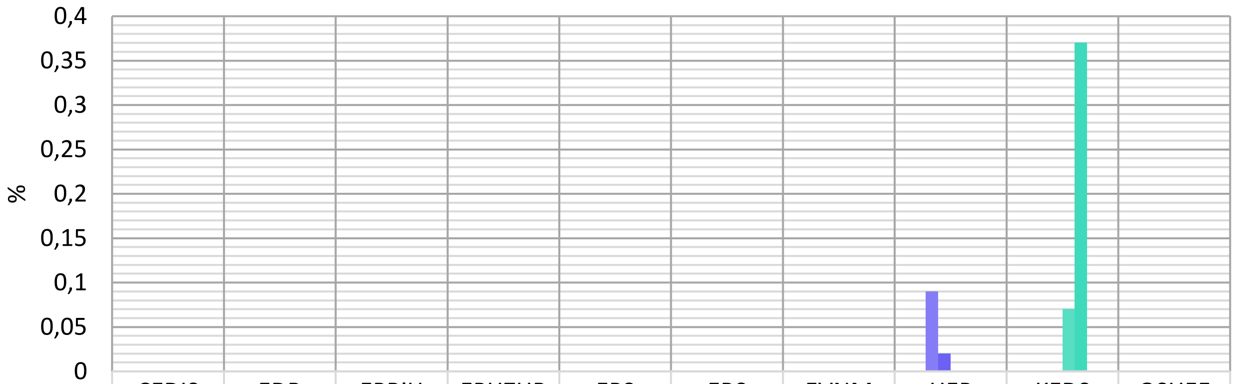
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0,83	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0,65	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0

Figure 8.10 Share of yearly detected MV connection points with tampered meters in the period 2008-2015



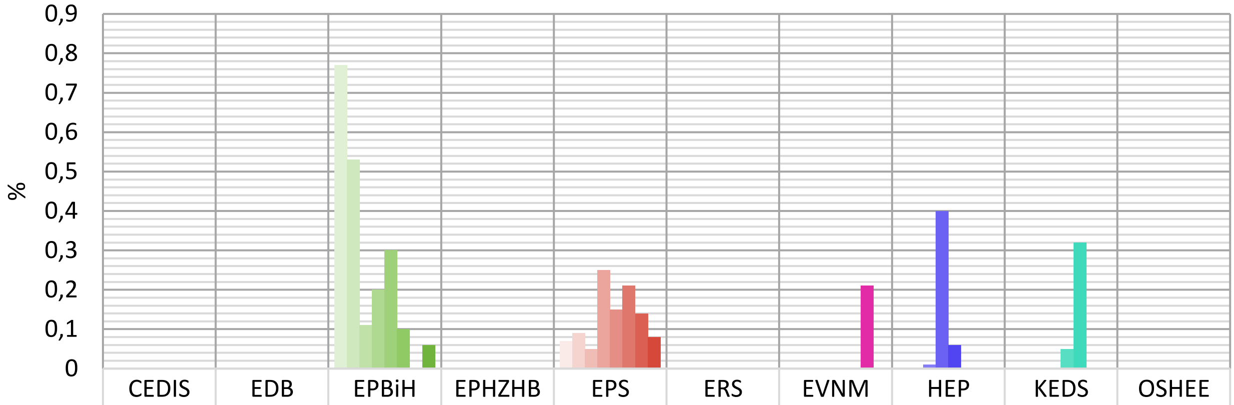
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,91	0,04	0,04	0,13	0	0	0	0	0
2009	0	0,57	0,03	0,03	0,13	0	0	0	0	0
2010	0,43	0,42	0,04	0,04	0,14	0	0,08	0,02	0	0
2011	0,22	0,22	0,04	0,01	0,52	0	0,22	0,02	0	0
2012	0,1	0,29	0,03	0,01	0,56	0	0,03	0,02	0,12	0
2013	0,15	0,24	0,03	0	0,48	0	0,02	0	0,68	0
2014	0,17	0,08	0,03	0	0,41	0	0,01	0	0,83	0
2015	0,13	0,09	0,01	0	0,3	0	0,01	0	0,66	0

Figure 8.11 Share of yearly detected households connection points with tampered meters in the period 2008-2015



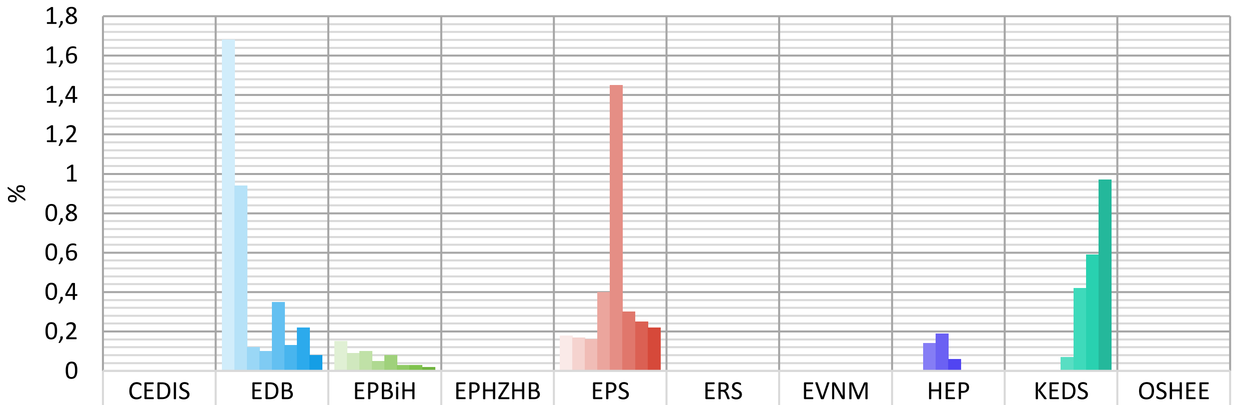
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0,09	0	0
2011	0	0	0	0	0	0	0	0,02	0	0
2012	0	0	0	0	0	0	0	0	0,07	0
2013	0	0	0	0	0	0	0	0	0,37	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0

Figure 8.12 Share of yearly detected public lighting connection points with tampered meters in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0,77	0	0,07	0	0	0	0	0
2009	0	0	0,53	0	0,09	0	0	0	0	0
2010	0	0	0,11	0	0,05	0	0	0,01	0	0
2011	0	0	0,2	0	0,25	0	0	0,4	0	0
2012	0	0	0,3	0	0,15	0	0	0,06	0,05	0
2013	0	0	0,1	0	0,21	0	0	0	0,32	0
2014	0	0	0	0	0,14	0	0,21	0	0	0
2015	0	0	0,06	0	0,08	0	0	0	0	0

Figure 8.13 Share of yearly detected LV-commercial with peak power registration connection points with tampered meters in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	1,68	0,15	0	0,18	0	0	0	0	0
2009	0	0,94	0,09	0	0,17	0	0	0	0	0
2010	0	0,12	0,1	0	0,16	0	0	0,14	0	0
2011	0	0,1	0,05	0	0,4	0	0	0,19	0	0
2012	0	0,35	0,08	0	1,45	0	0	0,06	0,07	0
2013	0	0,13	0,03	0	0,3	0	0	0	0,42	0
2014	0	0,22	0,03	0	0,25	0	0	0	0,59	0
2015	0	0,08	0,02	0	0,22	0	0	0	0,97	0

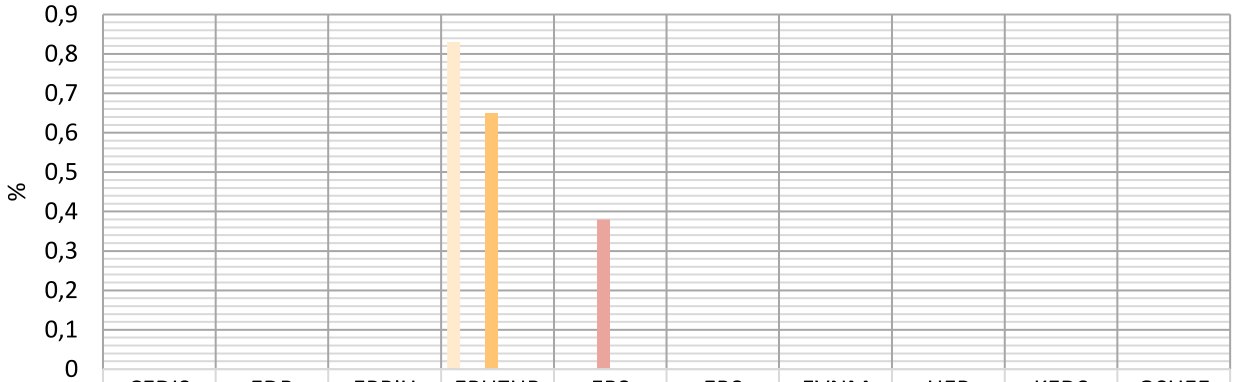
Figure 8.14 Share of yearly detected LV-commercial without peak power registration connection points with tampered meters in the period 2008-2015

8.4 RATIO OF DETECTED IRREGULARITIES

Numbers of detected unauthorized connection points (without metering) and detected connections with tampered meters have been added together and then divided by the number of conducted inspections in a certain year, and it is shown on Figures 8.15 - 8.19.

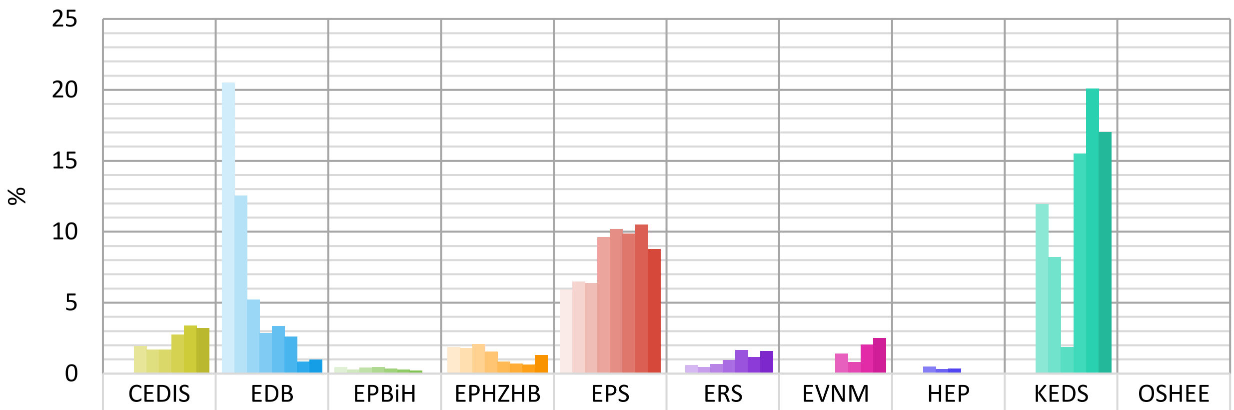
As stated in subchapters 8.2 and 8.3, lumps sum data related to all consumer categories are shown in the largest category, i.e. household category, whenever it couldn't be distributed by each category portion.

Consequently, the highest ratio of detected irregularities (unauthorized connection, tampered meter) and number of conducted inspections was recorded in the household category, i.e. 20,5% (EDB, 2008). In other words, in average every fifth controlled connection was irregular. This portion in EDB is reduced in 2015 to below 1%. In KEDS this share in the households category was in the last three years very high (17,54% in average) and it was more than 9 times higher compared to 2012 and also much higher then in 2010 and 2011. It is suggested here to double-check the reasons for these variations and large shares.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0,83	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0,65	0,38	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0

Figure 8.15 Ratio of detected irregularities (unauthorized connection, tampered meter) and number of conducted inspections - MV

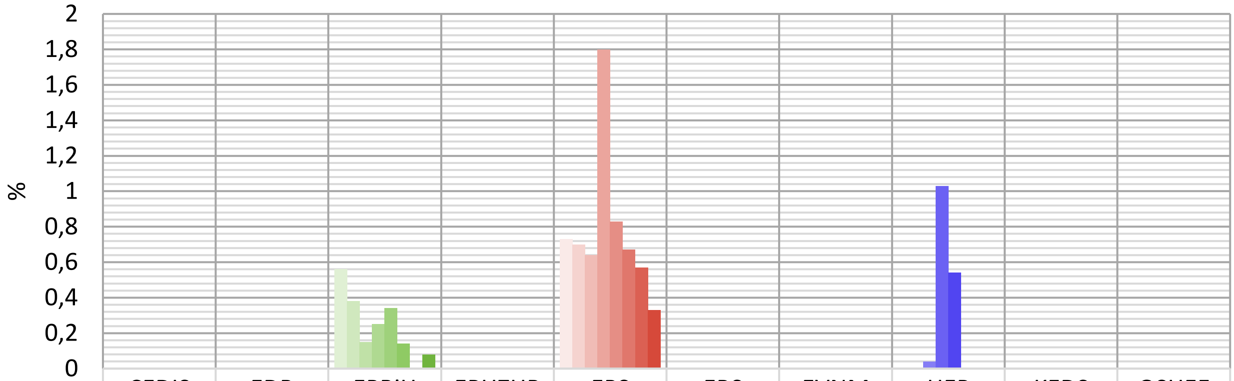


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	20,5	0,46	1,88	5,93	0	0	0	0	0
2009	0	12,56	0,29	1,81	6,49	0,61	0	0	0	0
2010	1,93	5,23	0,42	2,09	6,39	0,46	0	0,48	11,96	0
2011	1,69	2,86	0,45	1,54	9,63	0,66	0	0,33	8,22	0
2012	1,7	3,34	0,34	0,83	10,19	0,95	1,4	0,36	1,86	0
2013	2,75	2,61	0,27	0,71	9,86	1,64	0,8	0	15,5	0
2014	3,37	0,83	0,21	0,64	10,49	1,17	2,04	0	20,1	0
2015	3,22	0,99	0,05	1,29	8,77	1,58	2,51	0	17,02	0

Figure 8.16 Ratio of detected irregularities (unauthorized connection, tampered meter) and number of conducted inspections – households

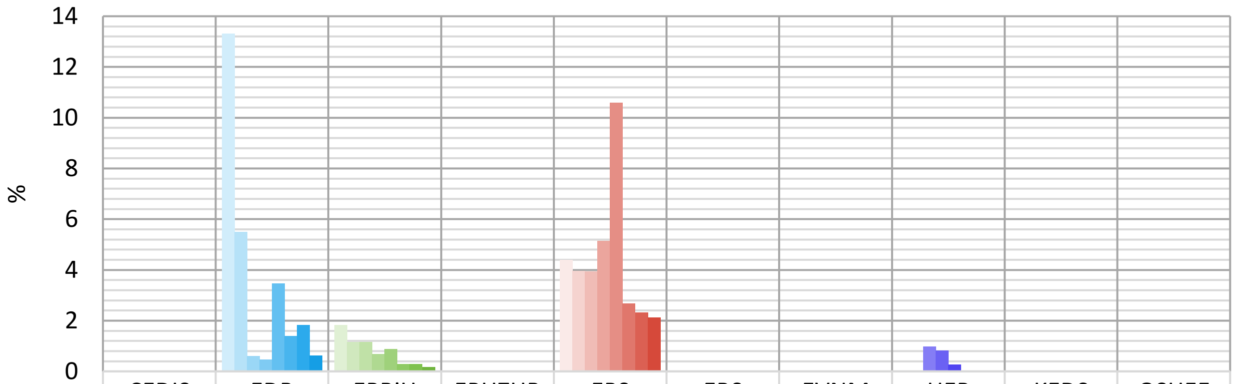
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0,51	0	0	0	0	0	0	0
2010	0	0	0,72	0	0,16	0	0	0,59	0	0
2011	0	0	0,43	0	0	0	0	0,09	0	0
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0

Figure 8.17 Ratio of detected irregularities (unauthorized connection, tampered meter) and number of conducted inspections – public lighting



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0,56	0	0,73	0	0	0	0	0
2009	0	0	0,38	0	0,7	0	0	0	0	0
2010	0	0	0,15	0	0,64	0	0	0,04	0	0
2011	0	0	0,25	0	1,8	0	0	1,03	0	0
2012	0	0	0,34	0	0,83	0	0	0,54	0	0
2013	0	0	0,14	0	0,67	0	0	0	0	0
2014	0	0	0	0	0,57	0	0	0	0	0
2015	0	0	0,08	0	0,33	0	0	0	0	0

Figure 8.18 Ratio of detected irregularities (unauthorized connection, tampered meter) and number of conducted inspections – LV-commercial with peak power registration



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	13,32	1,82	0	4,39	0	0	0	0	0
2009	0	5,5	1,16	0	3,96	0	0	0	0	0
2010	0	0,61	1,15	0	3,93	0	0	0,97	0	0
2011	0	0,46	0,69	0	5,14	0	0	0,81	0	0
2012	0	3,46	0,88	0	10,59	0	0	0,26	0	0
2013	0	1,39	0,29	0	2,67	0	0	0	0	0
2014	0	1,83	0,28	0	2,32	0	0	0	0	0
2015	0	0,62	0,17	0	2,12	0	0	0	0	0

Figure 8.19 Ratio of detected irregularities (unauthorized connection, tampered meter) and number of conducted inspections – LV-commercial without peak power registration

8.5 METERING CYCLES (METER READING REGIME)

The standard business model of electricity retailing involves the electricity company billing the customer for the amount of energy used in a previous month. In some countries (e.g. households in KEDS), if the retailer believes that the customer may not pay the bill, a prepayment meter may be installed (it requires the customer to make advance payment before electricity can be used). Billing the customer for the amount of energy used presumes "scheduled meter readings". Scheduled means an actual meter reading on a cycle that equates to the end–use customer's billing cycle, usually monthly.

In the SEE DSOs, all electricity meters should be read 12 times a year (monthly), except households in HEP that should be read only twice a year and households in OSHEE that should be read just once a year (Table 8.1). Due to difference between number of bills and number of meter readings per year, monthly bills for households in HEP and OSHEE are estimated until scheduled meter reading is performed.

Table 8.1 Meter reading regime in 2015

DSO	Prescribed meter reading cycle	Allowed deviations from the scheduled readings (in days)	Self-reading envisaged by regulation
CEDIS	monthly	-10 days prior to end of month (households and LV - commercial without peak power registration) +5 days from the end of the month (LV - commercial with peak power registration) +2 days from the end of the month (MV)	n.a.
EDB	monthly	-6 days prior to end of month (households) -2 days prior to end of month (all other customers)	no
EPBiH	monthly	30	no
EPHZHB	monthly	-3 days prior to end of month (households, public lighting, LV commercial without peak power registration) 0 days prior to end of month (other customers, i.e. remotely read)	no
EPS	monthly	5	no
ERS	monthly	±3 days from the end of the month	no
EVNM	monthly	±21 days from the scheduled meter reading (households) ±3 days form the end of the month (all other customers)	no
HEP	twice (exceptionally at least once) a year (households) monthly (all other customers)	±21 days from the scheduled meter reading (households) ±3 days from the scheduled meter reading (all other customers)	yes for households

KEDS	monthly	±1 day from the end of the month (MV and LV - commercial without peak power registration) ±8 from the end of the month (all other customers)	no
OSHEE	once a year (households) monthly (all other customers)	±21 days from the scheduled meter reading (households) ±3 days from the scheduled meter reading (all other customers)	no

Once DSO does schedule meter read, if DSO:

- overestimated what customer owe it receives a credit to its account,
- underestimated what customer owe it will have to make up the difference in the next billing period.

However, contrary to other DSOs practices, Croatian metering regulation envisages self-reading for households (up to 10 times a year; if household supplies the readings, the utility has the responsibility to take an actual reading every 6 months.). This way, if households would like all bills to be based on actual meter readings instead of estimates, they may supply the utility with readings during estimated billing periods.

8.6 REGULARITY OF METER READINGS

In this subsection, the regularity of meter readings is evaluated according to provisions in the metering regulation. To evaluate performance, number of readings conducted during a year and number of readings conducted in a timely manner (within a prescribed schedule) were analyzed here.

In the following Figures the labels have the following meaning:

- "Percentage of meters read according to schedule and in a timely manner" is given as a percentage of all meters that are read (at least once) during a year.
- "Percentage of meters read according to the schedule" gives a share of meters (out of all meters in service in observed consumption category) that are read in line with the prescribed number of readings per one year (some of these readings might not be conducted in a timely manner, i.e. standard given in 3rd column of Table 8.1 is breached).
- "Percentage of breach" gives a share of meters (out of all meters in service in observed consumption category) that are read but not in line with the prescribed number of readings per one year.
- "No meter reading during a year" gives a share of meters (out of all meters in service in observed consumption category) that are not read during a year.

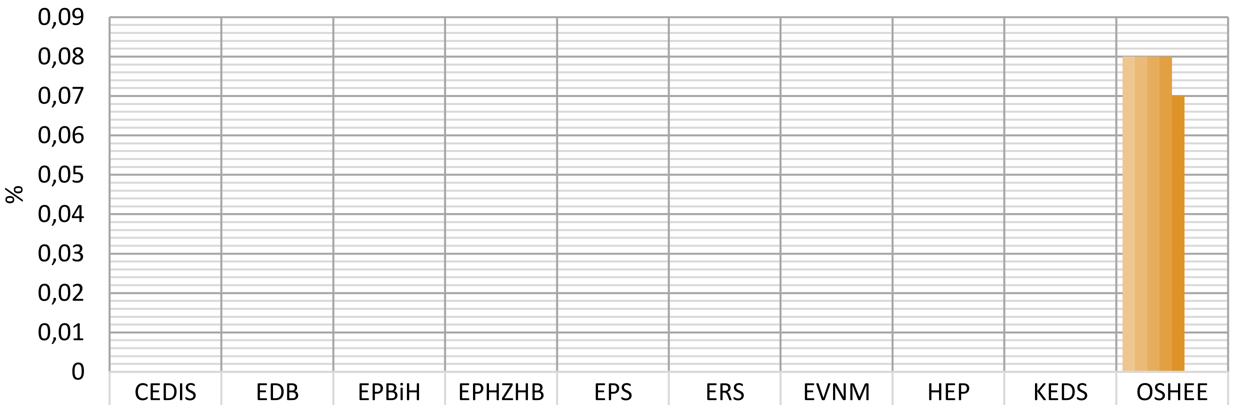
For some consumption category sum of shares of meters read according to the schedule, shares of breach and shares of meters without any reading during a year must give 100 %.

The data presented in this subchapter are incomplete since:

- EPHZHB and KEDS did not provide any relevant data,
- CEDIS and EVNM provided yearly lump sum data for all consumption categories,
- CEDIS, ERS, EVNM and HEP didn’t provide data for whole observed period (provided data are mainly related to period 2012-2015).

The shares of meters without any readings during a year are shown on the Figures 8.20 - 8.24 . The highest share was detected in household category, 14,5% (OSHEE, 2011). It is followed by HEP (8% in 2014) and EVNM (2,25% in 2011), while in other DSOs this share was significantly lower. In OSHEE households meters are read once a year, while in HEP it is read twice a year. This is the main reason for high shares given below, since here we have higher possibility of meter not being read during a year compared to those DSOs with monthly readings.

Other consumption categories in all DSOs have monthly readings, and primarily because of that they had relatively low shares of meters without any reading during a year. The exceptions were detected in HEP and OSHEE for LV commercial without peak power registration category (6% and 3%, respectively).

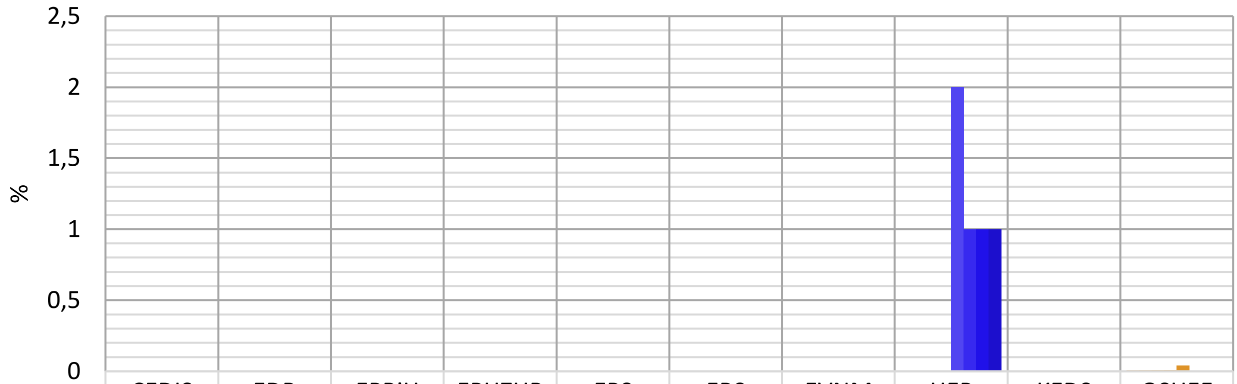


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0,08
2009	0	0	0	0	0	0	0	0	0	0,08
2010	0	0	0	0	0	0	0	0	0	0,08
2011	0	0	0	0	0	0	0	0	0	0,08
2012	0	0	0	0	0	0	0	0	0	0,07
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0

Figure 8.20 Share of MV connection points without meter reading during a year

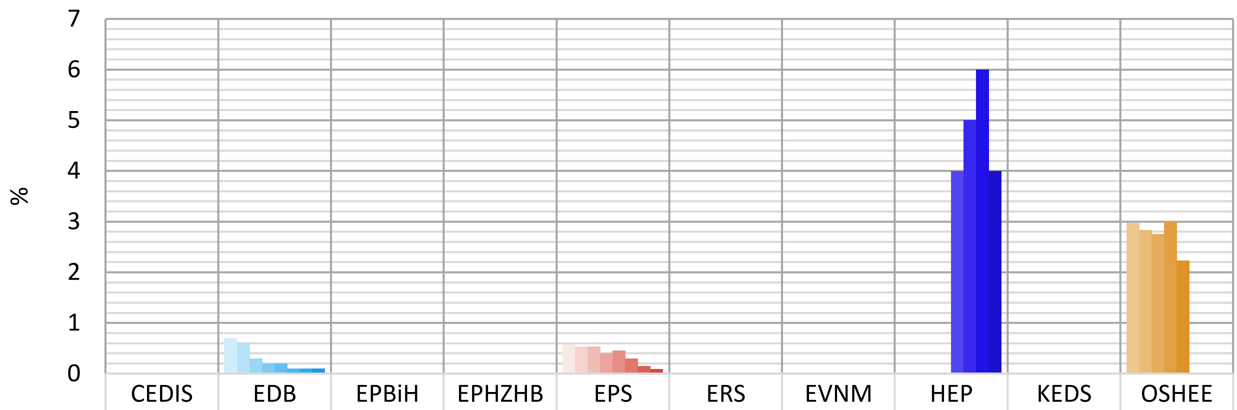
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,3	0	0	0,07	0	0	0	0	13,63
2009	0	0,2	0	0	0,06	0	0	0	0	13,35
2010	0	0,1	0	0	0,08	0	0	0	0	12,79
2011	0	0,1	0	0	0,08	0	2,25	0	0	14,5
2012	0	0,2	0	0	0,1	0	1,94	5	0	11,64
2013	0	0,2	0	0	0,1	0	2,21	4	0	0
2014	0	0,1	0	0	0,08	0	1,67	8	0	0
2015	0	0,1	0	0	0,09	0	1,61	7	0	0

Figure 8.21 Share of households connection points without meter reading during a year



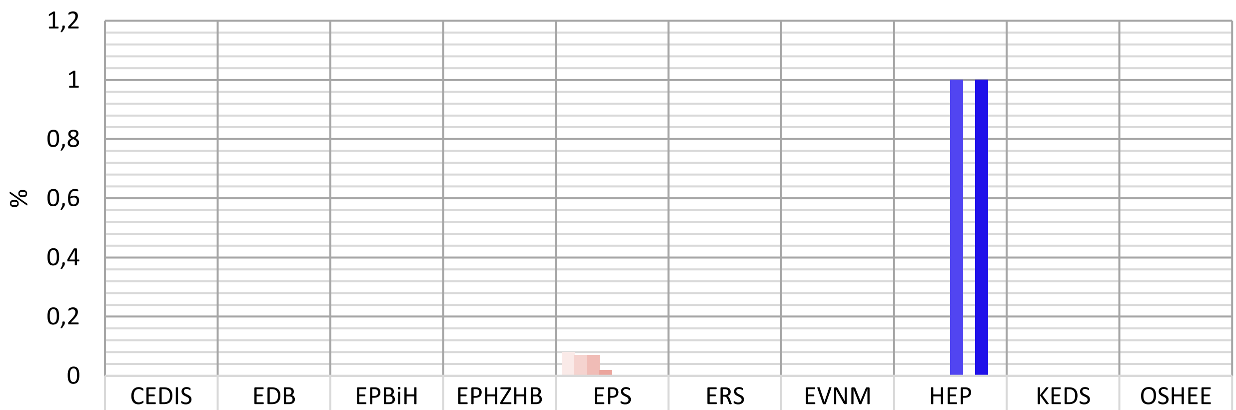
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0,01
2009	0	0	0	0	0	0	0	0	0	0,01
2010	0	0	0	0	0	0	0	0	0	0,01
2011	0	0	0	0	0	0	0	0	0	0,01
2012	0	0	0	0	0	0	0	2	0	0,04
2013	0	0	0	0	0	0	0	1	0	0
2014	0	0	0	0	0	0	0	1	0	0
2015	0	0	0	0	0	0	0	1	0	0

Figure 8.22 Share of public lighting connection points without meter reading during a year



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,7	0	0	0,57	0	0	0	0	2,97
2009	0	0,6	0	0	0,53	0	0	0	0	2,83
2010	0	0,3	0	0	0,53	0	0	0	0	2,75
2011	0	0,2	0	0	0,4	0	0	0	0	3,01
2012	0	0,2	0	0	0,45	0	0	4	0	2,23
2013	0	0,1	0	0	0,3	0	0	5	0	0
2014	0	0,1	0	0	0,15	0	0	6	0	0
2015	0	0,1	0	0	0,09	0	0	4	0	0

Figure 8.23 Share of LV-commercial connection points without peak power registration without meter reading during a year

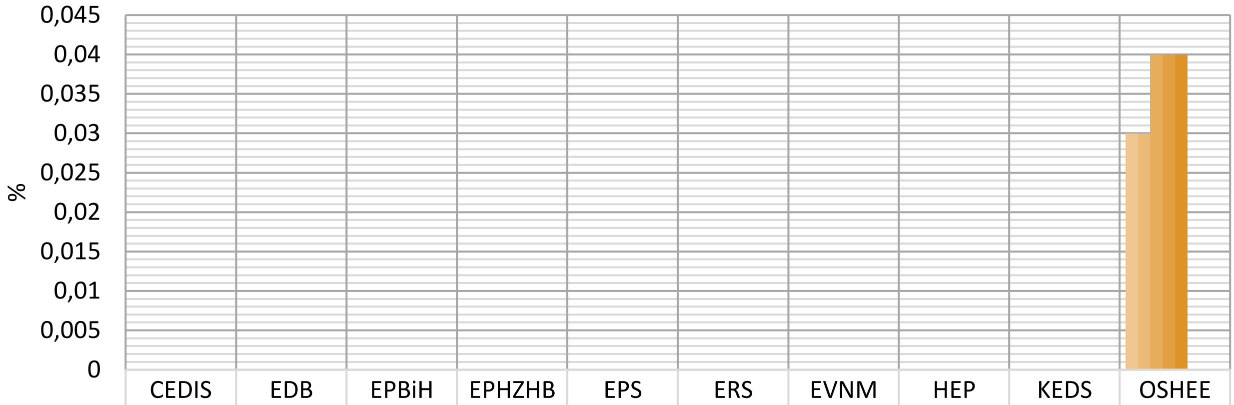


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0,08	0	0	0	0	0
2009	0	0	0	0	0,07	0	0	0	0	0
2010	0	0	0	0	0,07	0	0	0	0	0
2011	0	0	0	0	0,02	0	0	0	0	0
2012	0	0	0	0	0	0	0	1	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	1	0	0
2015	0	0	0	0	0	0	0	0	0	0

Figure 8.24 Share of LV-commercial connection points with peak power registration without meter reading during a year

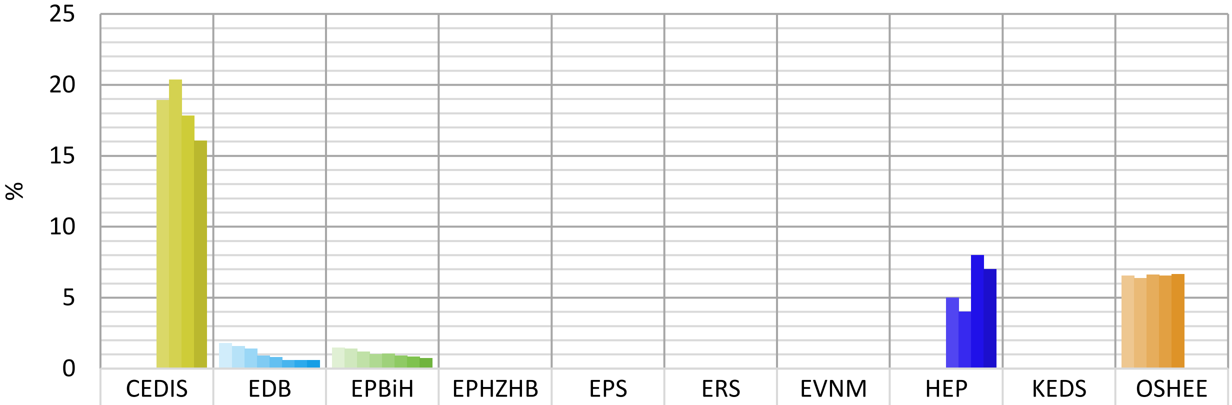
Figures 8.25 - 8.29 show shares of connection points with readings not in line with the prescribed number of readings per year. Most breaches occurred in the households category; e.g. OSHEE had average of 6,55% in the period 2008-2012, while HEP had average of 6% in the period 2012-2015. CEDIS had the highest average share of 18,3% in the period 2012-2015, but those data are the lump sum for all categories.

Figures 8.30 - 8.35 give share of connection points with meter reading according to the schedule and in a timely manner. For HV and MV customers this share was 100% in all DSOs except in ERS in 2014 and 2015 when it was 99%. In other consumer categories, this share was in all available DSOs higher than 94%, except in HEP where the lowest value was 75% for public lighting in 2013.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0,03
2009	0	0	0	0	0	0	0	0	0	0,03
2010	0	0	0	0	0	0	0	0	0	0,04
2011	0	0	0	0	0	0	0	0	0	0,04
2012	0	0	0	0	0	0	0	0	0	0,04
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0

Figure 8.25 Share of MV connection points with readings not in line with the prescribed number of readings per year

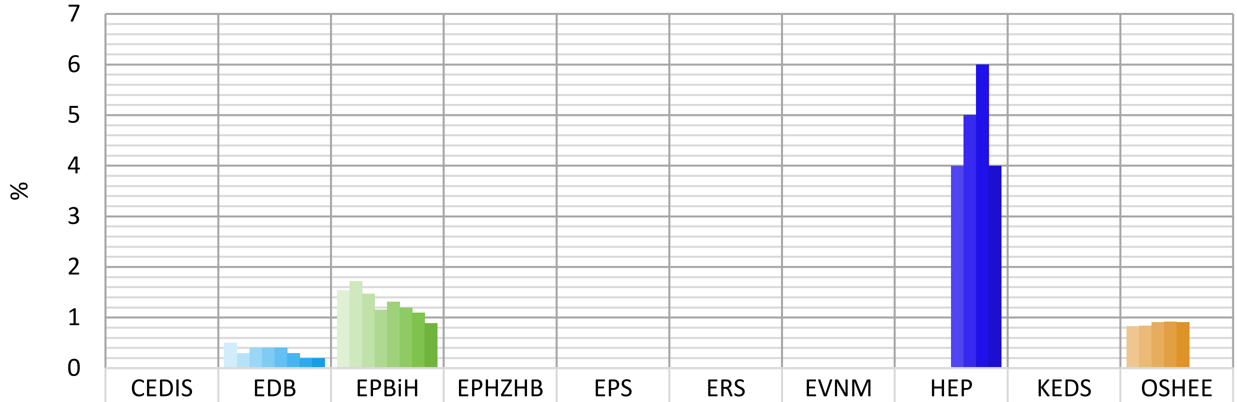


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	1,8	1,47	0	0	0	0	0	0	6,55
2009	0	1,6	1,4	0	0	0	0	0	0	6,37
2010	0	1,4	1,21	0	0	0	0	0	0	6,62
2011	0	0,9	1,03	0	0	0	0	0	0	6,56
2012	18,92	0,8	1,06	0	0	0	0	5	0	6,65
2013	20,35	0,6	0,91	0	0	0	0	4	0	0
2014	17,82	0,6	0,86	0	0	0	0	8	0	0
2015	16,08	0,6	0,73	0	0	0	0	7	0	0

Figure 8.26 Share of households connection points with readings not in line with the prescribed number of readings per year

	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0,01
2009	0	0	0	0	0	0	0	0	0	0,01
2010	0	0	0	0	0	0	0	0	0	0,01
2011	0	0	0	0	0	0	0	0	0	0,01
2012	0	0	0	0	0	0	0	2	0	0,01
2013	0	0	0	0	0	0	0	1	0	0
2014	0	0	0	0	0	0	0	1	0	0
2015	0	0	0	0	0	0	0	1	0	0

Figure 8.27 Share of public lighting connection points with readings not in line with the prescribed number of readings per year

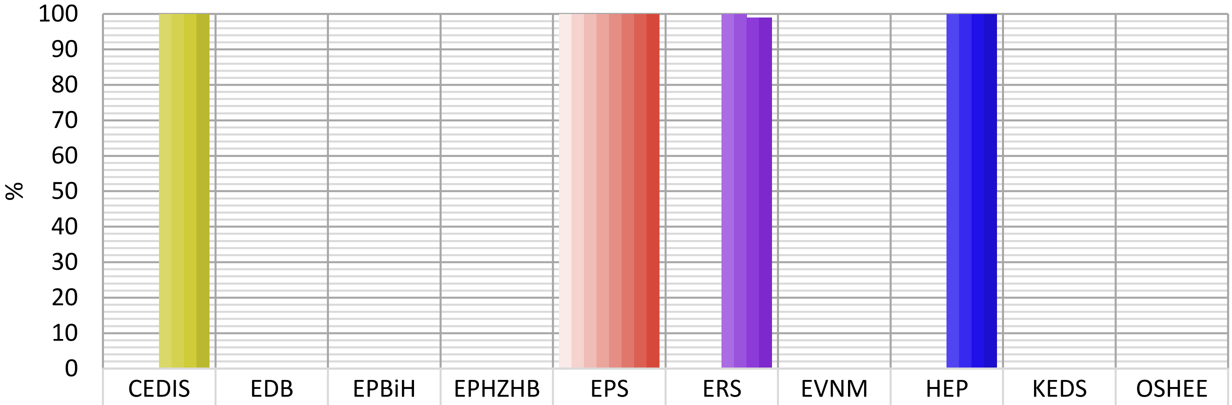


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,5	1,54	0	0	0	0	0	0	0,83
2009	0	0,3	1,72	0	0	0	0	0	0	0,84
2010	0	0,4	1,47	0	0	0	0	0	0	0,91
2011	0	0,4	1,15	0	0	0	0	0	0	0,92
2012	0	0,4	1,31	0	0	0	0	4	0	0,91
2013	0	0,3	1,19	0	0	0	0	5	0	0
2014	0	0,2	1,09	0	0	0	0	6	0	0
2015	0	0,2	0,89	0	0	0	0	4	0	0

Figure 8.28 Share of LV-commercial connection points without peak power registration with readings not in line with the prescribed number of readings per year

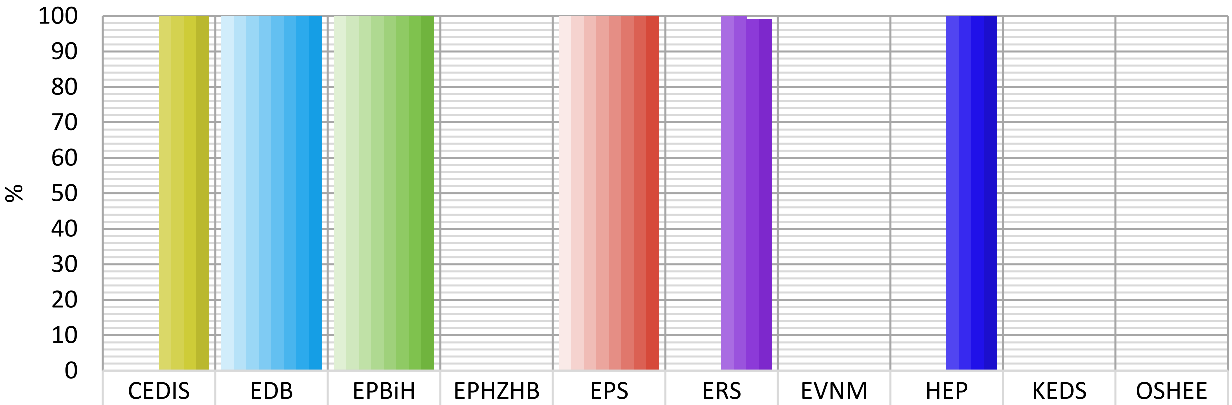
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0,01
2009	0	0	0	0	0	0	0	0	0	0,01
2010	0	0	0	0	0	0	0	0	0	0,01
2011	0	0	0	0	0	0	0	0	0	0,01
2012	0	0	0	0	0	0	0	1	0	0,01
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	1	0	0
2015	0	0	0	0	0	0	0	0	0	0

Figure 8.29 Share of LV-commercial connection points with peak power registration with readings not in line with the prescribed number of readings per year



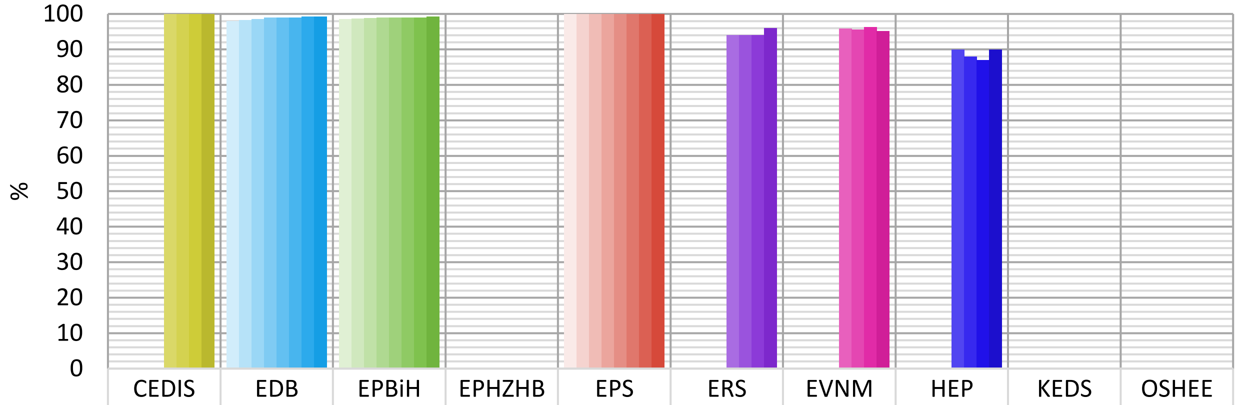
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	100	0	0	0	0	0
2009	0	0	0	0	100	0	0	0	0	0
2010	0	0	0	0	100	0	0	0	0	0
2011	0	0	0	0	100	0	0	0	0	0
2012	100	0	0	0	100	100	0	100	0	0
2013	100	0	0	0	100	100	0	100	0	0
2014	100	0	0	0	100	99	0	100	0	0
2015	100	0	0	0	100	99	0	100	0	0

Figure 8.30 Share of HV connection points with meter reading according to schedule and in a timely manner



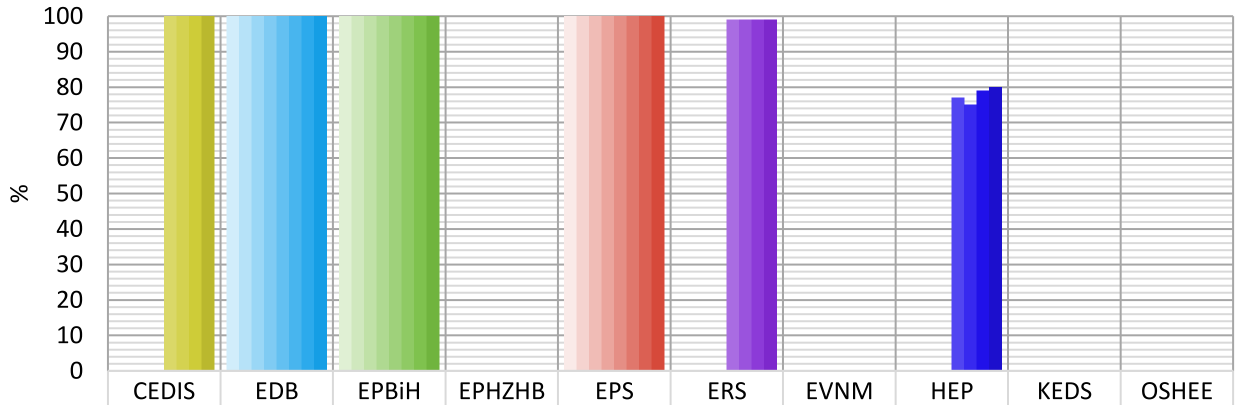
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	100	100	0	100	0	0	0	0	0
2009	0	100	100	0	100	0	0	0	0	0
2010	0	100	100	0	100	0	0	0	0	0
2011	0	100	100	0	100	0	0	0	0	0
2012	100	100	100	0	100	100	0	100	0	0
2013	100	100	100	0	100	100	0	100	0	0
2014	100	100	100	0	100	99	0	100	0	0
2015	100	100	100	0	100	99	0	100	0	0

Figure 8.31 Share of MV connection points with meter reading according to schedule and in a timely manner



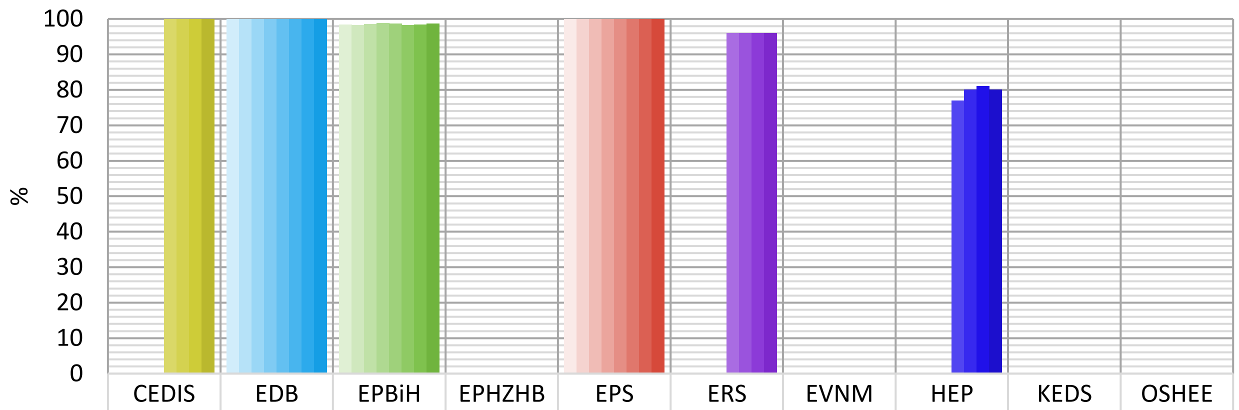
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	97,9	98,53	0	100	0	0	0	0	0
2009	0	98,2	98,6	0	100	0	0	0	0	0
2010	0	98,5	98,79	0	100	0	0	0	0	0
2011	0	99	98,97	0	100	0	0	0	0	0
2012	100	99	98,94	0	100	94	95,85	90	0	0
2013	100	99	98,89	0	100	94	95,57	88	0	0
2014	100	99,2	98,99	0	100	94	96,27	87	0	0
2015	100	99,2	99,22	0	100	96	95,08	90	0	0

Figure 8.32 Share of households connection points with meter reading according to schedule and in a timely manner



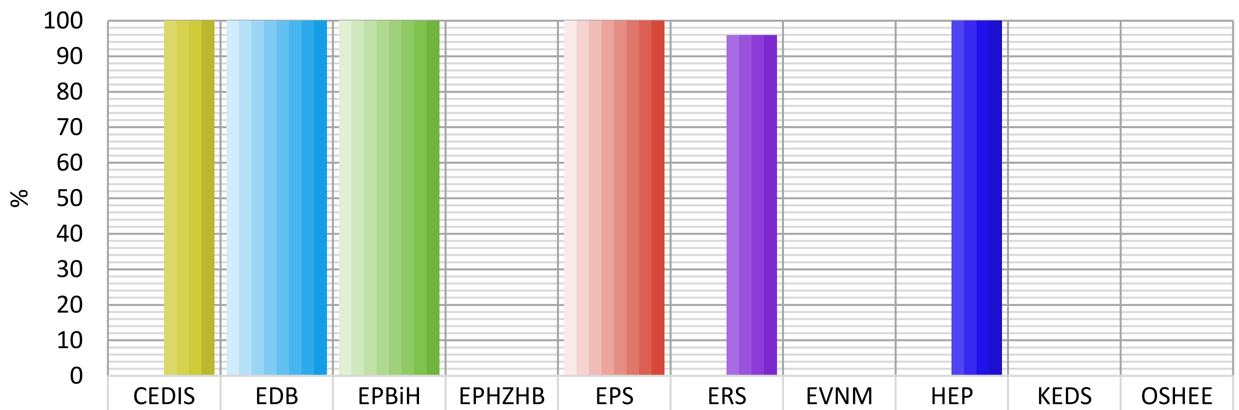
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	100	100	0	100	0	0	0	0	0
2009	0	100	100	0	100	0	0	0	0	0
2010	0	100	100	0	100	0	0	0	0	0
2011	0	100	100	0	100	0	0	0	0	0
2012	100	100	100	0	100	99	0	77	0	0
2013	100	100	100	0	100	99	0	75	0	0
2014	100	100	100	0	100	99	0	79	0	0
2015	100	100	100	0	100	99	0	80	0	0

Figure 8.33 Share of public lighting connection points with meter reading according to schedule and in a timely manner



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	100	98,46	0	100	0	0	0	0	0
2009	0	100	98,28	0	100	0	0	0	0	0
2010	0	100	98,53	0	100	0	0	0	0	0
2011	0	100	98,85	0	100	0	0	0	0	0
2012	100	100	98,69	0	100	96	0	77	0	0
2013	100	100	98,29	0	100	96	0	80	0	0
2014	100	100	98,45	0	100	96	0	81	0	0
2015	100	100	98,67	0	100	96	0	80	0	0

Figure 8.34 Share of LV-commercial connection points without peak power registration with meter reading according to schedule and in a timely manner



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	100	100	0	100	0	0	0	0	0
2009	0	100	100	0	100	0	0	0	0	0
2010	0	100	100	0	100	0	0	0	0	0
2011	0	100	100	0	100	0	0	0	0	0
2012	100	100	100	0	100	96	0	100	0	0
2013	100	100	100	0	100	96	0	100	0	0
2014	100	100	100	0	100	96	0	100	0	0
2015	100	100	100	0	100	96	0	100	0	0

Figure 8.35 Share of LV-commercial connection points with peak power registration with meter reading according to schedule and in a timely manner

8.7 OBSERVATIONS/RECOMMENDATIONS

In South East Europe unauthorized connection points (connections without metering) and unauthorized use of meters (e.g. tempered meters, tempered time switch, broken seal) are still serious issue for the DSOs. Estimated share of unauthorized connections (given as a portion of total number of connection points) goes up to 6,5 % on the regional level. Although share of yearly detected unauthorized connections and share of yearly detected connections with tampered meters, in total number of connection points, was lower than 1,7%, in some DSOs, e.g. in KEDS, growing trend was detected in given timeframe. Detected irregularities in some years exceeded 20 % of conducted inspections (either planned inspections or inspections due to reported finding of irregularity/fraud). Therefore, to detect unauthorized connections and to reduce respective losses in the system, consumer connections and meters should be more frequently inspected. Besides, expansion of meter coverage is another important measure to allow improved internal energy auditing by which the DSO is able to track energy flows from substations to customers and detect theft (e.g. this practice has been efficiently implemented in EPHZHB). Accordingly, meter coverage at substation and feeder level is also very important.

Monthly readings of almost all electricity meters are required which is very valuable initial position for market activities and distribution system operation (exception are households in HEP and OSHEE). Croatia is the only country with self-reading for the households envisaged by the law. Self-reading shall be strongly encouraged for customers that are not having monthly meter reading.

Due to ordinary monthly readings, all DSOs in given timeframe had relatively low shares of meters without any reading during a year. Exceptions were found in the households and LV commercial customers without peak power registration in OSHEE (13% and 2,7% in average for the period 2008-2012 period, respectively) and HEP (6% and 4,8% in average for the period 2012-2015, respectively). It is very important to have at least one reading per year. If there is no access to the meter, then the DSO estimates the consumption. In the areas with meter access is significant issue, DSO shall require a customer to make an appointment to provide access for a special meter read (special reading means reading performed outside of the usual reading cycle for the customer/meter). Ultimately, DSO should have the authority to discontinue supplying premises where there is failure to provide this access.

The highest share of meters not read according to prescribed schedule in the period 2008-2015 was 20,35% in CEDIS, and the highest values were recorded in the household category. Performance of the DSOs shall be subject to quality of service standards defined by the regulatory authority (e.g. standard aimed to have all meters read when scheduled). Remote meter reading and smart metering programs definitely facilitate easier and more precise meter reading and billing based on the actually consumed electricity (i.e. there's no need for electricity consumption estimations).

9 DISCONNECTION AND RECONNECTION / RE-SUPPLY

This section deals with disconnections of the customers due to bill non-payments and/or theft (illegal connection). Table 9.1 provides the data on legal conditions for disconnection and penalties for illegal connections. These data haven't been changed from those given in the 1st Benchmarking study, except adding one new DSO – Montenegrin CEDIS.

Table 9.1 Data provided by the DSOs on legal conditions for disconnection and penalties

DSO	Legal conditions for disconnection	Penalties for illegal connections
CEDIS	Prescribed in General terms and conditions for the supply of electricity. The conditions for disconnection are the debt for the consumed electric energy, theft of service, customer request for the disconnection etc.	The amount of unauthorized (illegal) electricity consumption is estimated in line with the prescribed methodology.
EDB	Prescribed by the Electricity Law and the General terms and conditions for the supply of electricity	Customer is obliged to pay the charge for the period of illegal consumption. The amount of electricity (kWh) is defined depending on the voltage level, nominal current of connection fuses or nominal current of connection conductors and tariff level (household, industry, etc). DSO has the right to disconnect the customer and initiate criminal proceedings.
EPBIH	Prescribed by the Electricity Law and the General terms and conditions for the supply of electricity	Prescribed by the Electricity Law.
EPHZHB	Prescribed by the Electricity Law and the General terms and conditions for the supply of electricity	General terms and conditions for the supply of electricity prescribe methodology for illegal electricity consumption estimation.
EPS	Legal framework differs customer electricity supply suspension and customer disconnection. Customer electricity supply suspension is due to: • failure to comply with the connection contract/authorization, • failure to reduce peak power that is exceeding **contracted** value, • customer allowed another person to connect to their installations or use electricity supplied through their meter, • replacement of main fuses or power/current limiting devices by fuses or limiting devices whose nominal current is higher than contracted or approved, not affecting accuracy of electricity metering, • failure to comply with the terms of supply contract (on supplier request),	By detection of illegal electricity usage, customer is disconnected and parallel proceedings (criminal and civil) are initiated. In accordance with a criminal law illegal electric system usage is sentenced by a fine or imprisonment up to 3 years (most common judge issues a suspended sentence). In the civil proceeding, illegal electric service usage is sentenced by a fine (compensation to DSO for damage caused by illegal electric service usage). For estimation of illegal electricity consumption, period of illegal consumption cannot be longer than 12 months (usually period form the last connection inspection). Illegal consumption estimation is based on the voltage level and nominal

DSO	Legal conditions for disconnection	Penalties for illegal connections
	• on customer request. Customer disconnection is due to: • electricity supply suspension lasting longer than a year, • using service in a manner that interferes with the service of others or the operation of nonstandard equipment, • unauthorized electric service usage: 1. customer connected to the distribution system without approval, 2. unauthorized reconnection, 3. electric energy consumption without a metering device or with bypassing the metering device, 4. electric energy consumption using a metering device that the customer has disabled from recording consumption accurately, 5. electric energy consumption using a metering device on which the seal of the DSO or an authorized organization has been damaged by the customer, 6. replacement of main fuses or power/current limiting devices by fuses or limiting devices whose nominal current is higher than contracted or approved, thus affecting accuracy of electricity metering.	current of connection fuses or nominal current of conductors for the connection.
ERS	Prescribed by General terms and conditions for the supply of electricity, electricity supply suspension and/or limitation to customer and customer disconnection are implemented in the following cases: • customer connected to the distribution system without approval, • there is evidence of theft of service, • there has been tampering with the equipment of the DSO, • non-payment in a timely manner, • using service in a manner that interferes with the service of others or the operation of nonstandard equipment, • customer allowed another person to connect to their installations or use electricity supplied through their meter, • customer does not allow access to his/her property or to the property under his/her tenure for the purpose of preventing DSO to perform metering, reading, control, calibration, replacement of meters, • customer breached provisions of the supply contract.	General terms and conditions for the supply of electricity prescribe methodology for illegal electricity consumption estimation. Unauthorized consumption shall be documented by responsible body within the Ministry of Internal Affairs. The relevant police station, following completion of the documents, submits to the competent criminal prosecutor application for investigation based on suspicion of the commission for the acts of theft of electricity. Based on the evidence of illegal electricity consumption, the criminal prosecutor press charges in front of the competent court. According to the Electricity Law illegal connection to the electrical network is sentenced by up to 1 year imprisonment.
EVNM	Prescribed by Supply Rules and Distribution Grid Code. • DSO, on Supplier's request, has a right to disconnect the customer because of one unpaid bill in prescribed time period (due date). • DSO has a right to disconnect the customer in the cases when:	Customer is obliged to pay charge for illegal consumption for the period of illegal consumption, but not longer than 12 months. The quantity of estimated electricity theft (kWh) depends on the voltage level, nominal fuses and tariff level (household, industry, etc).

DSO	Legal conditions for disconnection	Penalties for illegal connections
	1. customer is connected to the distribution system without approval, 2. customer does not allow access to his/her property or to the property under his/her tenure for the purpose of preventing DSO to perform metering, reading, control, calibration, replacement of meters, 3. the existing consumer has denied or has not signed the Electricity Supply Contract with the Supplier, 4. it has been ordered by a competent court or other competent authority, 5. the use of distribution system users' facilities, devices and installations causes immediate hazard for the life and health of people and the property, 6. the approval decision's validity for connecting to the distribution system has expired.	The DSO has a right to initiate judicial procedure for electricity theft in accordance to the Criminal Law.
HEP	Unauthorized (illegal) use of electricity is prescribed by the General terms and conditions for the supply of electricity as: • failure to pay a bill to the supplier/DSO or to make a deferred payment arrangement by the date of disconnection (prior to disconnecting service DSO is obliged to send termination notice with scheduled turn-off date), • failure to comply with the terms of a deferred payment arrangement or other payment agreement made with the supplier/DSO (e.g. prepayment, payment guarantees, installation of prepayment meter), • service is connected or reconnected without approval, or there has been tampering with the equipment of the DSO or customer does not allow access to its property or to the property under its tenure for the purpose of preventing DSO to perform metering, reading, control, calibration, replacement of meters.	Unauthorized (illegal) electricity consumption is estimated in line with the methodology prescribed by the General terms and conditions for the supply of electricity. DSO disconnects the customer and calculates illegal consumption based on the voltage level and nominal current of conductors for the connection. By failure to pay a bill for unauthorized (illegal) electricity consumption owed to the DSO, DSO shall initiate legal action to compensate the damages.
KEDS	Prescribed by the Rules on disconnection and reconnection of customers in the Energy Sector.	The DSO is entitled to charge fees for issuance of the disconnection and reconnection notice, and for disconnection and reconnection of the customer. Penalties for the illegal connection are defined in the Law on Electricity. Any person who connects or reconnects illegally shall be punished by prescribed fines: natural persons: € 500-€ 5.000, legal persons: € 5.000 - € 50.000.
OSHEE	According to the energy supply contract the legal conditions for disconnections are:	Penalties for illegal connections are: • disconnection of the electricity supply, • criminal charges.

DSO	Legal conditions for disconnection	Penalties for illegal connections
	• the client does not pay the invoice within 30 days after the due date, which is no later than the last calendar day of the month following the invoice issuing month, • in order to proceed with the disconnection, the supplier has to notify the client in writing 48 hours in advance.	According to the Criminal Code illegal connection to the power network constitutes a penal contravention and is sentenced by a fine or imprisonment up to 2 years. Electricity theft is punishable by a fine or up to 3 years of imprisonment.

As in the first edition of SEE DSO Benchmarking Study (2008 – 2012), this report focuses on two issues, disconnections due to non-payment of bills to DSO/supplier and disconnections due to theft. Regarding reconnection or resupply of electricity (depending on whether the electricity is disconnected or electricity supply is suspended), two types of reconnection/resupply were analyzed: with and without charge. In each of these types, disconnections due to non-payment and disconnection due to unauthorized use of electricity (theft) were discerned. Furthermore, prescribed (required) time for resupply (time which elapses from the date on which all conditions for resupply of customer are fulfilled) and actual average time for reconnection/resupply were analyzed for both reconnection/resupply types (with and without charge) and for both reasons (non-payment and theft). Besides, average fee charged for reconnection/resupply is given, too.

While reading this report it is important to have in mind that:

- CEDIS provided data on number of disconnections due to non-payment and theft only for the period 2013-2015 as lump sums for all categories. Data for HV and public lightening categories related to time periods and charges for reconnections haven’t been provided for the whole observed period.
- EPBiH didn’t provide any data for 2008 and 2009.
- EPHZHB provided data on number of disconnections due to non-payment and theft for commercial categories (with and without peak power registration) as lump sums in the whole observed period.
- EPS didn’t provide data on average reconnection charge for disconnections due to unauthorized consumption in the period 2008-2011 for all categories, and in the period 2012-2015 data for HV, MV and public lighting category since there haven’t been any records on unauthorized consumption.
- ERS did not provide data on actuals for reconnection/resupply, while data on prescribed time periods were provided for only 2012. Average reconnection charges weren’t provided for 2008 and 2009. Data on number of disconnections due to non-payment and theft were provided as lump sums in the period 2012-2015.
- EVNM provided lump sums data on number of disconnections due to non-payment and theft in the period 2012-2015 for all categories, while this data were not provided for the rest of the observed period.

- HEP provided data on number of disconnections due to non-payment and theft for two categories, households and lump sum data for entrepreneurship. These data were given for 2011 and 2012 and as lump sums for the period 2013-2015.
- KEDS didn't provide data on number of disconnections due to non-payment and theft in the period 2008-2010.
- OSHEE didn't provide data on number of disconnections due to non-payment and theft for the period 2013-2015 for HV and MV category, while for the same period data for public lighting and both commercial categories (with and without peak power registration) were given as the lump sums. Also, data related to prescribed and realized time periods for reconnections for both, non-payment and theft types, were not provided for the period 2013-2015.

9.1 NUMBER OF SUPPLY SUSPENSIONS AND DISCONNECTIONS DUE TO NON-PAYMENT AND THEFT

Figures 9.1 - 9.5 give ratios of disconnection/supply suspensions and number of connection points in the different consumption categories in the period 2008-2015. Data given as lump sum for all categories are shown in the household category, while data given for commercial categories as lump sum are shown in the largest commercial category, i.e. commercial without peak power registration category.

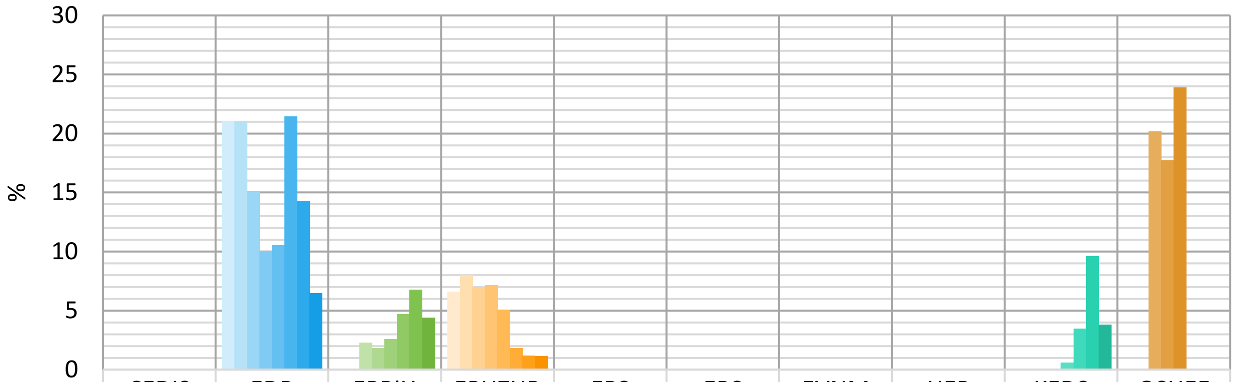
Data submitted by HEP for the period 2013-2015 are not given on following figures since it was given as lump sum for the whole 2013-2015 period. In the households category of HEP consumers in the period 2008 – 2015 there were 79.791 disconnections due to non-payment and theft, while in all other categories in the same period there were 18.323 disconnections.

Number of disconnections due to non-payment and theft for OSHEE given as lump sum in 2015 for public lighting, and both commercial categories were distributed proportionally to its values in 2012.

It is concluded that:

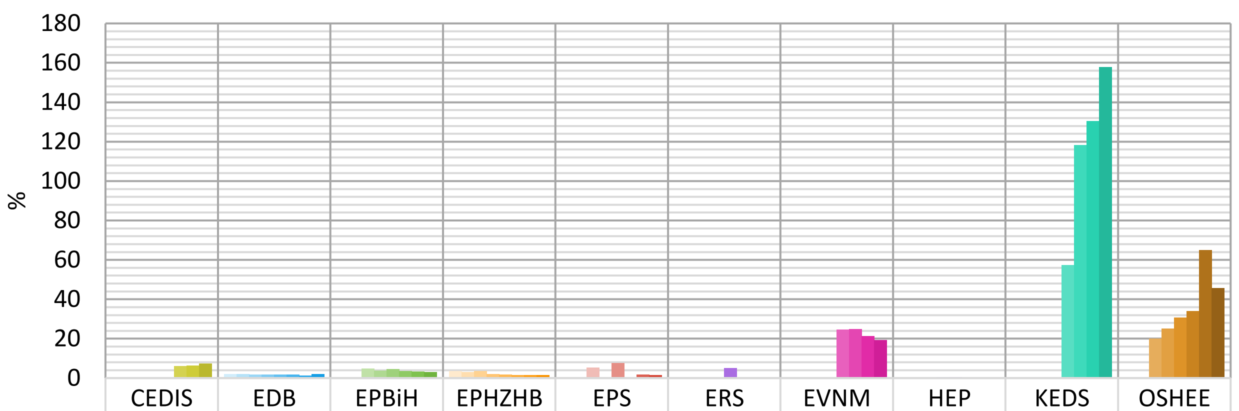
- In MV consumption category the highest disconnection rates were 23,91% (OSHEE, 2012) and 21,05% (EDB, 2008 and 2009). It means that in average almost every fourth MV customer was disconnected once a year. These values are extremely high.
- In the households category disconnection rate over 100% was recorded in KEDS. The highest value was huge - 157,71% in 2015. In other words, in average every household in KEDS had over 1,5 disconnections in 2015. Moreover, KEDS, as well as OSHEE have faced an increasing trend. Data for EVNM, as stated above, refer to all categories and the trend has been decreasing.
- In the public lightening category KEDS also had the highest values, up to 60,87%. Among other DSOs high values were recorded in OSHEE (up to 17,28%) and in EPHZHB (up to 12,43%).

- Both LV commercial categories also recorded disconnection rate values over 100%. KEDS recorded the highest disconnection rate of 118,08% in LV commercial without peak power registration category, while EDB had the highest ratio of 160,87% in LV commercial with peak power registration category.



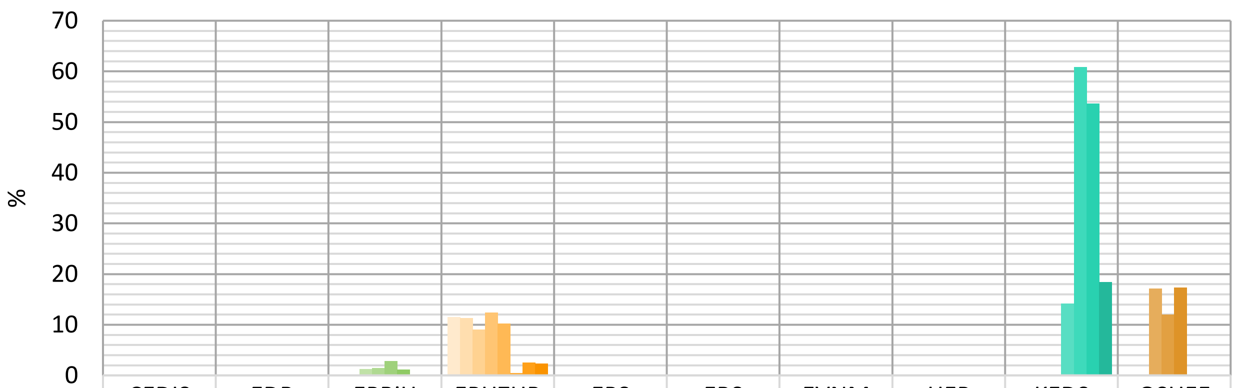
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	21,05	0	6,61	0	0	0	0	0	0
2009	0	21,05	0	8	0	0	0	0	0	0
2010	0	15	2,27	6,99	0	0	0	0	0	20,19
2011	0	10	1,83	7,14	0	0	0	0	0	17,71
2012	0	10,53	2,56	5,03	0	0	0	0	0,58	23,91
2013	0	21,43	4,67	1,81	0	0	0	0	3,45	0
2014	0	14,29	6,76	1,17	0	0	0	0	9,58	0
2015	0	6,45	4,38	1,14	0	0	0	0	3,81	0

Figure 9.1 Ratio of disconnection/supply suspensions and connection points in MV consumption category



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	1,94	0	3,56	0	0	0	0	0	0
2009	0	1,91	0	3,07	0	0	0	0	0	0
2010	0	1,87	4,91	3,54	5,31	0	0	0	0	20,07
2011	0	1,86	3,68	2,06	0	0	0	0,57	0	25,2
2012	0	1,69	4,43	1,65	7,66	5,16	24,52	0,57	57,43	30,8
2013	5,95	1,64	3,56	1,62	0	0	24,9	0	118,22	34,07
2014	6,26	1,32	3,32	1,53	1,68	0	21,28	0	130,39	64,95
2015	7,22	2,1	3	1,42	1,56	0	19,23	0	157,71	45,65

Figure 9.2 Ratio of disconnection/supply suspensions and connection points in households consumption category

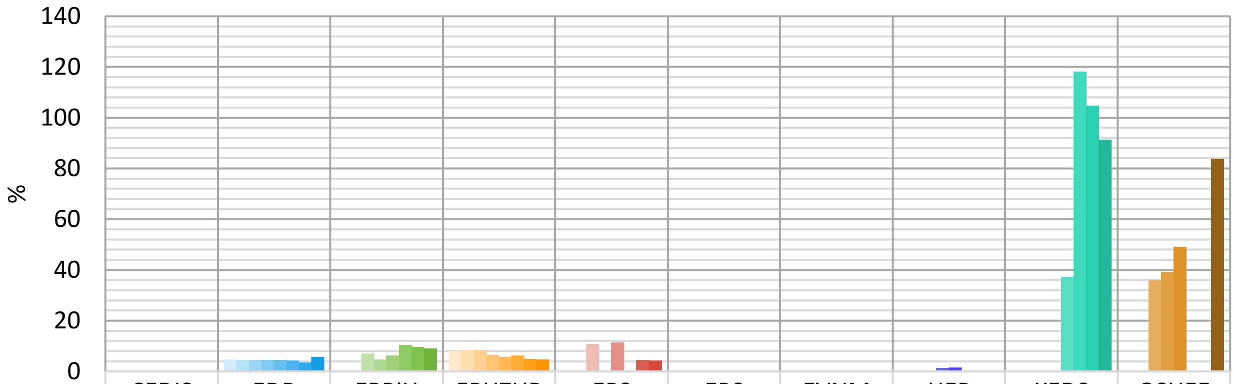


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	11,53	0	0	0	0	0	0
2009	0	0	0	11,25	0	0	0	0	0	0
2010	0	0	1,27	9	0	0	0	0	0	17,09
2011	0	0	1,47	12,43	0	0	0	0	0	12,03
2012	0	0	2,77	10,25	0	0	0	0	14,15	17,28
2013	0	0	1,12	0,44	0	0	0	0	60,87	0
2014	0	0	0,16	2,52	0	0	0	0	53,67	0
2015	0	0	0,13	2,3	0	0	0	0	18,36	0

Figure 9.3 Ratio of disconnection/supply suspensions and connection points in public lighting consumption category

	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	123,81	0	0	0	0	0	0	0	0
2009	0	100	0	0	0	0	0	0	0	0
2010	0	98,39	80,48	0	3,93	0	0	0	0	5,92
2011	0	92,06	51,15	0	0	0	0	0	0	5,28
2012	0	93,22	60,53	0	4,24	0	0	0	7,91	6,41
2013	0	101,75	8,3	0	0	0	0	0	24,51	0
2014	0	82,14	7,2	0	6,28	0	0	0	46,88	0
2015	0	160,87	5,61	0	6,25	0	0	0	26,76	0

Figure 9.4 Ratio of disconnection/supply suspensions and connection points in LV-commercial with peak power registration consumption category



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	4,54	0	8,09	0	0	0	0	0	0
2009	0	4,39	0	8,38	0	0	0	0	0	0
2010	0	4,53	7,06	8,44	10,85	0	0	0	0	35,88
2011	0	4,53	4,57	6,37	0	0	0	1,36	0	39,13
2012	0	4,41	6,26	5,67	11,28	0	0	1,45	37,27	48,97
2013	0	4,27	10,29	6,14	0	0	0	0	118,08	0
2014	0	3,51	9,58	4,87	4,37	0	0	0	104,62	0
2015	0	5,57	8,94	4,62	4,31	0	0	0	91,26	83,83

Figure 9.5 Ratio of disconnection/supply suspensions and connection points in LV-commercial without peak power registration consumption category

9.2 RECONNECTION/RESUPPLY

In the analysis of reconnection/resupply, there are two different cases:

1) disconnections due to non-payment and

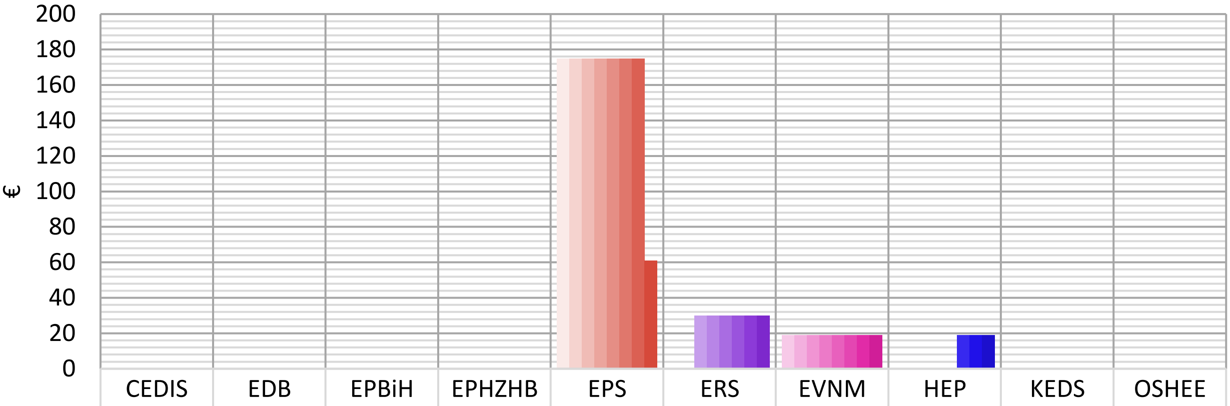
2) disconnections due to unauthorized consumptions (theft).

Also, for the reconnection/resupply activity there are two dates to be observed: prescribed and realized. The reconnections/resupplies can be done with and without any charge. Due to yearly invariability of prescribed dates for reconnection/resupply, respective figures are shown in the Appendix (Figures 19.113 - 19.136), while here we give the main findings and descriptions.

Prescribed dates for reconnection/resupply upon disconnections due to non-payment were in the range between one and three working days. Since 2014, in CEDIS this time period is reduced from two to one day. Realized time period for reconnection/resupply upon disconnections due to non-payment in EDB has been in declining trend from three to one working day, while in other DSOs it remains at the level of one day (reconnection/resupply in EPS is done within 1-1,5 day). Internal DSO prescribed time period for reconnection/resupply upon disconnections due to non-payment in EVNM is the same day for prompt reconnection (higher reconnection charge) or the next day after the payment of reconnection charge. In all DSOs realized time periods have been within prescribed intervals.

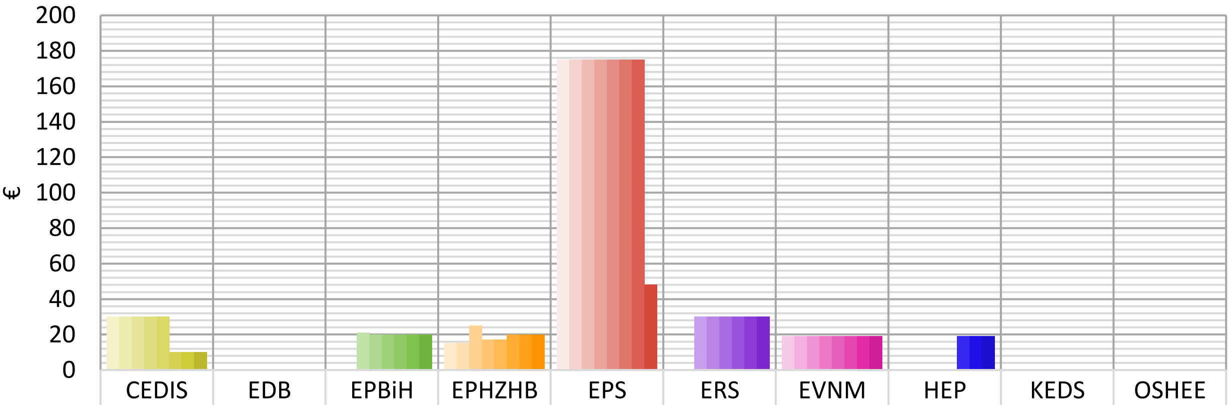
EPS and OSHEE have higher prescribed time periods for reconnection/resupply upon disconnections due to unauthorized consumption (theft), i.e. 15 and 10-14 days, respectively. Hence, realized time periods for reconnection/resupply in this two DSOs were higher, up to 12 days. In KEDS there is no prescribed time period within reconnection/resupply upon disconnections due to unauthorized consumption (theft). All other DSOs have the same prescribed time periods for reconnection/resupply upon disconnections due to theft as due to non-payment reasons. EDB recorded decreasing trend of realized time periods in the period 2008-2015, from three to one working day. As for non-payment reasons, for unauthorized consumption (theft) all realized time periods for reconnection/resupply were within prescribed intervals.

KEDS and OSHEE don't have any reconnection/resupply charge. All other SEE DSOs have reconnection/resupply charges (one-time payments) that differ upon reasons of disconnection (non-payment and theft). Furthermore, some DSOs (EPHZHB, EVNM and HEP) have several different charges, mostly one charge for prompt reconnection/resupply (within 24 hours including non-working days) and one for ordinary reconnections/resupplies (within prescribed time period). On Figures 9.6 - 9.17 average reconnection/resupply charges upon disconnections due to both reasons are shown. Charges for reconnections/resupplies upon disconnections due to unauthorized consumptions are in some DSOs equal to those due to non-payment reasons, while in other DSOs it is greater. Moreover, in some DSOs these charges are different for different consumption categories. In EPS reconnection/resupply charges upon disconnections due to unauthorized consumption refer to the standard price of new grid connection, since consumer with unauthorized consumption is considered as new consumer and he is obliged to submit new grid connection request. In all DSOs, reconnection/resupply can be done after customer pays the debt or estimated unauthorized electricity consumption cost.



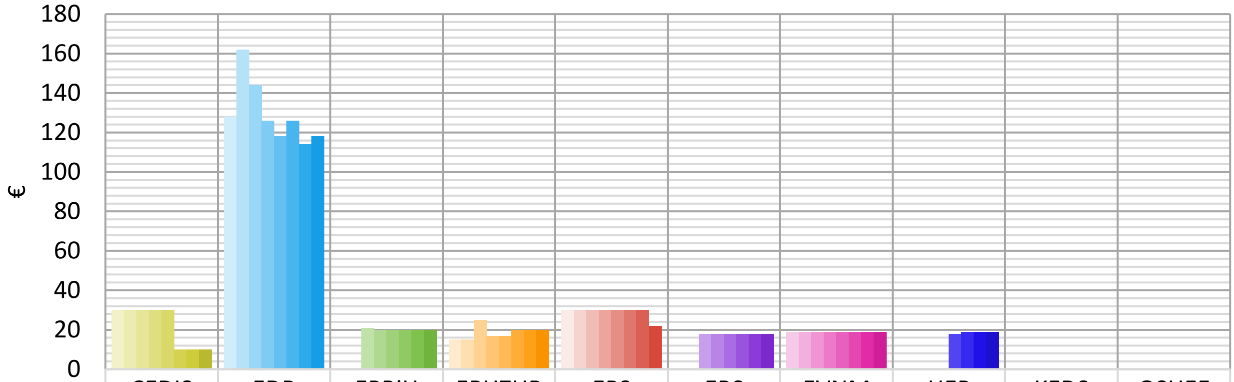
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	175	0	19	0	0	0
2009	0	0	0	0	175	0	19	0	0	0
2010	0	0	0	0	175	30	19	0	0	0
2011	0	0	0	0	175	30	19	0	0	0
2012	0	0	0	0	175	30	19	0	0	0
2013	0	0	0	0	175	30	19	19	0	0
2014	0	0	0	0	175	30	19	19	0	0
2015	0	0	0	0	61	30	19	19	0	0

Figure 9.6 Average reconnection charges upon disconnections due to non-payment in HV consumption category



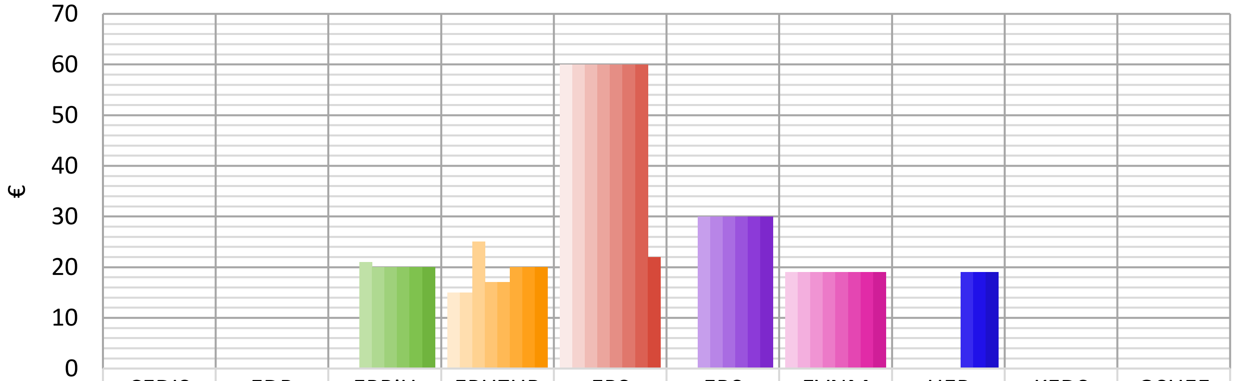
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	30	0	0	15	175	0	19	0	0	0
2009	30	0	0	15	175	0	19	0	0	0
2010	30	0	21	25	175	30	19	0	0	0
2011	30	0	20	17	175	30	19	0	0	0
2012	30	0	20	17	175	30	19	0	0	0
2013	10	0	20	20	175	30	19	19	0	0
2014	10	0	20	20	175	30	19	19	0	0
2015	10	0	20	20	48	30	19	19	0	0

Figure 9.7 Average reconnection charges upon disconnections due to non-payment in MV consumption category



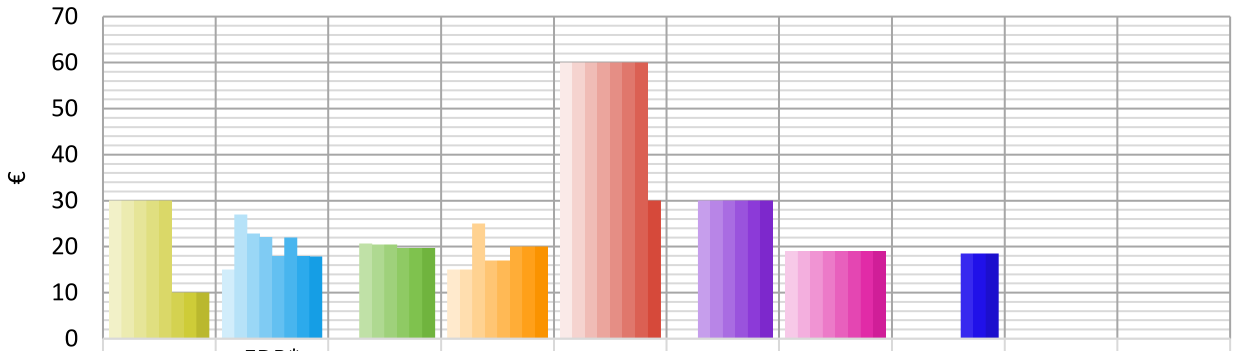
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	30	128	0	15	30	0	19	0	0	0
2009	30	162	0	15	30	0	19	0	0	0
2010	30	144	21	25	30	18	19	0	0	0
2011	30	126	20	17	30	18	19	0	0	0
2012	30	118	20	17	30	18	19	18	0	0
2013	10	126	20	20	30	18	19	19	0	0
2014	10	114	20	20	30	18	19	19	0	0
2015	10	118	20	20	22	18	19	19	0	0

Figure 9.8 Average reconnection charges upon disconnections due to non-payment in households consumption category



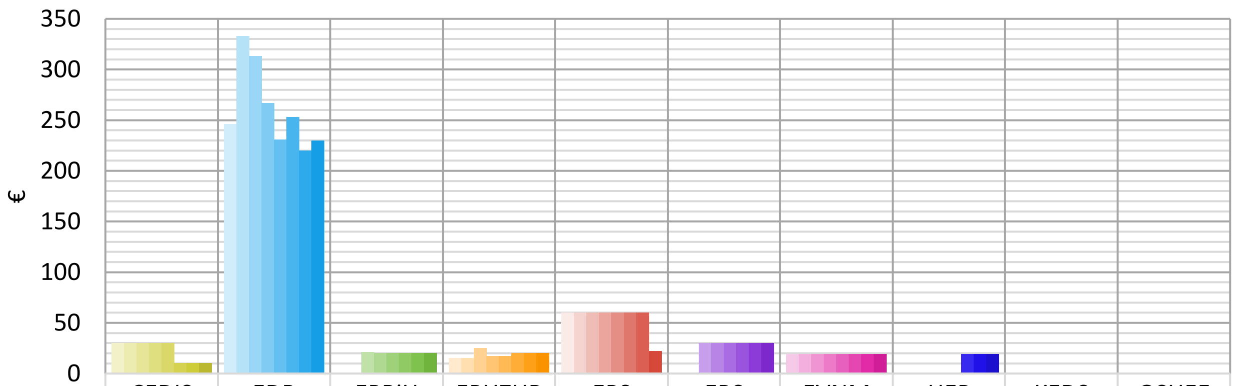
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	15	60	0	19	0	0	0
2009	0	0	0	15	60	0	19	0	0	0
2010	0	0	21	25	60	30	19	0	0	0
2011	0	0	20	17	60	30	19	0	0	0
2012	0	0	20	17	60	30	19	0	0	0
2013	0	0	20	20	60	30	19	19	0	0
2014	0	0	20	20	60	30	19	19	0	0
2015	0	0	20	20	22	30	19	19	0	0

Figure 9.9 Average reconnection charges upon disconnections due to non-payment in public lighting consumption category



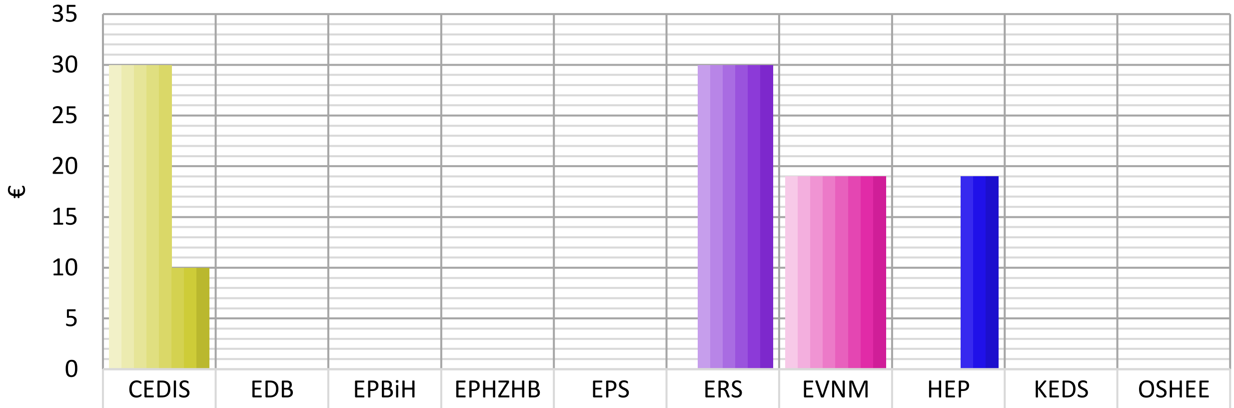
	CEDIS	EDB* x100	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	30	15	0	15	60	0	19	0	0	0
2009	30	27	0	15	60	0	19	0	0	0
2010	30	22,81	20,68	25	60	30	19	0	0	0
2011	30	22,05	20,42	17	60	30	19	0	0	0
2012	30	17,95	20,42	17	60	30	19	0	0	0
2013	10	22	19,652	20	60	30	19	18,508	0	0
2014	10	18	19,652	20	60	30	19	18,508	0	0
2015	10	17,9	19,652	20	30	30	19	18,508	0	0

Figure 9.10 Average reconnection charges upon disconnections due to non-payment in LV-commercial with peak power registration consumption category (values for EDB are in hundreds €)



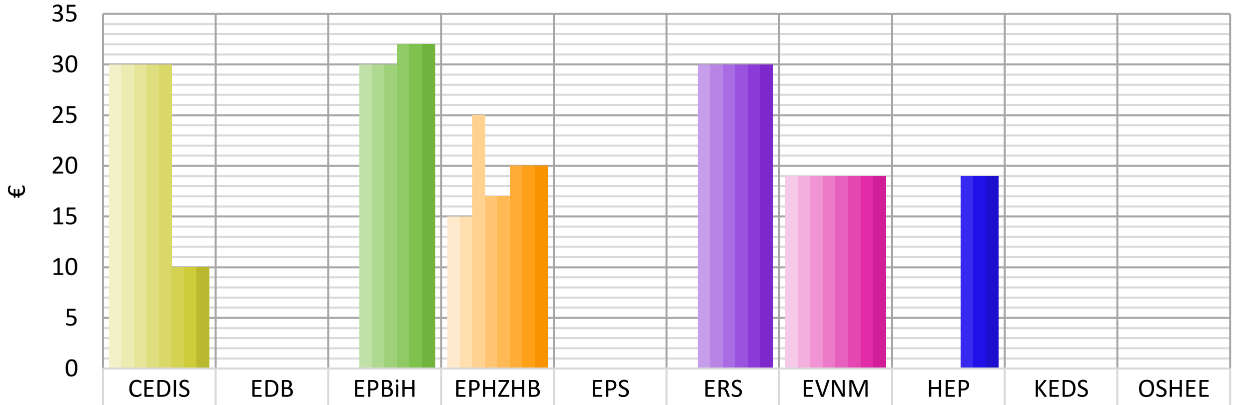
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	30	246	0	15	60	0	19	0	0	0
2009	30	333	0	15	60	0	19	0	0	0
2010	30	313	21	25	60	30	19	0	0	0
2011	30	267	20	17	60	30	19	0	0	0
2012	30	231	20	17	60	30	19	0	0	0
2013	10	253	20	20	60	30	19	19	0	0
2014	10	220	20	20	60	30	19	19	0	0
2015	10	230	20	20	22	30	19	19	0	0

Figure 9.11 Average reconnection charges upon disconnections due to non-payment in LV-commercial without peak power registration consumption category



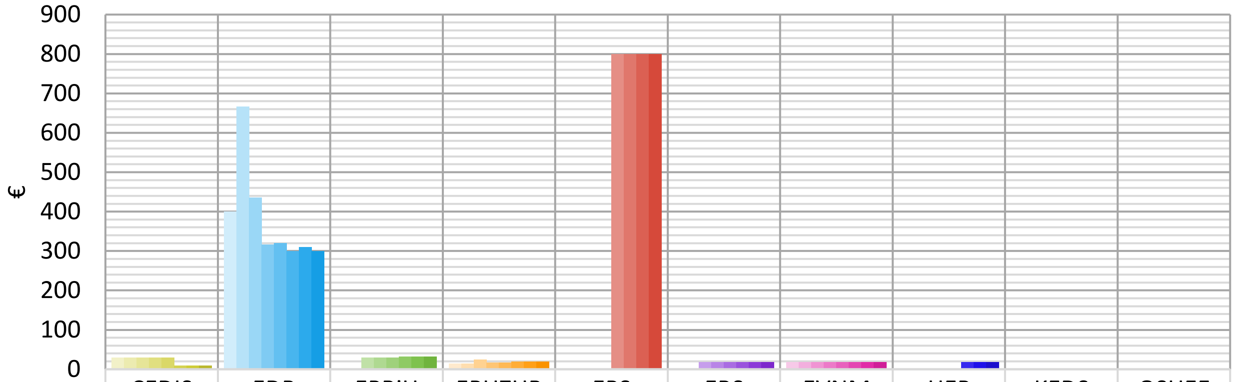
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	30	0	0	0	0	0	19	0	0	0
2009	30	0	0	0	0	0	19	0	0	0
2010	30	0	0	0	0	30	19	0	0	0
2011	30	0	0	0	0	30	19	0	0	0
2012	30	0	0	0	0	30	19	0	0	0
2013	10	0	0	0	0	30	19	19	0	0
2014	10	0	0	0	0	30	19	19	0	0
2015	10	0	0	0	0	30	19	19	0	0

Figure 9.12 Average reconnection charges upon disconnections due to electricity theft (unauthorized connection) in HV consumption category



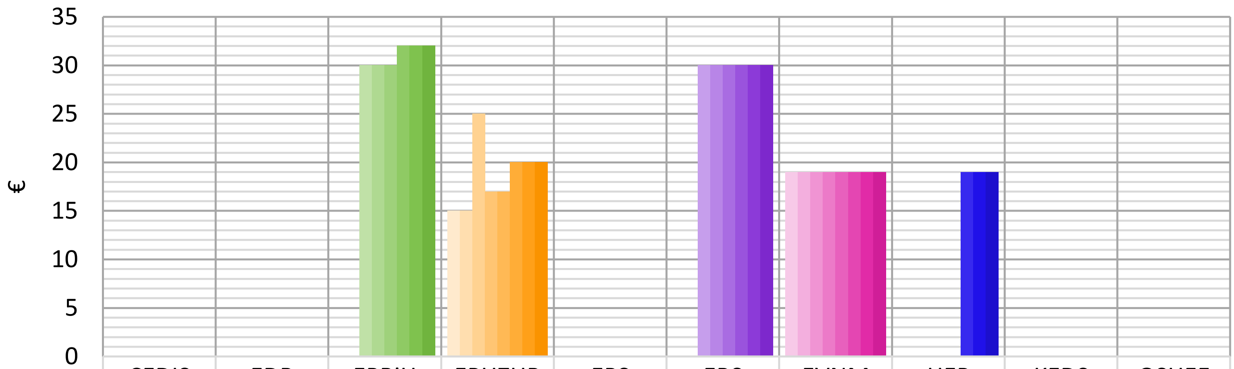
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	30	0	0	15	0	0	19	0	0	0
2009	30	0	0	15	0	0	19	0	0	0
2010	30	0	30	25	0	30	19	0	0	0
2011	30	0	30	17	0	30	19	0	0	0
2012	30	0	30	17	0	30	19	0	0	0
2013	10	0	32	20	0	30	19	19	0	0
2014	10	0	32	20	0	30	19	19	0	0
2015	10	0	32	20	0	30	19	19	0	0

Figure 9.13 Average reconnection charges upon disconnections due to electricity theft (unauthorized connection) in MV consumption category



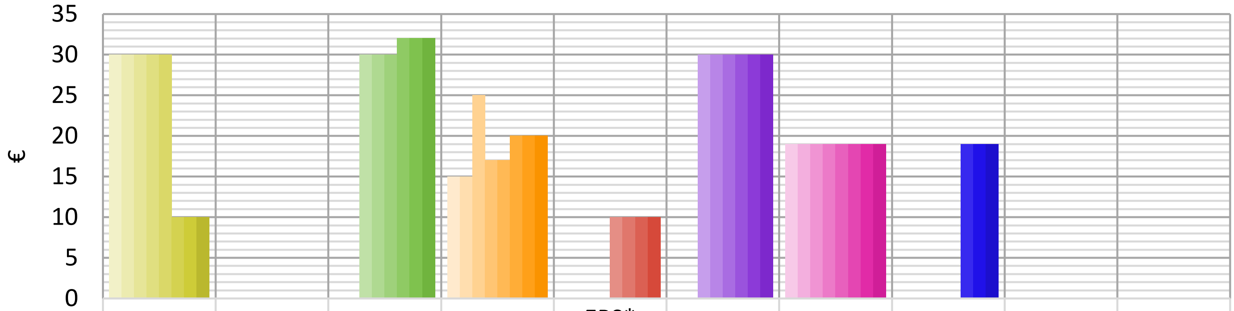
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	30	400	0	15	0	0	19	0	0	0
2009	30	667	0	15	0	0	19	0	0	0
2010	30	436	30	25	0	18	19	0	0	0
2011	30	316	30	17	0	18	19	0	0	0
2012	30	320	30	17	800	18	19	0	0	0
2013	10	300	32	20	800	18	19	19	0	0
2014	10	310	32	20	800	18	19	19	0	0
2015	10	300	32	20	800	18	19	19	0	0

Figure 9.14 Average reconnection charges upon disconnections due to electricity theft (unauthorized connection) in households consumption category



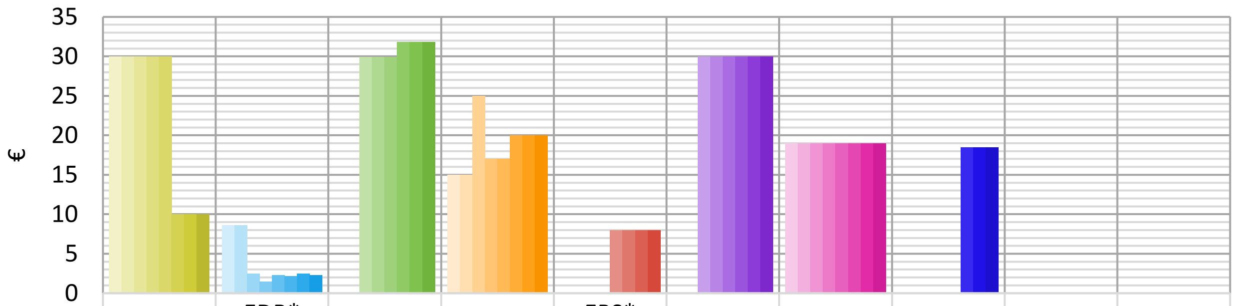
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	15	0	0	19	0	0	0
2009	0	0	0	15	0	0	19	0	0	0
2010	0	0	30	25	0	30	19	0	0	0
2011	0	0	30	17	0	30	19	0	0	0
2012	0	0	30	17	0	30	19	0	0	0
2013	0	0	32	20	0	30	19	19	0	0
2014	0	0	32	20	0	30	19	19	0	0
2015	0	0	32	20	0	30	19	19	0	0

Figure 9.15 Average reconnection charges upon disconnections due to electricity theft (unauthorized connection) in public lighting consumption category



	CEDIS	EDB	EPBiH	EPHZHB	EPS* x100	ERS	EVNM	HEP	KEDS	OSHEE
2008	30	0	0	15	0	0	19	0	0	0
2009	30	0	0	15	0	0	19	0	0	0
2010	30	0	30	25	0	30	19	0	0	0
2011	30	0	30	17	0	30	19	0	0	0
2012	30	0	30	17	10	30	19	0	0	0
2013	10	0	32	20	10	30	19	19	0	0
2014	10	0	32	20	10	30	19	19	0	0
2015	10	0	32	20	10	30	19	19	0	0

Figure 9.16 Average reconnection charges upon disconnections due to electricity theft (unauthorized connection) in LV-commercial with peak power registration consumption category (values for EPS are in hundreds €)



	CEDIS	EDB* 100	EPBiH	EPHZHB	EPS* x100	ERS	EVNM	HEP	KEDS	OSHEE
2008	30	8,6	0	15	0	0	19	0	0	0
2009	30	8,6	0	15	0	0	19	0	0	0
2010	30	2,5	29,9	25	0	30	19	0	0	0
2011	30	1,5	29,9	17	0	30	19	0	0	0
2012	30	2,3	29,9	17	8	30	19	0	0	0
2013	10	2,2	31,8	20	8	30	19	18,5	0	0
2014	10	2,5	31,8	20	8	30	19	18,5	0	0
2015	10	2,3	31,8	20	8	30	19	18,5	0	0

Figure 9.17 Average reconnection charges upon disconnections due to electricity theft (unauthorized connection) in LV-commercial without peak power registration consumption category (values for EDB and EPS are in hundreds €)

9.3 OBSERVATIONS/RECOMMENDATIONS

In almost all DSOs Supply Rules and Distribution Grid Code have provisions about unauthorized connection and use of electricity, legal conditions for disconnection, fines and penalties envisaged as well as methodology for estimating unauthorized electricity consumption. Unpaid bills to the supplier/DSO result with electricity supply suspension until its full payment or until formal agreement on payment schedule is reached. However, illegal connection in all DSOs results with service disconnection, juridical proceeding and is sentenced by a fine and/or imprisonment.

General prohibition to disconnect customers does not exists in the SEE DSOs (the same applies to European DSOs). A majority of SEE DSOs have specific measures available to prevent or at least to delay customer disconnection. Groups that benefit from a general prohibition of disconnection are people with life threatening illnesses, hospitals or other specific consumers or population groups that are deemed particularly vulnerable (e.g. elderly persons, children related institutions, cases in which there is a danger of severe property or health damage). Besides protecting vulnerable customers, this report recommends all DSOs to have warning mechanisms in place to give sufficient time and notification before the disconnection and, also, prohibiting power disconnection during critical period of time (e.g. cold winter months).

Looking at the shares of number of disconnections/supply suspensions in total number of connection points in the SEE DSOs, it is concluded that lower reconnection/resupply charges result with higher disconnection share (in almost all consumer categories KEDS and OSHEE have the highest disconnection shares. At the same time, they don’t have any reconnection/resupply charge). However, reconnection/resupply charges are not the only key for lower level of disconnections (e.g. EDB has very high reconnection/resupply charges, but the highest disconnection shares in LV commercial with power peak registration category). Non-payment and electricity theft issues are definitely much deeper and related to the overall socio-economic situation. Hence, it is recommended to all SEE DSOs, especially EDB, KEDS, OSHEE and EVNM to make additional steps toward responsible national authorities (ministries, regulatory agencies etc.) to define complete legal and social framework to resolve existing problems with electricity thefts and non-payments.

10 BILLING

Besides the primary function of charging the customers for the electricity supply and network services, electricity bill is also important as a comprehensive set of information on the electricity consumption, prices, savings and efficiency opportunities. Hence, billing the customers for the electricity distribution service should be based on accurate periodical meter readings.

The indicators of billing effectiveness provided in this chapter include:

1) frequency of provisional billing,

2) bill processing time and

3) frequency of billing errors.

CEDIS didn't provide any data related to the billing, while some DSOs provided partial data. All data related to the billing haven't been provided by EVNM (data missing for 2008-2010), by KEDS (2008 and 2009), and by OSHEE (2013-2015). In the following subchapters data related to specific parts of billing dataset are described in details.

10.1 FREQUENCY OF PROVISIONAL BILLING

Frequency of provisional billing corresponds to the share of bills issued on the bases of estimated consumption instead of a meter reading.

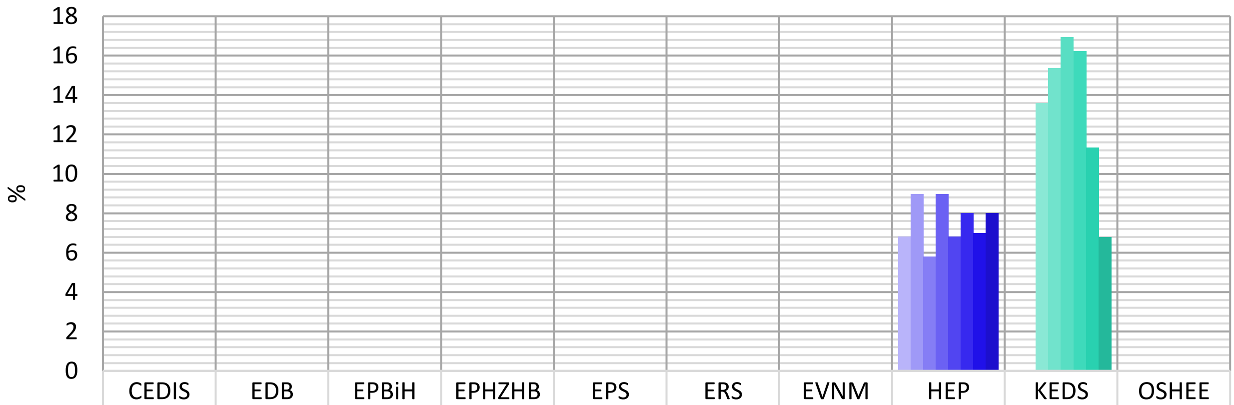
Besides above mentioned missing input data, data on frequency of provisional billing in EVNM were given as lump sums for all consumer categories in the period 2011-2015 and shown in the largest consumer category, i.e. households. In the DSOs with monthly readings, provisional billing has been used only exceptionally, when reading couldn't be conducted. Therefore, in ERS there is no available data, so ERS estimated that the number of provisional billing is about 2-3% of the total billing.

Other DSOs have shares of provisional billing up to 17 %, as shown on the Figures 10.1 - 10.4. For HV and MV customers provisional billing is not an issue in any DSO.

Due to its half-yearly meter readings with allowed estimation once a year, frequency of provisional billing for households in HEP is about 6-7 %. Data for EVNM refer to all categories (lump sum) and in observed period its had increasing trend. OSHEE has faced a significant decrease from 7 % in 2008 to less then 0,2 % in 2012 (data for OSHEE in the period 2013-2015 are not available). In other consumer categories, higher shares are recorded in HEP and KEDS. These DSOs had shares of provisional billings in LV commercial without peak power registration category at similar level as for the households, while in public lighting category HEP had slightly higher level of provisional billings than in the households category. KEDS had relatively high level of provisional billings, with the decreasing trend in the last few years.

	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,01	0	0	0	0	0	7,58	0	7,26
2009	0	0,01	0	0	0	0	0	7,18	0	6,01
2010	0	0	0	0	0	0	0	6,42	3,68	3,28
2011	0	0	0	0	0	0	2,25	7,18	4,24	0,1
2012	0	0	0	0	0	0	1,94	7,58	2,72	0,19
2013	0	0	0	0	0	0	2,21	7	3,6	0
2014	0	0	0	0	0	0	9,68	6	2,99	0
2015	0	0	0	0	0	0	12,67	7	1,91	0

Figure 10.1 Frequency of provisional billing for households consumers in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	6,81	0	0,01
2009	0	0	0	0	0	0	0	8,96	0	0,01
2010	0	0	0	0	0	0	0	5,79	13,58	0,01
2011	0	0	0	0	0	0	0	8,96	15,36	0
2012	0	0	0	0	0	0	0	6,81	16,93	0
2013	0	0	0	0	0	0	0	8	16,23	0
2014	0	0	0	0	0	0	0	7	11,32	0
2015	0	0	0	0	0	0	0	8	6,78	0

Figure 10.2 Frequency of provisional billing for public lighting consumers in SEE DSOs in the period 2008 - 2015

	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0,7	0	0
2009	0	0	0	0	0	0	0	0,81	0	0
2010	0	0	0	0	0	0	0	0,79	0,6	0
2011	0	0	0	0	0	0	0	0,81	0,23	0
2012	0	0	0	0	0	0	0	0,7	0,31	0
2013	0	0	0	0	0	0	0	0,7	0	0
2014	0	0	0	0	0	0	0	0,7	0	0
2015	0	0	0	0	0	0	0	0,7	0	0

Figure 10.3 Frequency of provisional billing for LV-commercial with peak power registration consumers in SEE DSOs in the period 2008 - 2015

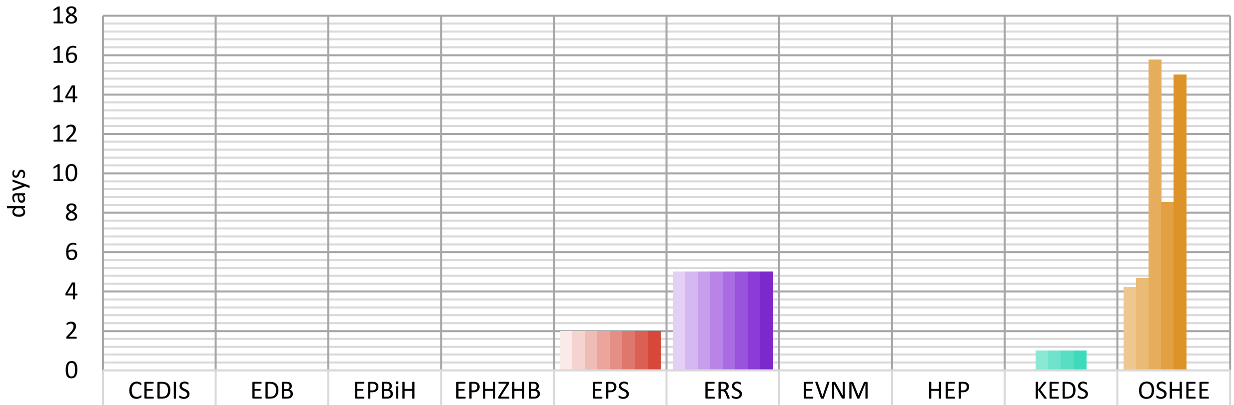
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,01	0	0	0	0	0	5,91	0	0,76
2009	0	0,01	0	0	0	0	0	6,12	0	0,5
2010	0	0	0	0	0	0	0	6,78	2,37	0,29
2011	0	0	0	0	0	0	0	6,12	4,7	0,01
2012	0	0	0	0	0	0	0	5,91	2,94	0,04
2013	0	0	0	0	0	0	0	6	3,78	0
2014	0	0	0	0	0	0	0	7	3,01	0
2015	0	0	0	0	0	0	0	6	1,88	0

Figure 10.4 Frequency of provisional billing for LV-commercial without peak power registration consumers in SEE DSOs in the period 2008 - 2015

10.2 BILL PROCESSING TIME

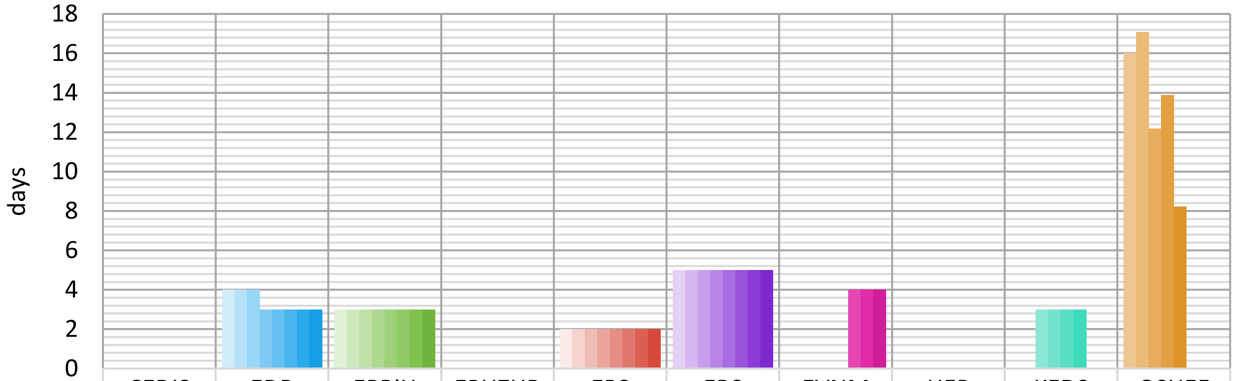
Bill processing time is time interval between meter reading and bill dispatch.

Besides above mentioned missing input data, bill processing time for KEDS in the period 2008-2012 were also not available for this analysis. For HV (Figure 10.5) and MV (Figure 10.2) consumers, bill processing time was in the range of 1 to 5 days, with exception for OSHEE where it was up to 16 days. In the households category (Figure 10.7) EDB reported the highest bill processing time (15 days in the period 2008-2010) and it was reduced to 10 days since 2011. OSHEE had the highest bill processing time in the remaining three categories (Figures 10.8 - 10.10) (i.e. in public lighting category up to 14 days, LV commercial with peak power registration category up to 6 days and LV commercial without peak power registration up to 17 days).



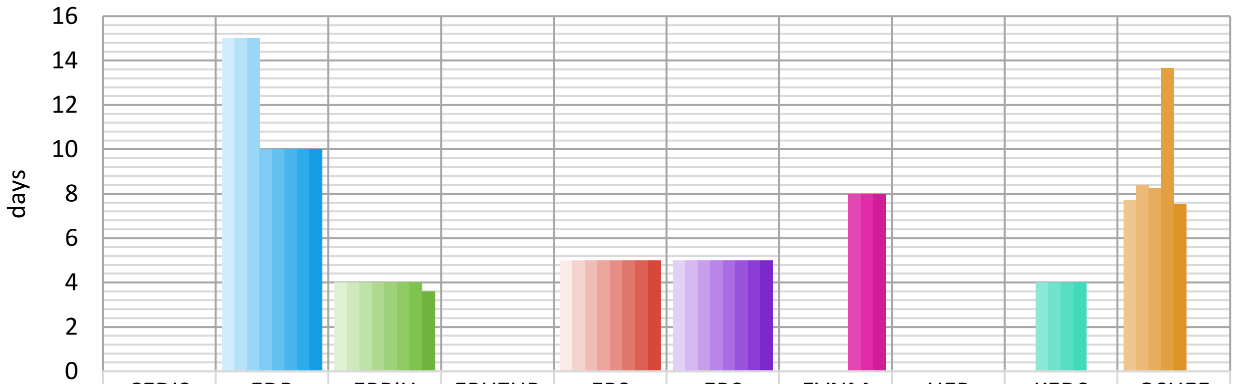
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	2	5	0	0	0	4,22
2009	0	0	0	0	2	5	0	0	0	4,67
2010	0	0	0	0	2	5	0	0	1	15,78
2011	0	0	0	0	2	5	0	0	1	8,53
2012	0	0	0	0	2	5	0	0	1	15
2013	0	0	0	0	2	5	0	0	1	0
2014	0	0	0	0	2	5	0	0	0	0
2015	0	0	0	0	2	5	0	0	0	0

Figure 10.5 Bill processing time for HV consumers in SEE DSOs in the period 2008 - 2015



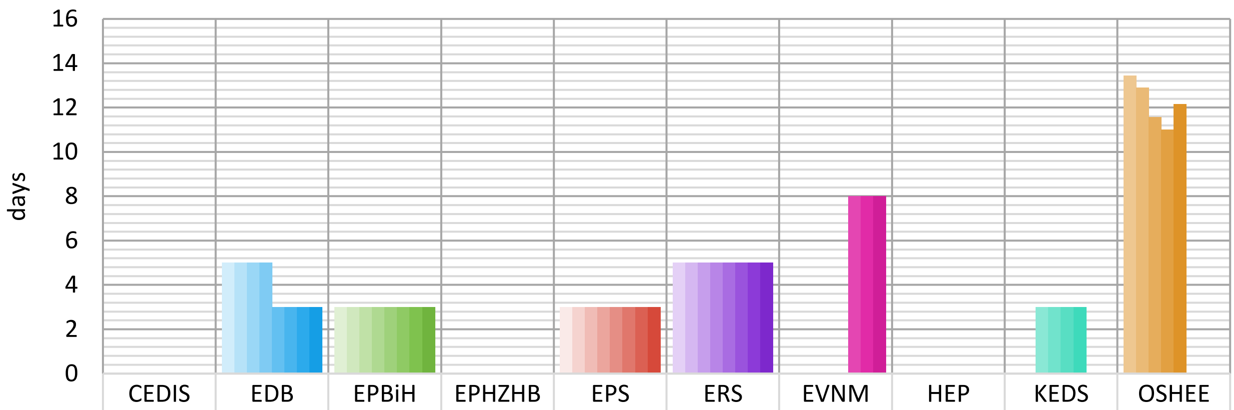
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	4	3	0	2	5	0	0	0	16
2009	0	4	3	0	2	5	0	0	0	17,08
2010	0	4	3	0	2	5	0	0	3	12,17
2011	0	3	3	0	2	5	0	0	3	13,89
2012	0	3	3	0	2	5	0	0	3	8,22
2013	0	3	3	0	2	5	4	0	3	0
2014	0	3	3	0	2	5	4	0	0	0
2015	0	3	3	0	2	5	4	0	0	0

Figure 10.6 Bill processing time for MV consumers in SEE DSOs in the period 2008 - 2015



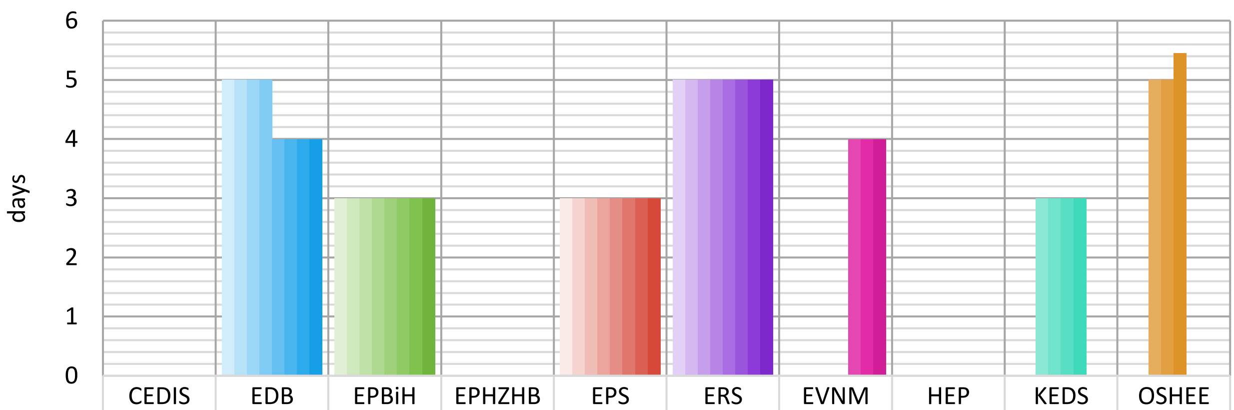
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	15	4	0	5	5	0	0	0	7,72
2009	0	15	4	0	5	5	0	0	0	8,4
2010	0	15	4	0	5	5	0	0	4	8,25
2011	0	10	4	0	5	5	0	0	4	13,65
2012	0	10	4	0	5	5	0	0	4	7,54
2013	0	10	4	0	5	5	8	0	4	0
2014	0	10	4	0	5	5	8	0	0	0
2015	0	10	3,6	0	5	5	8	0	0	0

Figure 10.7 Bill processing time for households consumers in SEE DSOs in the period 2008 - 2015



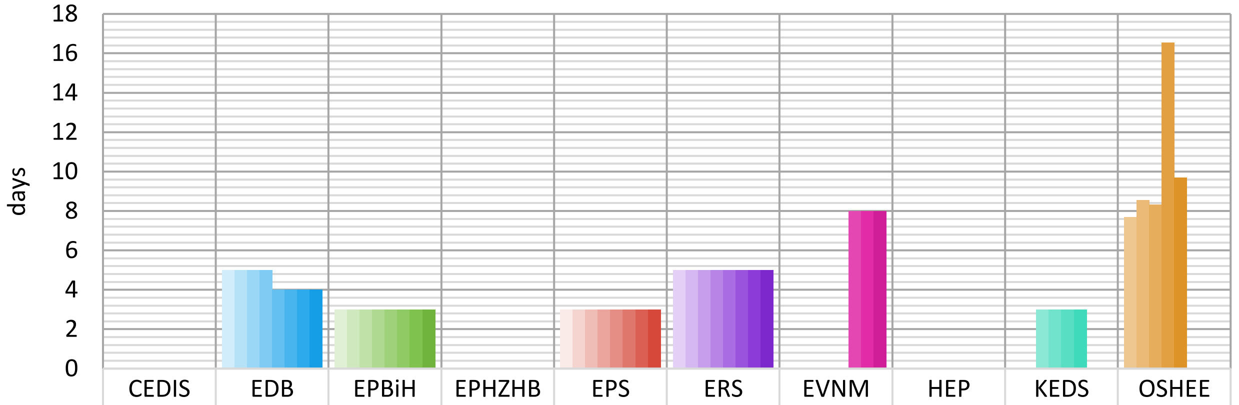
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	5	3	0	3	5	0	0	0	13,44
2009	0	5	3	0	3	5	0	0	0	12,9
2010	0	5	3	0	3	5	0	0	3	11,56
2011	0	5	3	0	3	5	0	0	3	11
2012	0	3	3	0	3	5	0	0	3	12,16
2013	0	3	3	0	3	5	8	0	3	0
2014	0	3	3	0	3	5	8	0	0	0
2015	0	3	3	0	3	5	8	0	0	0

Figure 10.8 Bill processing time for public lighting consumers in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	5	3	0	3	5	0	0	0	0
2009	0	5	3	0	3	5	0	0	0	0
2010	0	5	3	0	3	5	0	0	3	5
2011	0	5	3	0	3	5	0	0	3	5
2012	0	4	3	0	3	5	0	0	3	5,45
2013	0	4	3	0	3	5	4	0	3	0
2014	0	4	3	0	3	5	4	0	0	0
2015	0	4	3	0	3	5	4	0	0	0

Figure 10.9 Bill processing time for LV-commercial with peak power registration consumers in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	5	3	0	3	5	0	0	0	7,68
2009	0	5	3	0	3	5	0	0	0	8,56
2010	0	5	3	0	3	5	0	0	3	8,33
2011	0	5	3	0	3	5	0	0	3	16,55
2012	0	4	3	0	3	5	0	0	3	9,7
2013	0	4	3	0	3	5	8	0	3	0
2014	0	4	3	0	3	5	8	0	0	0
2015	0	4	3	0	3	5	8	0	0	0

Figure 10.10 Bill processing time for LV-commercial without peak power registration consumers in SEE DSOs in the period 2008 - 2015

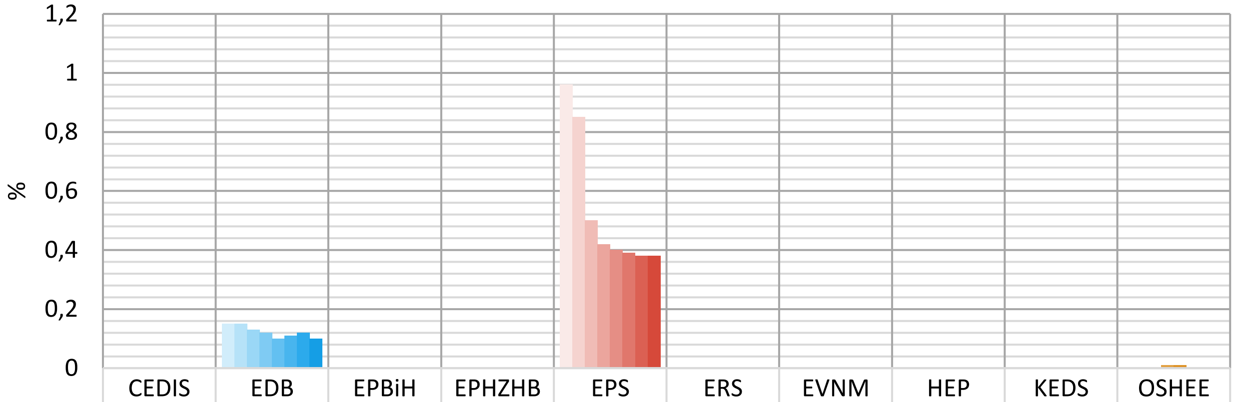
10.3 FREQUENCY OF BILLING ERRORS

In this report billing errors indicators are divided in two main types, depending on their impact on the consumers:

1) billing errors corrected before sending the bill to the consumers, and
2) billing errors corrected after the bill was sent (regardless whether the error was reported by the customer or not).

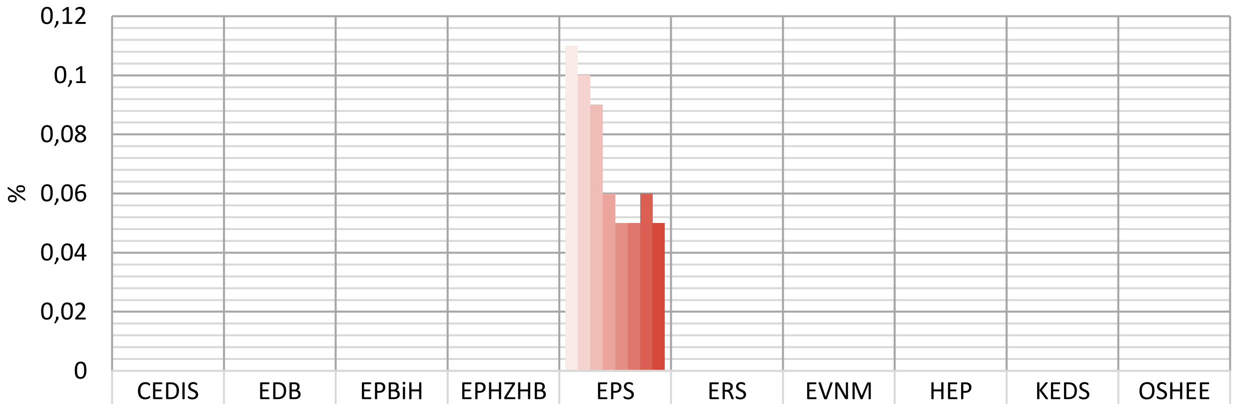
Regarding the first type of billing errors, i.e. bill errors corrected before sending the bill, besides unavailable input data, additional three DSOs didn't provide the data (EPHZHB, HEP and KEDS). EVNM provided lump sums for the period 2011-2015, all shown in the household category, while in ERS there was no relevant records.

Frequency of the first type of billing errors for HV and MV consumers was negligible. In other consumer categories (Figures 10.11 - 10.14) these errors were registered only by EDB, EPS and OSHEE, with the highest value below 1%. The internal DSO procedures for billing control has been contributing to the trend of billing errors reduction.



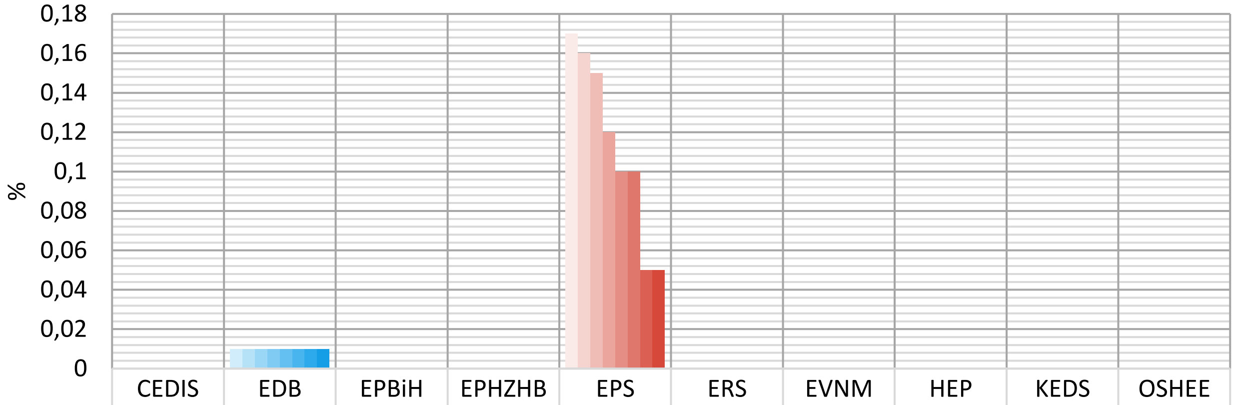
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,15	0	0	0,96	0	0	0	0	0
2009	0	0,15	0	0	0,85	0	0	0	0	0
2010	0	0,13	0	0	0,5	0	0	0	0	0
2011	0	0,12	0	0	0,42	0	0	0	0	0,01
2012	0	0,1	0	0	0,4	0	0	0	0	0,01
2013	0	0,11	0	0	0,39	0	0	0	0	0
2014	0	0,12	0	0	0,38	0	0	0	0	0
2015	0	0,1	0	0	0,38	0	0	0	0	0

Figure 10.11 Frequency of billing errors corrected before sending the bills for households consumers in SEE DSOs in period 2008 - 2015



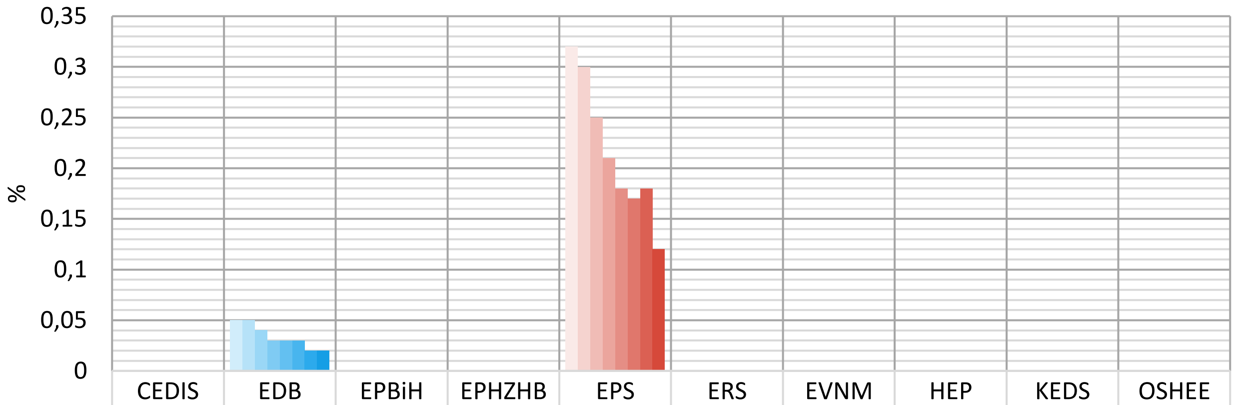
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0,11	0	0	0	0	0
2009	0	0	0	0	0,1	0	0	0	0	0
2010	0	0	0	0	0,09	0	0	0	0	0
2011	0	0	0	0	0,06	0	0	0	0	0
2012	0	0	0	0	0,05	0	0	0	0	0
2013	0	0	0	0	0,05	0	0	0	0	0
2014	0	0	0	0	0,06	0	0	0	0	0
2015	0	0	0	0	0,05	0	0	0	0	0

Figure 10.12 Frequency of billing errors corrected before sending the bills for public lighting consumers in SEE DSOs in period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,01	0	0	0,17	0	0	0	0	0
2009	0	0,01	0	0	0,16	0	0	0	0	0
2010	0	0,01	0	0	0,15	0	0	0	0	0
2011	0	0,01	0	0	0,12	0	0	0	0	0
2012	0	0,01	0	0	0,1	0	0	0	0	0
2013	0	0,01	0	0	0,1	0	0	0	0	0
2014	0	0,01	0	0	0,05	0	0	0	0	0
2015	0	0,01	0	0	0,05	0	0	0	0	0

Figure 10.13 Frequency of billing errors corrected before sending the bills for LV-commercial with peak power registration consumers in SEE DSOs in period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,05	0	0	0,32	0	0	0	0	0
2009	0	0,05	0	0	0,3	0	0	0	0	0
2010	0	0,04	0	0	0,25	0	0	0	0	0
2011	0	0,03	0	0	0,21	0	0	0	0	0
2012	0	0,03	0	0	0,18	0	0	0	0	0
2013	0	0,03	0	0	0,17	0	0	0	0	0
2014	0	0,02	0	0	0,18	0	0	0	0	0
2015	0	0,02	0	0	0,12	0	0	0	0	0

Figure 10.14 Frequency of billing errors corrected before sending the bills for LV-commercial without peak power registration consumers in SEE DSOs in period 2008 - 2015

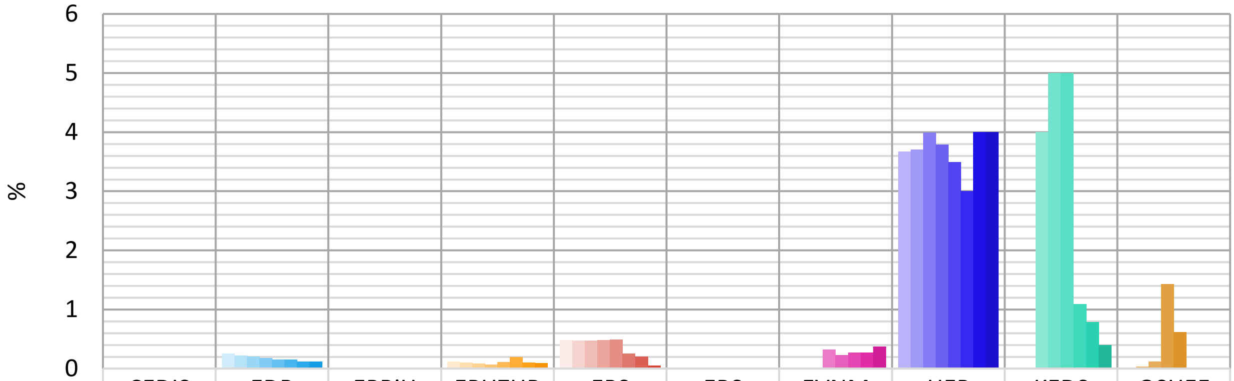
In addition to already mentioned missing dataset, several DSOs didn't provide the data on distribution of billing errors corrected after sending the bill per each consumer category. Therefore, HEP provided two sets of data, one for the household category and the other for entrepreneurship category that is shown within the LV commercial without peak power registration category. KEDS provided lump sums data in the period 2011-2015, while EPHZHB provided lump sums in the whole observed period. Lump sums, as in the other chapters, are shown here within the biggest consumer category, i.e. household category.

For the first type of billing errors (corrected before sending the bills), in ERS there are no relevant statistics on corrected billing errors after the bill was sent.

Frequencies of billing errors corrected after sending the bills to consumers are shown on Figures 10.15 - 10.19. In all consumer categories, the highest shares of corrected bills were recorded in HEP and KEDS. Relatively high shares existed in households category, up to 5%, and in LV commercial without peak power registration category, up to 2%. In the other categories, this share was below 1,2%.

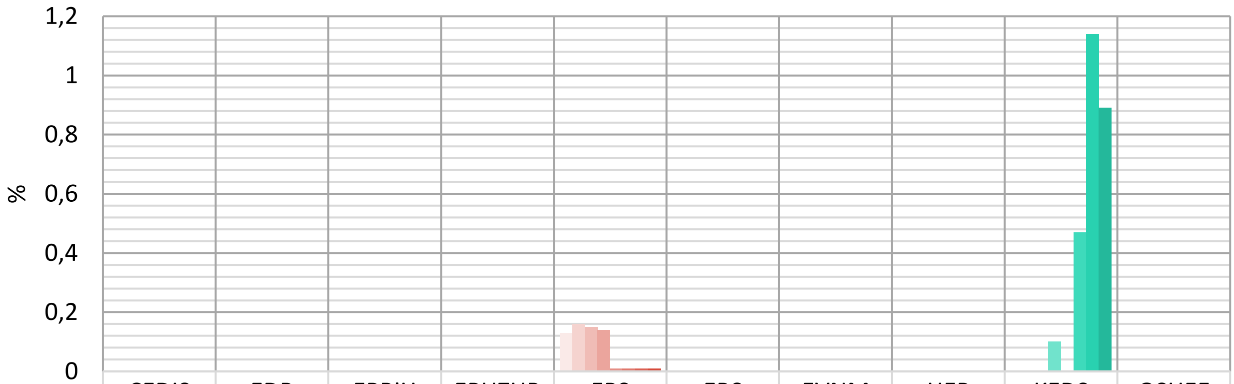
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0,02
2012	0	0	0	0	0	0	0	0	0	0,01
2013	0	0	0	0	0	0	0	0	0,11	0
2014	0	0	0	0	0	0	0	0	0,32	0
2015	0	0	0	0	0	0	0	0	0,22	0

Figure 10.15 Frequency of billing errors corrected after sending the bills for MV consumers in SEE DSOs in period 2008 - 2015



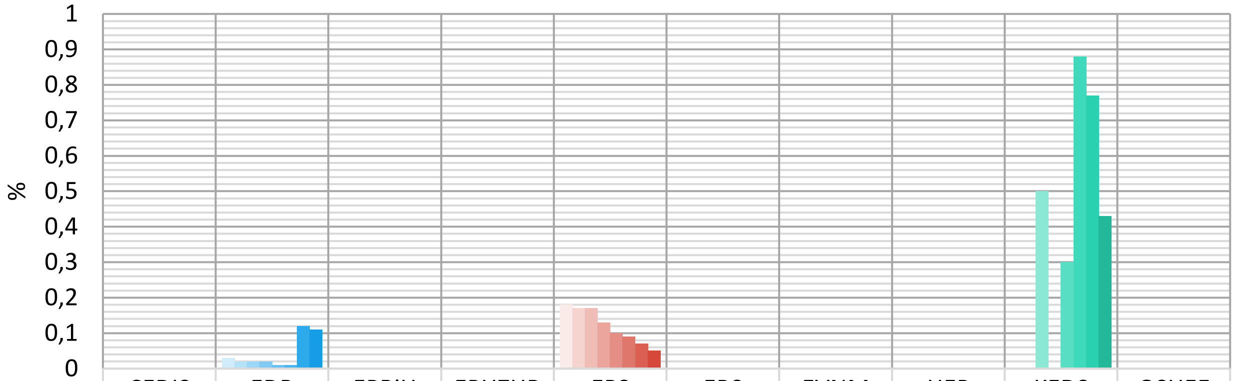
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,25	0	0,12	0,48	0	0	3,67	0	0,02
2009	0	0,22	0	0,1	0,47	0	0	3,7	0	0,03
2010	0	0,2	0	0,08	0,47	0	0	3,99	4	0,12
2011	0	0,18	0	0,07	0,48	0	0,32	3,79	5	1,43
2012	0	0,15	0	0,11	0,49	0	0,23	3,49	5	0,62
2013	0	0,15	0	0,19	0,25	0	0,27	3	1,09	0
2014	0	0,12	0	0,1	0,2	0	0,27	4	0,79	0
2015	0	0,12	0	0,09	0,05	0	0,37	4	0,4	0

Figure 10.16 Frequency of billing errors corrected after sending the bills for households consumers in SEE DSOs in period 2008 - 2015



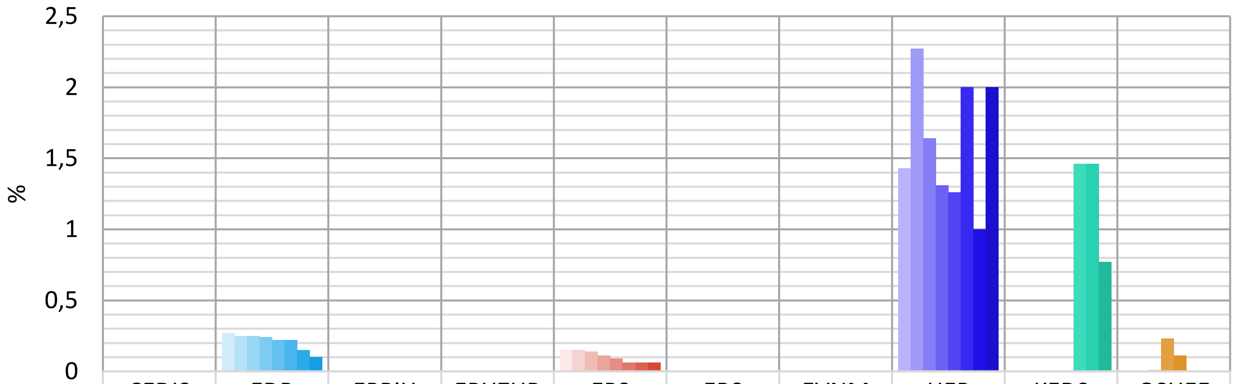
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0,13	0	0	0	0	0
2009	0	0	0	0	0,16	0	0	0	0	0
2010	0	0	0	0	0,15	0	0	0	0	0
2011	0	0	0	0	0,14	0	0	0	0,1	0
2012	0	0	0	0	0,01	0	0	0	0	0
2013	0	0	0	0	0,01	0	0	0	0,47	0
2014	0	0	0	0	0,01	0	0	0	1,14	0
2015	0	0	0	0	0,01	0	0	0	0,89	0

Figure 10.17 Frequency of billing errors corrected after sending the bills for public lighting consumers in SEE DSOs in period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,03	0	0	0,18	0	0	0	0	0
2009	0	0,02	0	0	0,17	0	0	0	0	0
2010	0	0,02	0	0	0,17	0	0	0	0,5	0
2011	0	0,02	0	0	0,13	0	0	0	0	0
2012	0	0,01	0	0	0,1	0	0	0	0,3	0
2013	0	0,01	0	0	0,09	0	0	0	0,88	0
2014	0	0,12	0	0	0,07	0	0	0	0,77	0
2015	0	0,11	0	0	0,05	0	0	0	0,43	0

Figure 10.18 Frequency of billing errors corrected after sending the bills for LV-commercial with peak power registration consumers in SEE DSOs in period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,27	0	0	0,15	0	0	1,43	0	0
2009	0	0,25	0	0	0,15	0	0	2,27	0	0
2010	0	0,25	0	0	0,14	0	0	1,64	0	0,01
2011	0	0,24	0	0	0,11	0	0	1,31	0	0,23
2012	0	0,22	0	0	0,09	0	0	1,26	0	0,11
2013	0	0,22	0	0	0,06	0	0	2	1,46	0
2014	0	0,15	0	0	0,06	0	0	1	1,46	0
2015	0	0,1	0	0	0,06	0	0	2	0,77	0

Figure 10.19 Frequency of billing errors corrected after sending the bills for LV-commercial without peak power registration consumers in SEE DSOs in period 2008 - 2015

10.4 OBSERVATIONS/RECOMMENDATIONS

Provisional billing should be avoided as much as possible and bills should be based on accurate and timely conducted periodical meter readings. In this way, bills will truly fulfil the role of being a comprehensive source of information to consumers on energy consumption, prices, opportunities for savings and efficiency etc.

For households, it is recommended self-reading to be more intensively promoted as an effective alternative to meter reading conducted by the DSO staff, especially in the DSOs with non-monthly readings.

Majority of billing errors are supposed to be detected and corrected before sending the bill to consumer, which is still not the case in the SEE DSOs. Therefore, it is recommended to develop more accurate and strict procedures for controlling and auditing of the entire metering and billing process as well as correction of errors in timely manner.

11 REVENUE COLLECTION

Collection effectiveness refers to the DSO's ability to collect payment in a timely manner against the bills it issues. Due to possible existence of 'problematic' customer classes (in contrast to the collections from most of the customers) the performance has been segmented among customer types, so that it focuses on processes that the DSO management can control or influence.

Apart from these challenges, the measures should also reflect best practices toward streamlining the collection process. For example, the traditional approach to revenue collection was that the DSO issues a bill and waits for the customer to pay in person at the nearest district office. Many DSOs have made bill payment much easier for customers in an effort to reduce the collection period, such as by accepting payment at other locations such as bank branches, at ATMs, at selected merchants, by credit card, using the internet banking, and by pre-pay card.

The proposed measures in this report are grouped as follows:

- average days of bill payment overdue,
- share of bills collected in fiscal year,
- amount of overdue payments (arrears),

11.1 AVERAGE DAYS OF BILL PAYMENT OVERDUE

Figures 11.1 - 11.6 provide data on average days of bill payment overdue per consumer categories. CEDIS and EPHZHB didn't provide any data for the whole observed period, while OSHEE didn't provide data for the period 2013-2015. ERS provided data only for HV consumer category. Data for two categories, households and commercial category (shown in LV commercial category without peak power registration category), were provided by EPS for the whole observed period of time and by HEP for the period 2011-2015. EVNM provided lump sums data for the period 2010-2015, as shown in the households category on the Figure 11.3.

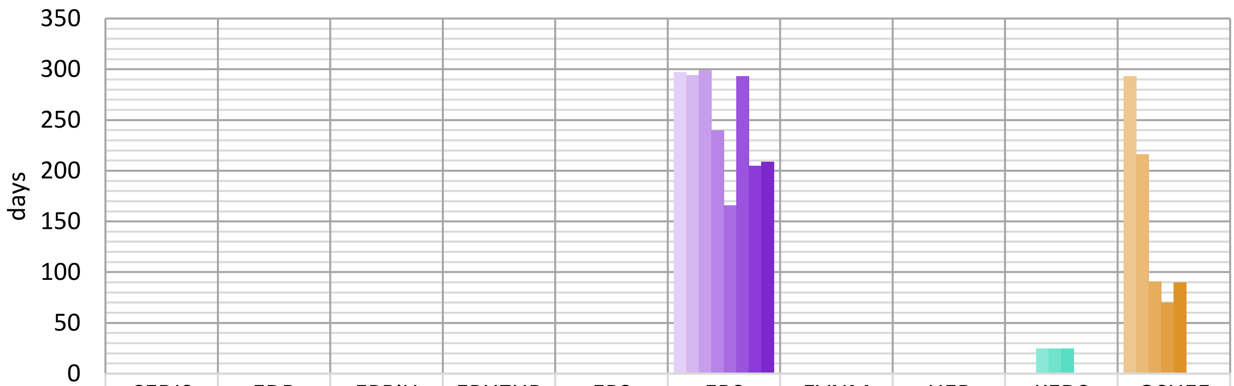
Based on the unbundling principles and operations, the collection risks are remaining with PES in Kosovo, while KEDS is paid within 30 days for provision of distribution services by PES. The principles were applied in the accounting unbundling till end of 2014 and after that in legal unbundling of operations. DSO can't provide data for the PES, so KEDS provided data only for the period 2010-2012. Data for 2008 and 2009 were unavailable.

It could be observed that ERS and OSHEE had very high bill payment overdue period at HV category, in average 250 and 152 days during the observed period, respectively. Also, both DSOs recorded decreasing trend since 2008, 42% lower in 2015 relative to 2008 for ERS and 225% lower in 2012 relative to 2008 for OSHEE.

At MV level, two out of three DSOs which provided data (EPBiH and KEDS) had bill payment period bellow a month, 29 and 15 days respectively. From the other side, this payment period in OSHEE was very high (206 days in average) with slight decreasing trend.

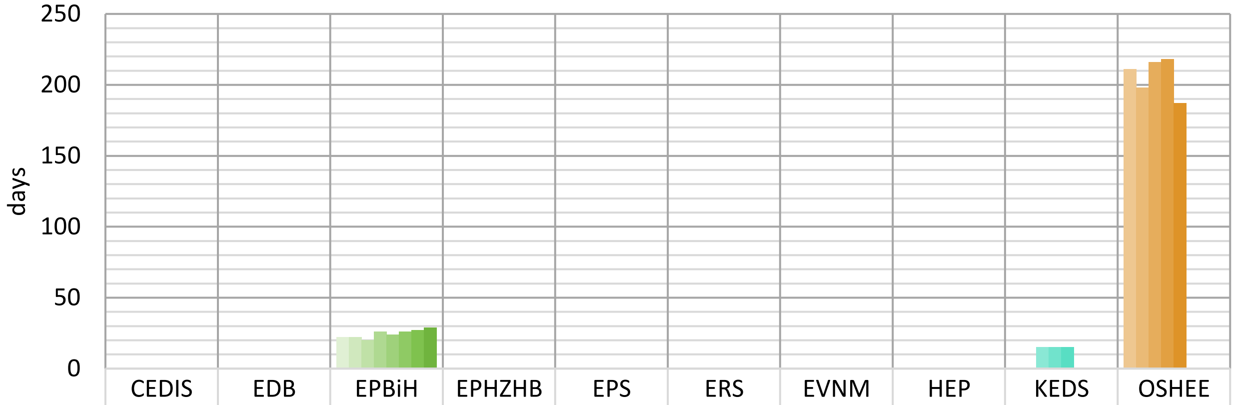
As mentioned above, EVNM lump sum data were set in households category, as the largest consumer category. Hence, bill payment period in EVNM was in the range between 58 (in 2015) and 72 days (in 2010), i.e. with recorded decreasing trend. OSHEE in households category also had the highest bill payment period, in average 181 day during given timeframe which is around 6 months overdue. In other DSOs, this period was in the range between 10 and 35 days.

In other three LV categories (public lighting and both commercial categories) OSHEE also had the highest bill payment periods, from 92 days (i.e. around 3 months overdue, recorded in LV commercial with peak power registration category in 2010) to 245 days (i.e. around 8 months overdue, recorded in public lighting category in 2011). In other DSOs, HEP had in average 59 days bill payment overdue period in commercial category.



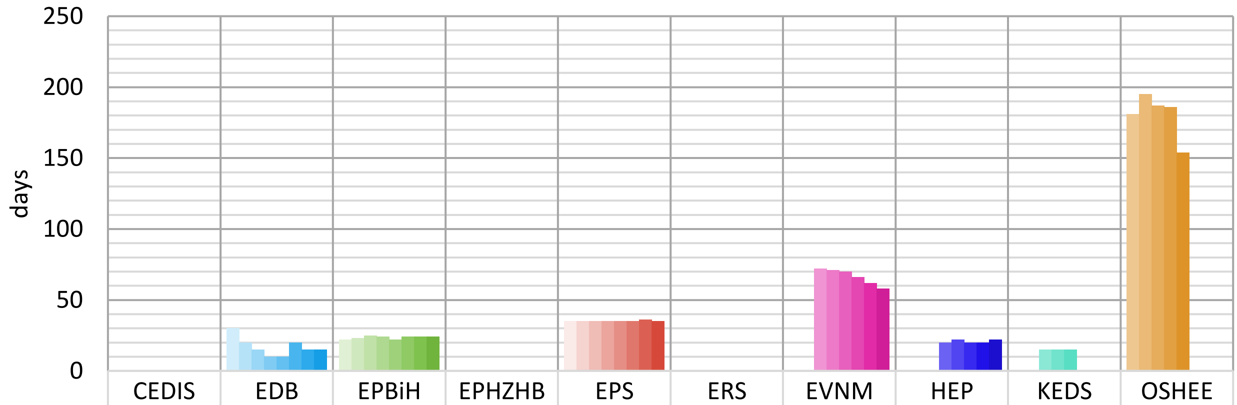
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	297	0	0	0	293
2009	0	0	0	0	0	294	0	0	0	216
2010	0	0	0	0	0	299	0	0	25	91
2011	0	0	0	0	0	240	0	0	25	70
2012	0	0	0	0	0	166	0	0	25	90
2013	0	0	0	0	0	293	0	0	0	0
2014	0	0	0	0	0	205	0	0	0	0
2015	0	0	0	0	0	209	0	0	0	0

Figure 11.1 Average days of bill payment overdue for HV consumers in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	22	0	0	0	0	0	0	211
2009	0	0	22	0	0	0	0	0	0	198
2010	0	0	20	0	0	0	0	0	15	216
2011	0	0	26	0	0	0	0	0	15	218
2012	0	0	24	0	0	0	0	0	15	187
2013	0	0	26	0	0	0	0	0	0	0
2014	0	0	27	0	0	0	0	0	0	0
2015	0	0	29	0	0	0	0	0	0	0

Figure 11.2 Average days of bill payment overdue for MV consumers in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	30	22	0	35	0	0	0	0	181
2009	0	20	23	0	35	0	0	0	0	195
2010	0	15	25	0	35	0	72	0	15	187
2011	0	10	24	0	35	0	71	20	15	186
2012	0	10	22	0	35	0	70	22	15	154
2013	0	20	24	0	35	0	66	20	0	0
2014	0	15	24	0	36	0	62	20	0	0
2015	0	15	24	0	35	0	58	22	0	0

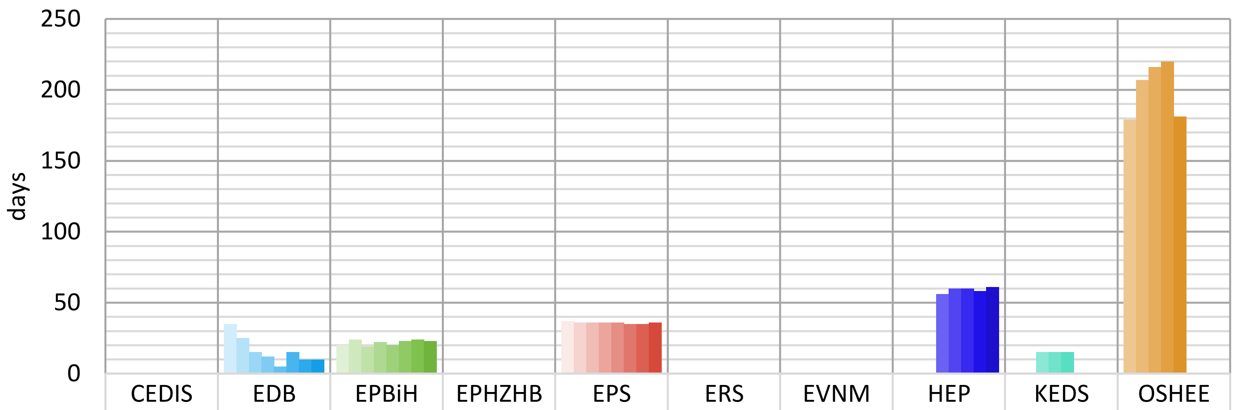
Figure 11.3 Average days of bill payment overdue for households consumers in SEE DSOs in the period 2008 - 2015

	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	16	0	0	0	0	0	0	153
2009	0	0	20	0	0	0	0	0	0	158
2010	0	0	19	0	0	0	0	0	15	221
2011	0	0	21	0	0	0	0	0	15	245
2012	0	0	17	0	0	0	0	0	15	187
2013	0	5	22	0	0	0	0	0	0	0
2014	0	5	26	0	0	0	0	0	0	0
2015	0	5	23	0	0	0	0	0	0	0

Figure 11.4 Average days of bill payment overdue for public lighting consumers in SEE DSOs in the period 2008 - 2015

	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	60	19	0	0	0	0	0	0	0
2009	0	40	16	0	0	0	0	0	0	0
2010	0	30	20	0	0	0	0	0	15	92
2011	0	15	16	0	0	0	0	0	15	170
2012	0	0	18	0	0	0	0	0	15	166
2013	0	15	20	0	0	0	0	0	0	0
2014	0	10	21	0	0	0	0	0	0	0
2015	0	10	20	0	0	0	0	0	0	0

Figure 11.5 Average days of bill payment overdue for LV-commercial with peak power registration consumers in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	35	20	0	37	0	0	0	0	179
2009	0	25	24	0	36	0	0	0	0	207
2010	0	15	19	0	36	0	0	0	15	216
2011	0	12	22	0	36	0	0	56	15	220
2012	0	5	20	0	36	0	0	60	15	181
2013	0	15	23	0	35	0	0	60	0	0
2014	0	10	24	0	35	0	0	58	0	0
2015	0	10	23	0	36	0	0	61	0	0

Figure 11.6 Average days of bill payment overdue for LV-commercial without peak power registration consumers in SEE DSOs in the period 2008 - 2015

11.2 SHARE OF BILLS COLLECTED IN FISCAL YEAR

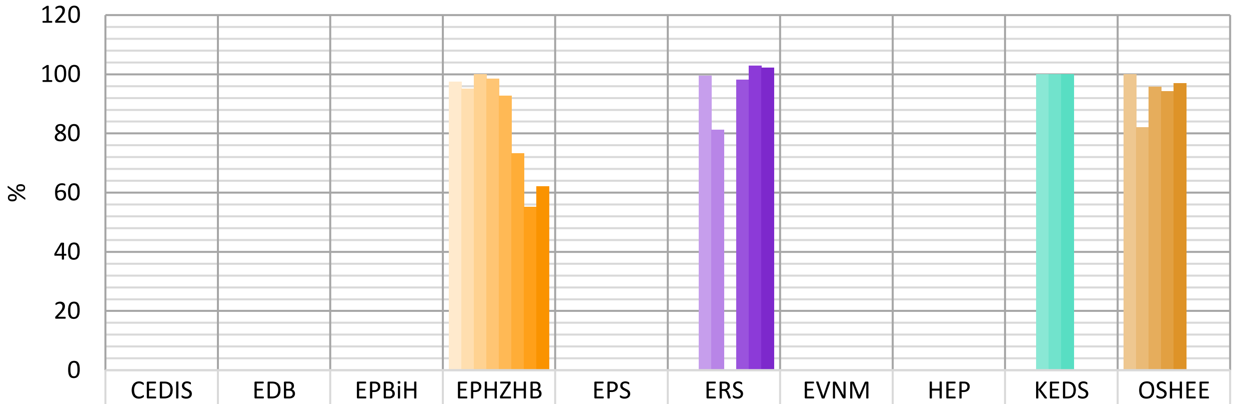
On Figures 11.7 - 11.12 are shown shares of collected bills in total number of issued bills. For this measure CEDIS didn't provide any data for the whole observed period, while KEDS and OSHEE provided data only for the period 2010-2012 and 2008-2012, respectively. EVNM provided data for the period 2012-2015 as lump sums of all categories, as well as ERS for 2008, 2009 and 2012. Therefore, ERS provided data for both commercial categories and public lighting category as lump sums for the rest years in the observed period. HEP and EPS provided data for two categories: households and non-households (commercial), with missing data for HEP in 2009 and for EPS in 2008, 2009 and 2013. EPHZHB also provided lump sum data for the both commercial categories in the observed period. These data related to non-households (commercial) category are shown in LV commercial without power reading category.

Yearly data over 100% means that beside collected payment of the issued bills there are collected some overdue from previous years. In HV consumer category the lowest ratio of collected bills was 55% (EPHZHB, 2014), and here should be noted that EPHZHB during the given timeframe had highly decreasing trend. At MV level, situation is quite better where in the last available years this share was over 95%.

In households category are shown lump sums data for EVNM and ERS. It is worrying fact that in OSHEE are in average collected only 69% of issued bills in household category. The situation isn't much better in KEDS where the average of uncollected bills was 83% in the period 2010-2012, but, as explained above, since 2013 in Kosovo PES is overtook the Collection risks and KEDS services are payed within

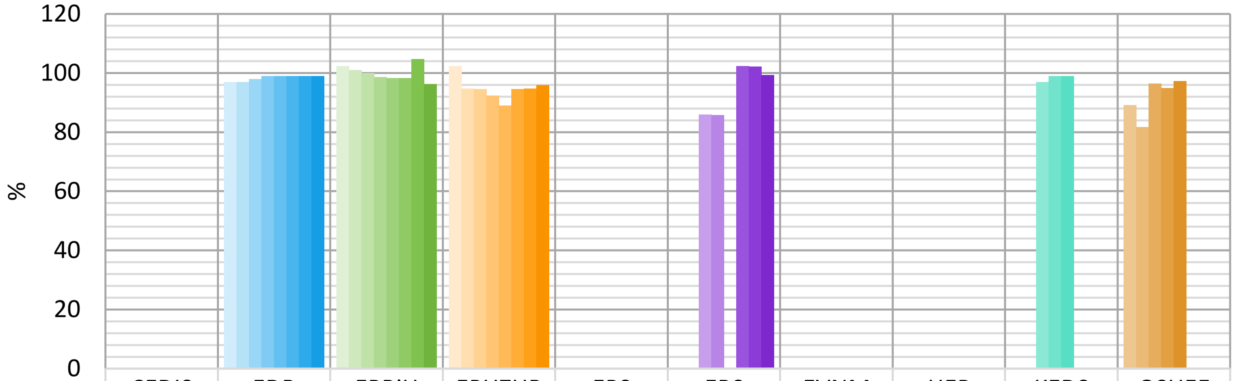
30 days. All other DSOs had over 90% of bills collection share within a fiscal year in the given timeframe, exception was only EDB in 2008 with share of 82%.

OSHEE also had the lowest bill collection shares in the all three remaining consumer categories. In public lighting category OSHEE in average had this share at level of 78%, with highly decreasing trend during available years. The situation is slightly worst in LV commercial with peak power registration category where OSHEE had share of collected bills in average 75%, with also decreasing trend. In LV commercial without peak power registration category the situation is quite better where this share was in average at level of 87%.



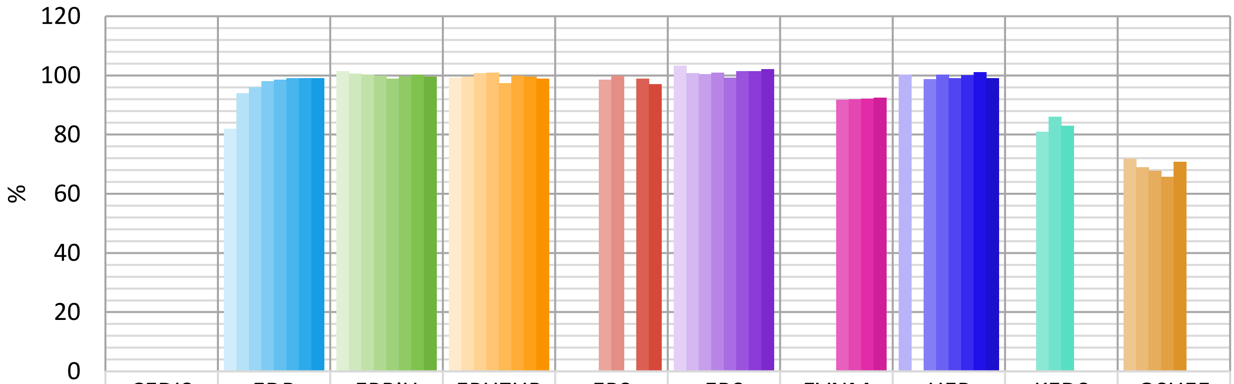
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	97,6	0	0	0	0	0	100
2009	0	0	0	95,16	0	0	0	0	0	82,11
2010	0	0	0	100,08	0	99,6	0	0	100	95,76
2011	0	0	0	98,59	0	81,3	0	0	100	94,32
2012	0	0	0	92,73	0	0	0	0	100	97
2013	0	0	0	73,36	0	98,23	0	0	0	0
2014	0	0	0	55,31	0	102,98	0	0	0	0
2015	0	0	0	62,15	0	102,31	0	0	0	0

Figure 11.7 Ratio of collected to issued bills, in fiscal year for HV consumers in the period 2008 - 2015



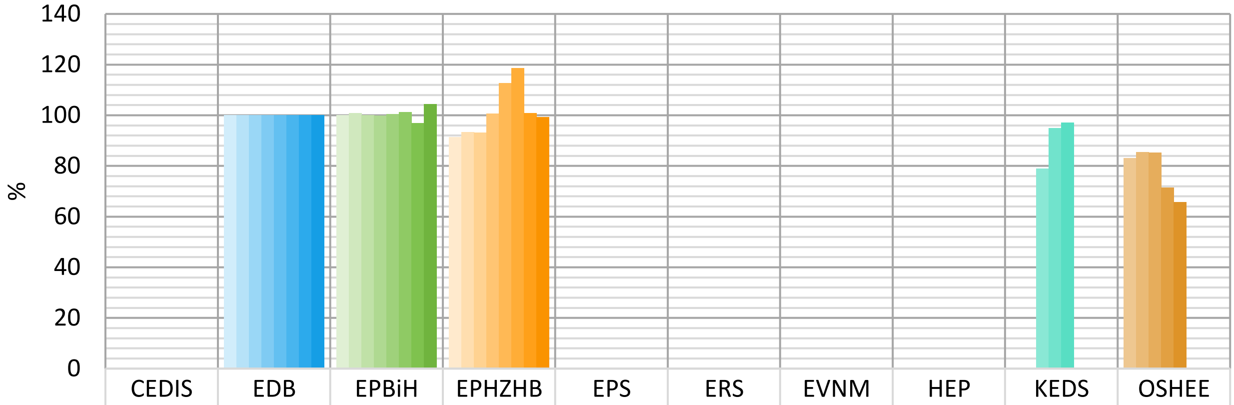
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	97	102,41	102,39	0	0	0	0	0	89,19
2009	0	97	100,94	94,66	0	0	0	0	0	81,77
2010	0	98	99,97	94,54	0	85,9	0	0	97	96,35
2011	0	99	98,59	92,36	0	85,8	0	0	99	94,83
2012	0	99	98,25	88,97	0	0	0	0	99	97,29
2013	0	99	98,29	94,61	0	102,3	0	0	0	0
2014	0	99	104,76	94,76	0	102,17	0	0	0	0
2015	0	99	96,28	95,86	0	99,24	0	0	0	0

Figure 11.8 Ratio of collected to issued bills, in fiscal year for MV consumers in the period 2008 - 2015



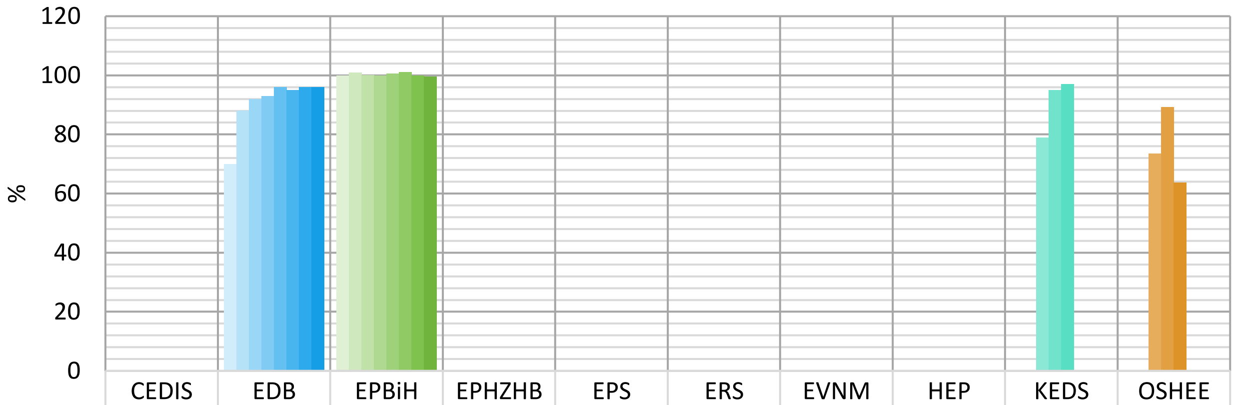
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	82	101,36	99,2	0	103,26	0	100,24	0	71,88
2009	0	94	100,51	99,6	0	100,66	0	0	0	68,95
2010	0	96	100,27	100,66	0	100,39	0	98,68	81	67,69
2011	0	98	99,88	100,97	98,49	100,9	0	100,26	86	65,78
2012	0	98,5	98,96	97,37	99,9	99,2	91,7	99	83	70,8
2013	0	99	99,75	99,86	0	101,37	92	100	0	0
2014	0	99	100,16	99,53	98,8	101,47	92,1	101	0	0
2015	0	99	99,51	98,87	97,1	102,03	92,4	99	0	0

Figure 11.9 Ratio of collected to issued bills, in fiscal year for households consumers in the period 2008 - 2015



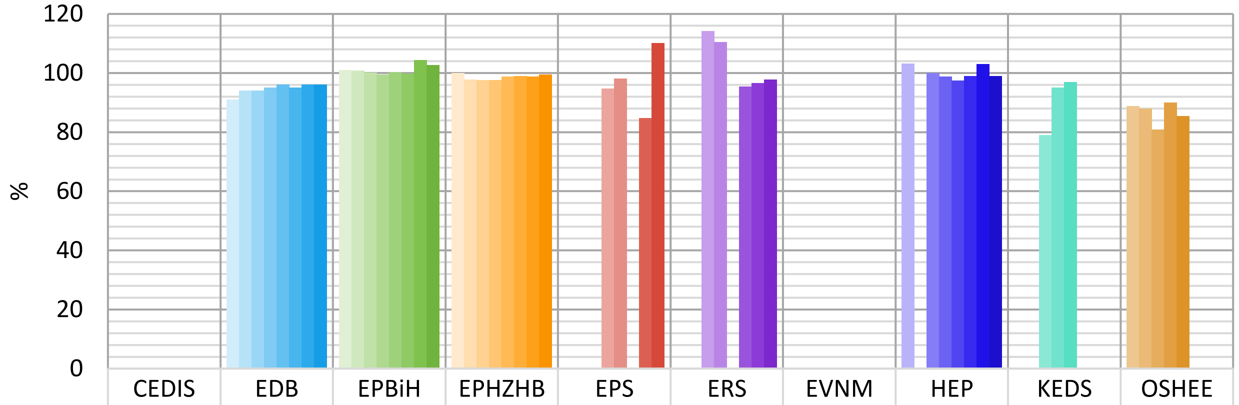
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	100	99,97	91,32	0	0	0	0	0	83
2009	0	100	100,84	93,27	0	0	0	0	0	85,52
2010	0	100	100,08	93,11	0	0	0	0	79	85,26
2011	0	100	99,93	100,59	0	0	0	0	95	71,51
2012	0	100	100,48	112,76	0	0	0	0	97	65,64
2013	0	100	101,2	118,58	0	0	0	0	0	0
2014	0	100	96,88	100,74	0	0	0	0	0	0
2015	0	100	104,3	99,21	0	0	0	0	0	0

Figure 11.10 Ratio of collected to issued bills, in fiscal year for public lighting category in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	70	99,93	0	0	0	0	0	0	0
2009	0	88	100,84	0	0	0	0	0	0	0
2010	0	92	100,13	0	0	0	0	0	79	73,43
2011	0	93	99,88	0	0	0	0	0	95	89,18
2012	0	96	100,53	0	0	0	0	0	97	63,7
2013	0	95	101,03	0	0	0	0	0	0	0
2014	0	96	99,83	0	0	0	0	0	0	0
2015	0	96	99,5	0	0	0	0	0	0	0

Figure 11.11 Ratio of collected to issued bills, in fiscal year for LV-commercial with peak power registration category in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	91	101,06	99,96	0	0	0	103,2	0	88,83
2009	0	94	100,74	97,82	0	0	0	0	0	87,99
2010	0	94	100,12	97,61	0	114,25	0	99,94	79	80,78
2011	0	95	99,43	97,51	94,78	110,4	0	98,84	95	90,05
2012	0	96	100,36	98,78	98,08	0	0	97,36	97	85,49
2013	0	95	99,73	98,91	0	95,41	0	99	0	0
2014	0	96	104,44	98,71	84,8	96,6	0	103	0	0
2015	0	96	102,69	99,46	110,1	97,73	0	99	0	0

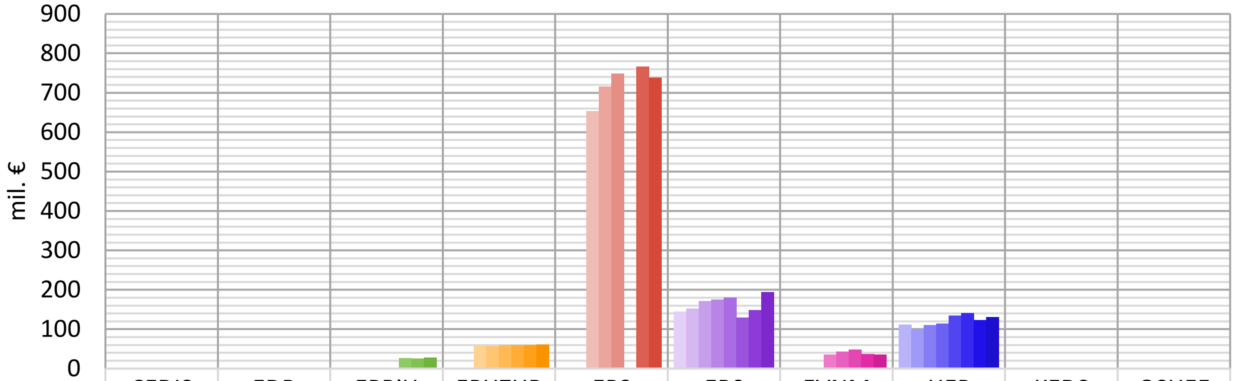
Figure 11.12 Ratio of collected to issued bills, in fiscal year for LV-commercial without peak power registration category in the period 2008 - 2015

11.3 AMOUNT OF OVERDUE PAYMENTS

Since three DSOs (CEDIS, KEDS and OSHEE) didn't submit any data on consumer's arrears, and since several DSOs submit lump sums data for several or all categories or provided data for only two categories (households and non-households) on the following figure is shown total amount of consumer's arrears in the period 2008-2015 as the cumulative amount at the end of the year (from the given year and previous years).

In the observed period, EPS (the largest SEE DSO) had the highest cumulative consumer's arrears, up 766 mil. € in 2014. It is almost 5,5 times higher than the highest cumulative customer's arrear in the second highest DSO, HEP. Comparing this cumulative consumer's arrears with the DSO's total yearly operating income, it is observed that in EPS in 2014 and 2015 this share of cumulative consumer's arrears in total yearly operating income was 102% and even 180%, respectively. In other words, in 2015 in EPS level of cumulative consumer's arrears exceeds EPS's total operating income for almost double. Moreover, this share in the observed period had increasing trend. Here should be noted that in EPS total operating income is converted from national currency to euro, but despite this total operating income in 2015 was 74% lower than 2008 (comparing incomes in euro).

CEDIS also had very high share of cumulative consumer's arrears in total yearly operating income in the given timeframe, in average 81%. In other DSOs, this share was below 25%. This share couldn't be calculated for EPHZHB since total operating income in EPHZHB doesn't contain all incomes related to electricity.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	2,65	0	0	0	144,81	0	111	0	0
2009	0	1,98	0	0	0	152,49	0	100,75	0	0
2010	0	1,77	0	58,05	653,53	171,76	0	110,78	0	0
2011	0	0,82	0	57,47	715,95	175,24	35,81	114,53	0	0
2012	0	0,74	0	59,17	748,45	180,61	43,37	134,94	0	0
2013	0	0,76	26,73	59	0	129,28	47,58	140,33	0	0
2014	0	0,75	25,03	59,56	766,03	147,97	36,28	123,03	0	0
2015	0	0,74	27,48	60,36	738,59	194,13	35,54	130,2	0	0

Figure 11.13 Cumulative consumer's arrears in the SEE DSOs in the period 2008 - 2015

11.4 OBSERVATIONS/RECOMMENDATIONS

The maturity of bill payment is usually about 2-3 weeks of issue. The bill collections up to one month can be considered as collections in timely manner. OSHEE had problems with bill collection in all consumer categories during the observed time period, in average ranged from 143 days (about 5 months) to 206 days (about 7 months). ERS had even bigger problems with the bill collection at HV consumer category during the observed time period, in average 250 days (about 8 months). In other DSOs, HEP in given timeframe had in average about 2 months' time period of bill payment in commercial category, and EVNM had also in average bill payment time period of 2 months for all consumer category.

As expected, having in mind length of bill collection time period, in all consumer categories OSHEE had the lowest ratio of collected and issued bills. Only exception was HV consumer category where EPHZHB had the lowest percentage of collected bills (in average only 84%, with highly decreasing trend in the observed period). OSHEE had average share of collected in issued bills above 90% only in HV and MV consumer categories. Other DSOs that submitted data had average achievement of bill collection higher than 90% in all consumer categories, except KEDS in households category (in average 83%).

Cumulative costumer's arrears for electricity in some DSOs were very high. Comparing to DSOs total yearly income, in EPS cumulative customer's arrears were 1,8 times higher (in 2015) than total yearly income, while in ERS average cumulative customer's arrears were at level of 80% of total yearly income. In other DSOs that submitted data, cumulative customer's arrears were below 25% of DSOs total yearly income.

The SEE DSOs have restricted resource for non-payment or delayed payment, e.g. limited legal recourse to recover unpaid bills, inability to write-down bad customer debts or negotiate payments, effective inability to disconnect non-paying customers (e.g. for political or social reasons) etc. Hence, DSOs collection performance is complicated and complex process.

12 COMPETITIVENESS ANALYSIS

In this section, financial and performance indicators for observed DSOs have been evaluated. CEDIS didn't supply any financial information, while data submitted by EVNM for the period 2008-2012 included data related to distribution, supply and generation (EVNM's hydropower plants) services and since 2013 data only related to distribution services. Furthermore, all financial data for HEP and partially for OSHEE have been converted from national currency to euro.

12.1 STAFFING BENCHMARK

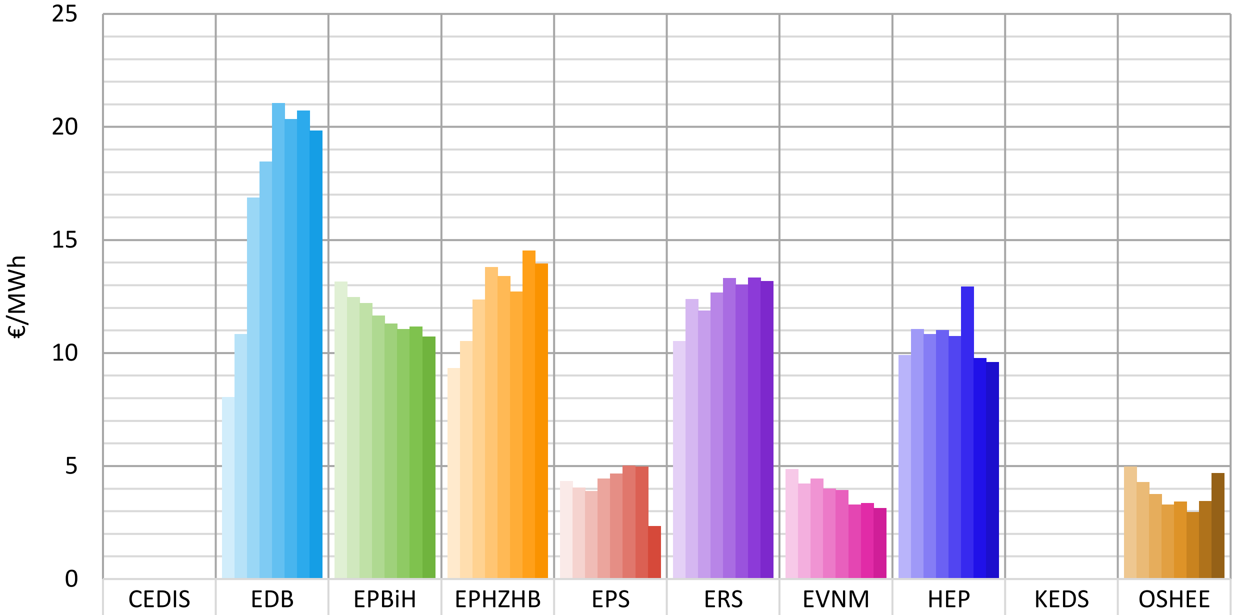
Distribution and retail business is relatively labor intensive, implying companies should strive for efficient level of staffing and staffing cost. CEDIS and KEDS didn't submit any relevant information about labor cost. Labor cost in HEP (2013) and in EPS (2015) should be double checked.

To be able to benchmark DSOs, in this section several indicators are shown as follows:

labor cost per MWh distributed energy,

- labor cost per MWh delivered energy,
- labor cost per metering point,
- labor cost per employee,
- level of employment per metering point.

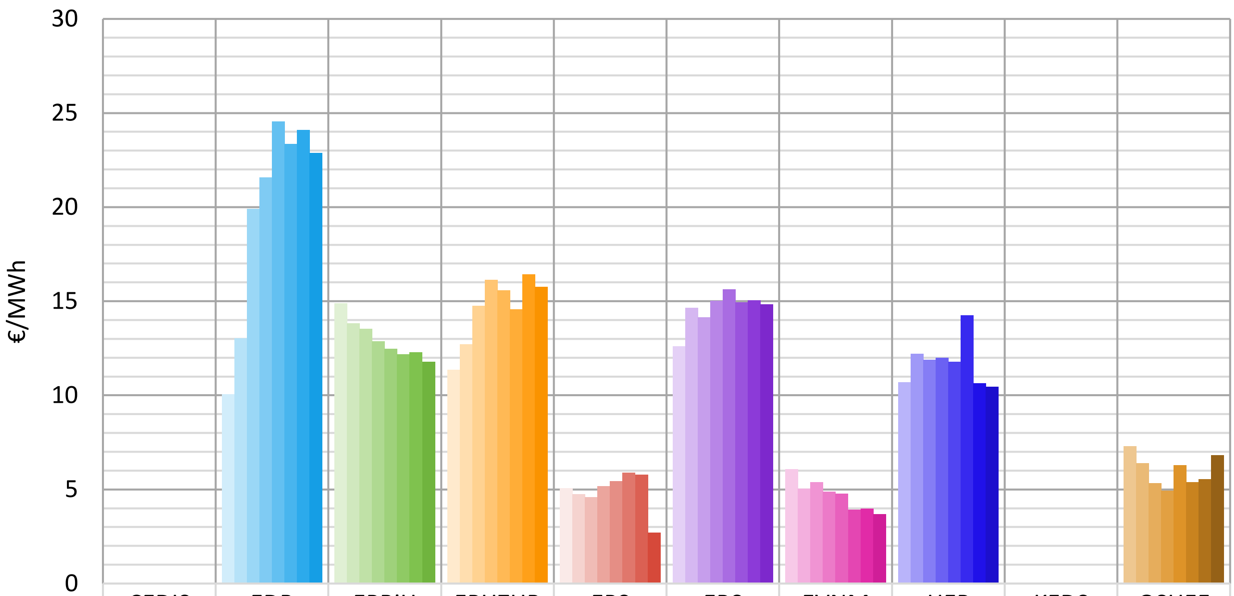
Figure 12.1 shows labor cost per MWh of distributed energy (delivered electricity + electricity losses). The lowest average costs are observed in OSHEE, EVNM and EPS respectively with costs below 5 €/MWh. In the observed period EDB, EPHZHB and ERS recorded increasing trend, while EPBiH and EVNM recorded decreasing trend. Increasing trend is result of faster growth number of employees, and consequently labor costs, compared to realized energy consumption in the observed period. Decreasing trend in EPBiH is due to growing energy consumption and decreasing labor cost, and in EVNM is result of faster decreasing labor cost, as result of decreasing number of employees, than changes in energy consumption.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	8,05	13,15	9,33	4,32	10,52	4,85	9,91	0	4,97
2009	0	10,83	12,47	10,52	4,03	12,37	4,22	11,06	0	4,28
2010	0	16,88	12,21	12,35	3,89	11,88	4,44	10,84	0	3,76
2011	0	18,46	11,65	13,8	4,43	12,66	3,99	11	0	3,29
2012	0	21,04	11,3	13,39	4,66	13,31	3,93	10,75	0	3,41
2013	0	20,34	11,05	12,71	5,02	13,02	3,28	12,94	0	2,95
2014	0	20,71	11,17	14,53	4,96	13,32	3,36	9,77	0	3,44
2015	0	19,83	10,71	13,94	2,33	13,17	3,13	9,59	0	4,68

Figure 12.1 Labor cost per MWh distributed energy

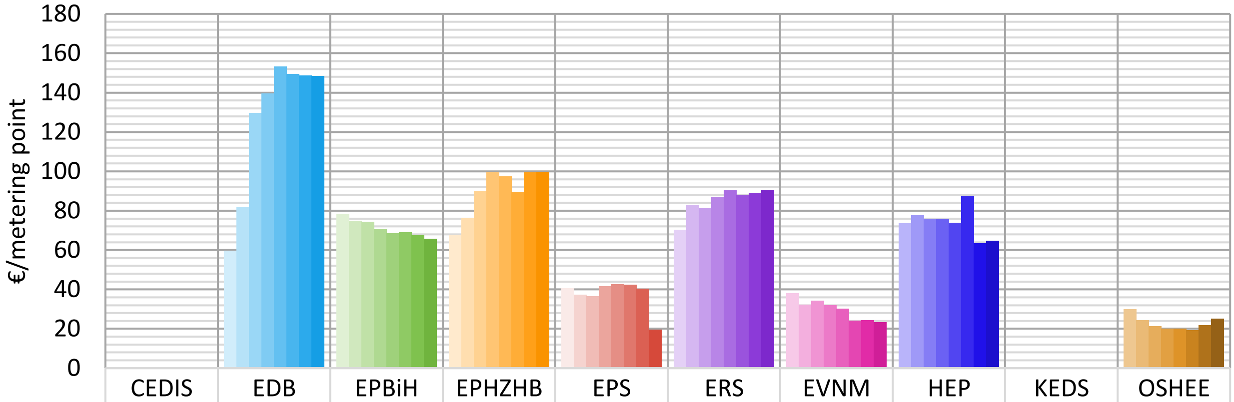
Slightly different results are obtained when delivered energy to final consumers was analyzed (without energy losses in the network), as shown on Figure 12.2. Here can be seen how DSO energy losses influence to this ratio. Comparing average ratios of delivered energy with and without energy losses in the observed period, it is concluded that losses in OSHEE had the greatest impact on this ratio, increase of 56% when energy losses are excluded. In other DSOs, this growth was in the range between 9% (HEP) and 21% (EVNM).



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	10,06	14,88	11,35	5,05	12,61	6,06	10,68	0	7,29
2009	0	13,03	13,83	12,7	4,75	14,64	5,03	12,19	0	6,4
2010	0	19,89	13,52	14,74	4,58	14,15	5,37	11,88	0	5,32
2011	0	21,57	12,87	16,14	5,17	15,01	4,88	11,98	0	4,93
2012	0	24,54	12,47	15,58	5,43	15,63	4,76	11,77	0	6,29
2013	0	23,35	12,18	14,57	5,89	14,94	3,93	14,25	0	5,37
2014	0	24,08	12,29	16,43	5,78	15,05	3,98	10,63	0	5,53
2015	0	22,86	11,77	15,76	2,71	14,83	3,67	10,44	0,01	6,81

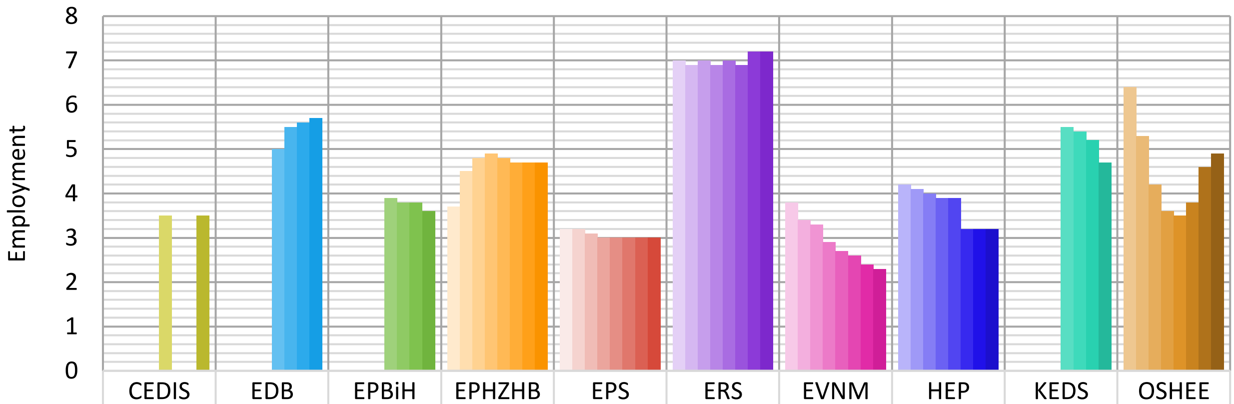
Figure 12.2 Labor cost per MWh delivered energy

On the following figure labor costs per metering point are shown. Here again the similar pattern is present. Increase trend in EDB, EPHZHB and ERS was due to faster growing labor costs than changes in number of metering points, and decreasing trend in EPBiH and EVNM was due to faster decreasing labor costs than changes in number of metering points in the observed period. Number of employees directly impact on labor cost that are consisted of employee's gross salaries, benefits and compensations to employees. On Figures 12.4 and 12.5 are shown number of employees per 1000 metering points and labor cost per employee in the observed period, respectively. It can be seen that in EDB growing in number of employees was at the expense of decreasing labor cost per employee. Opposite situation was in HEP where decreasing number of employees was accompanied with increasing labor cost per employee. EPBiH and EVNM decreased number of employees to maintain labor cost per employee about the same level. EPHZHB, EPS (without 2015) and ERS during the observed period increased labor cost per employee, while OSHEE maintain almost the same level of labor cost per employee in the observed period even the number of employees recorded big changes (drop in 2012 by 36% since 2008, and recovering after 2012).



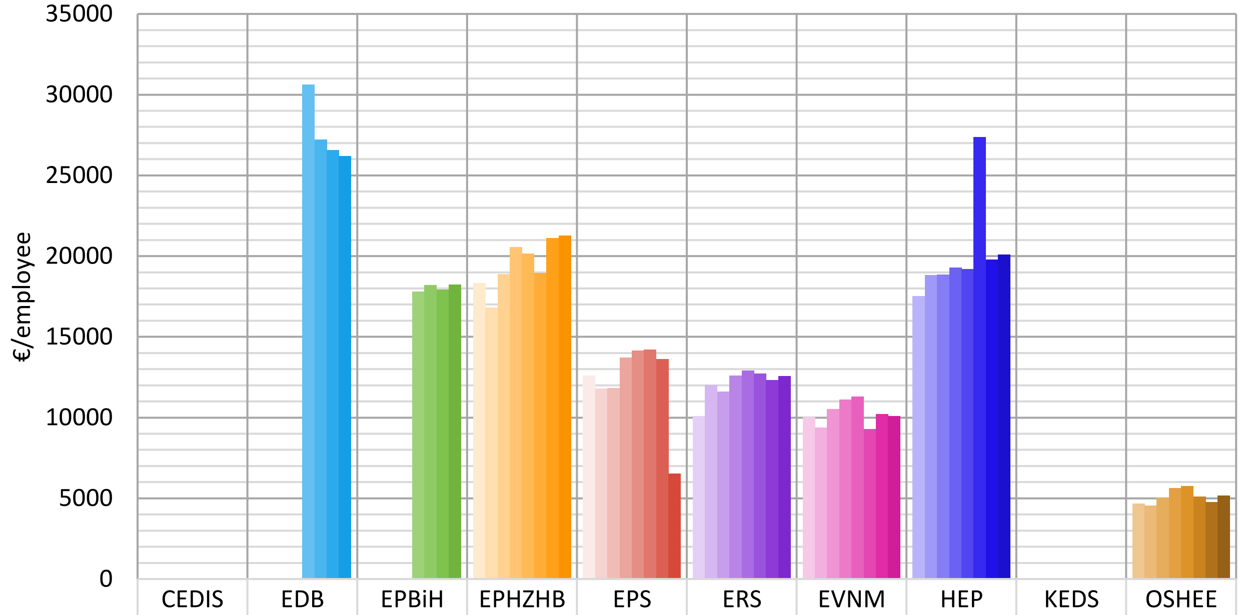
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	59,66	78,38	67,76	40,7	70,34	38	73,62	0	29,84
2009	0	81,76	74,87	75,98	37,24	83,03	32,11	77,57	0	24,27
2010	0	129,73	74,26	90,04	36,5	81,41	34,27	75,79	0	21,21
2011	0	139,52	70,54	99,8	41,66	87,08	32,02	75,85	0	20,05
2012	0	153,13	68,54	97,39	42,52	90,35	30,22	73,89	0	20,07
2013	0	149,35	68,98	89,56	42,4	88,14	24,03	87,28	0,01	19,3
2014	0	148,55	67,45	99,39	40,42	88,95	24,3	63,53	0,02	21,81
2015	0	148,3	65,63	99,61	19,4	90,62	23,45	64,6	0,04	25,06

Figure 12.3 Labor cost per metering point



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	3,7	3,2	7	3,8	4,2	0	6,4
2009	0	0	0	4,5	3,2	6,9	3,4	4,1	0	5,3
2010	0	0	0	4,8	3,1	7	3,3	4	0	4,2
2011	0	0	0	4,9	3	6,9	2,9	3,9	0	3,6
2012	3,5	5	3,9	4,8	3	7	2,7	3,9	5,5	3,5
2013	0	5,5	3,8	4,7	3	6,9	2,6	3,2	5,4	3,8
2014	0	5,6	3,8	4,7	3	7,2	2,4	3,2	5,2	4,6
2015	3,5	5,7	3,6	4,7	3	7,2	2,3	3,2	4,7	4,9

Figure 12.4 Employment per 1000 metering points



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	18321	12580	10074	10035	17506	0	4660
2009	0	0	0	16791	11785	12010	9364	18818	0	4536
2010	0	0	0	18869	11821	11592	10520	18850	0	5023
2011	0	0	0	20557	13718	12585	11117	19283	0	5620
2012	0	30601	17793	20152	14134	12892	11286	19191	0	5753
2013	0	27210	18202	18927	14189	12706	9270	27373	2	5094
2014	0	26549	17929	21100	13619	12310	10194	19771	4	4770
2015	0	26192	18232	21252	6539	12547	10083	20083	7	5148

Figure 12.5 Labor cost per employee

It is important to indicate potential *limitations* of this analysis. In particular, we were not able to identify to what degree did the DSOs outsource services. It is possible that some DSOs rely completely on their own staff whilst other outsource some services: to what degree this happens could not be determined. Thus, to get the complete picture of employment efficiency this issue deserves further investigation.

12.2 CAPITAL EXPENDITURE BENCHMARK

The next question we address is to what degree do DSOs renew their assets. To this end we use the following benchmarks:

- depreciation to book value,
- investment to book value,
- difference between investment to book value and depreciation to book value.

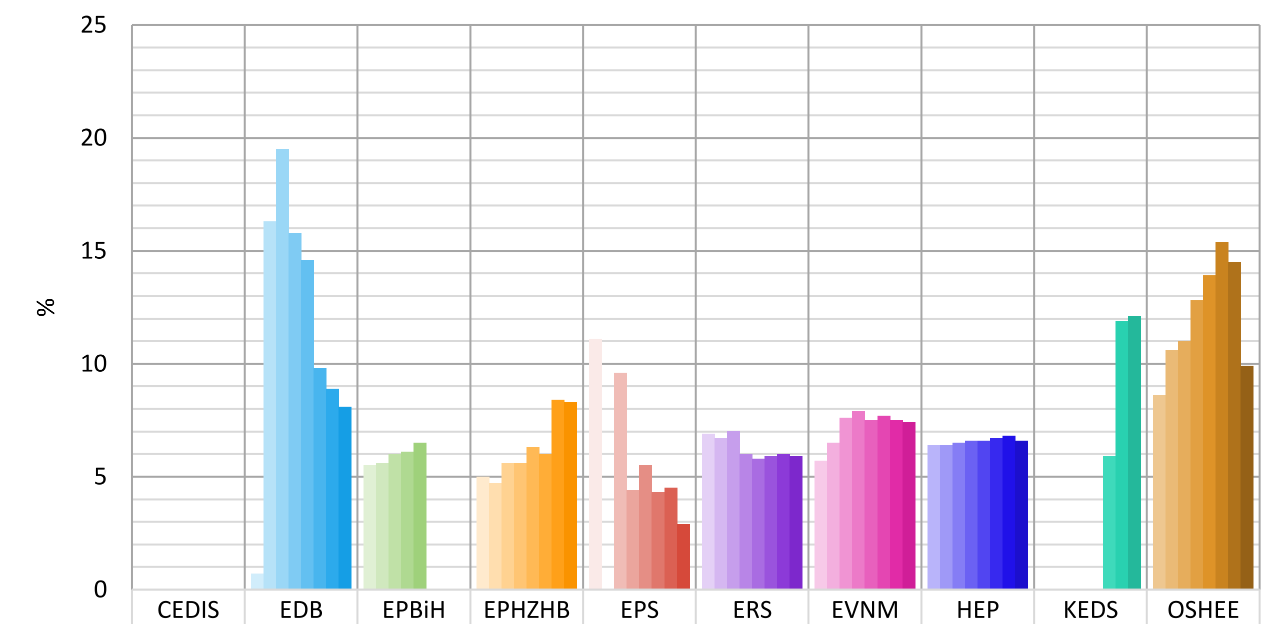
In essence DSOs should investment in the amount which is sufficient to replace depreciated assets.

Figure 12.6 shows a ratio of depreciation to book value of property plant and equipment (PPE). In 2015, most of the DSOs exhibit values below or around 8% except KEDS and OSHEE. Values of around

8 % are to be expected as this value is commensurate with average distribution asset life. In the observed period EDB had very high depreciation rates (19,5% in 2010) that reduced to 8,1% in 2015. Unlike other DSOs who own and operate the network, EDB owns part of the network, while other part is owned by the government who also makes investments in the network.

Although KEDS had the youngest distribution network and the lowest calculated transformers age, one of the reasons for high depreciation rates in KEDS in the last two years of the observed period could be increased installed capacity of MV/LV transformers and increased number of MV and LV feeders per substation. Therefore, one of the reasons could be increased share of cable network from 8% (2014) to 13% (2015) in total network length.

In the observed period, OSHEE had the oldest distribution network (39 years) and the highest calculated transformers age (35 years) from all the SEE DSOs. Thus, reasons for high depreciation rates in the observed period could be increased number of MV/LV substations, as well as increased number and installed capacity of MV/LV transformers. Increased average MV feeder length was also recorded in OSHEE in the observed period.

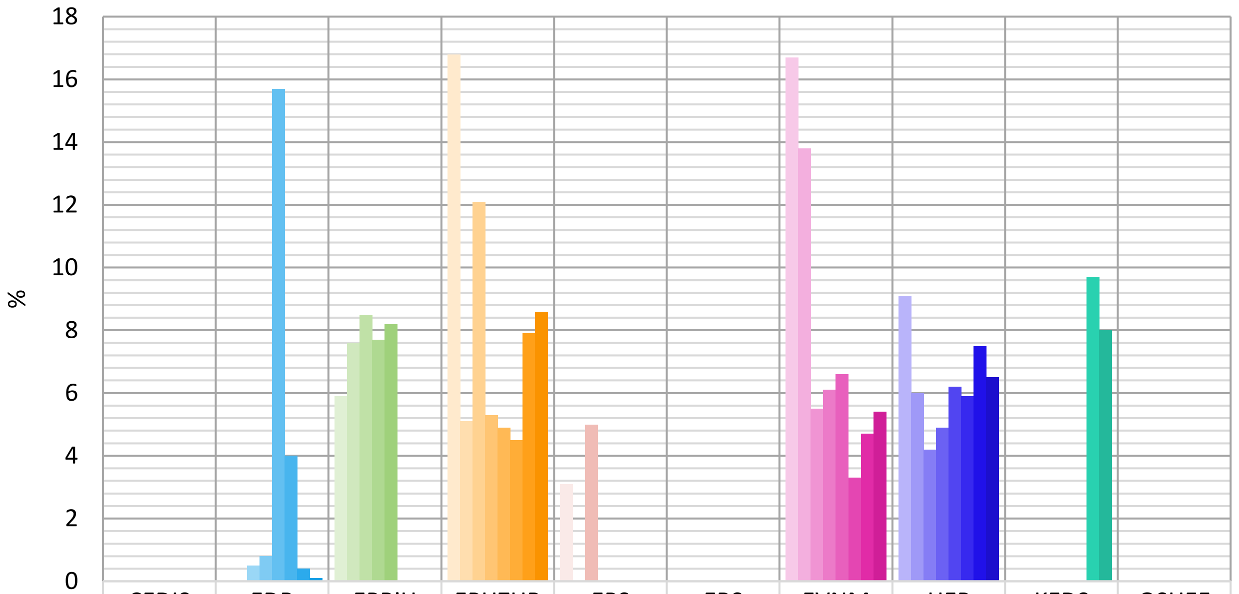


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,7	5,5	5	11,1	6,9	5,7	6,4	0	8,6
2009	0	16,3	5,6	4,7	0	6,7	6,5	6,4	0	10,6
2010	0	19,5	6	5,6	9,6	7	7,6	6,5	0	11
2011	0	15,8	6,1	5,6	4,4	6	7,9	6,6	0	12,8
2012	0	14,6	6,5	6,3	5,5	5,8	7,5	6,6	0	13,9
2013	0	9,8	0	6	4,3	5,9	7,7	6,7	5,9	15,4
2014	0	8,9	0	8,4	4,5	6	7,5	6,8	11,9	14,5
2015	0	8,1	0	8,3	2,9	5,9	7,4	6,6	12,1	9,9

Figure 12.6 Depreciation to book value

Whilst the previous figure showed the pace of asset depreciation, the following figure shows the pace of investment in capital equipment. Zeros depicts unavailable data. It could be seen that in the most

DSOs investments in 2014 and 2015 were higher than in 2013 since in 2014 those DSOs suffered extensive damage due to the floods that hit the area in which they operate.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	5,9	16,8	3,1	0	16,7	9,1	0	0
2009	0	0	7,6	5,1	0	0	13,8	6	0	0
2010	0	0,5	8,5	12,1	5	0	5,5	4,2	0	0
2011	0	0,8	7,7	5,3	0	0	6,1	4,9	0	0
2012	0	15,7	8,2	4,9	0	0	6,6	6,2	0	0
2013	0	4	0	4,5	0	0	3,3	5,9	0	0
2014	0	0,4	0	7,9	0	0	4,7	7,5	9,7	0
2015	0	0,1	0	8,6	0	0	5,4	6,5	8	0

Figure 12.7 Investment to book value

In order to compare the values of investment and depreciation to book value more easily, the following table gives their difference. Positive values imply that the ratio of investment to book value is greater than depreciation to book value, hence the DSO is investing more than it is depreciating. Blank cells determine unavailable data. Taking the average value for the eight years' period, three DSOs (EPBiH, EPHZHB and EVNM) have on average invested more than what has been written off, whilst four DSOs (EDB, EPS, HEP and KEDS) have invested less than what was written off in the period 2008 – 2015.

Table 12.1 Difference between investment to book value and depreciation to book value

DSO	2008	2009	2010	2011	2012	2013	2014	2015	Average

CEDIS									
EDB			-19.0%	-15.0%	1.1%	-5.8%	-8.5%	-8.0%	-9.2%
EPBiH	0.4%	2.0%	2.5%	1.6%	1.7%				1.6%
EPHZHB	11.8%	0.4%	6.5%	-0.3%	-1.4%	-1.5%	-0.5%	0.3%	1.9%
EPS	-8.0%		-4.6%						-6.3%
ERS									
EVNM	11.0%	7.3%	-2.1%	-1.8%	-0.9%	-4.4%	-2.8%	-2.0%	0.5%
HEP	2.7%	-0.4%	-2.3%	-1.7%	-0.4%	-0.8%	0.7%	-0.1%	-0.3%
KEDS							-2.2%	-4.1%	-3.2%
OSHEE									

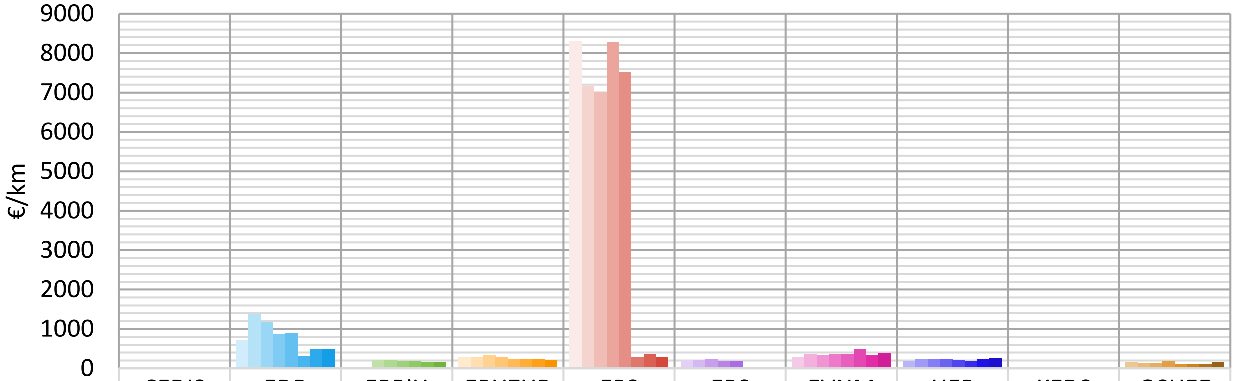
12.3 MAINTENANCE COST

Table 12.2 shows ratio of maintenance cost to book value of distribution assets. Blank cells determine unavailable data. In the most DSOs, this ratio was below 6% in the observed period. Exceptions were EDB and EPS. Possible explanation for EDB might be that EDB owns only part of the network and it is responsible for maintenance of the entire network. Maintenance cost data for EPS in the period 2008-2012 were very high and it should be double checked.

Table 12.2 Maintenance cost to book value of assets

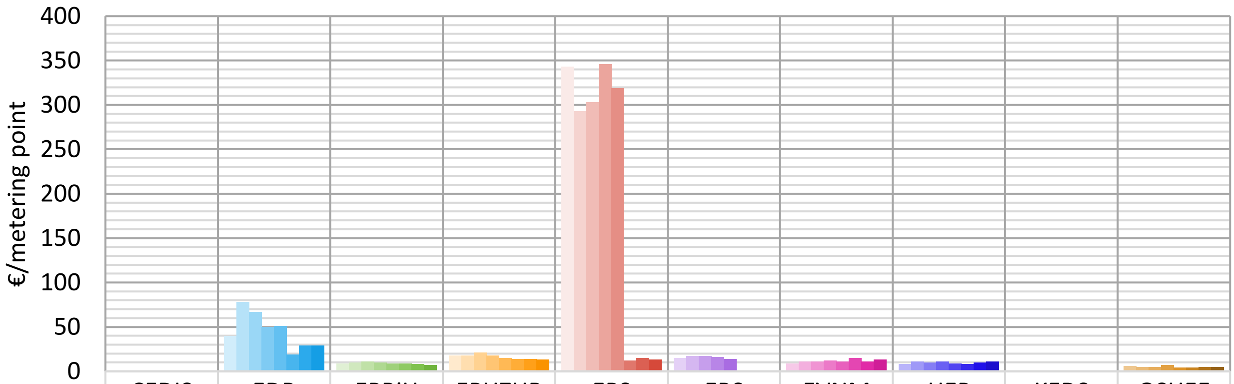
DSO	2008	2009	2010	2011	2012	2013	2014	2015	Average
CEDIS									
EDB*	414%	130%	108%	77%	67%	18%	21%	18%	106%
EPBIH	2%	2%	2%	2%	2%				2%
EPHZHB	3%	2%	3%	2%	2%	2%	2%	2%	2%
EPS	67%		80%	38%	48%	2%	3%	2%	34%
ERS	3%	2%	2%	2%	2%				2%
EVNM	3%	3%	3%	4%	4%	5%	3%	4%	4%
HEP	1%	2%	2%	2%	1%	1%	2%	2%	1%
KEDS						5%	6%	4%	5%
OSHEE	3%	3%	3%	4%	3%	3%	3%	4%	3%

Ratio of maintenance cost to book value of assets is supplemented with ratio of maintenance cost to network length and number of metering points, as shown on Figures 12.8 and 12.9. Both following figures has similar patterns. Excluding EPS in the period 2008-2012 from analyses, it can be seen that EDB had the highest values of both indicators, especially in the period 2008-2012. Most of other DSOs had rather similar levels of maintenance expenditure per kilometer of network length and per metering point.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	714	0	296	8301	207	290	187	0	156
2009	0	1374	0	284	7152	218	361	239	0	128
2010	0	1162	220	346	7008	221	341	231	0	137
2011	0	869	208	282	8275	194	365	243	0	183
2012	0	893	185	230	7528	171	362	203	0	113
2013	0	311	181	227	294	0	477	183	0	98
2014	0	484	155	224	349	0	334	236	0	110
2015	0	487	145	212	289	0	383	262	0	148

Figure 12.8 Ratio of maintenance cost to network length



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	40	9	18	343	15	9	8	0	6
2009	0	78	10	18	293	17	11	11	0	5
2010	0	67	11	21	303	17	11	10	0	5
2011	0	50	10	18	346	16	12	11	0	7
2012	0	51	9	15	319	14	11	9	0	4
2013	0	19	9	14	12	0	15	8	0	4
2014	0	29	8	14	15	0	11	10	0	5
2015	0	29	7	13	13	0	13	11	0	5

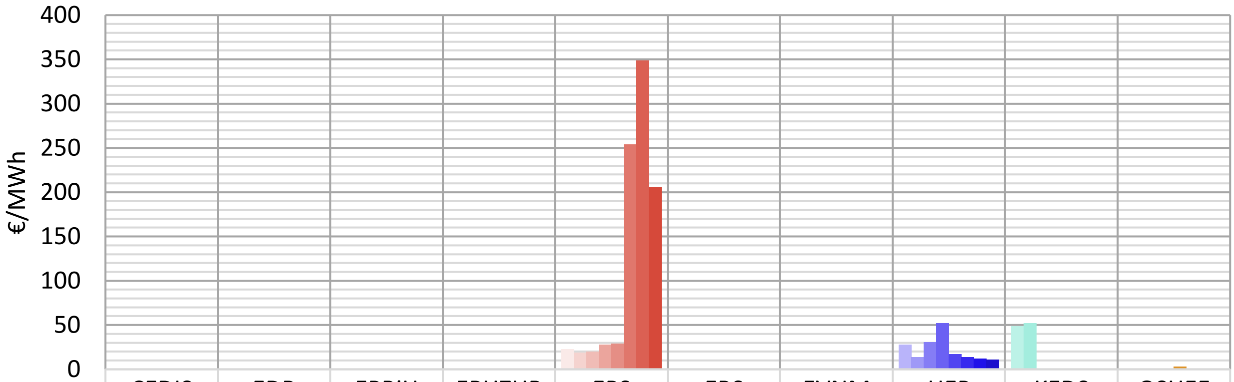
Figure 12.9 Ratio of maintenance cost to number of metering points

12.4 COMPETITIVENESS

Figures 12.10 - 12.15 shows average tariffs calculated as ratio of revenues from collected bills and delivered electricity per consumer category. Average tariff is also calculated as sum of revenues at each consumer category divided by total delivered electricity.

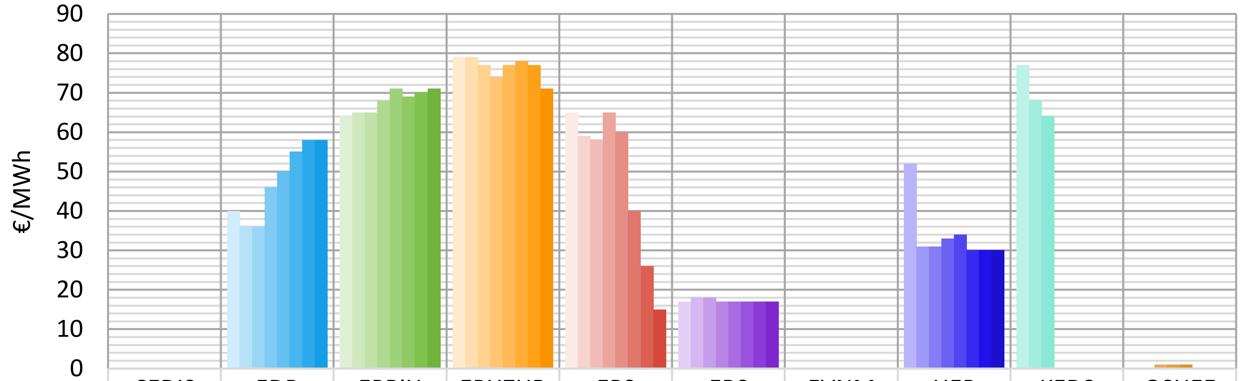
CEDIS and EVNM didn't supply any data related to revenues from delivered energy for the whole observed period, while KEDS and OSHEE didn't provide this data for the periods 2011-2012 and 2013-2015 (except data for households in OSHEE related on revenue from energy), respectively. Moreover, OSHEE provided only data for revenue related to energy, i.e. didn't submit any data on other revenue (power, monthly fee, meter reading, etc.). In EPS, this data were partially known, so an estimation was given. In the period 2008-2012 this data for HEP included total sales revenue (including revenue related to energy, power, charges related to use of distribution and transmission network etc.), while since 2013 only revenue related to use of distribution and transmission network were given. All this facts on input data should be taken into account when evaluating tariffs.

Considering average tariff on Figure 12.16, it can be seen that EDB, EPBiH and slightly EPHZHB had increasing trend, while EPS and KEDS had highly decreasing trend in the observed period. Data on revenue related to energy in OSHEE are to low and should be double checked. The highest yearly average price for delivered electricity was 84 €/MWh.



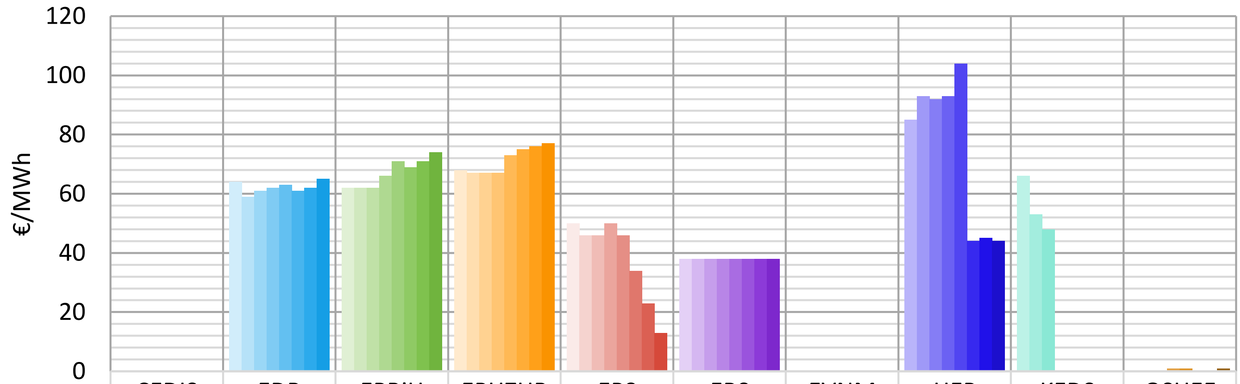
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	23	0	0	28	49	0
2009	0	0	0	0	19	0	0	14	52	0
2010	0	0	0	0	20	0	0	31	0	0
2011	0	0	0	0	28	0	0	52	0	0
2012	0	0	0	0	29	0	0	17	0	3
2013	0	0	0	0	254	0	0	14	0	0
2014	0	0	0	0	349	0	0	12	0	0
2015	0	0	0	0	206	0	0	11	0	0

Figure 12.10 Average high voltage tariff in the period 2008 – 2015



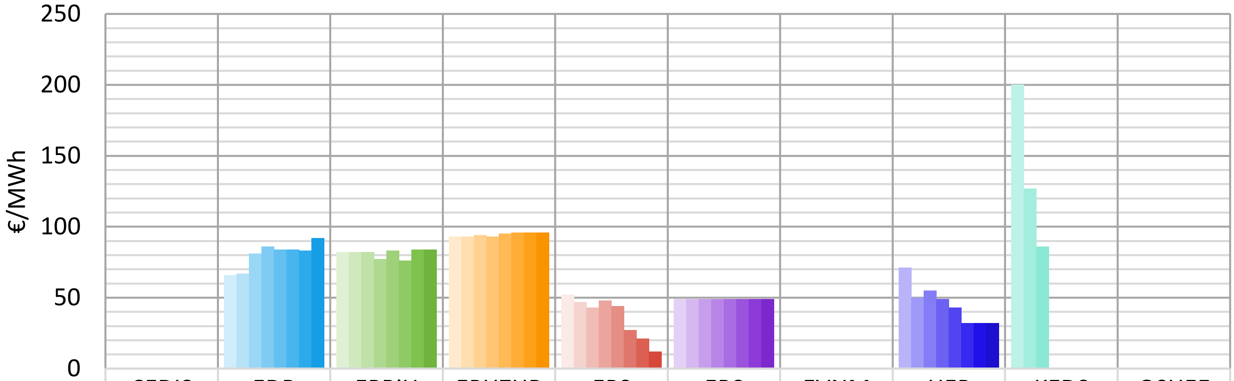
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	40	64	79	65	17	0	52	77	0
2009	0	36	65	79	59	18	0	31	68	0
2010	0	36	65	77	58	18	0	31	64	1
2011	0	46	68	74	65	17	0	33	0	1
2012	0	50	71	77	60	17	0	34	0	1
2013	0	55	69	78	40	17	0	30	0	0
2014	0	58	70	77	26	17	0	30	0	0
2015	0	58	71	71	15	17	0	30	0	0

Figure 12.11 Average medium voltage tariff in the period 2008 – 2015



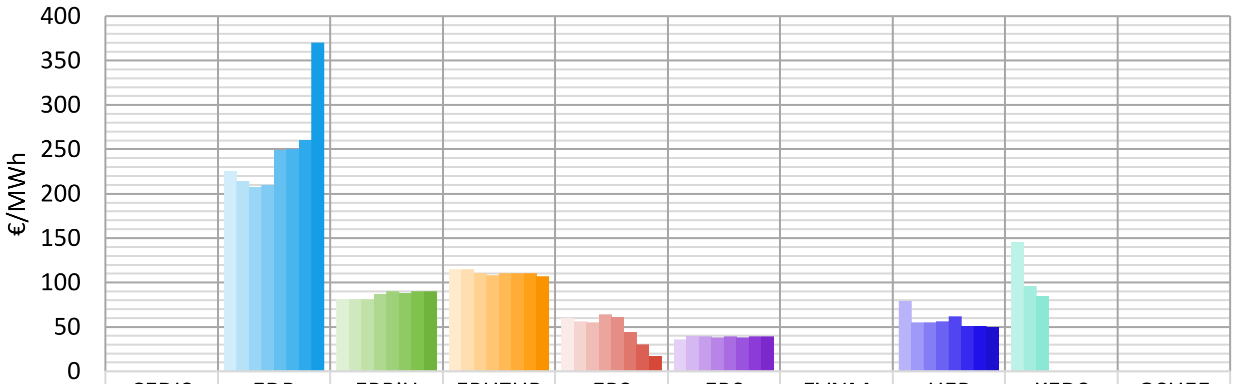
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	64	62	68	50	38	0	85	66	0
2009	0	59	62	67	46	38	0	93	53	0
2010	0	61	62	67	46	38	0	92	48	0
2011	0	62	66	67	50	38	0	93	0	1
2012	0	63	71	73	46	38	0	104	0	1
2013	0	61	69	75	34	38	0	44	0	0
2014	0	62	71	76	23	38	0	45	0	0
2015	0	65	74	77	13	38	0	44	0	1

Figure 12.12 Average low voltage tariff for households in the period 2008 - 2015



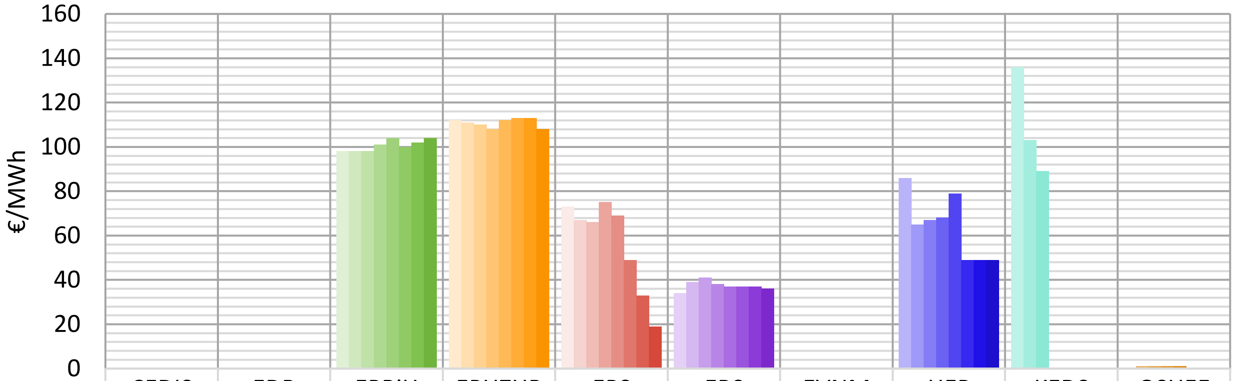
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	66	82	93	52	49	0	71	200	0
2009	0	67	82	93	47	49	0	50	127	0
2010	0	81	82	94	43	49	0	55	86	0
2011	0	86	77	93	48	49	0	49	0	0
2012	0	84	83	95	44	49	0	43	0	0
2013	0	84	76	96	27	49	0	32	0	0
2014	0	83	84	96	21	49	0	32	0	0
2015	0	92	84	96	12	49	0	32	0	0

Figure 12.13 Average low voltage tariff for public lighting in the period 2008 - 2015



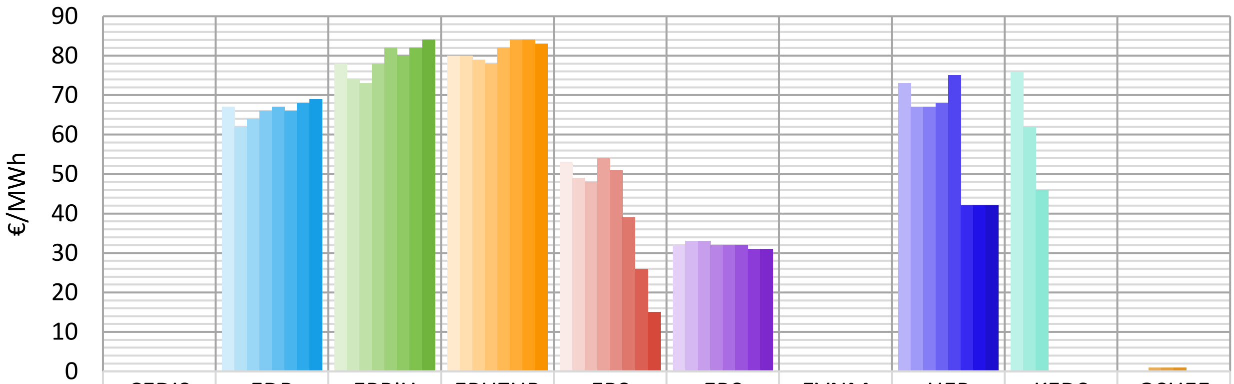
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	226	81	115	60	36	0	79	146	0
2009	0	214	81	115	56	40	0	55	96	0
2010	0	208	81	111	55	39	0	55	85	0
2011	0	210	87	108	64	38	0	56	0	0
2012	0	249	90	110	61	39	0	62	0	1
2013	0	250	88	110	44	38	0	51	0	0
2014	0	260	90	110	30	39	0	51	0	0
2015	0	370	90	107	17	39	0	50	0	0

Figure 12.14 Average low voltage tariff for LV-commercial with peak power registration consumers in the period 2008 – 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	98	112	73	34	0	86	136	0
2009	0	0	98	111	67	39	0	65	103	1
2010	0	0	98	110	66	41	0	67	89	1
2011	0	0	101	108	75	38	0	68	0	1
2012	0	0	104	112	69	37	0	79	0	1
2013	0	0	100	113	49	37	0	49	0	0
2014	0	0	102	113	33	37	0	49	0	0
2015	0	0	104	108	19	36	0	49	0	0

Figure 12.15 Average low voltage tariff for LV-commercial without peak power registration consumers in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	67	78	80	53	32	0	73	76	0
2009	0	62	74	80	49	33	0	67	62	0
2010	0	64	73	79	48	33	0	67	46	1
2011	0	66	78	78	54	32	0	68	0	1
2012	0	67	82	82	51	32	0	75	0	1
2013	0	66	80	84	39	32	0	42	0	0
2014	0	68	82	84	26	31	0	42	0	0
2015	0	69	84	83	15	31	0	42	0	0

Figure 12.16 Average tariff in SEE DSOs in period 2008 - 2015

12.5 OBSERVATIONS/RECOMMENDATIONS

The goal of preceding analysis was to determine to what degree do financial and operating benchmarks diverge among the participating DSOs.

Labor costs per distributed electricity indicator shown that there are three groups of DSOs, ones with the average costs below 5 €/MWh, seconds with the average costs ranged from 10 to 13 €/MWh and EDB with average costs of 17 €/MWh.

Labor costs per delivered electricity reflected influence of DSOs energy losses on distribution performance, and shown that energy losses in OSHEE had the greatest impact on this indicator.

Ratio of depreciation to book value of property plant and equipment (PPE) is expected to be around 8% since this value is commensurate with average distribution asset life. Ratios greater than 8% in the observed period were recorded in EDB, KEDS and OSHEE, and possible reasons for that were given.

High maintenance costs recorded in EDB can be justified by the fact that EDB is owner only part of the network and it is responsible for maintenance of the entire network. Except maintenance costs in EPS in the period 2008-2012, that should be double checked, average maintenance costs to book value of assets in other DSOs in the observed period was up to 6%.

In general, while analyzing the received data, we observed the lack of standardization regarding the reported data. Having identified some of the issues we propose more detailed data collection exercise is carried out with the following emphasis:

- revenues from distribution and / or retail services should be clearly identified. It is important to distinguish revenue from sale of electricity and revenue from use of distribution network,
- pass through costs should be clearly identified and not taken into account (e.g. transmission costs),
- all data should then be adjusted to reflect purchasing power differences among countries.

13 CUSTOMER SERVICE

Performance measures for connection services generally focus on the amount of time required for a customer to obtain a new connection or another type of service related to his connection. From a customer's perspective, this is a vital aspect of DSO service. Alongside billing and repair issues, connection services are a significant source of customer complaints and hence a focus area for DSOs' efforts at performance improvement.

The proposed performance measures in this report focus on service response times. As described in the 6th CEER Benchmarking Report on the Quality of Electricity and Gas Supply, performance benchmarks in developed country markets go a step beyond service response time and track other measures. However, this level of detail is not expected in the observed DSOs records (i.e. no adequate statistical data exists for most commercial quality indicators). Therefore, this report focuses on measures that DSOs are expected to track in some form:

a) lead time to provide new connection:
The time required to obtain power supply from the time that the customer submits an application to the DSO. From the DSO perspective, this should not include time lost if the customer's application is not complete according to the DSOs published requirements. Hence, the starting point is when the application is recognized as complete until the time when inspection results in approval.

b) lead time to provide service upgrades or other changes to service:
Changes to service include changes from single to three phase, voltage supply upgrades, change in allowed peak demand, and the like, all of which require applications to the DSO.

c) lead time to test/replace meters in case of request/complaint:
This measure is related to customers' complaint that the meter readings are faulty and the meter, in fact, may require recalibration or replacement. The DSO performance on this measure reflects on its commitment to accurate metering and ability to improve collections. This is the time which is needed to inspect the meter in case of meter failures and counted in days from the date of receipt of the customer's notice on the meter problem until the date of inspection of the meter.

Connection-related activities have a complex structure. It could be observed that DSOs use different approaches (criteria) in grouping data related to lead time for new connection. Some DSOs differentiated connection procedures based on:

- the type of customer; in addition to the obvious household type, categorizations used in different DSOs distinguish between industry, commercial customers on different voltage levels, etc.,
- voltage level,
- allowed peak demand,
- connection line length and entity responsible for connection construction (DSO or customer),
- different procedure steps: approval, commissioning, and realization.

Besides, DSOs data could not be easily compared (benchmarked) since all DSO did not comply with the request to provide data on *realized time* required to obtain power supply from the time that the customer submits an application to the DSO (e.g. HEP and KEDS provided legal obligations).

We suppose that some DSOs included time for construction works (EPHZHB, EPBIH) while others provided data for certain connection process phases only (in most cases approval and commissioning). In this sense, there is a doubt that the times indicated by some DSOs (e.g. ERS, EDB, EPS) are longer if the whole lead time to provide new connection is addressed.

Beside averages, ERS provided data on best and worst performing distribution area lead time for connection after connection agreement signed.

To summarize, data from the second questionnaire related to the commercial quality are hardly comparable. Main reasons are:

- DSOs have used different approaches in grouping data,
- some DSOs provided real data while other standards (upper/lower limits that must be meet),
- DSO have not followed the same structure while preparing data – some provided data for the whole process (all phases) while others only for certain phases.

Therefore, only some remarks are given in sections analyzing particular groups of data.

The diversity of regulation and data provided by DSOs are clearly shown in Table 13-1.

Table 13-1 Lead time for new connection - data structure as provided by DSOs

DSO		Days
CEDIS		
Lead time to provide new connection - LV customers		n.a.
Lead time to provide new connection - LV customers		n.a.
Lead time to provide new connection - MV customers		n.a.
EDB		
Lead time to provide new connection - LV households		10 - 15
Lead time to provide new connection - other LV customers		12 - 17
EPBIH		
Lead time to provide new connection - LV customers		45
Lead time to provide new connection - MV customers		150
EPHZHB		
Lead time to provide new connection - LV customers		60
Lead time to provide new connection - MV customers		180
EPS *(two steps recognized)*		
Approval	HV	29
	MV	27
	LV	20

DSO		Days
Commissioning *(all conditions satisfied)*	HV	n.a.
	MV	12
	LV	10
ERS *(after connection contract signed)*		
Lead time to provide new connection - other LV customers		12 (on average)
Lead time to provide new connection - LV households		13 (on average)
Lead time to provide new connection - MV customers		6 (on average)
EVNM *(two steps recognized)*		
Approval	Lead time to provide new connection - up 40 kW	15
	Lead time to provide new connection - between 40 and 400 kW	15
	Lead time to provide new connection - above 40 kW	40
Realization	Lead time to provide new connection - up 40 kW	30
	Lead time to provide new connection - between 40 and 400 kW	50
	Lead time to provide new connection - above 40 kW	50
HEP *(provisions of energy-related laws on approval and commissioning lead times only)*		
Lead time to provide new connection - LV customers		45
Lead time to provide new connection - MV customers		45
KEDS *(provisions of energy-related laws)*		
Approval	Lead time to provide new connection – industry all voltage levels	40
	Lead time to provide new connection – LV customers, connection line up to 250 m in length	20
	Lead time to provide new connection - LV customers, connection line up to 35 m in length	15
Commissioning *(customer constructs connection)*		5
Connection construction (DSO)		5
OSHEE		
Lead time to provide new connection - up until 20 kW		78,8
Lead time to provide new connection - above to 20 kW		78,6

EPS provided data on the level of performance with regard to time for new connection. For example, if there are some “overall standards” (OS) related to the minimum level of performance (commonly in % of cases) that should be met in the given period (e.g. in a 90 % of new customers’ connection approval provided within 30 days), then these data can be used to evaluate DSO performance.

Table 13-2 Level of performance (compliance percentage) with regard to time for new connection - EPS

Service	Voltage level		
	HV	MV	LV
	[%]		
Connection approval provided within 30 days	100	51	72
Commissioning provided within 15 days	100	71	66

Table 13-3 contains interesting data provided by Kosovo KEDS on the overall and guaranteed standards with regard to connection related services (related to a voltage level, type of consumer and distance of connection). KEDS have not provided its actual values on achieved performance.

Table 13-3 Overall (OS) standards and requirements (R) related to new connection – KEDS

Service	Standard (expected level of quality)
New connections for level 35 kV, 10 kV, and for 0,4 kV industrial consumers consent shall be given	(OS) within 40 days in 80 % of the cases
New connections for level 0,4 kV commercial and household consumers with distances up to 250 m consent shall be given	(OS) within 20 days in 80 % of the cases
New connections for level 0,4 kV commercial and household consumers with distance up to 35 m consent shall be given	(OS) within 15 days in 90 % of the cases
Commissioning where consumer responsible for connection construction shall be provided	(OS) within 5 days in 90 % of the cases
Where DSO responsible for new connection construction at 35 kV, 10 kV, and 0.4 kV levels action shall be carried out	(R) within 5 days

Since all DSOs except one (Croatia following the EU accession changed its legal status from a Contracting Party to that of a Participant) are Contracting Parties to the Energy Community, this report suggests starting with the adoption of CEER guidelines in future reports. To be able to compare data on lead time for the new connection it is very important to follow guidelines on input data monitoring for calculation of first 4 indicators used in CEER report for setting standards related to connection:

- time for response to customer claim for network connection,
- time for cost estimation for simple works,
- time for connecting new LV customers to the network,
- time between signing contract and the start of supply,
- time for disconnection upon customer’s request (data of this measure was not considered in this report).
- time for a switching off supplier (a new indicator that has not be considered in this report).

This list of four indicators represents the whole process for connection (first there is the request for connection, to which there are two possible responses (feasibility response and estimation of costs); then, when the estimated cost is accepted by the customer, there is the work for realizing the connection; last, there is the activation of the supply (only in this last step can the supplier be involved)). The last two indicators were not considered in this report, while indicator time for a switching off supplier also not considered in Quality of Electricity Supply in the Energy Community, Annex on the 6th CEER Benchmarking Report.

It is worth mentioning that, based on 6th CEER benchmarking report, median value of standard for lead time to provide new LV connection in EU countries equals 46 working days (15 days for response to customer claim, 14 days for cost estimation for simple works, 11 days for connecting LV customer to the network and 6 days for commissioning after signing contract). These are only indicative values since countries standards for connection-related activities often have a complex structure depending upon the complexity of the work to be done.

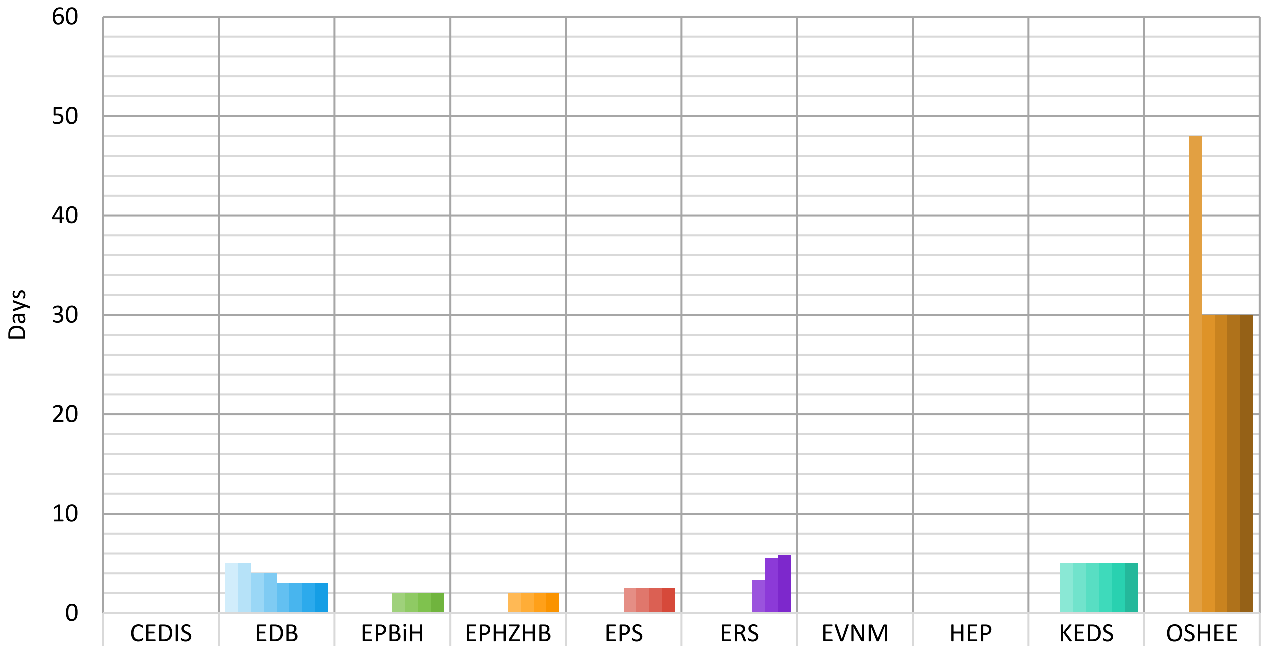
Table 13-4 provides analysis, prepared by regulators in SEE for the Energy Community, published as an Annex in 5th CEER Benchmarking Report on the Quality of Electricity Supply regarding Commercial quality, related to *standards* for connection related activities in 6 SEE countries: Montenegro, Bosnia and Herzegovina, Croatia, FYR of Macedonia, Serbia and UNMIK. These standards can be compared to the EU countries standards provided in 4th column (*source: 6th CEER Benchmarking Report*).

Table 13-4 Commercial quality standards for connection related activities in observed countries (source: Annex on the 6th CEER benchmarking report and 6th CEER Benchmarking Report)

Quality indicator	**Countries** *grouped by type of standard*	**Standard** *median value and range*	**Standard EU** *median value and range*	**Company involved**
Time to response to customer claim for network connection	OS: Albania OAR: Montenegro, Bosnia and Herzegovina, Croatia, FYR of Macedonia, Serbia, UNMIK	25 days 15-30 days	*15 days* *8-30 days*	DSO
Time for cost estimation for simple works	OS: Albania OAR: Montenegro, Bosnia and Herzegovina, FYR of Macedonia, UNMIK None: Croatia, Serbia	21 days 8-30 days	*14 days* *8-30 days*	DSO
Time for connecting new customers to the network	OS: Albania, UNMIK OAR: FYR of Macedonia, Croatia, Serbia None: FYR of Macedonia	20 days 4-45 days	*11 days* *2-126 days*	DSO
Time to disconnection upon customers request (de-activation of supply)	OAR: Montenegro, FYR of Macedonia, Serbia, UNMIK O/M: Bosnia and Herzegovina None: Albania, Croatia	12 days 3-30 days	*5 days* *3-5 days*	DSO

OS – Overall standard; OAR – Other available requirement; O/M – only monitoring

Regarding the duration of an inspection of a meter failure (lead time to test/replace meters in case of request/complaint), almost all DSOs provided data (CEDIS, EVNM, and HEP did not provide data). Three DSO provided historical data (OSHEE, EDB, KEDS), showing that in OSHEE and EDB lead time to test/replace meters in case of request/complaint declines steadily. ERS differentiated data by the voltage level of customer connection and consumption category (LV - households 6,1 day; other LV customers 2,2 day; calculated average based on a number of existing customers equals 5,8 days in 2015).



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	5	0	0	0	0	0	0	0	0
2009	0	5	0	0	0	0	0	0	0	0
2010	0	4	0	0	0	0	0	0	5	0
2011	0	4	0	0	0	0	0	0	5	48
2012	0	3	2	2	2,5	0	0	0	5	30
2013	0	3	2	2	2,5	3,3	0	0	5	30
2014	0	3	2	2	2,5	5,5	0	0	5	30
2015	0	3	2	2	2,5	5,8	0	0	5	30

Figure 13.1 DSOs data provided on lead time to test/replace meters in case of request/complaint

It is worth mentioning that, as given in 6th CEER benchmarking report, the median value of standard for lead time to test/replace meters in case of request/complaint in EU countries equals 6,5 working days (standards range 3-20 days). In general, only a few regulators have set standards relating to metering. Regarding the duration of an inspection of a meter failure, the typical standards in use are relatively heterogeneous. Compensation in case of non-performance is applied in a small number of EU countries.

13.1 COMPLAINTS HANDLING

Complaint handling is an important function of customer service and is a key indicator of service quality for many regulatory commissions. This report focuses on:

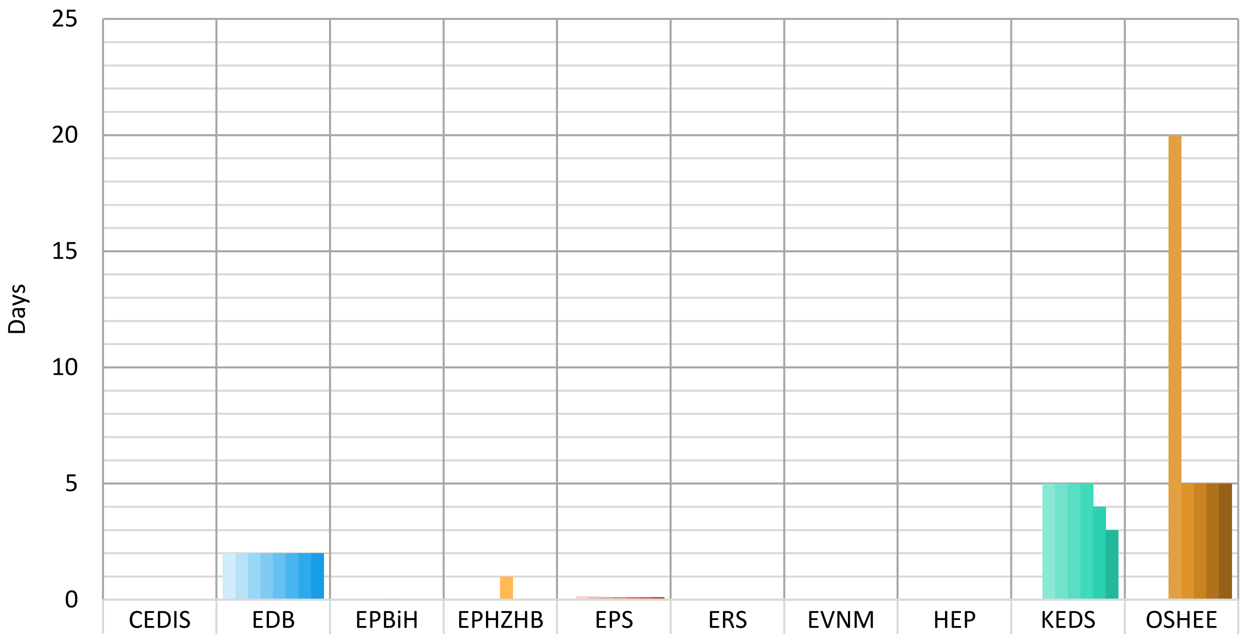
a) Complaint response time:
Taking the customer's perspective, this is the time from submission of the complaint to an activation by the DSO toward resolving the complaint (such as the arrival of the service personnel to address the issue, rescheduling of a service call and satisfactory clarification of a payment dispute). In this report, this is the time needed to respond to customer's written complaint or enquiry, and shall be counted in days from the date of registration of the customer written complaint or enquiry (the date of receipt of the letter) until the date of dispatch of the written response to the intervention.

b) Complaints handled annually/100 customers:
This measure provides the volume of customer complaints, normalized by the number of customers. The measure is better characterized as an indicator of customers' satisfaction rather than the effectiveness of handling complaints.

c) Customers care staffing level/100 customer:
This is an indicator of the effort and resources devoted by DSO to customer service (omits services such as maintenance and repair).

Complaint response time is indicator related to the period between the registration of a customer complaint or enquiry and the date of the response to it. In this report, ERS data relate to voltage quality complaints only. Response times do not exceed 5 days in all DSOs except in OSHEE in 2011 – 20 days, which is surprisingly low. Namely, based on 6th CEER benchmarking report, the median value of standard for response time to customer complaints and enquiries in EU countries equals 15 working days (standards range 5-30 days), and in Energy Community contracting parties 26 days (standards range 15-30 days). Therefore, it is expected to be close to this standard value.

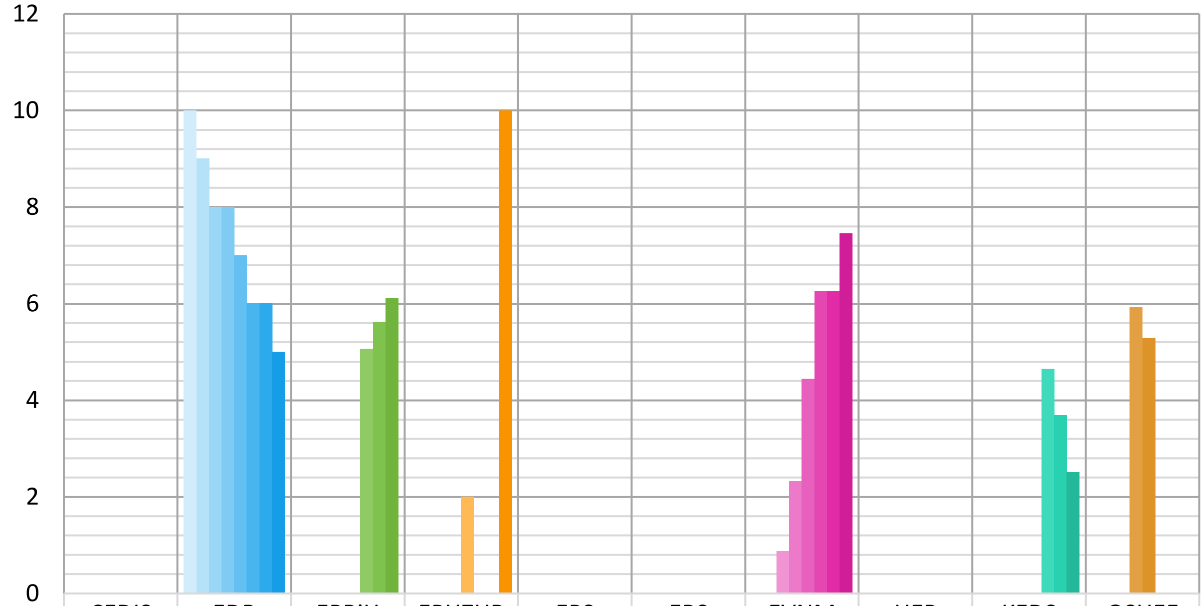
On this point, it can be concluded that the DSOs did not record complaints as envisaged in the study questionnaire (e.g. this was evident from the remark given by EPS in 2nd questionnaire) and, what is equally important, scope of complaints observed by the DSO differs considerably (some DSOs focused on several technical and nontechnical services, while others were focused only to one or two technical). Therefore, data provided are not the good starting point for mutual comparison. In future reports, more efforts should be devoted to the development of clear definitions and understanding of indicators and to the harmonization of data collection procedures in SEE DSOs.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	2	0	0	0	0	0	0	0	0
2009	0	2	0	0	0,15	0	0	0	0	0
2010	0	2	0	0	0,13	0	0	0	5	0
2011	0	2	0	0	0,12	0	0	0	5	20
2012	0	2	0,05	1	0,11	0	0	0	5	5
2013	0	2	0	0,04	0,11	0	0	0	5	5
2014	0	2	0	0,04	0,11	0	0	0	4	5
2015	0	2	0	0,04	0,11	0	0	0	3	5

Figure 13.2 Data provided by DSOs on complaint/enquiry response time

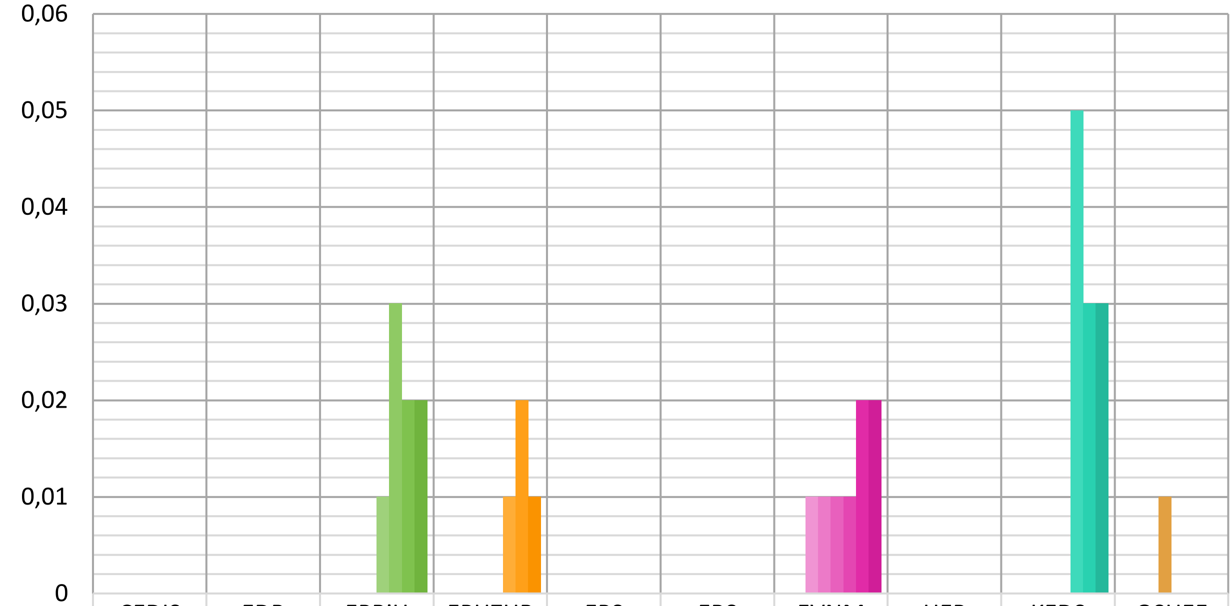
4 out of 10 DSOs did not provide any data on complaints (Figure 13.3). Some DSOs (EDB, EVNM, OSHEE) provided even historical data, where EDB, KEDS and OSHEE indicated a steady decline, while in EVNM and EPBiH steady increase in number of complaints has been reported.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	10	0	0	0	0	0	0	0	0
2009	0	9	0	0	0	0	0	0	0	0
2010	0	8	0	0	0	0	0,87	0	0	0
2011	0	8	0	0	0	0	2,32	0	0	5,92
2012	0	7	0,02	2	0	0	4,44	0	0	5,29
2013	0	6	5,06	0	0	0	6,25	0	4,65	0
2014	0	6	5,62	0	0	0	6,25	0	3,69	0
2015	0	5	6,11	10	0	0	7,45	0	2,51	0

Figure 13.3 Data provided by DSOs on complaints handled annually/100 customers

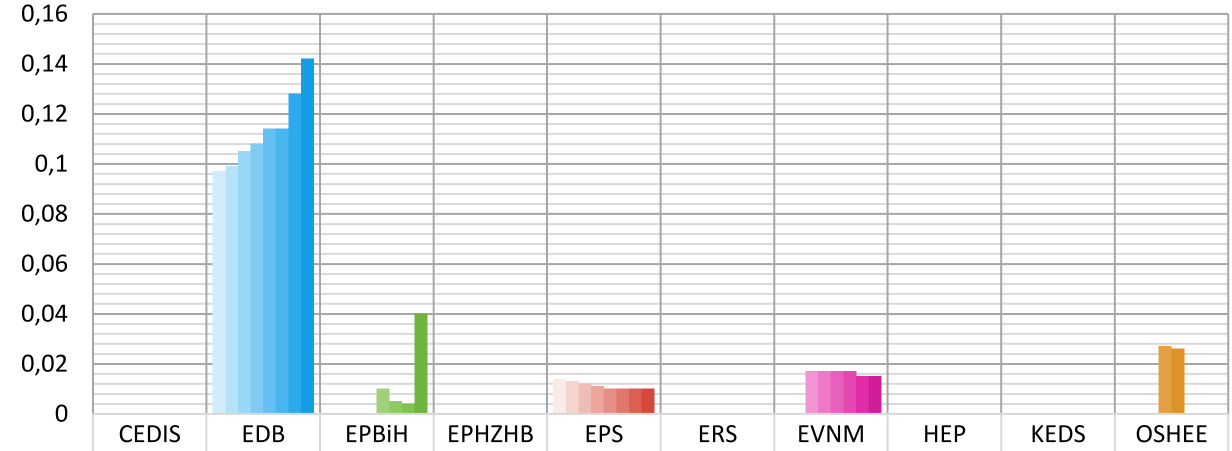
A number of complaints handled by the regulator annually per 100 customers are shown on Figure 13.4, without data in 5 out of 10 DSOs. The trend of change of this parameter differs among the DSOs. At first, EPBiH and EPHZHB indicated an increase, and then decline. EVNM reported unchanged values, but afterwards in 2014 the value has increased. KEDS reported decline of this indicator.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0,01	0	0	0
2011	0	0	0	0	0	0	0,01	0	0	0,01
2012	0	0	0,01	0	0	0	0,01	0	0	0
2013	0	0	0,03	0,01	0	0	0,01	0	0,05	0
2014	0	0	0,02	0,02	0	0	0,02	0	0,03	0
2015	0	0	0,02	0,01	0	0	0,02	0	0,03	0

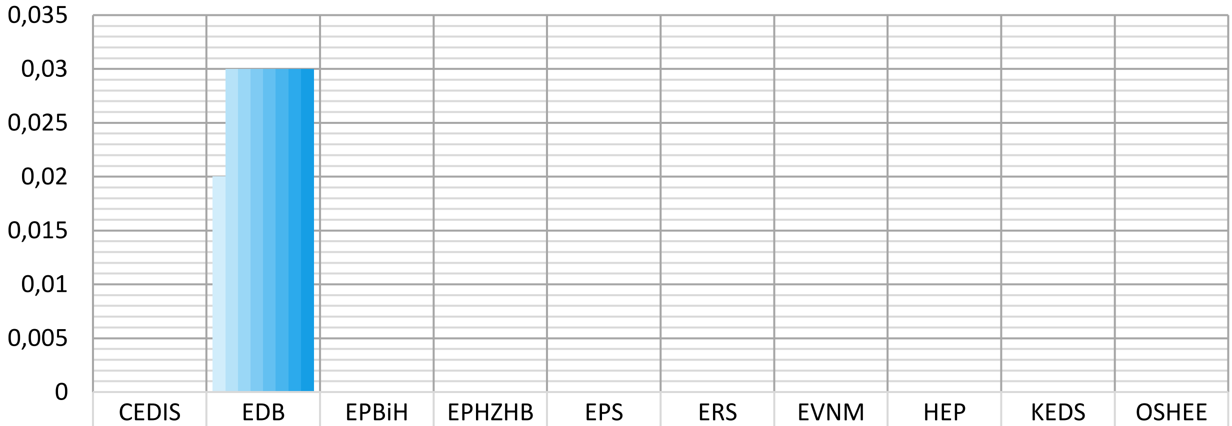
Figure 13.4 Data provided by regulator on complaints handled annually/100 customers

5 out of 10 DSOs did not provide data on customers' care staffing level/100 customer (Figure 13.5). Some DSOs (OSHEE, EDB, EPS, EVNM) provided even historical data which indicate a steady decline in customers' care staffing level in and EPBiH (except in 2015), EPS, EVNM, and OSHEE, steady increase in EDB. Only in EDB data for number of employees responsible for providing special service were collected (Figure 13.6).



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,097	0	0	0,014	0	0	0	0	0
2009	0	0,099	0	0	0,013	0	0	0	0	0
2010	0	0,105	0	0	0,012	0	0,017	0	0	0
2011	0	0,108	0	0	0,011	0	0,017	0	0	0,027
2012	0	0,114	0,01	0	0,01	0	0,017	0	0	0,026
2013	0	0,114	0,005	0	0,01	0	0,017	0	0	0
2014	0	0,128	0,004	0	0,01	0	0,015	0	0	0
2015	0	0,142	0,04	0	0,01	0	0,015	0	0	0

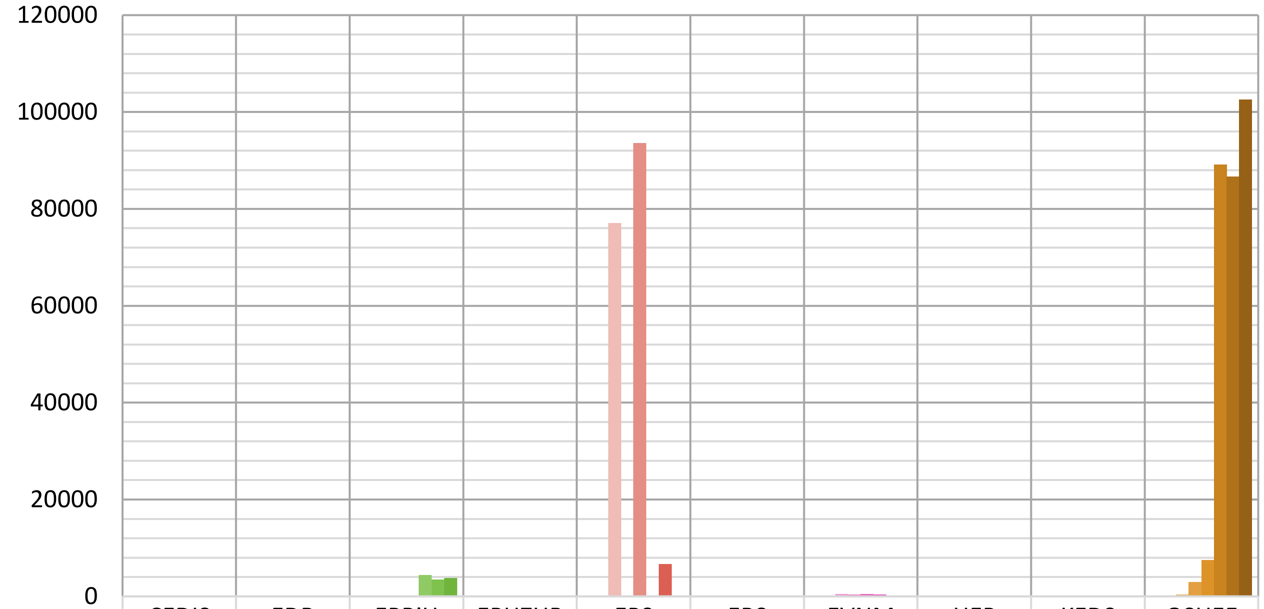
Figure 13.5 Data provided by DSOs on customers' care staffing level/100 customer



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,02	0	0	0	0	0	0	0	0
2009	0	0,03	0	0	0	0	0	0	0	0
2010	0	0,03	0	0	0	0	0	0	0	0
2011	0	0,03	0	0	0	0	0	0	0	0
2012	0	0,03	0	0	0	0	0	0	0	0
2013	0	0,03	0	0	0	0	0	0	0	0
2014	0	0,03	0	0	0	0	0	0	0	0
2015	0	0,03	0	0	0	0	0	0	0	0

Figure 13.6 Number of employees by DSOs providing special service/1000 customer

The number of litigation cases initiated per years by the DSOs is shown on the Figure 13.7. The trend of steady increase in a high number of litigation cases is detected in OSHEE, while EPS reported large decrease. In EDB, EPHZHB, and EVNM steady decline is reported, and in 2015 in EDB there were none.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	7	0	0	0	0	0	0	0	0
2009	0	6	0	0	0	0	0	0	0	0
2010	0	6	0	0	77093	0	421	0	0	318
2011	0	7	0	0	0	0	348	0	0	2970
2012	0	5	0	46	93554	0	415	0	0	7436
2013	0	3	4399	86	0	0	352	0	0	89141
2014	0	2	3467	97	6642	0	140	0	0	86674
2015	0	0	3747	62	0	0	176	0	0	102514

Figure 13.7 Number of litigation cases by SEE DSOs initiated/annually

OSHEE data on registered customer complaints as aggregated indicators of DSOs effectiveness in customer service are given in Table 13-5. This data, although not effective mean to compare with the other DSOs, are useful for performance measurement in comparison to the OSHEE progress in customer service (e.g. in between 2012 and 2015). For example, in 8 categories number of complaints increased and in the other 5 it declined.

Table 13-5 Data structure on customer complaints - OSHEE

Description	2012	2015
Invoices	15.546	70.140
Wrong tariff	328	5.338
Economic damage	5.476	7.758
Unmatched payments	10.025	2.183
More than one contract	566	33.604
Measurement scheme problems	25.379	42.162
Cross metering	1.420	1.342
Defects in the company's distribution network and infrastructure	2.002	8.307
Appeal for power theft	696	599
Voltage quality	398	8.307
Blackouts	108	599
Services delays	526	0
To company employees	19	0
Total	**62.489**	**180.339**

Table 13-6 Commercial quality standards for customer care activities (source: Annex on the 6th CEER benchmarking report and 6th CEER benchmarking report)

Quality indicator	**Countries** *grouped by type of standard*	**Standard** *median value and range*	**Standard EU** *median value and range*	**Company involved**
Response time to customer complaints and enquiries (total, including voltage complaints and interruption complaint)	OAR: Montenegro, Bosnia and Herzegovina, Croatia, FYR of Macedonia, UNMIK O/M: Serbia None: Albania	26 days 15-30 days	*15 days* *5-30 days*	DSO
Time for answering the voltage complaints (part of response time to customer complaints and enquiries)	OAR: Montenegro, Bosnia and Herzegovina, Croatia, FYR of Macedonia, UNMIK O/M: Serbia None: Albania	16 days 2-30 days	*30 days* *10-60 days*	DSO
Time for answering the interruption complaint as part of response time to customer complaints and enquiries	OAR: Montenegro, FYR of Macedonia, UNMIK O/M: Serbia None: Albania, Bosnia and Herzegovina, Croatia	20 days 15-30 days	*30 days* *20 hours-30 days*	DSO
Response time to questions in relation with costs and payments (excluding connection)	OAR: Montenegro, Bosnia and Herzegovina, UNMIK None: Albania, Croatia, FYR of Macedonia, Serbia	8 days 1h-8 days	*14 days* *5-30 days*	DSO

OS – Overall standard; OAR – Other available requirement; O/M – only monitoring

Table 13-6 and Table 13-7 provide analysis prepared by the regulators for the Energy Community Secretariat, published as the Annex on the 6th CEER Benchmarking Report on the Quality of Electricity Supply in the Energy Community regarding Commercial quality, related to *standards* for customer care activities and technical service in 5 SEE countries: Montenegro, Bosnia and Herzegovina (EDP, EPBiH, EPHZHB, and ERS), Macedonia, Serbia and Kosovo. These standards can be compared to the EU countries (Croatia) standards provided in 4th column (source: 6th CEER Benchmarking Report).

Table 13-7 Commercial quality standards for technical activities (require and include time for elimination of the problem by DSO) (source: Annex on the 6th CEER benchmarking report and 6th CEER benchmarking report)

Quality indicator	**Countries** *grouped by type of standard*	**Standard** *median value and range*	**Standard EU** *median value and range*	**Company involved**
Time between the date of the answer to the VQ complaint and the elimination of the problem	OS: UNMIK OAR: Bosnia and Herzegovina, Serbia None: Montenegro, Albania, Croatia, FYR of Macedonia	25 days 1-60 days	*1 months* *6 days -24 months*	DSO
Time until the start of the restoration of supply following failure of fuse of DSO	OS: UNMIK OAR: FYR of Macedonia O/M: Bosnia and Herzegovina None: Albania, Croatia, Montenegro, Serbia	12 hours 1-24 hours	*4 hours* *3-6 hours*	DSO
Time for giving information in advance of a planned interruption	OS: UNMIK OAR: Bosnia and Herzegovina, Croatia, FYR of Macedonia, Serbia None: Albania, Montenegro	3 days 1-10 days	*3 days* *1-15 days*	DSO
Time until the restoration of supply in case of unplanned interruption	O/M: Bosnia and Herzegovina OAR: Croatia, FYR of Macedonia, Serbia None: Albania, Montenegro, UNMIK	18 hours 2-24 hours	*12 hours* *4-24 hours*	DSO

OS – Overall standard; OAR – Other available requirement; O/M – only monitoring

Obviously, many DSOs have no formal tracking mechanisms for complaints or responses. Since all observed countries are contracting parties to the Energy Community (Croatia as a part of the EU), it is recommended to start with commercial quality data monitoring in line with recommendations outlined in CEERs benchmarking reports (in CEER report indicators relating to the commercial quality have been grouped in four main groups: connection, customer care, technical service, metering and billing).

The service providers shall in their customer centers introduce and keep the book of complaints, preferably in electronic form, so those customers who are dissatisfied with a particular service (waiting time, personal attention, etc.) are enabled to complain.

Besides that, service providers shall establish and implement a complaints procedure which shall be:

- effective (aimed at solving the problem),
- readily assessable (with clearly set steps, procedures, and responsibilities),
- speedy (with time limits for dealing with complaints)
- confidential (the privacy of the individual customers should be protected)
- integrated (with the organization's operation and practices).

Staff in the customer center and local management shall be empowered to resolve complaints promptly. The complaints facilitator shall produce a monthly management report to monitor both the volume of complaints received and the response performance in relation to these complaints.

13.2 OTHER CUSTOMER SERVICE

The proposed measures for connection services and complaint handling do not cover all important facets of DSO customer service performance. For this report following measures have been analyzed:

a) customers access to services
   This measure considers ease of access to the DSO as an indicator of customers' service. In the report, the focus has been to indicate the range of types of access points and reporting channels. For most DSOs, customer access points are principally the district offices, district payment centers, call-in centers, some DSOs also provide web-based services.

b) DSO staff resources providing special services
   Personnel staffing levels devoted to activities other than connections and complaint handling (i.e. product promotions, training or consumer education programs, energy audits and DSM programs, power factor correction services, diagnostic fault testing service, the technical system in lighting system design and so on). These services have been increasingly important for DSO public image.

Table 13-8 provides data provided by DSOs on a range of types of access points (point of contacts with the DSO). In all DSOs, there are customer care centers and call centers where customers can make a complaint, ask a question, claim something (e.g. enquiry for a new connection), participate in some activity. Vital information related to the operation of distribution system such as planned maintenance, are published on the company website and/or in the media (radio, press). HEP and EPS have introduced online account access web application ("My account") which serves customers for consumption tracking, notification/review of meter readings, to get information about invoices and their consumption.

Table 13-9 summarizes the data provided by DSOs on types of customer access points, and all of them dated from 2012.

Table 13-8 Customer access to services (types of access points) – DSO data

DSO	Types of access points
CEDIS	n.a.
EDB	Communication with customers takes place most often through the media (e.g. radio, TV announcements) and company ***web page***. ***Customer care center, 3 payment centers, free phone communication, email service.***
EPBIH	52 ***customer care centers***, ***6 call centers,*** company ***web page***.
EPHZHB	35 ***customer care centers***, 1 ***call centers,*** company ***web page***.
EPS	There are 5 large ***call centers*** (customers can get information about the state of the distribution system, planned maintenance, etc.). Besides, such information can be obtained by phone calls to the DSO local offices. Planned outages are published on the **website** of distribution areas, as well as in the **local press**. Progress is present in terms of application of ***modern internet and mobile technologies*** to improve customer service: to ***provide information*** about planned interruptions, bills (current status, print invoices), consumption calculator, tariffs, payment options and personal invoice, about distribution services, customer notification of supply interruption, unauthorized consumption, meter reading value; surveys on customer satisfaction with DSO services.
ERS	In all local offices, there is ***customer care center*** (e.g. information access points). Vital information is published on the **website** of DSO. Besides, customers can send their queries in written, by email or by a phone call to call centers.
EVNM	Customers can send their queries, enquires and complaint in written, by email, fax or by a phone call to call centers. ***Customer care centers*** in all branches. Payment centers (payment of bills, complaints regarding bills). Company web page.
HEP	75 ***customer care centers*** 10 ***call centers*** ***free phone communication*** in all (21) branches Vital information is published on the **website** of DSO. Customers can send their queries, enquires and complaint in written, by email, web application. Web-based application “My account” for consumption tracking, notification of meter reading value, information about invoices, consumption, etc.
KEDS	7 ***customer care centers*** 1 ***call center*** located in the headquarters Customers can send their queries, enquires and complaint by email, phone, web application.
OSHEE	44 ***customer care centers***. Each of them includes customer care service and cash point desk. There are 7 additional payment desks which operate separately from customer care centers. One ***call center*** located in the headquarters manages the ***email services***. Company ***web page***.

Table 13-9 Summary of range of types of access points

Type/DSO	CEDIS	EDB	EPBIH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
Customer care centers/Payment centers	n.a.	1/3	52	32	5	yes*	yes*	75	7	44/7
Call centers	n.a.	yes	6	1	yes	yes	yes	10	1	1
The Internet (company web page)	n.a.	yes	yes	yes	yes	yes	yes	yes	yes	yes
Web services (personal account)	n.a.				yes			yes		

**in all local offices*

Except for EDB (on the **Error! Reference source not found.** it is shown that 0,028 employees are p roviding special service per 1000 customers in the period 2009 - 2015), other DSOs did not provide data related to so-called special services (in this report these are all services other than services related to connections and complaint handling).

13.3 OBSERVATIONS/RECOMMENDATIONS

Customer rights in SEE DSOs are definitely lagging behind in comparison to customer rights in the EU DSOs. On the other hand, DSOs customer service may be a DSO's principal means to establish/improve the public image (especially when increasing tariffs).

Although it seemed the indicators in this group are instantly recognizable, the actual standards and ranges used by different DSOs show that customer services in future reports should be developed in terms of definitions needed for precise benchmarking of DSOs.

As observed in 6th CEER Benchmarking Report on the Quality of Electricity Supply, no adequate statistical data exists for most commercial quality indicators. In SEE DSOs commercial quality is largely enforced by standards that in essence are not guaranteed to the customers because there is no compensation for individual customers and often there is no penalty defined. For most of these standards, penalties are based either on vague and imprecise general penal provisions or simply do not exists (even if required by primary legislation).

Therefore, further development of the legislation and practice to accommodate even basic service quality regulation is needed. Standards for technical services (and the legal framework governing the supplier business) must be developed to accommodate scenarios where customers contact the DSO directly or their supplier for technical services. In complaint procedures and afterward benchmarking, precise definitions of triggers and time intervals are crucial, as well as defining the entity on which a certain trigger/event/process applies to since it is different if the customer calls his supplier in comparison to the scenario where the customer calls to the DSO directly. This is important to differentiate because of better and faster resolving of some problems, and for the better benchmarking results with the aim of creating new commercial quality standards.

For customer complaints, only average times can be calculated (or more often estimated). All DSOs lack call centers standards and do not record visits/appointments. It could be concluded that there is a need for developing technical systems designed for customer care.

Most of the observed DSOs are only in very early stages of developing service quality regulation. This report suggests DSOs follow with:

- the establishment of the legal framework,
- usage of standards and guidelines of good practice (e.g. definitions should be developed to allow monitoring and acquisition of data, standards should be based on specific and precise definitions),
- the implementation of the monitoring system,
- quality standards and incentive schemes.

With regard to quality standards, the challenge is in identifying a set of performance targets that are appropriate for DSO in the region today, which may be just a brief list that can be broadened as the capability and standards of customer service improve over time (e.g. start with certain aspect related to connection services such as: time for response to customer claim for network connection, time for connecting new customers to the network, and certain aspects related to complaint handling: response time to customer complaints and enquiries, time for answering the interruption complaint, etc.).

Additionally, to improve customer satisfaction, DSOs should consider offering services other than connection and complaint handling (e.g. DSM, technical assistance, diagnostic, power factor corrections, etc.).

It may be useful for DSOs to employ formal surveys related to customer satisfaction with services they provide. Next step should be the implementation of IT solutions for Customer Relationship Management (CRM), as suggested in Annex on the 6th CEER benchmarking report. The most important paradigm for companies is to implement the ability to track the specific customer with a specific issue (time, cases, etc.) from which they can get relevant information for the establishment of the commercial quality standards related to customer care.

14 COMPARISON TO THE EU DSOS INDICATORS

SEE DSOs and respective national indicators have been compared to the EU DSOs and national indicators, using the last available Eurelectric report on Power distribution in Europe, 2013[6]. Selected indicators are shown on the following Figures 14.1 - 14.7. Data for SEE DSOs relate to 2015, while data for the other EU DSOs are mainly for 2013.

[6] http://www.eurelectric.org/media/113155/dso_report-web_final-2013-030-0764-01-e.pdf

Figure 14.1 Number of DSOs and total distributed power (TWh) at national level in Europe

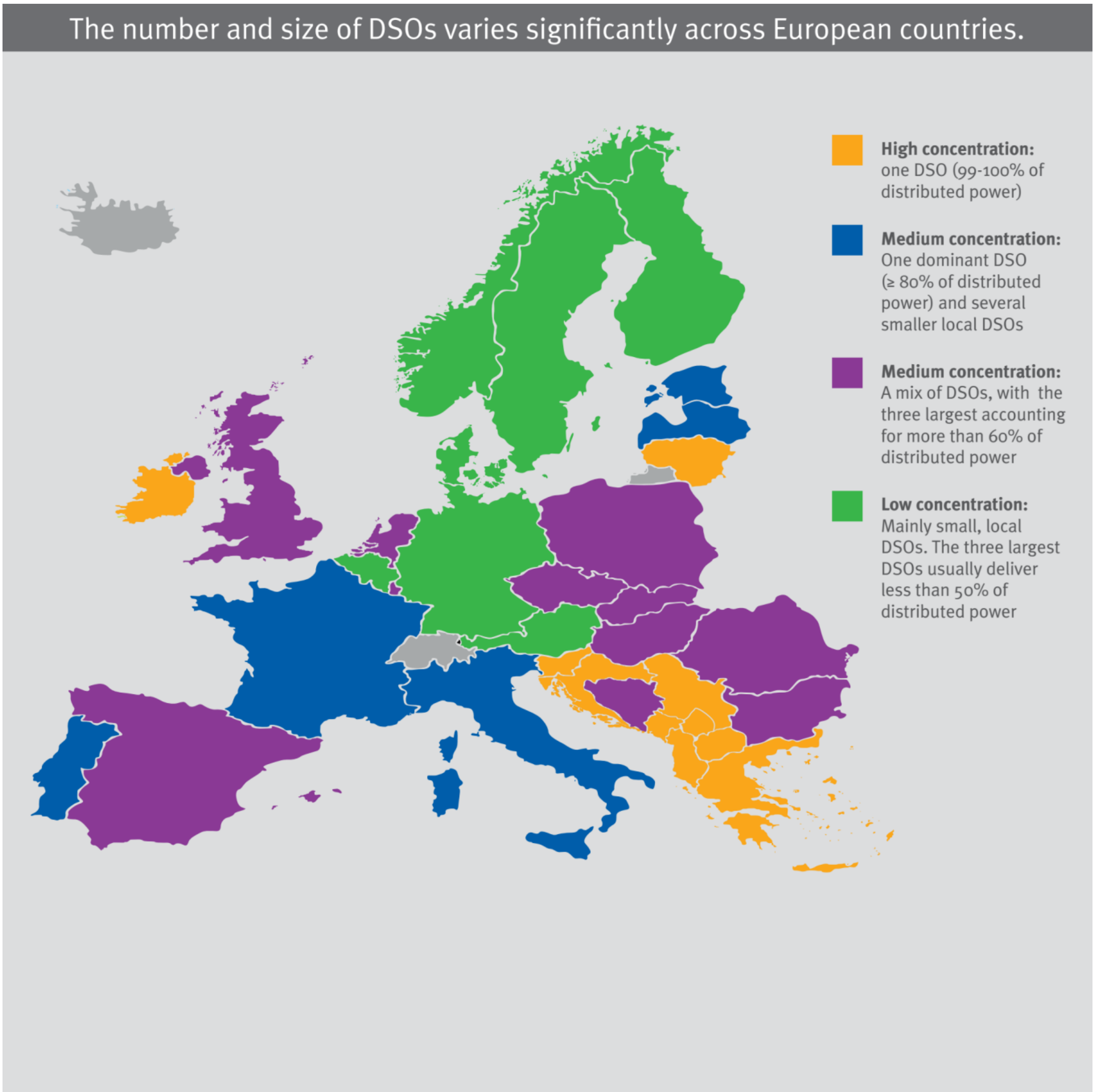
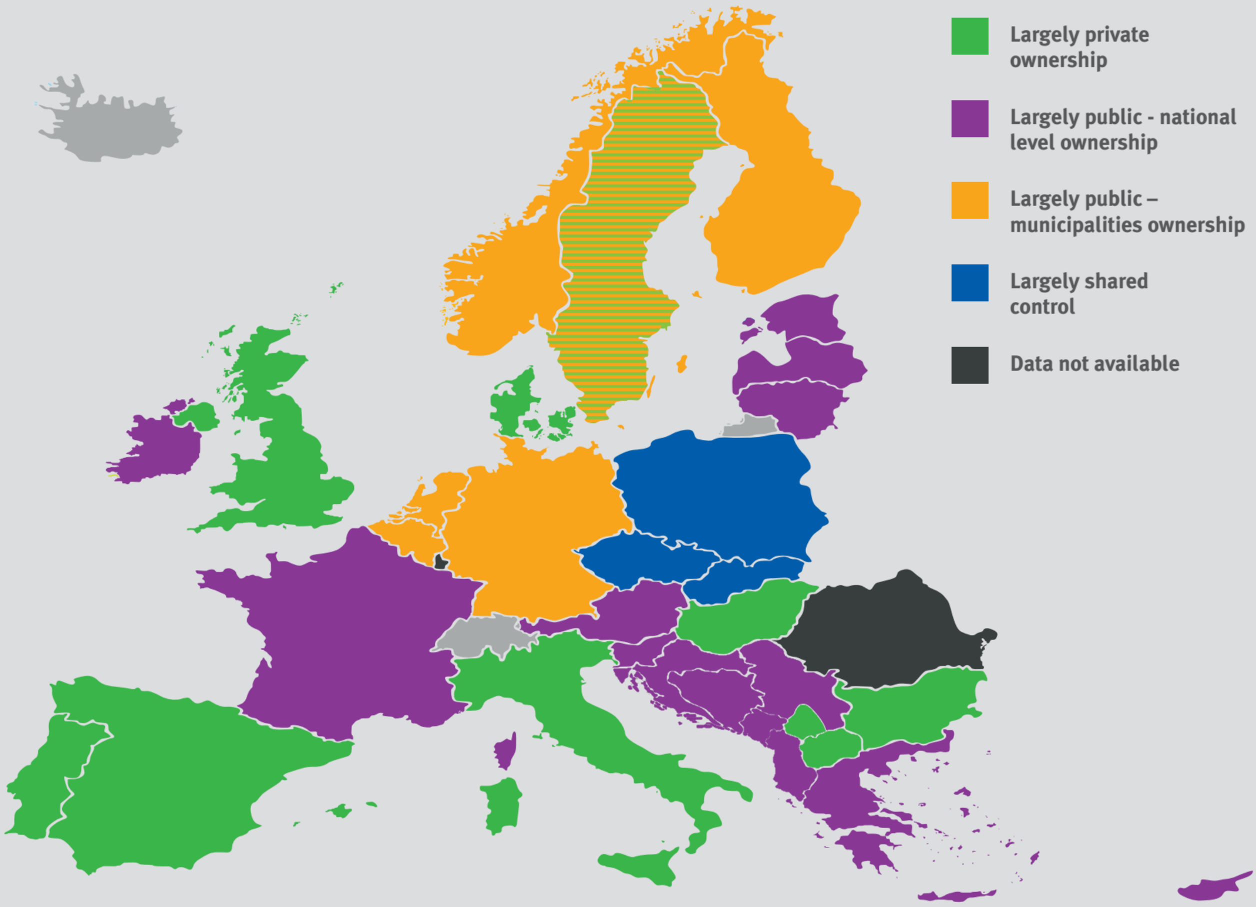


Figure 14.2 Number and size of DSOs at national level in Europe

DSOs can be either fully public or fully privatised. In addition, various forms of public-private-partnership exist.[4]



This diversity is due to the historical organisation of distribution and differences in the role of local/national authorities. Most DSOs own the network and are granted an operation licence by local or national public authorities. In some countries, like France or Germany, DSOs are granted concession contracts to operate the network for a certain amount of time while the public authorities remain the owner in the long term. In these cases, DSOs are in charge of operation and maintenance as well as capital investment.

4 For each country the percentage of each type of ownership was calculated by aggregating the kWh distributed by each type of company. Where the DSOs are fully or partly publicly owned, the form of the mother company ownership was considered in the calculation. For Bulgaria, 2012 data were used.

Figure 14.3 DSO ownership at national level in Europe

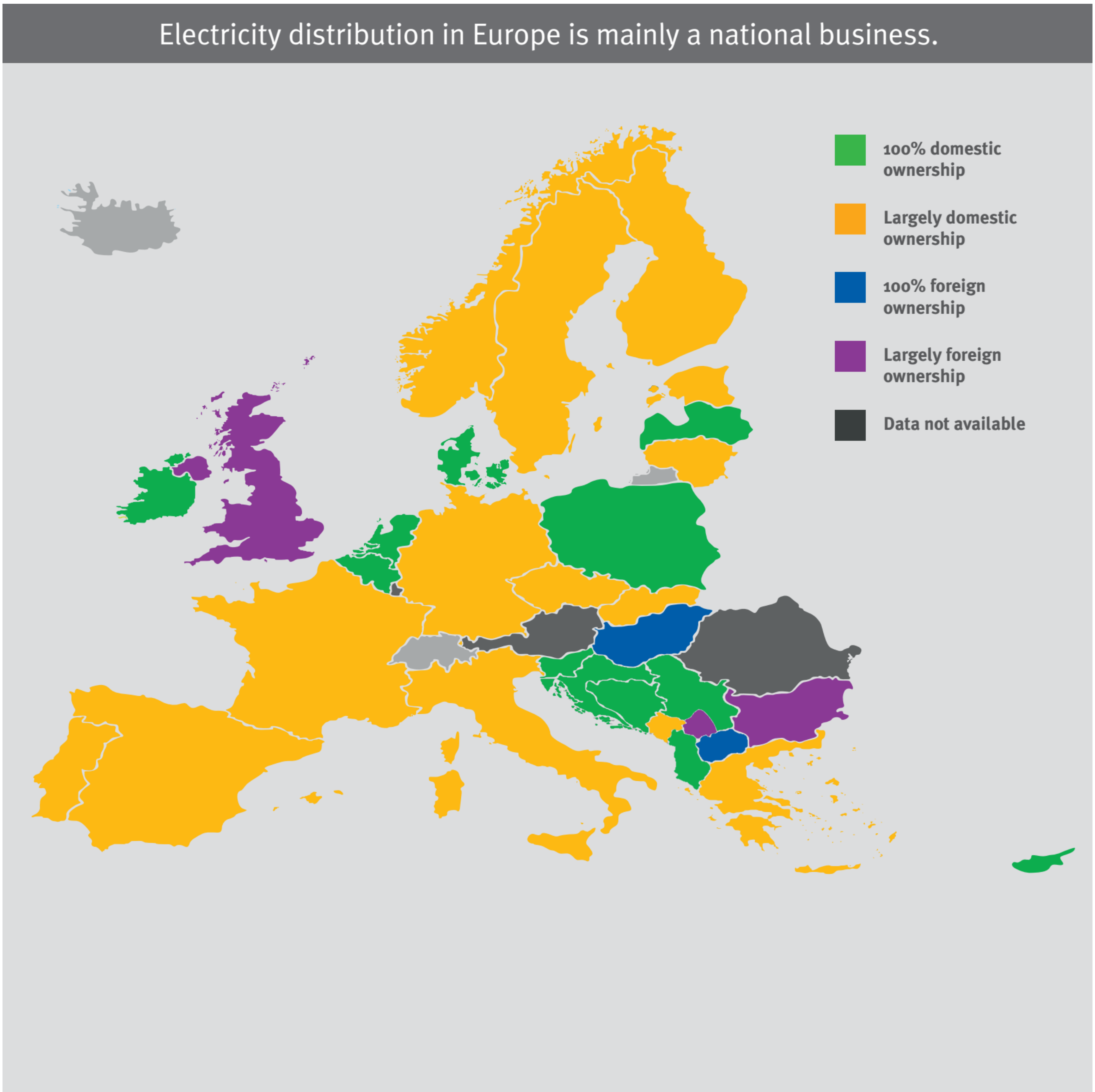
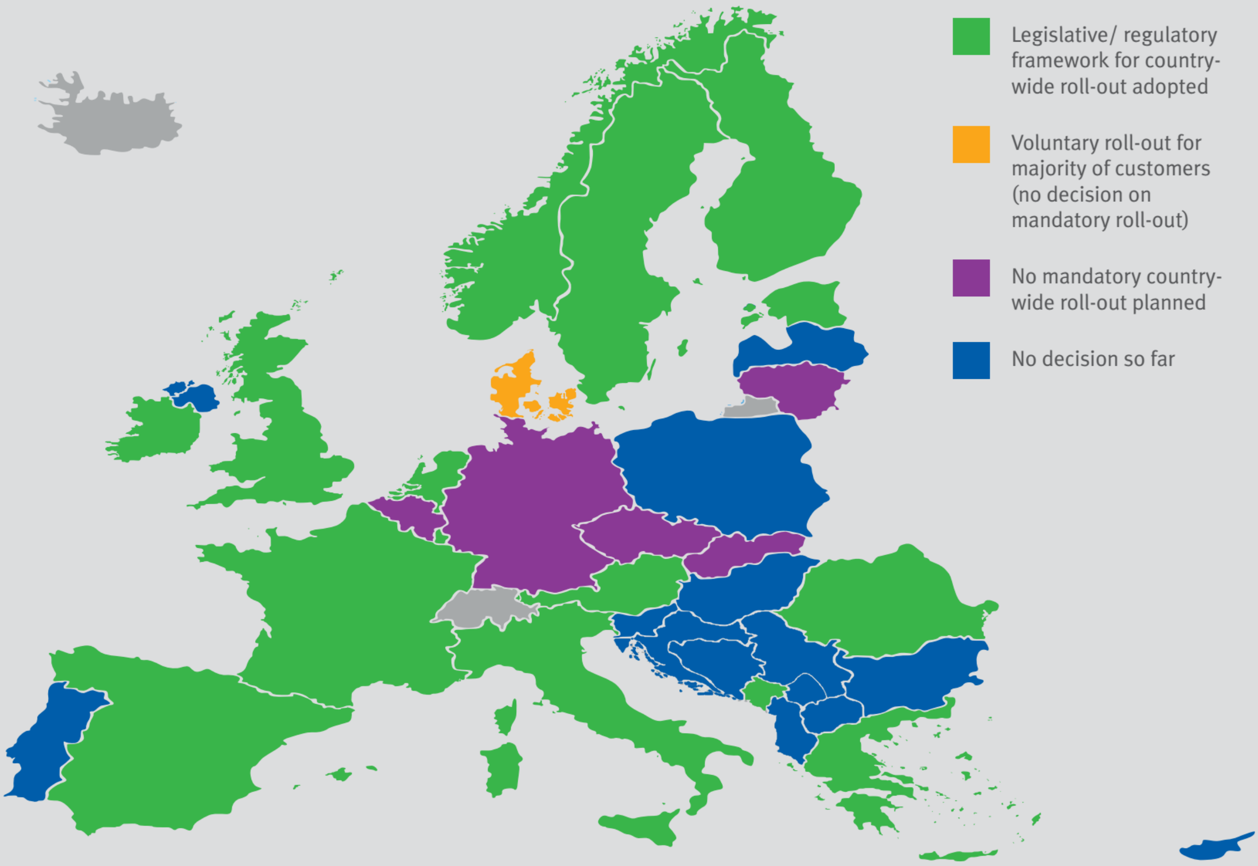


Figure 14.4 Distribution ownership at national level in Europe

Smart meters: mandatory for more than 80% of customers in 14 European countries by 2020.[6]



In Italy and Sweden, smart meters have already fully replaced conventional meters. In Germany, a roll-out covering 15% of customers is planned. In Slovakia, a roll-out covering 25-30% of customers is planned.

Following a negative cost-benefit analysis (CBA), three countries (Belgium, Czech Republic and Lithuania) have decided not to proceed with a mandatory nation-wide roll-out. DSOs are sometimes nevertheless going ahead with the smart meter installation based on individual targets (Belgium, Denmark). In seven countries, no roll-out decision has yet been taken.

6 The figure represents a snapshot of smart metering CBAs in Europe based on information available in September 2013. Remarks: France has taken a positive roll-out decision but no decision on financing. No decision on mandatory rollout has yet been made in Northern Ireland. Source: EURELECTRIC and European Commission data.

Figure 14.5 Smart metering installation decisions in Europe

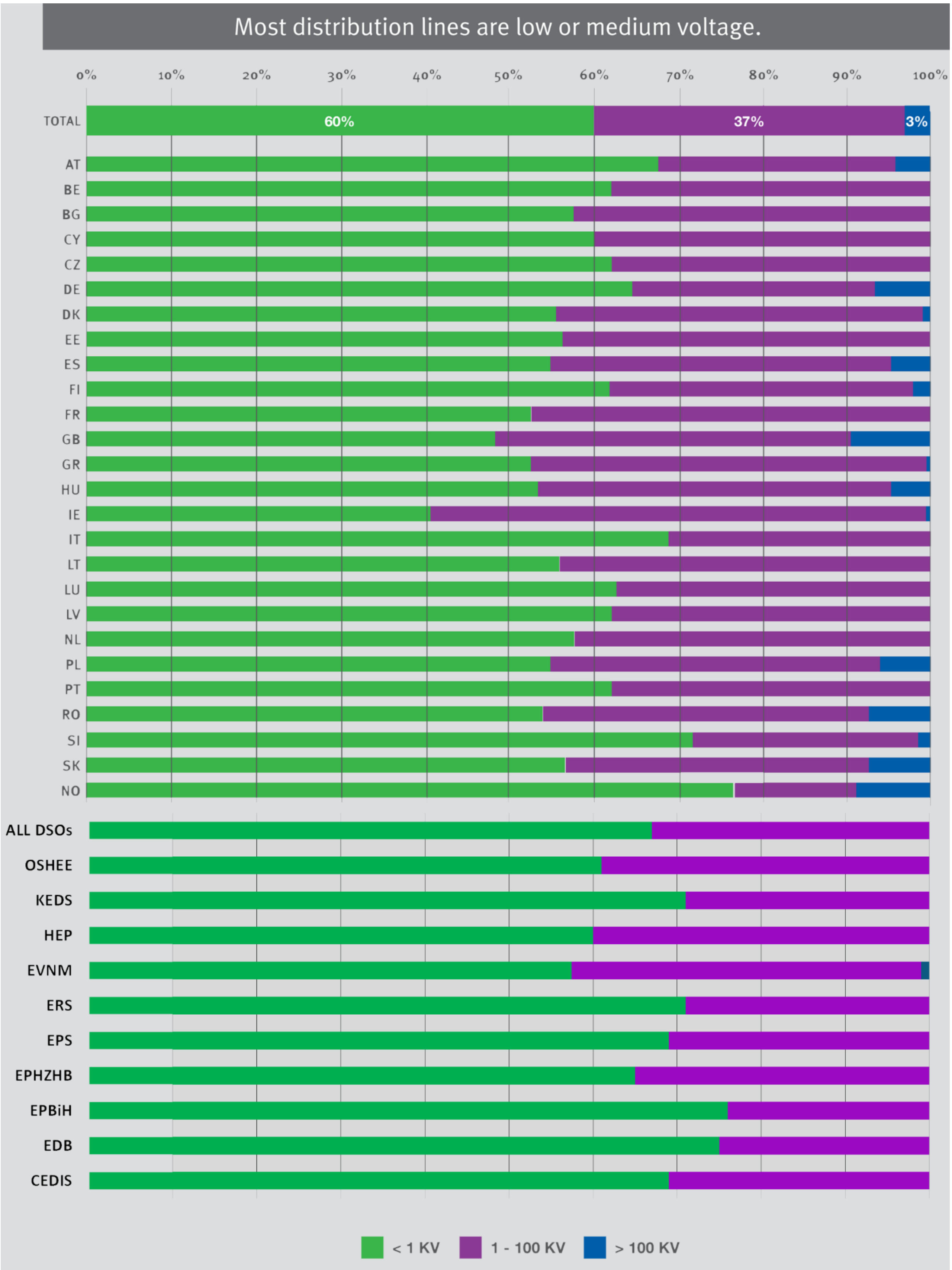


Figure 14.6 Share of HV (> 100 kV), MV (1-100 kV) and LV (< 1 kV) in total network length in Europe

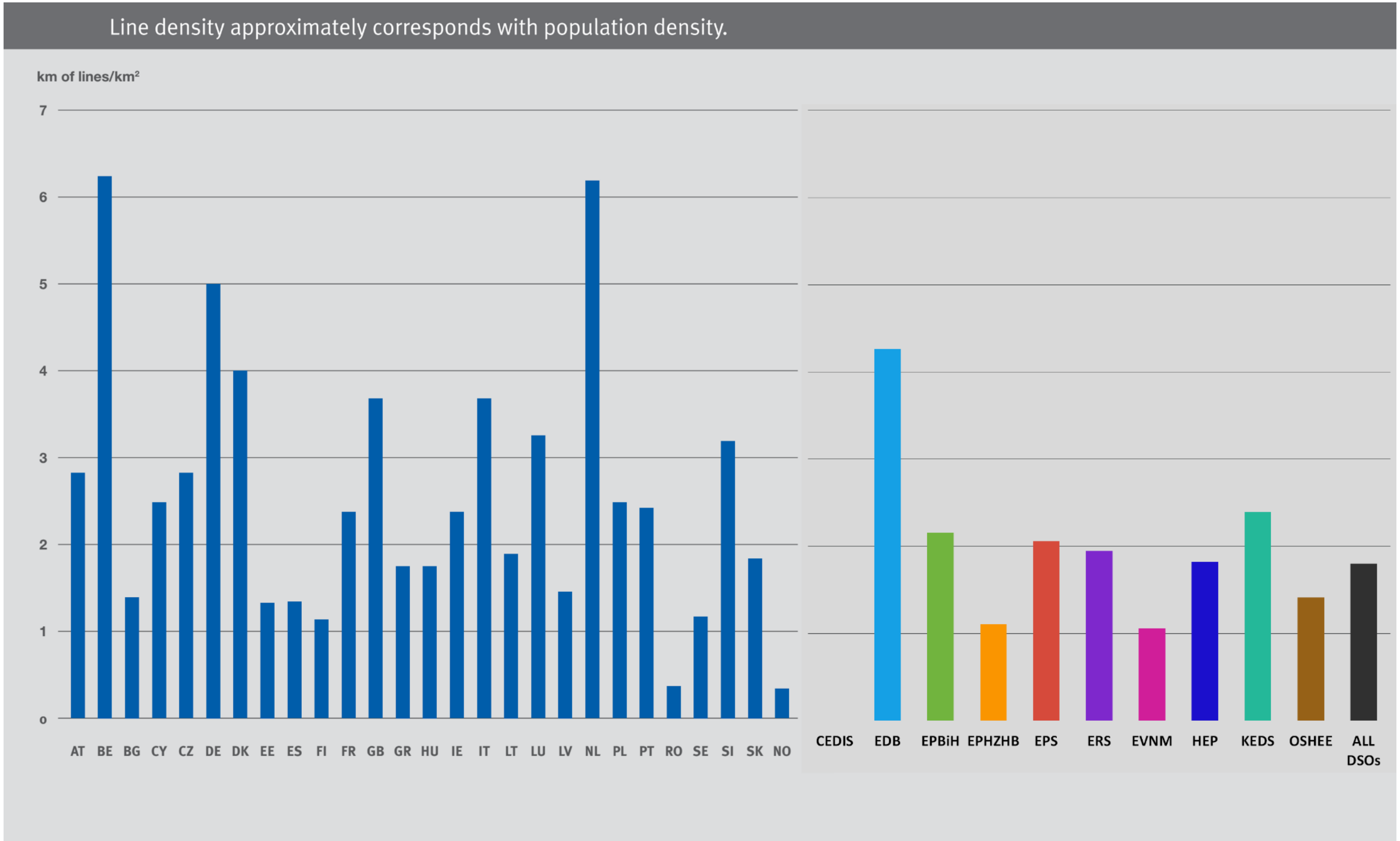


Figure 14.7 Distribution network length per supply area size in Europe

15 COMPARISON TO THE US DSOS INDICATORS

One of the tasks to be realized in this study is to benchmark SEE DSOs with DSOs from the western countries. For this purpose, American Electric Power with its 7 subsidiaries have been chosen since American Electric Power (AEP) is a major investor-owned electric utility in the United States, delivering electricity to more than 5,7 million customers in 11 states. AEP ranks among the nation's largest electricity generators, owning nearly 38.000 MW of generating capacity in the U.S. AEP also owns the nation's largest electricity transmission system, a nearly 63.000 km of the network that includes 765 kV ultra-high voltage transmission lines; i.e. more than all other U.S. transmission systems combined. AEP's transmission system directly or indirectly serves about 10 % of the electricity demand in the Eastern Interconnection, the interconnected transmission system that covers 38 eastern and central U.S. states and eastern Canada, and approximately 11 % of the electricity demand in Electric Reliability Council of Texas, the transmission system that covers a large part of Texas.

AEP's utility units operate as AEP Ohio, AEP Texas, Appalachian Power (in Virginia, West Virginia, and Tennessee), Indiana Michigan Power, Kentucky Power, Public Service Company of Oklahoma, and Southwestern Electric Power Company (in Arkansas, Louisiana and east Texas). AEP's headquarters are in Columbus, Ohio.

The main AEP characteristics are shown on the following Figure.

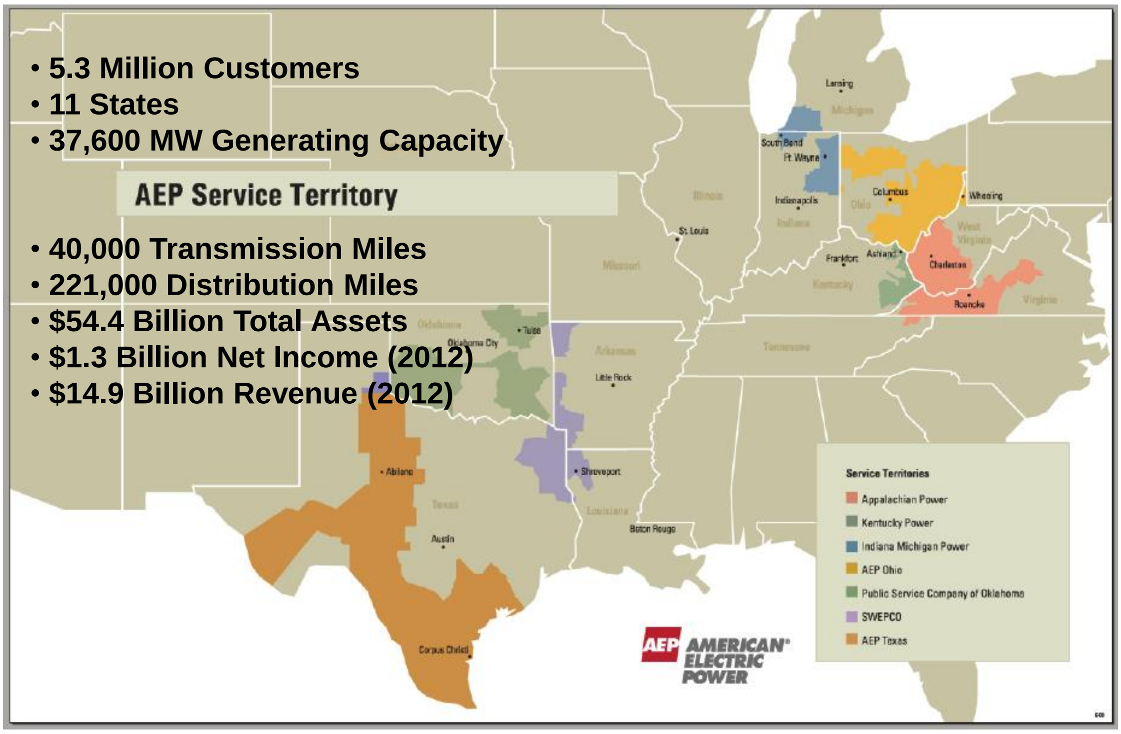


Figure 15.1 Main characteristics of AEP

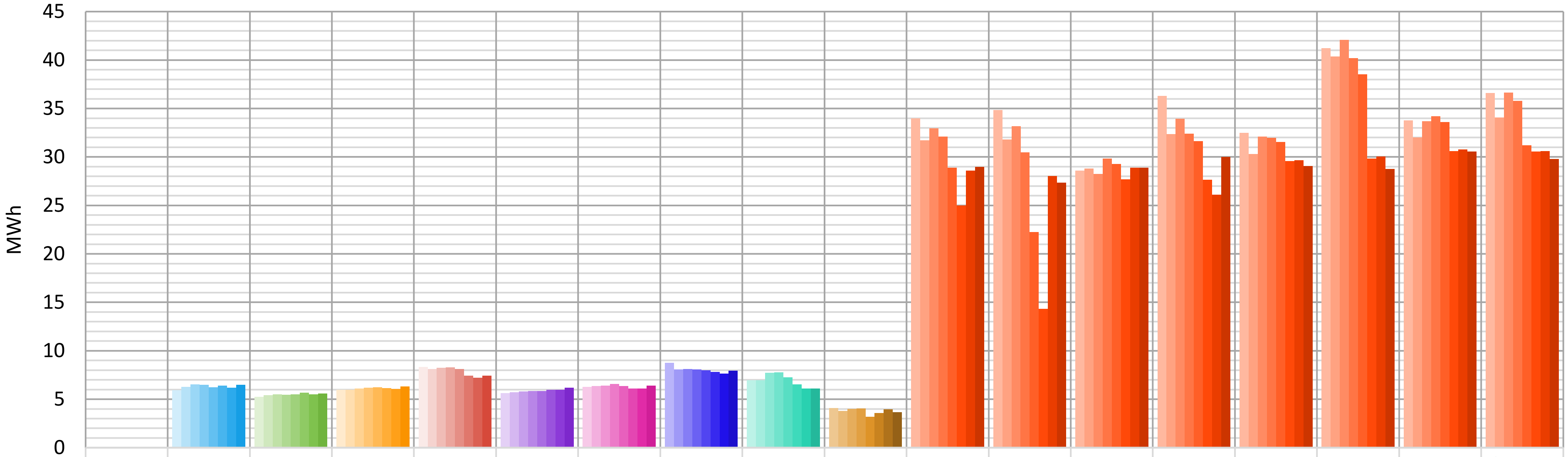
15.1 DELIVERED ELECTRICITY

These 7 AEP companies and total of AEP are having similar level of electricity delivered per consumer, especially in 2015 (27 – 31 MWh/year, i.e. relative standard deviation of 3,1%), as shown on Figure 15.2. It is much higher than in DSOs in SEE where values for 2015 range from 3.679 kWh/consumer (OSHEE) to 7.934 kWh/consumer (HEP), with an average of 6.229 kWh/consumer. Comparing this average value for SEE DSOs in 2015 and 2012 to the values that AEP had in the same years, it is observed that this ratio slightly increased (AEP had 4,6 times in 2012 to 4,7 times in 2015 higher delivered electricity per consumer than SEE DSOs). This clearly shows different level of economic development and/or small to medium industrial activity.

Similar to that, US companies are also having much higher level of electricity delivered per employee (28 – 36 GWh/employee, relative standard deviation in 2015 was 8%), as shown on Figure 15.3. It is much higher than in SEE DSOs where average electricity delivered per employee in 2015 was 1,567 GWh/employee (on average 20 times lower in 2015, compared to 2012 this difference increased for 25%). When evaluating this indicator, several facts should be taken into account, e.g. whether DSO is bundled with supply business, and/or with other parts of vertically integrated company, level of outsourcing of its tasks, etc. At first, it can be assumed with great certainty that US companies are significantly more efficient.

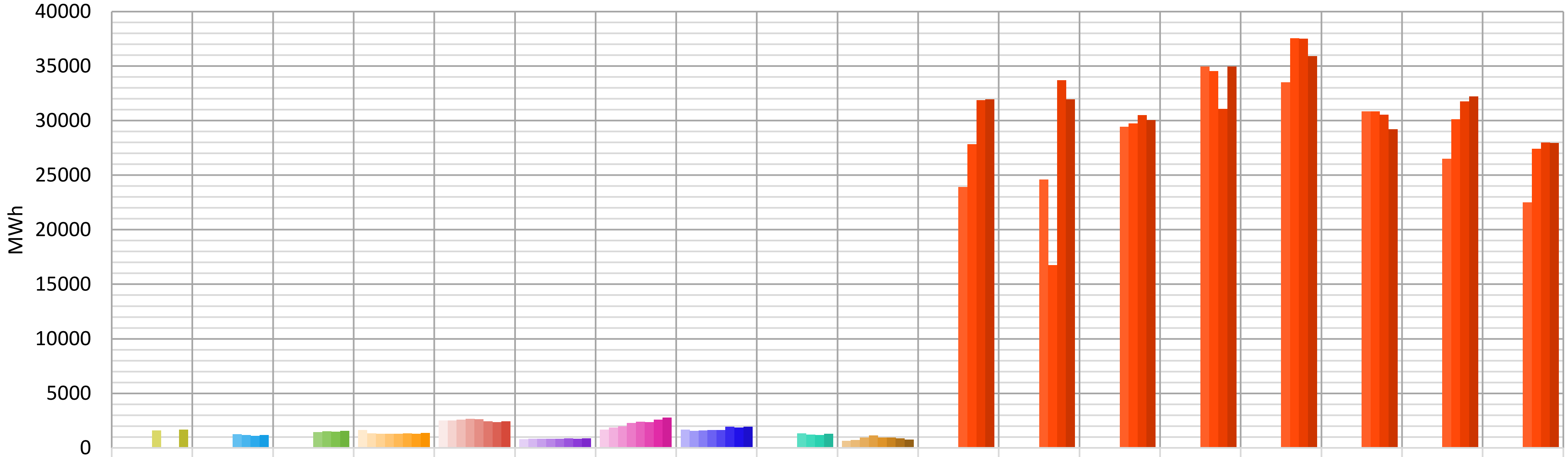
The number of customers per employee is calculated and shown on Figure 15.4. It shows that average number of customers per employee in SEE DSOs in 2015 was 247 (2% higher than 2012), while in the US DSOs in 2015 it was 1102 (33% higher than 2012), i.e. this ratio in 2015 in US DSOs was 4,5 times higher than in SEE DSOs (31% higher than in 2012).

Figure 15.5 shows the level of electricity delivered per network length. Again, US companies are having significantly higher values than those from the SEE DSOs. In 2015 in the SEE DSOs average value was 123 MWh/km (5% lower than 2012), while in the US DSOs this value was 466 MWh/km (8% higher than 2012). This suggests that the distribution network infrastructure in US AEP is about four times more efficiently used than in SEE.



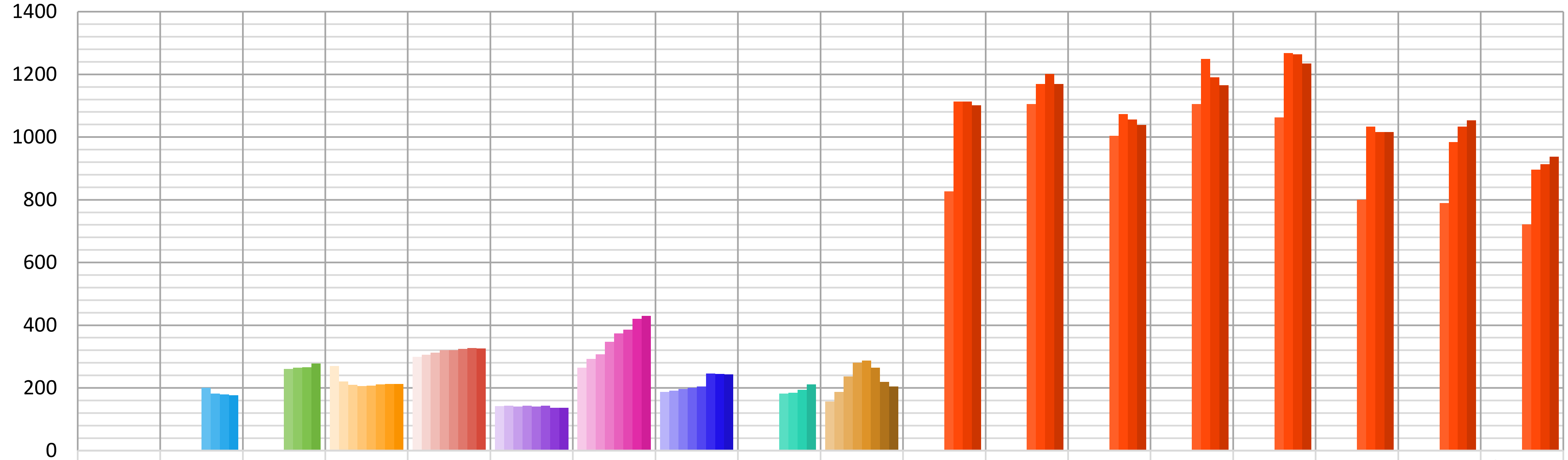
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	AEP	AEP-OH	AEP-TX	APCo	I&M	KPCo	PSO	SWEPCO
2008	0	5,929	5,267	5,969	8,328	5,625	6,271	8,764	6,955	4,091	33,986	34,83	28,608	36,287	32,5	41,21	33,764	36,592
2009	0	6,274	5,415	5,982	8,106	5,722	6,379	8,089	6,966	3,793	31,706	31,799	28,809	32,355	30,297	40,369	32,035	34,053
2010	0	6,524	5,494	6,107	8,263	5,808	6,383	8,11	7,751	3,99	32,959	33,161	28,248	33,929	32,121	42,068	33,688	36,639
2011	0	6,468	5,482	6,185	8,271	5,855	6,564	8,053	7,787	4,065	32,112	30,485	29,845	32,421	31,973	40,189	34,184	35,808
2012	0	6,24	5,499	6,252	8,125	5,835	6,348	7,98	7,273	3,191	28,908	22,239	29,297	31,615	31,543	38,532	33,586	31,194
2013	0	6,397	5,663	6,147	7,414	5,959	6,118	7,804	6,523	3,591	25,014	14,335	27,692	27,662	29,595	29,823	30,622	30,568
2014	0	6,17	5,49	6,051	7,2	5,973	6,105	7,632	6,085	3,944	28,598	28,039	28,871	26,106	29,666	30,056	30,755	30,624
2015	0	6,489	5,574	6,321	7,412	6,177	6,385	7,934	6,09	3,679	28,983	27,338	28,906	30	29,075	28,747	30,571	29,791

Figure 15.2 Electricity delivered per consumer in SEE and US DSOs in the period 2008-2015



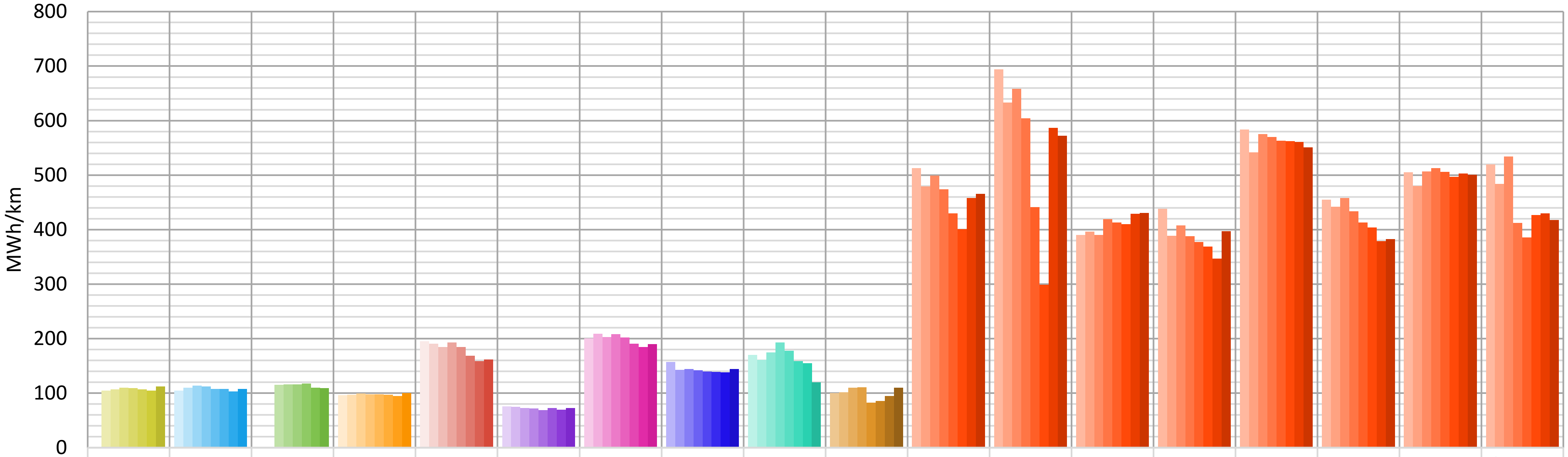
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	AEP	AEP-OH	AEP-TX	APCo	I&M	KPCo	PSO	SWEPCO
2008	0	0	0	1614	2492	799	1656	1639	0	639	0	0	0	0	0	0	0	0
2009	0	0	0	1322	2480	820	1861	1543	0	709	0	0	0	0	0	0	0	0
2010	0	0	0	1280	2581	819	1960	1586	0	945	0	0	0	0	0	0	0	0
2011	0	0	0	1274	2655	838	2279	1610	0	1140	0	0	0	0	0	0	0	0
2012	1568	1247	1427	1294	2604	825	2371	1630	1320	915	23913	24593	29421	34963	33522	30836	26499	22485
2013	0	1165	1494	1299	2407	850	2361	1921	1208	948	27836	16753	29717	34537	37531	30837	30122	27394
2014	0	1103	1459	1285	2354	818	2561	1860	1178	863	31872	33680	30481	31084	37492	30523	31766	27964
2015	1649	1146	1549	1349	2417	846	2745	1925	1283	756	31951	31948	30039	34955	35888	29196	32204	27954

Figure 15.3 Electricity delivered per employee in SEE and US DSOs in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	AEP	AEP-OH	AEP-TX	APCo	I&M	KPCo	PSO	SWEPCO
2008	0	0	0	270	299	142	264	187	0	156	0	0	0	0	0	0	0	0
2009	0	0	0	221	306	143	292	191	0	187	0	0	0	0	0	0	0	0
2010	0	0	0	210	312	141	307	196	0	237	0	0	0	0	0	0	0	0
2011	0	0	0	206	321	143	347	200	0	280	0	0	0	0	0	0	0	0
2012	0	200	260	207	320	141	374	204	182	287	827	1106	1004	1106	1063	800	789	721
2013	0	182	264	211	325	143	386	246	185	264	1113	1169	1073	1249	1268	1034	984	896
2014	0	179	266	212	327	137	420	244	194	219	1114	1201	1056	1191	1264	1016	1033	913
2015	0	177	278	213	326	137	430	243	211	205	1102	1169	1039	1165	1234	1016	1053	938

Figure 15.4 Number of consumers per employee in SEE and US DSOs in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	AEP	AEP-OH	AEP-TX	APCo	I&M	KPCo	PSO	SWEPCO
2008	0	105	0	96	195	76	201	157	170	100	513	694	390	438	584	455	505	520
2009	105	110	0	97	191	75	209	143	161	102	479	633	396	389	542	442	480	484
2010	107	114	115	99	185	73	203	144	175	110	499	658	390	408	575	458	507	534
2011	110	112	116	98	193	72	208	142	193	111	474	604	419	388	570	434	513	412
2012	109	108	116	98	185	69	202	140	178	83	430	441	413	377	563	413	506	386
2013	107	108	118	97	169	73	191	139	159	86	401	299	410	369	562	404	497	427
2014	105	103	110	95	159	70	185	138	155	95	458	587	429	347	561	379	503	430
2015	112	108	109	100	162	73	190	144	120	110	466	572	431	397	551	383	501	418

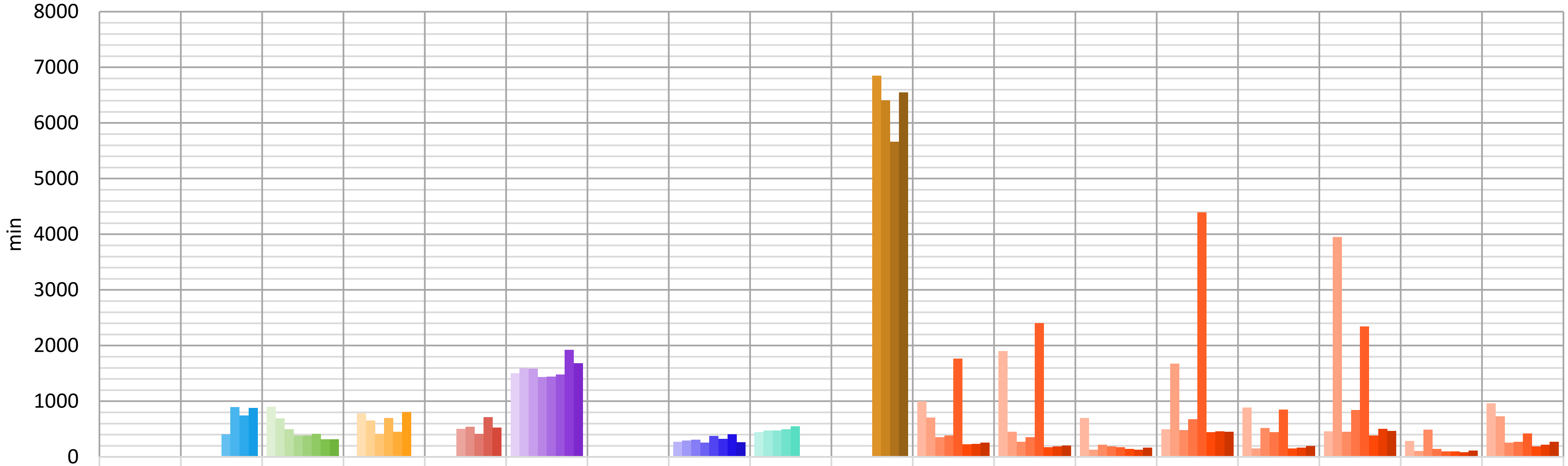
Figure 15.5 Electricity delivered per network length in SEE and US DSOs in the period 2008-2015

15.2 CONTINUITY OF SUPPLY

SAIDI indicator for unplanned interruptions at all voltage levels is shown on Figure 15.6. In the US DSOs this values had very high relative standard deviation in the observed period, 82%. In 2015, this value in US AEP was lower than in any SEE DSOs, especially compared to OSHEE which had much higher value than any other SEE DSO.

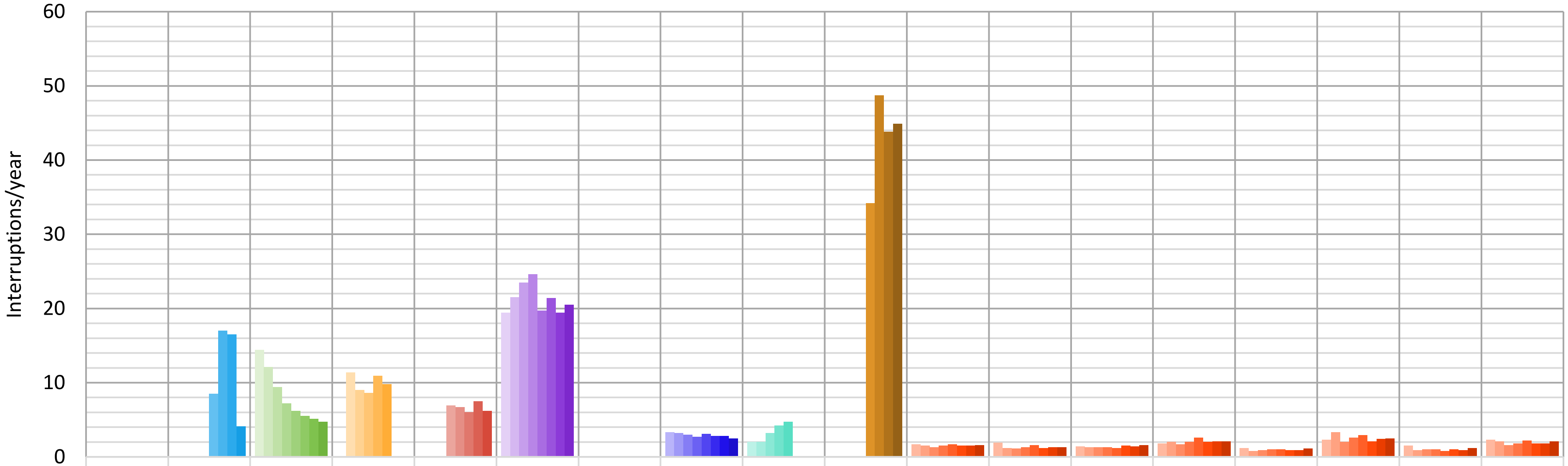
Similarly, SAIFI indicator for unplanned interruptions at all voltage levels shows large differences between SEE and US DSOs. In given US DSOs SAIFI for unplanned interruptions was below 3 interruptions per year in 2015, while in SEE DSOs it was in the range between 2,5 interruptions/year (HEP) and 44,9 interruptions/year (OSHEE), as shown on 15.8.

SAIDI and SAIFI indicators for planned interruptions at all voltage levels for the US DSOs in the period 2013-2015 were unavailable, Figures 15.8 and 15.9. Comparing those values for 2012, it can be seen that this values in the US DSOs were practically near to zero. In other words, network maintenance and other planned activities in the US cause almost no supply interruptions, mostly due to “live working” (work without disconnection) or different maintenance practice. In the SEE DSOs, SAIDI ranged between 25 minutes (KEDS, 2012) and 1045 minutes (OSHEE, 2014), while SAIFI ranged between 0,22 interruptions/year (KEDS, 2012) to 9,69 interruptions/year (ERS, 2009).



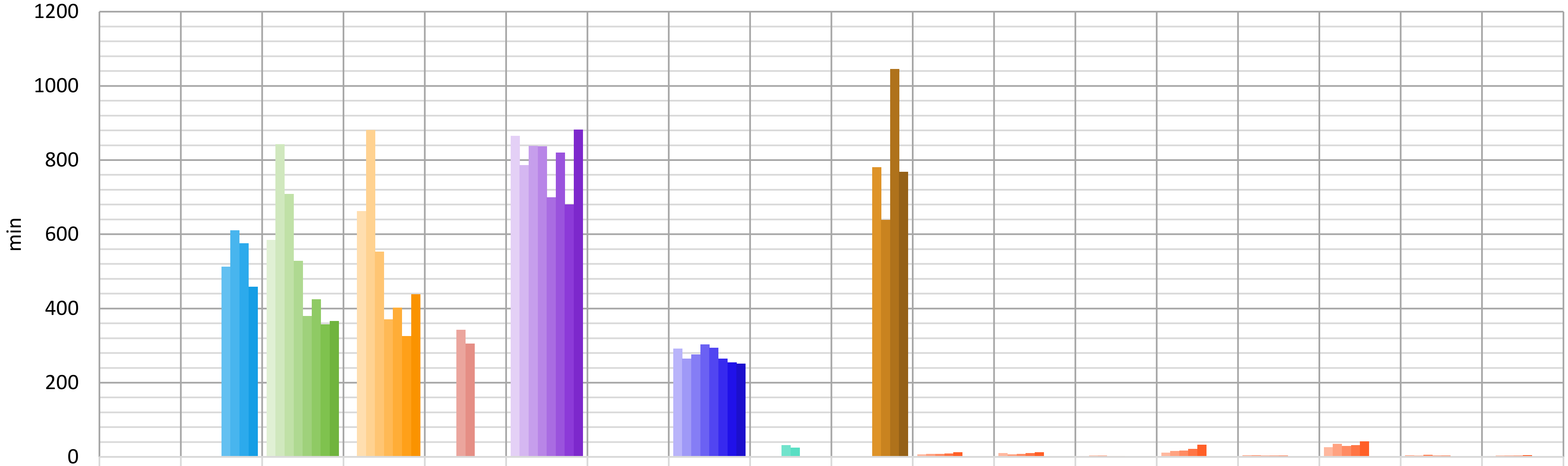
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	AEP	AEP-OH	AEP-TX	APCo	I&M	KPCo	PSO	SWEPCO
2008	0	0	903	0	0	1501	0	270	445	0	999	1899	695	497	884	455	285	961
2009	0	0	689	784	0	1589	0	296	471	0	704	453	130	1676	149	3953	101	727
2010	0	0	495	654	0	1582	0	307	476	0	355	271	215	481	521	452	486	252
2011	0	0	380	412	501	1434	0	251	494	0	380	351	185	677	444	841	140	269
2012	0	402	383	699	541	1444	0	372	548	6849	1764	2402	174	4389	850	2343	97	419
2013	0	890	415	448	409	1476	0	320	0	6407	221	174	140	441	147	383	94	190
2014	0	740	317	802	710	1925	0	402	0	5662	232	187	126	454	162	505	84	216
2015	0	878	312	0	522	1679	0	265	0	6547	251	202	164	448	193	468	112	271

Figure 15.6 SAIDI - unplanned interruptions at all voltage levels - all events in SEE and US DSOs in the period 2008-2015



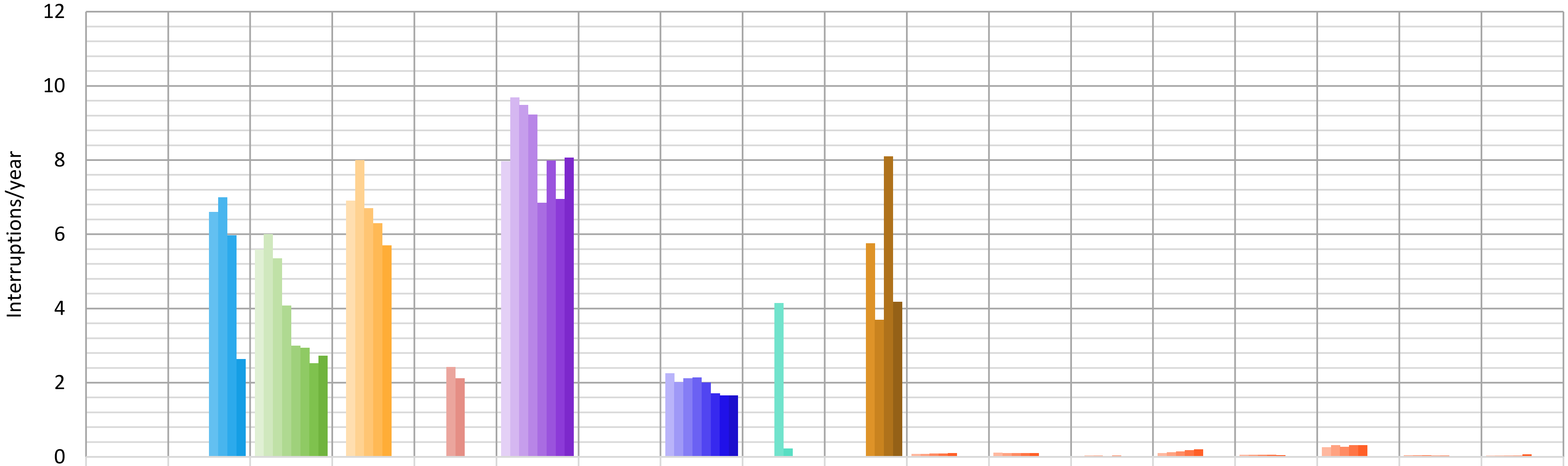
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	AEP	AEP-OH	AEP-TX	APCo	I&M	KPCo	PSO	SWEPCO
2008	0	0	14,4	0	0	19,4	0	3,3	2	0	1,7	1,9	1,4	1,8	1,2	2,3	1,5	2,3
2009	0	0	12,1	11,4	0	21,5	0	3,2	2	0	1,5	1,2	1,3	2	0,8	3,3	0,9	2,1
2010	0	0	9,4	9	0	23,5	0	3	3,2	0	1,3	1,1	1,3	1,7	0,9	2	1	1,6
2011	0	0	7,2	8,6	6,9	24,6	0	2,7	4,2	0	1,5	1,3	1,3	2	1	2,6	1	1,8
2012	0	8,5	6,2	10,9	6,7	19,7	0	3,1	4,7	34,2	1,7	1,6	1,2	2,6	1	2,9	0,8	2,2
2013	0	17	5,5	9,8	6	21,4	0	2,8	0	48,7	1,5	1,2	1,5	2	0,9	2,1	1	1,8
2014	0	16,5	5,1	0	7,5	19,4	0	2,8	0	43,8	1,5	1,3	1,4	2,1	0,9	2,4	0,9	1,8
2015	0	4,1	4,7	0	6,2	20,5	0	2,5	0	44,9	1,6	1,3	1,6	2,1	1,1	2,5	1,2	2,1

Figure 15.7 SAIFI - unplanned interruptions at all voltage levels - all events in SEE DSOs and USA DSOs in period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	AEP	AEP-OH	AEP-TX	APCo	I&M	KPCo	PSO	SWEPCO
2008	0	0	584	0	0	865	0	292	0	0	7	10	2	11	4	26	4	2
2009	0	0	843	662	0	786	0	265	0	0	8	7	3	16	4	35	3	3
2010	0	0	708	881	0	838	0	276	0	0	8	8	3	17	3	29	5	3
2011	0	0	528	553	342	837	0	303	31	0	9	10	2	21	3	32	3	3
2012	0	512	380	371	305	699	0	294	25	781	12	12	2	33	3	42	3	4
2013	0	610	425	402	0	820	0	265	0	639	0	0	0	0	0	0	0	0
2014	0	576	357	325	0	680	0	254	0	1045	0	0	0	0	0	0	0	0
2015	0	458	366	438	0	882	0	251	0	768	0	0	0	0	0	0	0	0

Figure 15.8 SAIDI - planned interruptions at all voltage levels - all events in SEE and US DSOs in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	AEP	AEP-OH	AEP-TX	APCo	I&M	KPCo	PSO	SWEPCO
2008	0	0	5,59	0	0	7,96	0	2,25	0	0	0,08	0,11	0,02	0,1	0,06	0,26	0,04	0,03
2009	0	0	6	6,9	0	9,69	0	2,02	0	0	0,08	0,1	0,03	0,12	0,06	0,32	0,04	0,03
2010	0	0	5,35	8	0	9,48	0	2,12	0	0	0,09	0,1	0,03	0,15	0,06	0,27	0,04	0,03
2011	0	0	4,08	6,7	2,42	9,22	0	2,14	4,15	0	0,09	0,1	0,02	0,18	0,05	0,32	0,03	0,03
2012	0	6,6	2,99	6,3	2,12	6,85	0	2	0,22	5,76	0,1	0,1	0,03	0,2	0,04	0,31	0,03	0,07
2013	0	7	2,94	5,7	0	7,99	0	1,71	0	3,69	0	0	0	0	0	0	0	0
2014	0	5,97	2,52	0	0	6,95	0	1,66	0	8,1	0	0	0	0	0	0	0	0
2015	0	2,64	2,73	0	0	8,06	0	1,66	0	4,18	0	0	0	0	0	0	0	0

Figure 15.9 SAIFI - planned interruptions at all voltage levels - all events in SEE and US DSOs in the period 2008–2015

15.3 NUMBER OF INTERRUPTIONS

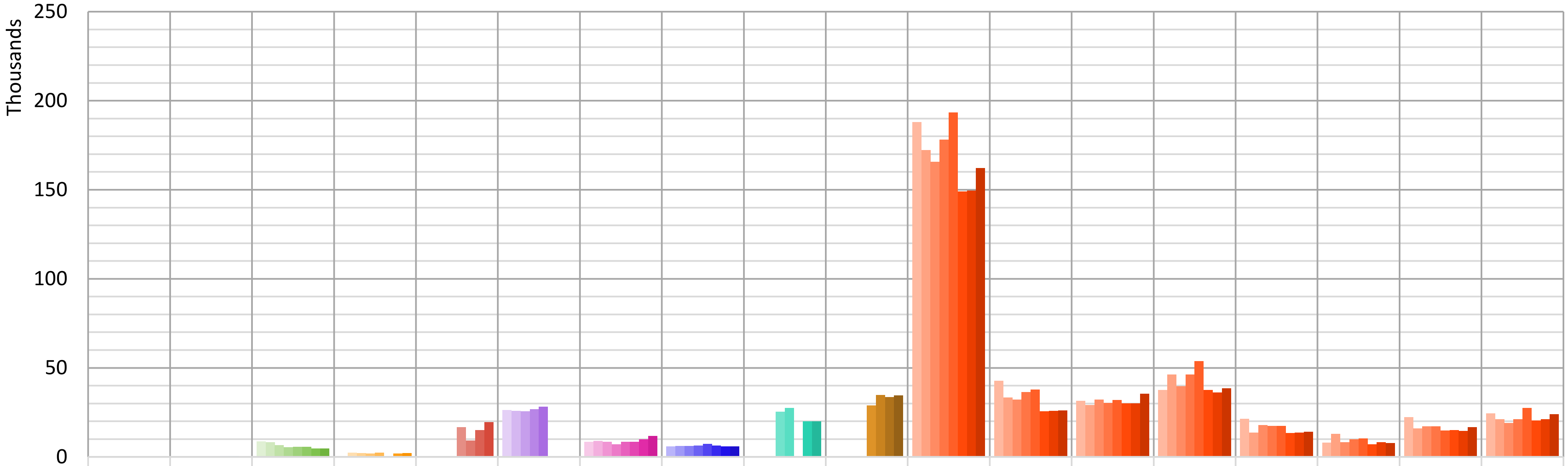
A distinction is often made between the types of interruptions, based on their duration (source: CEER - 6th Benchmarking Report on Quality of Electricity and Gas Supply, 2016). In most European countries, an interruption is referred to as a “short interruption” if it lasts 3 minutes or less. A long interruption is an interruption that lasts more than 3 minutes. These definitions are in accordance with the European standard EN 501601. The reason for this distinction has to do with the way in which continuity data has traditionally been collected. The event that has traditionally been recorded by the system operator was the manual reconnection of the supply. The start of the interruption, when due to the automatic opening of a piece of switchgear (typically a circuit breaker triggered by a protection relay), was not recorded in some cases, or was recorded only by the data-acquisition system and not included in continuity statistics. Also, the end of the interruption was not recorded if the interrupting device was closed automatically (in practice referred to as “auto-reclosing”). The collection of data for these interruptions requires automatic registration, either of voltages at the customer connection or of switching actions in the network. As the duration of interruptions terminated by auto-reclosing is much shorter than interruptions terminated manually, the former are referred to as “short interruptions”. Apart from the difficulties in recording automatically-terminated interruptions, there are other reasons for treating these interruptions differently. The aim of the auto-reclosing scheme is to prevent customers from experiencing long interruptions with durations of several hours or more. Instead, the customers experience short interruptions, with durations between a few seconds and a few minutes. In many cases, the auto-reclosing scheme is such that the customer experiences more short interruptions with the scheme than long interruptions without the scheme. Traditionally, for many customers, the impact of a 1-minute interruption is negligible or at least, much less than the impact of a 1-hour interruption. The result of the auto-reclosing scheme has therefore traditionally been a reduction of the total inconvenience for customers. Due to a number of developments, beyond the scope of this report, the situation has changed.

However, the impact is strongly dependent on the type of customer, with industrial and commercial customers typically being impacted more than household customers. For a growing number of customers, especially industrial customers, even 1-minute interruptions are of similar concern as a longer interruption. Therefore, the need has arisen for information on the number and duration of short interruptions. In some more developed systems, a further distinction between short interruptions and transient interruptions is made, where the transient interruptions are interruptions of up to a few seconds. The reason for this distinction is partially due to the difference in origin between short and transient interruptions and partly due to the difference of the impact of the interruptions on customers. The impact of transient interruptions is typically less, but in cases of large motor loads a transient interruption may lead to equipment damage when there is insufficient coordination between the motor protection and the auto-reclose scheme. Also, damage to electronic equipment due to transient interruptions has been reported.

For the purpose of this study the data on long unplanned and long planned interruptions were collected both for SEE and US DSOs. The following Figure shows total number of long unplanned interruptions in SEE and US DSOs. Besides already mentioned exceptions (OSHEE, ERS and KEDS), total number of long unplanned interruptions is significantly lower in SEE than in the US DSOs, as expected due to network size. With exception of AEP (which is the sum of all other US DSOs), the other US DSOs in 2015 were all below 39.000 long unplanned interruptions.

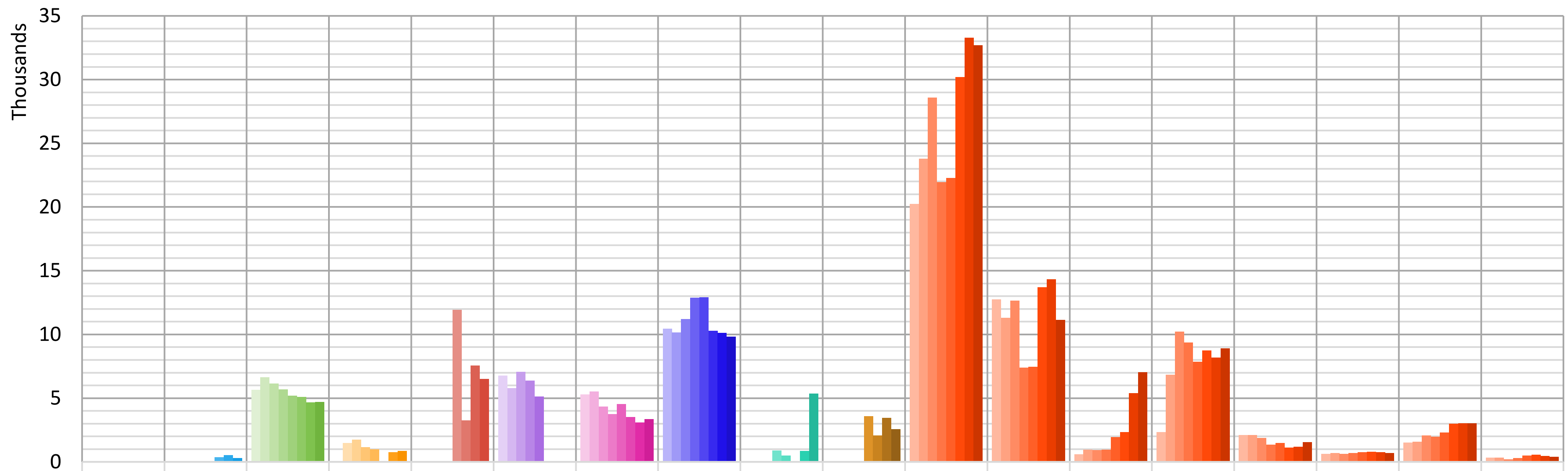
Total number of long planned interruptions are shown on Figure 15.11. These data are showing large variations between different DSOs, starting from KEDS and EPS in SEE and AEP-OH and AEP-TX in the US. In general, it can be concluded that there are no regional specificities that would explain differences in number of long planned interruptions in SEE and the US.

On Figure 15.12 are shown shares of aerial and cable networks in the SEE and US DSOs, since it is known that cable network experience much lower power interruptions. It can be seen that SEE DSOs and US DSOs in average have similar ratios of these two network types.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	AEP	AEP-OH	AEP-TX	APCo	I&M	KPCo	PSO	SWEPCO
2008	0	0	8706	0	0	26260	8470	5911	0	0	187862	42722	31481	37553	21409	7963	22252	24482
2009	0	0	8272	2356	0	25759	8965	6131	0	0	172214	33234	29151	46199	13524	12889	16050	21167
2010	0	0	6543	1999	0	25648	8484	6074	0	0	165743	32106	32045	39536	17711	8205	17214	18926
2011	0	0	5474	1816	0	26760	7096	6229	25226	0	178167	36242	30264	46267	17354	9734	17125	21181
2012	0	0	5686	2240	16683	28123	8322	7357	27390	28958	193256	37855	31904	53691	17440	10220	14692	27454
2013	0	425	5675	0	9208	0	8543	6319	0	34810	149019	25665	30046	37635	13241	7043	14891	20498
2014	0	375	4754	1966	14910	0	9906	5875	19819	33477	149377	25755	29960	36183	13588	8247	14612	21032
2015	0	241	4693	2189	19363	0	11729	5815	19961	34522	162237	26032	35426	38491	14028	7766	16529	23965

Figure 15.10 Total number of long unplanned interruptions in SEE and US DSOs in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	AEP	AEP-OH	AEP-TX	APCo	I&M	KPCo	PSO	SWEPCO
2008	0	0	5650	0	0	6764	5279	10440	0	0	20249	12761	598	2337	2105	611	1506	331
2009	0	0	6644	1483	0	5787	5511	10134	0	0	23779	11303	943	6846	2096	677	1579	335
2010	0	0	6143	1735	0	7064	4350	11191	0	0	28567	12650	928	10206	1885	620	2079	199
2011	0	0	5683	1137	0	6365	3741	12893	877	0	21948	7378	951	9350	1333	676	1956	304
2012	0	0	5187	981	11915	5128	4547	12904	488	3595	22275	7468	1941	7850	1492	760	2290	474
2013	0	354	5091	0	3244	0	3500	10288	0	2067	30184	13683	2340	8734	1117	777	2993	540
2014	0	523	4655	758	7552	0	3093	10123	836	3434	33275	14321	5401	8172	1165	752	3023	441
2015	0	293	4702	850	6516	0	3335	9836	5358	2570	32687	11135	7024	8892	1552	679	3008	397

Figure 15.11 Total number of long planned interruptions in SEE and US DSOs in the period 2008-2015

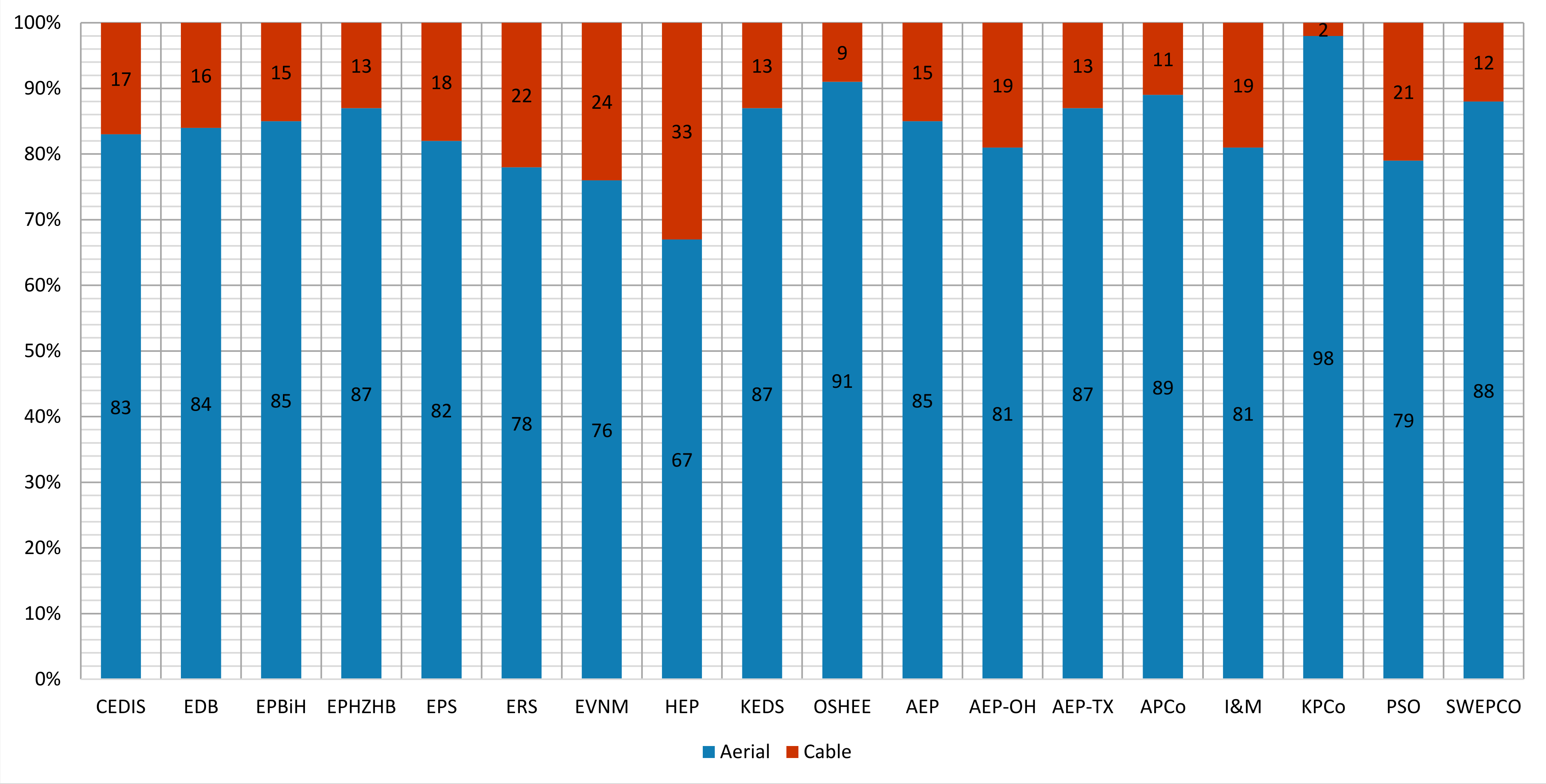
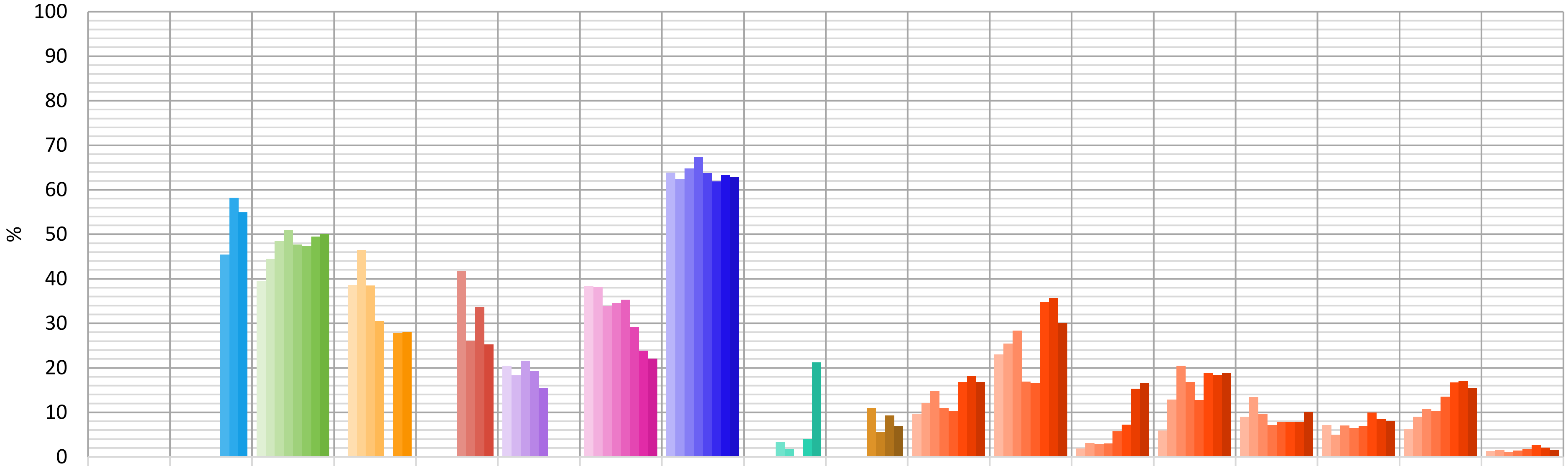


Figure 15.12 Share of aerial and cable network in SEE and US DSOs in 2015

15.4 SHARE OF PLANNED TO TOTAL INTERRUPTIONS

Finally, it is interesting to analyze the share of planned in total number of interruptions. The following Figure show some kind of structural difference between SEE and the US DSOs. In SEE DSOs average share of planned in total number of interruptions in 2015 (for those DSOs which submitted the data) was 38%, while in US AEP this value was 17% (lower more than double). These values again prove that the maintenance and other planned interruptions are performed in different way in the US and SEE DSOs. Differences mainly refer to “live working” (i.e. work on the equipment without its disconnection). This could be one of the areas in which SEE DSOs could analyze and take over US practice and experience in order to reduce number and duration of planned interruptions.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	AEP	AEP-OH	AEP-TX	APCo	I&M	KPCo	PSO	SWEPCO
2008	0	0	39,4	0	0	20,5	38,4	63,8	0	0	9,7	23	1,9	5,9	9	7,1	6,3	1,3
2009	0	0	44,5	38,6	0	18,3	38,1	62,3	0	0	12,1	25,4	3,1	12,9	13,4	5	9	1,6
2010	0	0	48,4	46,5	0	21,6	33,9	64,8	0	0	14,7	28,3	2,8	20,5	9,6	7	10,8	1
2011	0	0	50,9	38,5	0	19,2	34,5	67,4	3,4	0	11	16,9	3	16,8	7,1	6,5	10,3	1,4
2012	0	0	47,7	30,5	41,7	15,4	35,3	63,7	1,8	11	10,3	16,5	5,7	12,8	7,9	6,9	13,5	1,7
2013	0	45,4	47,3	0	26,1	0	29,1	61,9	0	5,6	16,8	34,8	7,2	18,8	7,8	9,9	16,7	2,6
2014	0	58,2	49,5	27,8	33,6	0	23,8	63,3	4	9,3	18,2	35,7	15,3	18,4	7,9	8,4	17,1	2,1
2015	0	54,9	50	28	25,2	0	22,1	62,8	21,2	6,9	16,8	30	16,5	18,8	10	8	15,4	1,6

Figure 15.13 Share of planned in total number of interruptions in SEE and US DSOs in the period 2008–2015

16 RECOMMENDATIONS

At the beginning of SEE DSO benchmarking project in 2013 the working group set basic targets, while after the first benchmarking study in 2015 SEE DSO agreed on the future work recommendations. Based on all collected data, calculations and other countries' experience, the main study recommendations were divided in three groups:

- organizational recommendations,
- data harmonization and
- share best practices in distribution business,

In the meantime some of the recommendations from the first benchmarking study were adopted and implemented, as shown in the following Table.

Table 16.1 Table of recommendations for SEE DSOs implemented after the first SEE DSO benchmarking report

Organizational recommendations	
Harmonization of definitions and data	Based on the last few years of SEE DSO benchmarking experience the harmonization of definitions and data was mainly fulfilled and succesfull. In most of the cases there are no more different definitions of the same indicators, nor missunderstandings on the input data set.
Periodical reporting	Since the first Benchmarking report (2008-2012) SEE DSO agreed on this form and content of the common benchmarking reporting. Future editions were recommended to be prepared on annual or bi-annual basis and this edition is proof that this recommendation was implemented.

Data harmonization	
Distinction between network and supply service	Most of DSOs have been providing supply service to at least part of the customers. Therefore it was necessary to: ▪ Determine obligations for legal and functional unbundling as defined in national legislative. ▪ Determine common understanding on supply services. ▪ Estimate share of staff and infrastructure (offices) functionally related to supply service. This issue was mainly resolved in the meantime, so this report is having no further details on network and supply service separation.
Common rules for registering of DSO network energy balance	There are significant differences in structure of energy consumptions, possible other deliveries from distribution network as well as energy inflows to the distribution network. Since the energy losses are one of the most significant issues for most of

	DSOs, it was necessary to establish common way of balancing the energy flows and common rule for calculation of the losses: ▪ Determination of possible energy inflows to the distribution network (from transmission network or other DSO, from power plants connected to DSO network). ▪ Determination of possible energy deliveries from DSO network (to final customers, for DSO own consumption, for power plants own consumption, to other DSOs, to transmission network, …). ▪ Treatment of HV consumption in calculation of losses. Within this report it can be said that these recommendations were implemented.
Registering power supply interruptions as a measure of security of supply	Power supply interruptions can be used as a direct measure of security of supply. However, to use common continuity of supply indicators in such a way, the following prerequisites should be met: ▪ Common rules in registering power supply interruptions, with special emphasis on those originating from MV network. ▪ Common rules for definition of exceptional events with regard to power supply interruptions. In the last few years within this project significant effort has been put to implement this recommendation. This reports proves it's been partly fulfilled, but it is important to improve it continuously.

Share best practices in distribution business	
US experience in reduction of planned interruptions and level of network usage	In the first report it was concluded that in regional DSOs number of planned interruptions has been comparable to number of unplanned interruptions. The US DSOs have provided significantly different data, with shares of planned interruptions of only a few percent of total number of interruptions. This indicated that a lot can be learned from US experience in: ▪ network maintenance and ▪ network operation. In the meantime there were several presentations with deeper insight in relevant US experience and regulatory framework, as well as study tour visit to the US counterparts. It was definitely helpful for SEE DSO and it is recommended to continue with this kind of knowledge sharing.
Reduction of commercial losses	Although potential reductions vary from only a few percent up to about 30 %, all DSOs increased their efforts in reduction of commercial losses. Among other, the following measures are proven to be effective: ▪ detection of unauthorized connections or meter tampering, ▪ meter coverage at MV/LV substation and MV feeder levels.
DSO unbundling (legal and functional)	The obligation for legal and functional unbundling and rebranding of DSO for EU member states was set by the 2nd EU energy directive package (2003). The WG DSOs are bound to it by signature of the Energy Community Treaty and a number of them is currently in the process of complying to those obligations. It was recommended that DSOs share experience and solutions to possible obstacles that they had to overcome along the way. In the meantime, most of SEE DSO made significant progress.

However, this (second) benchmarking report also resulted with the following set of recommendations, given in the following Table.

Table 16.2 Table of recommendations for SEE DSOs to be implemented after this (second) benchmarking report

Organizational recommendations	
Continuous monitoring of selected data and indicators	What remains now is establishment of a system for continuous and automatic data collection and monitoring rather than occasional ad-hoc analysis. Accordingly, it is recommended to develop web based SEE DSO benchmarking platform that can be filled and used on-line by the SEE DSOs with occasional detailed reports as this one. To recap, the following steps are recommended: ▪ Establishment of a secure web-site designed for specific benchmarking data entry. ▪ Data collection should generally complete by the end of May for the previous year. ▪ Benchmarking team should meet annually (January) to discuss any changes in the strategic direction of the group and consider any new members.
Periodical reporting	▪ As already agreed, it is recommended to continue with bi-annual issues of SEE DSO benchmarking reports.

Data harmonization	
Estimation of technical and non-technical losses	Non-technical losses can be estimated only indirectly, as a difference between the total losses and technical ones. However, technical losses are also subject of an estimation based on very complex balancing and load/energy flow calculations. The WG agreed to launch new project and report on the energy efficiency in distribution network in line with legal obligations, with the aims: ▪ To analyze existing drivers and incentives (regulatory mechanisms) for SEE DSOs to decrease losses ▪ To elaborate SEE DSOs network development plans with regard of technical loss reduction ▪ To elaborate how DSO shall mobilize in addressing the provisions of the Article 15 of the EED and draw on the potential on the greater flexibility within the grid of DGs and demand side resources ▪ To review existing methodologies and potential improvement for determination of the technical and non-technical losses in the distribution network (input data, calculations, indispensable estimations)

Registering power supply interruptions as a measure of security of supply	As given above, in the last few years within this project significant effort has been put to implement this recommendation, but it is important to improve it continuously.

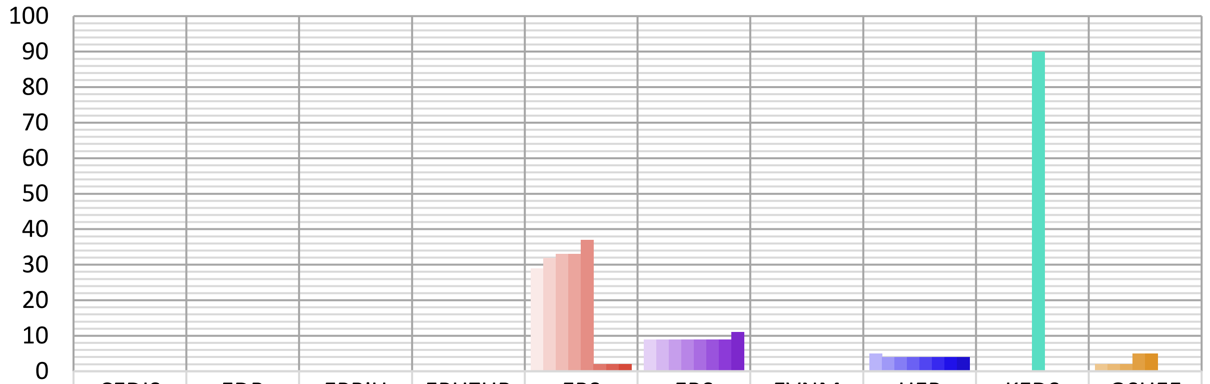
Share best practices in distribution business	
US experience in reduction of planned interruptions and level of network usage	Generally, in regional DSOs number of planned interruptions is comparable to number of unplanned interruptions. The US DSOs provided significantly different data, with shares of planned interruptions of only a few percent of total number of interruptions. This indicates that a lot can be learned from US experience in: ▪ network maintenance and ▪ network operation. It is recommended to continue with deeper insight in relevant US experience and regulatory framework.
Use of remote control or automation in MV networks	Reduction of durations of power supply interruptions can most effectively be achieved by extensive installation and use of remote control or even automation in MV network. Therefore, it is necessary to compare the DSOs with regard to: ▪ current status of SCADA and control centers, ▪ current status of remote control and automation along MV network, ▪ experience in reduction of time needed for location of faults in the MV network, ▪ best practices in optimal allocation of remote control switches along MV network.
Use of AMI for reduction of non-technical losses and registering of power supply interruptions	AMI can, among the usual functions of electricity meters, be used for: ▪ locating losses, to a certain extent, ▪ registering power supply interruptions, ▪ control of the connection point, ▪ measurement of voltage quality. Within the scope of activities, the WG is primarily interested in best practices with regard to first three aspects.
Reduction of commercial losses	Although reductions of commercial losses was significant in the last few years, all DSOs should continue with their efforts. Among other, the following measures are proven to be effective: ▪ detection of unauthorized connections or meter tampering, ▪ meter coverage at MV/LV substation and MV feeder levels.
Protection of vulnerable customers which cannot cover their energy bills	In order to improve their revenue collection, DSOs should take active role in deriving adequate measures, compliant to the 3rd EU energy directive package, for protection of vulnerable customers which cannot cover their energy bills.
Development of procedures for control and auditing of metering and billing process	Majority of billing errors should be detected and corrected before sending the bill to customer. Therefore, more accurate and strict procedures for control and auditing of the entire metering and billing process and correction of errors in timely manner should be developed.

17 LIST OF FIGURES

18 LIST OF TABLES

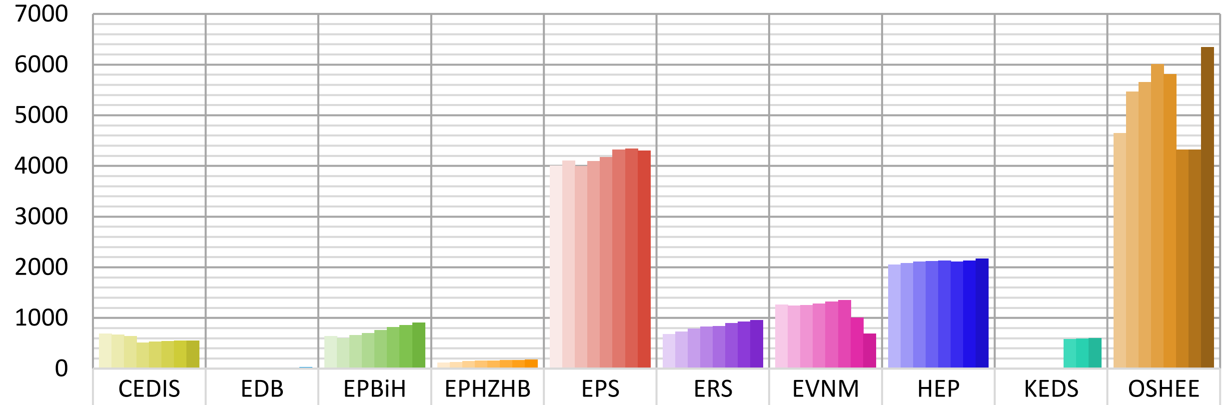
19 APPENDIX

19.1 NUMBER OF METERING POINTS



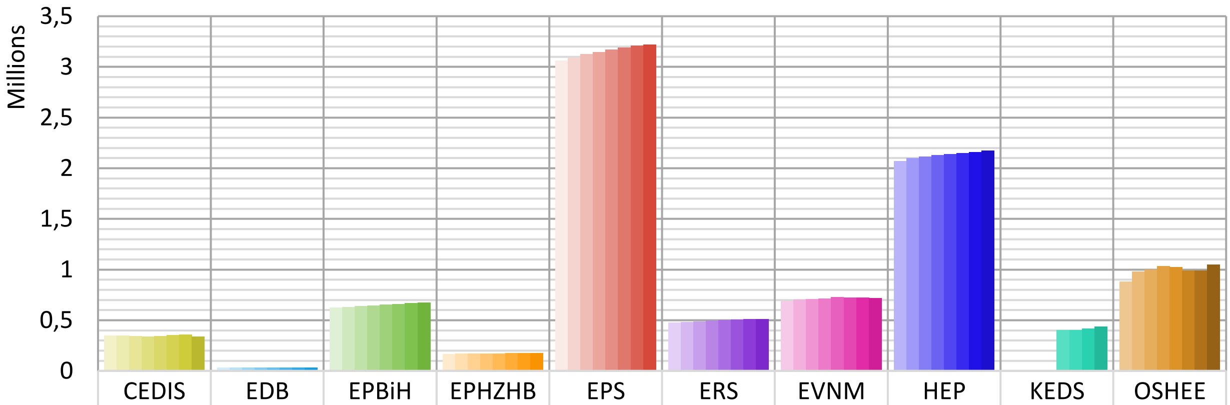
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	29	9	0	5	0	2
2009	0	0	0	0	32	9	0	4	0	2
2010	0	0	0	0	33	9	0	4	0	2
2011	0	0	0	0	33	9	0	4	0	5
2012	0	0	0	0	37	9	0	4	90	5
2013	0	0	0	0	2	9	0	4	0	0
2014	0	0	0	0	2	9	0	4	0	0
2015	0	0	0	0	2	11	0	4	0	0

Figure 19.1 Number of metering points in HV consumer category in SEE DSOs in the period 2008 - 2015



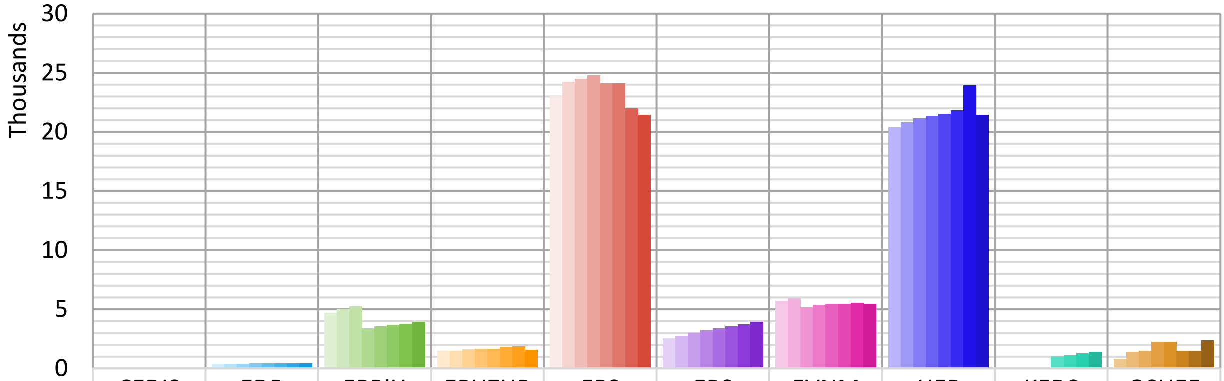
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	694	19	641	121	4003	678	1261	2056	0	4647
2009	672	19	604	125	4103	725	1244	2081	0	5465
2010	645	20	660	143	3997	788	1250	2112	0	5651
2011	513	20	701	154	4099	828	1284	2124	0	6012
2012	529	19	760	159	4176	836	1321	2135	0	5813
2013	543	14	814	166	4318	898	1351	2114	579	4318
2014	549	14	853	171	4342	928	1003	2127	595	4318
2015	547	31	905	176	4300	958	688	2167	603	6347

Figure 19.2 Number of metering points in MV consumer category in SEE DSOs in the period 2008 - 2015



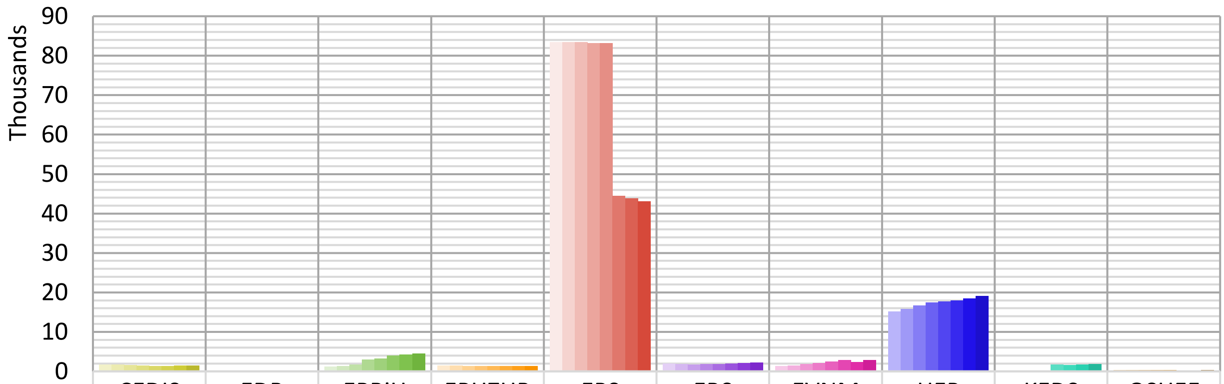
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	346196	31193	621830	167101	3060900	474541	689056	2069016	0	878313
2009	345526	31338	630503	168736	3091990	482570	704394	2099133	0	977584
2010	344416	31449	637086	169851	3124354	487964	708647	2116379	0	1001021
2011	337267	31492	645244	171156	3145909	493599	714688	2130247	0	1035149
2012	343392	31733	652102	172416	3171804	498891	725958	2137283	400170	1024497
2013	350712	30781	659705	173488	3190334	503661	722030	2148375	400501	990390
2014	356682	30892	668503	174391	3208908	508473	721106	2157442	418163	990390
2015	339709	30823	674648	175281	3221581	512083	719532	2171110	437610	1047485

Figure 19.3 Number of metering points in households consumer category in SEE DSOs in the period 2008 - 2015



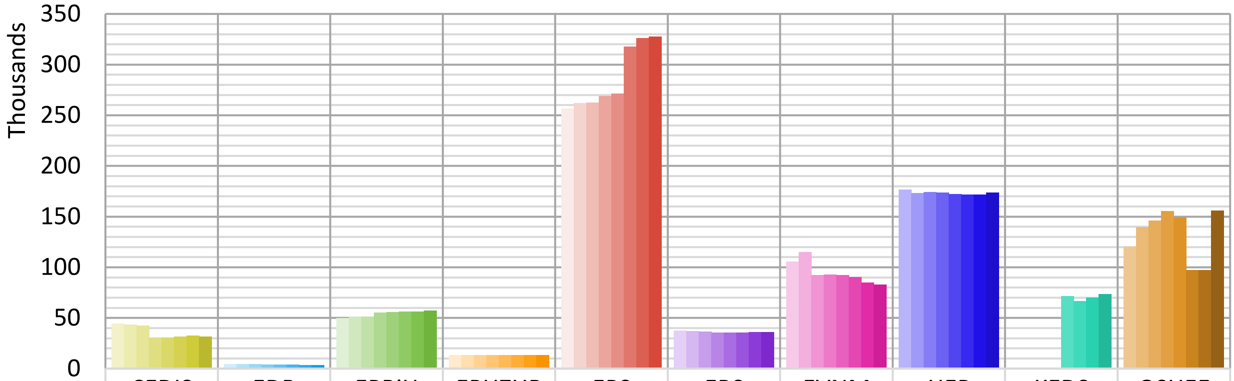
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	379	4704	1474	23013	2515	5707	20401	0	798
2009	0	392	5031	1484	24233	2728	5910	20818	0	1396
2010	0	398	5225	1611	24469	2985	5152	21126	0	1463
2011	0	399	3395	1649	24764	3219	5378	21351	0	2244
2012	0	399	3546	1659	24095	3380	5444	21537	1018	2251
2013	0	404	3668	1812	24111	3549	5465	21817	1086	1468
2014	0	418	3777	1862	21970	3726	5526	23934	1267	1468
2015	0	424	3921	1567	21441	3911	5472	21454	1400	2352

Figure 19.4 Number of metering points in public lighting consumer category in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	1769	63	1215	1427	83446	1960	1282	15109	0	306
2009	1723	65	1320	1406	83384	1831	1495	15810	0	335
2010	1605	62	1738	1382	83476	1720	1854	16636	0	338
2011	1463	63	2983	1361	83189	1796	2139	17386	0	341
2012	1328	59	3275	1316	83183	1893	2487	17741	1731	343
2013	1350	57	4035	1351	44488	1995	2872	18007	1567	224
2014	1399	56	4283	1376	43789	2103	2396	18401	1666	224
2015	1428	46	4456	1379	43054	2217	2877	19120	1779	358

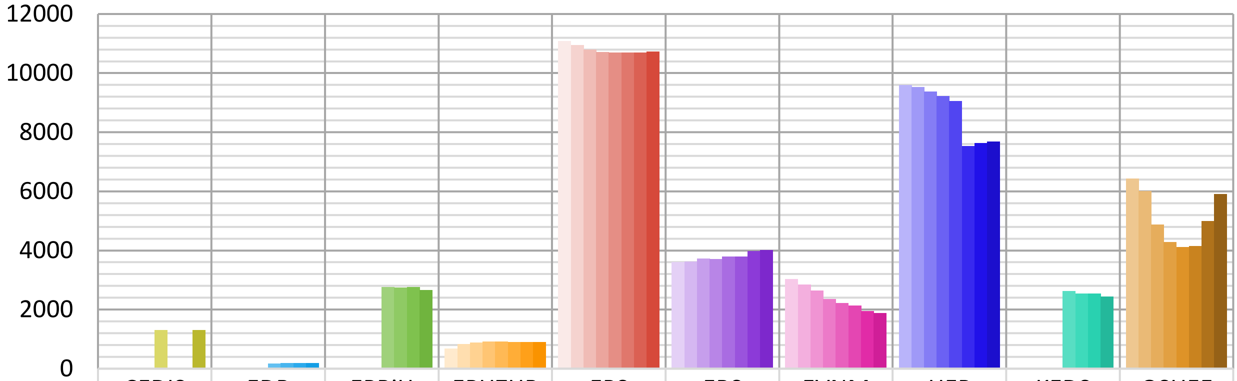
Figure 19.5 Number of metering points in LV-commercial with peak power registration consumer category in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	44521	4470	49934	13460	256458	37568	105778	176411	0	120507
2009	43315	4346	51056	13441	262020	37198	115009	172965	0	139603
2010	42264	4153	51119	13307	262228	36523	92347	174075	0	145899
2011	29949	3882	54978	13322	268912	35714	92834	173796	0	155514
2012	30664	3760	55728	13368	271122	35606	92156	172185	71740	149041
2013	31542	3724	56380	13180	317654	35682	90087	171552	66756	97196
2014	32515	3648	56184	13056	326339	36009	84683	171803	70132	97196
2015	31387	3645	56983	13408	327402	36193	83046	173807	73407	155728

Figure 19.6 Number of metering points in LV-commercial without peak power registration consumer category in SEE DSOs in the period 2008 – 2015

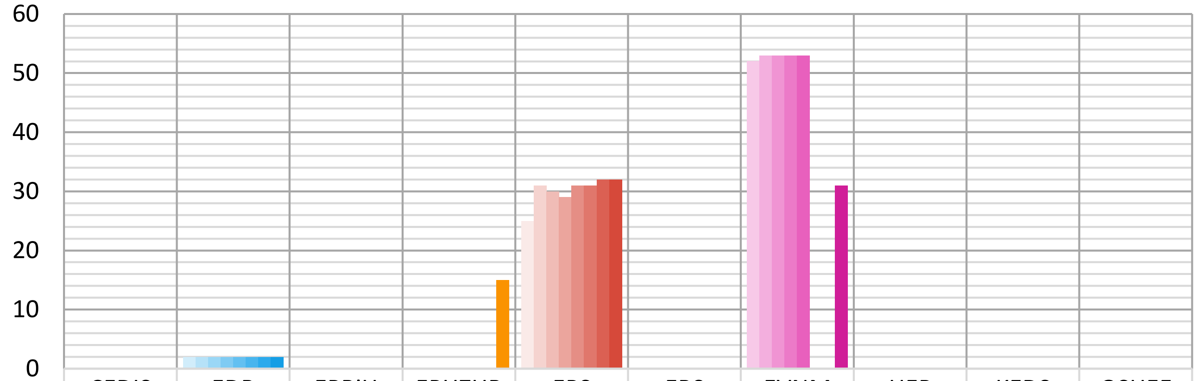
19.2 NUMBER OF EMPLOYEES



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	679	11089	3612	3041	9601	0	6433
2009	0	0	0	838	10952	3630	2839	9525	0	6015
2010	0	0	0	889	10801	3722	2636	9370	0	4875
2011	0	0	0	911	10711	3703	2351	9224	0	4278
2012	1311	180	2756	913	10692	3789	2215	9052	2627	4123
2013	0	192	2746	899	10700	3786	2130	7531	2540	4144
2014	0	196	2760	899	10700	3983	1942	7627	2540	5000
2015	1311	198	2667	899	10734	4011	1888	7680	2443	5901

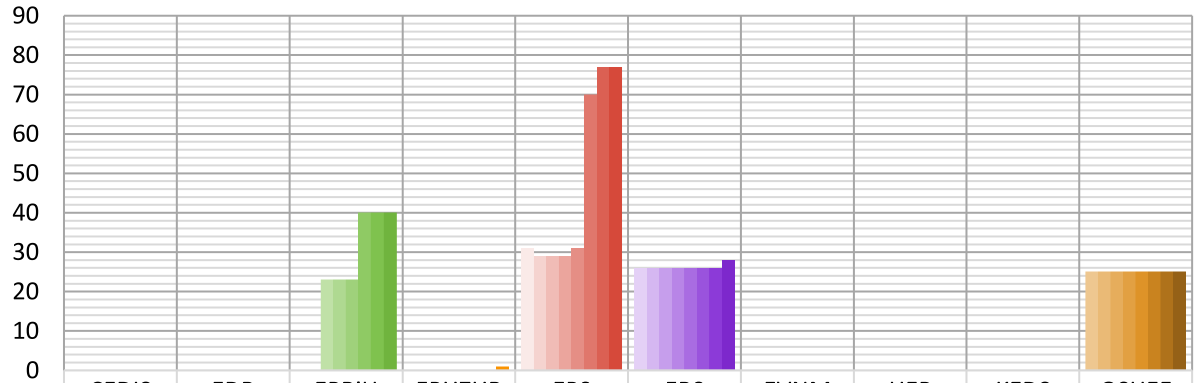
Figure 19.7 Number of employees in SEE DSOs in the period 2008-2015

19.3 NUMBER OF SUBSTATIONS



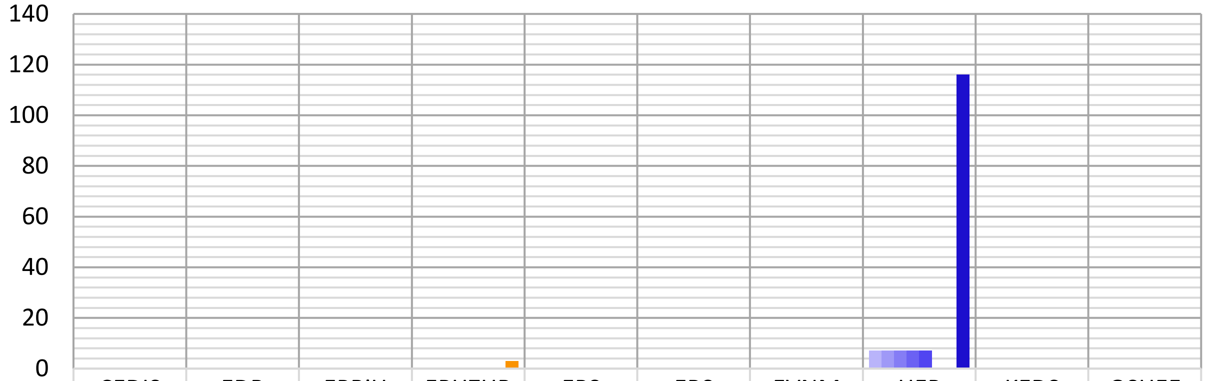
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	2	0	0	25	0	52	0	0	0
2009	0	2	0	0	31	0	53	0	0	0
2010	0	2	0	0	30	0	53	0	0	0
2011	0	2	0	0	29	0	53	0	0	0
2012	0	2	0	0	31	0	53	0	0	0
2013	0	2	0	0	31	0	0	0	0	0
2014	0	2	0	0	32	0	0	0	0	0
2015	0	2	0	15	32	0	31	0	0	0

Figure 19.8 Number of 110/35/10(20) kV substations in SEE DSOs in the period 2008 - 2015



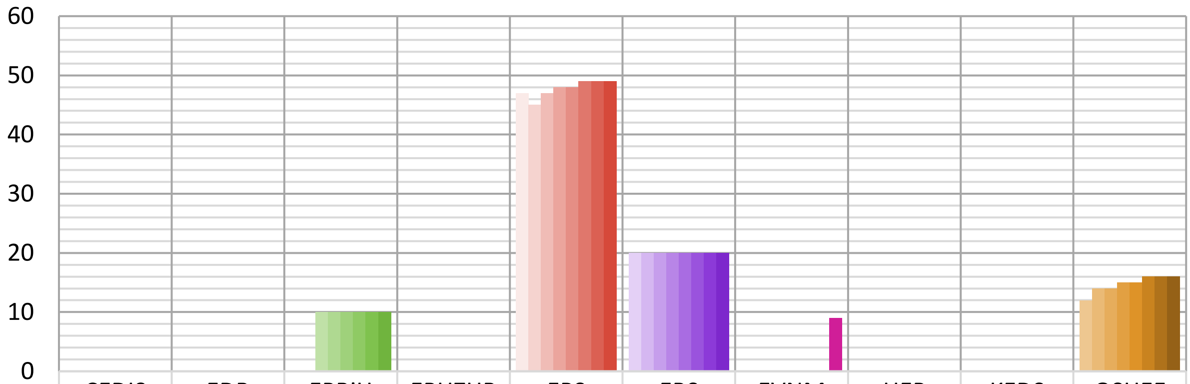
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	31	26	0	0	0	25
2009	0	0	0	0	29	26	0	0	0	25
2010	0	0	23	0	29	26	0	0	0	25
2011	0	0	23	0	29	26	0	0	0	25
2012	0	0	23	0	31	26	0	0	0	25
2013	0	0	40	0	70	26	0	0	0	25
2014	0	0	40	0	77	26	0	0	0	25
2015	0	0	40	1	77	28	0	0	0	25

Figure 19.9 Number of 110/35 kV substations in SEE DSOs in the period 2008 - 2015



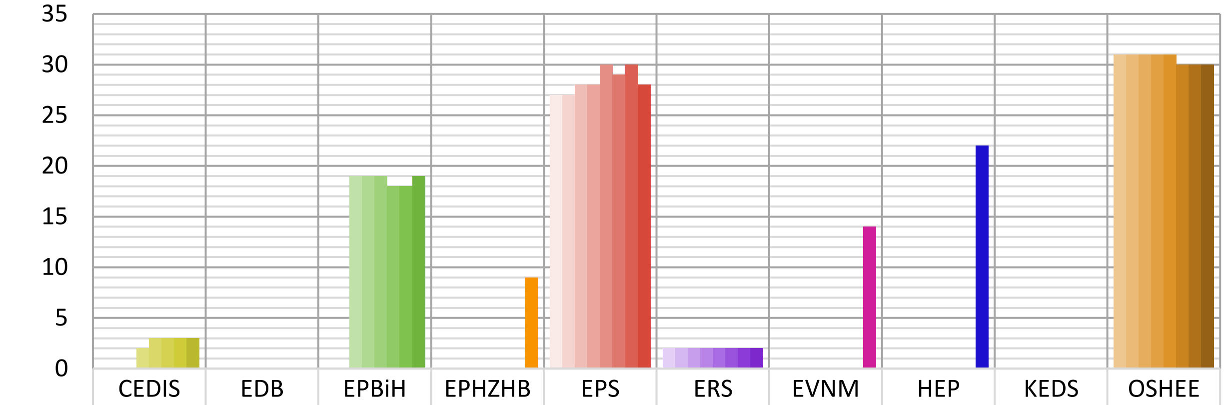
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	7	0	0
2009	0	0	0	0	0	0	0	7	0	0
2010	0	0	0	0	0	0	0	7	0	0
2011	0	0	0	0	0	0	0	7	0	0
2012	0	0	0	0	0	0	0	7	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	3	0	0	0	116	0	0

Figure 19.10 Number of 110/10(20) kV substations in SEE DSOs in the period 2008 - 2015



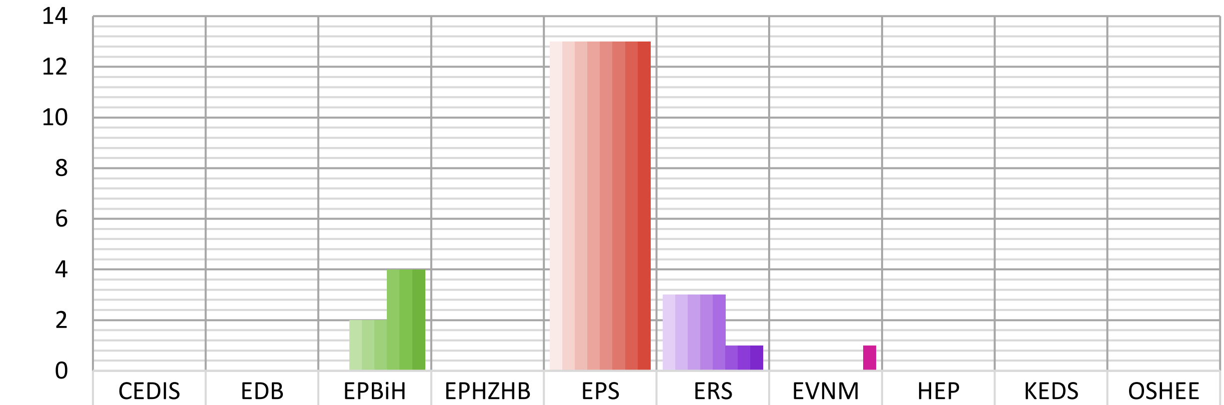
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	47	20	0	0	0	12
2009	0	0	0	0	45	20	0	0	0	14
2010	0	0	10	0	47	20	0	0	0	14
2011	0	0	10	0	48	20	0	0	0	15
2012	0	0	10	0	48	20	0	0	0	15
2013	0	0	10	0	49	20	0	0	0	16
2014	0	0	10	0	49	20	0	0	0	16
2015	0	0	10	0	49	20	9	0	0	16

Figure 19.11 Number of 110/20 kV substations in SEE DSOs in the period 2008 - 2015



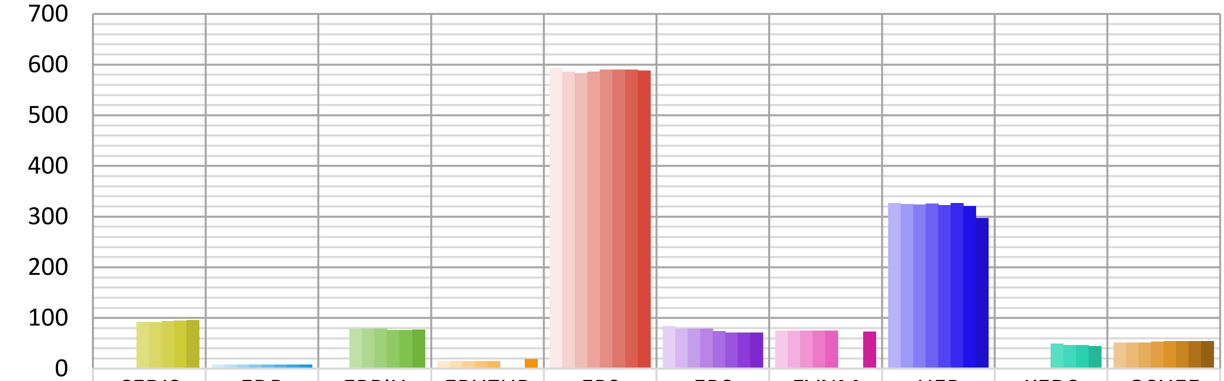
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	27	2	0	0	0	31
2009	0	0	0	0	27	2	0	0	0	31
2010	0	0	19	0	28	2	0	0	0	31
2011	2	0	19	0	28	2	0	0	0	31
2012	3	0	19	0	30	2	0	0	0	31
2013	3	0	18	0	29	2	0	0	0	30
2014	3	0	18	0	30	2	0	0	0	30
2015	3	0	19	9	28	2	14	22	0	30

Figure 19.12 Number of 110/10 kV substations in SEE DSOs in the period 2008 - 2015



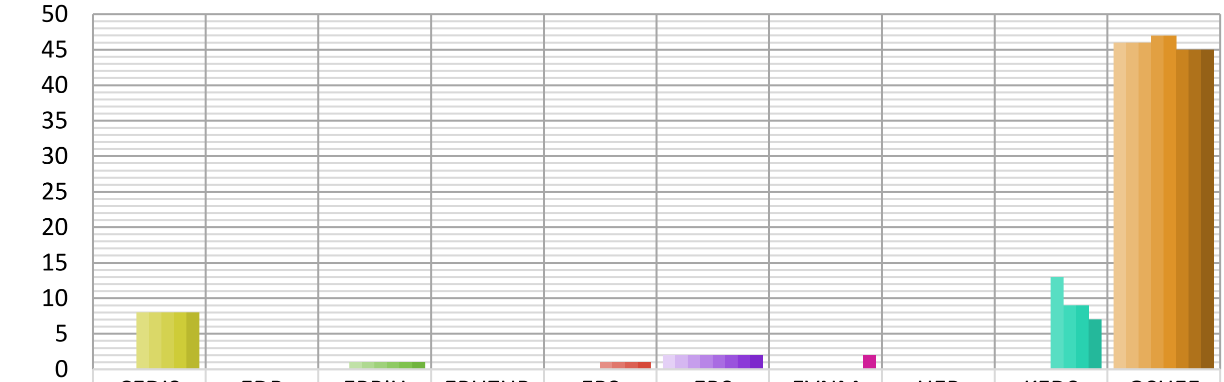
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	13	3	0	0	0	0
2009	0	0	0	0	13	3	0	0	0	0
2010	0	0	2	0	13	3	0	0	0	0
2011	0	0	2	0	13	3	0	0	0	0
2012	0	0	2	0	13	3	0	0	0	0
2013	0	0	4	0	13	1	0	0	0	0
2014	0	0	4	0	13	1	0	0	0	0
2015	0	0	4	0	13	1	1	0	0	0

Figure 19.13 Number of 35/20 kV substations in SEE DSOs in the period 2008 - 2015



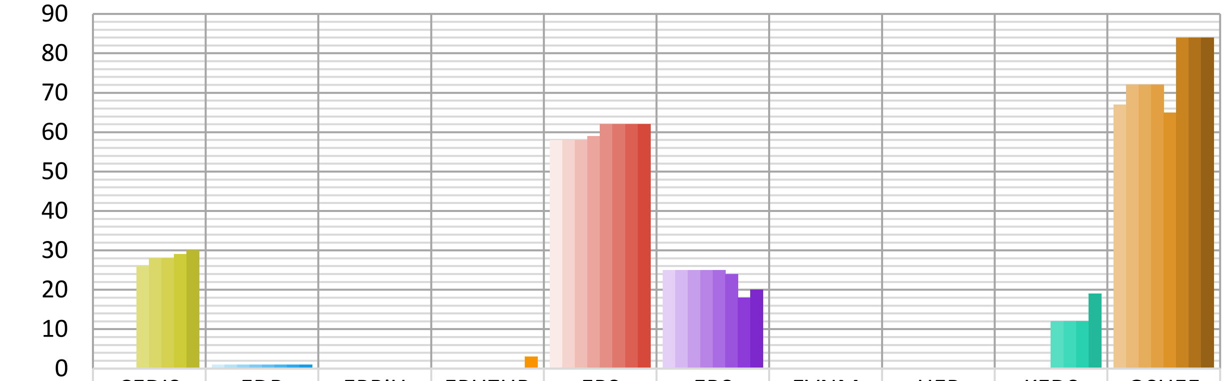
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	8	0	15	593	84	75	327	0	51
2009	0	8	0	15	586	79	75	325	0	51
2010	0	8	79	15	583	79	75	324	0	51
2011	92	8	79	15	586	79	75	326	0	53
2012	92	8	79	15	590	74	75	323	49	54
2013	94	8	76	0	590	71	0	327	46	54
2014	95	8	76	0	590	71	0	321	46	54
2015	96	8	77	19	588	71	73	297	44	54

Figure 19.14 Number of 35/10 kV substations in SEE DSOs in the period 2008 - 2015



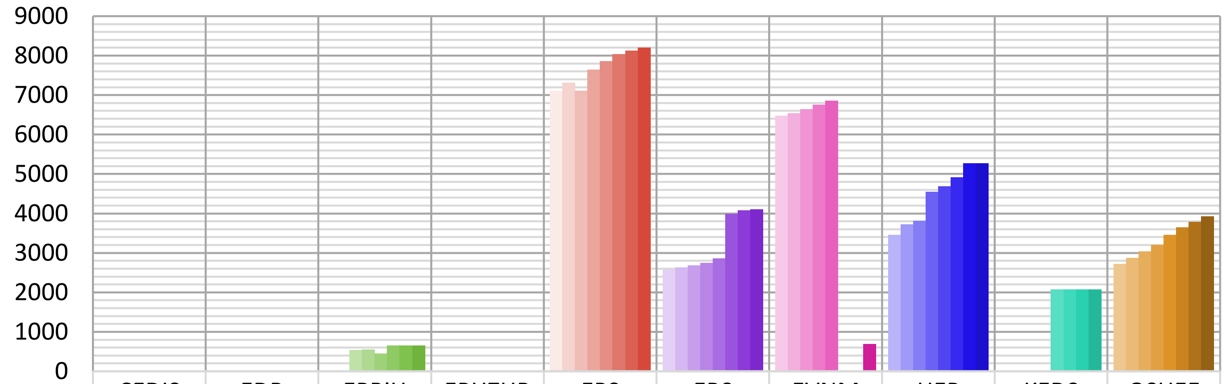
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	2	0	0	0	46
2009	0	0	0	0	0	2	0	0	0	46
2010	0	0	1	0	0	2	0	0	0	46
2011	8	0	1	0	0	2	0	0	0	47
2012	8	0	1	0	1	2	0	0	13	47
2013	8	0	1	0	1	2	0	0	9	45
2014	8	0	1	0	1	2	0	0	9	45
2015	8	0	1	0	1	2	2	0	7	45

Figure 19.15 Number of 35/6 kV substations in SEE DSOs in the period 2008 - 2015



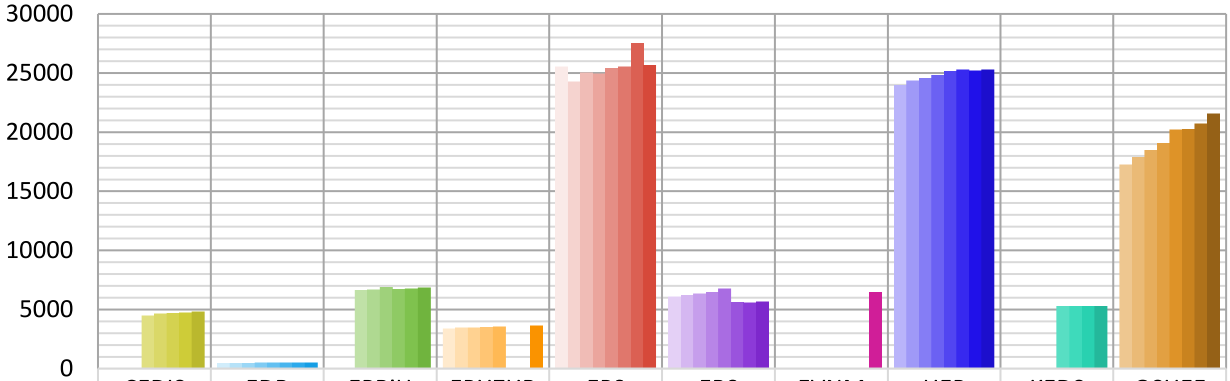
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	1	0	0	58	25	0	0	0	67
2009	0	1	0	0	58	25	0	0	0	72
2010	0	1	0	0	58	25	0	0	0	72
2011	26	1	0	0	59	25	0	0	0	72
2012	28	1	0	0	62	25	0	0	12	65
2013	28	1	0	0	62	24	0	0	12	84
2014	29	1	0	0	62	18	0	0	12	84
2015	30	1	0	3	62	20	0	0	19	84

Figure 19.16 Number of 35/0,4 kV substations in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	7106	2584	6475	3463	0	2716
2009	0	0	0	0	7309	2635	6541	3720	0	2880
2010	0	0	544	0	7117	2688	6645	3818	0	3043
2011	0	0	548	0	7638	2742	6758	4550	0	3207
2012	0	0	449	0	7861	2866	6859	4693	2074	3458
2013	0	0	648	0	8044	3996	0	4911	2074	3646
2014	0	0	651	0	8126	4084	0	5278	2074	3791
2015	0	0	658	0	8204	4104	691	5278	2074	3930

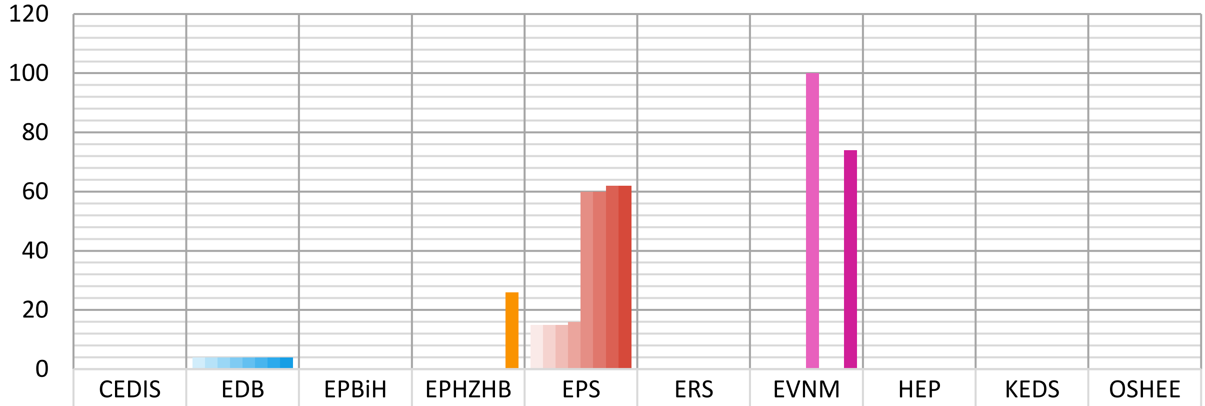
Figure 19.17 Number of 20/0,4 kV substations in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	467	0	3389	25528	6100	0	23970	0	17270
2009	0	476	0	3444	24273	6222	0	24337	0	17868
2010	0	482	6625	3472	25047	6346	0	24588	0	18465
2011	4490	486	6683	3517	24935	6473	0	24804	0	19063
2012	4629	487	6896	3563	25431	6767	0	25169	5286	20196
2013	4693	490	6726	0	25542	5639	0	25277	5286	20256
2014	4752	496	6784	0	27535	5597	0	25210	5286	20738
2015	4803	496	6848	3646	25682	5683	6470	25307	5286	21564

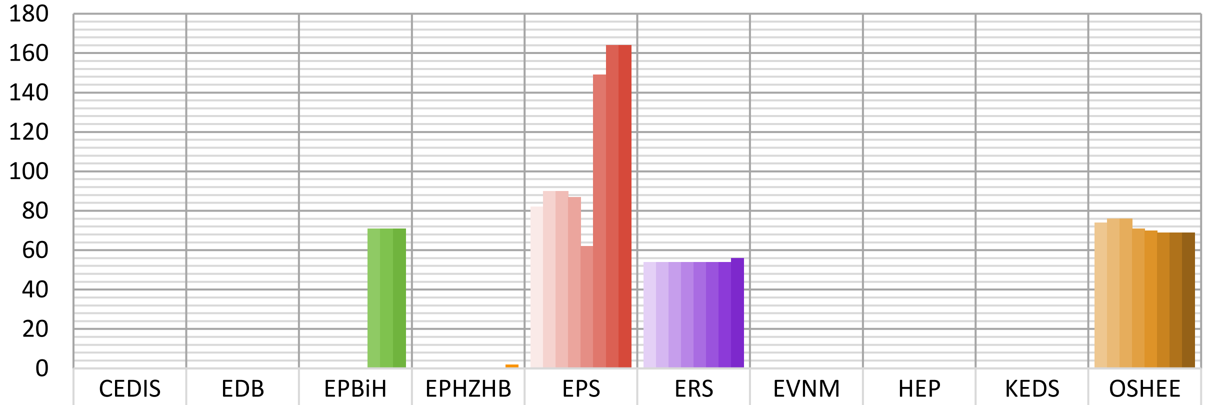
Figure 19.18 Number of 10/0,4 kV substations in SEE DSOs in the period 2008 – 2015

19.4 NUMBER OF TRANSFORMERS



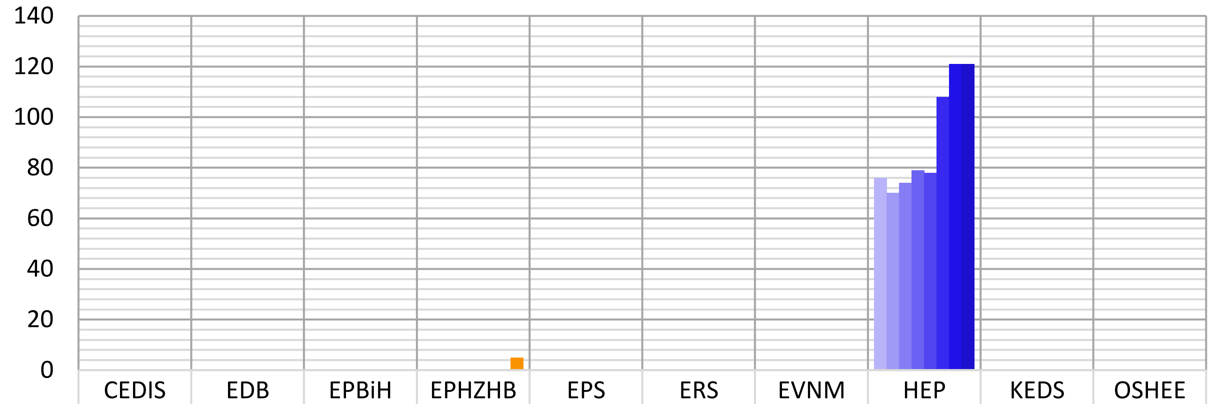
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	4	0	0	15	0	0	0	0	0
2009	0	4	0	0	15	0	0	0	0	0
2010	0	4	0	0	15	0	0	0	0	0
2011	0	4	0	0	16	0	0	0	0	0
2012	0	4	0	0	60	0	100	0	0	0
2013	0	4	0	0	60	0	0	0	0	0
2014	0	4	0	0	62	0	0	0	0	0
2015	0	4	0	26	62	0	74	0	0	0

Figure 19.19 Number of 110/35/10(20) kV transformers in SEE DSOs in the period 2008 - 2015



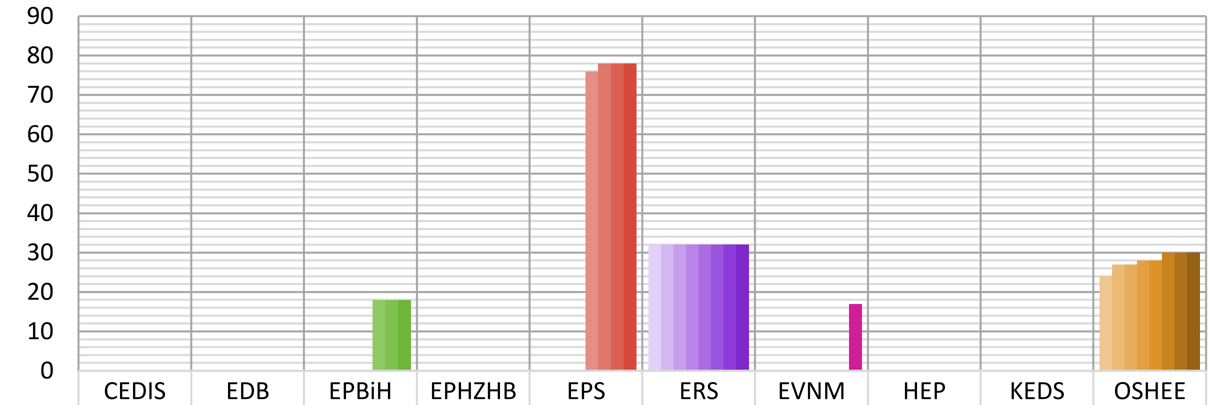
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	82	54	0	0	0	74
2009	0	0	0	0	90	54	0	0	0	76
2010	0	0	0	0	90	54	0	0	0	76
2011	0	0	0	0	87	54	0	0	0	71
2012	0	0	0	0	62	54	0	0	0	70
2013	0	0	71	0	149	54	0	0	0	69
2014	0	0	71	0	164	54	0	0	0	69
2015	0	0	71	2	164	56	0	0	0	69

Figure 19.20 Number of 110/35 kV transformers in SEE DSOs in the period 2008 - 2015



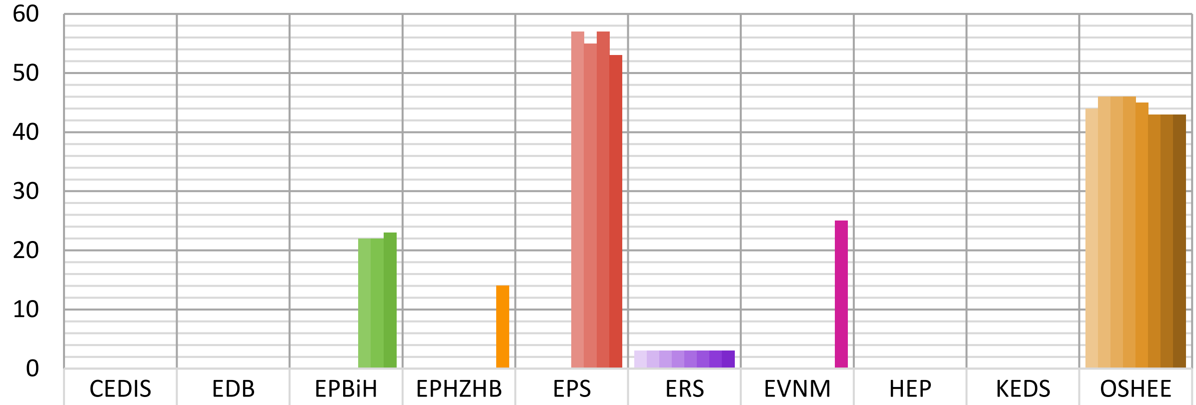
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	76	0	0
2009	0	0	0	0	0	0	0	70	0	0
2010	0	0	0	0	0	0	0	74	0	0
2011	0	0	0	0	0	0	0	79	0	0
2012	0	0	0	0	0	0	0	78	0	0
2013	0	0	0	0	0	0	0	108	0	0
2014	0	0	0	0	0	0	0	121	0	0
2015	0	0	0	5	0	0	0	121	0	0

Figure 19.21 Number of 110/10(20) kV transformers in SEE DSOs in the period 2008 - 2015



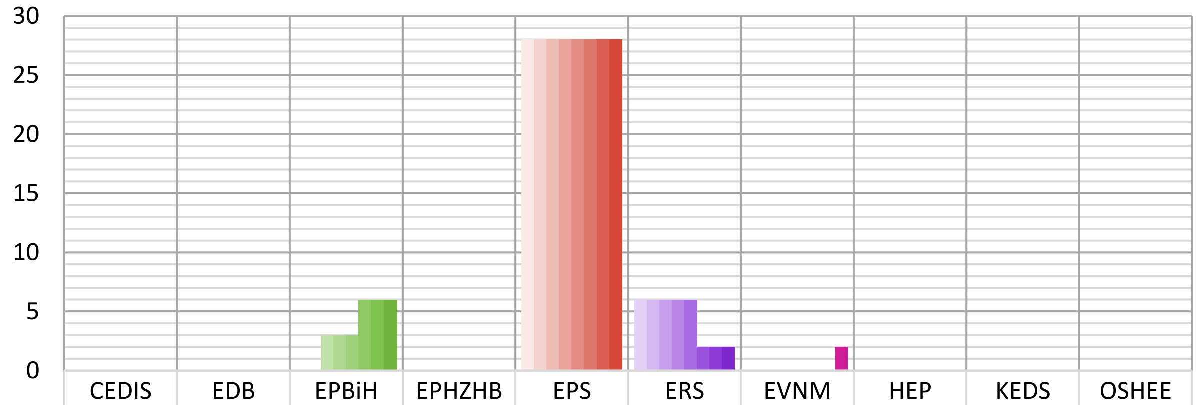
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	32	0	0	0	24
2009	0	0	0	0	0	32	0	0	0	27
2010	0	0	0	0	0	32	0	0	0	27
2011	0	0	0	0	0	32	0	0	0	28
2012	0	0	0	0	76	32	0	0	0	28
2013	0	0	18	0	78	32	0	0	0	30
2014	0	0	18	0	78	32	0	0	0	30
2015	0	0	18	0	78	32	17	0	0	30

Figure 19.22 Number of 110/20 kV transformers in SEE DSOs in the period 2008 - 2015



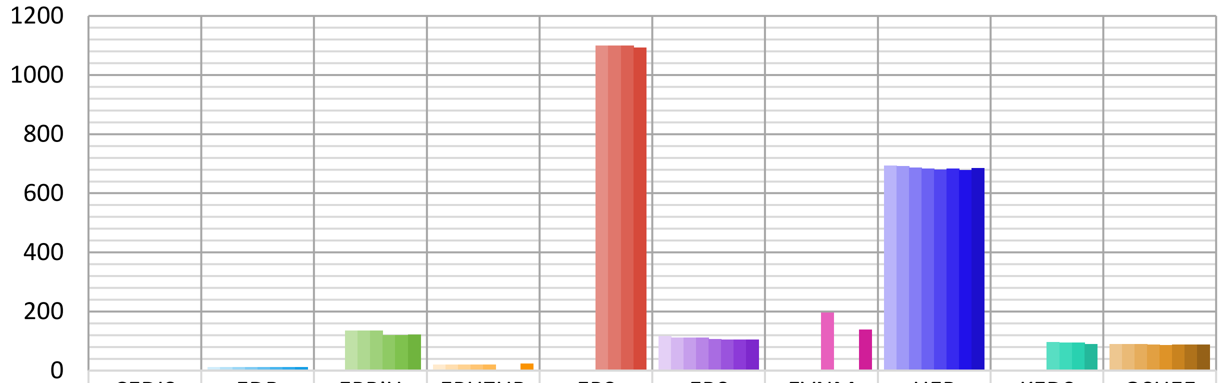
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	3	0	0	0	44
2009	0	0	0	0	0	3	0	0	0	46
2010	0	0	0	0	0	3	0	0	0	46
2011	0	0	0	0	0	3	0	0	0	46
2012	0	0	0	0	57	3	0	0	0	45
2013	0	0	22	0	55	3	0	0	0	43
2014	0	0	22	0	57	3	0	0	0	43
2015	0	0	23	14	53	3	25	0	0	43

Figure 19.23 Number of 110/10 kV transformers in SEE DSOs in the period 2008 - 2015



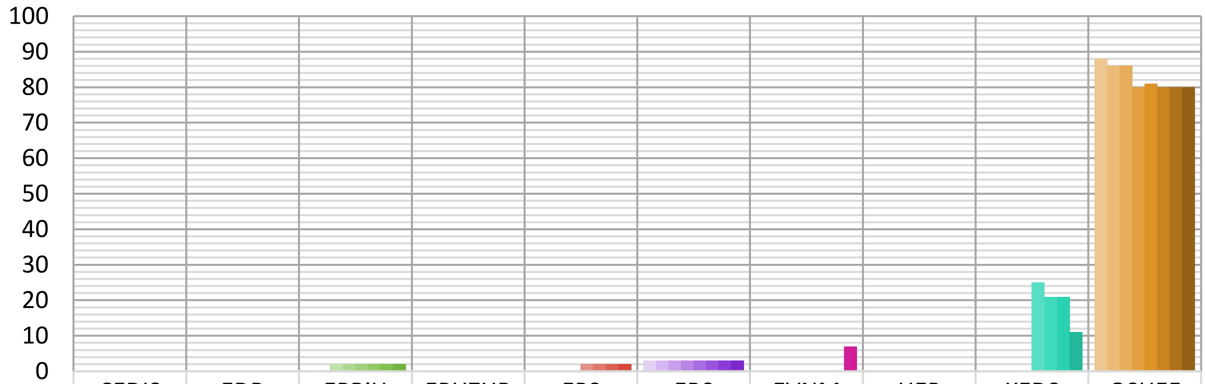
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	28	6	0	0	0	0
2009	0	0	0	0	28	6	0	0	0	0
2010	0	0	3	0	28	6	0	0	0	0
2011	0	0	3	0	28	6	0	0	0	0
2012	0	0	3	0	28	6	0	0	0	0
2013	0	0	6	0	28	2	0	0	0	0
2014	0	0	6	0	28	2	0	0	0	0
2015	0	0	6	0	28	2	2	0	0	0

Figure 19.24 Number of 35/20 kV transformers in SEE DSOs in the period 2008 - 2015



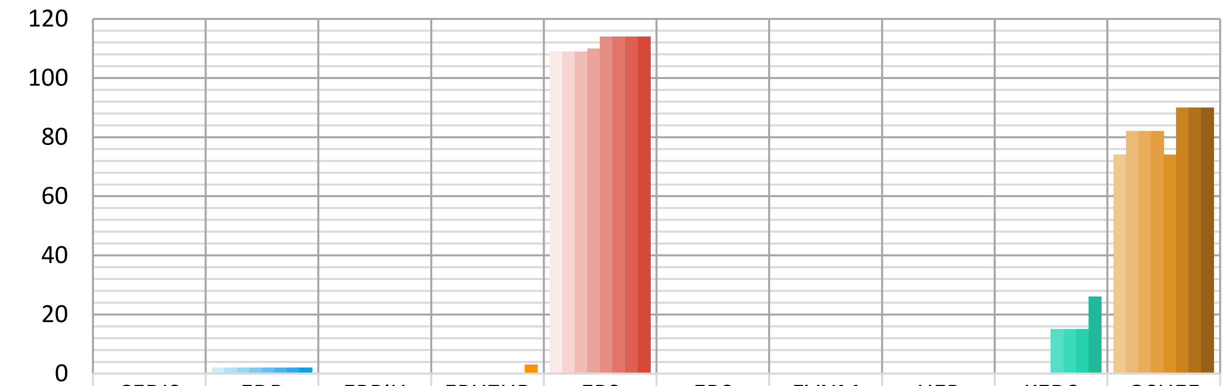
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	12	0	20	0	117	0	693	0	90
2009	0	12	0	20	0	112	0	691	0	89
2010	0	12	136	20	0	112	0	686	0	89
2011	0	12	136	20	0	112	0	684	0	87
2012	0	12	136	20	1100	107	196	680	97	86
2013	0	12	120	0	1100	104	0	683	95	87
2014	0	12	120	0	1100	104	0	679	95	87
2015	0	12	121	24	1092	104	138	685	90	87

Figure 19.25 Number of 35/10 kV transformers in SEE DSOs in the period 2008 - 2015



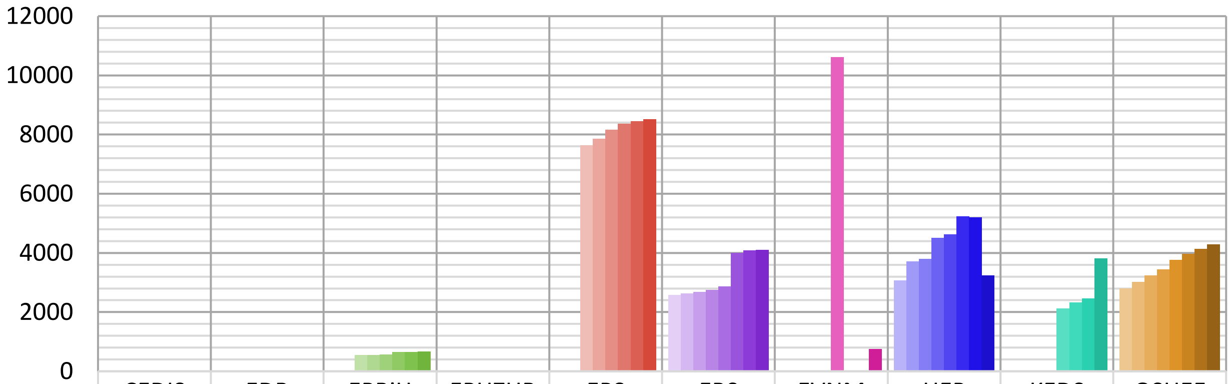
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	3	0	0	0	88
2009	0	0	0	0	0	3	0	0	0	86
2010	0	0	2	0	0	3	0	0	0	86
2011	0	0	2	0	0	3	0	0	0	80
2012	0	0	2	0	2	3	0	0	25	81
2013	0	0	2	0	2	3	0	0	21	80
2014	0	0	2	0	2	3	0	0	21	80
2015	0	0	2	0	2	3	7	0	11	80

Figure 19.26 Number of 35/6 kV transformers in SEE DSOs in the period 2008 - 2015



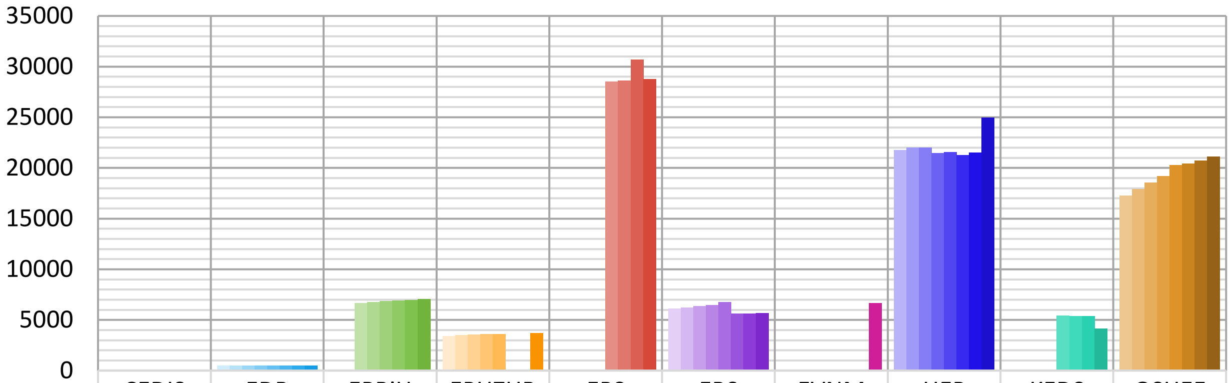
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	2	0	0	109	0	0	0	0	74
2009	0	2	0	0	109	0	0	0	0	82
2010	0	2	0	0	109	0	0	0	0	82
2011	0	2	0	0	110	0	0	0	0	82
2012	0	2	0	0	114	0	0	0	15	74
2013	0	2	0	0	114	0	0	0	15	90
2014	0	2	0	0	114	0	0	0	15	90
2015	0	2	0	3	114	0	0	0	26	90

Figure 19.27 Number of 35/0,4 kV transformers in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	2584	0	3070	0	2804
2009	0	0	0	0	0	2635	0	3709	0	3018
2010	0	0	548	0	7641	2688	0	3797	0	3232
2011	0	0	552	0	7854	2742	0	4505	0	3446
2012	0	0	566	0	8161	2866	10615	4628	2119	3765
2013	0	0	656	0	8360	3996	0	5234	2321	3972
2014	0	0	659	0	8442	4084	0	5202	2455	4140
2015	0	0	666	0	8520	4104	750	3235	3822	4282

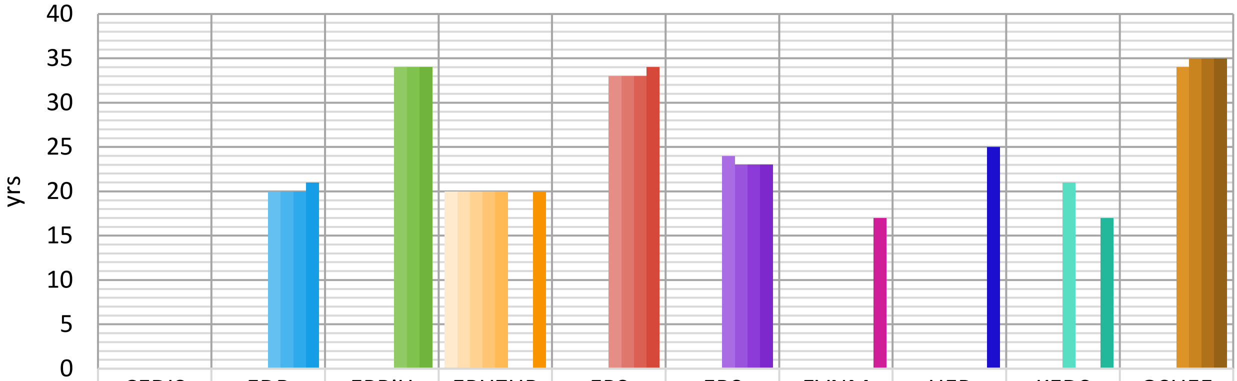
Figure 19.28 Number of 20/0,4 kV transformers in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	475	0	3420	0	6100	0	21751	0	17252
2009	0	484	0	3503	0	6222	0	21987	0	17895
2010	0	490	6639	3531	0	6346	0	22017	0	18539
2011	0	494	6755	3576	0	6473	0	21445	0	19182
2012	0	495	6871	3622	28536	6767	0	21568	5401	20281
2013	0	498	6889	0	28610	5639	0	21251	5357	20404
2014	0	499	6969	0	30670	5597	0	21521	5357	20728
2015	0	499	7054	3710	28750	5683	6667	24980	4118	21109

Figure 19.29 Number of 10/0,4 kV transformers in SEE DSOs in the period 2008 – 2015

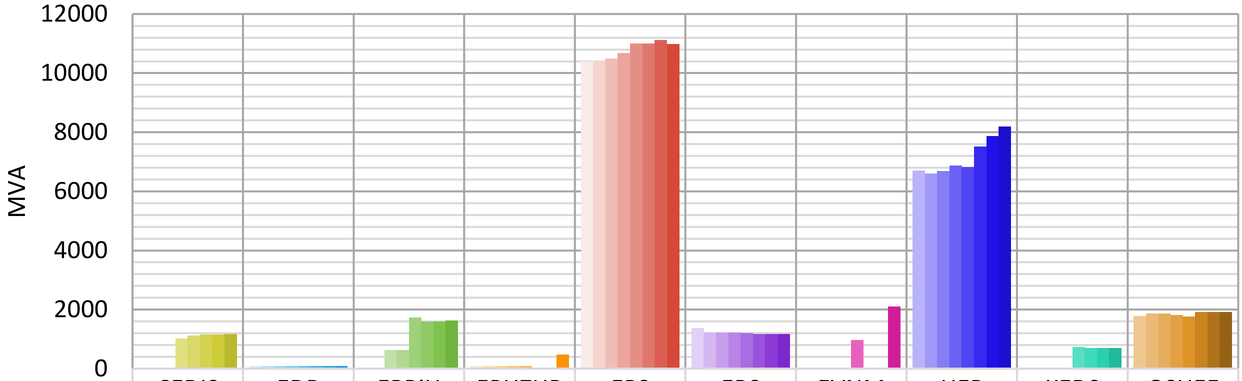
19.5 DISTRIBUTION TRANSFORMERS AGE



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	20	0	0	0	0	0	0
2009	0	0	0	20	0	0	0	0	0	0
2010	0	0	0	20	0	0	0	0	0	0
2011	0	0	0	20	0	0	0	0	0	0
2012	0	20	0	20	33	24	0	0	21	34
2013	0	20	34	0	33	23	0	0	0	35
2014	0	20	34	0	33	23	0	0	0	35
2015	0	21	34	20	34	23	17	25	17	35

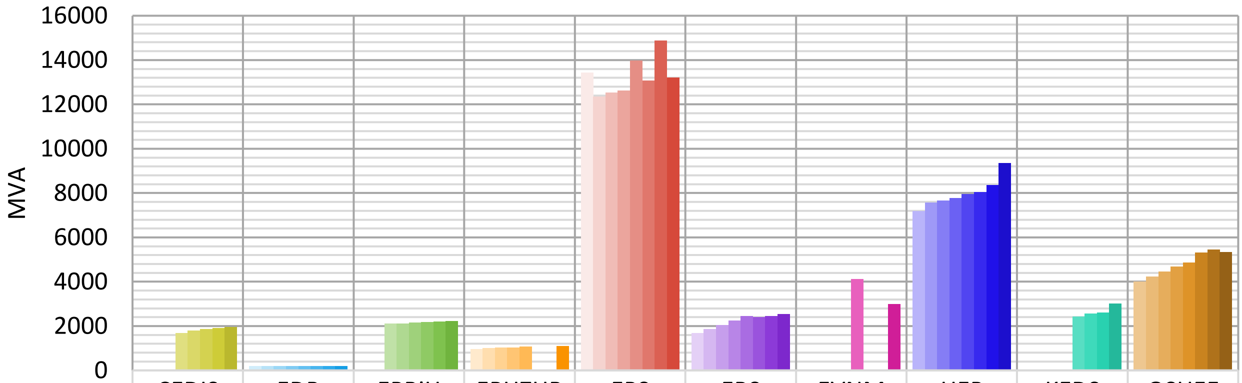
Figure 19.30 Calculated average age of distribution transformers in SEE DSOs in the period 2008-2015

19.6 SUM CAPACITY OF TRANSFORMERS



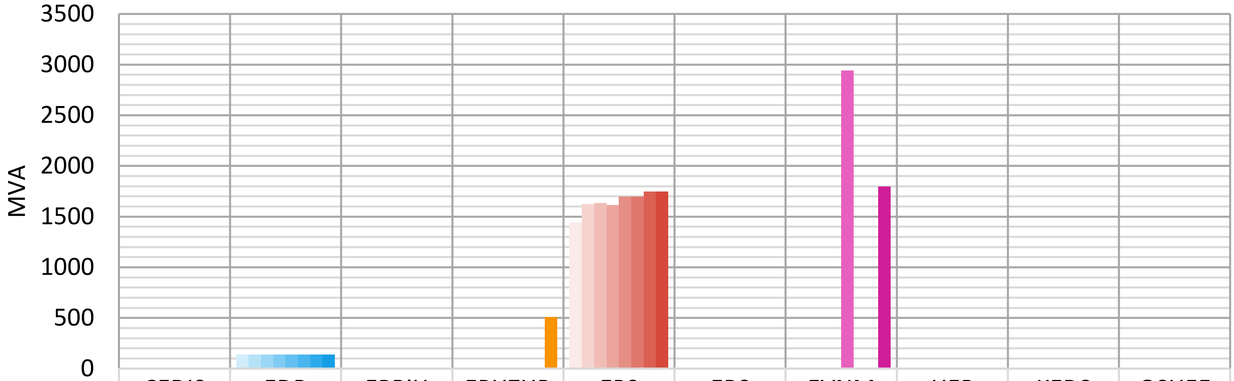
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	96	0	86	10395	1369	0	6700	0	1775
2009	0	96	0	86	10422	1225	0	6609	0	1861
2010	0	96	638	86	10490	1225	0	6681	0	1861
2011	1019	96	638	86	10674	1225	0	6866	0	1812
2012	1115	96	1729	86	11005	1210	968	6829	731	1768
2013	1156	96	1593	0	11000	1176	0	7522	695	1919
2014	1161	96	1593	0	11125	1176	0	7872	695	1919
2015	1169	96	1636	483	10990	1176	2099	8184	701	1919

Figure 19.31 Sum capacity of X/MV transformers in SEE DSOs in the period 2008-2015



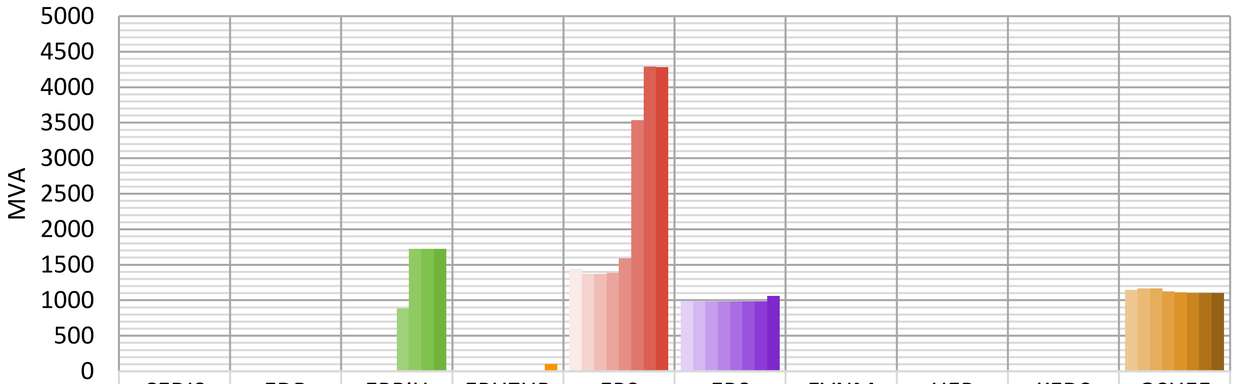
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	184	0	965	13425	1685	0	7185	0	3996
2009	0	189	0	999	12356	1852	0	7561	0	4231
2010	0	190	2098	1017	12528	2035	0	7665	0	4453
2011	1677	191	2115	1037	12619	2236	0	7774	0	4674
2012	1793	192	2146	1065	13967	2457	4107	7940	2420	4867
2013	1856	193	2169	0	13071	2412	0	8034	2549	5313
2014	1906	194	2188	0	14881	2449	0	8348	2595	5448
2015	1959	194	2214	1092	13199	2542	2978	9350	3005	5324

Figure 19.32 Sum capacity of MV/LV transformers in SEE DSOs in the period 2008-2015



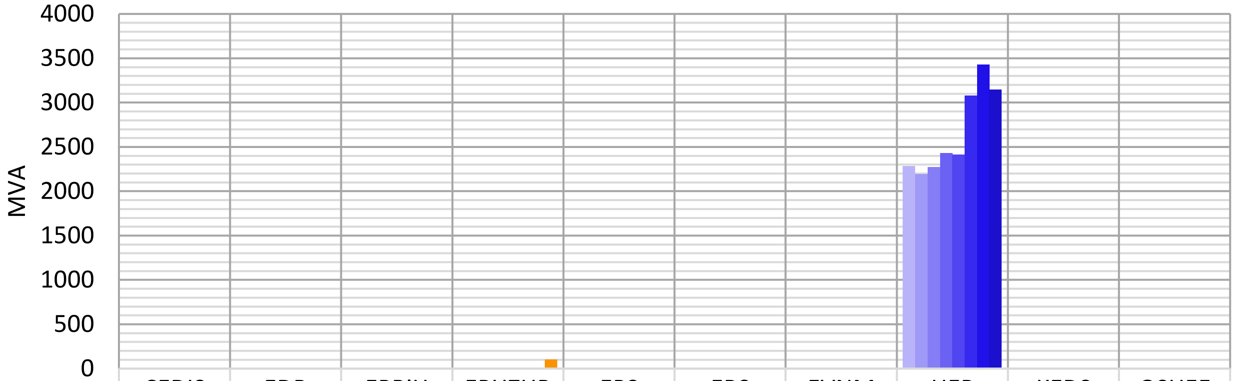
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	140	0	0	1438	0	0	0	0	0
2009	0	140	0	0	1623	0	0	0	0	0
2010	0	140	0	0	1633	0	0	0	0	0
2011	0	140	0	0	1614	0	0	0	0	0
2012	0	140	0	0	1698	0	2942	0	0	0
2013	0	140	0	0	1698	0	0	0	0	0
2014	0	140	0	0	1747	0	0	0	0	0
2015	0	140	0	508	1747	0	1794	0	0	0

Figure 19.33 Sum capacity of 110/35/10(20) kV transformers in SEE DSOs in the period 2008 - 2015



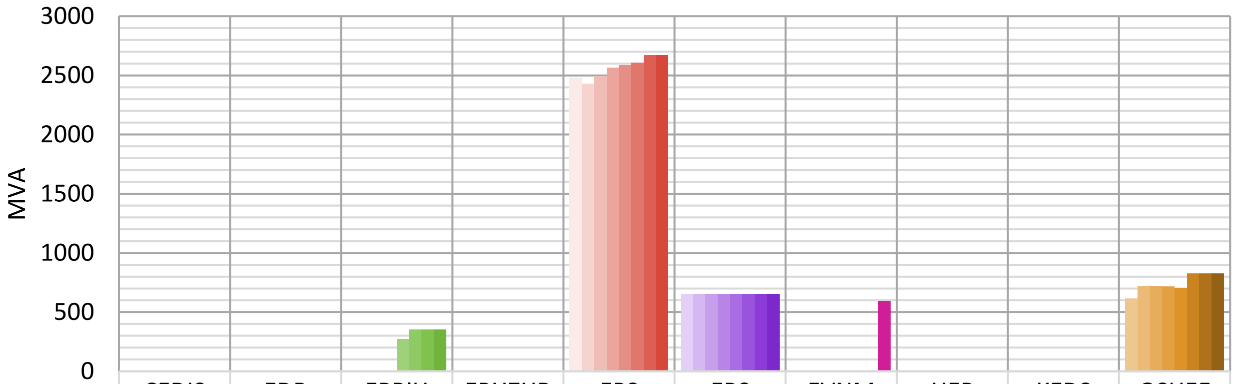
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	1444	986	0	0	0	1142
2009	0	0	0	0	1374	986	0	0	0	1167
2010	0	0	0	0	1374	986	0	0	0	1167
2011	0	0	0	0	1384	986	0	0	0	1121
2012	0	0	888	0	1586	986	0	0	0	1111
2013	0	0	1726	0	3536	986	0	0	0	1103
2014	0	0	1726	0	4292	986	0	0	0	1103
2015	0	0	1726	103	4284	1061	0	0	0	1103

Figure 19.34 Sum capacity of 110/35 kV transformers in SEE DSOs in the period 2008 - 2015



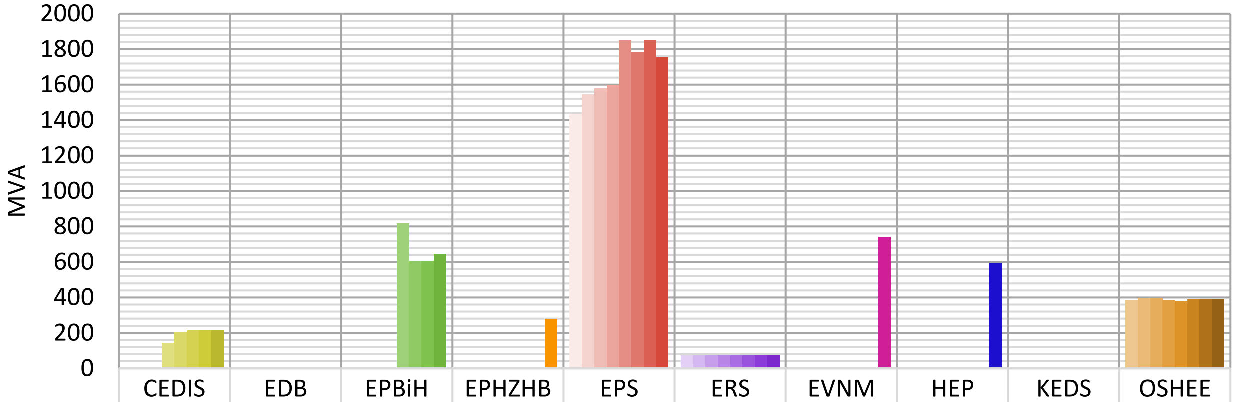
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	2286	0	0
2009	0	0	0	0	0	0	0	2192	0	0
2010	0	0	0	0	0	0	0	2272	0	0
2011	0	0	0	0	0	0	0	2432	0	0
2012	0	0	0	0	0	0	0	2412	0	0
2013	0	0	0	0	0	0	0	3080	0	0
2014	0	0	0	0	0	0	0	3428	0	0
2015	0	0	0	100	0	0	0	3146	0	0

Figure 19.35 Sum capacity of 110/10(20) kV transformers in SEE DSOs in the period 2008 - 2015



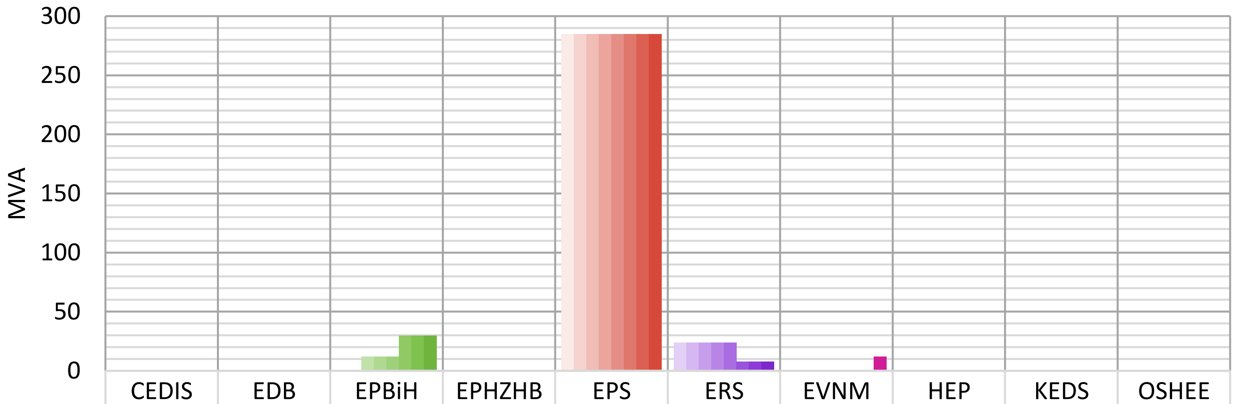
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	2482	655	0	0	0	617
2009	0	0	0	0	2431	655	0	0	0	722
2010	0	0	0	0	2494	655	0	0	0	722
2011	0	0	0	0	2566	655	0	0	0	718
2012	0	0	274	0	2586	655	0	0	0	703
2013	0	0	352	0	2608	655	0	0	0	827
2014	0	0	352	0	2671	655	0	0	0	827
2015	0	0	352	0	2671	655	594	0	0	827

Figure 19.36 Sum capacity of 110/20 kV transformers in SEE DSOs in the period 2008 - 2015



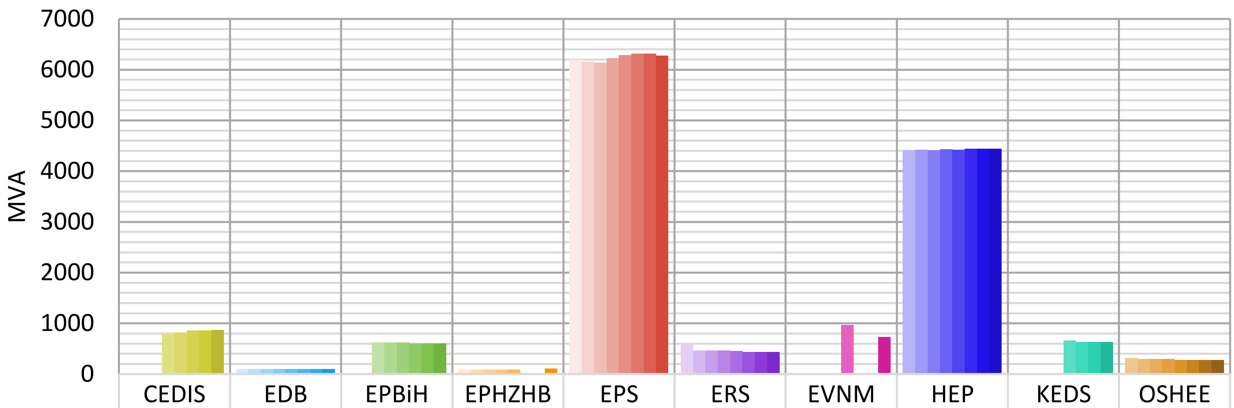
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	1434	72	0	0	0	386
2009	0	0	0	0	1546	72	0	0	0	396
2010	0	0	0	0	1578	72	0	0	0	396
2011	143	0	0	0	1598	72	0	0	0	387
2012	206	0	818	0	1848	72	0	0	0	381
2013	214	0	606	0	1785	72	0	0	0	388
2014	214	0	606	0	1848	72	0	0	0	388
2015	214	0	646	280	1753	72	740	594	0	388

Figure 19.37 Sum capacity of 110/10 kV transformers in SEE DSOs in the period 2008 - 2015



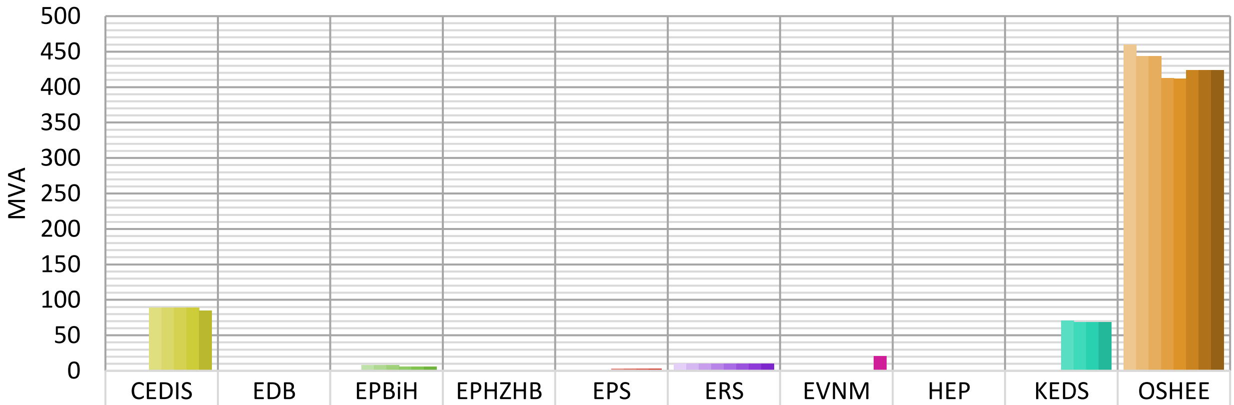
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	285	24	0	0	0	0
2009	0	0	0	0	285	24	0	0	0	0
2010	0	0	12	0	285	24	0	0	0	0
2011	0	0	12	0	285	24	0	0	0	0
2012	0	0	12	0	285	24	0	0	0	0
2013	0	0	30	0	285	8	0	0	0	0
2014	0	0	30	0	285	8	0	0	0	0
2015	0	0	30	0	285	8	12	0	0	0

Figure 19.38 Sum capacity of 35/20 kV transformers in SEE DSOs in the period 2008 - 2015



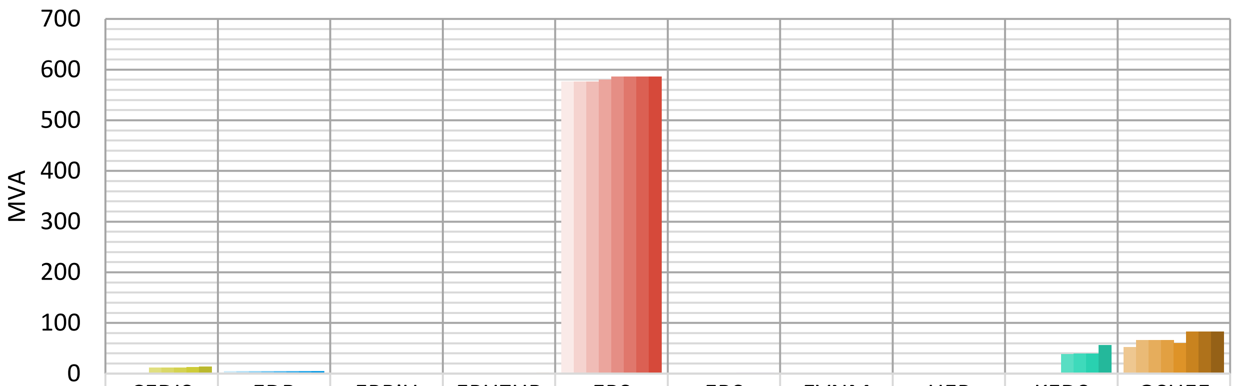
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	96	0	86	6193	609	0	4414	0	312
2009	0	96	0	86	6160	465	0	4417	0	299
2010	0	96	618	86	6134	465	0	4409	0	299
2011	787	96	618	86	6226	465	0	4434	0	295
2012	820	96	618	86	6284	450	968	4417	660	271
2013	853	96	598	0	6318	432	0	4442	626	280
2014	858	96	598	0	6318	432	0	4444	626	280
2015	870	96	601	103	6278	432	734	4444	632	280

Figure 19.39 Sum capacity of 35/10 kV transformers in SEE DSOs in the period 2008 - 2015



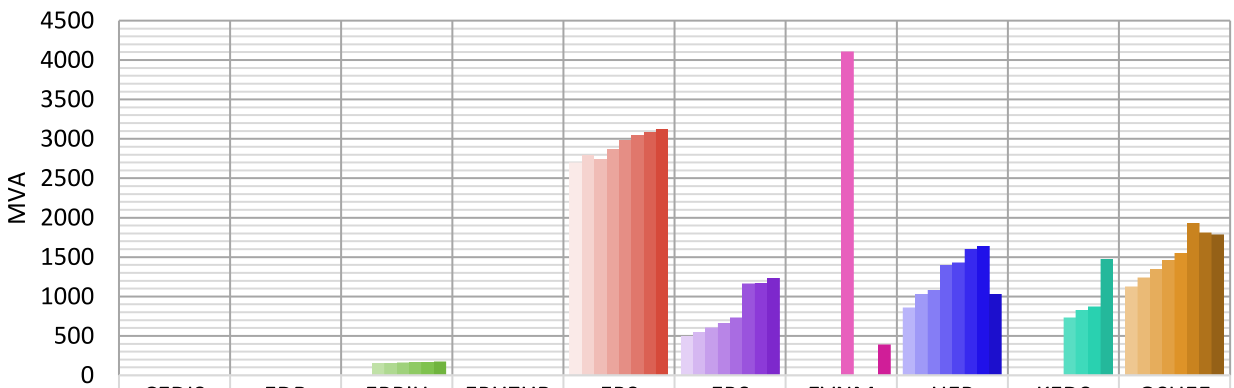
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	10	0	0	0	460
2009	0	0	0	0	0	10	0	0	0	444
2010	0	0	8	0	0	10	0	0	0	444
2011	89	0	8	0	0	10	0	0	0	413
2012	89	0	8	0	3	10	0	0	71	412
2013	89	0	6	0	3	10	0	0	69	424
2014	89	0	6	0	3	10	0	0	69	424
2015	85	0	6	0	3	10	21	0	69	424

Figure 19.40 Sum capacity of 35/6 kV transformers in SEE DSOs in the period 2008 - 2015



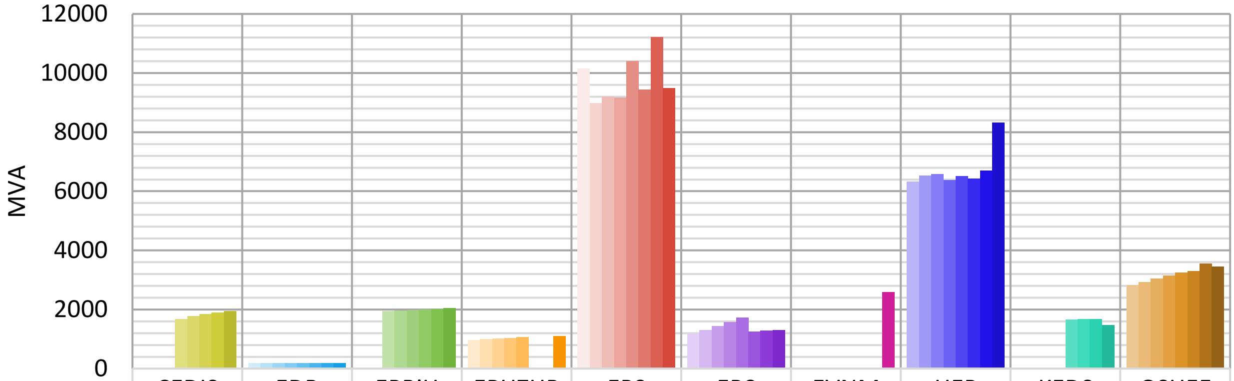
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	5	0	0	576	0	0	0	0	52
2009	0	5	0	0	576	0	0	0	0	66
2010	0	5	0	0	576	0	0	0	0	66
2011	12	5	0	0	580	0	0	0	0	66
2012	12	5	0	0	586	0	0	0	38	60
2013	12	5	0	0	586	2	0	0	39	83
2014	13	5	0	0	586	2	0	0	39	83
2015	14	5	0	2	586	2	0	0	56	83

Figure 19.41 Sum capacity of 35/0,4 kV transformers in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	2697	501	0	860	0	1128
2009	0	0	0	0	2794	551	0	1029	0	1239
2010	0	0	157	0	2744	605	0	1079	0	1351
2011	0	0	157	0	2868	665	0	1397	0	1462
2012	0	0	160	0	2986	731	4107	1431	732	1554
2013	0	0	169	0	3051	1165	0	1599	830	1931
2014	0	0	170	0	3086	1170	0	1642	875	1810
2015	0	0	172	0	3125	1232	392	1030	1475	1786

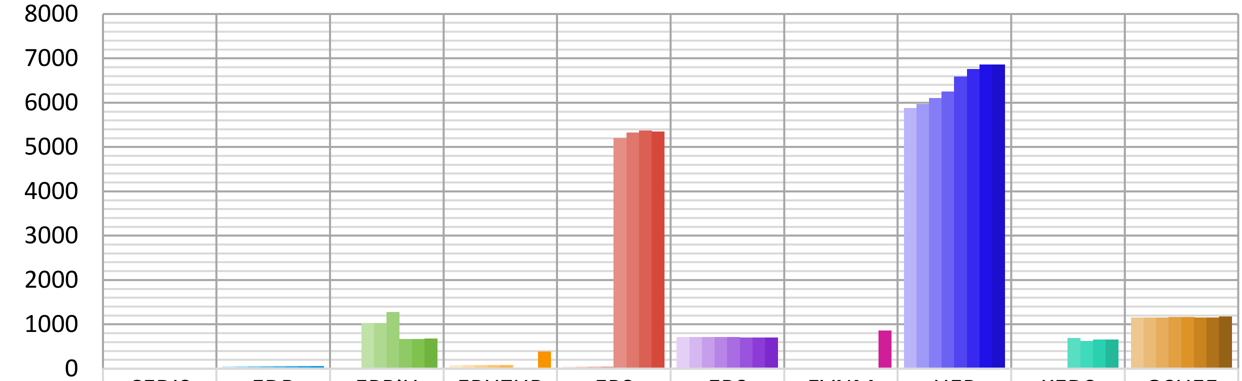
Figure 19.42 Sum capacity of 20/0,4 kV transformers in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	179	0	965	10152	1184	0	6325	0	2816
2009	0	184	0	999	8985	1301	0	6532	0	2926
2010	0	185	1941	1017	9208	1429	0	6586	0	3036
2011	1665	186	1957	1037	9171	1571	0	6377	0	3146
2012	1781	187	1986	1065	10395	1726	0	6509	1650	3253
2013	1843	188	2000	0	9434	1244	0	6435	1681	3299
2014	1893	189	2017	0	11209	1277	0	6706	1681	3555
2015	1945	189	2043	1090	9488	1309	2586	8320	1474	3454

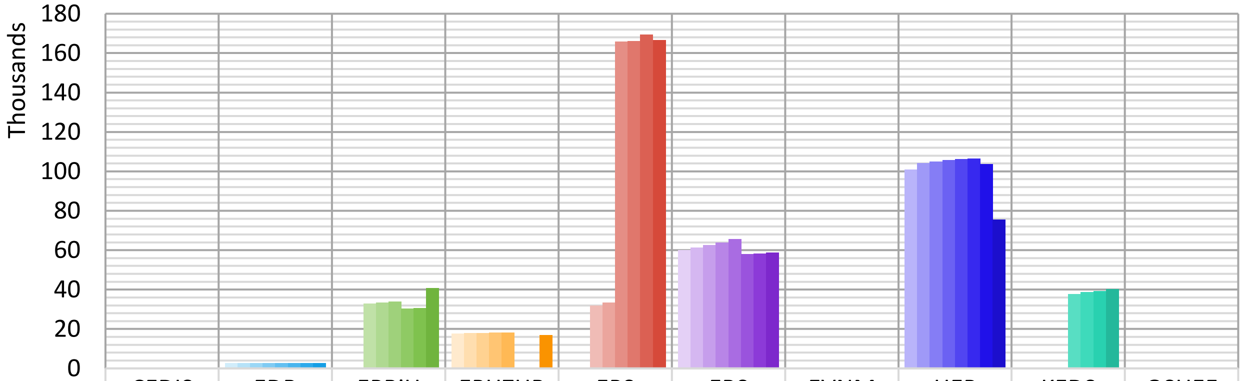
Figure 19.43 Sum capacity of 10/0,4 kV transformers in SEE DSOs in the period 2008 – 2015

19.7 NUMBER OF FEEDERS



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	57	0	86	50	717	0	5876	0	1149
2009	0	57	0	86	50	717	0	5967	0	1149
2010	0	57	1029	86	50	717	0	6109	0	1149
2011	0	57	1029	86	50	717	0	6255	0	1165
2012	0	57	1278	86	5205	717	0	6592	686	1166
2013	0	57	664	0	5321	705	0	6764	621	1152
2014	0	57	664	0	5372	705	0	6862	656	1151
2015	0	57	674	385	5345	705	865	6862	662	1178

Figure 19.44 Number of MV feeders in SEE DSOs in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	2580	0	17564	339	60073	0	100788	0	0
2009	0	2652	0	17804	339	61273	0	104265	0	0
2010	0	2700	32936	17936	31803	62496	0	104995	0	0
2011	0	2732	33425	18128	33462	63744	0	105685	0	0
2012	0	2740	33938	18216	165716	65508	0	106288	37615	0
2013	0	2752	30426	0	166036	57906	0	106487	38605	0
2014	0	2772	30599	0	169322	58158	0	103652	39275	0
2015	0	2772	40825	16943	166633	58802	0	75530	40110	0

Figure 19.45 Number of LV feeders in SEE DSOs in the period 2008-2015

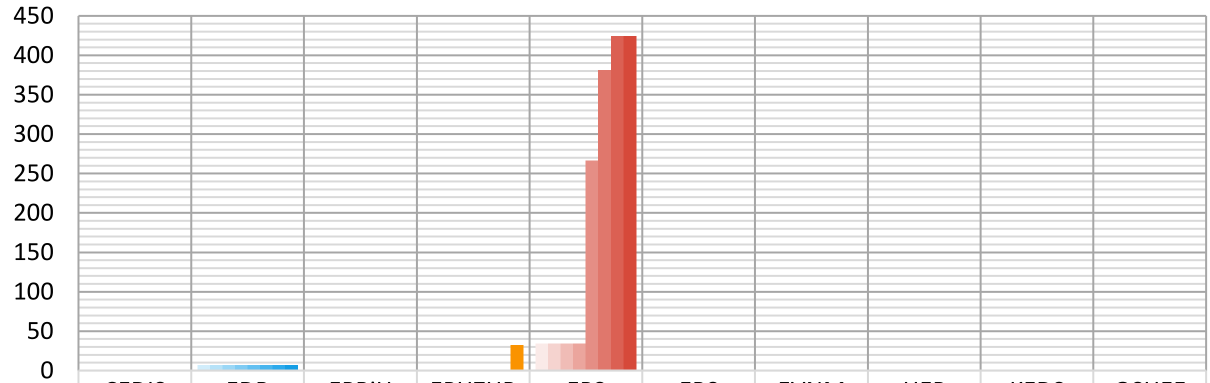
Below are given some notes on the number of feeders in SEE DSOs.

In EDB:

- to the total number of 35 kV feeders are not added 7 reserve feeders on the TS 110/35/10(20) kV;
- to the total number of 10 kV feeders are not added 14 reserve feeders, 3 in TS 110/35/10(20) kV and 11 in TS 35/10 kV.

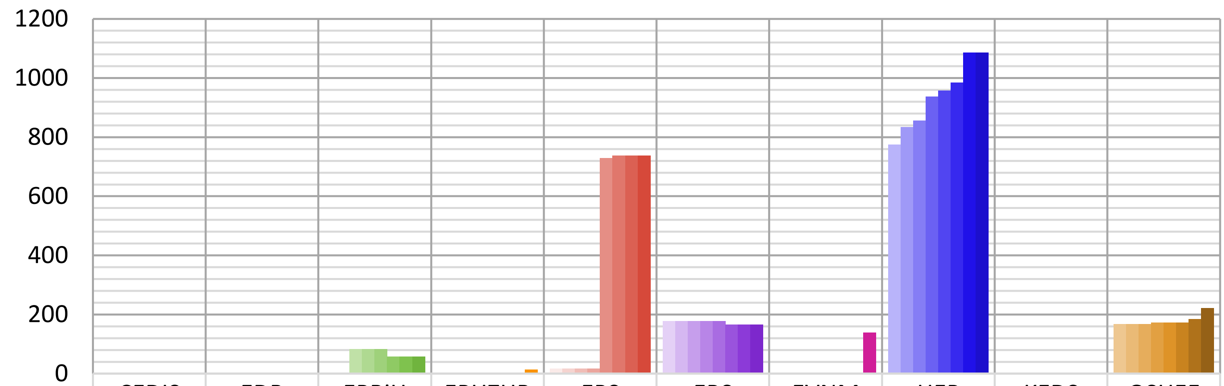
In EPS:

- 35 kV and 10 kV feeders at TS 110/35/10(20) kV are given as lump sum, and they are shown on following figures as 35 kV feeders;
- 35 kV and 20 kV feeders at TS 110/35/20 kV are given as lump sum, and they are shown on following figures as 35 kV feeders;
- 6 kV and 0,4 kV feeders at TS 36/6/0,4 kV are given as lump sum, and they are shown on following figures as 6 kV feeders.



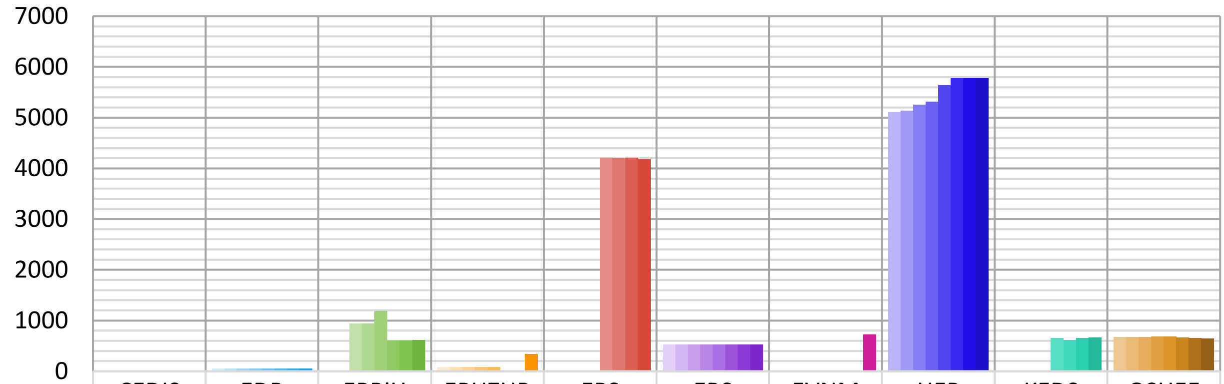
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	7	0	0	34	0	0	0	0	0
2009	0	7	0	0	34	0	0	0	0	0
2010	0	7	0	0	34	0	0	0	0	0
2011	0	7	0	0	34	0	0	0	0	0
2012	0	7	0	0	266	0	0	0	0	0
2013	0	7	0	0	381	0	0	0	0	0
2014	0	7	0	0	424	0	0	0	0	0
2015	0	7	0	32	424	0	0	0	0	0

Figure 19.46 Total number of 35 kV feeders



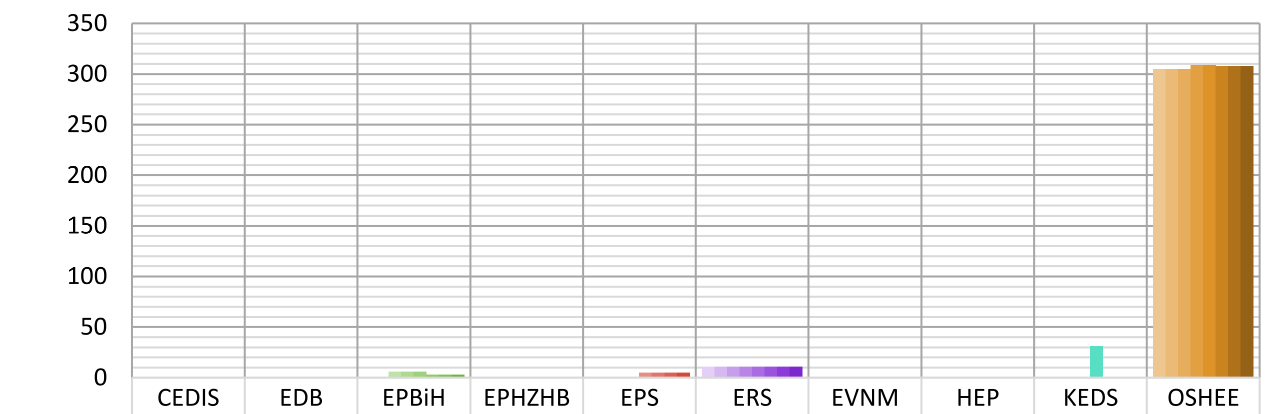
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	16	178	0	774	0	167
2009	0	0	0	0	16	178	0	834	0	167
2010	0	0	83	0	16	178	0	856	0	167
2011	0	0	83	0	16	178	0	937	0	173
2012	0	0	83	0	729	178	0	957	0	173
2013	0	0	57	0	738	166	0	984	0	173
2014	0	0	57	0	738	166	0	1086	0	185
2015	0	0	57	13	738	166	138	1086	0	221

Figure 19.47 Total number of 20 kV feeders



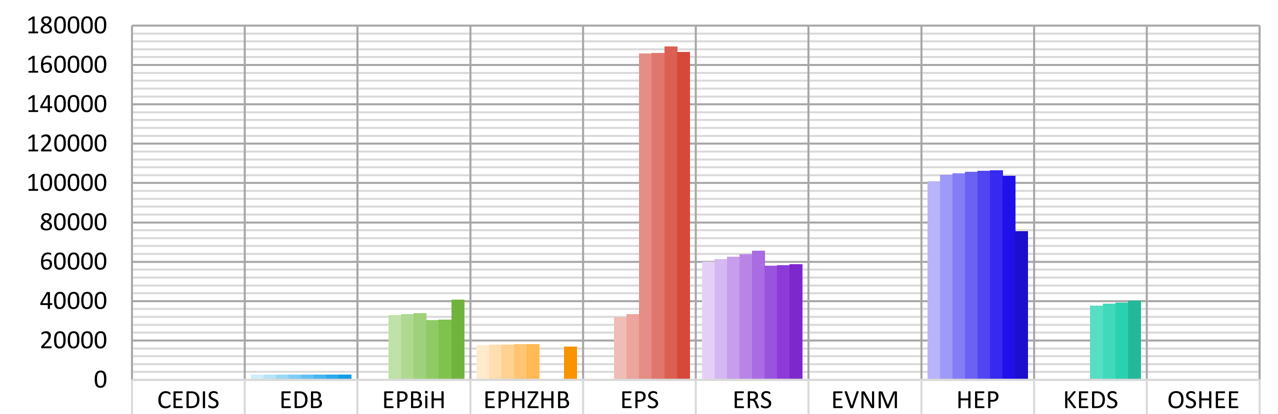
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	50	0	86	0	528	0	5102	0	677
2009	0	50	0	86	0	528	0	5133	0	677
2010	0	50	940	86	0	528	0	5253	0	677
2011	0	50	940	86	0	528	0	5318	0	683
2012	0	50	1189	86	4205	528	0	5635	655	684
2013	0	50	604	0	4197	528	0	5780	621	671
2014	0	50	604	0	4205	528	0	5776	656	658
2015	0	50	614	340	4178	528	727	5776	662	649

Figure 19.48 Total number of 10 kV feeders



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	11	0	0	0	305
2009	0	0	0	0	0	11	0	0	0	305
2010	0	0	6	0	0	11	0	0	0	305
2011	0	0	6	0	0	11	0	0	0	309
2012	0	0	6	0	5	11	0	0	31	309
2013	0	0	3	0	5	11	0	0	0	308
2014	0	0	3	0	5	11	0	0	0	308
2015	0	0	3	0	5	11	0	0	0	308

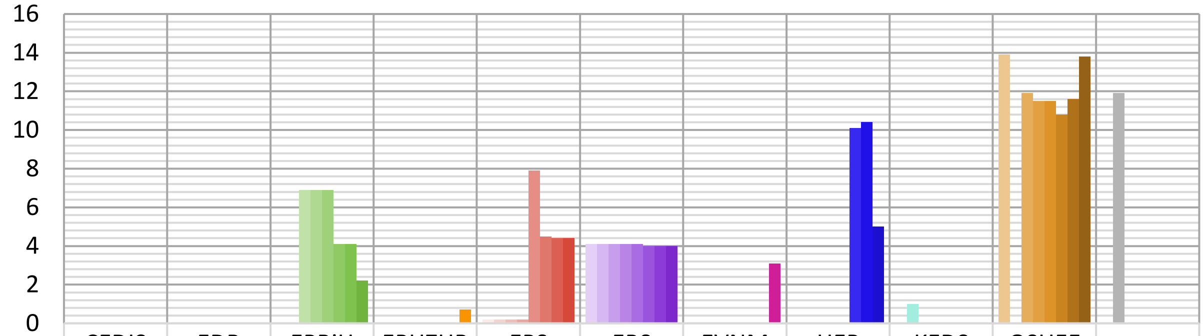
Figure 19.49 Total number of 6 kV feeders



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	2580	0	17564	339	60073	0	100788	0	0
2009	0	2652	0	17804	339	61273	0	104265	0	0
2010	0	2700	32936	17936	31803	62496	0	104995	0	0
2011	0	2732	33425	18128	33462	63744	0	105685	0	0
2012	0	2740	33938	18216	165716	65508	0	106288	37615	0
2013	0	2752	30426	0	166036	57906	0	106487	38605	0
2014	0	2772	30599	0	169322	58158	0	103652	39275	0
2015	0	2772	40825	16943	166633	58802	0	75530	40110	0

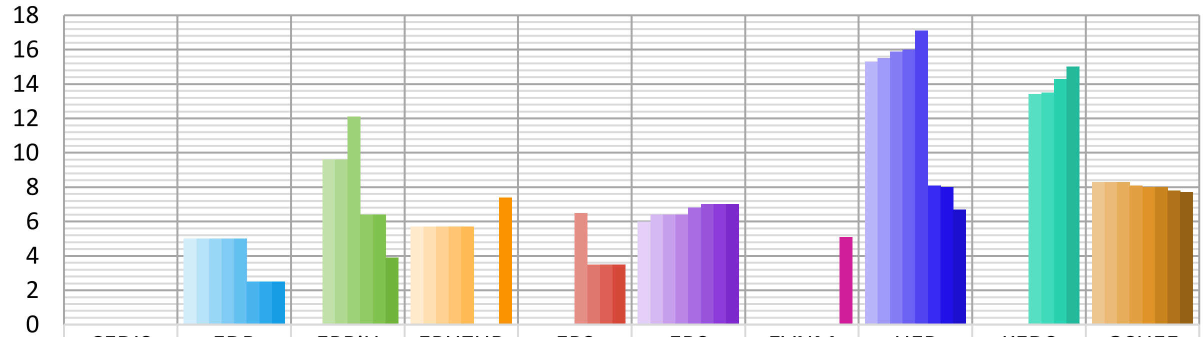
Figure 19.50 Total number of 0,4 kV feeders

19.8 NUMBER OF FEEDERS PER SUBSTATIONS



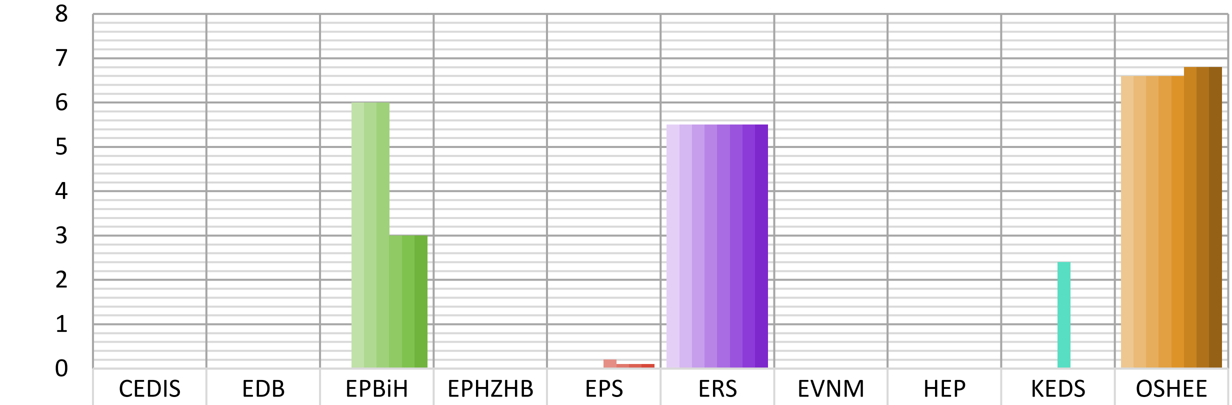
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	
2008	0	0	0	0	0,2	4,1	0	0	0	13,9	
2009	0	0	0	0	0,2	4,1	0	0	1	0	11,9
2010	0	0	6,9	0	0,2	4,1	0	0	0	11,9	
2011	0	0	6,9	0	0,2	4,1	0	0	0	11,5	
2012	0	0	6,9	0	7,9	4,1	0	0	0	11,5	
2013	0	0	4,1	0	4,5	4	0	10,1	0	10,8	
2014	0	0	4,1	0	4,4	4	0	10,4	0	11,6	
2015	0	0	2,2	0,7	4,4	4	3,1	5	0	13,8	

Figure 19.51 Average number of MV (20 kV) feeders per substation in SEE DSOs in the period 2008-2015



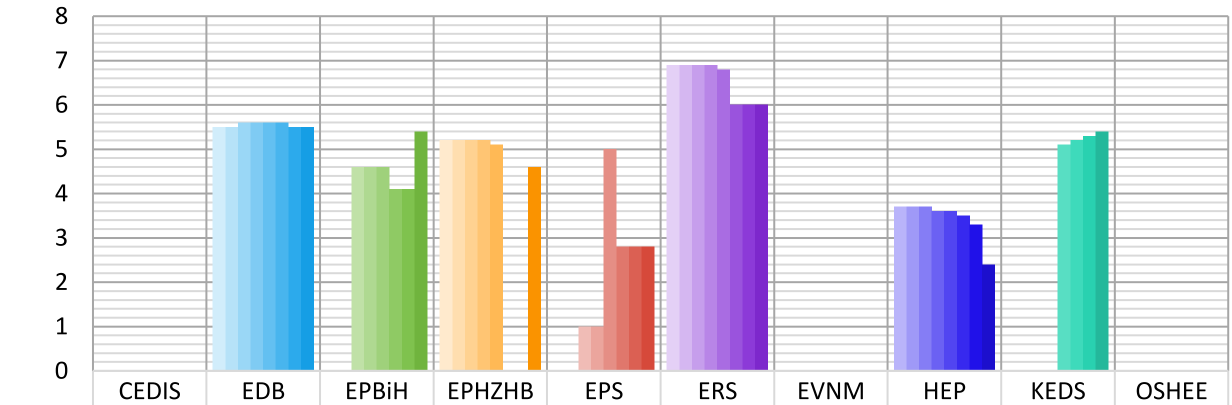
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	5	0	5,7	0	6	0	15,3	0	8,3
2009	0	5	0	5,7	0	6,4	0	15,5	0	8,3
2010	0	5	9,6	5,7	0	6,4	0	15,9	0	8,3
2011	0	5	9,6	5,7	0	6,4	0	16	0	8,1
2012	0	5	12,1	5,7	6,5	6,8	0	17,1	13,4	8
2013	0	2,5	6,4	0	3,5	7	0	8,1	13,5	8
2014	0	2,5	6,4	0	3,5	7	0	8	14,3	7,8
2015	0	2,5	3,9	7,4	3,5	7	5,1	6,7	15	7,7

Figure 19.52 Average number of MV (10 kV) feeders per substation in SEE DSOs in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	5,5	0	0	0	6,6
2009	0	0	0	0	0	5,5	0	0	0	6,6
2010	0	0	6	0	0	5,5	0	0	0	6,6
2011	0	0	6	0	0	5,5	0	0	0	6,6
2012	0	0	6	0	0,2	5,5	0	0	2,4	6,6
2013	0	0	3	0	0,1	5,5	0	0	0	6,8
2014	0	0	3	0	0,1	5,5	0	0	0	6,8
2015	0	0	3	0	0,1	5,5	0	0	0	6,8

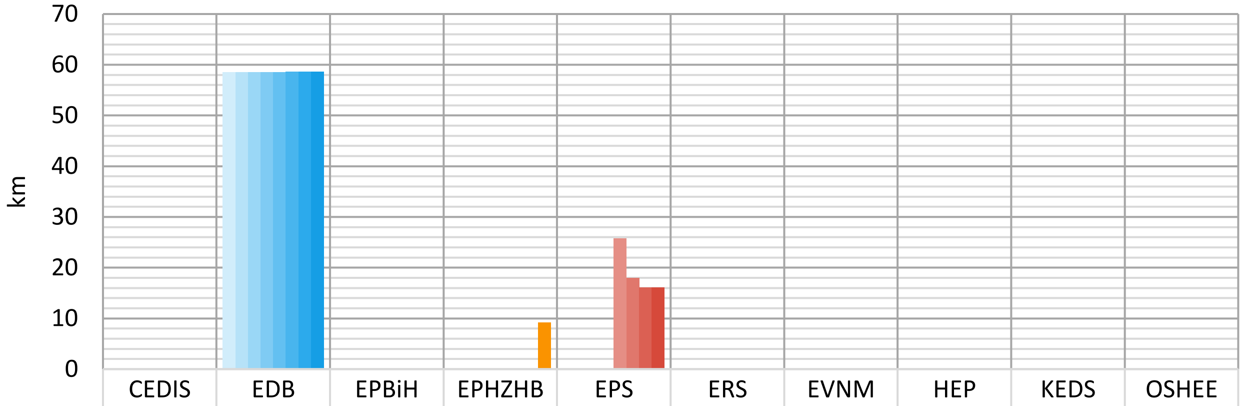
Figure 19.53 Average number of MV (6 kV) feeders per substation in SEE DSOs in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	5,5	0	5,2	0	6,9	0	3,7	0	0
2009	0	5,5	0	5,2	0	6,9	0	3,7	0	0
2010	0	5,6	4,6	5,2	1	6,9	0	3,7	0	0
2011	0	5,6	4,6	5,2	1	6,9	0	3,6	0	0
2012	0	5,6	4,6	5,1	5	6,8	0	3,6	5,1	0
2013	0	5,6	4,1	0	2,8	6	0	3,5	5,2	0
2014	0	5,5	4,1	0	2,8	6	0	3,3	5,3	0
2015	0	5,5	5,4	4,6	2,8	6	0	2,4	5,4	0

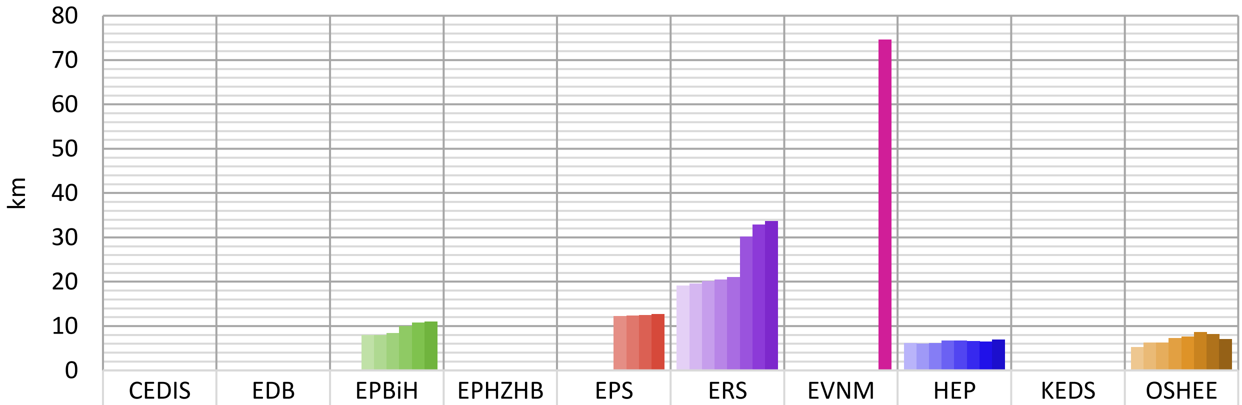
Figure 19.54 Average number of LV (0,4 kV) feeders per substation in SEE DSOs in the period 2008-2015

19.9 AVERAGE FEEDER LENGTH



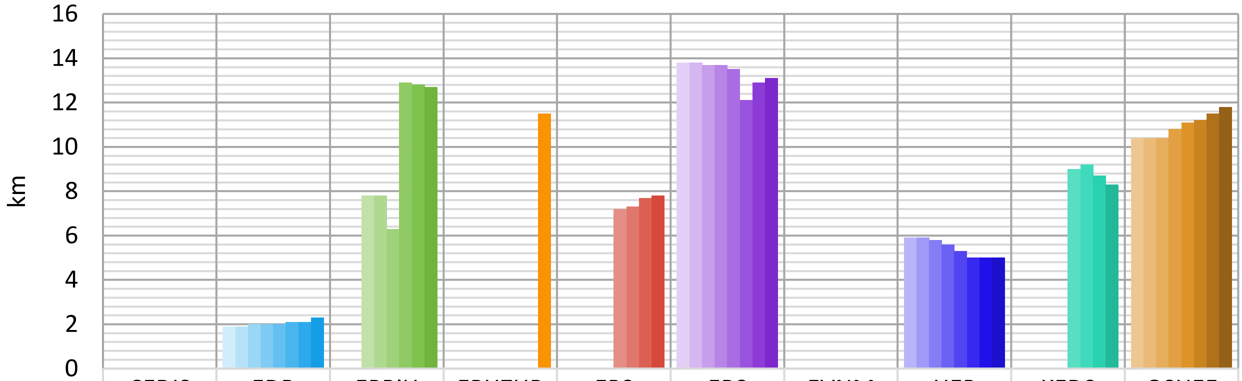
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	58,5	0	0	0	0	0	0	0	0
2009	0	58,5	0	0	0	0	0	0	0	0
2010	0	58,5	0	0	0	0	0	0	0	0
2011	0	58,5	0	0	0	0	0	0	0	0
2012	0	58,5	0	0	25,8	0	0	0	0	0
2013	0	58,6	0	0	18	0	0	0	0	0
2014	0	58,6	0	0	16,1	0	0	0	0	0
2015	0	58,6	0	9,2	16,1	0	0	0	0	0

Figure 19.55 Average MV (35 kV) feeder length in SEE DSOs in the period 2008-2015



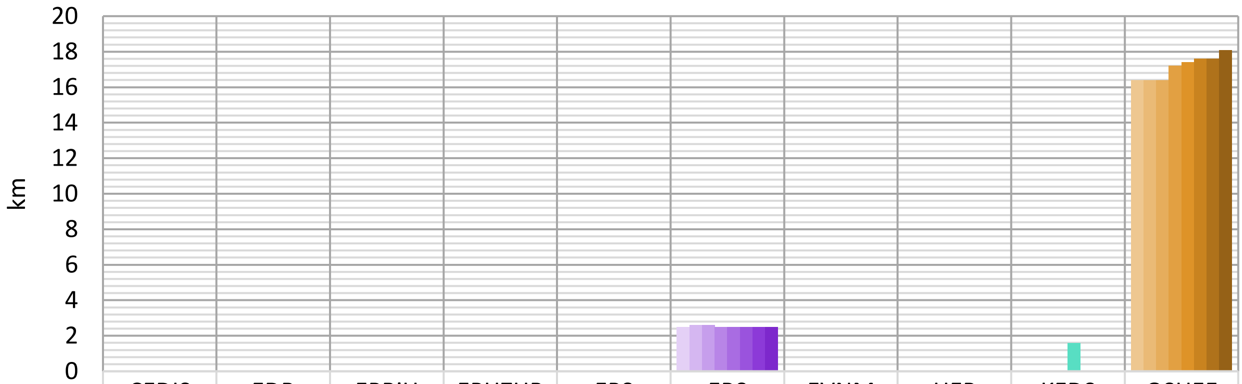
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	19,1	0	6,1	0	5,2
2009	0	0	0	0	0	19,6	0	6	0	6,3
2010	0	0	7,9	0	0	20,1	0	6,2	0	6,3
2011	0	0	8	0	0	20,5	0	6,7	0	7,3
2012	0	0	8,4	0	12,2	21	0	6,7	0	7,6
2013	0	0	10	0	12,3	30,2	0	6,6	0	8,6
2014	0	0	10,8	0	12,5	32,9	0	6,5	0	8,2
2015	0	0	11	0	12,7	33,7	74,6	6,9	0	7,1

Figure 19.56 Average MV (20 kV) feeder length in SEE DSOs in the period 2008-2015



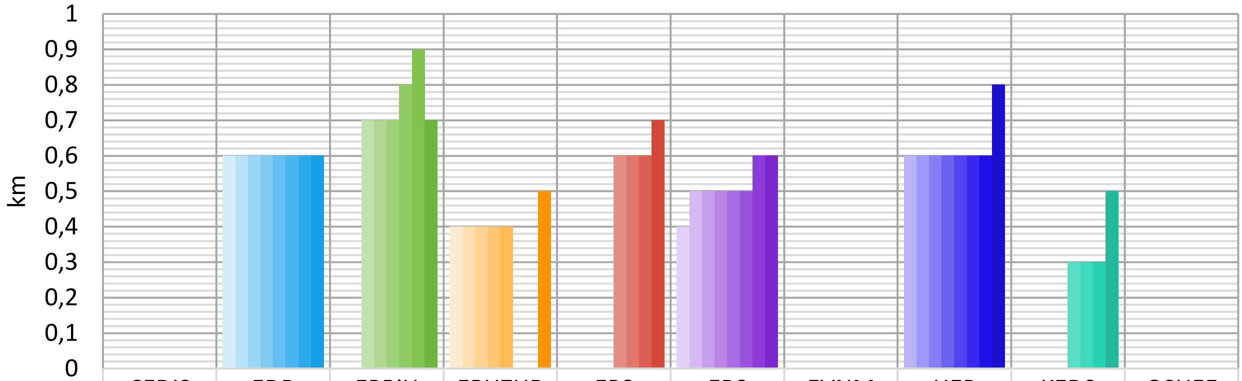
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	1,9	0	0	0	13,8	0	5,9	0	10,4
2009	0	1,9	0	0	0	13,8	0	5,9	0	10,4
2010	0	2	7,8	0	0	13,7	0	5,8	0	10,4
2011	0	2	7,8	0	0	13,7	0	5,6	0	10,8
2012	0	2	6,3	0	7,2	13,5	0	5,3	9	11,1
2013	0	2,1	12,9	0	7,3	12,1	0	5	9,2	11,2
2014	0	2,1	12,8	0	7,7	12,9	0	5	8,7	11,5
2015	0	2,3	12,7	11,5	7,8	13,1	0	5	8,3	11,8

Figure 19.57 Average MV (10 kV) feeder length in SEE DSOs in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	2,5	0	0	0	16,4
2009	0	0	0	0	0	2,6	0	0	0	16,4
2010	0	0	0	0	0	2,6	0	0	0	16,4
2011	0	0	0	0	0	2,5	0	0	0	17,2
2012	0	0	0	0	0	2,5	0	0	1,6	17,4
2013	0	0	0	0	0	2,5	0	0	0	17,6
2014	0	0	0	0	0	2,5	0	0	0	17,6
2015	0	0	0	0	0	2,5	0	0	0	18,1

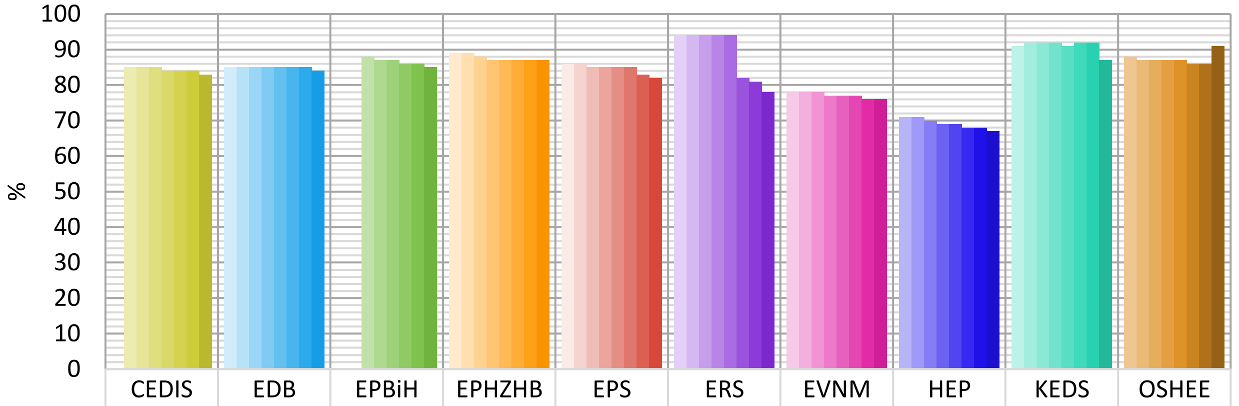
Figure 19.58 Average MV (6 kV) feeder length in SEE DSOs in the period 2008-2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0,6	0	0,4	0	0,4	0	0,6	0	0
2009	0	0,6	0	0,4	0	0,5	0	0,6	0	0
2010	0	0,6	0,7	0,4	0	0,5	0	0,6	0	0
2011	0	0,6	0,7	0,4	0	0,5	0	0,6	0	0
2012	0	0,6	0,7	0,4	0,6	0,5	0	0,6	0,3	0
2013	0	0,6	0,8	0	0,6	0,5	0	0,6	0,3	0
2014	0	0,6	0,9	0	0,6	0,6	0	0,6	0,3	0
2015	0	0,6	0,7	0,5	0,7	0,6	0	0,8	0,5	0

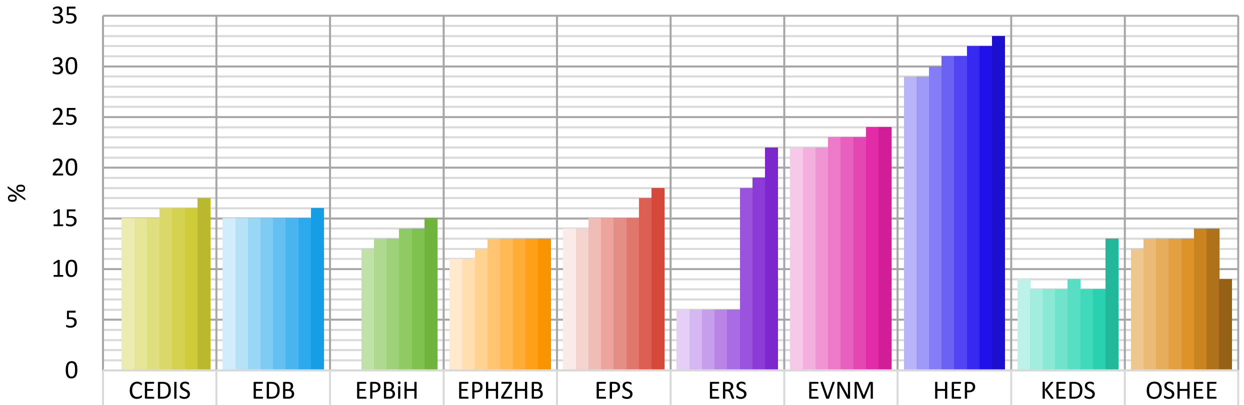
Figure 19.59 Average LV (0,4 kV) feeder length in SEE DSOs in the period 2008-2015

19.10 DISTRIBUTION NETWORK LENGTH



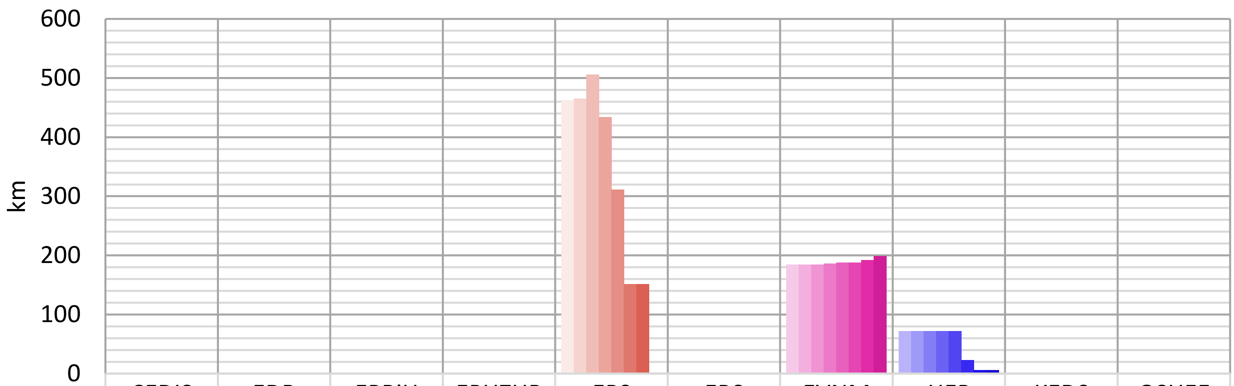
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	85	0	89	86	94	78	71	91	88
2009	85	85	0	89	86	94	78	71	92	87
2010	85	85	88	88	85	94	78	70	92	87
2011	85	85	87	87	85	94	77	69	92	87
2012	84	85	87	87	85	94	77	69	91	87
2013	84	85	86	87	85	82	77	68	92	86
2014	84	85	86	87	83	81	76	68	92	86
2015	83	84	85	87	82	78	76	67	87	91

Figure 19.60 Share of aerial network in SEE DSOs in the period 2008 - 2015



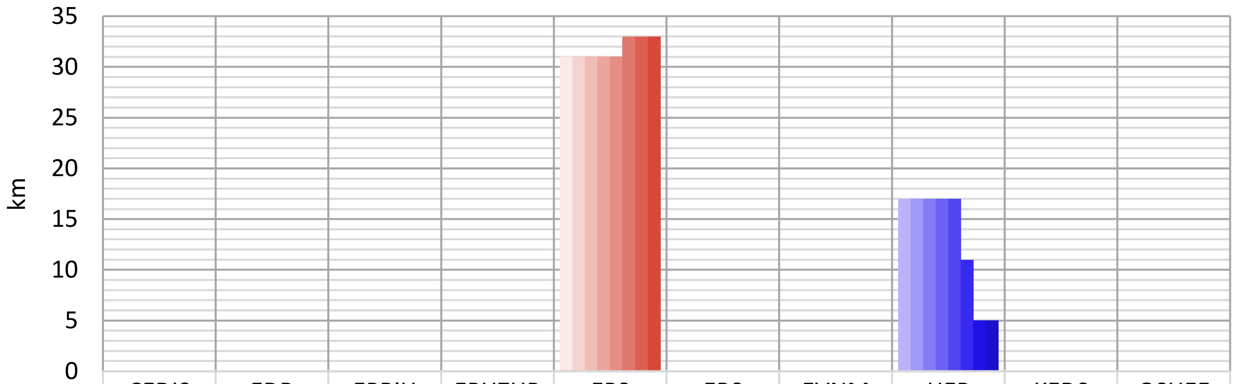
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	15	0	11	14	6	22	29	9	12
2009	15	15	0	11	14	6	22	29	8	13
2010	15	15	12	12	15	6	22	30	8	13
2011	15	15	13	13	15	6	23	31	8	13
2012	16	15	13	13	15	6	23	31	9	13
2013	16	15	14	13	15	18	23	32	8	14
2014	16	15	14	13	17	19	24	32	8	14
2015	17	16	15	13	18	22	24	33	13	9

Figure 19.61 Share of cable network in SEE DSOs in the period 2008-2015



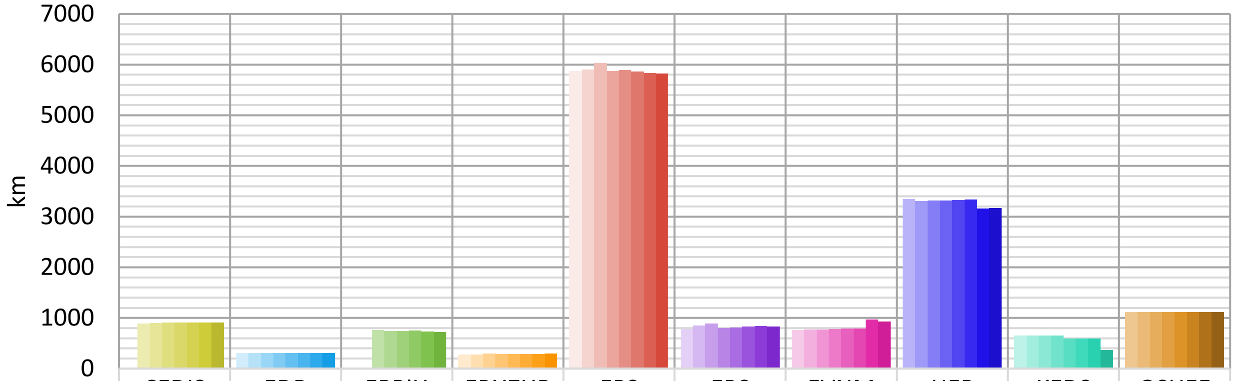
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	463	0	184	72	0	0
2009	0	0	0	0	465	0	184	72	0	0
2010	0	0	0	0	506	0	184	72	0	0
2011	0	0	0	0	434	0	186	72	0	0
2012	0	0	0	0	311	0	188	72	0	0
2013	0	0	0	0	151	0	188	23	0	0
2014	0	0	0	0	151	0	192	6	0	0
2015	0	0	0	0	2	0	199	6	0	0

Figure 19.62 Length of 110 kV - aerial distribution network in SEE DSOs in the period 2008 - 2015



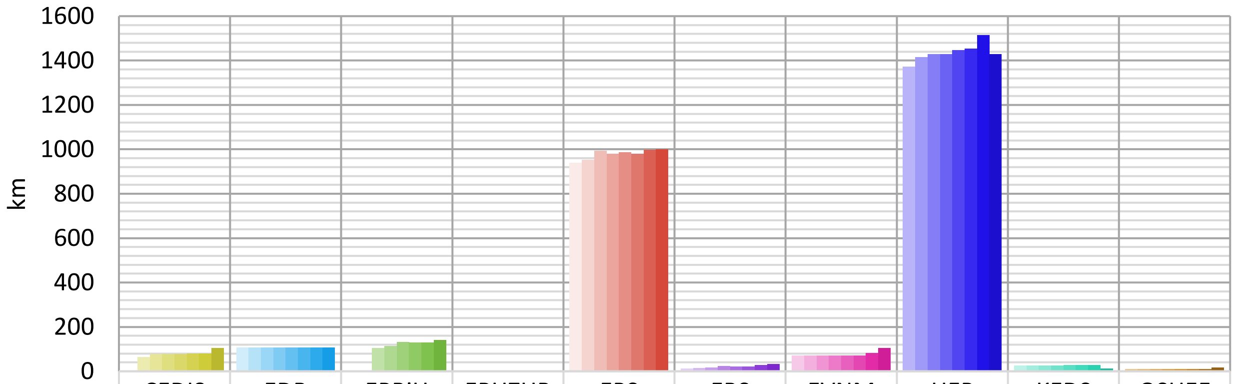
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	31	0	0	17	0	0
2009	0	0	0	0	31	0	0	17	0	0
2010	0	0	0	0	31	0	0	17	0	0
2011	0	0	0	0	31	0	0	17	0	0
2012	0	0	0	0	31	0	0	17	0	0
2013	0	0	0	0	33	0	0	11	0	0
2014	0	0	0	0	33	0	0	5	0	0
2015	0	0	0	0	33	0	0	5	0	0

Figure 19.63 Length of 110 kV - cable distribution network in SEE DSOs in the period 2008 - 2015



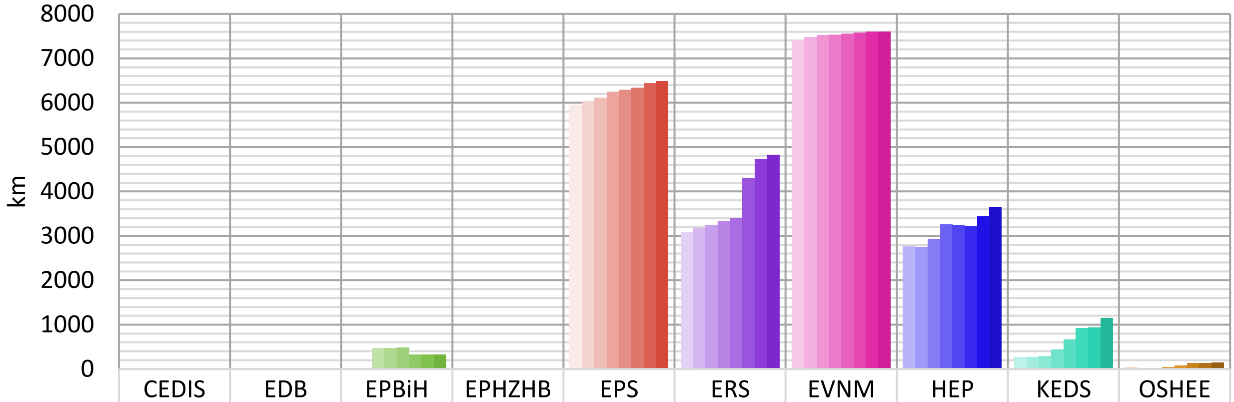
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	302	0	280	5874	781	762	3341	648	1112
2009	886	302	0	280	5901	851	770	3309	648	1112
2010	897	302	757	291	6032	886	770	3317	648	1112
2011	903	302	744	285	5869	795	779	3319	648	1112
2012	903	302	742	285	5886	805	788	3326	596	1112
2013	903	302	747	287	5863	825	788	3335	596	1112
2014	903	302	725	289	5831	840	966	3154	596	1112
2015	907	302	719	291	5823	828	929	3163	361	1113

Figure 19.64 Length of 35 kV - aerial distribution network in SEE DSOs in the period 2008 - 2015



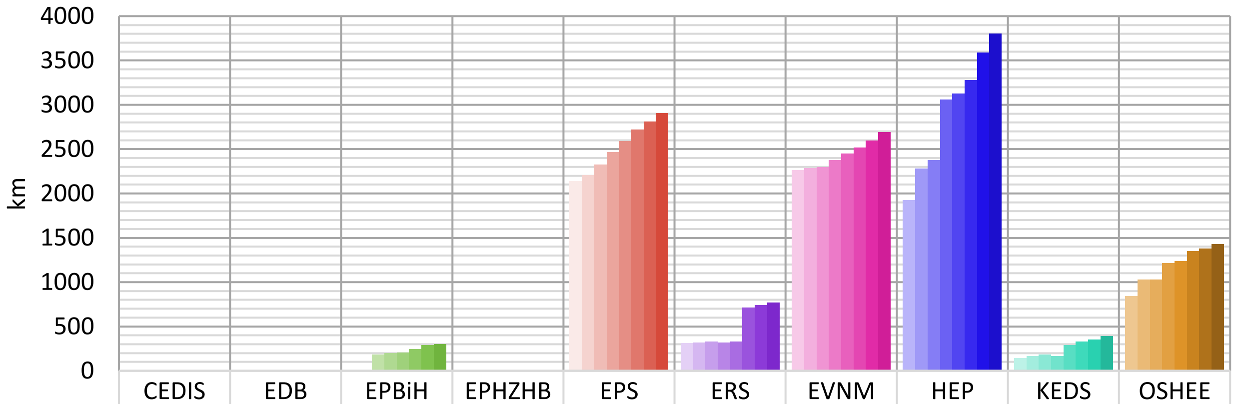
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	108	0	3	940	13	71	1373	26	11
2009	64	108	0	4	954	14	71	1416	26	11
2010	77	108	104	4	994	17	71	1429	26	11
2011	78	108	115	4	980	23	72	1429	26	11
2012	78	108	133	4	987	21	72	1447	29	11
2013	79	108	130	4	981	21	72	1453	29	11
2014	79	108	129	4	999	29	83	1514	29	11
2015	104	108	141	4	1000	32	104	1430	12	18

Figure 19.65 Length of 35 kV - cable distribution network in SEE DSOs in the period 2008 - 2015



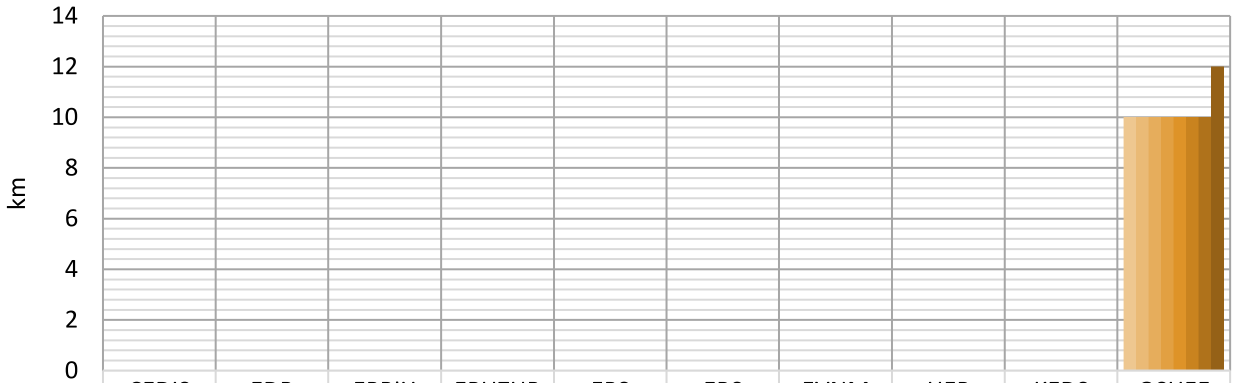
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	5950	3094	7410	2761	265	31
2009	0	0	0	0	6029	3169	7481	2748	274	20
2010	0	0	469	0	6117	3245	7519	2935	297	20
2011	0	0	468	0	6243	3323	7538	3263	441	48
2012	0	0	487	0	6297	3402	7551	3244	665	76
2013	0	0	322	0	6334	4309	7582	3222	927	137
2014	0	0	323	0	6441	4719	7597	3435	936	136
2015	0	0	324	0	6482	4825	7603	3649	1146	148

Figure 19.66 Length of 20 kV - aerial distribution network in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	2141	314	2264	1926	145	843
2009	0	0	0	0	2206	321	2285	2283	165	1031
2010	0	0	184	0	2324	329	2297	2377	184	1031
2011	0	0	198	0	2467	321	2379	3060	167	1213
2012	0	0	208	0	2590	329	2449	3127	293	1237
2013	0	0	247	0	2719	711	2517	3279	332	1353
2014	0	0	290	0	2810	743	2594	3590	355	1381
2015	0	0	304	0	2906	769	2691	3802	393	1429

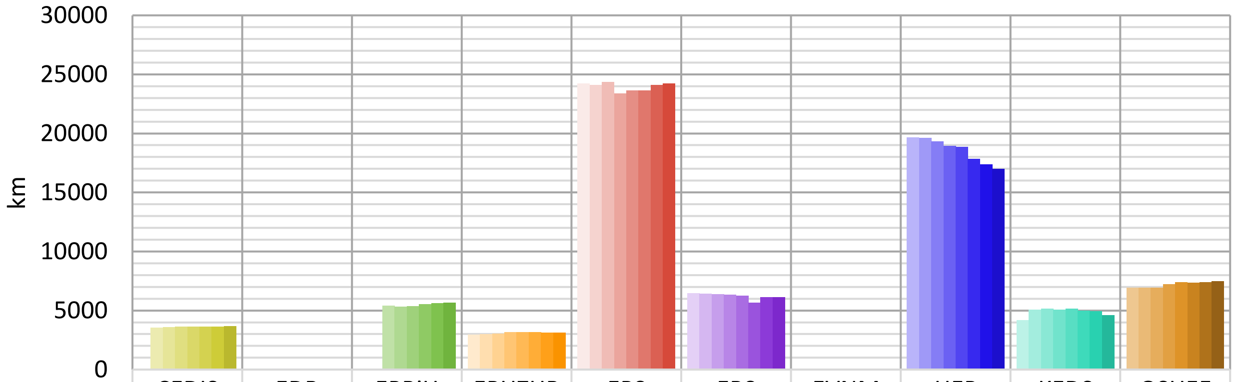
Figure 19.67 Length of 20 kV - cable distribution network in SEE DSOs in the period 2008 – 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	10
2009	0	0	0	0	0	0	0	0	0	10
2010	0	0	0	0	0	0	0	0	0	10
2011	0	0	0	0	0	0	0	0	0	10
2012	0	0	0	0	0	0	0	0	0	10
2013	0	0	0	0	0	0	0	0	0	10
2014	0	0	0	0	0	0	0	0	0	10
2015	0	0	0	0	0	0	0	0	0	12

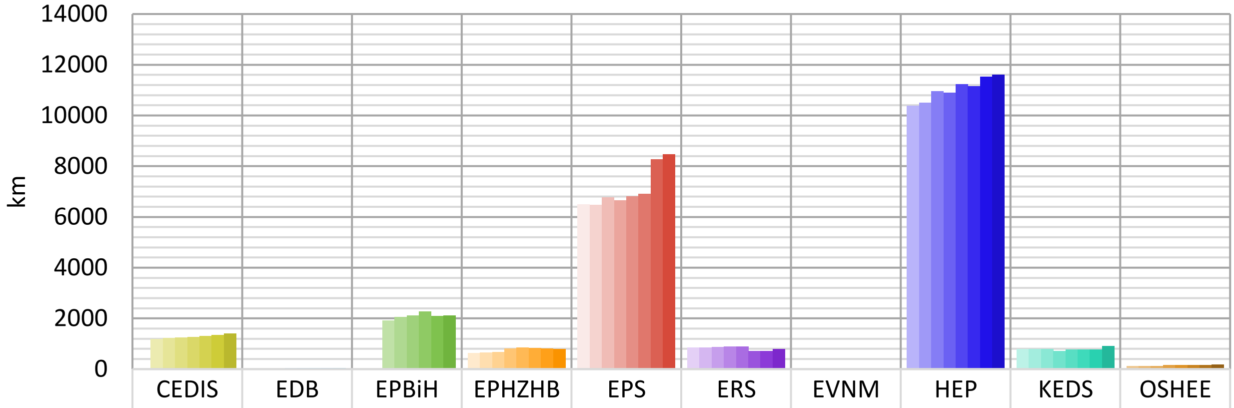
Figure 19.68 Length of 16 kV - aerial distribution network in SEE DSOs in the period 2008 – 2015

In the SEE DSOs in the period 2008 – 2015 weren't 16 kV cable distribution networks.



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	63	0	2945	24206	6450	0	19668	4171	6909
2009	3544	63	0	2999	24086	6421	0	19614	5071	6902
2010	3592	64	5388	3036	24334	6380	0	19297	5159	6902
2011	3604	64	5300	3145	23374	6326	0	18930	5046	7211
2012	3606	65	5368	3176	23620	6233	0	18852	5141	7404
2013	3627	69	5517	3156	23625	5666	0	17829	4967	7343
2014	3630	69	5618	3136	24083	6117	0	17373	4947	7369
2015	3660	73	5650	3117	24215	6127	0	17002	4584	7471

Figure 19.69 Length of 10 kV - aerial distribution network in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	30	0	642	6501	846	0	10385	789	123
2009	1186	33	0	651	6480	850	0	10513	795	131
2010	1228	34	1915	669	6769	864	0	10960	801	131
2011	1250	35	2052	811	6652	888	0	10902	709	161
2012	1261	35	2117	845	6816	900	0	11237	774	168
2013	1298	35	2274	830	6905	721	0	11158	777	169
2014	1339	38	2096	815	8266	713	0	11533	777	169
2015	1404	43	2120	800	8481	795	0	11616	917	176

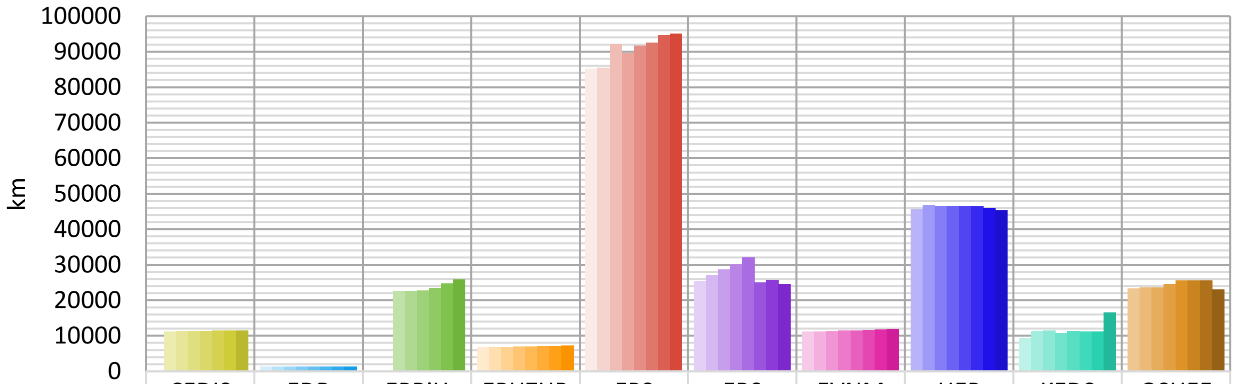
Figure 19.70 Length of 10 kV - cable distribution network in SEE DSOs in the period 2008 - 2015

	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	21	0	0	44	4699
2009	8	0	0	0	0	21	0	0	44	4854
2010	8	0	0	0	0	21	0	0	44	4854
2011	8	0	0	0	0	20	0	0	44	4994
2012	8	0	0	0	0	20	0	0	44	5072
2013	8	0	0	0	0	20	0	0	45	5112
2014	8	0	0	0	0	20	0	0	45	5154
2015	8	0	0	0	0	20	0	0	42	5286

Figure 19.71 Length of 6 kV - aerial distribution network in SEE DSOs in the period 2008 - 2015

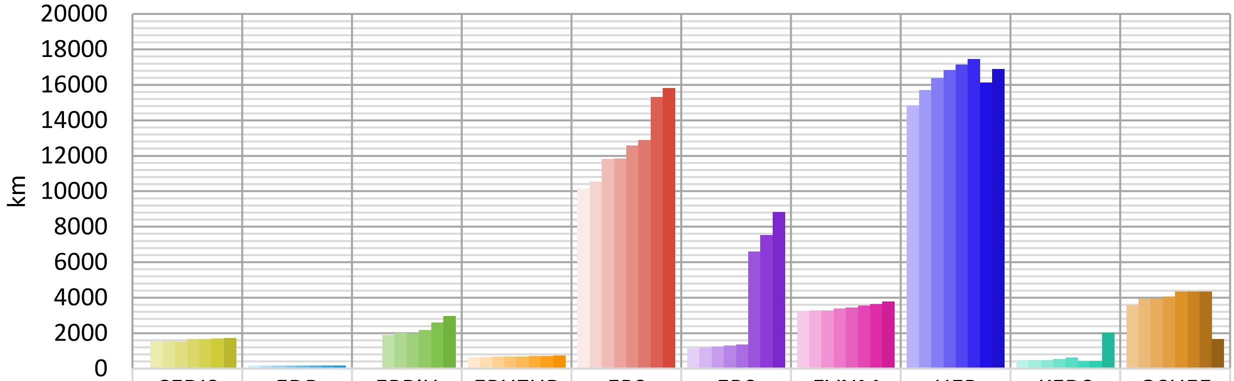
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	6	0	0	2	307
2009	5	0	0	0	0	8	0	0	2	160
2010	5	0	0	0	0	8	0	0	2	160
2011	5	0	0	0	0	8	0	0	2	309
2012	5	0	0	0	0	8	0	0	5	292
2013	5	0	0	0	0	8	0	0	5	309
2014	5	0	0	0	0	8	0	0	5	280
2015	5	0	0	0	0	8	0	0	8	300

Figure 19.72 Length of 6 kV - cable distribution network in SEE DSOs in the period 2008 - 2015



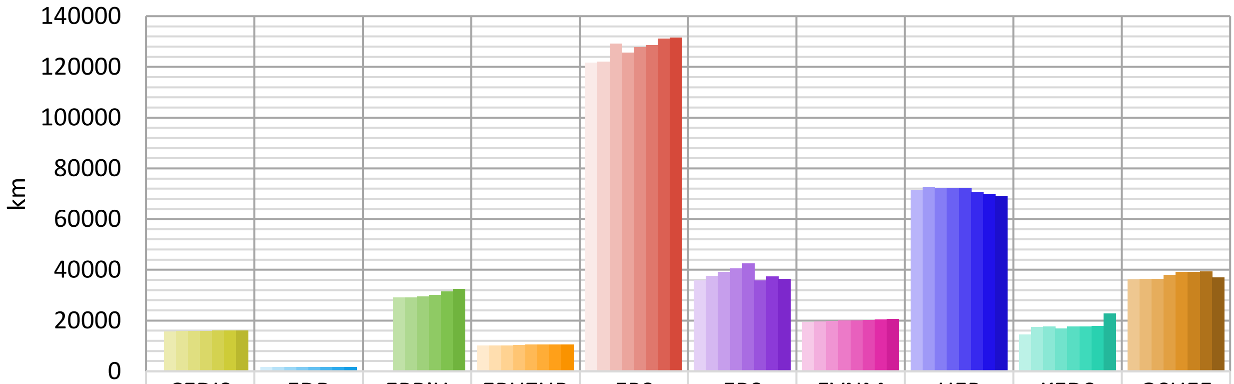
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	1368	0	6854	85230	25482	11150	45641	9337	23399
2009	11196	1376	0	6857	85512	27087	11267	46857	11386	23574
2010	11341	1381	22577	6877	92131	28720	11355	46621	11503	23574
2011	11387	1384	22596	6942	89604	30099	11440	46589	10724	24629
2012	11409	1386	22816	7026	91716	32069	11498	46637	11294	25554
2013	11489	1389	23433	7092	92515	25090	11646	46428	11213	25554
2014	11530	1394	24807	7158	94629	25677	11756	46069	11242	25554
2015	11535	1399	25805	7225	95103	24572	11921	45318	16598	22982

Figure 19.73 Length of 0,4 kV - aerial distribution network in SEE DSOs in the period 2008 - 2015



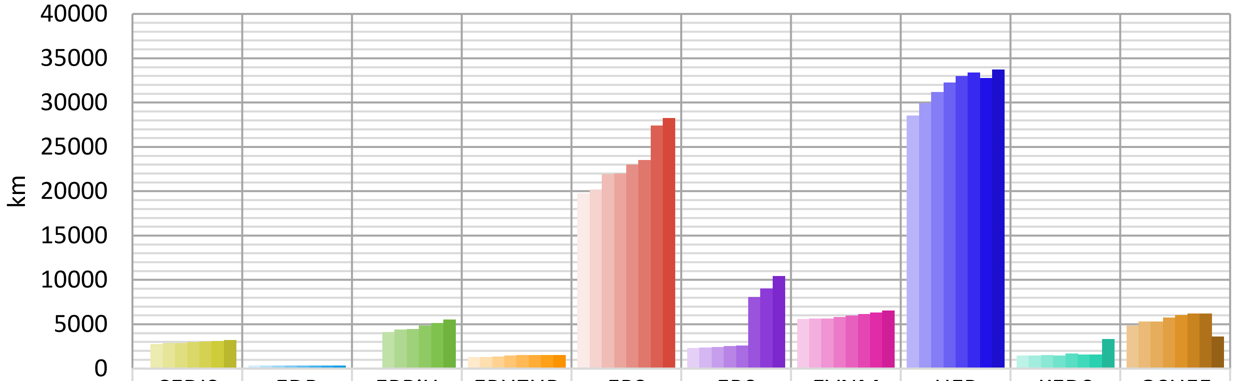
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	176	0	650	10145	1120	3223	14832	474	3584
2009	1515	176	0	651	10531	1172	3257	15703	483	3939
2010	1549	176	1891	667	11824	1226	3282	16375	485	3939
2011	1510	176	2008	670	11833	1283	3378	16820	546	4055
2012	1658	176	1972	677	12576	1342	3451	17135	610	4334
2013	1667	176	2177	694	12886	6582	3559	17465	423	4334
2014	1686	177	2598	712	15299	7522	3647	16122	423	4334
2015	1721	177	2954	729	15815	8813	3765	16877	2017	1669

Figure 19.74 Length of 0,4 kV - cable distribution network in SEE DSOs in the period 2008 - 2015



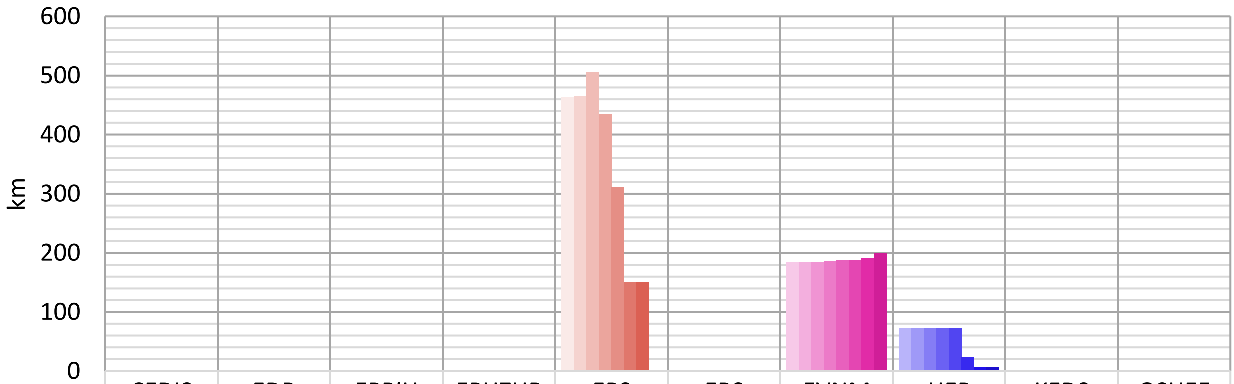
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	1733	0	10080	121724	35828	19506	71483	14465	36160
2009	15634	1741	0	10136	121994	37548	19701	72600	17423	36472
2010	15838	1747	29191	10204	129120	39252	19829	72242	17651	36472
2011	15902	1751	29108	10372	125526	40562	19942	72173	16903	38004
2012	15926	1753	29413	10487	127830	42529	20025	72131	17741	39228
2013	16027	1760	30020	10535	128488	35910	20204	70837	17747	39268
2014	16071	1765	31473	10584	131135	37373	20510	70037	17766	39335
2015	16110	1774	32498	10633	131625	36372	20652	69138	22731	37011

Figure 19.75 Length of aerial distribution network in SEE DSOs in the period 2008 - 2015



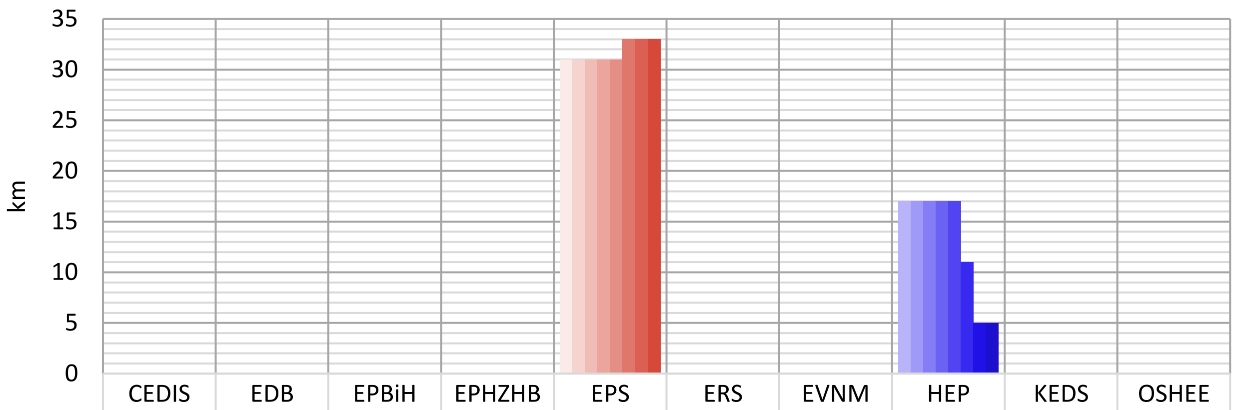
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	314	0	1295	19758	2299	5557	28533	1436	4869
2009	2770	317	0	1306	20202	2365	5613	29932	1471	5273
2010	2859	319	4094	1340	21942	2445	5651	31158	1498	5273
2011	2843	319	4373	1485	21962	2524	5829	32228	1450	5750
2012	3002	319	4429	1526	22999	2601	5972	32963	1712	6041
2013	3048	319	4828	1529	23523	8043	6148	33365	1566	6177
2014	3109	323	5113	1531	27407	9014	6324	32764	1589	6176
2015	3234	328	5519	1534	28235	10417	6559	33730	3347	3592

Figure 19.76 Length of cable distribution network in SEE DSOs in the period 2008 - 2015



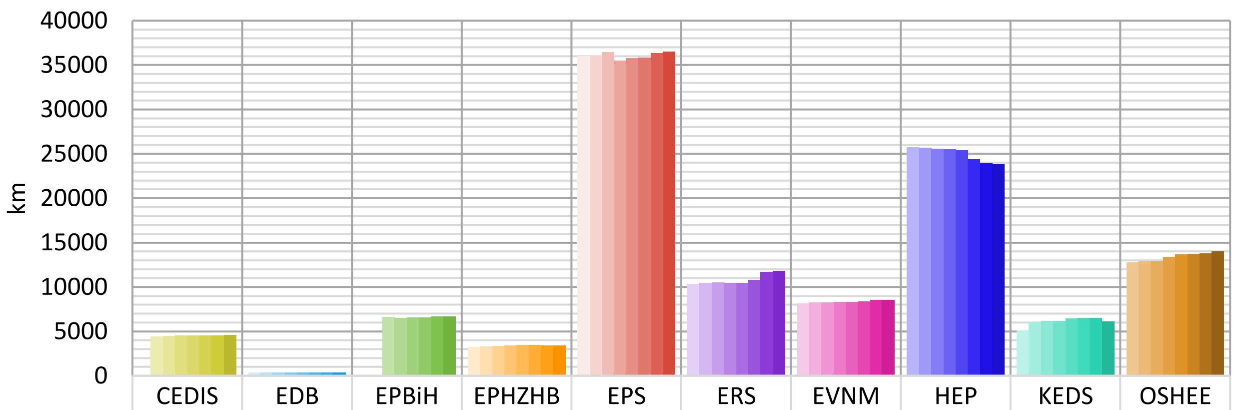
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	463	0	184	72	0	0
2009	0	0	0	0	465	0	184	72	0	0
2010	0	0	0	0	506	0	184	72	0	0
2011	0	0	0	0	434	0	186	72	0	0
2012	0	0	0	0	311	0	188	72	0	0
2013	0	0	0	0	151	0	188	23	0	0
2014	0	0	0	0	151	0	192	6	0	0
2015	0	0	0	0	2	0	199	6	0	0

Figure 19.77 Length of HV aerial distribution network in SEE DSOs in the period 2008 - 2015



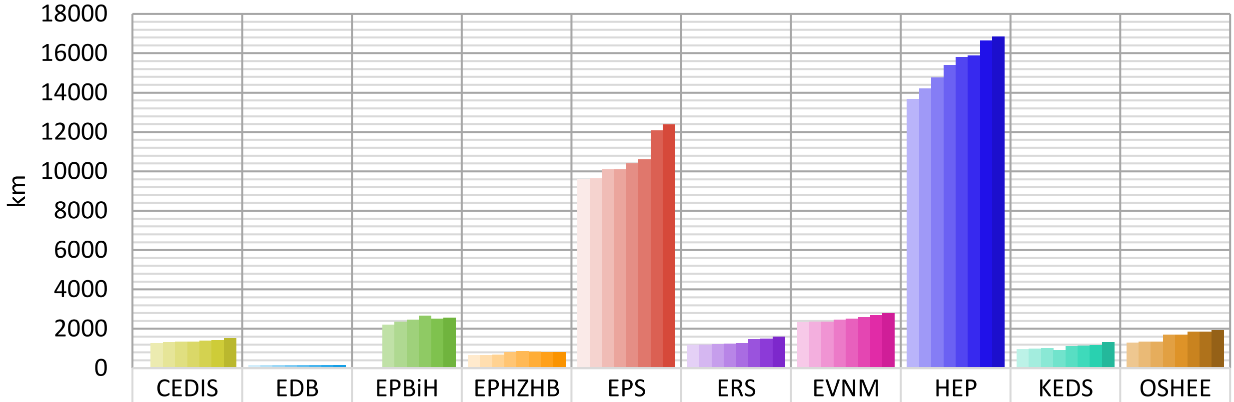
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	31	0	0	17	0	0
2009	0	0	0	0	31	0	0	17	0	0
2010	0	0	0	0	31	0	0	17	0	0
2011	0	0	0	0	31	0	0	17	0	0
2012	0	0	0	0	31	0	0	17	0	0
2013	0	0	0	0	33	0	0	11	0	0
2014	0	0	0	0	33	0	0	5	0	0
2015	0	0	0	0	33	0	0	5	0	0

Figure 19.78 Length of HV cable distribution network in SEE DSOs in the period 2008 - 2015



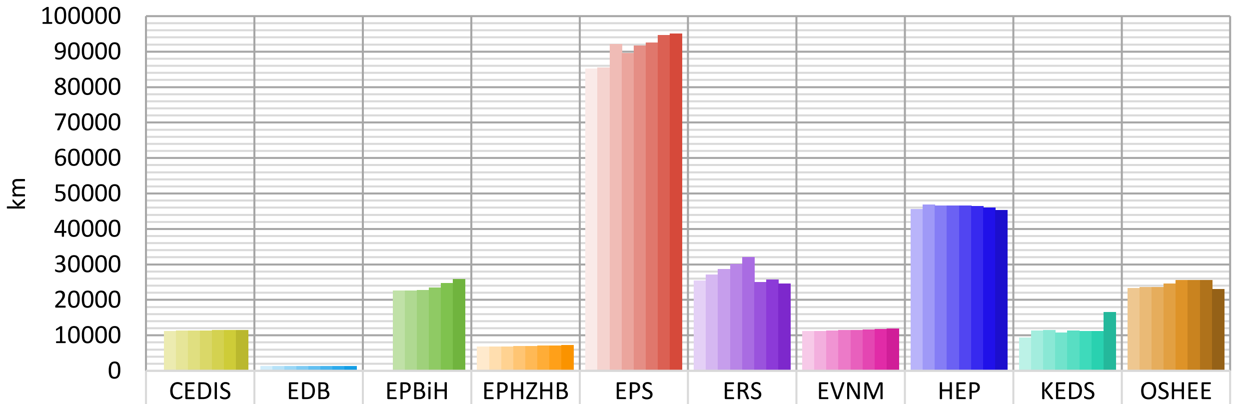
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	365	0	3226	36030	10346	8172	25770	5128	12761
2009	4438	365	0	3280	36016	10461	8251	25671	6037	12898
2010	4497	366	6614	3327	36483	10532	8289	25549	6148	12898
2011	4515	366	6512	3430	35487	10463	8317	25512	6179	13375
2012	4517	367	6597	3461	35802	10461	8339	25422	6447	13674
2013	4538	371	6586	3443	35822	10820	8370	24386	6534	13714
2014	4541	371	6667	3426	36355	11696	8562	23963	6524	13781
2015	4575	375	6693	3408	36520	11800	8532	23814	6133	14029

Figure 19.79 Length of MV aerial distribution network in SEE DSOs in the period 2008 - 2015



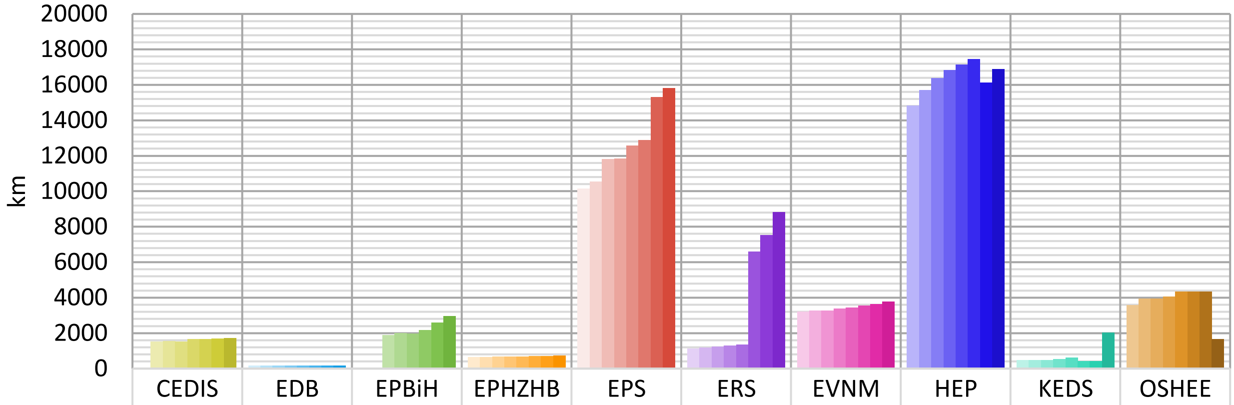
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	138	0	645	9582	1179	2334	13684	962	1285
2009	1255	141	0	655	9639	1194	2357	14212	988	1334
2010	1310	142	2203	673	10087	1219	2369	14766	1013	1334
2011	1333	143	2365	815	10098	1241	2452	15391	904	1695
2012	1344	143	2458	849	10392	1258	2521	15811	1102	1707
2013	1381	143	2650	834	10605	1461	2589	15889	1143	1843
2014	1423	146	2515	819	12076	1493	2677	16637	1166	1842
2015	1513	151	2565	805	12387	1604	2794	16848	1330	1923

Figure 19.80 Length of MV cable distribution network in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	1368	0	6854	85230	25482	11150	45641	9337	23399
2009	11196	1376	0	6857	85512	27087	11267	46857	11386	23574
2010	11341	1381	22577	6877	92131	28720	11355	46621	11503	23574
2011	11387	1384	22596	6942	89604	30099	11440	46589	10724	24629
2012	11409	1386	22816	7026	91716	32069	11498	46637	11294	25554
2013	11489	1389	23433	7092	92515	25090	11646	46428	11213	25554
2014	11530	1394	24807	7158	94629	25677	11756	46069	11242	25554
2015	11535	1399	25805	7225	95103	24572	11921	45318	16598	22982

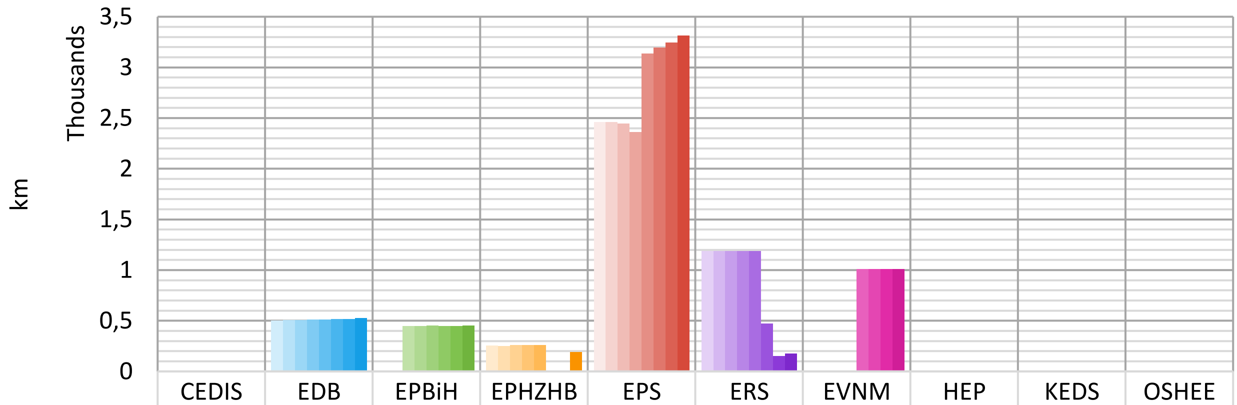
Figure 19.81 Length of LV aerial distribution network in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	176	0	650	10145	1120	3223	14832	474	3584
2009	1515	176	0	651	10531	1172	3257	15703	483	3939
2010	1549	176	1891	667	11824	1226	3282	16375	485	3939
2011	1510	176	2008	670	11833	1283	3378	16820	546	4055
2012	1658	176	1972	677	12576	1342	3451	17135	610	4334
2013	1667	176	2177	694	12886	6582	3559	17465	423	4334
2014	1686	177	2598	712	15299	7522	3647	16122	423	4334
2015	1721	177	2954	729	15815	8813	3765	16877	2017	1669

Figure 19.82 Length of LV cable distribution network in SEE DSOs in the period 2008 – 2015

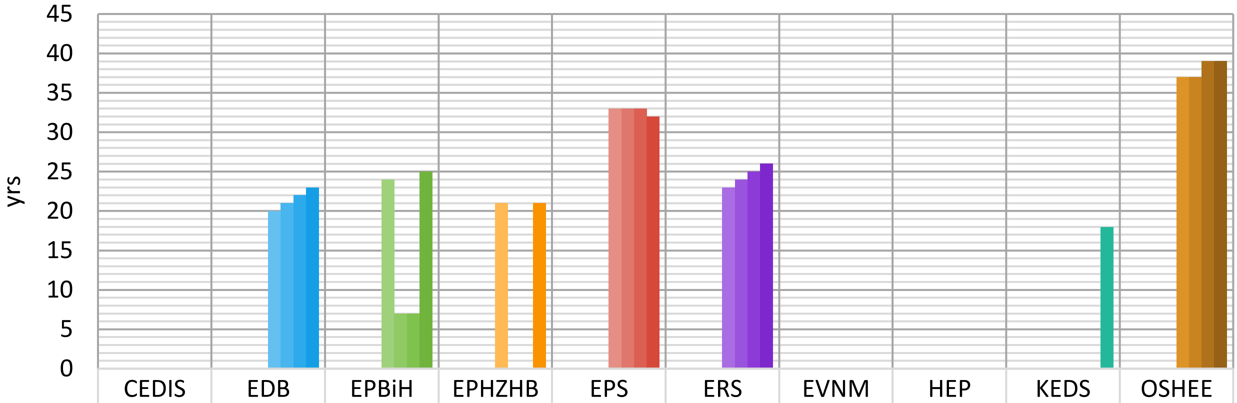
19.11 DISTRIBUTION NETWORK OPERATED AND NOT OWNED BY DSO



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	503	0	252	2461	1189	0	0	0	0
2009	0	506	0	251	2458	1189	0	0	0	0
2010	0	508	446	257	2444	1189	0	0	0	0
2011	0	509	447	257	2361	1189	0	0	0	0
2012	0	510	452	257	3134	1189	1009	0	0	0
2013	0	514	446	0	3195	471	1009	0	0	0
2014	0	517	447	0	3244	152	1009	0	0	0
2015	0	526	450	191	3314	176	1009	0	0	0

Figure 19.83 Length of distribution network operated but not owned by SEE DSOs in the period 2008 – 2015

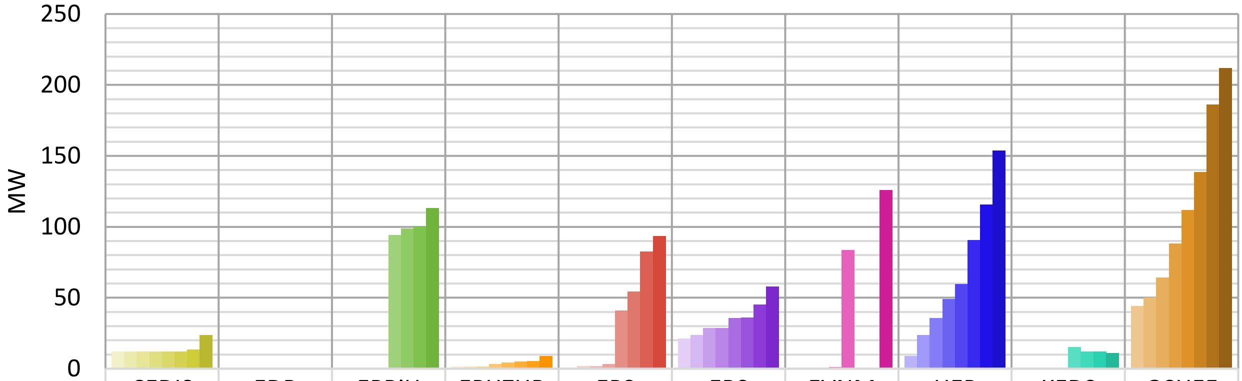
19.12 DISTRIBUTION NETWORK AGE



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0
2012	0	20	24	21	33	23	0	0	0	37
2013	0	21	7	0	33	24	0	0	0	37
2014	0	22	7	0	33	25	0	0	0	39
2015	0	23	25	21	32	26	0	0	18	39

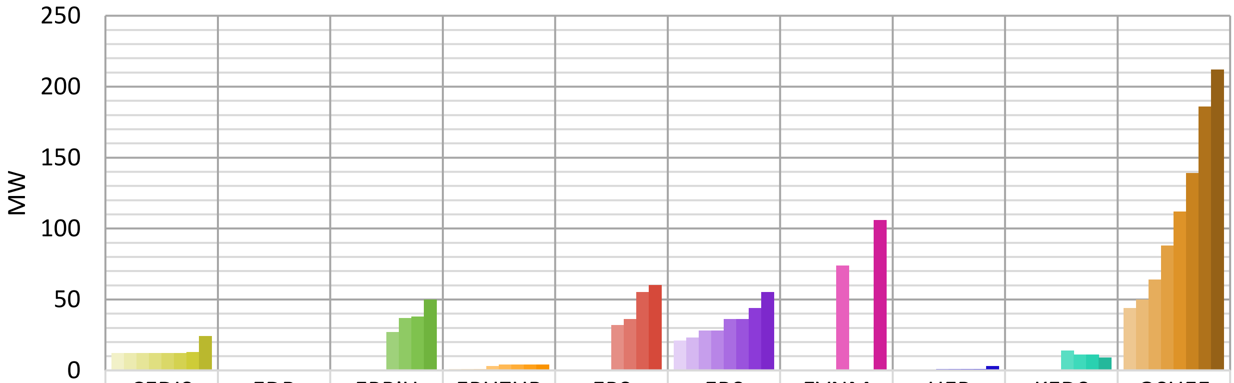
Figure 19.84 Distribution network age in SEE DSOs in the period 2008-2015

19.13 DISTRIBUTED GENERATION DATA



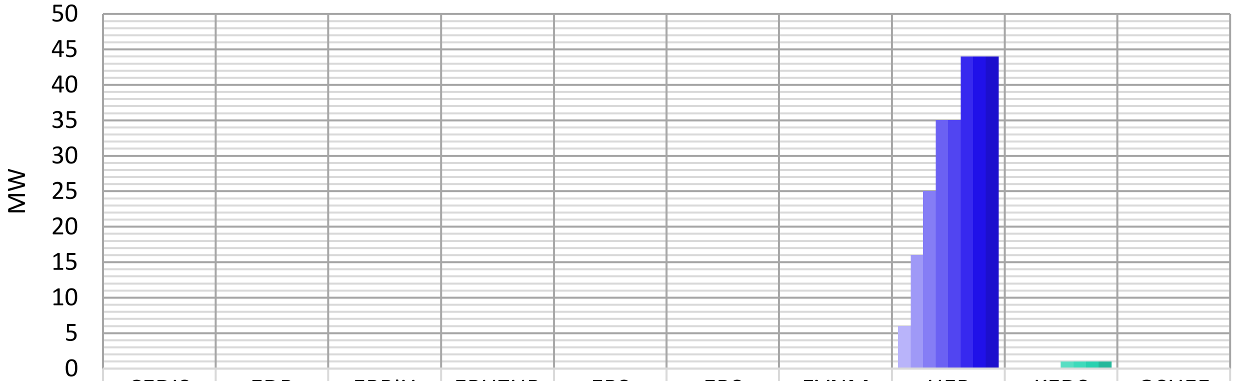
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	12120	0	0	1340	0	21242	0	8990	0	43970
2009	12120	0	0	1340	1800	23542	10	23590	0	50110
2010	12120	0	0	1340	1800	28542	169	35564	0	64340
2011	12120	0	0	3410	3215	28542	1308	49141	0	88375
2012	12120	0	94074	4225	40807	35682	83696	59686	15324	111655
2013	12120	0	98813	5165	54265	36142	0	90840	11990	138630
2014	13370	0	100339	5243	82730	45146	0	115791	11990	186198
2015	23740	0	113305	8909	93613	57750	125910	153722	10872	211808

Figure 19.85 Distributed generation installed capacity in SEE DSOs in the period 2008 - 2015



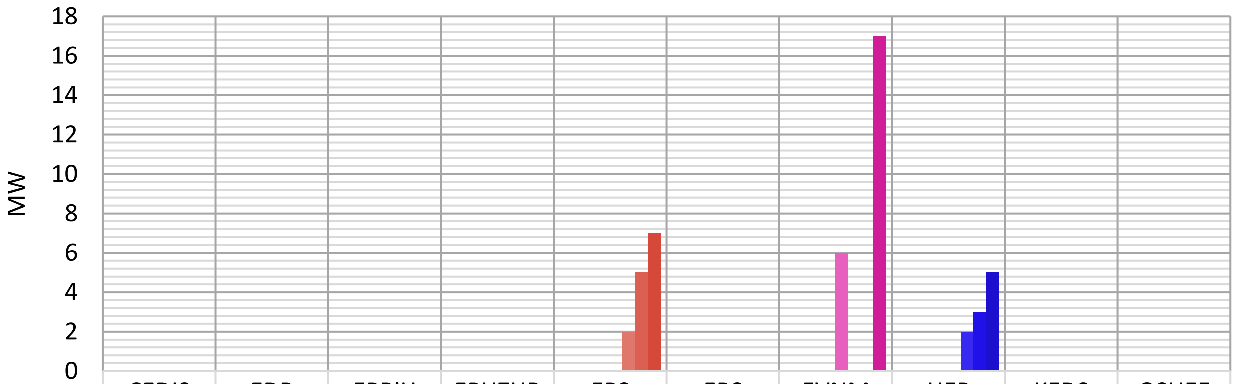
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	12	0	0	1	0	21	0	0	0	44
2009	12	0	0	1	0	23	0	0	0	50
2010	12	0	0	1	0	28	0	0	0	64
2011	12	0	0	3	0	28	0	1	0	88
2012	12	0	27	4	32	36	74	1	14	112
2013	12	0	37	4	36	36	0	1	11	139
2014	13	0	38	4	55	44	0	1	11	186
2015	24	0	50	4	60	55	106	3	9	212

Figure 19.86 Hydro powerplant installed capacity at MV level in SEE DSOs in the period 2008 - 2015



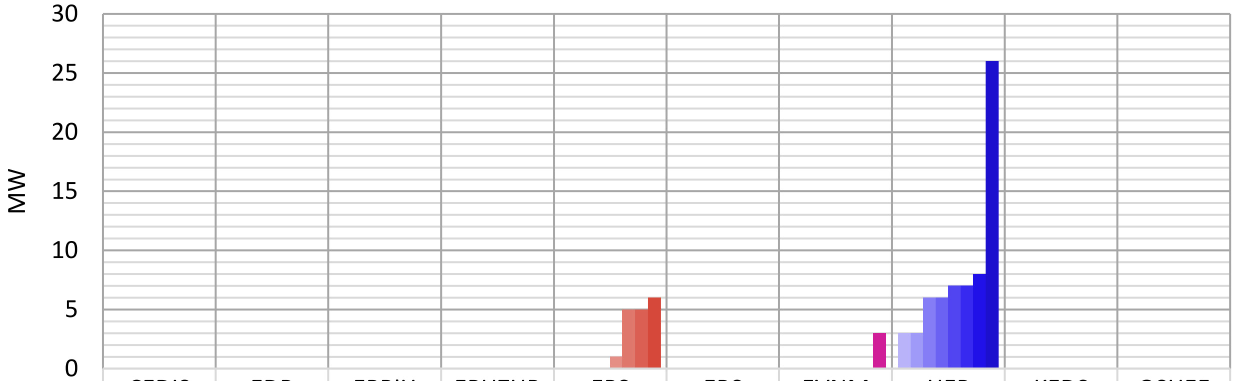
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	6	0	0
2009	0	0	0	0	0	0	0	16	0	0
2010	0	0	0	0	0	0	0	25	0	0
2011	0	0	0	0	0	0	0	35	0	0
2012	0	0	0	0	0	0	0	35	1	0
2013	0	0	0	0	0	0	0	44	1	0
2014	0	0	0	0	0	0	0	44	1	0
2015	0	0	0	0	0	0	0	44	1	0

Figure 19.87 Wind powerplant installed capacity at MV level in SEE DSOs in the period 2008 - 2015



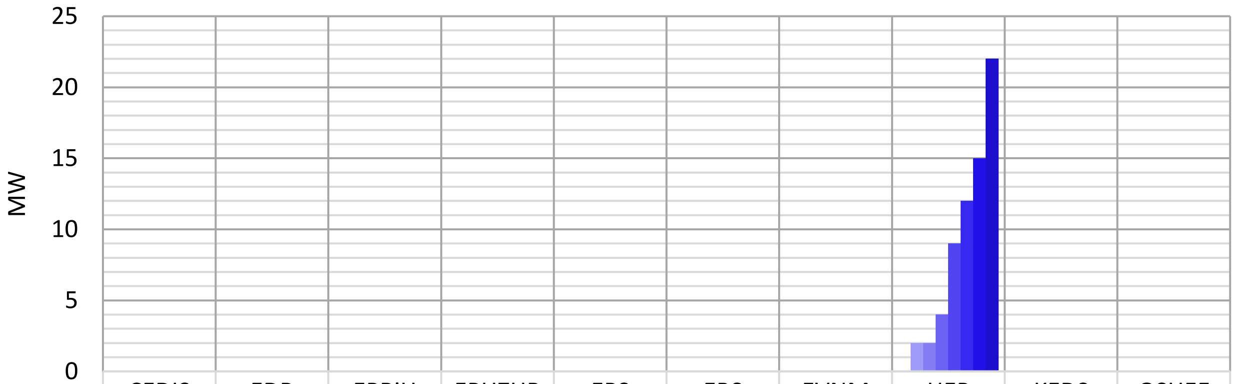
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	6	0	0	0
2013	0	0	0	0	2	0	0	2	0	0
2014	0	0	0	0	5	0	0	3	0	0
2015	0	0	0	0	7	0	17	5	0	0

Figure 19.88 PV powerplant installed capacity at MV level in SEE DSOs in the period 2008 - 2015



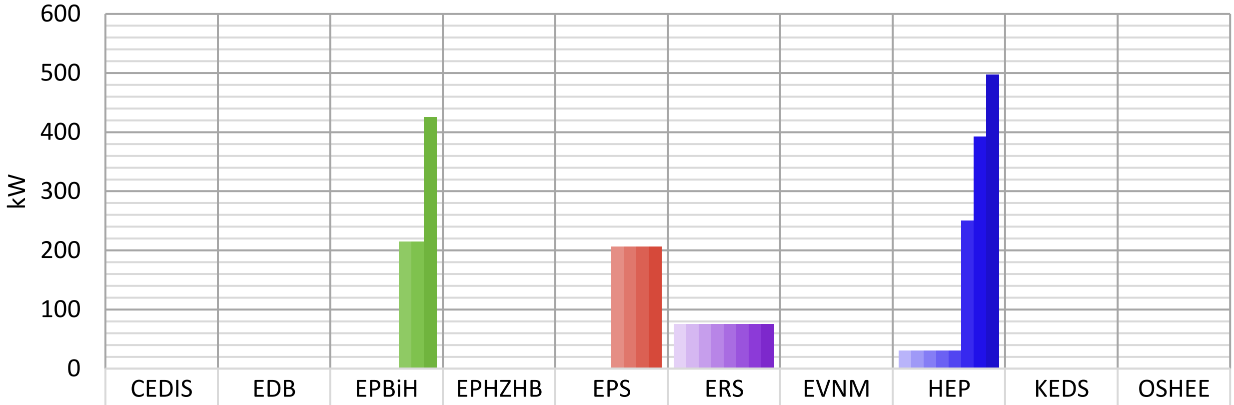
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	3	0	0
2009	0	0	0	0	0	0	0	3	0	0
2010	0	0	0	0	0	0	0	6	0	0
2011	0	0	0	0	0	0	0	6	0	0
2012	0	0	0	0	1	0	0	7	0	0
2013	0	0	0	0	5	0	0	7	0	0
2014	0	0	0	0	5	0	0	8	0	0
2015	0	0	0	0	6	0	3	26	0	0

Figure 19.89 Biomass powerplant installed capacity at MV level in SEE DSOs in the period 2008 - 2015



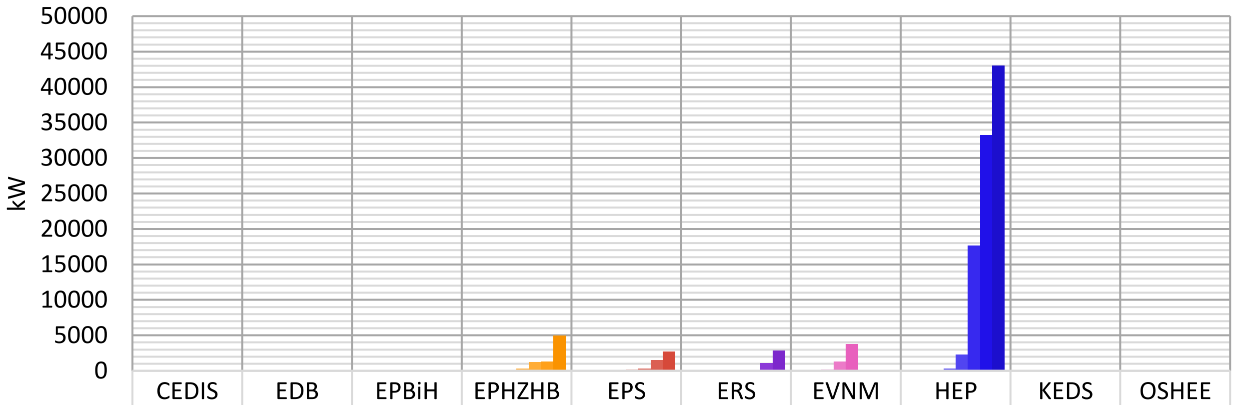
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	2	0	0
2010	0	0	0	0	0	0	0	2	0	0
2011	0	0	0	0	0	0	0	4	0	0
2012	0	0	0	0	0	0	0	9	0	0
2013	0	0	0	0	0	0	0	12	0	0
2014	0	0	0	0	0	0	0	15	0	0
2015	0	0	0	0	0	0	0	22	0	0

Figure 19.90 Biogas powerplant installed capacity at MV level in SEE DSOs in the period 2008 - 2015



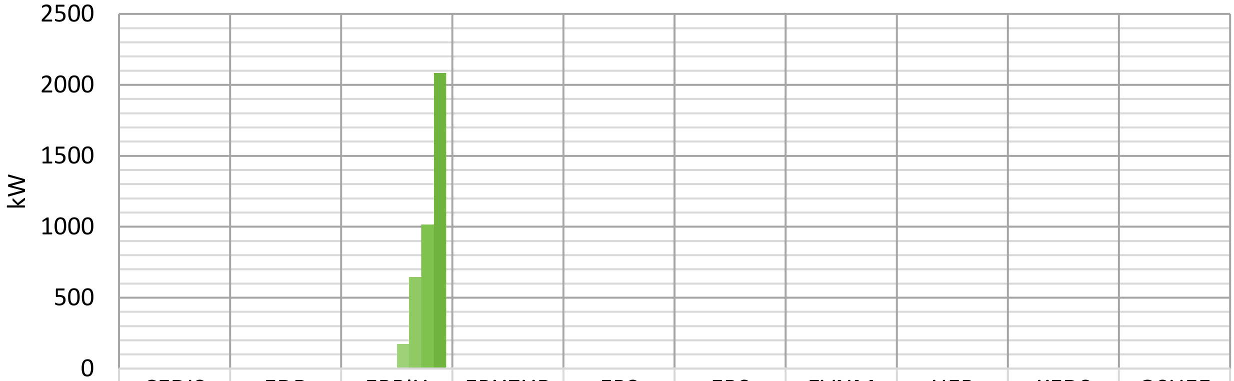
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	75	0	30	0	0
2009	0	0	0	0	0	75	0	30	0	0
2010	0	0	0	0	0	75	0	30	0	0
2011	0	0	0	0	0	75	0	30	0	0
2012	0	0	0	0	206	75	0	30	0	0
2013	0	0	215	0	206	75	0	250	0	0
2014	0	0	215	0	206	75	0	392	0	0
2015	0	0	425	0	206	75	0	497	0	0

Figure 19.91 Hydro powerplant installed capacity at LV level in SEE DSOs in the period 2008 - 2015



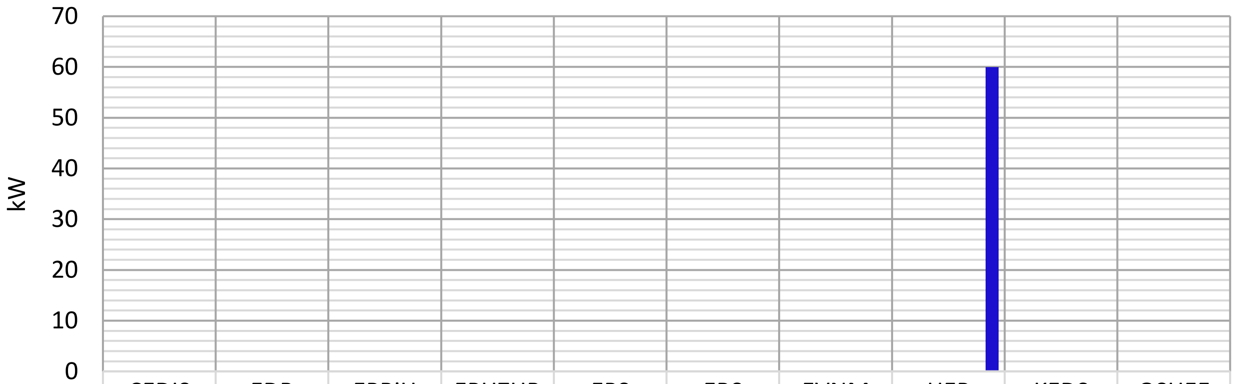
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	10	0	0
2009	0	0	0	0	0	0	10	10	0	0
2010	0	0	0	0	0	0	169	56	0	0
2011	0	0	0	0	0	0	1308	313	0	0
2012	0	0	0	300	175	0	3787	2274	0	0
2013	0	0	0	1240	335	0	0	17626	0	0
2014	0	0	0	1318	1485	1104	0	33265	0	0
2015	0	0	0	4984	2693	2876	0	42998	0	0

Figure 19.92 PV powerplant installed capacity at LV level in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0
2012	0	0	172	0	0	0	0	0	0	0
2013	0	0	644	0	0	0	0	0	0	0
2014	0	0	1015	0	0	0	0	0	0	0
2015	0	0	2083	0	0	0	0	0	0	0

Figure 19.93 Solar thermal powerplant installed capacity at LV level in SEE DSOs in the period 2008 - 2015

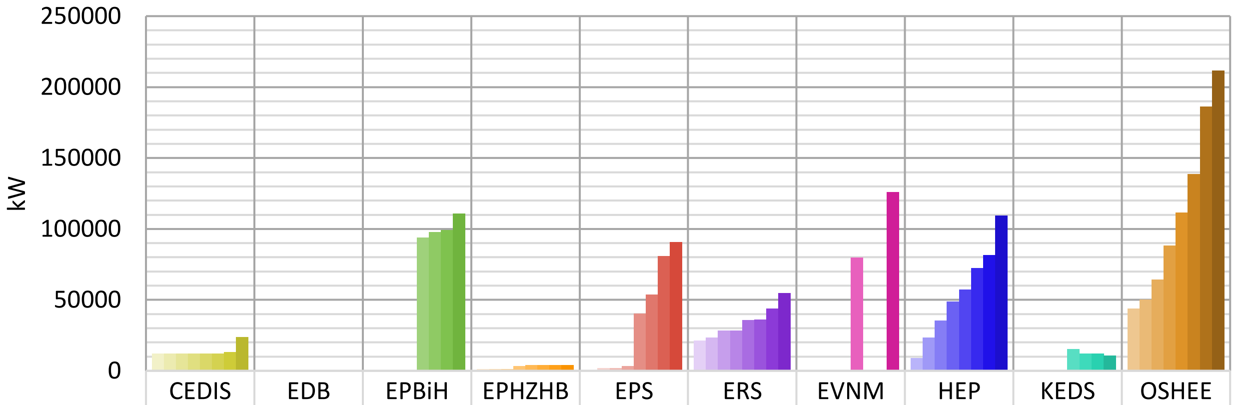


	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	60	0	0

Figure 19.94 Biomass powerplant installed capacity at LV level in SEE DSOs in the period 2008 - 2015

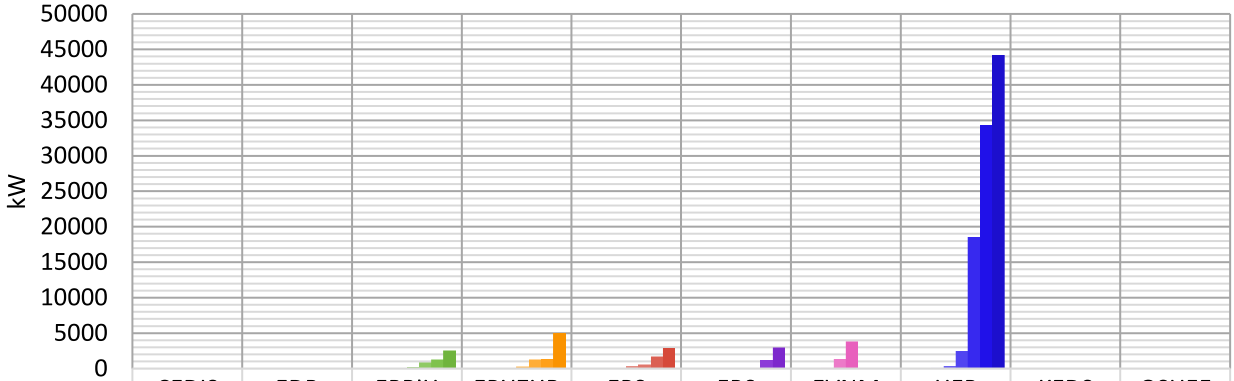
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	135	0	0
2013	0	0	0	0	0	0	0	135	0	0
2014	0	0	0	0	0	0	0	135	0	0
2015	0	0	0	0	0	0	0	135	0	0

Figure 19.95 Biogas powerplant installed capacity at LV level in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	12120	0	0	1340	0	21167	0	8950	0	43970
2009	12120	0	0	1340	1800	23467	0	23550	0	50110
2010	12120	0	0	1340	1800	28467	0	35445	0	64340
2011	12120	0	0	3410	3215	28467	0	48765	0	88375
2012	12120	0	93902	3925	40427	35607	79909	57214	15324	111655
2013	12120	0	97954	3925	53724	36067	0	72320	11990	138630
2014	13370	0	99109	3925	81039	43967	0	81490	11990	186198
2015	23740	0	110798	3925	90714	54799	125910	109523	10872	211808

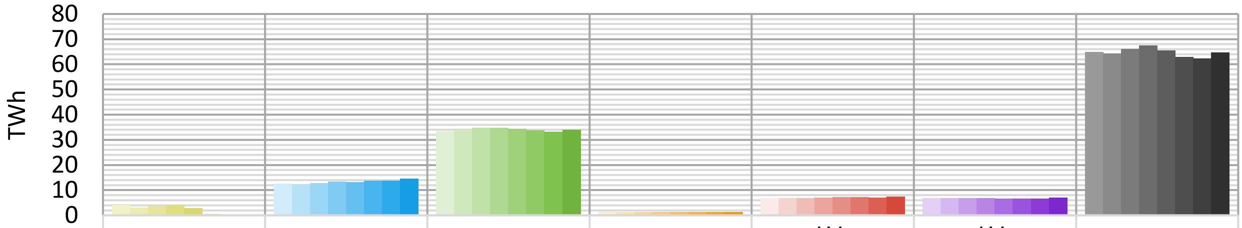
Figure 19.96 Powerplants installed capacity at MV level in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	75	0	40	0	0
2009	0	0	0	0	0	75	10	40	0	0
2010	0	0	0	0	0	75	169	119	0	0
2011	0	0	0	0	0	75	1308	376	0	0
2012	0	0	172	300	381	75	3787	2472	0	0
2013	0	0	859	1240	541	75	0	18520	0	0
2014	0	0	1230	1318	1691	1179	0	34301	0	0
2015	0	0	2508	4984	2899	2951	0	44199	0	0

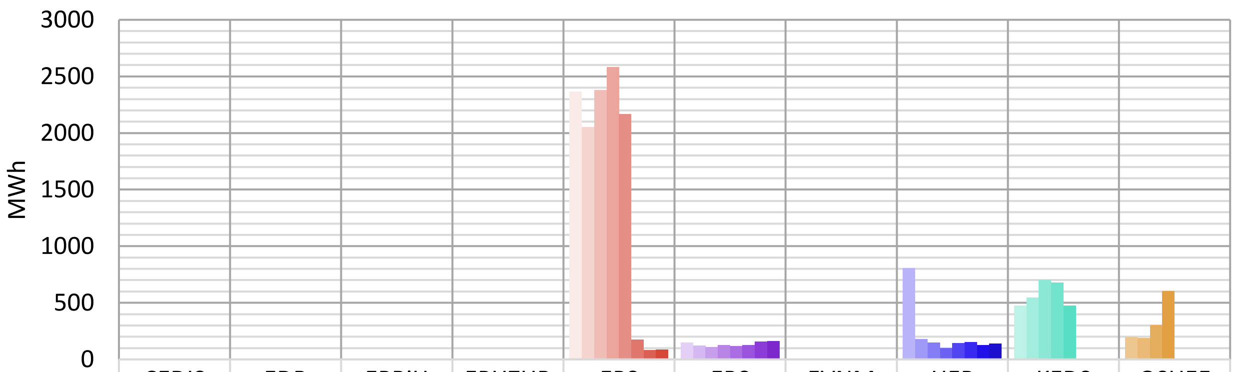
Figure 19.97 Powerplants installed capacity at LV level in SEE DSOs in the period 2008 – 2015

19.14 ELECTRICITY DELIVERED TO FINAL CONSUMERS



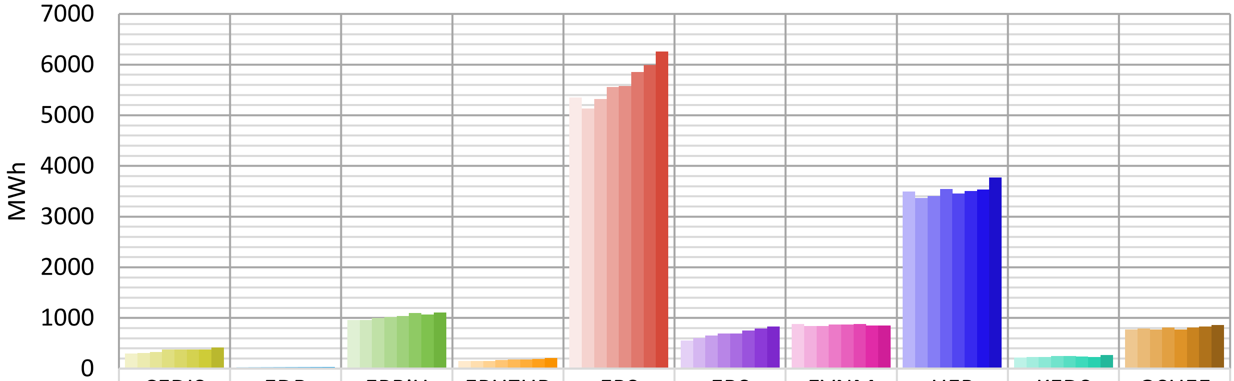
	HV	MV	LV-households	LV-public lighting	LV-commercial with peak power registration	LV-commercial without peak power registration	All categories
2008	3,99	12,67	33,42	1,23	6,75	6,82	64,88
2009	3,09	12,39	34	1,28	6,77	6,89	64,42
2010	3,64	12,72	34,78	1,29	6,84	6,84	66,11
2011	4,09	13,31	34,82	1,25	7,12	6,91	67,5
2012	2,9	13,2	34,32	1,26	7,25	6,67	65,6
2013	0,45	13,71	33,72	1,31	7,22	6,59	63,01
2014	0,36	13,85	33,23	1,21	7,1	6,58	62,33
2015	0,38	14,56	34,02	1,26	7,46	6,95	64,63

Figure 19.98 Electricity delivered to different consumer categories in SEE DSOs in the period 2008 - 2015



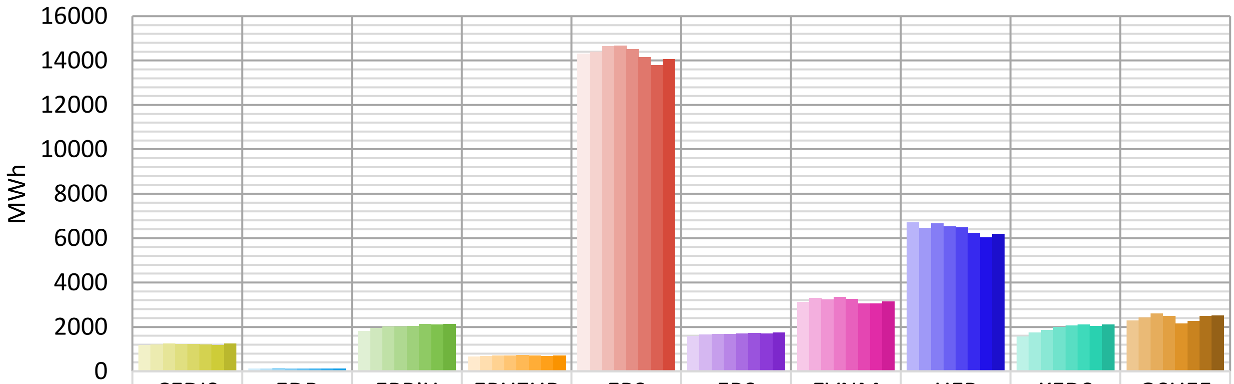
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	2366,895	148,233	0	806,428	473,447	197,296
2009	0	0	0	0	2052,318	120,904	0	180,326	544,041	187,518
2010	0	0	0	0	2378,155	110,263	0	147,958	700,618	304,481
2011	0	0	0	0	2580,347	124,082	0	99,76	679,488	604,769
2012	0	0	0	0	2168,191	119,185	0	142,967	473,07	0,319
2013	0	0	0	0	176,608	126,214	0	150,508	0	0
2014	0	0	0	0	83,84	155,872	0	123,737	0	0
2015	0	0	0	0	85,489	159,301	0	140,053	0	0

Figure 19.99 Electricity delivered to HV consumers in SEE DSOs in the period 2008 - 2015



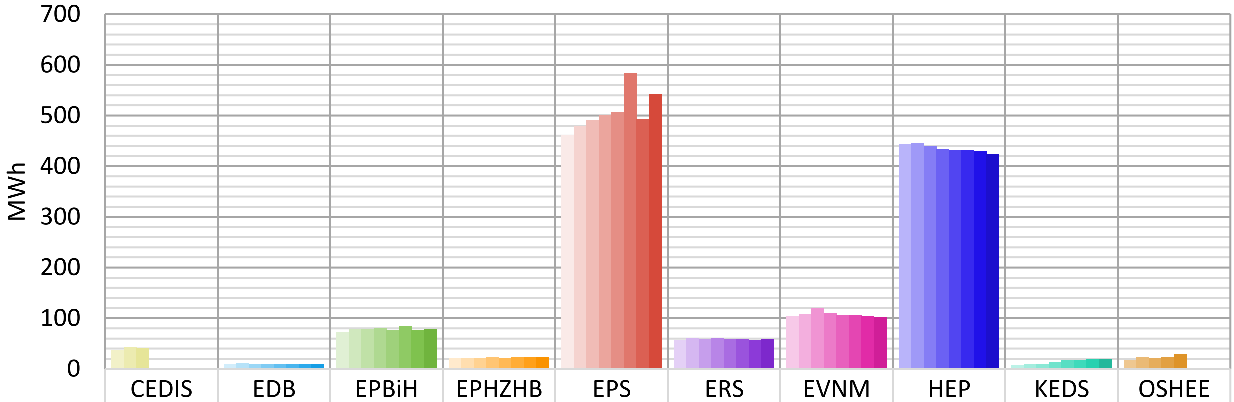
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	297,749	26,972	955,905	144,986	5344,592	549,756	877,686	3492,679	215,839	764,888
2009	305,998	28,706	957,867	143,699	5126,509	600,36	841,024	3362,145	227,478	791,597
2010	329,571	33,576	994,629	150,117	5317,137	654,562	840,986	3399,354	226,6	772,398
2011	373,879	32,828	1018,518	166,472	5552,532	692,999	871,257	3541,173	244,433	812,548
2012	376,639	30,177	1030,975	176,531	5569,773	690,044	867,262	3450,572	240,949	771,462
2013	374,389	28,004	1090,584	175,422	5855,727	753,563	879,942	3506,754	239,401	808,38
2014	375,228	24,596	1060,993	184,002	5985,229	788,644	844,622	3530,605	229,713	825,219
2015	412,549	32,151	1101,86	202,924	6254,008	827,499	849,181	3765,714	262,827	854,384

Figure 19.100 Electricity delivered to MV consumers in SEE DSOs in the period 2008 - 2015



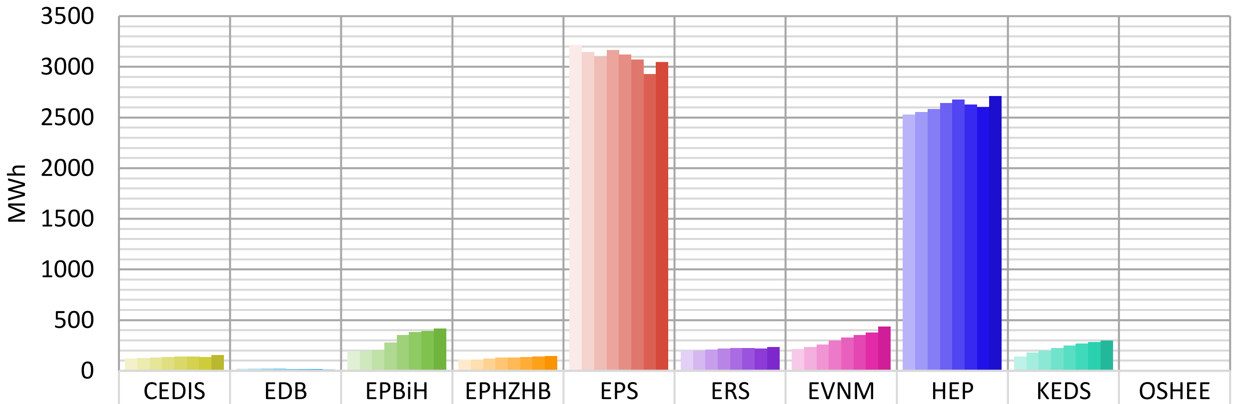
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	1191,414	126,581	1807,727	673,429	14312,83	1598,367	3134,206	6711,928	1575,403	2287,152
2009	1210,345	132,346	1956,826	689,65	14412,37	1662,563	3299,687	6471,768	1743,114	2425,474
2010	1245,047	135,82	2017,678	707,445	14645,16	1685,379	3233,037	6664,707	1855,984	2594,646
2011	1230,67	134,366	2029,373	710,923	14665,63	1677,098	3345,16	6540,376	1988,095	2500,973
2012	1225,233	133,171	2050,311	721,877	14516,98	1695,205	3257,489	6486,495	2069,376	2162,544
2013	1216,588	131,422	2132,041	707,514	14145,96	1717,817	3057,162	6236,983	2114,792	2261,313
2014	1181,292	127,019	2101,506	687,137	13802,15	1706,515	3045,964	6032,926	2047,54	2501,8
2015	1250,798	134,048	2121,166	708,762	14062,19	1759,169	3142,061	6202,454	2112,77	2522,261

Figure 19.101 Electricity delivered to households consumers in SEE DSOs in the period 2008 - 2015



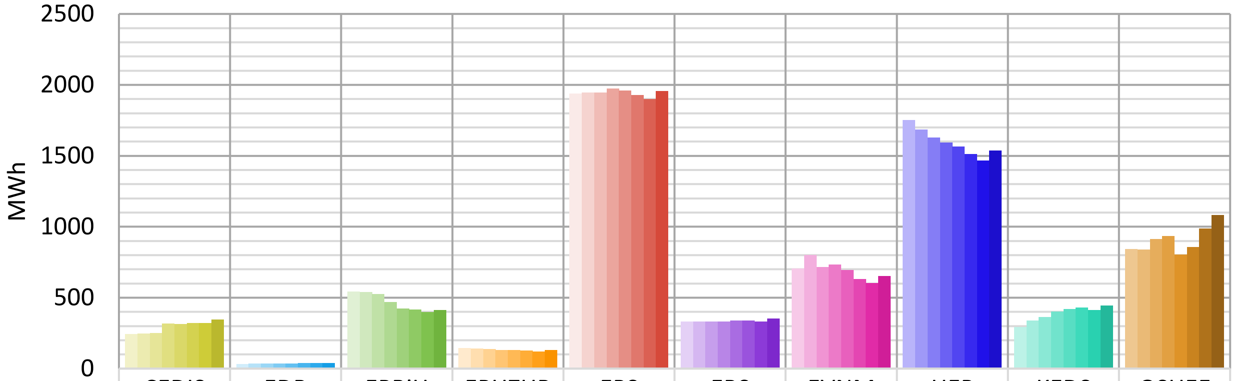
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	36,446	8,493	73,175	21,862	461,217	55,822	104,612	444,277	7,927	16,733
2009	42,312	10,908	77,739	21,682	479,09	60,326	107,346	446,329	8,515	22,179
2010	41,624	9,057	77,742	21,299	490,892	59,06	119,038	440,314	9,949	21,411
2011	0	8,714	81,017	22,334	500,541	59,803	110,254	432,872	12,834	23,053
2012	0	8,959	76,46	21,703	507,238	59,56	105,79	432,203	16,954	28,309
2013	0	9,299	83,917	22,404	583,083	57,648	105,299	432,26	17,963	0
2014	0	9,554	76,648	23,169	492,026	56,25	104,408	428,833	18,512	0
2015	0	9,983	77,428	23,628	542,164	58,091	102,614	424,683	19,377	0

Figure 19.102 Electricity delivered to public lighting consumers in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	122,871	20,034	194,594	112,114	3216,415	201,292	215,378	2529,296	140,984	0
2009	126,561	21,451	197,221	111,234	3144,35	202,215	234,77	2554,865	177,877	0
2010	132,893	23,458	207,028	121,587	3099,7	208,936	257,6	2583,646	200,572	0
2011	137,781	22,089	279,528	130,608	3165,307	218,822	297,376	2644,409	224,381	0
2012	139,366	17,597	354,362	130,808	3120,22	223,913	328,354	2676,854	249,129	6,94
2013	139,045	17,551	381,251	136,649	3070,058	225,492	354,175	2628,836	268,249	0
2014	138,051	17,356	389,856	140,406	2928,809	219,68	375,27	2602,141	283,437	0
2015	152,976	11,306	417,738	147,135	3048,158	235,374	437,321	2711,724	296,614	0

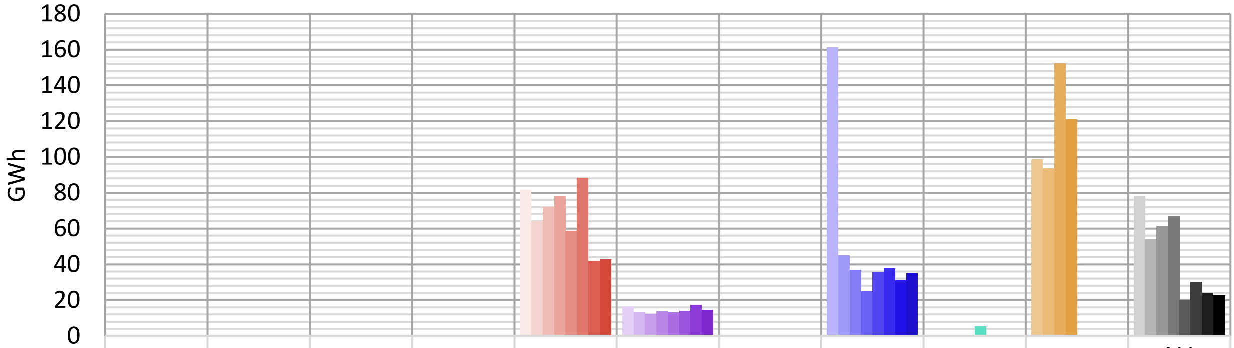
Figure 19.103 Electricity delivered to LV-commercial with peak power registration consumers in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	241,346	32,205	541,155	143,383	1936,972	331,417	703,886	1750,85	292,355	843,175
2009	246,254	33,448	538,562	141,482	1943,847	331,279	799,256	1685,489	336,559	837,564
2010	249,534	33,478	525,482	137,222	1943,615	331,762	714,722	1626,898	362,159	912,614
2011	315,707	33,936	469,211	130,287	1973,397	331,311	733,996	1592,245	400,094	933,955
2012	313,955	34,551	421,794	130,222	1957,58	336,569	693,392	1564,043	418,759	801,702
2013	320,498	37,482	415,869	125,908	1927,202	338,942	631,376	1510,741	428,394	857,401
2014	321,317	37,581	398,444	120,144	1900,905	330,207	603,269	1465,112	413,492	986,286
2015	345,155	39,414	411,714	129,997	1955,51	353,797	650,76	1535,983	443,704	1082,799

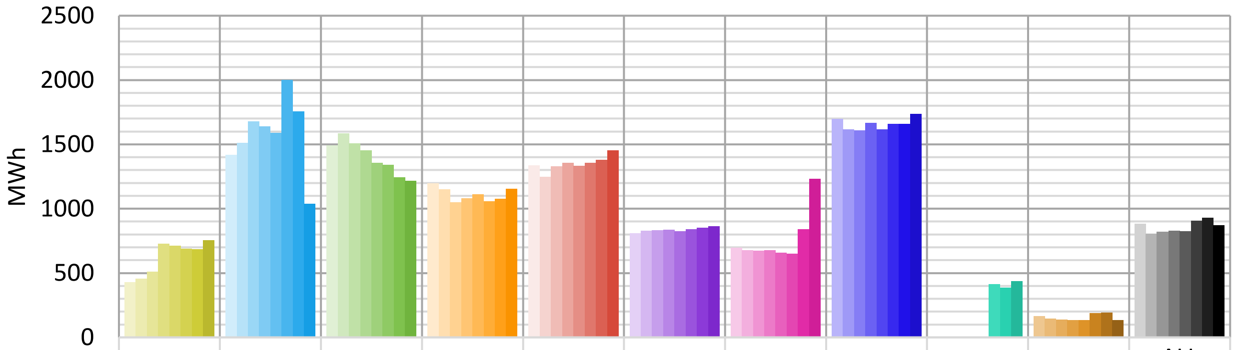
Figure 19.104 Electricity delivered to LV-commercial without peak power registration consumers in SEE DSOs in the period 2008 – 2015

19.15 ELECTRICITY DELIVERED PER METERING POINT



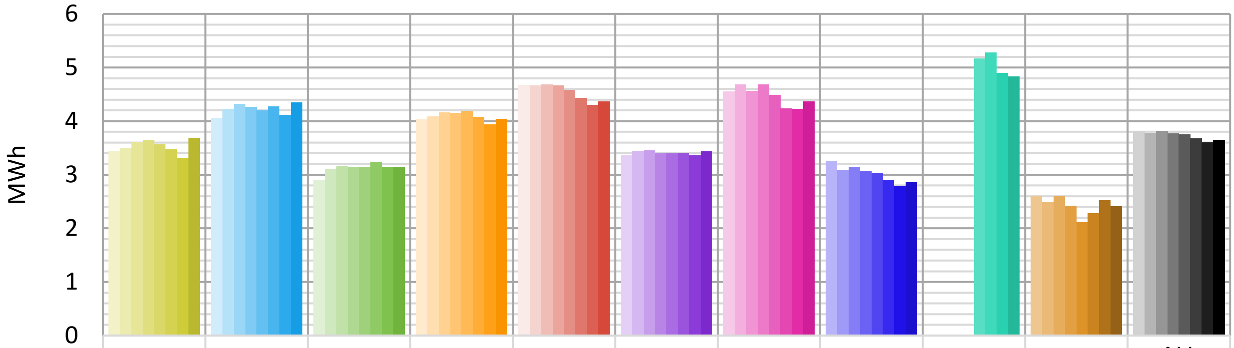
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	0	0	0	0	81,617	16,47	0	161,286	0	98,648	78,197
2009	0	0	0	0	64,135	13,434	0	45,082	0	93,759	54,065
2010	0	0	0	0	72,065	12,251	0	36,989	0	152,241	61,268
2011	0	0	0	0	78,192	13,787	0	24,94	0	120,954	66,842
2012	0	0	0	0	58,6	13,243	0	35,742	5,256	0,064	20,026
2013	0	0	0	0	88,304	14,024	0	37,627	0	0	30,222
2014	0	0	0	0	41,92	17,319	0	30,934	0	0	24,23
2015	0	0	0	0	42,744	14,482	0	35,013	0	0	22,638

Figure 19.105 Electricity delivered per HV metering point in SEE DSOs in the period 2008 - 2015



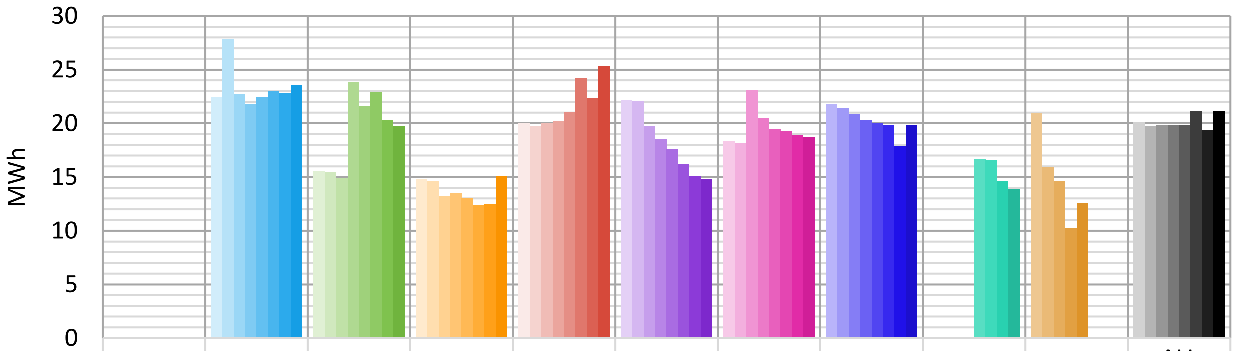
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	429	1420	1491	1198	1335	811	696	1699	0	165	882
2009	455	1511	1586	1150	1249	828	676	1616	0	145	808
2010	511	1679	1507	1050	1330	831	673	1610	0	137	818
2011	729	1641	1453	1081	1355	837	679	1667	0	135	830
2012	712	1588	1357	1110	1334	825	657	1616	0	133	823
2013	689	2000	1340	1057	1356	839	651	1659	413	187	907
2014	683	1757	1244	1076	1378	850	842	1660	386	191	929
2015	754	1037	1218	1153	1454	864	1234	1738	436	135	871

Figure 19.106 Electricity delivered per MV metering point in SEE DSOs in the period 2008 - 2015



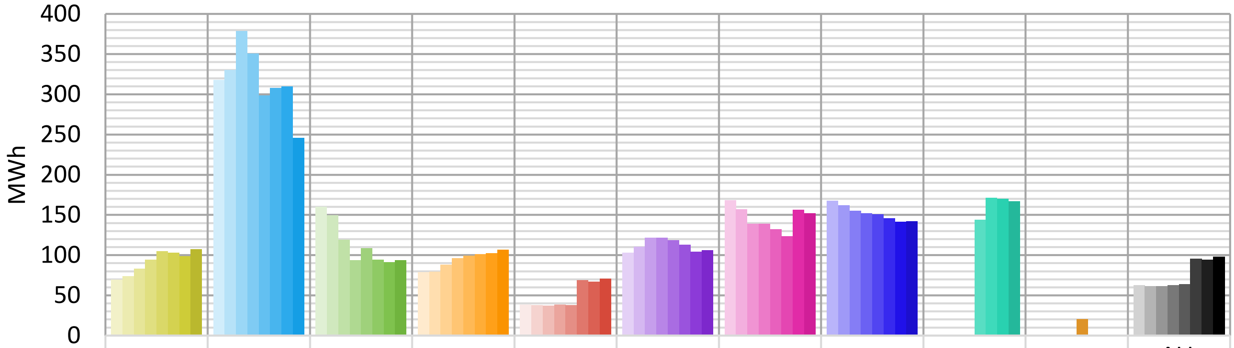
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	3,441	4,058	2,907	4,03	4,676	3,368	4,549	3,244	0	2,604	3,819
2009	3,503	4,223	3,104	4,087	4,661	3,445	4,684	3,083	0	2,481	3,781
2010	3,615	4,319	3,167	4,165	4,687	3,454	4,562	3,149	0	2,592	3,82
2011	3,649	4,267	3,145	4,154	4,662	3,398	4,681	3,07	0	2,416	3,772
2012	3,568	4,197	3,144	4,187	4,577	3,398	4,487	3,035	5,171	2,111	3,747
2013	3,469	4,27	3,232	4,078	4,434	3,411	4,234	2,903	5,28	2,283	3,677
2014	3,312	4,112	3,144	3,94	4,301	3,356	4,224	2,796	4,897	2,526	3,599
2015	3,682	4,349	3,144	4,044	4,365	3,435	4,367	2,857	4,828	2,408	3,646

Figure 19.107 Electricity delivered per households metering point in SEE DSOs in the period 2008 - 2015



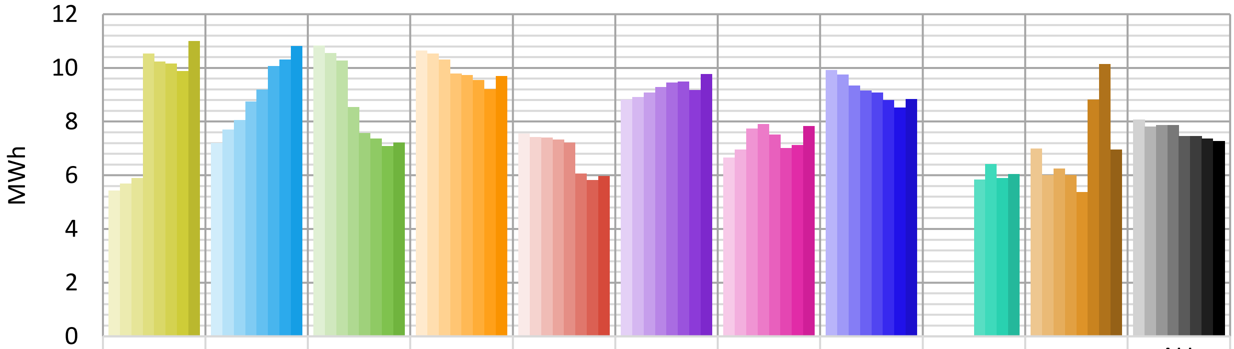
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	0	22,41	15,556	14,831	20,042	22,196	18,331	21,777	0	20,969	20,108
2009	0	27,826	15,452	14,611	19,77	22,114	18,163	21,44	0	15,888	19,77
2010	0	22,757	14,879	13,221	20,062	19,785	23,105	20,842	0	14,635	19,844
2011	0	21,839	23,864	13,544	20,212	18,576	20,501	20,274	0	10,273	19,849
2012	0	22,454	21,562	13,082	21,052	17,621	19,432	20,068	16,654	12,576	19,852
2013	0	23,016	22,878	12,364	24,183	16,243	19,268	19,813	16,541	0	21,189
2014	0	22,856	20,293	12,443	22,395	15,097	18,894	17,917	14,611	0	19,357
2015	0	23,544	19,747	15,079	25,286	14,853	18,753	19,795	13,84	0	21,11

Figure 19.108 Electricity delivered per public lighting metering point in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	69,458	317,994	160,16	78,566	38,545	102,7	168,002	167,403	0	0	62,218
2009	73,454	330,01	149,41	79,114	37,709	110,439	157,037	161,598	0	0	61,594
2010	82,8	378,36	119,119	87,979	37,133	121,474	138,943	155,305	0	0	61,166
2011	94,177	350,618	93,707	95,965	38,05	121,839	139,026	152,1	0	0	62,474
2012	104,944	298,254	108,202	99,398	37,51	118,285	132,028	150,885	143,922	20,233	63,936
2013	102,996	307,919	94,486	101,147	69,009	113,015	123,32	145,99	171,186	0	95,366
2014	98,679	309,933	91,024	102,039	66,885	104,46	156,623	141,413	170,13	0	94,012
2015	107,126	245,787	93,747	106,697	70,798	106,188	152,006	141,827	166,731	0	97,679

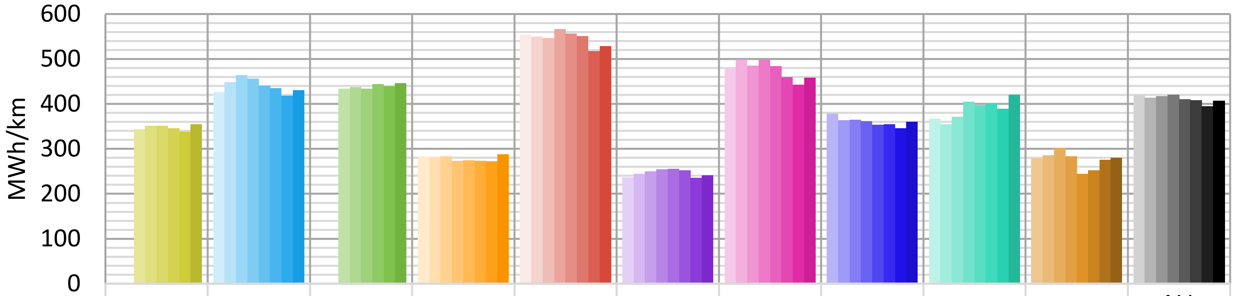
Figure 19.109 Electricity delivered per LV-commercial with peak power registration metering point in SEE DSOs in the period 2008 - 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	5,421	7,205	10,837	10,653	7,553	8,822	6,654	9,925	0	6,997	8,064
2009	5,685	7,696	10,548	10,526	7,419	8,906	6,95	9,745	0	6	7,816
2010	5,904	8,061	10,28	10,312	7,412	9,084	7,74	9,346	0	6,255	7,878
2011	10,542	8,742	8,535	9,78	7,338	9,277	7,907	9,162	0	6,006	7,859
2012	10,239	9,189	7,569	9,741	7,22	9,453	7,524	9,084	5,837	5,379	7,452
2013	10,161	10,065	7,376	9,553	6,067	9,499	7,009	8,806	6,417	8,821	7,461
2014	9,882	10,302	7,092	9,202	5,825	9,17	7,124	8,528	5,896	10,147	7,377
2015	10,997	10,813	7,225	9,696	5,973	9,775	7,836	8,837	6,044	6,953	7,276

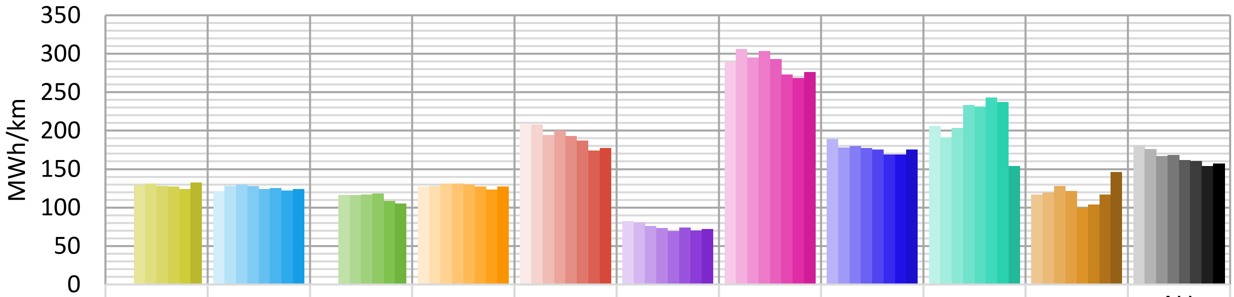
Figure 19.110 Electricity delivered per LV-commercial without peak power registration metering point in SEE DSOs in the period 2008 - 2015

19.16 ELECTRICITY DELIVERED PER NETWORK LENGTH



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	0	426	0	283	554	237	479	378	367	279	421
2009	0	448	0	282	550	245	498	364	355	286	414
2010	344	464	434	284	547	250	485	365	371	302	417
2011	352	456	437	273	567	255	498	361	405	283	421
2012	351	441	434	274	556	256	484	354	397	245	411
2013	346	435	444	273	551	252	459	355	400	252	409
2014	338	418	439	272	518	235	443	346	389	276	395
2015	355	431	446	288	529	241	458	360	420	280	407

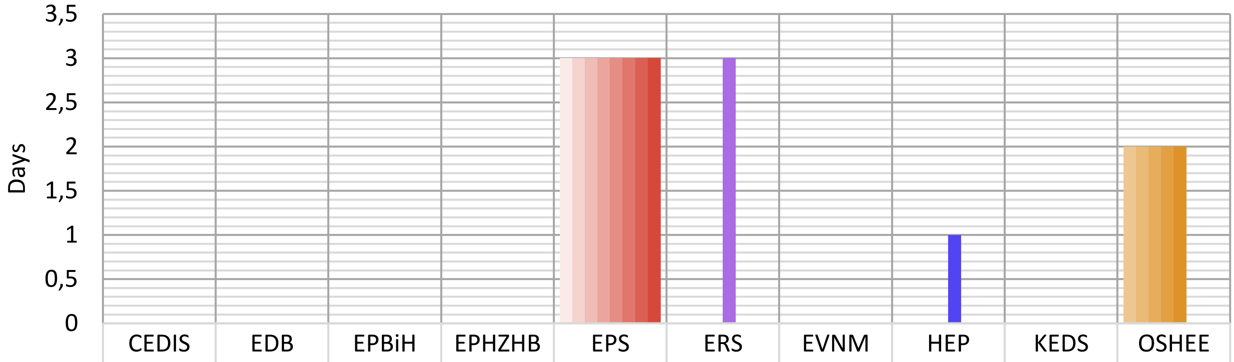
Figure 19.111 Electricity delivered per MV distribution network length in SEE DSOs in the period 2008 – 2015



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE	ALL DSOs
2008	0	121	0	127	209	82	289	189	206	117	181
2009	0	128	0	128	208	80	306	178	191	119	176
2010	129	130	116	131	194	76	295	180	203	128	167
2011	131	128	116	131	200	73	303	177	233	121	168
2012	128	124	117	130	193	69	293	175	231	100	162
2013	127	125	118	127	187	74	273	169	243	104	160
2014	124	122	108	123	174	70	268	169	237	117	154
2015	132	124	105	127	177	72	276	175	154	146	157

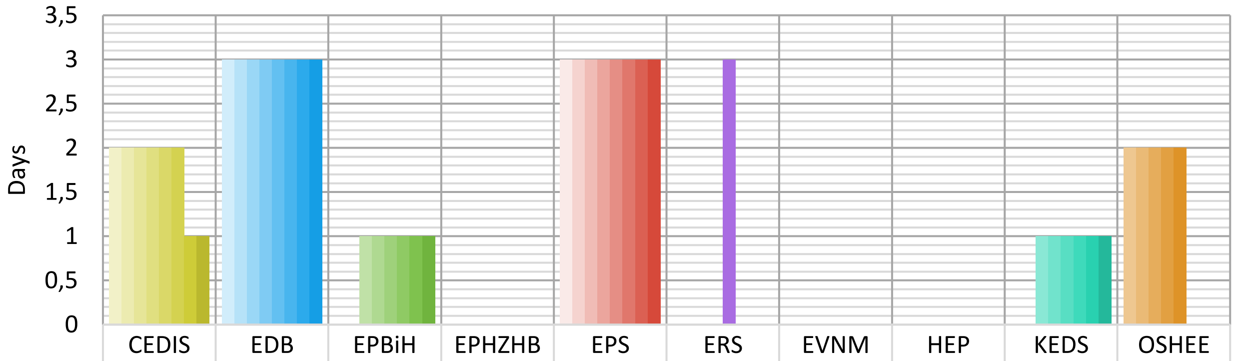
Figure 19.112 Electricity delivered per LV distribution network length in SEE DSOs in the period 2008 – 2015

19.17 RECONNECTION/RESUPPLY



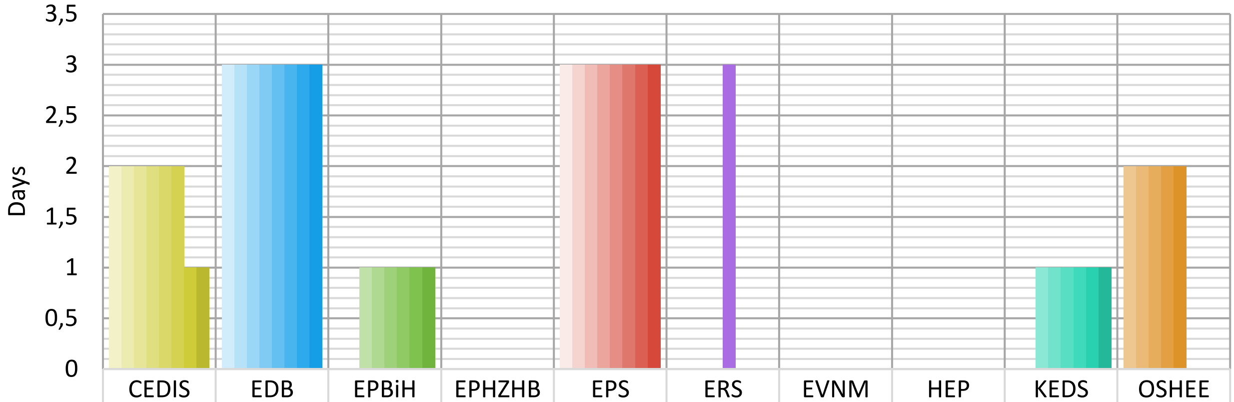
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	3	0	0	0	0	2
2009	0	0	0	0	3	0	0	0	0	2
2010	0	0	0	0	3	0	0	0	0	2
2011	0	0	0	0	3	0	0	0	0	2
2012	0	0	0	0	3	3	0	1	0	2
2013	0	0	0	0	3	0	0	0	0	0
2014	0	0	0	0	3	0	0	0	0	0
2015	0	0	0	0	3	0	0	0	0	0

Figure 19.113 Prescribed time period for reconnection/resupply upon disconnection due to non-payment in HV consumption category



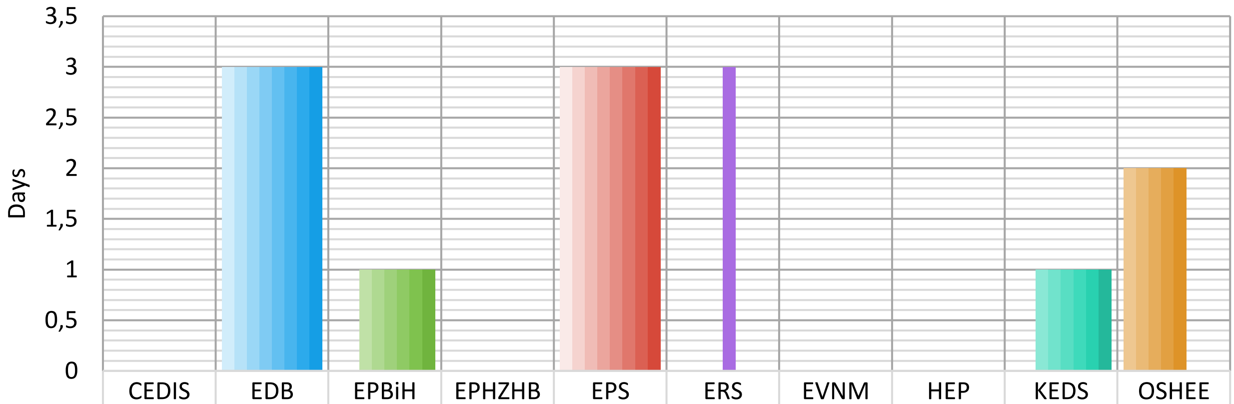
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	2	3	0	0	3	0	0	0	0	2
2009	2	3	0	0	3	0	0	0	0	2
2010	2	3	1	0	3	0	0	0	1	2
2011	2	3	1	0	3	0	0	0	1	2
2012	2	3	1	0	3	3	0	0	1	2
2013	2	3	1	0	3	0	0	0	1	0
2014	1	3	1	0	3	0	0	0	1	0
2015	1	3	1	0	3	0	0	0	1	0

Figure 19.114 Prescribed time period for reconnection/resupply upon disconnection due to non-payment in MV consumption category



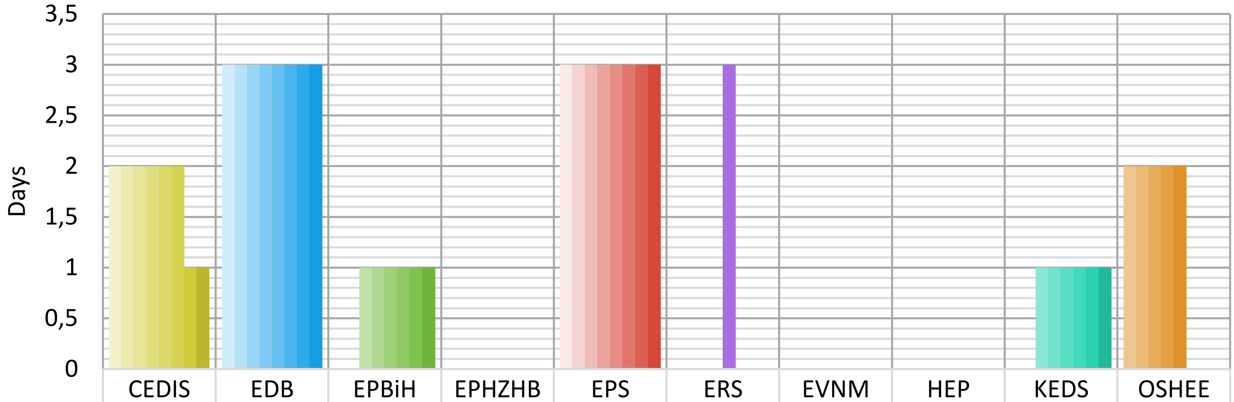
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	2	3	0	0	3	0	0	0	0	2
2009	2	3	0	0	3	0	0	0	0	2
2010	2	3	1	0	3	0	0	0	1	2
2011	2	3	1	0	3	0	0	0	1	2
2012	2	3	1	0	3	3	0	0	1	2
2013	2	3	1	0	3	0	0	0	1	0
2014	1	3	1	0	3	0	0	0	1	0
2015	1	3	1	0	3	0	0	0	1	0

Figure 19.115 Prescribed time period for reconnection/resupply upon disconnection due to non-payment in households consumption category



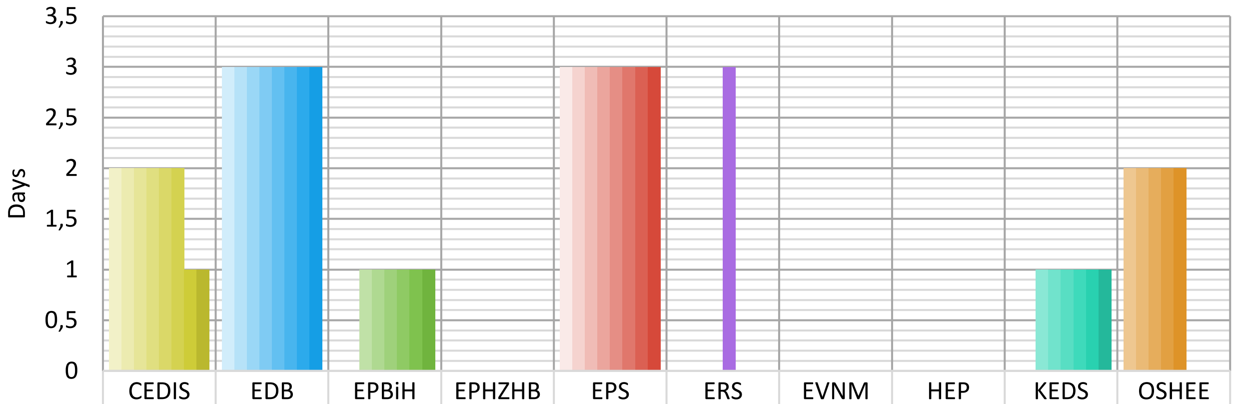
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	3	0	0	3	0	0	0	0	2
2009	0	3	0	0	3	0	0	0	0	2
2010	0	3	1	0	3	0	0	0	1	2
2011	0	3	1	0	3	0	0	0	1	2
2012	0	3	1	0	3	3	0	0	1	2
2013	0	3	1	0	3	0	0	0	1	0
2014	0	3	1	0	3	0	0	0	1	0
2015	0	3	1	0	3	0	0	0	1	0

Figure 19.116 Prescribed time period for reconnection/resupply upon disconnection due to non-payment in public lighting consumption category



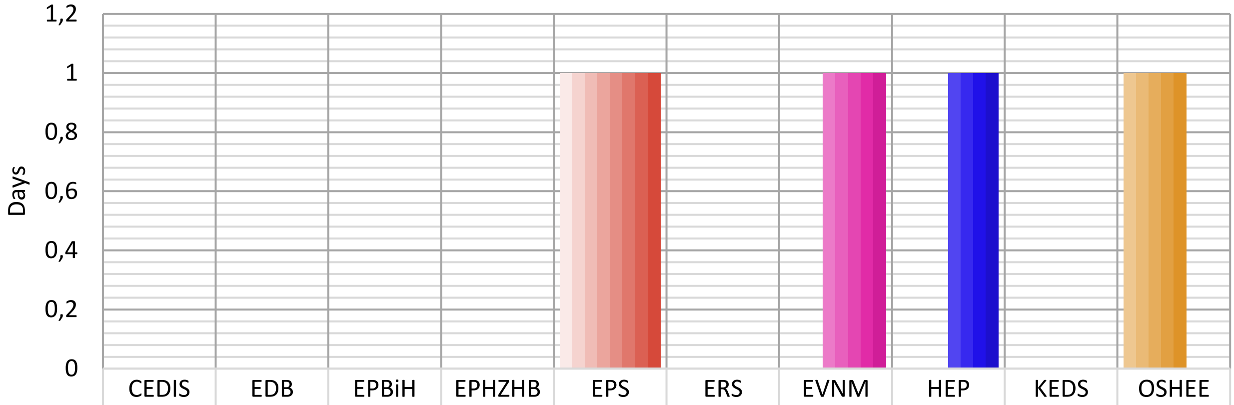
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	2	3	0	0	3	0	0	0	0	2
2009	2	3	0	0	3	0	0	0	0	2
2010	2	3	1	0	3	0	0	0	1	2
2011	2	3	1	0	3	0	0	0	1	2
2012	2	3	1	0	3	3	0	0	1	2
2013	2	3	1	0	3	0	0	0	1	0
2014	1	3	1	0	3	0	0	0	1	0
2015	1	3	1	0	3	0	0	0	1	0

Figure 19.117 Prescribed time period for reconnection/resupply upon disconnection due to non-payment in LV-commercial with peak power registration consumption category



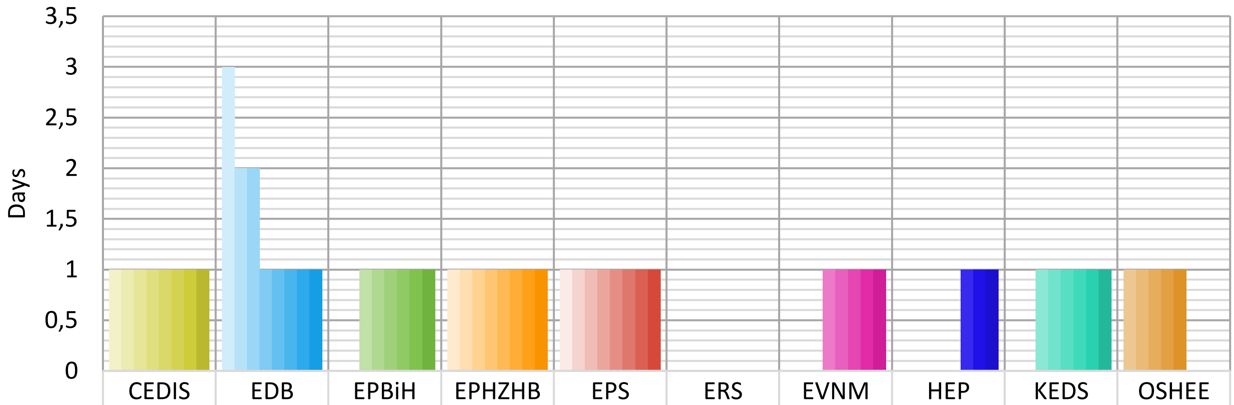
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	2	3	0	0	3	0	0	0	0	2
2009	2	3	0	0	3	0	0	0	0	2
2010	2	3	1	0	3	0	0	0	1	2
2011	2	3	1	0	3	0	0	0	1	2
2012	2	3	1	0	3	3	0	0	1	2
2013	2	3	1	0	3	0	0	0	1	0
2014	1	3	1	0	3	0	0	0	1	0
2015	1	3	1	0	3	0	0	0	1	0

Figure 19.118 Prescribed time period for reconnection/resupply upon disconnection due to non-payment in LV-commercial without peak power registration consumption category



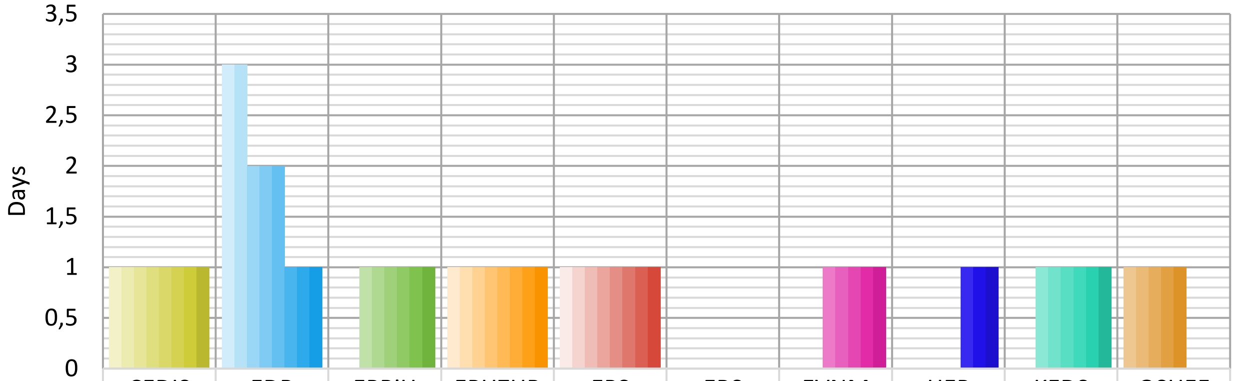
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	1	0	0	0	0	1
2009	0	0	0	0	1	0	0	0	0	1
2010	0	0	0	0	1	0	0	0	0	1
2011	0	0	0	0	1	0	1	0	0	1
2012	0	0	0	0	1	0	1	1	0	1
2013	0	0	0	0	1	0	1	1	0	0
2014	0	0	0	0	1	0	1	1	0	0
2015	0	0	0	0	1	0	1	1	0	0

Figure 19.119 Realized (actual) time period for reconnection/resupply upon disconnection due to non-payment in HV consumption category



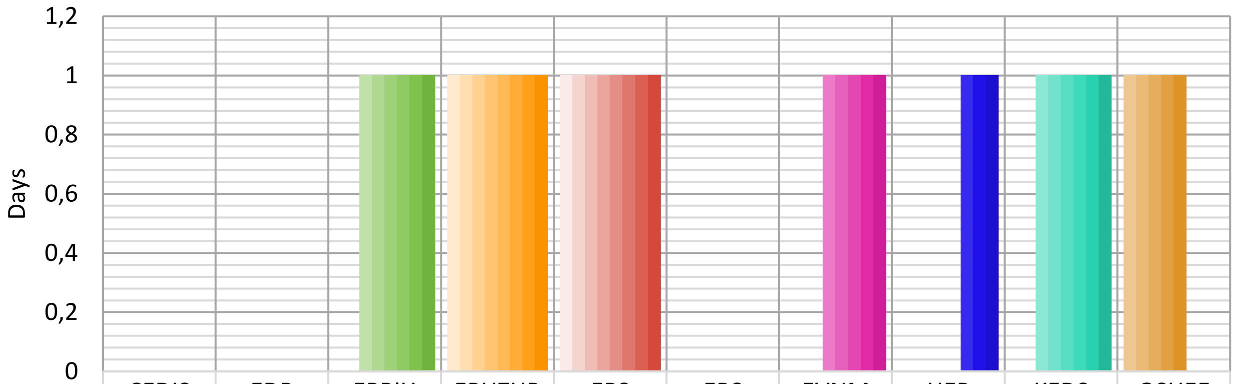
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	1	3	0	1	1	0	0	0	0	1
2009	1	2	0	1	1	0	0	0	0	1
2010	1	2	1	1	1	0	0	0	1	1
2011	1	1	1	1	1	0	1	0	1	1
2012	1	1	1	1	1	0	1	0	1	1
2013	1	1	1	1	1	0	1	1	1	0
2014	1	1	1	1	1	0	1	1	1	0
2015	1	1	1	1	1	0	1	1	1	0

Figure 19.120 Realized (actual) time period for reconnection/resupply upon disconnection due to non-payment in MV consumption category



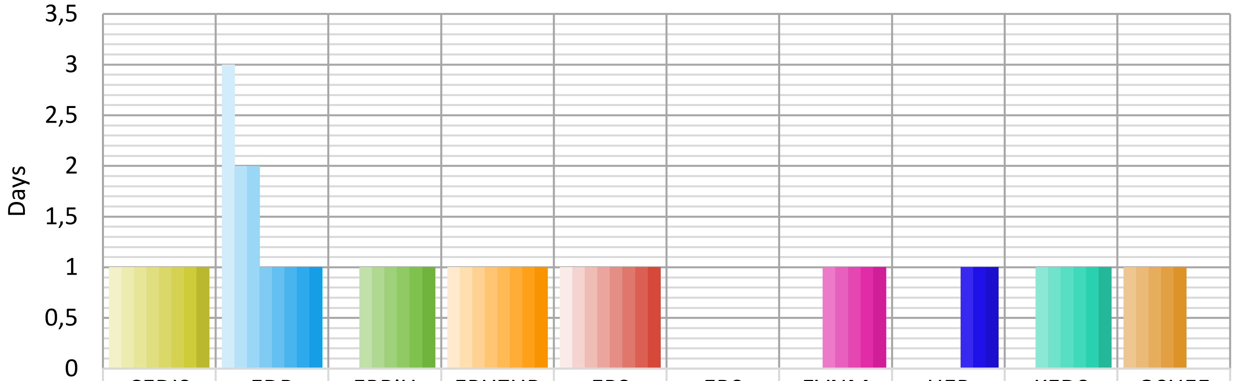
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	1	3	0	1	1	0	0	0	0	1
2009	1	3	0	1	1	0	0	0	0	1
2010	1	2	1	1	1	0	0	0	1	1
2011	1	2	1	1	1	0	1	0	1	1
2012	1	2	1	1	1	0	1	0	1	1
2013	1	1	1	1	1	0	1	1	1	0
2014	1	1	1	1	1	0	1	1	1	0
2015	1	1	1	1	1	0	1	1	1	0

Figure 19.121 Realized (actual) time period for reconnection/resupply upon disconnection due to non-payment in households consumption category



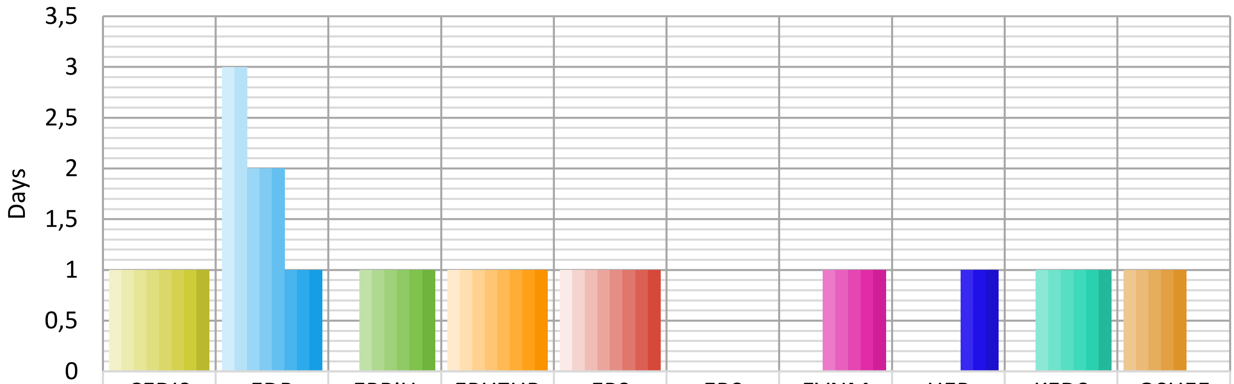
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	1	1	0	0	0	0	1
2009	0	0	0	1	1	0	0	0	0	1
2010	0	0	1	1	1	0	0	0	1	1
2011	0	0	1	1	1	0	1	0	1	1
2012	0	0	1	1	1	0	1	0	1	1
2013	0	0	1	1	1	0	1	1	1	0
2014	0	0	1	1	1	0	1	1	1	0
2015	0	0	1	1	1	0	1	1	1	0

Figure 19.122 Realized (actual) time period for reconnection/resupply upon disconnection due to non-payment in public lighting consumption category



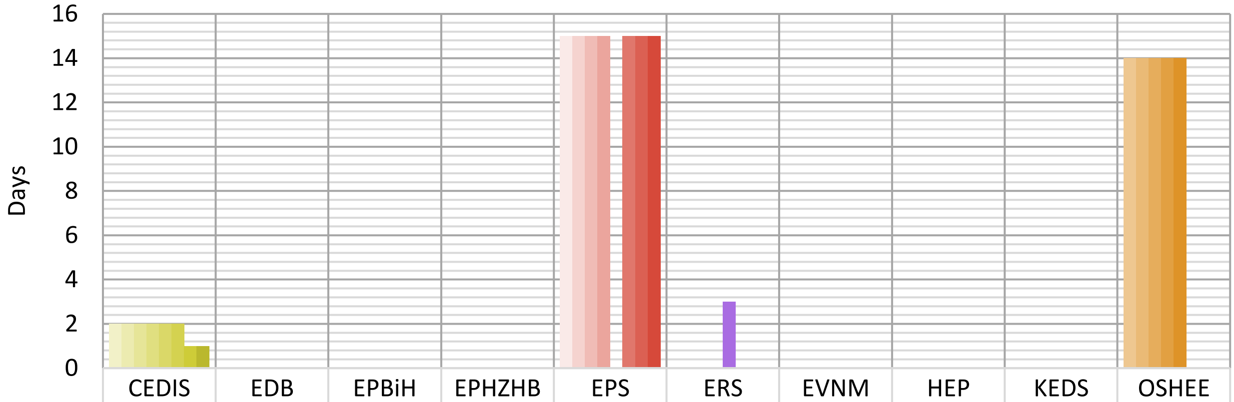
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	1	3	0	1	1	0	0	0	0	1
2009	1	2	0	1	1	0	0	0	0	1
2010	1	2	1	1	1	0	0	0	1	1
2011	1	1	1	1	1	0	1	0	1	1
2012	1	1	1	1	1	0	1	0	1	1
2013	1	1	1	1	1	0	1	1	1	0
2014	1	1	1	1	1	0	1	1	1	0
2015	1	1	1	1	1	0	1	1	1	0

Figure 19.123 Realized (actual) time period for reconnection/resupply upon disconnection due to non-payment in LV-commercial with peak power registration consumption category



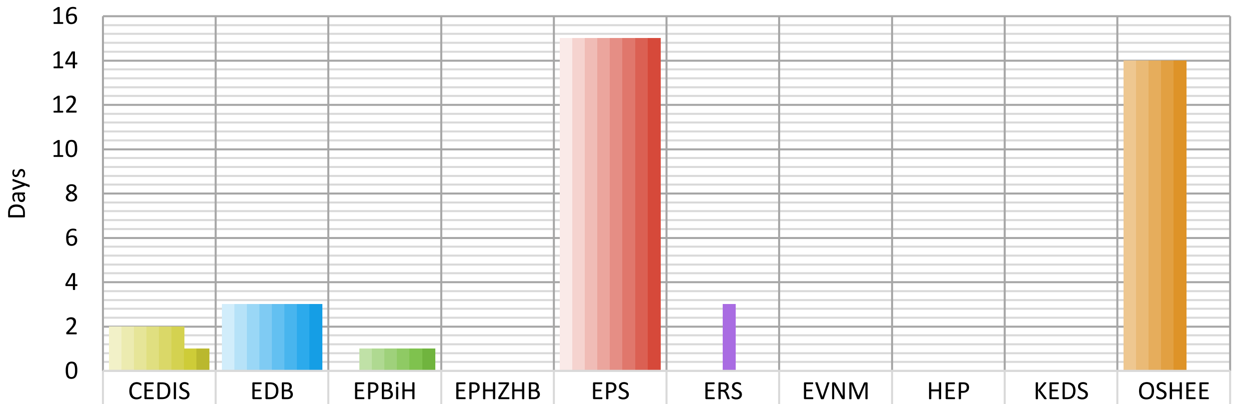
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	1	3	0	1	1	0	0	0	0	1
2009	1	3	0	1	1	0	0	0	0	1
2010	1	2	1	1	1	0	0	0	1	1
2011	1	2	1	1	1	0	1	0	1	1
2012	1	2	1	1	1	0	1	0	1	1
2013	1	1	1	1	1	0	1	1	1	0
2014	1	1	1	1	1	0	1	1	1	0
2015	1	1	1	1	1	0	1	1	1	0

Figure 19.124 Realized (actual) time period for reconnection/resupply upon disconnection due to non-payment in LV-commercial without peak power registration consumption category



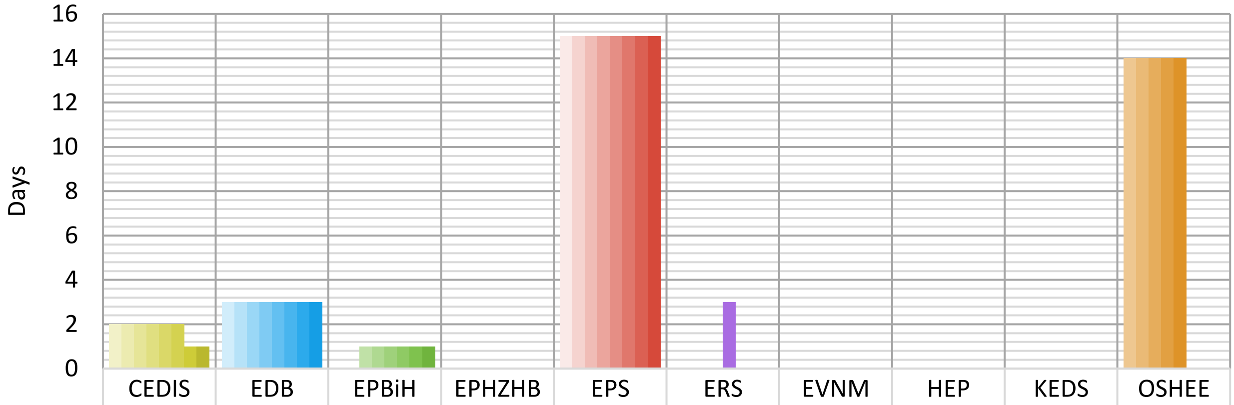
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	2	0	0	0	15	0	0	0	0	14
2009	2	0	0	0	15	0	0	0	0	14
2010	2	0	0	0	15	0	0	0	0	14
2011	2	0	0	0	15	0	0	0	0	14
2012	2	0	0	0	0	3	0	0	0	14
2013	2	0	0	0	15	0	0	0	0	0
2014	1	0	0	0	15	0	0	0	0	0
2015	1	0	0	0	15	0	0	0	0	0

Figure 19.125 Prescribed time period for reconnection upon disconnection due to electricity theft (unauthorized connection) in HV consumption category



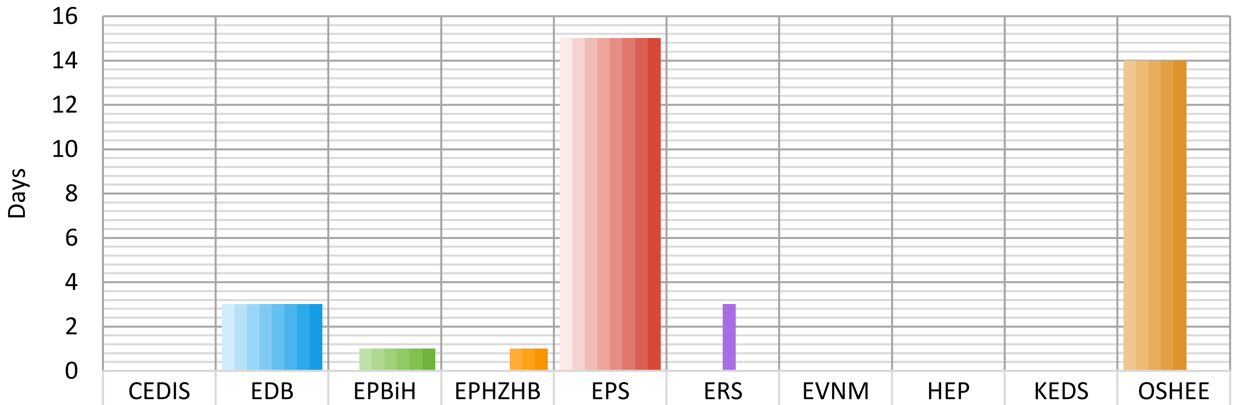
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	2	3	0	0	15	0	0	0	0	14
2009	2	3	0	0	15	0	0	0	0	14
2010	2	3	1	0	15	0	0	0	0	14
2011	2	3	1	0	15	0	0	0	0	14
2012	2	3	1	0	15	3	0	0	0	14
2013	2	3	1	0	15	0	0	0	0	0
2014	1	3	1	0	15	0	0	0	0	0
2015	1	3	1	0	15	0	0	0	0	0

Figure 19.126 Prescribed time period for reconnection upon disconnection due to electricity theft (unauthorized connection) in MV consumption category



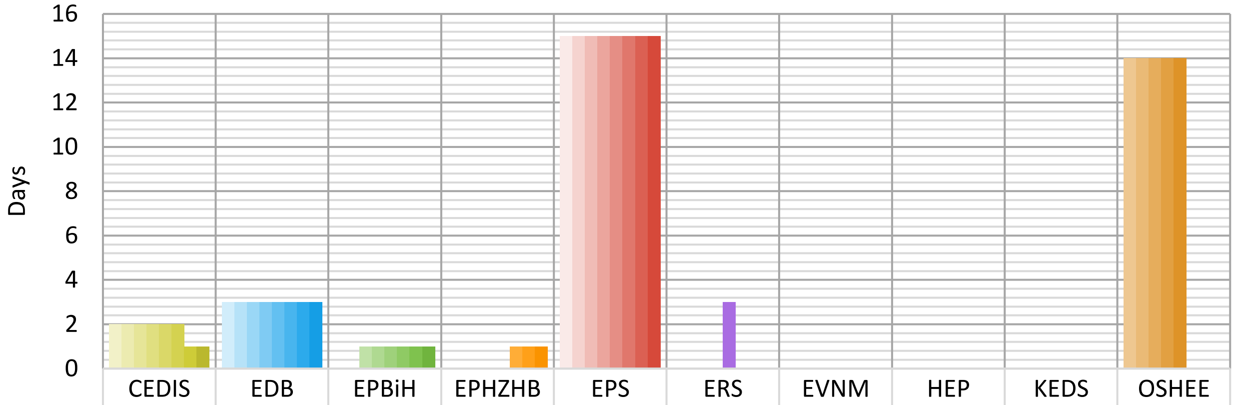
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	2	3	0	0	15	0	0	0	0	14
2009	2	3	0	0	15	0	0	0	0	14
2010	2	3	1	0	15	0	0	0	0	14
2011	2	3	1	0	15	0	0	0	0	14
2012	2	3	1	0	15	3	0	0	0	14
2013	2	3	1	0	15	0	0	0	0	0
2014	1	3	1	0	15	0	0	0	0	0
2015	1	3	1	0	15	0	0	0	0	0

Figure 19.127 Prescribed time period for reconnection upon disconnection due to electricity theft (unauthorized connection) in households consumption category



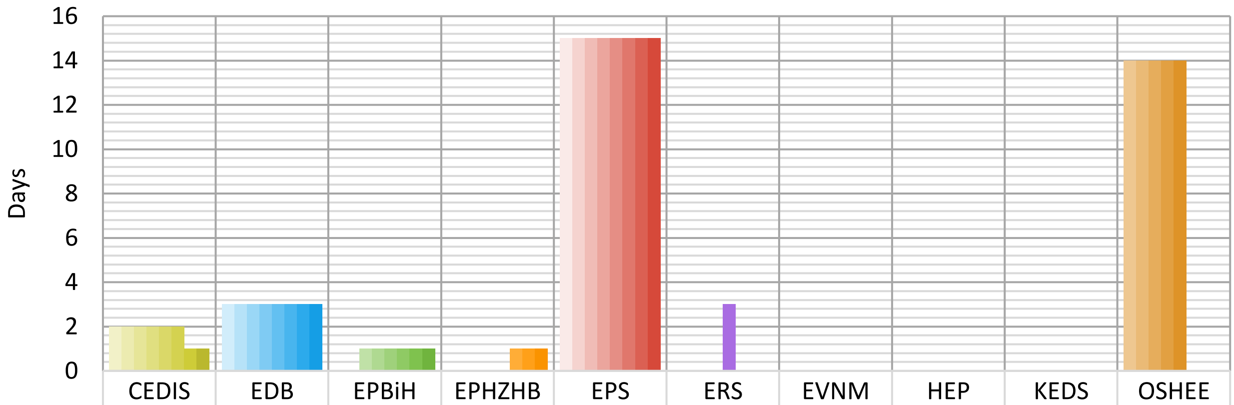
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	3	0	0	15	0	0	0	0	14
2009	0	3	0	0	15	0	0	0	0	14
2010	0	3	1	0	15	0	0	0	0	14
2011	0	3	1	0	15	0	0	0	0	14
2012	0	3	1	0	15	3	0	0	0	14
2013	0	3	1	1	15	0	0	0	0	0
2014	0	3	1	1	15	0	0	0	0	0
2015	0	3	1	1	15	0	0	0	0	0

Figure 19.128 Prescribed time period for reconnection upon disconnection due to electricity theft (unauthorized connection) in public lighting consumption category



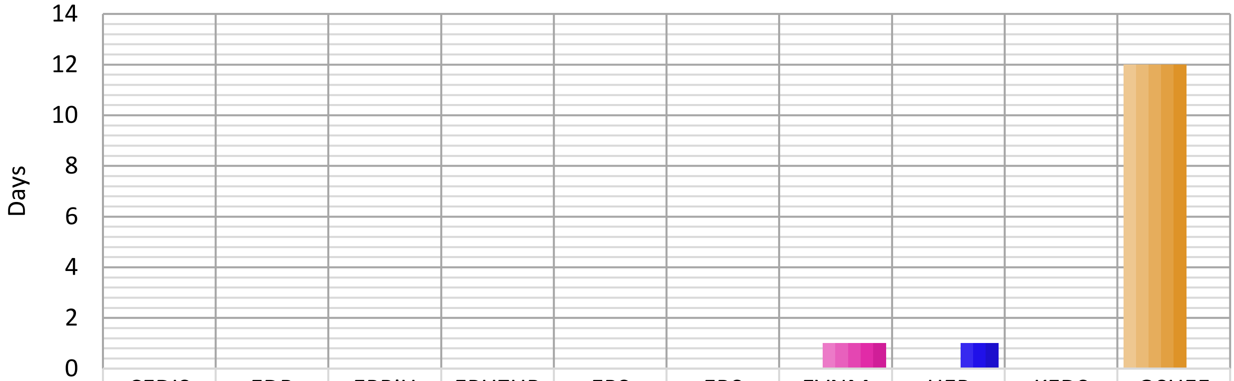
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	2	3	0	0	15	0	0	0	0	14
2009	2	3	0	0	15	0	0	0	0	14
2010	2	3	1	0	15	0	0	0	0	14
2011	2	3	1	0	15	0	0	0	0	14
2012	2	3	1	0	15	3	0	0	0	14
2013	2	3	1	1	15	0	0	0	0	0
2014	1	3	1	1	15	0	0	0	0	0
2015	1	3	1	1	15	0	0	0	0	0

Figure 19.129 Prescribed time period for reconnection upon disconnection due to electricity theft (unauthorized connection) in LV-commercial with peak power registration consumption category



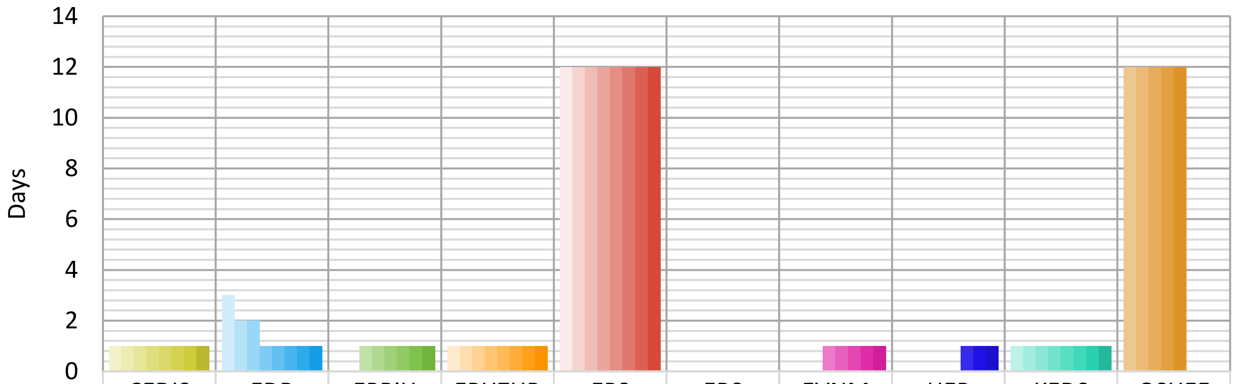
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	2	3	0	0	15	0	0	0	0	14
2009	2	3	0	0	15	0	0	0	0	14
2010	2	3	1	0	15	0	0	0	0	14
2011	2	3	1	0	15	0	0	0	0	14
2012	2	3	1	0	15	3	0	0	0	14
2013	2	3	1	1	15	0	0	0	0	0
2014	1	3	1	1	15	0	0	0	0	0
2015	1	3	1	1	15	0	0	0	0	0

Figure 19.130 Prescribed time period for reconnection upon disconnection due to electricity theft (unauthorized connection) in LV-commercial without peak power registration consumption category



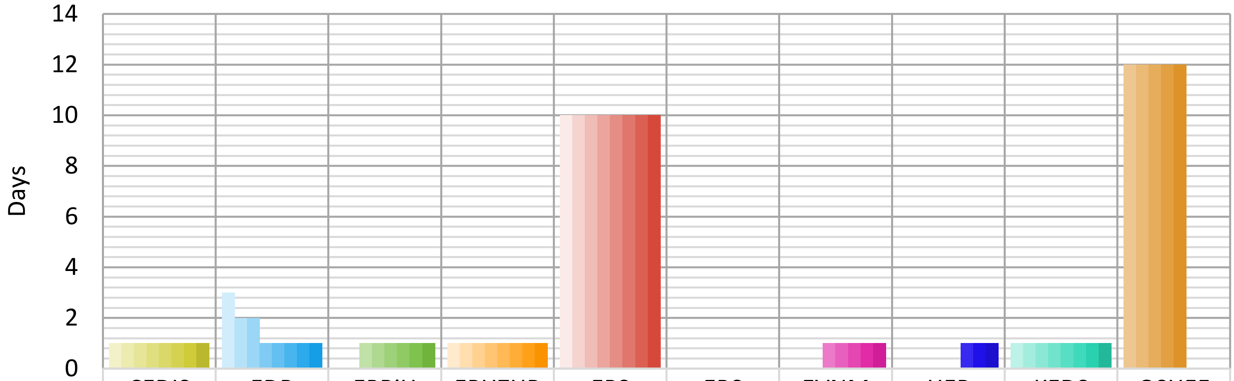
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	0	0	0	0	0	0	12
2009	0	0	0	0	0	0	0	0	0	12
2010	0	0	0	0	0	0	0	0	0	12
2011	0	0	0	0	0	0	1	0	0	12
2012	0	0	0	0	0	0	1	0	0	12
2013	0	0	0	0	0	0	1	1	0	0
2014	0	0	0	0	0	0	1	1	0	0
2015	0	0	0	0	0	0	1	1	0	0

Figure 19.131 Realized (actual) time period for reconnection/resupply upon disconnection due to electricity theft (unauthorized connection) in HV consumption category



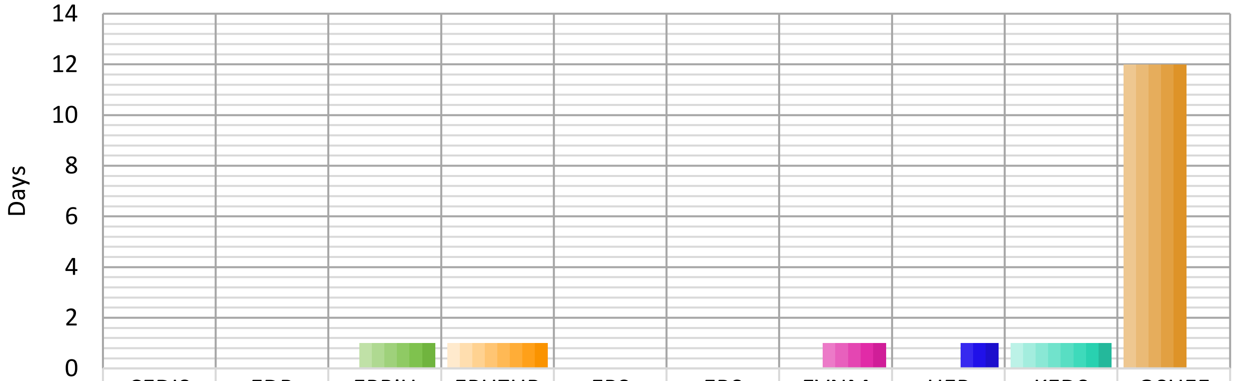
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	1	3	0	1	12	0	0	0	1	12
2009	1	2	0	1	12	0	0	0	1	12
2010	1	2	1	1	12	0	0	0	1	12
2011	1	1	1	1	12	0	1	0	1	12
2012	1	1	1	1	12	0	1	0	1	12
2013	1	1	1	1	12	0	1	1	1	0
2014	1	1	1	1	12	0	1	1	1	0
2015	1	1	1	1	12	0	1	1	1	0

Figure 19.132 Realized (actual) time period for reconnection/resupply upon disconnection due to electricity theft (unauthorized connection) in MV consumption category



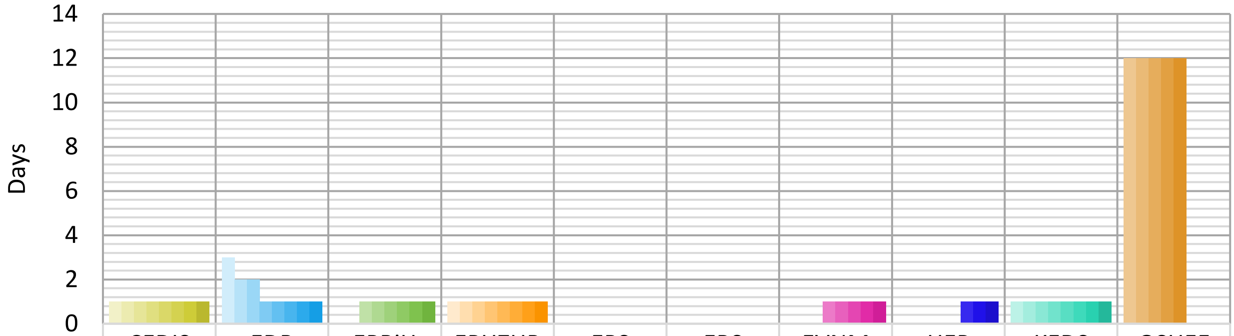
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	1	3	0	1	10	0	0	0	1	12
2009	1	2	0	1	10	0	0	0	1	12
2010	1	2	1	1	10	0	0	0	1	12
2011	1	1	1	1	10	0	1	0	1	12
2012	1	1	1	1	10	0	1	0	1	12
2013	1	1	1	1	10	0	1	1	1	0
2014	1	1	1	1	10	0	1	1	1	0
2015	1	1	1	1	10	0	1	1	1	0

Figure 19.133 Realized (actual) time period for reconnection/resupply upon disconnection due to electricity theft (unauthorized connection) in households consumption category



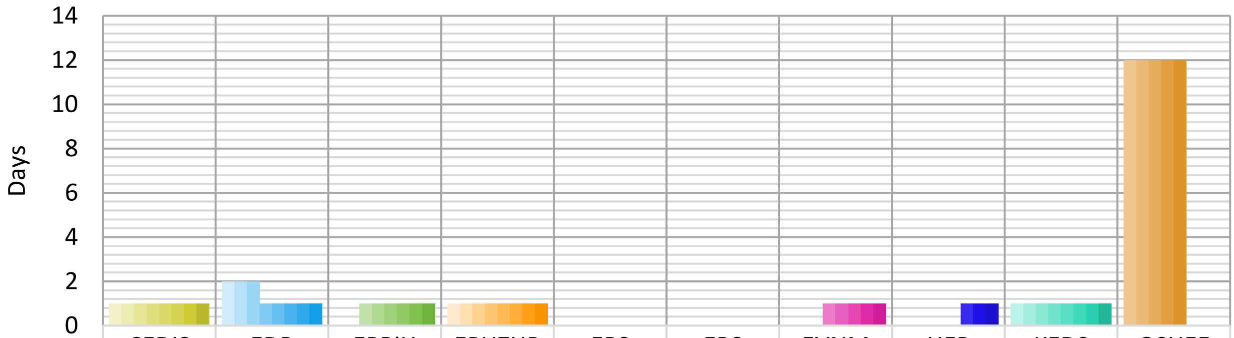
	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	0	0	0	1	0	0	0	0	1	12
2009	0	0	0	1	0	0	0	0	1	12
2010	0	0	1	1	0	0	0	0	1	12
2011	0	0	1	1	0	0	1	0	1	12
2012	0	0	1	1	0	0	1	0	1	12
2013	0	0	1	1	0	0	1	1	1	0
2014	0	0	1	1	0	0	1	1	1	0
2015	0	0	1	1	0	0	1	1	1	0

Figure 19.134 Realized (actual) time period for reconnection/resupply upon disconnection due to electricity theft (unauthorized connection) in public lighting consumption category



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	1	3	0	1	0	0	0	0	1	12
2009	1	2	0	1	0	0	0	0	1	12
2010	1	2	1	1	0	0	0	0	1	12
2011	1	1	1	1	0	0	1	0	1	12
2012	1	1	1	1	0	0	1	0	1	12
2013	1	1	1	1	0	0	1	1	1	0
2014	1	1	1	1	0	0	1	1	1	0
2015	1	1	1	1	0	0	1	1	1	0

Figure 19.135 Realized (actual) time period for reconnection/resupply upon disconnection due to electricity theft (unauthorized connection) in LV-commercial with peak power registration consumption category



	CEDIS	EDB	EPBiH	EPHZHB	EPS	ERS	EVNM	HEP	KEDS	OSHEE
2008	1	2	0	1	0	0	0	0	1	12
2009	1	2	0	1	0	0	0	0	1	12
2010	1	2	1	1	0	0	0	0	1	12
2011	1	1	1	1	0	0	1	0	1	12
2012	1	1	1	1	0	0	1	0	1	12
2013	1	1	1	1	0	0	1	1	1	0
2014	1	1	1	1	0	0	1	1	1	0
2015	1	1	1	1	0	0	1	1	1	0

Figure 19.136 Realized (actual) time period for reconnection/resupply upon disconnection due to electricity theft (unauthorized connection) in LV-commercial without peak power registration consumption category