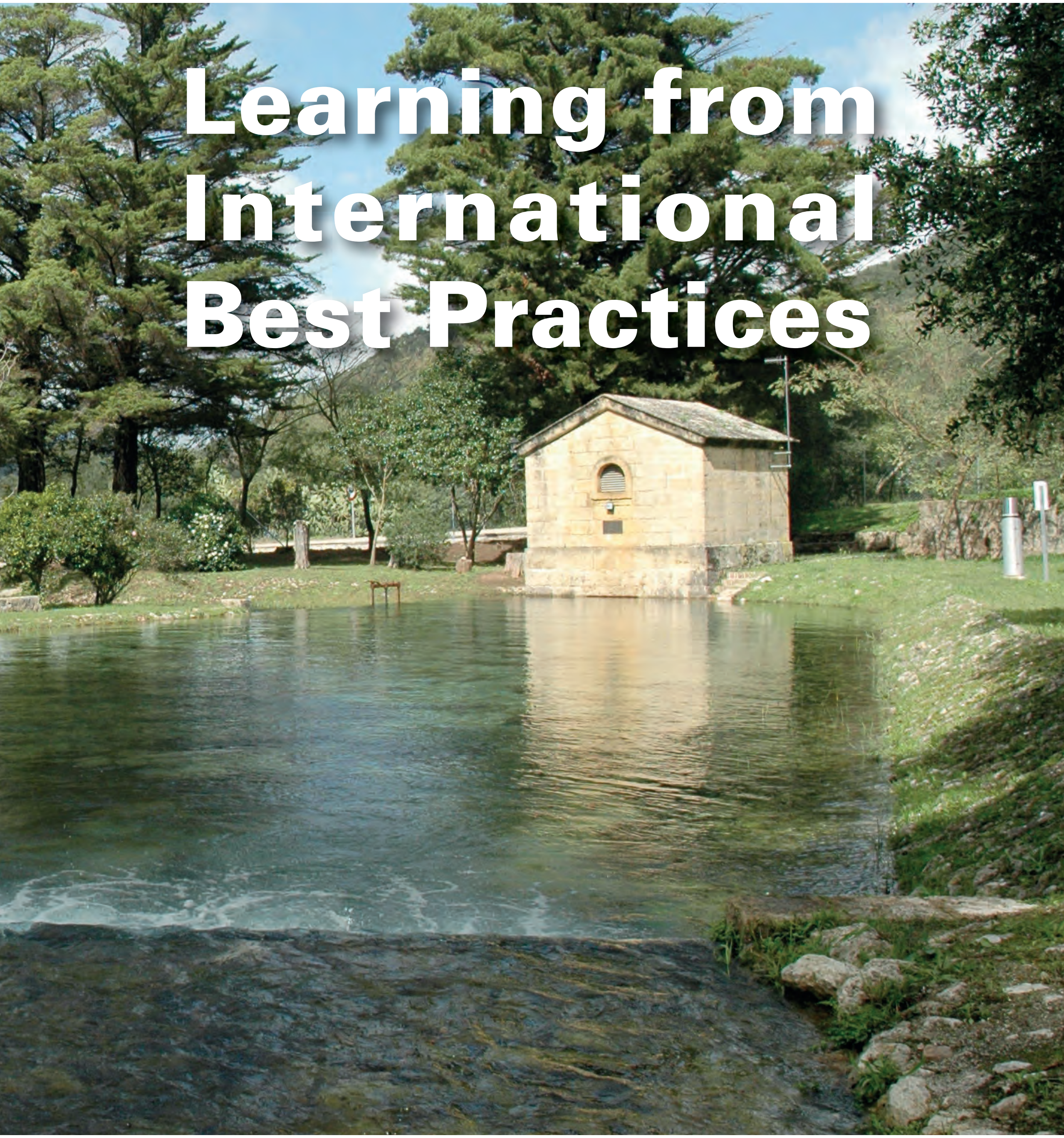
European
Benchmarking
Co-operation

Learning from International Best Practices



2015 WATER & WASTEWATER BENCHMARK

Participants 2015 exercise

Belgium
- Aquafin NV
- Brussels Drinking Water
- Brussels Wastewater
- De Watergroep
- Intercommunale des Eaux du Centre du Brabant Wallon
- Société Wallonne des Eaux
- VIVAQUA

Cyprus
- Water Board of Lemesos

France
- Service public de l'eau Eau de Paris

Germany
- Hamburg Wasser
- hanseWasser Bremen GmbH

Italy
- CAP Holding S.p.A.
- Società Metropolitana Acque Torino S.p.A.

Japan
- Sewerage Utility, City of Yokohama

Norway
- City of Oslo, Water and Sewerage Works

Poland
- Aquanet Spólka Akcyjna
- MPWik S.A. W Krakowie
- MPWiK S.A. Wroclaw

Portugal
- FCC Aqualia Portugal

Russia
- Joint Stock Company Mosvodokanal
- State Enterprise "Vodokanal of Saint-Petersburg"

Singapore
- Public Utility Board

Spain
- Aquajerez, S.L
- Canal de Isabel II Gestión S.A.
- Empresa Metropolitana de Abastecimiento de Aguas de Sevilla S.A.

Sweden
- Sydvatten A.B. (Southern Sweden Water Supply)

Switzerland
- Services Industriels de Genève

The Netherlands
- Brabant Water N.V.
- Evides Waterbedrijf N.V.
- Hoogheemraadschap Amstel, Gooi en Vecht
- N.V. Dunea
- N.V. PWN Waterleidingbedrijf Noord-Holland
- N.V. Waterbedrijf Groningen
- N.V. Waterleiding Maatschappij Limburg
- N.V. Waterleidingmaatschappij Drenthe
- Oasen N.V.
- Stichting Waternet
- Vitens N.V.

United Kingdom
- Dwr Cymru Welsh Water
- Northumbrian Water Limited
- Severn Trent Water Limited
- Yorkshire Water

United States
- Charleston Water System

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2015 WATER & WASTEWATER BENCHMARK

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Foreword

Carl-Emil Larsen
CEO Danish Water and Wastewater Association (DANVA)
Chairman of the Board of EBC Foundation

The year 2015 has once more been a special year for EBC Foundation. The Foundation, as the successor of the EBC project consortium, successfully continued its Western European benchmarking programme, facilitated regional benchmarking in the Danube region and launched a new ICT Platform for its benchmarking participants. Also, it elaborated on a benchmarking formula for the future. This formula envisaged can best be characterized as a 'next step in benchmarking', now the emphasis in EBC's activities will not only be on performance assessment but on improvement based on assessment results at the same time.

Next step in benchmarking

Together with the EU EIP Water Action Group on benchmarking, the development has started of a roadmap towards improvement and innovation in water- & wastewater services. Based on a deeper analysis of the assessment results, individual utilities may be assisted by the Foundation to put together their own improvement agenda while for a group of interested utilities common topics – like resource efficiency – may be tackled on a more collective basis in a collaborative, project-oriented approach to speed up and foster improvement & innovation. In this 'collective' approach EBC may help participants to make existing knowledge better accessible or lead the way in setting up collaborative R&D projects to develop innovative solutions possibly with the help of Horizon 2020 or Eureka/Eurostars.

A new ICT Platform

EBC Foundation considers a smoothly functioning and user friendly ICT Platform at the heart of all its benchmarking projects. The growing number of utility participants in East- and West Europe made it necessary for the Foundation to develop a new Platform to better cope with participants' wishes, offer multilingual tools and facilitate running multiple benchmarking exercises in parallel, with enhanced data quality management.
In close co-operation with key-users, within one year a new ICT Platform has been developed and implemented together with our partner ABF Research in Delft, the Netherlands. The new

tooling already proved its value early 2015, for the Danube Water Program participants in particular, when exactly on schedule, the first benchmarking reports in the new format were successfully completed by EBC Foundation.

Western Europe

In 2015, 43 utilities from 17 different countries participated in the annual benchmarking exercise for Western Europe (IB2014). From 21-23 October 2015, 85 utility representatives (including delegations from the four benchmarking hubs in the Danube region) gathered in the most south-western tip of Europe, in the charming Spanish city Jerez de la Frontera, for the annual benchmarking workshop. Aqualia the water management company of the Spanish services group FCC, kindly offered to host and co-organise this year's workshop. The delegates appreciated the new and different character of the annual workshop this year where the focus was not only on performance assessment but on improvement based on assessment as well; on top of that they mentioned especially the networking opportunities and the possibilities to learn from each other's know-how and experiences.

Participants were happy with the new ICT Platform, but also called for its further expansion with a discussion forum and a possibility to share good practices for an enhanced interaction between participants. Meanwhile, activities to fill in this wish of participants are underway.

Danube Water Program

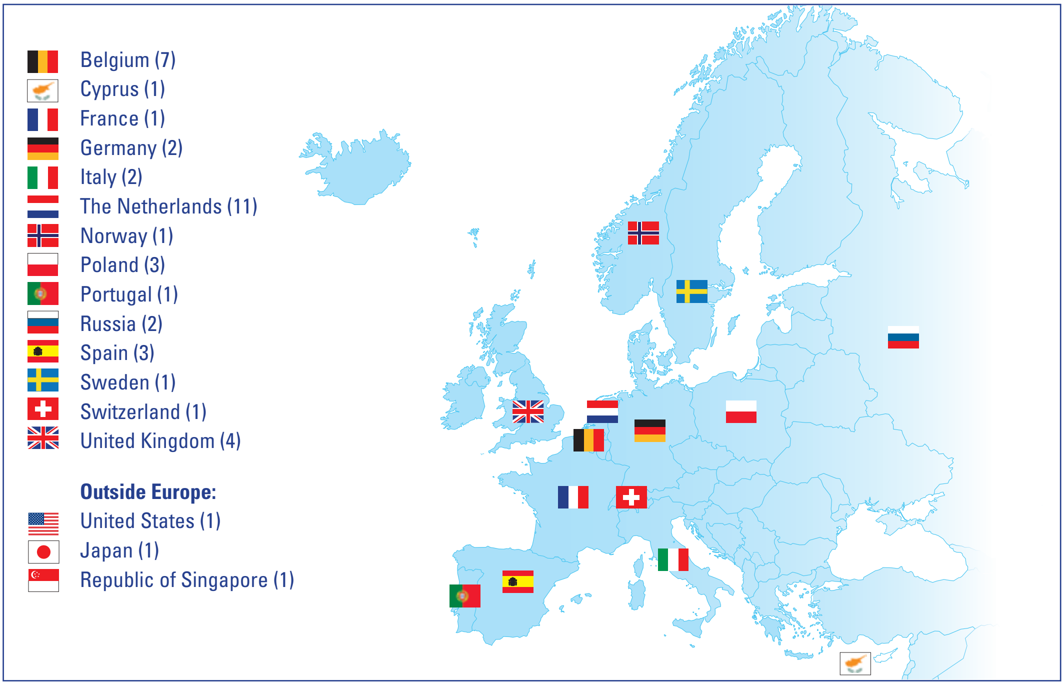
Per 1 December 2015 the first contract period with IAWD on the Danube Water Program came to an end. This capacity building project is considered very successful by IAWD as well as by all four "hubs" established in Bulgaria, in Albania & Kosovo, in the Former Yugoslavia region and (halfway 2015) in Ukraine. EBC Foundation acts as a benchmarking knowledge- and service centre and supports the hubs by training local benchmarking staff, by providing methodologies, necessary documents and ICT-tools and by connecting utility networks to exchange best practices. So far, 56 utilities from the Danube region have been involved in this first phase of benchmarking and capacity building supported by EBC.

Improving water services never ends

All in all, looking back at this first operational year of the Foundation, developments were fast, effective and full of promises for the future. Therefore, I am happy to use this opportunity to invite utilities around Europe to join EBC's next international benchmarking exercise (IB2015) and be part of this international peer utility network. The reason is simple: Improving water services never ends.

Introduction

Since 2007, the European Benchmarking Co-operation (EBC) carries out an international benchmarking programme for European water- & wastewater utilities, with the objective to improve their services. This publication briefly reports on EBC's core programme for Western Europe. In 2015 EBC organised its ninth international benchmarking exercise, welcoming 43 participants from 17 different countries. Three of the participating utilities are based in countries outside Europe (Japan, Singapore and the United States). The 2015 exercise processed data from 2014. The project was coordinated by EBC and supported by ABF Research in Delft, the Netherlands.



The benchmarking process started early 2015 with an invitation to European water utilities to join EBC's benchmarking exercise.
Eventually, 43 utilities from 17 different countries decided to participate. EBC offers utilities three different levels of participation (basic, standard and advanced) to make the benchmarking programme accessible to all type of water utilities, no matter if they are used to advanced data collection, or just begin with basic data collection. During the data collection process, participants are supported by EBC through an expert helpdesk to assure a high quality level of the data.

The data collection started in May, using the completely renewed benchmarking platform www.waterbenchmark.org. As always, EBC paid a lot of attention to the data quality. After the initial collection phase, with several checks online, the submitted data were subject to three rounds of analysis and correction, resulting in a validated data set which was used for the final company reports and this public report.
Like every year, in the 2015 benchmarking exercise improvements have been made in the set of questions and in the reporting. The Climate Footprint analysis has been further refined and several questions have been added to enable future exchanges with IBNet, the World Bank's global largest database of performance information of water- and wastewater utilities.

From 21-23 October 2015, 85 representatives of the participating utilities and a delegation from the regional benchmarking programmes in the Danube region gathered in Jerez de la Frontera in Spain for EBC's annual benchmarking workshop, which was hosted and co-organised by the Spanish water management company FCC Aqualia. The two-day event provided participants with a network platform where they could exchange good practices and ideas for improvements. In total, 22 sessions were dedicated to discuss numerical results of the exercise (performance assessment) and best practices (performance improvement). Also, FCC Aqualia organised site visits to the water facilities for Jerez de la Frontera as well as a wastewater treatment plant with innovative bio-fuel production.
At the traditional workshop dinner, the Benchmarking Co-ordinator of the Year Award was handed to Øivind Ryenbakken (Oslo kommune VAV) and to Ryoichiro Orii (Yokohama Sewerage Utility) and Osamu Fujiki (Nihon Suiko Sekkei, Yokohama's benchmarking advisor). Right after the benchmarking workshop in Jerez, participants could make the last corrections in their dataset; final reports were distributed early December.

Utility representatives at the 2015 benchmarking workshop in Jerez de la Frontera, Spain

DRINKING WATER

Drinking water

This section contains an overview of this year's performance assessment on drinking water services. Data of other services that the participating companies may have provided (i.e. wastewater or gas distribution) are excluded from the analysis. In EBC's benchmarking programme, the indicators are divided into five performance areas: water quality, reliability, service quality, sustainability and finance & efficiency. The current public report only shows a subset of the available performance indicators for the drinking water service to illustrate key findings. In the ideal situation the group of participants that compares performance would be the same over time. The group of utilities that participated in the 2015 exercise however differs from the one in previous years. Hence, the current group level results cannot be compared with those of previous years. In the individual company reports, participants can however track changes both in their own and in their peers' performance.

Coverage

The percentage of resident population served by utilities of the current EBC group is high. Almost all utilities in the group serve 100% of the total resident population; the median value for the group is 100,0%.

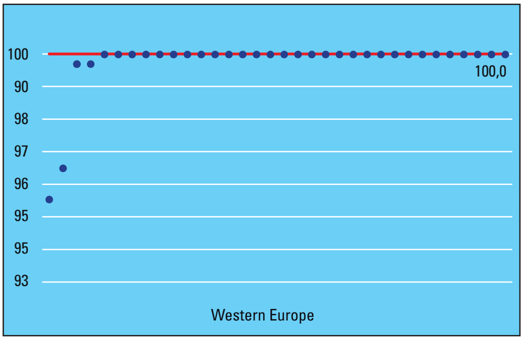


Figure 1:

Population coverage (%)

Note:
Each data point represents the score of a participating utility. The horizontal line shows the median value. According to the programme's Code of Conduct performance comparisons in this public report do not show participants' names. Note that the number of data points varies per figure, because not all participating utilities have submitted a full dataset.

Water quality

Water quality is generally seen as the most important aspect of the drinking water service. Consumers need safe and clean water as a basic commodity. To assess the water quality of the participating utilities, EBC measures the percentage of quality tests in compliance with national regulatory standards. Since the standards for water quality differ between countries, test compliance does not allow for an absolute comparison. However, the variation between standards is limited, since the majority of the participating utilities originate from Europe, where the national standards are based on the European Drinking Water Directive.
Water quality compliance is very high across the current EBC group. Most companies score

close to 100% and the median value is 99,95%. It is worth mentioning that a non-compliant test does not necessarily mean an imminent health risk for the consumer. It can for example be a non-hazardous flaw (i.e. an abnormal colour). Furthermore, many regulatory standards contain a safety margin, so that a case of non-compliance does not necessarily mean public health is at risk.

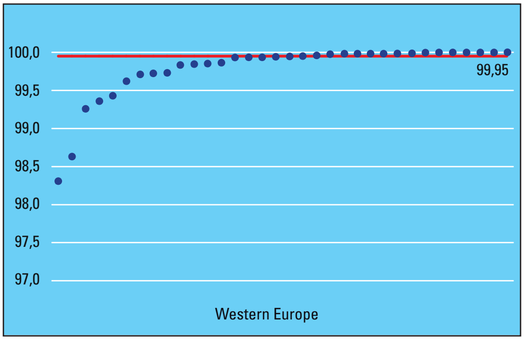


Figure 2:
Quality of supplied water (%)

Reliability

Reliability also is an essential performance indicator for a water utility. The customer expects a continuous supply of safe and clear water. EBC uses mains failures as an indicator of reliability. Mains failures are breaks and leakages of mains pipes, valves and fittings leading to interruption or low-pressure supply. Results of reliability vary widely within the current EBC group with values ranging from 1,4 to 96,7 failures per 100 km. Factors that may influence the mains failure rate include the network condition, soil condition, traffic load and water pressure. It is also worth mentioning that an improvement in monitoring failures may (at first) cause an increase in mains failures, as not in all cases failures are properly registered. The median value is 14,5 failures per 100 km.

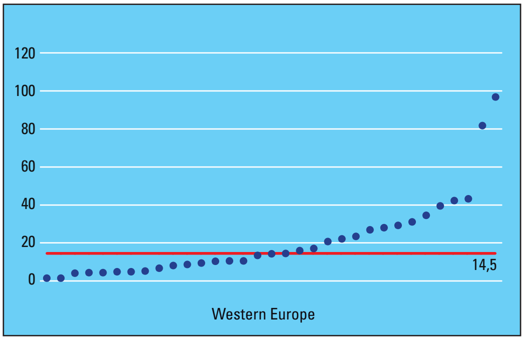


Figure 3:
Mains failures (No./100km)

In addition to mains failures the programme looks at distribution losses and (at the advanced level) at customer minutes lost. The vast majority of utilities in the current EBC group faces distribution losses between 0,7 and 14,5 m^3/km mains length per day. The median value for the group is 6,34 m^3/km per day. Failures may also occur without the customer noticing.

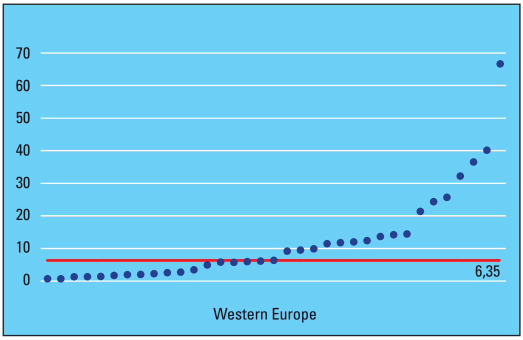


Figure 4:
Distribution losses per mains length (m^3/km/day)

Service Quality

If the service of a water utility is not up to the required standard of the customer, the customer can file a complaint. Hence the number of complaints filed by utilities' customers is an adequate measure for service quality. EBC measures service complaints. These complaints are related to the actual supply of drinking water, including water pressure, (medium to long term) continuity, water quality and (short term) interruptions. Complaints on billing are also measured in the programme, but not taken into account in this indicator. The majority of the current EBC group scores very well with a median value of 0,72 complaints per 1000 properties. The emergence of social media also created a new channel of communication between consumers and utilities. Many water utilities are increasingly using social media to better inform their customers. Hence, through these new channels, mutual understanding is facilitated and formal complaints may be prevented.

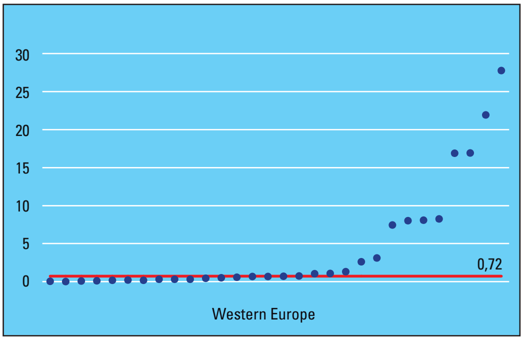


Figure 5:
Service complaints per connected property (complaints/1000 properties)

Sustainability

Sustainability is a key point of the agenda of many water utilities. It can be approached and measured in various ways. The EBC programme uses the widely recognised Triple Bottom Line approach, which investigates social, environmental and economic sustainability.

Social sustainability

Water is a basic necessity, and customers usually do not have viable alternatives to their local water supplier. This unilateral reliance leaves it to the utility to make sure its product is affordable. Hence, EBC measures social sustainability of the drinking water services by showing the water bill as a share of the disposable household income. In the current EBC group this ranges from 0,20% to 1,03%, with a median of 0,64%.

Environmental sustainability

The EBC programme measures environmental sustainability through several indicators, which include electricity use for water production, energy recovery, inefficiency of use of water resources, the reuse of treatment residuals and climate footprint. Figure 7 shows the electricity used by pumps in the abstraction, treatment and distribution of water, per m^3 that is produced. The use of electricity is influenced by the type of water resources, geography and treatment processes. Pumps are the most voracious consumers of electricity, which makes their efficiency an important factor in the reduction of electricity use.
This benchmarking exercise resulted in a median electricity usage for pumping of 0,49 kWh per m^3 water produced.

Figure 6:
Share of water bill in disposable household income (%)

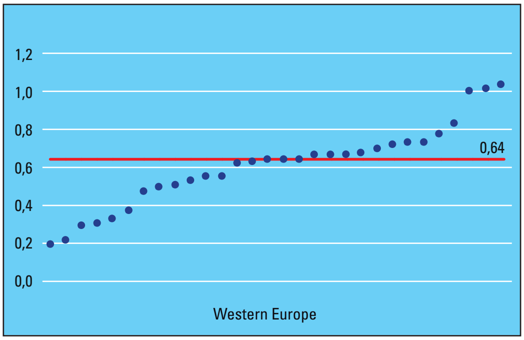
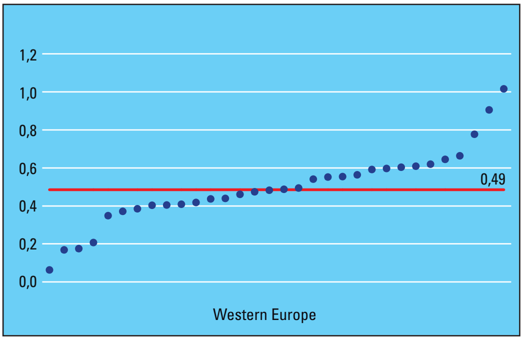


Figure 7:
Electricity use per m^3 water produced (kWh/m^3)



For utilities that participate at the advanced level, scope 1, scope 2 and scope 3 indicators for the climate footprint are analysed within the EBC programme. In the current report the most relevant one, scope 2, is highlighted. Scope 2 emissions originate from the generation of purchased energy for own use by the utility. The participants of this years' benchmarking exercise show a range of scores from 0 kg till 0,37 kg CO_2-equivalent per m^3 drinking water, with a median value of 0,07 kg.

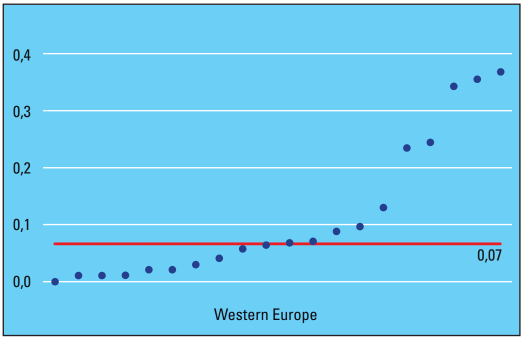


Figure 8:
Climate footprint scope 2 per m^3 direct revenue drinking water (kg CO_2-eq./m^3)

Economic sustainability

While making sure that water is ample available to the public, and taking their environmental footprint into account, water utilities need to make sure their activities are economically sustainable. Utilities renovate or replace mains to keep the network fit for future use. The percentage of mains rehabilitation is the share of the network that has been renovated or replaced because the condition of the mains deteriorates. Higher percentages of main rehabilitation usually occur in combination with a higher average network age. Virtually all utilities in the current EBC group rehabilitate between 0,1% and 1,1% of their network. The median value is 0,55% on an annual basis.

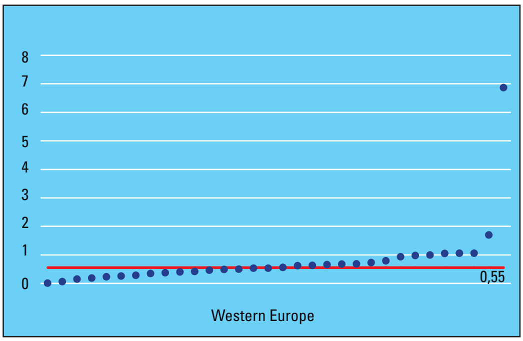


Figure 9:
Mains rehabilitation (%/year)

Economic sustainability also means collecting sales revenues to cover total costs by a ratio of 1 or more. About two third of the EBC participants meet this criterion. With a ratio below 1, utilities will have to rely on other sources of income (e.g. subsidies, reserves or income from other activities). These utilities are less sustainable on the long run. The median value for the current EBC group is 1,04.

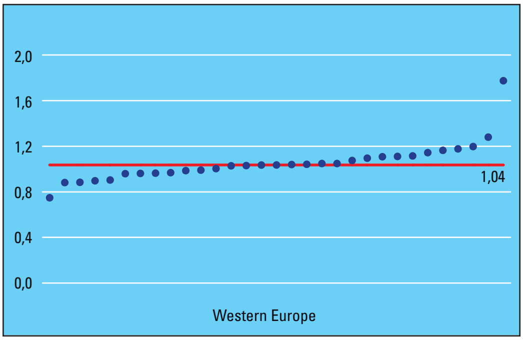


Figure 10:

Total cost coverage ratio

Finance & Efficiency

The EBC performance assessment framework contains an extensive set of indicators on finance and efficiency. This set includes total cost, running cost, personnel intensity and charges. Since water utilities are committed to provide water of the highest possible quality at the lowest possible price, water charges are an important financial performance indicator. Average water charges for direct consumption are calculated by dividing total direct revenues by the sold volume. Many utilities have a tariff structure with a fixed connection fee and a variable rate per unit sold. As a result the price per m^3 a household actually pays will often depend on its consumption. The median price of water for the current EBC group is € 1,24/m^3.

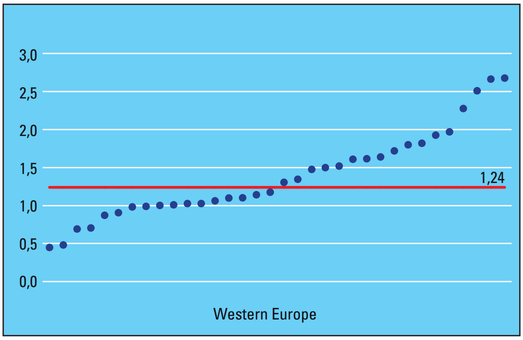


Figure 11:

Average water charges for direct consumption (€/m^3)

Personnel intensity is a relevant performance indicator on the efficiency side. It is measured as the number of full-time employees (fte) per 1000 properties. The scores on this indicator are computed using a standard 40 hour full-time working week. In the current EBC group the personnel intensity ranges from 0,16 to 2,02 fte per 1000 properties with a median value of 0,82 fte per 1000 properties.

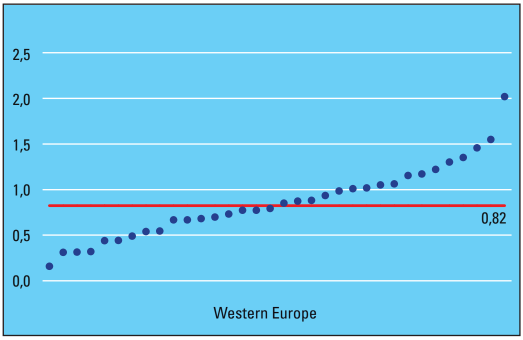


Figure 12:
Personnel intensity (fte/1000 properties)

Like in many other cases, one needs to be careful with drawing conclusions from one graph. Utilities with lower personnel intensity do not necessarily perform better than utilities with higher personnel intensity. Personnel intensity is an important indicator, but does not represent the total manpower efficiency of a utility; for instance, the level of outsourcing of activities to third parties has to be taken into account as well to get a more complete picture. This underlines the value of the annual benchmarking workshop, in which participants jointly search for the full story behind the figures.

WASTEWATER

Wastewater

This section presents an overview of the performance comparison of this year's benchmarking exercise for wastewater services. We consider the same performance areas as for drinking water: water quality, reliability, service quality, sustainability and finance & efficiency. The data is gathered on the wastewater activities specifically. This means that measures and costs of other services that a participant may provide (i.e. drinking water or district heating) are excluded from the analysis. The performance indicators shown in this section are only a subset of the available indicators.
The group of utilities that participated in the 2015 exercise differs from the one in previous years. Hence, the current group level results cannot be compared with those of previous years. In the individual company reports, participants can however track changes both in their own and in their peers' performance.

Coverage

With a median value of 99,4%, the percentage of the resident population in the service area of utilities in the current EBC group that is connected to the sewer system managed by those utilities is high.

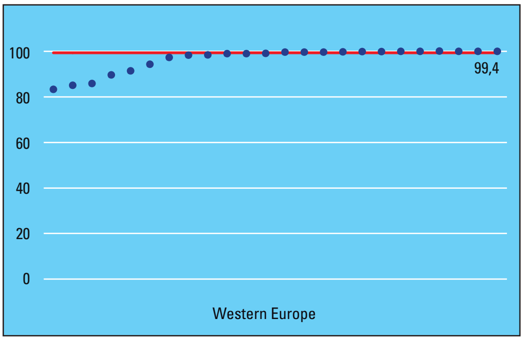


Figure 13:
Resident population connected to sewer system (%)

Wastewater quality

The wastewater that is collected by a utility (in many cases mixed with storm water) needs to be treated before returning in the environment. The treated water needs to be in compliance with the local discharge consents to minimize negative impact on receiving waters. These consents vary between and within countries, which means that the same percentage of compliance can have a different meaning for the different utilities. The compliance within the current EBC group is generally high with a median value of 99,7%.

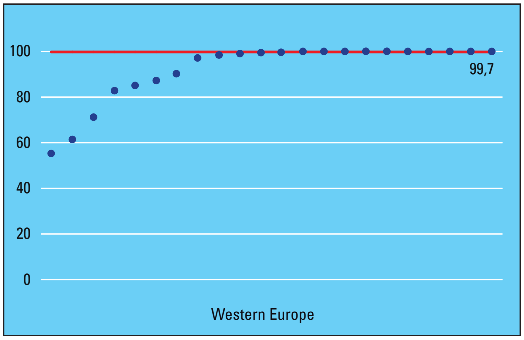


Figure 14:
Wastewater treatment plant compliance with discharge consents (%)

Reliability

To assess wastewater reliability, EBC is using sewer blockages as the main indicator. Sewer blockages include all occurrences under the company's responsibility, whether they are due to collapse, root ingress, grease or debris. Utilities within the current EBC group strive to improve monitoring. This may (at first) result in an increase in the detection rates, as not all blockages are currently properly registered. However, eventually this should improve the service of the water companies. On the customer side, utilities can reduce blockages by educating people, especially in the case of blockages caused by grease. The scores on sewage blockages vary widely within the current EBC group: between 0 and 245 blockages per 100 km sewer per year, with a median value of 40,9 blockages.

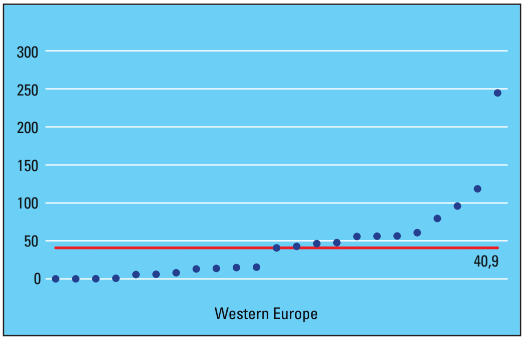


Figure 15:
Sewer and connection blockages (No./100 km sewer)

Another relevant indicator from the perspective of the customer, the number of floodings from combined sewers, also shows large variations within the current EBC group. For the vast majority of utilities in the current EBC group the number of floodings per 100 km of combined sewer vary between 0 and 18, with a median value of 0,3.

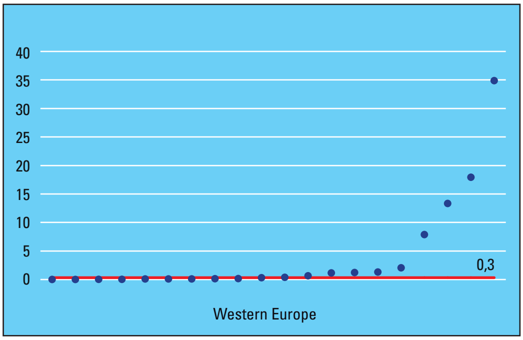


Figure 16:
Flooding from combined sewers (No./100 km sewer)

Service Quality

Service quality for wastewater services is measured using the same indicators as for drinking water. The customer can file a complaint if the service of a wastewater utility is not up to the required standards. The majority of the current EBC group scores very well with a median of 0,9 complaints per 1000 inhabitants per year.
Different types of complaints are occurring in different part of the wastewater chain. For instance, blockages and flooding complaints occur more often in the collection and transport mains (network), while the treatment facilities are often faced with complaints due to pollution, odour and rodents.

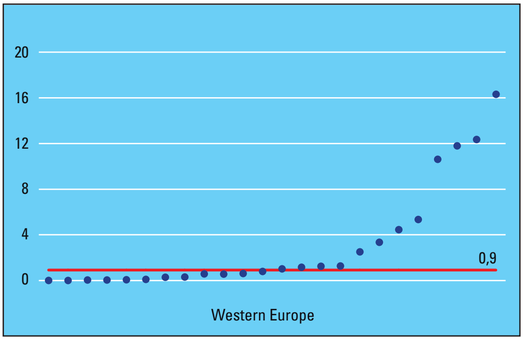


Figure 17:
Total complaints (No./1000 inhabitants/year)

Sustainability

Similar to drinking water services, wastewater services are benchmarked on sustainability using the Triple Bottom Line approach which takes into account social, environmental and economic sustainability.

Social sustainability

The EBC programme measures the social sustainability of wastewater services by calculating the share of the wastewater bill in the disposable household income. This measure gives a good impression of the affordability of the wastewater services, accounted for differences in wealth between nations. The EBC group of current participants shows a profound range from 0,22% to 1,38%, with a median value for this indicator of 0,55%.

Environmental sustainability

EBC's benchmarking programme measures environmental sustainability with several indicators. Examples are the electricity used for treating wastewater as well as generating electricity from it, the percentage of the sludge generated in the treatment process that is utilised in a sustainable way or the frequency of use of overflow devices to surface water. In the current report we reveal the results for the energy consumption of the wastewater treatment plants as well as results for the climate footprint scope 2.

The energy consumption of the majority of participants is fairly distributed between 23,3 kWh and 40,9 kWh per population equivalent served. The median value for the current EBC group is 28,4 kWh. The energy consumption of the wastewater treatment plants largely depends on the level of treatment, which in turn depends on the local discharge consents.

Figure 18:
Share of wastewater bill in disposable household income (%)

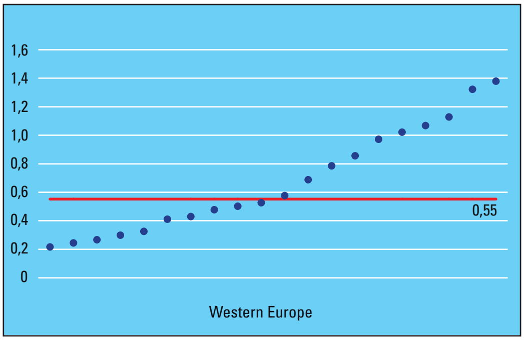
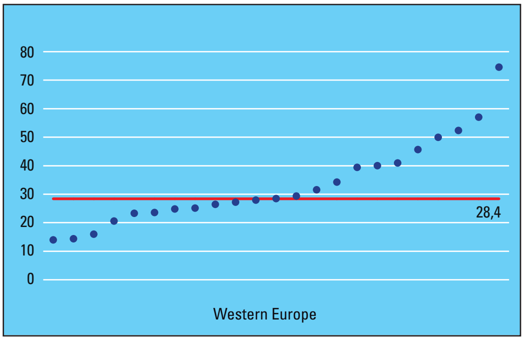


Figure 19:
Wastewater treatment plant energy consumption (kWh/p.e. served)



For utilities that participate at the advanced level, scope 1, scope 2 and scope 3 indicators for the climate footprint are analysed within the EBC programme. In the current report the most relevant one, scope 2, is highlighted. Scope 2 emissions originate from the generation of purchased energy for own use by the utility. Most utilities in the current EBC group report values between 2,6 and 20,9 kg CO_2-equivalent per population equivalent. Some utilities report small or even negative values. The median value for the entire group is 7,3 kg CO_2-equivalent per population equivalent.

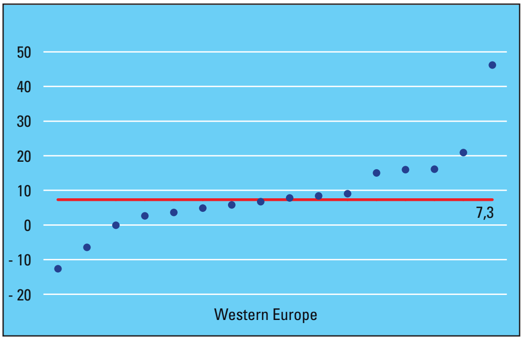


Figure 20:
Climate footprint scope 2 per population equivalent (kg CO_2-equivalent per p.e.)

Economic sustainability

Like with drinking water utilities, wastewater utilities need to make sure their activities are economically sustainable.
Utilities renovate or replace sewers to keep the network fit for future use. The percentage of sewer rehabilitation is the share of the network that has been renovated or replaced because the condition of the sewers deteriorates. Higher percentages of sewer rehabilitation usually occur in combination with a higher average network age. The median value for sewer rehabilitation for the current EBC group is 0,30% per year.

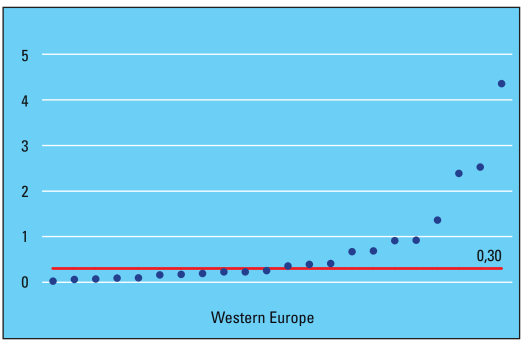


Figure 21:
Sewer rehabilitation (%/year)

Total cost by sales coverage ratio is an important measure for economic sustainability. With this ratio, one can identify if a utility is able to recover its costs from its sales revenues. These revenues consist of all charges to the customers for the collection, transport and treatment of wastewater. With a ratio below 1, utilities will have to rely on other sources of income like subsidies, reserves or income from other activities. A little more than half of the 2015 EBC participants score above 1, making these utilities more likely to be economically sustainable on the long run. The scores range from 0,53 till 1,40, with a median value of 1,01.

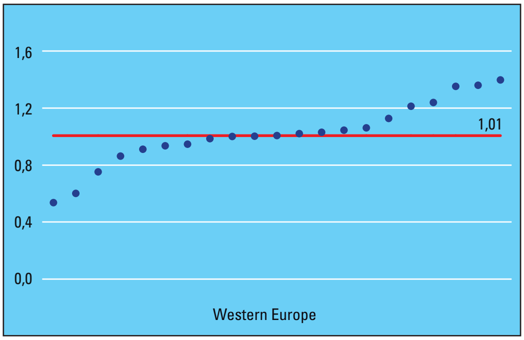


Figure 22:

Total cost service coverage ratio

Finance and efficiency

Like with drinking water utilities, finance & efficiency is a highly relevant topic for wastewater utilities. There is a high variance between the EBC participants for the amount spent on sewage services per connected property. The highest charges registered are over 5 times higher than the lowest (€377 versus €72 per property). The median value for the current EBC group is €172 per property. Corrected for differences in purchasing power the gap between highest and lowest charges reduces to 3,5. Cost reduction (and, consequently, lower charges) are an important goal for most wastewater utilities. Hence this indicator is a great example of where exchange of best practices could be beneficial for utilities.

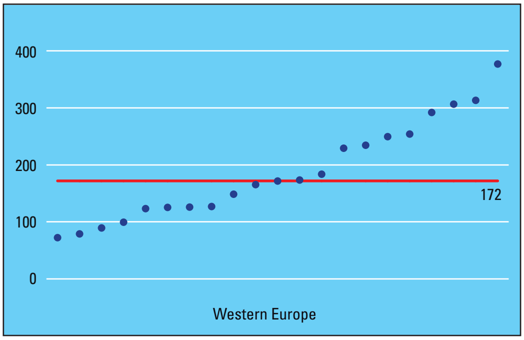


Figure 23:

Average charges per connected property (€/property)

Personnel intensity is a relevant performance indicator on the efficiency side. It is measured as the number of full-time employees (fte) per 1000 properties. The scores on this indicator are computed using a standard 40 hour full-time working week. In the current EBC group the personnel intensity ranges from 0,27 to 1,32 fte per 1000 properties with a median value of 0,64 fte per 1000 properties.

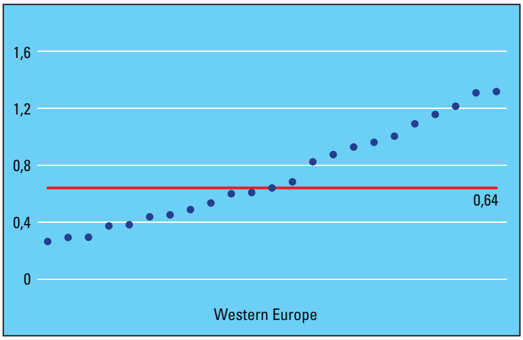


Figure 24:
Personnel intensity (fte/1000 properties)

Like in many other cases, one needs to be careful with drawing conclusions from one graph. Utilities with lower personnel intensity do not necessarily perform better than utilities with higher personnel intensity. Personnel intensity is an important indicator, but does not represent the total manpower efficiency of a utility; for instance, the level of outsourcing of activities to third parties has to be taken into account as well to get a more complete picture. This underlines the value of the annual benchmarking workshop, in which participants jointly search for the full story behind the figures.

GOOD PRACTICES

Good practices snapshots 1

hanseWasser Bremen
Advanced Stormwater Management

Katja Aschenbrenner
Quality Management

Christian Reder
Stormwater Management Expert

Since the 1990s, the City of Bremen has met the legal discharge compliance for combined sewage and has improved the water quality of its water courses. This was achieved in two phases. The first phase comprised the construction of combined sewer overflow (CSO) basins and stormwater relief sewers to increase the storage volume for combined sewage.

Since the implementation of these measures the CSO rate has complied with the legal requirements. The second phase focused on a further reduction of CSO discharges and measures to mitigate the negative effects on the marshland water bodies.
Since 1999 hanseWasser has been responsible for the wastewater collection and treatment in Bremen. About 50 million m³ of wastewater from the City of Bremen and several surrounding municipalities is treated and disposed in the two wastewater treatment plants (WWTP) of Seehausen and Farge. Older, inner-city areas are served by a combined sewer system. Areas equipped with sewers after 1945 have a separated sewer system. Figure 1 gives a broad graphical overview of Bremen's sewer system.
Like a natural border, the river Weser separates the city. The tidal influence of the North Sea changes the water level in the Weser up to 4 meters twice a day. Additionally, the area slopes from the river Weser to the low lying marshlands. The geomorphological structure prevents a free gravitational flow to the WWTPs. Therefore, the wastewater in Bremen's sewer system has to be pumped to the WWTP.

Heavy rainfall events especially affect the combined sewer system. The capacity of the combined sewers is insufficient to carry the total volume of combined sewage to the WWTPs.

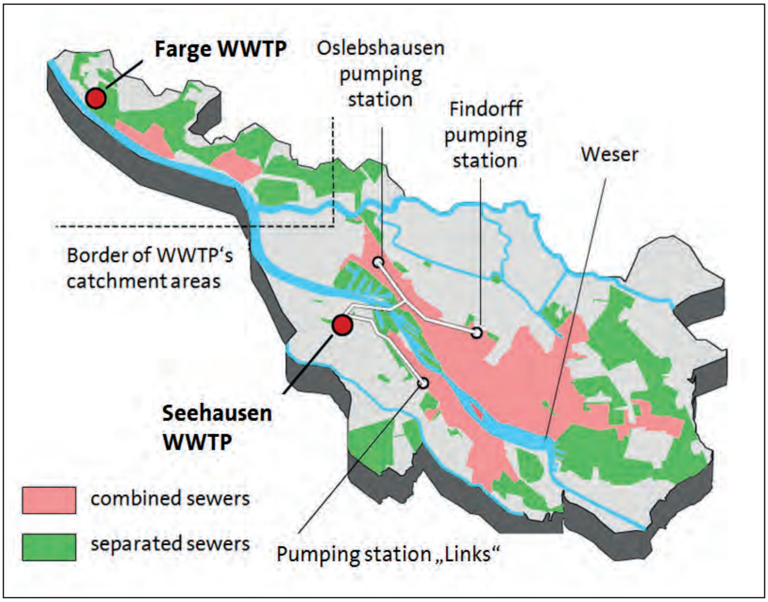


Figure 1:
Map of Bremen and its sewer system

To relieve the combined sewers, a part of the contaminated rain water has to be discharged from the CSOs into the Weser and small marshland water bodies. The annual CSO rate is related to the total amount of stormwater collected in the combined sewer system. Before further action was taken, a model based simulation estimated an overflow rate of approximately 20 % for the catchment area of the Seehausen WWTP. In the 1970s and 1980s this led to a massive impact on the receiving waters.
The federal water law requires the reduction of the impact on water courses due to discharges of combined sewage. It stipulates an acceptable water treatment before discharges occur. An expert legal report from 1985 determined that the 5-years-average CSO rate has to fall below a maximum of 13 % for the catchment area of the Seehausen WWTP.

Since 2000 the legal requirements have been tightened with the implementation of the EU Water Framework Directive. It demands the achieving and maintaining a good qualitative status of all water bodies within the European Union. The target for the City of Bremen is to reduce any negative effects of CSOs on the sensitive marshland water bodies.

To improve the water quality of Bremen's water courses and to fulfil the requirements of the federal water law, the municipality of Bremen initiated a remarkable and comprehensive program at the end of the 1980s called 'Mischwasser 90'. It implemented measures to reduce CSO discharges. Another major aim was to protect the city from flooding from the combined sewers. To increase the storage volume for combined sewage, more than 100 million DM (about 50 million Euros) were invested to construct CSO basins and storm relief sewers. These storage volumes can be activated by sewage flow diverters.

Long-term simulations predicted a decrease in the annual CSO rate to approximately 11 % as a result of the improvements made in the 'Mischwasser 90' program. Now the combined sewage is treated mechanically in sedimentation basins before being discharged. A comprehensive real time monitoring and control system was installed to manage the operation of both the general sewer system and the additional storage volume. In addition to the water that is pumped to the WWTPs, the combined sewage storage volume for the affected area is activated to relieve the sewer system during heavy rainfall. The storage volume consists of 97,000 m^3 of CSO basins, 28,000 m^3 of storm relief sewers and 145,000 m^3 of combined sewers.

Picture: A view through a storm relief sewer with the weir of the sewage flow diverter in the background

hanseWasser further improved the real time control of the sewer system to enable an optimal utilization of the free available volume in the combined sewer system. Now the centralized process control system includes the sewer system and the WWTPs which makes it possible to harmonize the flow to the WWTPs and to prevent flow peaks. This helps to avoid CSO discharges. In the central control centre at the Seehausen WWTP the process control system is permanently monitored by two highly qualified employees (European qualification level 6). They have had two years of training with the process control system so they are able to take corrective action if necessary.

Since the end of the 1990s all CSO volumes have been measured. With an average value of 6 % the annual CSO rate has sunk below the legal requirements. However, the small marshland water bodies are still affected by CSO discharges. Therefore, the current target is to further reduce CSO discharges and mitigate the impact on the small receiving waters. hanseWasser, the dike authorities and the municipality work together to achieve the target in which the sewer system, the WWTPs and the receiving waters are considered as parts of an integrated system. Additional measures were defined after validation of the measured and analysed data from CSOs and the receiving water bodies in 2007.
Not only technical process optimization but also a functioning information chain is essential to reduce and prevent impacts of stormwater events. In Bremen stormwater is defined as more than 12 mm of rainfall per hour. During such heavy rainfall, affected hanseWasser departments are informed via short messages and protocols. A team patrols sensitive inner city areas and visually monitors if any overflows occur. Citizens can report problems in the sewer system, such as sewer back-up to a 24-hour hotline.

The dike authority is informed immediately after CSOs in the marshland water courses. It takes control of the water regime and increases the fresh water inflow from the ‘Wümme’ river to the marshland water courses to dissolve the high loaded discharged combined sewage. Furthermore, it is planned to increase the flow from the main pumping station Findorff to the WWTP in an ongoing project.
All these measures and the cooperation of all responsible authorities further reduced the number of CSO discharges and showed positive effects on sensitive water bodies. Thus, Bremen is on track for achieving a good quality of its water bodies.

Good practices snapshots 2

Reststoffenunie
Resource recovery from the water cycle: 'A transition in thinking and doing'



Jacqueline de Danschutter
(Waternet)

Hay Koppers
(KWR)

Olaf van der Kolk
(Reststoffenunie)

Surface- , ground- and wastewater contain a wide spectrum of chemical elements which are removed in treatment plants of water- and wastewater utilities. Simply because that's what the sector is doing: producing drinking water and/or cleaning wastewater. However, if we do not consider the elements we remove as a 'problem' but as possible resources, a whole new world unfolds itself. Then, our sector may develop as a producer of valuable and high quality raw materials and products. A miracle? No, it has already been demonstrated.

In the Netherlands and parts of Belgium, water companies collaborate in a shared service centre called Reststoffenunie. The sole purpose of this organisation is bringing the residuals of the drinking water production – and since recently also from wastewater – to the market. Established in 1995 to solve the sectors' waste problems, nowadays Reststoffenunie acts as an important supplier of secondary raw materials to various economic sectors. In the digester-sector Reststoffenunie has even become a market leader for sulphurous control. This collective solution for resource recovery is not only successful in terms of finance, it also reduces the carbon footprint of the participants with 5%.

The collective solution

The cooperation between Reststoffenunie and the water companies is in principle quite simple: all participants (and shareholders) combine their residuals through this joint company. By doing so, they combine buying-, selling- and innovation power. This is very much needed

to create professional supply chains. After all, the volumes per treatment site are too small to be reliable and to be successful in the market.
Furthermore, supplying the market with resources demands specific competences which are generally not part of the core activities of water utilities. Competences required for bringing the residuals to the market are for example sales, business development, contract management, quality management, legislation and policy. Concentrating these efforts in a collective organisation saves individual efforts and money.

Utility benefits

All participants financially contribute to the organisation relative to their supply of residuals. In other words: the higher the volume, the higher the contribution. The services, like transportation, are sourced through the collective organisation, giving strong buying power due to the high(er) volume.
A realistic risk of working through a collective organisation is that participants lean back and wait for the others to act. Reststoffenunie anticipated on this through a solely for this purpose developed business model. In essence, it is quite simple: the sales revenues of residual X are paid to the treatment plant which has supplied this residual. In practice this means that a treatment plant which produces a good quality residual delivered at the agreed supply date, gets a better price than the one who did not. This has proven to be a quite stimulating model. It places high demands on the administration, but results in a fair and stimulating financial compensation.

Innovation leads to results

Innovation is an essential element of developing products and/or markets. Reststoffenunie therefore spends a significant part of its budget on innovation. In this innovation project, Reststoffenunie tries to work together with its participants, research institutions and (possible) customers. This has proven to be successful; over the last years several new supply chains have been developed.

A recent example is the development of a new product from the softening process in drinking water production. Traditionally, lime or caustic soda is added to raw water, causing $CaCO_3$ to start crystallizing. In a reactor sand (seeding material) is kept in suspension and the $CaCO_3$ starts to crystallize on this sand. The pellet starts to grow and when it's big enough is sinks and is discharged from the reactor. This results in a calcite pellet with a sand core.

Most customers prefer a pure calcite product, as the sand core leads to other chemical and chemical properties. Together with several drinking water companies and KWR Watercycle Institute, a project was launched where the same reactor was fed with a calcite seeding material. This resulted in a residual consisting of pure calcite, leading to more high end applications. This transition made it for example possible to supply Desso carpet company with calcite as a resource for their carpets. This and other success led to a progressive number of treatment plants changing to a pure calcite core.

Calcite for glass production

It didn't stop here. Since the residual of the softening process consists of pure calcite, the route of making the sectors' own seeding material was open. Several full scale tests at Waternet's plant at Weesperkarspel proved that seeding material originating from the sectors' own pellets even performed better than calcite from quarries. Since mid-2015, the plant in Weesperkarspel is softening fully on seeding material made from the plants' own softening pellets.

This innovation made the International Water Association (IWA) deciding to award Waternet, Reststoffenunie (representing all involved water companies), Ardagh and Desso the Resource Recovery Award.

Applying the concept in other regions?

Today, Reststoffenunie together with KWR Watercycle Institute is investigating to what extend the concept would be applicable for water- & wastewater utilities in other European member states and/or regions. If this turns out to be the case, the public-private partnership 'Allied Water' might be a vehicle to get things organised. If your utility is interested in resource recovery from treatment residuals, you may contact Olaf van der Kolk, director of Reststoffenunie, at vanderkolk@reststoffenunie.com.

Top: Calcite as filler for artificial grass

Bottom: Iron sludge for paving stone

PARTICIPANTS EXPERIENCES

Participants' experiences

MPWik Wroclaw

Benchmarking as a Tool for Improvement

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The origins of Municipal Water and Sewage Company S.A. in Wroclaw (MPWiK Wroclaw) date back to the end of the 19th century. In line with Polish legislation, the company is a sole supplier of water and provider of sewage services in Wroclaw, the capital city for the region of Lower Silesia.
In the era of economic transformations and being perceived by customers through the prism of commercial market, the company considers it essential to change its philosophy in the area of company management. Because of this, for some time now, the company has been undertaking activities aimed at creating a leading company in the sector and regional economy. These activities, being carried out on several levels, include in their scope, among others, the organisational structure as well as technical- and customer service areas.

However, in order to define the strategy, it is necessary to identify the market position of the company and areas for improvement. This is only possible by comparing the company with other utilities. Due to rather limited possibilities of carrying out benchmarking with other Polish utilities, it was decided to do so with other European utilities. That is why MPWiK Wroclaw joined the EBC programme in 2013.

Based on the 2013 EBC report (with data from 2012), three technical areas, where MPWiK Wroclaw's overall results were below average, were selected. These areas included the following: number of network blockages, water losses and energy consumption in water and

sewage treatment processes. In order to improve performance results in these areas, three remedial projects have been launched. Called 'The Priorities', the projects are aimed at diagnosing the causes behind unsatisfactory results as well as working out and implementing counter activities. Indicators derived from EBC reports were used to measure achieved results. After analysing the indicators from the following 2014 EBC report, it turned out that all the work within the framework of 'The Priorities' resulted in expected effects and the results achieved are significantly above the European average. The next stage was to indicate areas where the performance results were significantly higher than the European average. On the basis of the 2014 EBC report, seven technical areas were selected and it was decided to undertake actions aimed at achieving a leading position among European utilities.
To achieve that, seven improvement projects, called 'The Best', were established. The main goal of all the projects was to work out and implement activities making it possible to achieve a set goal. The annual EBC assessment reports are a tool used at MPWiK Wroclaw for continuous improvement of the company. Indicators included in the reports enable the company to set goals and monitor progress in reaching them.

Endnotes

1) **Share of (waste)water bill in disposable household income** is the percentage that the average (waste)water charges per property represents of the calculated household disposable income. The household disposable income is the amount of income left to a household after taxes have been paid, available for spending and saving. EBC's source for the calculation of household disposable income is Eurostat. It is calculated as the product of the mean equivalised net income (household income per adult equivalent) and the average number of adult equivalents per household.

2) **Average water charges** are calculated by dividing a company's revenues (direct revenues, residential, non-residential, or revenues from exported water), by the number of m^3 of authorized consumption, connected properties, or exported water (direct, residential or non-residential respectively).

3) **The total costs** are the sum of capital and running costs. Capital costs are defined as net interest plus depreciation, while running costs include personnel costs plus operational costs (external services, energy costs, purchased merchandises, leasing and rentals, levies and fees, exceptional earnings/losses, other operating costs).

4) **Average wastewater charges** are calculated by dividing a company's revenue (fees for collecting, transporting and treating the wastewater), by the number of properties connected to the sewer system managed by the utility (in apartment buildings, each household/property is counted separately).

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EBC

The European Benchmarking Co-operation

The EBC Foundation is a not-for-profit benchmarking initiative that facilitates water- & wastewater utilities in improving their services through benchmarking and learning from each other. EBC is structured as a foundation under Dutch law and is governed by a Board composed of representatives from DANVA, DWP (Danube Water Program), EurEau, Norsk Vann and Vewin.
EBC Foundation annually organises benchmarking exercises for water- & wastewater utilities in Europe and beyond. Next to the core programme for Western Europe, EBC facilitates regional benchmarking programmes in the Danube region in close collaboration with the local national water associations. Participation in EBC's benchmarking programme is on a voluntary basis. The programme is aligned with the IWA & AWWA benchmarking framework and applies the IWA Performance Indicator System. This provides a standard for exchange between the different programmes.

What does EBC's benchmarking programme offer?

EBC offers a learning-orientated utility improvement programme. It consists of two consecutive steps: performance assessment and performance improvement. To serve both large and small utilities, experienced and less experienced ones, EBC has developed a Performance Assessment Model with three different levels of detail: basic, standard and advanced. While at the basic level only elementary statistics and performance indicators are investigated, the advanced level offers quite detailed indicators for deeper analysis. Participants can choose the benchmarking level that matches their aspirations and availability of internal information. Five key performance areas are analysed to provide a balanced view on utilities' performance:

- Water quality
- Reliability
- Service quality
- Sustainability
- Finance & Efficiency

Next to these key areas, EBC analyses the asset management area in particular.

To secure the high-quality standard of the programme, the EBC benchmarking team and the participating utilities closely work together on data collection, data quality control and data reporting.
In the performance improvement step, utilities meet their peers in the annual benchmarking workshop where they exchange knowledge and best practices in technology, management and operations.

DANUBE WATER PROGRAM
IAWD
Smart policies, strong utilities, sustainable services

DANVA
The Danish Water and Wastewater Association

EurEau

Norsk Vann

Vewin