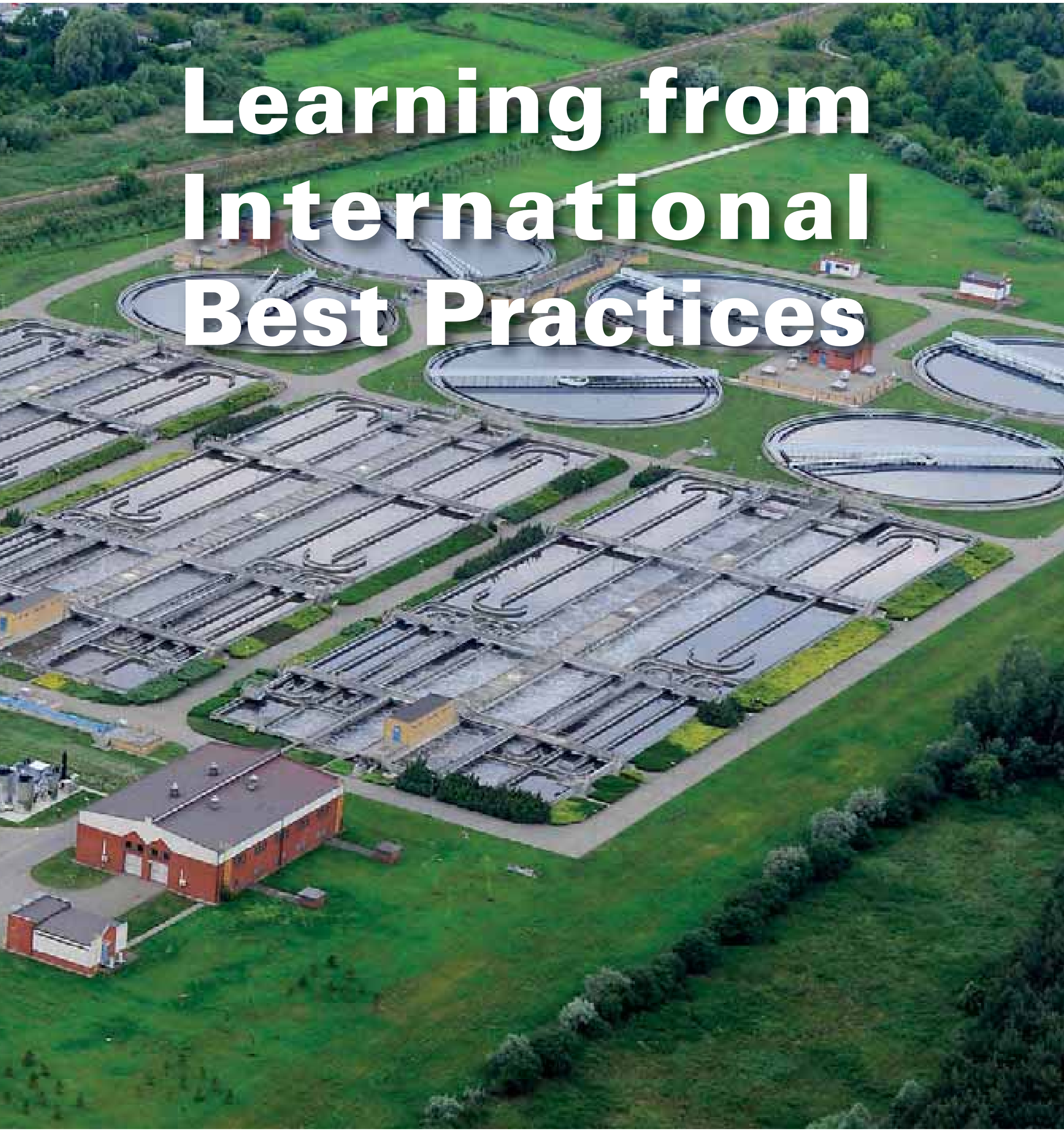
European
Benchmarking
Co-operation

Learning from International Best Practices



2016 WATER & WASTEWATER BENCHMARK

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 carbon footprint and asset management.

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.

European Benchmarking Co-operation

Learning from International Best Practices

2016 WATER & WASTEWATER BENCHMARK

Table of contents

Foreword 4

Introduction 7

Drinking water 10

Wastewater 20

Good practices snapshots 30

- **Water Services Corporation** 32
  The Smart Meters Project
- **Aarhus Vand** 36
  Transforming wastewater treatment from energy consuming to energy producing

Participants' experiences 40

- **EYDAP SA Athens Water Supply and Sewerage Company** 42
  Standard level in three months
- **Public Authority for Electricity and Water Oman** 44
  Drive efficiencies and improvements to service and asset management in the future

Endnotes 46

Colophon 48

Foreword

Toril Hofshagen
Managing director Norwegian Water (Norsk Vann)
Chair of the Board of EBC Foundation

10 years of benchmarking European water services

2016 brought the 10th edition of EBC's benchmarking exercises for European water- and wastewater utilities. It again was a vibrant year, with quite a list of positive developments. The Foundation successfully continued its Western European programme, and it again facilitated regional benchmarking programmes in the Danube region. Furthermore it extended its team, moved to a new office and introduced a brochure, a quarterly newsletter and video material as an extra outreach to current and future participants. But maybe even more important: The Foundation elaborated further on the new direction chosen last year. The focus in the Foundations' programme is not just on performance assessment, but also on improvement and innovation.

The 10th edition was a moment of celebration, but also a moment of contemplation. Where are we standing and where are we heading? The conclusion can be caught in one single sentence: After ten years, it's time to raise the bar!

New challenges for the water sector

Peter Dane, managing director of EBC, explained this main conclusion during his opening address at the annual benchmarking workshop for the Western European group: "Today, it is not enough anymore to supply safe drinking water and collect and treat wastewater in a way that it prevents problems to the environment. Stakeholders expect more from us: Utilities should be well managed, climate resilient, provide a sustainable service, contribute

to the circular economy and inform their customers in a transparent way, using modern communication technologies".
In the past year, EBC continued its effort to assist utilities in reaching these goals. To support this, EBC's benchmarking reports were slightly modified and new tools were introduced, like an overview of explanatory factors for performance differences. Also, the benchmarking platform now offers a feature to facilitate discussions and sharing good practices.

Western Europe

In 2016, 45 utilities from 20 different countries participated in the annual benchmarking exercise for Western Europe (IB2015). From 2-4 November 2016, 84 utility representatives (including delegations from the regional programmes in the Danube region) gathered in Poznań in Poland for the annual benchmarking workshop. Aquanet SA (http://www.aquanet.pl), the water- and wastewater company for the greater Poznań area, kindly offered to host and sponsor the IB2015 workshop in the fifth largest city of Poland.

The delegates participated in an open and constructive atmosphere, with a clear spirit of collaboration and taking lessons from colleagues. The workshop followed the same approach as introduced in the previous edition. The focus on improvement was supported by some very inspiring presentations of good practices by Water Services Corporation Malta on their experiences with smart metering (please find out more at page 32) and by Aarhus Vand A/S from Denmark on their project of transforming wastewater treatment from energy consuming to energy producing (please find out more at page 36).

Danube Water Program

The Danube Water Program continued its capacity building activities in the water sector in the Danube region. After the successful first pilot phase of the programme, a second phase (2016-2018) has commenced. In 2016, 45 utilities from the Danube region have been involved in utility benchmarking activities which were supported by EBC Foundation. By the end of November, the regional hub for the former Yugoslavia region organised its annual workshop in Montenegro; the Ukrainian and Bulgarian hub will follow in January/February 2017.

To embed local ownership of the benchmarking activities, EBC has developed a 'regional hub concept'. A concept, in which national utility associations, EBC Foundation and the Danube

Water Program (supported by IAWD and World Bank) joined forces. The concept has proven to be very successful and universally applicable. Therefore, EBC also offers utilities and their associations in other countries/regions who are interested in starting benchmarking- and improvement activities to collaborate through this model.

Nordic Water Cities

The Nordic Water Cities (previously the '11 cities group') formed an excellent test case for group reporting. Four Nordic utilities (re)joined the 2016 benchmarking exercise: Hofor A/S, VCS Denmark and Aarhus Vand A/S from Denmark and Sustainable Waste and Water, City of Gothenburg, Sweden. Together with Oslo Water and Sewerage Works (VAV) from Norway, participant since the beginning, 5 members of the Nordic Water Cities group are now part of the benchmarking network.

To better facilitate the discussions within the Nordic Water Cities, next to the regular company reports a specific Nordic Water Cities report has been introduced. This additional service is also available for other utility groups.

New opportunities ahead

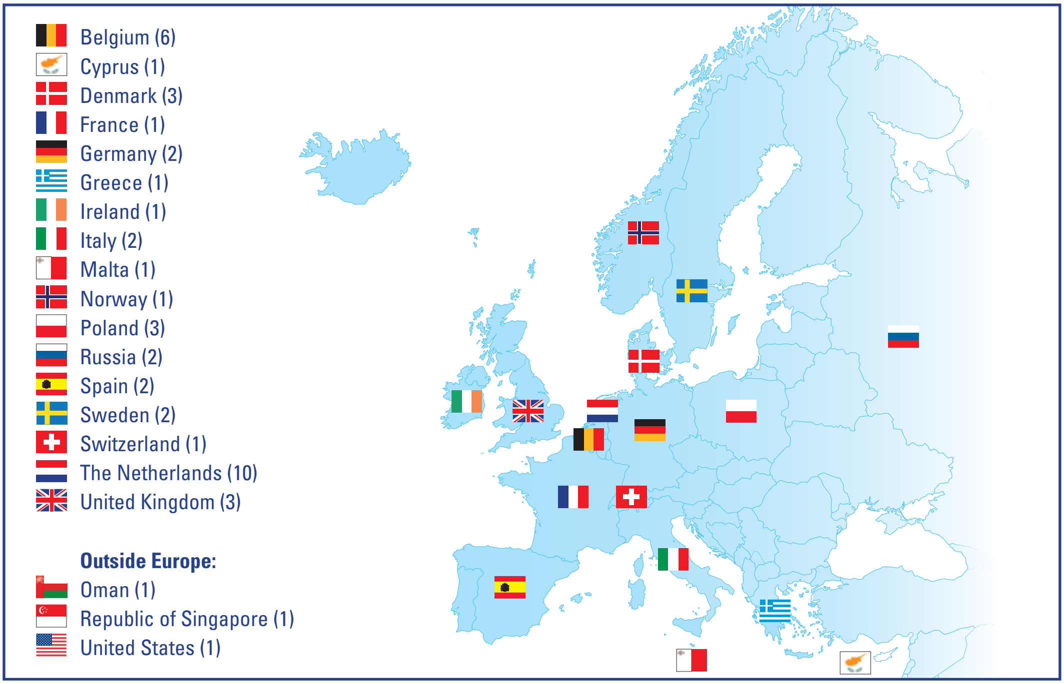
All in all it has been a fruitful year with a clear central message. The programme is now running for 10 years; years full of changes and developments, but our motto remains the same: We strive to support utilities in the continuous process of improving & innovating water services and raising transparency. Looking at all the recent developments and societal challenges ahead this becomes more important than ever; it is simply time to gear up.

EBC will continue looking for ways to better serve our participants in their efforts to improve water services. But we can only help improving when a utility becomes part of the network. Therefore, I would like to use this opportunity to invite utilities across Europe to join EBC's benchmarking programme and become part of this unique peer utility network. Together we can assess, learn and improve. Together we can raise that bar!

Introduction

Since 2007, the European Benchmarking Co-operation (EBC) operates 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 2016 EBC organised its 10th international benchmarking exercise for Western European utilities, welcoming 45 participants from 20 different countries. Three utilities are based in countries outside Europe (Oman, Singapore and the United States). The 2016 exercise processed data from 2015. The project was coordinated by EBC and supported by ABF Research in Delft, the Netherlands.



EBC offers three 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 which contribute to a high quality of the data.

The benchmarking process started early 2016 with an invitation to European water utilities to join EBC's benchmarking exercise.
The data collection started in May, using the 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. Data entry results that could not be verified by the EBC team were deleted from the dataset for the reports.

Like every year, in the 2016 benchmarking exercise improvements have been made in the set of questions and in the reporting. The definition of affordability has been further refined and several questions have been added to enable future exchanges with IBNet, the global largest database of performance information from the World Bank.

Utility representatives at the 2016 benchmarking workshop in Poznań in Poland

From 2-4 November 2016, over 84 representatives of the participating utilities and a delegation from the regional benchmarking programmes in the Danube region gathered in Poznań, Poland for EBC's annual benchmarking workshop, which was kindly hosted and co-organized by Aquanet Spólka Akcyjna, the water- and wastewater company for Poznań. The two-days event provided participants with a 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, Aquanet Spólka Akcyjna organised site visits to its Central wastewater treatment facility in Koziegłowy and the water treatment station in Mosina.

At the traditional workshop dinner, the Benchmarking Co-ordinator of the Year Award was handed to Paulina Bęcek-Cichuta (MPWIK Wroclaw) and to Lise Tarp Johansen (HOFOR). The EBC-team congratulates the winners of this year's award and encourages them to continue their good work! Right after the benchmarking workshop, participants could make the last corrections in their dataset. Final reports were distributed in December.

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 2016 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.

Service coverage

The percentage of resident population served by utilities of the current group of participants is high. Most utilities in the group serve 100% of the total resident population. The median value for the group is 100%.

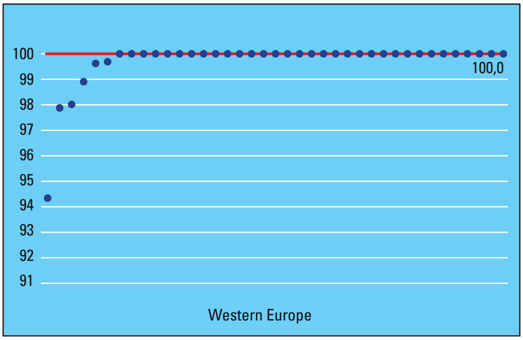


Figure 1:
Population coverage (%)

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 group. Most companies score close

to 100% and the median value is 99,94%. 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.

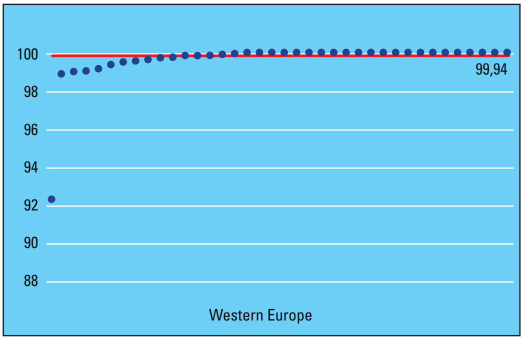


Figure 2:
Quality of supplied water (%)

Reliability

Reliability also is a key performance area for a water utility. The customers expect 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 group with values ranging from 1,4 to 91,9 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 11,6 No./100 km.

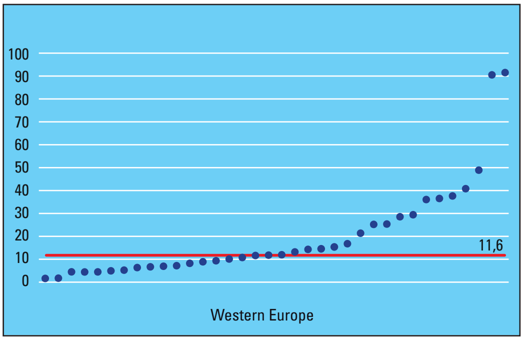


Figure 3:
Mains failures (No./100km)

In addition to mains failures the programme looks at distribution losses and (at the advanced level) at customer minutes lost. Utilities in the current group face distribution losses between 0,7 and 63 m^3 per km mains length per day. The median value for the group is 7,2 m^3/km/day. Failures may also occur without the customer noticing.

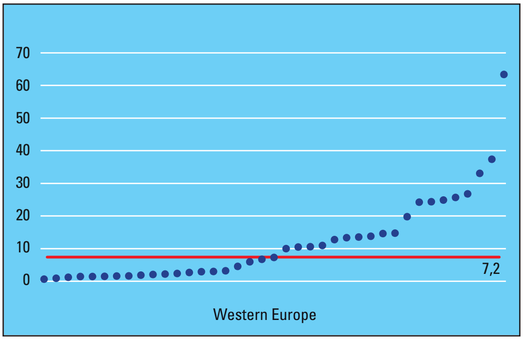


Figure 4:
Distribution losses per mains length (m^3/km/day)

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 a relevant measure for service quality. The EBC-programme 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 but not taken into account in this indicator. The majority of the current group scores very well with a median value of 0,96 complaints / 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.

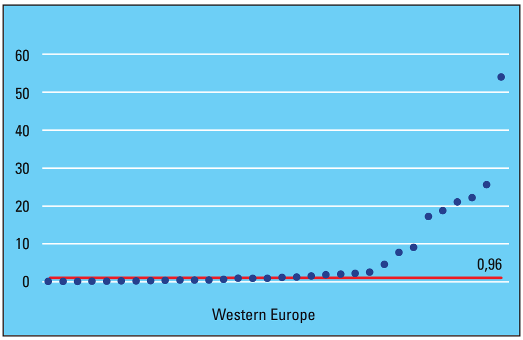


Figure 5:
Service complaints per connected property (complaints/1000 properties)

Sustainability

Sustainability is a key issue to 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 sustainability from a social, environmental and economic perspective.

Social sustainability

Water is a basic necessity, and customers usually do not have a realistic alternative 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 household consumption expenditures. In the current group of participants this ranges from 0,15% to 0,59%, with a median of 0,42%.

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, physical landscape 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 shows a median electricity usage of 0,49 kWh/m^3.

Figure 6:
Affordability based on household consumption expenditures (%)

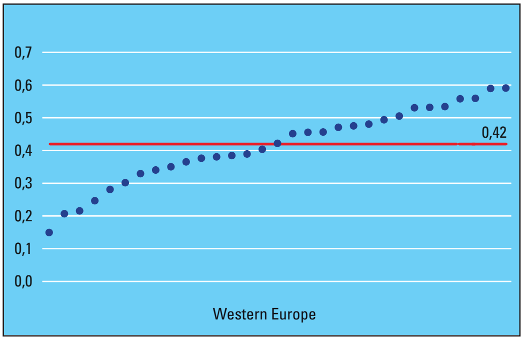
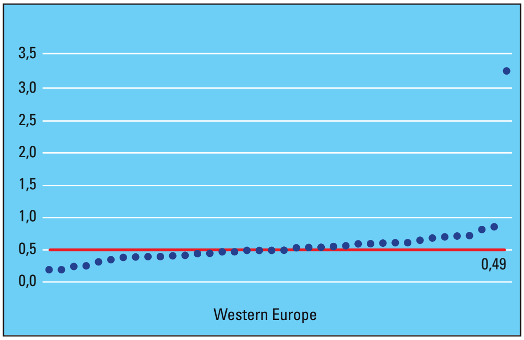


Figure 7:
Electricity use for production and distribution per m^3 water produced (kWh/m^3)



In terms of the climate footprint, scope 1, scope 2 and scope 3 indicators are analysed within the EBC programme. In the current report scope 2 is highlighted. Scope 2 emissions are emissions 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 0,01 kg till 0,39 kg CO_2-equivalent per m^3 drinking water, with a median value of 0,09 kg CO_2-eq./m^3.

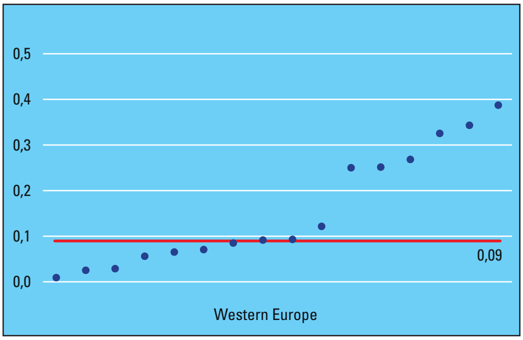


Figure 8:
Climate footprint scope 2 per m^3 direct revenue drinking water (kg CO_2-eq./m^3)

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. The condition of the infrastructure is a key element. The percentage of main rehabilitation is the share of the network that has been renovated or replaced because the condition of the mains deteriorates. Utilities renovate or replace mains to keep the network fit for future use. Higher percentages of main rehabilitation can be caused by a higher average network age. Virtually all utilities in the current group rehabilitate between 0 and 1,5% of their network. The median value is 0,57%/year.

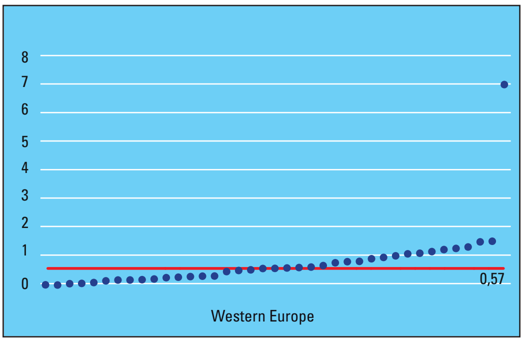


Figure 9:
Mains rehabilitation (%/year)

Economic sustainability also implies 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). This situation cannot last on the long run. The median value of the ratio for the current group is 1,05.

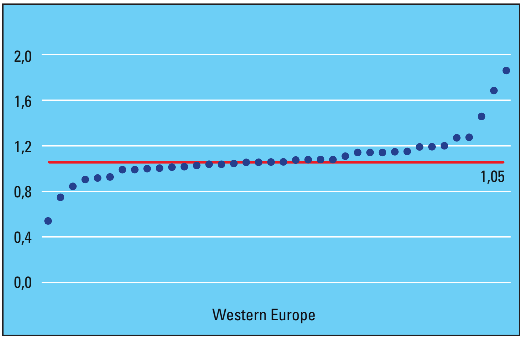


Figure 10:
Total cost by sales coverage ratio

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 group is €1,34/m^3.

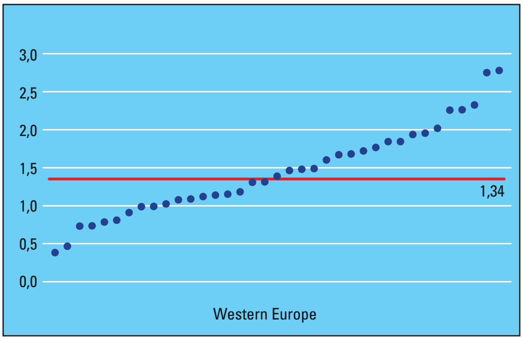


Figure 11:
Average water charges for direct consumption (€/m^3)

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. For reasons of comparability, the scores on this indicator are computed using a standard 40 hour full-time working week. In the current group the personnel intensity ranges from 0,22 to 2,07 fte per 1000 properties with a median value of 0,83 fte/1000 properties.

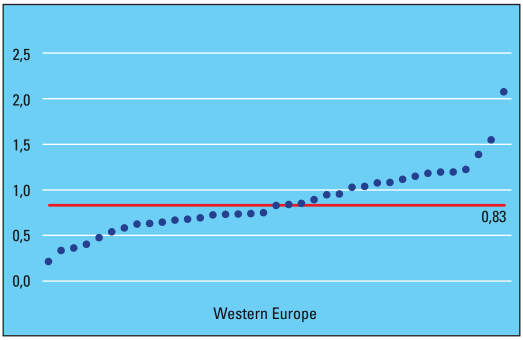


Figure 12:
Personnel intensity (fte/1000 properties)

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 2016 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.

Service coverage

The percentage of resident population in the service area of utilities in the current group that is connected to the sewer system managed by those utilities is high. The median value is 99,6%.

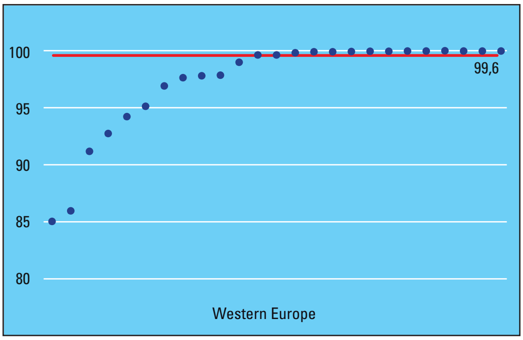


Figure 13:
Resident population connected to sewer system (%)

Wastewater quality

The wastewater (in many cases mixed with storm water) that is collected by a utility needs to be treated. The treated water needs to be in compliance with discharge consents to minimize the negative effect on the environment. These consents vary between and within countries, which means the same percentage can have different meaning for the different utilities.
The compliance within the current group is generally high with a median value of 100%.

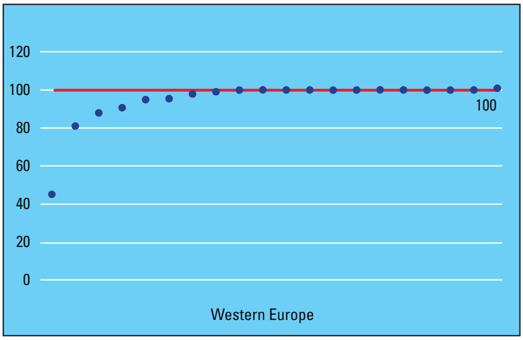


Figure 14:
Wastewater treatment plant compliance with discharge consents (%)

Reliability

To assess wastewater reliability EBC uses sewer blockages as the main indicator. These blockages include all occurrences under the company's responsibility, whether they are due to collapse, root ingress, grease or debris. Utilities within the current 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. Utilities can also reduce blockages by educating customers (especially in the case of blockages caused by grease). The results on sewage blockages vary widely within the current group between 0 and 349 blockages per 100 km sewer, per year, with a median value of 27 No./100 km sewer.

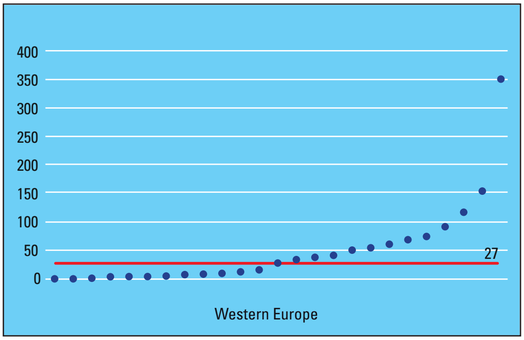


Figure 15:
Sewer and connection blockages (No./100 km sewer)

Also the number of floodings from combined sewers show large variations within the current group. The number of floodings per 100 km sewer vary for the vast majority of utilities in the current group between 0 and 18,3 with a median value of 0,5 No./100 km sewer.

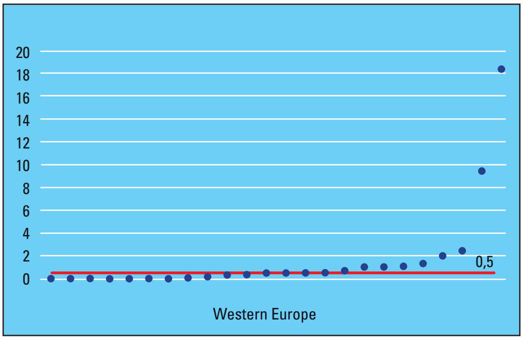


Figure 16:
Flooding from combined sewers (No./100 km sewer)

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 group scores very well with a median of 1,53 No. / 1000 inhabitants / year.
Different types of complaints are occurring in different parts 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.

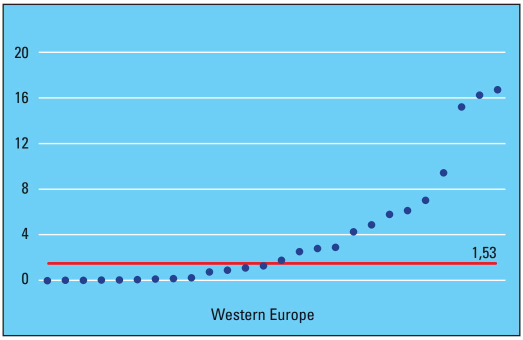


Figure 17:
Total complaints (No./1000 inhabitants/year)

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 household consumption expenditures. This measure gives a good impression of the affordability of the wastewater services, accounted for differences in wealth between nations. The group of current participants show a profound range from 0,18% to 0,82% with a median value for this indicator of 0,49%.

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 utilized 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 distributed between 17,7 kWh and 63,0 kWh per population equivalent served. The median value for the current group is 30,9 kWh / p.e. served by WWTP. The consumption of the wastewater treatment plants can differ depending on the level of treatment, which in turn depends on the local discharge consents.

Figure 18:
Affordability based on household consumption expenditures (%)

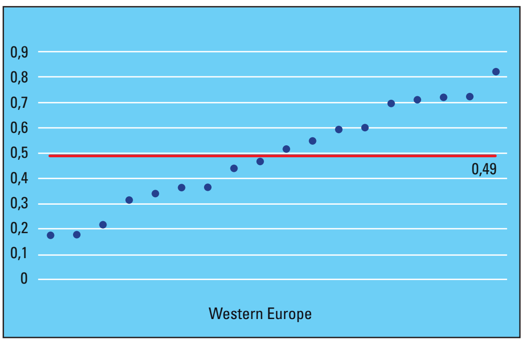
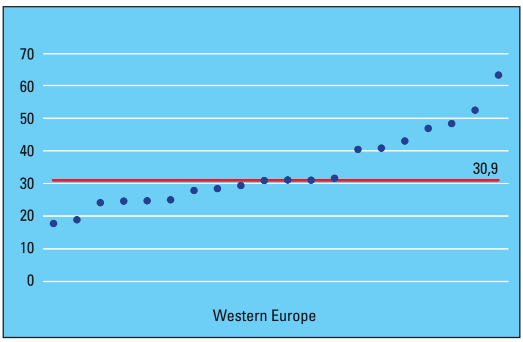


Figure 19:
Wastewater treatment plant energy consumption (kWh/p.e. served by WWTP)



In terms of the climate footprint, scope 1, scope 2 and scope 3 indicators are analysed within the EBC programme. In the current report scope 2 is highlighted. Scope 2 emissions are emissions from the generation of purchased energy for own use by the utility. Utilities in the current group report values between -11,9 and 20,2 kg CO_2-equivalent per population equivalent. The median value for the entire group is 8,3 kg CO_2-eq./p.e.

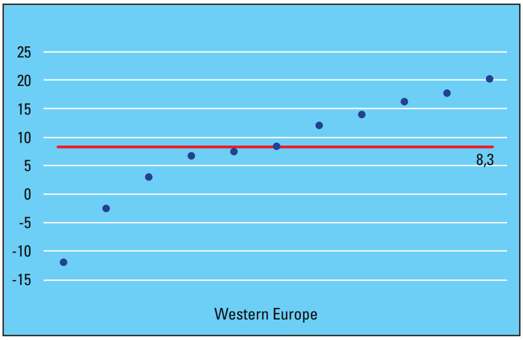


Figure 20:
Climate footprint scope 2 per population equivalent (kg CO_2-equivalent per p.e.)

Economic sustainability

Like with drinking water utilities, wastewater utilities need to make sure their activities are economically sustainable.
The percentage of sewer rehabilitation is the share of the network that has been renovated or replaced because the condition of the sewers deteriorates. Utilities renovate or replace sewers to keep the network fit for future use. Higher percentages of sewer rehabilitation can be caused by a higher average network age. The median value for sewer rehabilitation for the current group is 0,33% / year.

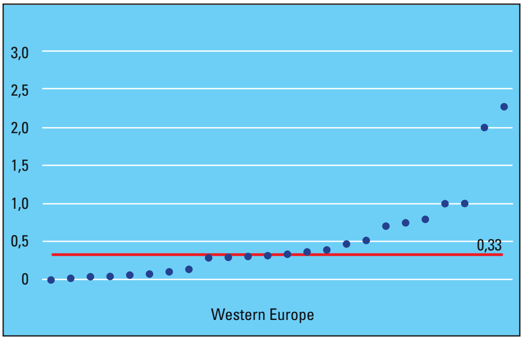


Figure 21:
Sewer rehabilitation (%/year)

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. More than half of the EBC participants score above 1, making these utilities more likely to be economically sustainable on the long run. The scores range from 0 till 3,57, with a median value of 1,03.

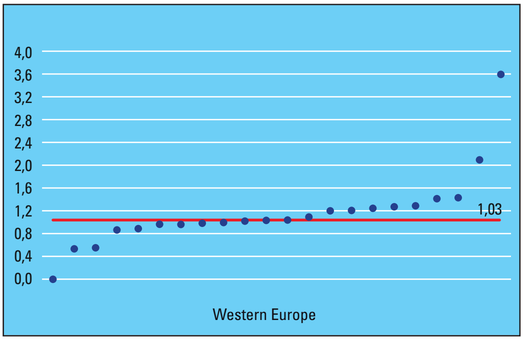


Figure 22:

Total cost service coverage ratio

Finance & Efficiency

Like with drinking water activities, 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 average of the 3 highest charges registered is over 10 times higher than the average of the three lowest (€387 versus €37 per property). The median value for the current group is €176 / property. Corrected for differences in purchasing power the gap between highest and lowest charges reduces to 5,9.
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.

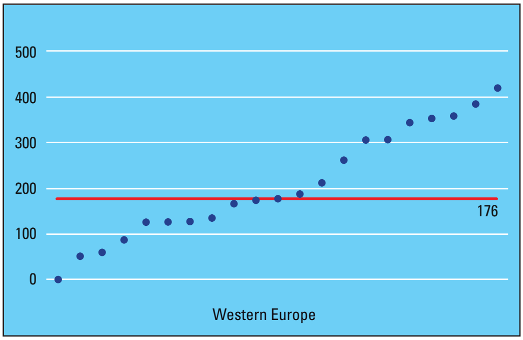


Figure 23:

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 group the personnel intensity ranges from 0,27 to 1,74 fte per 1000 properties with a median value of 0,61 fte per 1000 properties.

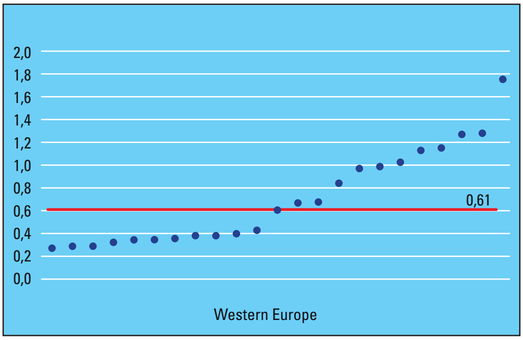


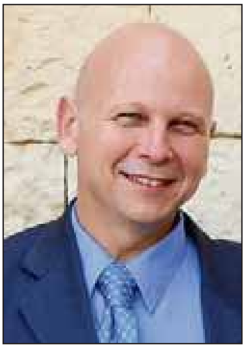
Figure 24:
Personnel intensity (fte/1000 properties)

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

Water Services Corporation
The Smart Meters Project



Stephen Galea St John
Senior Professional
Water Services Corporation

www.wsc.com.mt

Malta is an Island in the middle of the Mediterranean Sea. Enjoying a mild, dry climate and having no rivers or lakes, Malta is a very water-stressed country. The Water Services Corporation, which is the single national utility for the country, has its work cut out to ensure an adequate water supply that is not too costly.

In fact, almost 60% of Malta's water comes from desalination plants (using reverse osmosis technology). Having such a high water production cost, the utility has always favoured proper network management in order to keep water losses to a bare minimum. Whilst it has made huge strides to curb real losses over the past years, the WSC has also looked at ways to manage apparent losses. These are significantly high in Malta mostly because residents use indirect plumbing systems, which lead to low flows and consequently heavy meter under-registration.

A few years ago, in its endeavours to manage water losses, the WSC took up an ambitious project which included the installation of an Advanced Meter Management system (AMM) that caters for all its 260.000 customers. This fixed-network Smart Meters solution, provided by Suez Smart Solutions, France, is based on radio frequency technology. An RF transmitter module is fixed on existing meters having a pulse output. These modules regularly transmit data from the meters (pulse count) via RF to concentrators (VHF receivers) installed over the Maltese Islands. These receivers, which produce blanket reception over the country, in turn forward the data to base via GPRS. Hourly readings for each meter are registered.

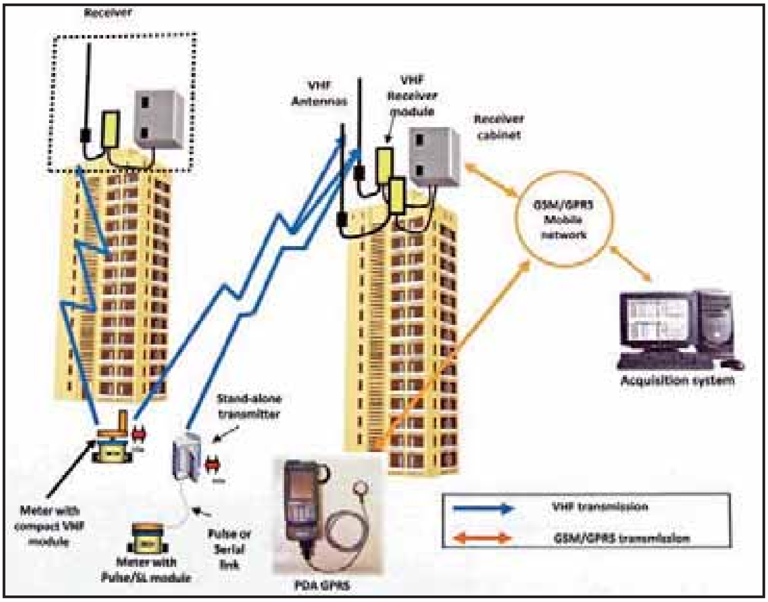


Figure 1: Smart Meters Project Architecture

The Smart Meters project started with the setting up of the receiver layer, consisting of around 250 VHF receivers strategically located all over Malta. Once these were installed, a sort of 'plug and play' scenario developed, as these gateways could now receive data from any dedicated RF transmitters (AMM modules) installed anywhere on the Island. The roll-out of fitting and initialising such transmitters on customers' water meters followed, until almost 90% of these meters now have an AMM module installed. The remaining meters are mostly found in vacant or unused premises, meaning that for all intents and purposes, the roll-out is practically ready.

Although the most obvious benefit of such a system is the automation of the customer billing process, also reducing the need to send persons on site to read the customer meters, there are other notable advantages of having Smart Meters. One such benefit is a new service that has proved to be very popular with WSC customers. This is the ability to detect leaks on the customer side. The availability of hourly readings means that water consumption can be profiled and an early warning for potential leaks is immediately sent to the customers in question, who can then perform the necessary repairs on their plumbing systems. This results in limiting expensive water bills for the customers concerned.

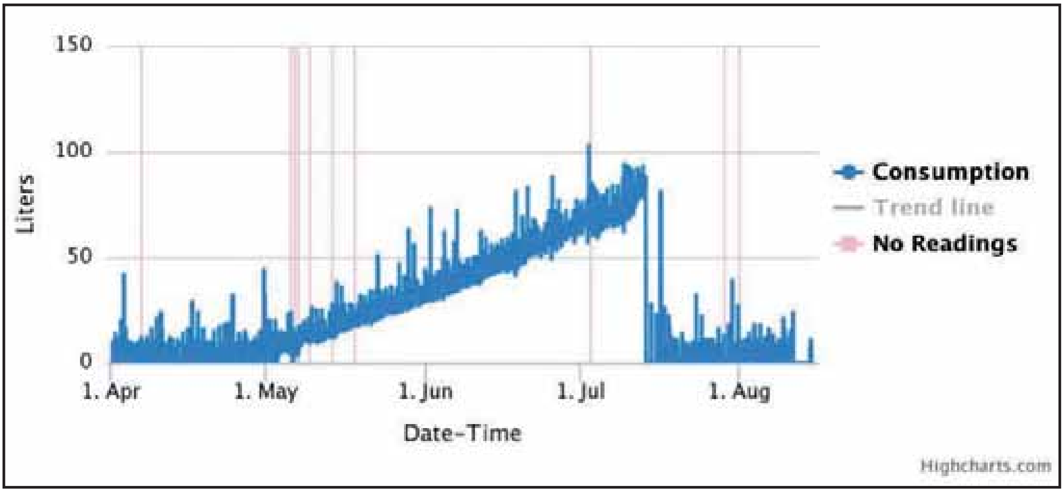


Figure 2: Customer water consumption hourly profile showing internal leak, which was subsequently fixed.

For the water engineer, the most obvious benefit of Smart Meters is the ability to conduct water accounting exercises on an almost real-time basis. Now the possibility of accurately using the more popular top-down measurement of leakage is achievable. Whilst before the Smart Meters project, the availability of customer meter readings and therefore the billed authorised consumption component of the water balance was neither timely nor in sync, this tool now made this feasible.

To compute a top-down water balance on a particular District Metered Area (DMA), all the meters within that DMA, including the DMA meter itself must be on AMM. Once the period for the balance is decided upon, then it is a simple matter of comparing the flow that passed through the DMA meter in that period (i.e. the System Input Volume or SIV) to the sum of all the customer consumptions within that DMA, over that same period. The difference between these two values is the non-revenue water component of that DMA.

Once the Smart Meters roll-out for a particular DMA was concluded, the WSC could attempt such a balance. The software application that was first used was very basic – essentially showing the overall consumption for the zone meter and each individual revenue meter and the difference between them. Whilst this is enough to run a balance, there is certainly other useful information that can be retrieved.

Hourly readings from 260.000 meters is a lot of data and this can be overwhelming unless properly managed. Following the early days of the Smart Meters project, the WSC's IT team has integrated data from the Smart Meters to a GIS platform and the result is far more informative and detailed. Now, the DMA water balance can be made on an hourly basis, rather than simply over the entire period. More information, such as meter reachability, is also available hourly, as are the meters that are stopped or not registering consumption. With such added detail, one can perform better analysis and interpretation of what is happening in the DMA. For example, looking at the variance on an hourly basis will give an indication of the type of loss, i.e. whether it is real or apparent, whether there are stopped or faulty customer meters, whether there is systematic illegal consumption, etc.

It must be emphasised that Smart Meters can never be a solution for meter under-registration. AMM will only report what the meter is measuring, no more, no less. However, at least, with such a system in place, readings are available immediately and in sync with each other and with the respective DMA meters. All this is helping the WSC to focus its resources on where there are the larger gains and this project will help it to better manage its apparent losses and achieve similar good results as with its real loss control programme.

Figure 3: AMM data integrated with GIS to compile a DMA water balance

Good practices snapshots 2

Aarhus Vand
Transforming wastewater treatment from energy consuming to energy producing


Henrik Frier
Head of department for service and maintenance at Aarhus Vand

Søren Larsen
Economic consultant at Aarhus Vand

www.aarhusvand.dk

In Aarhus wastewater is no longer a waste product; it is a source of green energy. Marselisborg Wastewater Treatment Plant has been transformed from an energy consumer to an energy producing plant. Production of energy from wastewater is no new invention. However, it is new that a wastewater treatment plant can produce as much as 150 - 160% energy based on normal household wastewater.

The wastewater treatment plant produces enough energy to cover all the energy used for the whole water cycle in the catchment area, from water production, water distribution over wastewater pumping to wastewater treatment. Water and wastewater facilities are usually big energy consumers. Typically water and wastewater treatment processes account for 25-40% of the municipality's electricity bill - energy that can be saved and money that can be freed up and put to better use elsewhere. The answer lies in understanding that the technology and knowledge is available to make water-management systems energy neutral.

Our Marselisborg Wastewater Treatment Plant (220.000 p.e.) has increased plant efficiency and reduced energy consumption by optimizing all its processes. The plant produces in 2016 app. 40% more electricity than it needs and 2,5 GW of heat for the district heating system without adding external organic waste or carbon. This excess energy is enough to serve the needs of the drinking water supply and wastewater treatment facilities in the entire catchment area of the plant.

Over the past five years Aarhus Vand has put great focus on energy savings and energy production. At Marselisborg Wastewater Treatment Plant we have implemented energy-saving technologies such as an advanced SCADA control system with on-line sensors, frequency drives, a new turbo compressor, sludge liquor treatment based on the anammox process, as well as optimized the fine bubble aeration system. This has resulted in a reduction in power consumption of app. 1 GWh/year which corresponds to about 25% in total savings.

During the same time period, the energy production has been improved through implementation of new energy efficient biogas engines (CHP), resulting in an increase in electricity production of approximately 1 GWh/year. Furthermore, a new heat exchanger has been installed with the aim of selling surplus heat to the district heating grid, which represents app. 2,2 GWh/year.

In 2015, Marselisborg Waste Water Treatment Plant had a total energy production of 9,6 GWh/year and an energy consumption of 6,3 GWh/year, equivalent to a net energy production of 153%. For electricity alone the production was 4,6 GWh/year and the consumption was 3,5 GWh/year, equivalent to a net electricity production of 131%. In total the installed technologies have a payback time of less than 5 years.

In Denmark tariffs for electricity are high. Aarhus Vand pays app. €0,1 /kWh excl. VAT. Producers of sustainable electricity can connect to the power grid covering the entire country of Denmark and produced electricity is sold for a guaranteed tariff of app. €0,15/kWh (including subsidies from the government for delivering ‘green’ electricity).

The Marselisborg Wastewater Treatment Plant in Aarhus, Denmark

Most cities in Denmark has a district heating grid enabling us to deliver surplus heat from the wastewater treatment plant to houses in Aarhus. The surplus heat is sold for a tariff of app. €0,02/kWh. The Danish government also claims a tax on the effluents from wastewater treatment plants. The taxes are:

Parameter	**€/kg**
Total Nitrogen	2,68
Total Phosphorus	14,80
BOD_5	1,48

Because of this tax we have an incentive to treat the wastewater better than required. On the other hand intensified treatment cost a lot of energy, mainly for aeration purposes in the biological processes.
The optimization task at the wastewater treatment plant has been – at the same time – to reduce electricity consumption and wastewater taxes and to increase electricity production and utilize surplus heat for district heating of houses. Total list of initiatives and their financial impacts:

Activity	**Investment €**	**Savings & sales €/year**
Process optimization	400.000	175.000
Improved aeration	250.000	26.000
Sludge liquor treatment	400.000	84.500
Peplacement of old gas engines	1.271.000	154.000
New gas engine and gas treatment	430.000	139.000
Surplus heat for district heating	166.000	33.000
Total	**2.917.000**	**611.500**

The return of investment (ROI) is 4,8 years.

In Aarhus Vand the total yearly budget for operational expenditures (OPEX) for wastewater treatment is app. €9,9 million. Transforming wastewater treatment from energy consuming to energy producing at Marselisborg Waste Water Treatment Plant has in fact reduced our total OPEX with 6,2% and sustainability goes hand in hand with financial efficiency.

Aarhus Vand has a strategy for recovery of resources. Our goal is to be energy neutral for both drinking water and wastewater by 2025. In Denmark drinking water = ground water. The country is flat as a pancake and the drinking water sector is net energy consuming. Our task is to recover as much energy from the wastewater as possible to make the entire company net energy producing.

At this moment we are designing and constructing our Egaa Waste Water Treatment Plant (120.000 p.e.) to be 150% energy producing. Before 2025 our Viby (83.000 p.e.) and Aaby (84.000 p.e.) Waste Water Treatment Plants will close and the wastewaterwill be treated at a new Marselisborg Waste Water Treatment Plant based on energy efficient processes and energy producing technologies.

The case of Marselisborg Waste Water Treatment Plant and Aarhus Vand has been internationally recognized in several media:

http://www.energylivenews.com/2016/11/28/energy-neutral-wastewater-management-at-danish-city

https://stateofgreen.com/en/profiles/aarhus-water-ltd/solutions/marselisborg-wwtp-energy-neutral-water-management

http://cphpost.dk/news/danish-wastewater-plant-garners-international-recognition.html

PARTICIPANTS EXPERIENCES

Participants' experiences

EYDAP SA Athens Water Supply and Sewerage Company
Standard level in three months

Dr Katerina Konstantopoulou,
Chemical Engineer, PhD,
Deputy Director of Coordination
and Control, EYDAP S.A

http://www.eydap.gr

EYDAP was founded in 1980 after the merge of the incumbent water supplier in Athens and Piraeus 'Hellenic Water Company' (EEY S.A., founded in 1927) and the 'Greater Athens Sewerage Organization' (OAP S.A., founded in 1950). EYDAP's area of service is the greater metropolitan area of Athens, extending almost to the entire Region of Attica.

EYDAP is the largest company of its kind in Greece and the 7th among IB2015 participants in water and SE/WWTP customers. With 9.000 km water pipelines and 8.300 km of sewers, EYDAP has 4 WTPs of 1.800.000 m^3/d total nominal capacity and 4 WWTPs of 6.217.000 p.e. design capacity. Today EYDAP's personnel numbers 2.200 employees.
In 1999, all of EYDAP's assets regarding raw water collection and transport to WTPs were transferred to the company 'EYDAP Assets', thus remaining the property of the Greek State. Since then, formally EYDAP has undertaken the role of maintenance and operation contractor for 'EYDAP Assets' in raw water's collection and transport. All assets regarding the WTPs, the DW network, the WW network and the WWTPs belong to EYDAP S.A.
In January 2000, EYDAP S.A. was listed on the Main Market of the Athens Stock Exchange with the Greek State as major shareholder. Due to the above the company has to keep track of performance indicators. There have been various attempts to this direction over the years, mostly based on a series of selected IWA indicators which were considered as appropriate for EYDAP's case. In 2013 EYDAP participated for the first time in EBC's IB2012 exercise, at the basic level.

In April 2016 EYDAP decided once again to participate in EBC's IB2015 exercise, at the standard level. Within a short period of 3 months (closing date for data entry in mid July 2016) without previous notice or preparation EYDAP's Divisions managed to respond to the pressure of collecting – on time and on such a short notice – the requested primary data, giving their best to translate and interpret all EBC's definitions and clarifications to numbers.

EYDAP's participation in IB2015 was a valuable experience, starting from the early stage of the extended collection and registration of various technical and financial parameters. There has been confirmation of issues such as structural deficiencies (overlapping responsibilities between departments) and lack of specific technical tools (DMAs). Positive matters were also confirmed, such as the effectiveness of the Finance Division, the achievement of low electricity consumption with high energy recovery etc.

This is the first year of EYDAP's participation at the standard level and therefore there is a lack of data for the previous years to be compared to. In addition, when evaluating EYDAP's position, the Greek financial crisis must also be taken into account. The crisis is reflected in a series of parameters such as the numerous billing complaints (which are inconsistent to the calculated affordability of the drinking water and wastewater bill), the low level of replacement investments and inspection of mains and sewer etc.

Overall, IB2015 was an excellent opportunity for EYDAP to underline its pros and cons and to make a 'to-do' list of priorities, within the framework of Greece's financial situation. It is also the beginning of a longer term cooperation with EBC, aiming to improve EYDAP's performance and to achieve greener PIs every year.

Participants' experiences

Public Authority for Electricity and Water Oman
Drive efficiencies and improvements

Saleh Nasser Al Rumhi
GM Policies & Strategies PAEW

www.paew.gov.om

The Public Authority for Water and Electricity in Oman (PAEW) was established by Royal Decree in 2007 to secure the supply of drinking water for the population of Oman. PAEW supplies drinking water to the majority of The Sultanate of Oman.

In 2015 PAEW had over 400.000 active customer connections with a piped supply of drinking water which equates to 64% of the population in PAEWs area of supply. PAEW also provided over 25 million m^3 of water through tankers to customers not connected to the piped network. The Sultanate of Oman relies heavily on desalination of water for the majority of supplies with around 80% being derived from desalination plants, the remaining 20% being sourced from groundwater via wells. There is a large ongoing capital programme to extend the coverage of the network and increase the number of customers receiving a piped supply of water which has resulted in a growth in customer numbers of around 10% a year over the last few years.

PAEW is seeking to be a world class utility and believes that the European Benchmarking Co-operation (EBC) provides access to resources and data that can assist PAEW in achieving this goal. PAEW decided to join EBC as it offered the combination of access to a robust and consistent data set for benchmarking combined with the annual workshop which affords the opportunity to network and share ideas as well as understanding the story behind the data. Participation in the EBC will enable PAEW to identify areas where improvements can be

made across all areas of the business. As part of our ongoing performance improvement programme PAEW will identify key areas of the business where the data indicates there is significant scope for improvements. To gain full benefit from the exercise PAEW believes that the managers who deliver the service for customers should be involved in the benchmarking exercise and not just the team who provide the data to the project.

This is the first year PAEW have participated in EBC however we are hopeful that through fully engaging in the process and by involving employees who are responsible for delivering for our customers we will be able to drive efficiencies and improvements to service and asset management in the future.

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).

Colophon

EBC Foundation
Koninginnegracht 19
2514 AB Den Haag
The Netherlands
Tel. +31 (0)70 205 78 30
www.waterbenchmark.org

Contact
info@waterbenchmark.org

Photo's
Aquanet Spólka Akcyjna, Poland: p.10 & 20
Water Services Corporation, Malta: p.30

Printer
De Swart
The Hague, The Netherlands

Design
studio@arnogeels.nl (The Hague)

December 2016

Participants 2016 exercise

Belgium
- VIVAQUA
- De Watergroep
- Aquafin NV
- Société Wallonne des Eaux
- IECBW scrl
- HYDROBRU

Cyprus
- Water Board of Lemesos

Denmark
- VCS Denmark
- HOFOR A/S
- Aarhus Vand A/S

France
- Service public de l'eau Eau de Paris

Germany
- Hamburg Wasser
- hanseWasser Bremen GmbH

Greece
- EYDAP SA Athens Water Supply and Sewerage Company

Ireland
- Irish Water

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

Malta
- Water Services Corporation

Norway
- City of Oslo, Water and Sewerage Works

Oman
- Public Authority for Electricity and Water Oman

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

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

Singapore
- Public Utility Board

Spain
- 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)
- Sustainable Waste and Water, City of Gothenburg

Switzerland
- Services Industriels de Genève

The Netherlands
- Brabant Water N.V.
- Evides Waterbedrijf N.V.
- 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
- Severn Trent Water Limited
- Yorkshire Water

United States
- Charleston Water System

Cover photo: Aquanet Spólka Akcyjna, Poland

EBC 2016 Water & Wastewater Benchmark

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

DANVA
The Danish Water and Wastewater Association

EurEau

Norsk Vann

Vewin