*Central and Eastern European Benchmarking Initiative*
*for Water Supply Utilities*


# HUNGARIAN INCEPTION PROJECT ON BENCHMARKING

## ::: DATA 2007 :::

# GENERAL REPORT

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General information on the CEEBI Project can be found at the CEEBI website:
www.ceebi.eu

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# 1 INTRODUCTION

Many countries have started benchmarking studies with the aim of improving performance in their water sectors. Metric benchmarking studies use standardized performance indicators like e.g. unit costs, water losses, renewal rates, supply safety, customer services. Benchmarking is used as a continuous process of comparing performance between different utilities but also over the timescale to track enhancements of each firm. The core idea of benchmarking is to provide and share information on best practices to achieve improvements in the company's performances.

Corresponding to the principles of benchmarking the aim of the project is to learn from the best in class. With benchmarking, potentials for optimizations can be detected as well as the efficiency of operation can be verified. First of all benchmarking may serve as an internal controlling instrument.

The CEEBI benchmarking is a voluntary and anonymous comparison of company performances. Strong focus is laid on data security and data confidentiality. All company-data are governed and interpreted confidentially by a neutral and objective project team.

The Hungarian inception project on benchmarking was carried out by the Budapest University of technology (BUTE) and the University of Natural Resources and Applied Life Sciences Vienna (BOKU).

The Hungarian inception project on benchmarking was carried out with 9 participants. Every utility could deliver more than one dataset e.g. different datasets for different service regions. In total the participants delivered 20 datasets valid for comparisons, which cover around 10 % of the Hungarian water supply sector.

# 2 GENERAL INFORMATION ON THE HUNGARIAN CEEBI

## 2.1 OBJECTIVES

Aim of the CEEBI project is to converge different benchmarking studies (IWA, IAWD, OVGW, and German Projects) and to achieve similar definitions of variables, context information and performance indicators used. This will ensure a high standard of project quality concerning the comparability and data quality.

Aim of the CEEBI inception phase is to see if utilities of one country are willing to join in a benchmarking study and if they are able to deliver the data requested. In future different CEEBI inception projects of different countries shall be merged as CEEBI Project.

A crucial step during data processing is to determine the most relevant influencing factors on performances for the appropriate definition of peer groups and to achieve an optimal validity of comparison. CEEBI shall induce an information sharing network among utilities that leads to the derivation of measures to enhance performance. The comparison with existing data of Austrian and German projects shall help to see other practices.

## 2.2 EXPECTED BENEFITS

Based on the feedback of participating utilities of the Austrian benchmarking project, the following three benefits can be expected:

- One of the first outcomes of data collection is the future availability of structured and consolidated data.
- The positions of the utilities within the sector will be determined and the performance of each firm can be documented to the stakeholders as e.g. customers, shareholders, municipality and authorities. This creates transparency and reduces mistrust.
- Gaps or deficits in a firm's performance can be identified and measures for improvement can be derived.

Additional expected benefits from the Hungarian Inception Project is that the comparison with existing data of Austrian and German projects shall help for the Hungarian water utilities to see other practices as well.

## 2.3 THE CEEBI PERFORMANCE INDICATOR SYSTEM

The definitions of the CEEBI project are mainly based on the IWA Performance Indicator System (Alegre et al, 2006). These definitions together with the experiences from the existing benchmarking projects, namely the Austrian OVGW Benchmarking Project with 70 Participants (Theuretzbacher-Fritz et al., 2006) and the Bavarian EffWB benchmarking project (Kiesl and Schielein, 2005) give the basis of the Hungarian Inception Project. In particular the experiences showed that some of the IWA definitions are not appropriate to small and medium scale water works and therefore had to be changed slightly to enable all participants to fill in the gathering form completely.

The inception phase of the CEEBI project only uses a few key performance indicators applied among some selected water supply utilities. Nevertheless some more sophisticated PIs are used and some recently developed Explanatory Factors like "Average Network Age Index (NAX)" (Neunteufel et al., 2007) were tested as well in the Hungarian inception project.

**Table 1: Key-Performance Indicators used in CEEBI compared with international Benchmarking projects (Laky et al., 2008)**

| **CEEBI** Key-Performance Indicators | **IWA** | **OVGW** | **IBNET** | **NEBC** |
|---|---|---|---|---|
| **Economic efficiency** | | | | |
| • Unit total costs (costs/$m^3$), divided in: | ✓ | ✓ | ~ | ✓ (metric) |
| o Unit running cost | ✓ | ✓ | ~ | ✓ (metric) |
| o Unit capital cost | ✓ | ✓ | | ✓ (metric) |
| • Total personnel divided in: | | | | |
| o Employees per 1,000 connections | ✓ | ✓ | ✓ | ✓ (basic) |
| o Employees per mains length | | ✓ | | |
| o Employees per 1,000 people supplied | ✓ | | ✓ | |
| o Employees per system input | | ✓ | | ~ (metric) |
| • Non-revenue water by volume | ✓ | ✓ | ✓ | ✓ (basic) |
| • Electricity costs divided in: | | | | |
| o Total energy consumption (kWh/$m^3$) | ✓ | ✓ | | ~ (metric) |
| o Standardised total energy consumption (kWh/$m^3$/1000 m) | ✓ | ✓ | | |
| **Quality** | | | | |
| • Water losses (%) | | ✓ | ~ | |
| • Water losses per mains length ($m^3$/km/day) | ✓ | ✓ | ~ | ✓ (metric) |
| • Water losses per connection ($m^3$/connection/year) | ✓ | ✓ | ~ | |
| • Infrastructure Leakage Index | ✓ | ✓ | | |
| • Mains failures (no./100 km/year) | ✓ | ✓ | ✓ | ✓ (metric) |
| • Mains failures without transmission pipes (no./100 km/year) *(to enhance comparability)* | | ✓ | | |
| • Network Average Age Index (NAX) | | ✓ | | |
| • Quality of supplied water (% of total number of treated water tests complying with the standards) | ✓ | ✓ | | ✓ (metric) |
| **Sustainability** | | | | |
| • Mains rehabilitation (%/year) | ✓ | ✓ | | |
| • Mains rehabilitation (%/year) without transmission pipes (to enhance comparability) | | ✓ | | |
| • Water tariffs for a residential consumption of 150 $m^3$ | ✓ | ✓ | ~ | ~ (basic) |
| • Total cost coverage ratio (%) | ✓ | ✓ | ~ | ✓ (metric) |
| **Reliability** | | | | |
| • Total reservoir capacity (within transmission and distribution system) (days) | ✓ | ✓ | | |
| • Peak Supply Safety (%) | | ✓ | | |
| • Service interruption (%) | ✓ | ✓ | ✓ | ~ (metric) |

The selected key performance indicators are listed in Table 1. according to four of the five IWA categories:

- Economic efficiency
- Quality
- Sustainability
- Reliability

The fifth area – customer service – was omitted in the inception phase yet as the IWA definitions and the experiences of the existing project diverge too much on that topic and a common appropriate standard has yet to be defined for future applications. The IWA PI values regarding the customer service are strongly influenced by the way recording of the complaints. If there are no uniform complaints registration systems, the costumer indicators will be not comparable.

The ticks in Table 1 indicate that this PI is used in other benchmarking projects as well, and "~" means that similar, however not exactly the same PI definition is used in the other project.

## 2.4 GENERAL STATISTICS ON THE HUNGARIAN WATER SUPPLY SECTOR AND THE PARTICIPANTS OF CEEBI INCEPTION PROJECT

Source: Hungarian Water Utility Association, Ministry of Environment and Water

**Water Balance**:

| |
|---|
| Average annual precipitation: 600 mm |
| Annual groundwater resources: 716 mill. $m^3$* |
| Total water demand: 4246 mill. $m^3$ |
| Total drinking water demand: 498 mill. $m^3$ |
| Total service water demand (e.g. industry) app. 3500 mill. $m^3$ |
| Total agricultural demand app. 250 mill. $m^3$ |
| Hungarian water supply is app. provided from: sub-surface water 94.1 %, thereof:<br>• Groundwater: 2.9 %<br>• Deep confined aquifer: 42.3 %<br>• Karstic water: 11.9 %<br>• Bank filtration: 42 %<br>• Thermal water: 0.9 % |

**Inhabitants supplied**:

| |
|---|
| Total inhabitants: 10 035 000 (source: KSH: Hungarian Central Statistical Office) |
| Total inhabitants with access to central water supply: 8 096 610 |

**Structure of water supply utilities**:

| |
|---|
| Total # of utilities: 360 |
| Total # of utilities supplying more than 1000 Inhabitants: 280 |
| Private owned and operated utilities: 1 |

**People employed in water supply services**:

| |
|---|
| Workers: 14 000 |
| Clerks: 6 000 |

**Per capita demand**:

| |
|---|
| Average daily per capita (without industry agriculture) 110 L |
| Average annual family demand (3 people) app. 120 m³ |

## 2.5 Methods of Analysis and Display

### 2.5.1 Boxplots

**T**he PI results are often displayed as so called Boxplots. In descriptive statistics, a boxplot (also known as a box-and-whisker diagram or plot) is a convenient way of graphically depicting groups of numerical data through their five-number summaries:

- the smallest observation (lower T-end),
- lower quartile,
- median,
- upper quartile, and
- largest observation (upper T-end)

**T**he space between lower quartile and upper quartile is displayed as a grey box;
the median is displayed as black line within the box;
the number of datasets is displayed as little white box in the middle of the median-line.

**A** boxplot may also indicate which observations, if any, might be considered outliers. The spacings between the different parts of the box help indicate the degree of dispersion (spread) in the data, and identify outliers. Figure 1. shows how a Boxplot is created out of a number of discrete PI results.

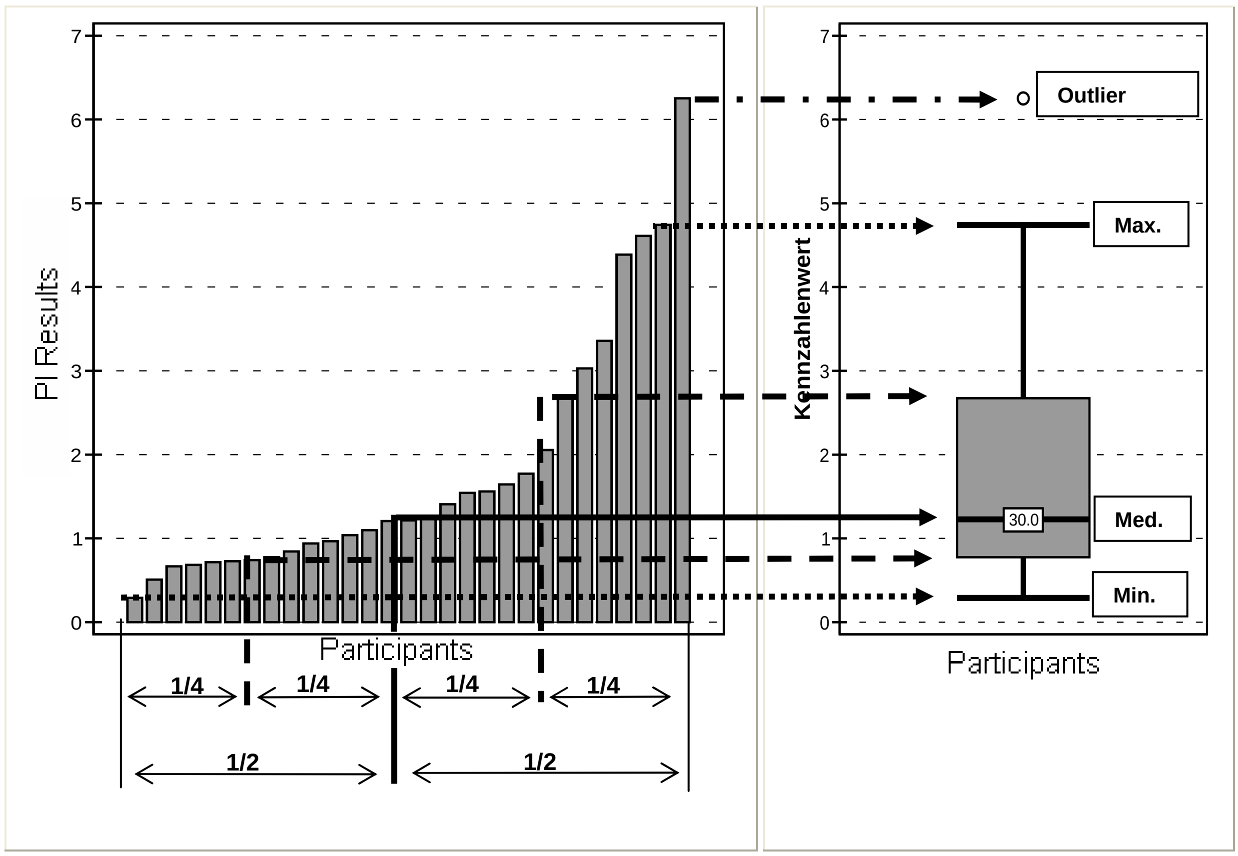


**Figure 1: Creation of Boxplot**

*Due to data privacy this public report displays only the medians (Med.). The Min. and Max. values as well as the lower and upper quartile (edges of the grey box) are masked out.*

### 2.5.2 Peer Groups of Participants in the Hungarian Inception Project

Please note:
Different average results between different peer groups do only display the influence of the criteria used to create the peer groups.

**It can not be stated that one utility of one certain group shows a better (or worse) performance than utilities of another peer group. Due to different influencing factors, valid comparisons must only be drawn between participants within one peer group.**

Grouping was carried out based on the experience of the Austrian benchmarking project. The PI results are usually indicated for each per group (according to urbanity, NAX, etc.).

### 2.5.3 Explanatory Factor "Average Network Age Index" (NAX) for Mains Failures and Water Losses

Concerning mains failures and water losses the strongest influencing factor beside the structural parameter "urbanity" was found to be the age of the pipe network. The simple calculation of the average mains age does not consider that different pipe materials have different service lives. The network age index NAX does and so provides estimation of how much of the expected service life has elapsed by the time. Beside the definition of peer groups the age index NAX can be used as an explanatory factor for several PIs; to estimate the influence of network age on asset related performance indicators; and in long terms as an estimation whether there is enough rehabilitation and renewal done or not. However it is not recommended to directly derive rehabilitation strategies from age index NAX or to use it as a performance indicator but the NAX can give useful hints whether detailed analyses are to be carried out.

In total the age index NAX takes into account 12 different material groups:

- asbestos cement
- reinforced concrete
- glass-fiber reinforced plastic (GRP)
- cast iron (grey iron) (CI)
- ductile graphite iron "old" - without protection against corrosion and without cement lining
- (until mid of the 1970th)
- ductile graphite iron "new" - with galvanizing against corrosion and cement lining
- (starting from mid 1970th)
- polyethylene (PE)
- polyvinyl chloride (PVC)
- steel "old" - without lining (until end of the 1970th)
- steel "new" - with cement lining and outer PE casing
- renovation (e.g. inlining)
- other pipe materials

To keep the data acquisition simple the differentiation into different pipe diameters was neglected.

Considerations Concerning the Composition of the Index Value:

Long time operation of a supply network should result in an "Average Network Age Index" of about 50 %. Therefore, the index value should be a far-spread composition of very new parts of pipe network, some medium aged parts and some old parts of network, next to being exchanged provided that failure rates correlate with pipe age. Other compositions can result in index values much lower than 50 % (recent built network), around 50 % or already higher or even much higher than 50 %. Networks with a homogenous relative age may result in a bulk-renewal. A cost-trap might be waiting even if the actual age index NAX is very low at present (Neunteufel et al., 2007).

### 2.5.4 Accuracy bands of data

**C**omparing the PI results it is necessary to consider the accuracy bands of the provided data. Any errors and inaccuracy of the input variables will be found as context information with the PI's calculated.

**T**herefore considering best practices, the accuracy bands (**Table 2**) have to be kept in mind.

**Table 2: Accuracy bands**

| | |
|---|---|
| A | very reliable, error max. 5 % |
| B | reliable, error 5 % to 20 % |
| C | unreliable, error 20 to 50% |
| D | very unreliable, error > 50 % |

# 3 RESULTS

## 3.1 ECONOMIC EFFICIENCY

| |
|---|
| Unit total costs (costs/m$^3$), divided in: |
| o Unit running cost |
| o Unit capital cost |
| Total personnel divided in: |
| o Employees per 1,000 connections |
| o Employees per mains length |
| o Employees per 1,000 people supplied |
| o Employees per system input |
| Non-revenue water by volume |
| Electricity costs divided in: |
| o Total energy consumption (kWh/m$^3$) |
| o Standardised total energy consumption (kWh/m$^3$/1000 m) |

***Detailed results on each PI shown as boxplots are only available in the individual reports provided only for the participants.***

**Summary**

For PIs **Unit total costs, Unit running costs and Unit capital cost,** the network delivery rate (m$^3$/km/year) was expected to be one of the most important influencing factors based on the results of previous benchmarking projects. Lower cost values were expected for higher network delivery rate, however based on the available 18 data sets for this PI, this trend couldn't be verified yet. The median values for PI **Unit capital cost** were below 25 HUF/m$^3$ for each peer-group. **Unit total cost** median values range from 180 to 115 HUF/m$^3$, for low (5 000 m$^3$/km/year) to medium (5 000-15 000 m$^3$/km/year) delivery rate, however the variation was very high in case of medium network delivery rate.

Urbanity was found to be important influencing factor for the PI **Employees per 1000 connections** in other benchmarking studies. The lowest PI value was expected in metropolitan areas, while the highest value was expected in case of rural areas. Based on the 20 dataset available in this case this expectation could not be verified. The median values for rural, urban and metropolitan areas were from 4 to 6 employees per 1000 connections, but no significant difference was observed between the peer-groups.

The PI value **Employees per mains length** increased with increasing urbanity. The reason is that in urban and metropolitan areas the number of service connections are higher (per mains length) than in the rural areas, which resulted in higher number of employees per mains length.  The median values range from 10 to 45 employees per 100 km mains length, for rural to metropolitan networks, however the variation was quite high especially in case of metropolitan area, where only 2 data sets were available for the analysis (Figure 2).

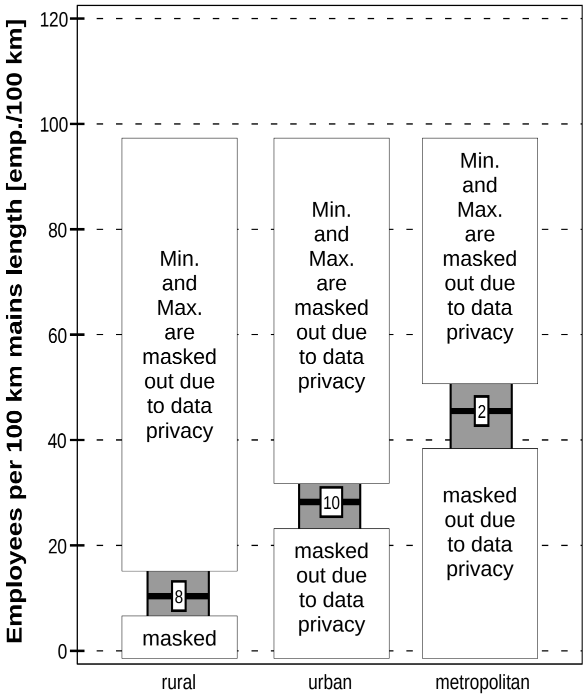


**Figure 2: Employees per 100 km mains length**

For PIs **Employees per 1000 people supplied** and **Employees per system input** lower values were expected with increasing urbanity, The median values range from 1.6 to 2.3 **Employees per 1000 people supplied**, however the variation was quite high within the peer-groups and the results don't verify the expectations. For PI **Employees per system input** the median values range from 20 to 35 employees per million $m^3$ water supplied per year, and the expected trend could not be verified.

## 3.2 QUALITY

| |
|---|
| Water losses (%) |
| Water losses per mains length ($m^3$/km/day) |
| Water losses per connection ($m^3$/connection/year) |
| Infrastructure Leakage Index |
| Mains failures (no./100 km/year) |
| Mains failures without transmission pipes (no./100 km/year) (to enhance comparability) |
| Network Average Age Index (NAX) |
| Quality of supplied water (% of total number of treated water tests complying with the standards) |

***Detailed results on each PI shown as boxplots are only available in the individual reports provided only for the participants.***

**Summary:**

For PI **Real water losses** no trend was observed with NAX or urbanity. The median value is around 16.5 %.

For PI **Water losses per mains length** the network structure (included in the urbanity) is the most important influencing factor. NAX has lower impact than urbanity. Urbanity displays a sum of influencing factors: increasing static and dynamic loads, increasing damage by third parties (other properties). The median values range from 2.7 to 4.9 $m^3$/km/day, for young to medium networks (no data was available for old networks) and from 1.5 to 11.5 $m^3$/km/day, for rural to metropolitan networks.

Also concerning the PIs **Water losses per service connection** and **ILI (Infrastructure Leakage Index)** the network structure (included in the urbanity) is the most influencing factor. For PI **Water losses per service connections** the median values range from 15 to 60 $m^3$/connection/year for rural to metropolitan networks. The **ILI** values range from 0.7 to 2.5 from rural to metropolitan networks. The ILI value theoretically cannot be lower than 1, however we observed lower values at several utilities. The reason is probably that these utilities estimated and reported higher average operating pressure than their real average operating pressure.

For **Mains failures** and **Mains failures without transmission lines** urbanity was found to be the most influencing factor. For PI **Mains failures** the median values range from 40 to 150 failures/100 km/year for rural to metropolitan networks (Figure 3). Excluding the transmission lines gave much better basis for comparison since the variation decreased for the metropolitan networks.

**Remark:**

The network age index provides estimation of how much of the expected service life has elapsed by the time. The reported estimated service life expectations from the Hungarian utilities are much similar to what reference age values were already used to calculate the network age index. Therefore the reference ages were left unchanged for future calculations.

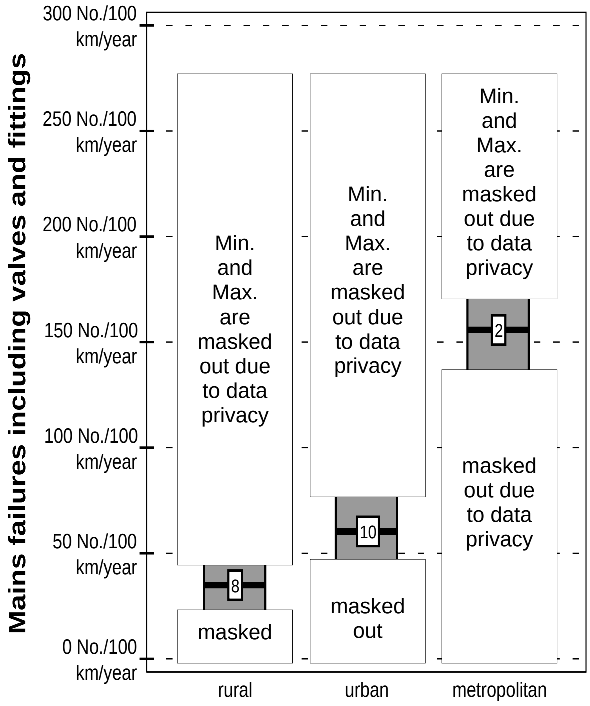


**Figure 3: Mains failures (transmission and distribution mains) including valves and fittings**

## 3.3 SUSTAINABILITY

| |
|---|
| • Mains rehabilitation (%/year) |
| • Mains rehabilitation (%/year) without transmission pipes (to enhance comparability) |
| • Water tariffs for a residential consumption of 150 m³ |
| • Total cost coverage ratio (%) |

***Detailed results on each PI shown as boxplots are only available in the individual reports provided only for the participants.***

**Summary**

Based on the expected service life, there are average rehabilitation needs from 1.2 % to 2 % per year. However, the reported values (PI: **Mains rehabilitation**) are around mostly between 0 – 0.2 %, which is far below the required rate. Only in case of young networks it can be an acceptable value because there is no need for rehabilitation yet.

Regarding **Water tariffs for a residential consumption of 150 m³** the median is about 113 €, which is lower than the international figures show, but compared to the national income this value is around 3 times higher than in other countries.

For the PI **Total cost coverage ratio** about half of the utilities reported values above 100 %, while about the other half is below. For those, who are below 100 %, the required rehabilitation cannot be financed anyway but also values above 100 % could drop below the threshold very quickly if costs for rehabilitation rise.

## 3.4 RELIABILITY

| |
|---|
| • Total reservoir capacity (within transmission and distribution system) (days) |
| • Peak Supply Safety (%) |
| • Service interruption (%) |

***Detailed results on each PI shown as boxplots are only available in the individual reports provided only for the participants.***

**Summary**

In general the **Total reservoir capacity** was planned for 0.5 days according to Hungarian standards, but due to the decrease of the consumption in the last decades, the values are generally 0.5 to 1 day at the present.

All utilities reported their **Peak supply safety** to be more than 100 %, which means they are having enough resources to supply the peak day. If a utility goes close to 100 %, they should ask the authorities for a rise in consensus or they have to look for new resources.

Most of the utilities had no **Service interruption**. There was only one utility had problems with service interruptions.

# 4 LITERATURE

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