



# **Benchmarking in the wastewater sector – taking stock**

Expanded reprint of a two part paper on objectives, results and success factors  
of more than 15 years of benchmarking in the German wastewater sector

# Benchmarking in the wastewater sector – taking stock

Kay Möller, Filip Bertzbach (Hamburg), Sabine Nothhaft (Munich), Peter Waidelich (Cologne) und Andreas Schulz (Essen)

## Summary

*Benchmarking works. The actual objective – going beyond the performance assessment and information of the public – is the performance improvement. Benchmarking is an individual process in the course of which confidential information also is exchanged between the partners. This is one of the reasons for the effectiveness of the method and it explains why the project results are reported on reluctantly. The study presented below documents the successes of the 15 years of benchmarking practice by means of concrete examples. The*

*optimised performance characteristics and actually achieved savings are itemised with the help of selected key performance indicators. In addition, factors of success of the benchmarking according to the set of rules and standards are confirmed and the further development of the methodical tool is illustrated. The application of the method can in the meantime, through the achieved successes, far more than make up for the outlay on participation for the wastewater utilities.*

## 1 Introduction

Since 1996 water utilities have been voluntarily using benchmarking as optimising tool [1, 2, 3, 4]. In the meantime, over 600 wastewater operators have carried out projects with aquabench GmbH alone, of which numerous ones are repeated regularly, and in the process have collected experiences at different levels using the tool. Nevertheless, doubts are repeatedly expressed about the uses of benchmarking. For example, in water supply “the success of the benchmarking is not measurable” and “is not well-received by customers” [5].

The effectiveness of benchmarking is to be demonstrated by means of the following questions:

1. What are the objectives of the benchmarking?  
How do national and international sets of rules and standards define these objectives? How are current discussions about a methodical further development to be integrated?
2. What, related to its objectives, has benchmarking effected? Can the results of benchmarking be integrated? Are there figures on the economic and technical successes of benchmarking available, which are capable of being generalised and are plausible? Where does benchmarking additionally take effect?
3. How and under what conditions does benchmarking function? What are the most important experiences from the 15 years of benchmarking practice? What are the success factors?

The point for the authors is to remember the original idea of benchmarking as a tool for performance improvement, to apply the tool and to further develop it. In the current discussion on methodical approaches a better performance assessment and the transparency towards politics and the public are at the focal point. The central objective of the benchmarking, the performance improvement and the improvement of the perception of the tasks here drop increasingly into the background. Nevertheless, the question remains: How does benchmarking support the perception of tasks and the performance improvement in wastewater disposal?

## 2 Aims of the benchmarking: performance assessment, performance improvement and information of the public

Both the national specialist associations and an international expert group of the International Water Association (IWA) define performance improvement as the aim of a benchmarking project.

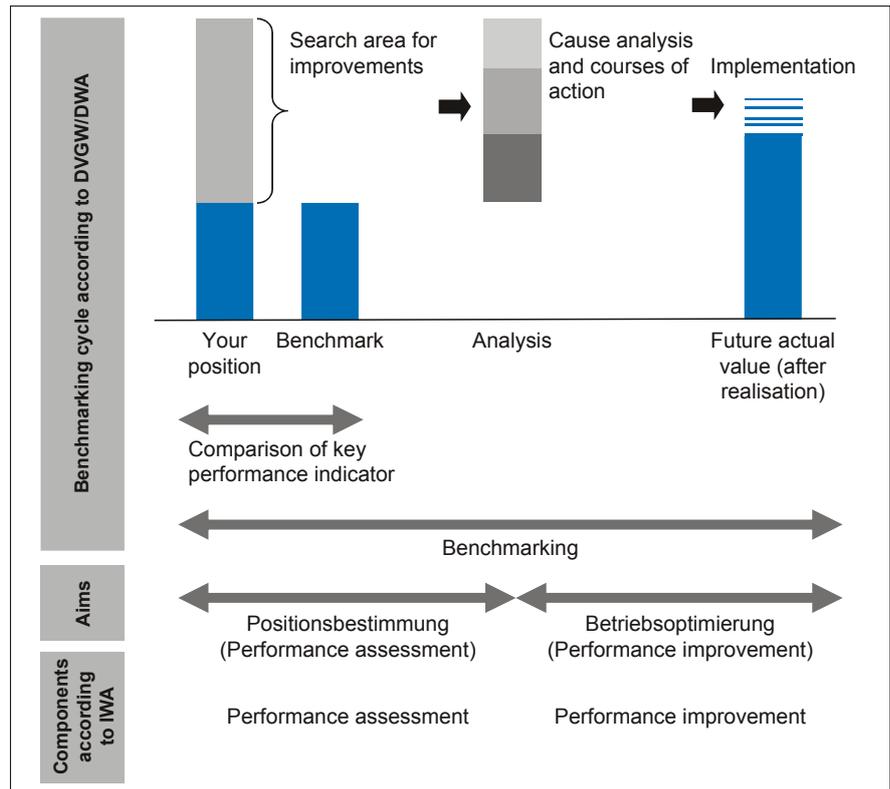
The German set of rules and standards defines benchmarking as “Tool for the optimisation of the technical and commercial processes” and describes it as “systematic and continuous (rotative) process for the identification, becoming acquainted with and adoption of methods and processes of benchmarking partners” [6]. The IWA expert group defines comparably:

“benchmarking is a tool for performance improvement through systematic search for and adaption of leading practices” [7]. The picture of the benchmarking cycle of DVGW/DWA illustrates this idea: at the end of the process new strategies should lead to future improved performances – recognisable by changed performance figures (Figure 1).

A higher level of performance and the performance improvement are not aimed solely at economic improvement. Along with economic efficiency in the well-known “Five Pillar Model” Quality, Security of supply and treatment, Customer Satisfaction and Sustainability are defined as performance areas, whose optimisation is also an objective. In addition, benchmarking can support the individual information of the decision-making bodies in-house.

Independent of this the experts are in agreement, that also the performance assessment is an important component of a benchmarking project [8]. “Benchmarking initiates, over and beyond the performance assessment, a systematic learning of respectively the best.” [6] The IWA experts describe the performance assessment almost identically as one of the “components” of a benchmarking project preceding the performance improvement: “... performance assessment and performance improvement should be considered consecutive components of benchmarking”. In Figure 1 the components are integrated schematically in the benchmarking cycle. A meaningful performance assessment goes well beyond a key performance comparison and is achieved already as a first result in the evaluation and analysis phase of a benchmarking project.

The performance assessment is the first step in the time sequence. It can be significantly supported by a central external project moderator. Important fundamentals and prerequisites are created for this performance assessment alone through the provision of clear survey documents and explicit definitions, through the quality control of the data as well as through a sensible and meaningful presentation of key performance figures and reporting.



**Figure 1: Benchmarking cycle according to [6] and the aims performance assessment and performance improvement as well as the components of benchmarking according to the IWA [7]**

To this is added a further aspect of the use of benchmarking: with the requirements on the provision of information within the scope of the EU Water Framework Directive and the discussion about prices in water supply, the requirements on the sector also increase. A meaningful performance assessment within the scope of a benchmarking project can be used for the information needs of politics, the public and companies and also has found entry into the joint declaration of the German associations of the water sector on the use of benchmarking in the sector from 2005 [9]. Benchmarking thus also supports the outward transparency of the performance of services. This takes place in the form of public reports on the benchmarking projects of the German Federal States or in the profile of the German water industry, from individual sustainability reports or through the current linking of benchmarking with the transparent presentation of charges and prices as currently carried out in Rheinland-Pfalz. In this respect it is not surprising, that also

the public discussion on benchmarking, places the aspect of the performance assessment right at the forefront.

With this background, work is currently being carried out using various approaches to the improvement of the performance assessment and performance comparison and the therefrom derivable information for the public:

- A sensible clustering and taking into account of the context information is already required in the technical advisory leaflet M-1100E [6]. This is followed by proposals for the individual systematic clustering of utilities depending on context information [10, 11], for the application of economic processes for the quantifying of efficiencies [12] or for scientific structuring and justification of the influence of context information [13, 14].
- The German Federal Ministry for the Environment, Nature Conservancy and Reactor Safety

is carrying out a research project in order to improve transparency of environment and resource costs as well as the efforts for sustainability of the sector within the scope of benchmarking projects [15, 16].

- The DWA Working Group WI-1.2 “Benchmarking, Balanced Scorecard/New Control Tools”, in the latest report, has published „Hinweise zur Analyse von (Unternehmens-) Kennzahlen aus Benchmarking-Projekten” [“Information on the analysis of (company) key performance figures from benchmarking projects“], which generally can support performance assessment [17].

All the above named approaches can contribute to the performance improvement but, in the first instance, target a meaningful performance assessment of the company. With all methodical discussions, however - ultimately in the interest of the citizens – the central question should continue to be: How does benchmarking support the perception of tasks and the performance improvement in wastewater disposal?

### 3 Effect of the benchmarking

#### 3.1 Methodical approach

The results below have been derived from benchmarking projects carried out over many years, in which only the companies participating continuously in the study have been included. In addition to the statements which refer not only to key performance indicator progressions, but also to actual modifications of the operating practice, interviews have been carried out with shareholders of aquabench and with five further companies in order to verify the influence of the benchmarking.

In water industry practice it is differentiated between the detailed investigation of individual processes (process benchmarking) and the comprehensive investigation of complete companies (corporate benchmarking). In special projects at the level of German federal states (so-called “state projects“), as a rule supported by the specialist associations of the water industry and, in part, also by ministries and municipal umbrella associations, the investigation of the company level is at the focal point (comp. also Chapter 4.4).

Table 1 gives an overview of the projects included in the present study, their project run time and number of participants.

Sought are those successes from benchmarking projects, which are palpably documentable. As successes of a benchmarking project are evaluated in the following improvements of the key performance indicators economic efficiency, security of supply and treatment, quality, customer orientation and sustainability related to a participant or to a benchmarking object. The result is presented in two ways: first as part of a positive overall development of a company or a process (Chapter 3.2) and, second, in the form of individual examples (Chapter 3.3). From the individual examples there results a picture of the measurable momentary contributions of the benchmarking and the different starting points, known as “optimising fields” (Table 2, Chapter 3.3.1).

Furthermore, it is to be noted, that not all successes are measurable in the sense of “immediately quantifiable”. Many participants stress the estimable value of the formation of networks resulting through benchmarking and the structured key performance indicator-based exchange of experience or the motivation of the members of staff involved triggered through the learning process. These incontestable “soft” effects of the benchmarking are not described below. They are, however, to be seen as characteristic component part of the benchmarking method and help to achieve the objective of a project.

Project	since	Period of consideration	Number of participants
State projects at corporate level	2005	2006 – 2010	> 600
Corporate benchmarking	2002	2004 – 2010	30
Sewer operation process benchmarking	1999	1999 – 2010	62
Wastewater treatment plant Benchmarking process benchmarking	1996	2002 – 2010	> 200*
Laboratory Benchmarking process benchmarking	2005	2006 – 2010	13
Indirect discharger monitoring process benchmarking	2005	2006 – 2010	15
Sewer construction Benchmarking process benchmarking	1998	2003 – 2010	24
Material management Benchmarking process benchmarking	1998	2002 – 2010	23

\* As opposed to other projects here it is not the number of companies mentioned but rather the WWTPs.

**Table 1: Projects included in the study**

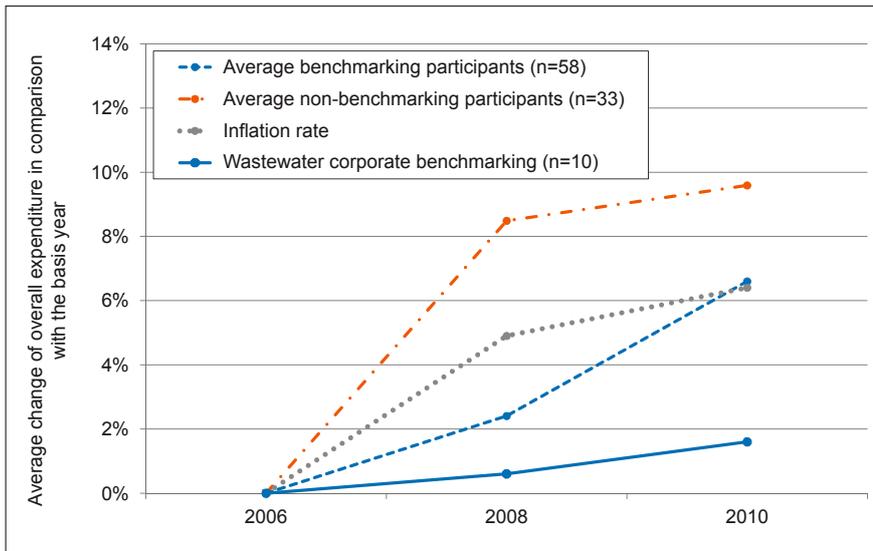


Figure 2: Development of the total expenditure for wastewater disposal 2006 - 2010

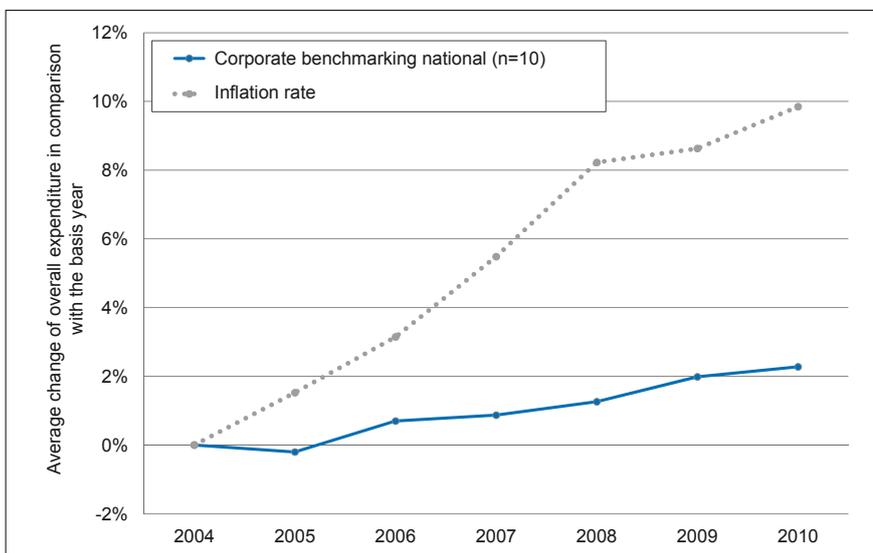


Figure 3: Development of the total expenditure for wastewater disposal 2004 - 2010

### 3.2 Benchmarking participants demonstrate favourable cost developments

Benchmarking participants work actively for a favourable cost development and thus for stability of charges. As evidence for this the development of the total expenditure for wastewater disposal for benchmarking participants (including state projects) and for benchmarking non-participants are compared in Figure 2. Development is basically dependent on the random sample and the starting year of the examination. The tendency is, however, similar

in all subsequent examples. The data of the benchmarking non-participants are taken from the DWA economic data survey. The mean value of the benchmarking participants results from 58 continuously participating companies, the mean value of the benchmarking non-participants from 33 data sets. For the period under consideration it shows that the outlay of the benchmarking participants is at a comparable level to the inflation rate [18] and lies below the outlay of the comparison group. A comparison of the individual values shows that the stronger increase in the benchmarking participants from 2008 to 2010 is

accounted for by the stronger increase in costs. So with 59 % of the benchmarking participants the total expenditure in this period has actually declined. Thus the majority of the participants in benchmarking projects indicate a favourable development.

If the circle of the benchmarking participants is reduced to the companies which take part not only in state projects but also in continuous corporate benchmarking wastewater, the development of the overall expenditure can be considered over a longer period and is even more positive (Figure 3).

The wastewater corporate benchmarking in its current form has existed since 2004 and continuous and complete data sets are available for 10 operators. The average total expenditure of these long-term participants, who are also participants of various process benchmarking projects, has in the past six years increased overall by 2.3 % only. In comparison to this the inflation rate for this period lies at 9.8 %.

In the process benchmarking projects the positive developments can also be substantiated. The average development of the total expenditure (operating expenditure plus capital expenditure for equipment) of the participants of sewer operation process benchmarking is shown in Figure 4.

The sewer operation process benchmarking in its current form has been in existence since 2002 and continuous and complete data sets are available for 11 operators. The average change of the total expenditure of the companies in the last eight years lies at 5.8 %, while the inflation rate in the same period has risen by 12.8 %.

The positive development for the wastewater treatment plant process benchmarking also can be documented. The project in its current form has been carried out since 2004. Many companies take part using alternating wastewater treatment plants. In order to be able to present a resilient temporal development, the data sets should be taken into account only from wastewater treatment plants which, within the period of consideration, have delivered no data for a maximum of one year. From more

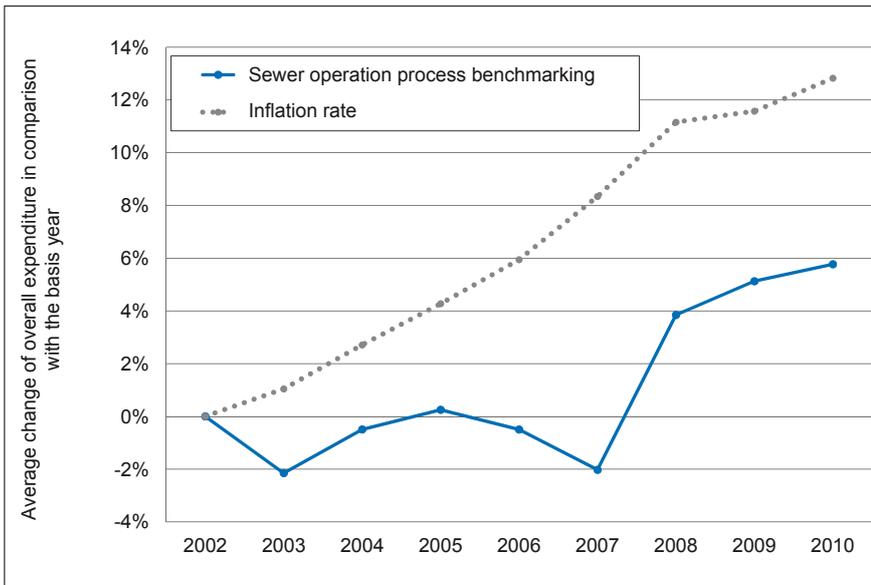


Figure 4: Development of the total expenditure for sewer operation

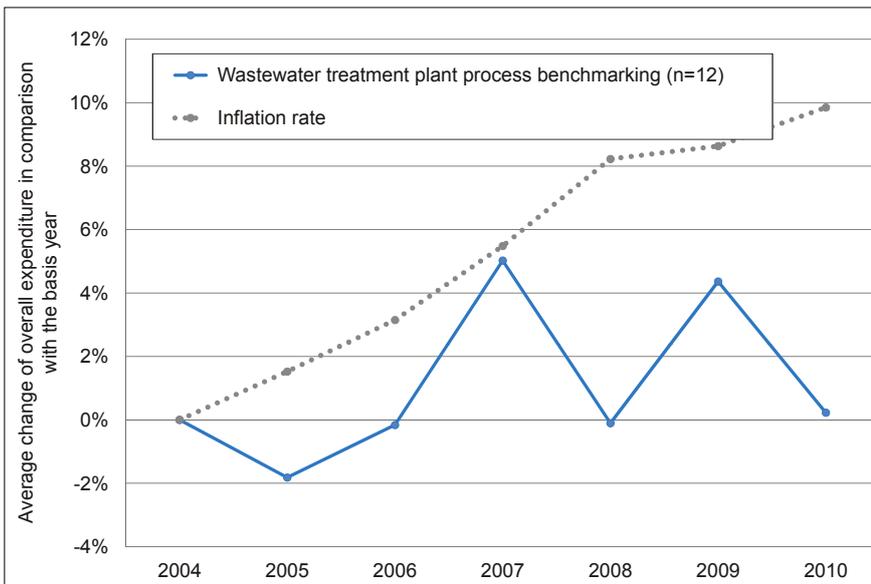


Figure 5: Development of the specific operating expenditure of wastewater treatment plants

than 200 wastewater treatment plants there are 12 data sets available which meet this condition. As the expenditure is dependent on the value of the COD load fed to the inlet of the wastewater treatment plant, the mean specific - that is related to inhabitants - operating expenditure of the wastewater treatment plants is depicted in Figure 5.

The change of the average specific operating expenditure of the participating wastewater treatment plants has varied in the past six years between

-2 % and 5 %. The variation of this value substantiates the importance of time series. Overall the average specific operating expenditure has risen by 0.2 %. In comparison to this the inflation rate lies at 9.8 %.

For the benchmarking participants, through the consideration of all five key performance indicators (according to the water industry “Five Pillar Model”: security of supply and treatment, quality, customer service, sustainability and economic efficiency), it

can be excluded that the positive development of the expenditure is at the expense of quality and/or sustainability. What cannot be clarified through this consideration is whether companies, who take part in benchmarking projects, demonstrate a more favourable cost development due to the benchmarking or whether these companies (who, where required, also apply other management tools) generally more intensely than other companies are looking for improvement. The diagrams are, however, an indication of the successes of benchmarking. Independent of this the following individual examples substantiate the contribution of benchmarking to the performance improvement.

### 3.3 Individual examples substantiate the effects of the benchmarking

#### 3.3.1 Overview

As opposed to the general development of costs in the companies, direct influences of benchmarking with individual examples of success are attestable. A success of the benchmarking exists:

- if a measure for the achievement of a positive change within the framework of the benchmarking has been developed;
- if the results of benchmarking (including exchange of experience) deliver the impulse for the development of a measure or supports a company in its awareness of how positive changes are to be effected.

In Table 2, 33 examples are named as illustration for these achievements of which some are fundamentally addressed below in order to impart an impression of the different modes of operation of the benchmarking. The majority of successes result from measures which have already been implemented, therefore the positive changes can also be verified and named. The saving, with the defined success examples, results from the difference between the original expenditure in the base year and the expenditure following implementa-

No.	Process benchmarking	Example	Key performance indicators	Optimisation fields					Performance characteristics				Savings	
				Decision principles (Chap 3.3.2)	Strategies of operation and maintenance	Technology and plant (3.3.4)	Processes and personnel (3.3.5)	Contracted service and purchasing (3.3.6)	Security of supply and treatment	Quality	Customer service	Sustainability	Economic efficiency	Achieved savings (No. of companies with which savings were taken into account with the calculation of savings)
1	Laboratory	Change of strategy	Specific expenditure analysis for wastewater treatment plant(WTP)/WTP		X								X	[1] €140,000
2	Laboratory	Laboratory organisation	Number of analysis methods per fulltime equivalent				X			X	X			
3	Indirect discharger monitoring	Sampling	Spec. expenditure for sampling/annual quantity of wastewater		X		X						X	[1] €100,000
4	Indirect discharger monitoring	Crew strength	Crew strength indirect discharger monitoring				X						X	[1] €65,000
5	Indirect discharger monitoring	Intensifying surveillance	Key performance indicators for type of monitoring		X				X	X	X	X		
6	Sewer construction	Construction standards	Average costs for manholes			X							X	[1] €170,000
7	Sewer construction	Cost planning	Cost assumptions for capitalised fixed assets	X						X				
8	Sewer construction	Sealing of sewers	Costs for excavation work			X							X	[1] €110,250
9	Sewer construction	Rehabilitation strategy	Percentage renovation on renewal rate			X				X		X		
10	Sewer construction	Construction surveillance	Resource management		X				X			X	X	Still not effective
11	Sewer construction	Type of shoring	Costs for excavation work			X							X	Still not effective
12	Sewer operation	Inspection strategy	Spec. overall expenditure of inspection (without sep. manhole inspection)		X								X	[1] €320,000
13	Sewer operation	Inspection implementation	Expenditure:performance ratio - inspection - non-patrolled sewers				X						X	[1] €90,000
14	Sewer operation	Cleaning implementation	Expenditure:performance ratio - cleaning sewers <= DN 1200			X	X						X	[2] €1,000,000
15	Sewer operation	Cleaning strategy	Proportion cleaned section of network		X								X	[5] €5,993,000
16	Sewer operation	Optical pre-check	Spec. overall expenditure optical pre-check		X								X	[1] €600,000
17	Sewer operation	Change of strategy	Spec. expenditure sub-processes (cleaning, inspection, structural maintenance)		X								X	
18	Sewer operation	Inspection pumping stations	Spec. number of visits to pumping stations and spec. inspection expenditure		X					X		X	X	[4] €640,000
19	Sewer operation	Cleaning pumping stations	Spec. overall expenditure for cleaning pumping stations		X								X	[1] €100,000
20	Sewer operation	Health circle	Number of sewer operation staff off sick				X					X	X	[1] €380,000
21	Wastewater treatment plant	Operation mode (load)	Spec. electrical energy consumption			X				X		X	X	[1] €165,000
22	Wastewater treatment plant	Disposal of residues	Operating expenditure disposal of residues					X					X	[1] €270,000
23	Wastewater treatment plant	Data basis	(various key performance figures)	X						X				
24	Wastewater treatment plant	Own energy generation	Costs for purchased electricity			X						X	X	[1] €60,000
25	Wastewater treatment plant	Sludge stabilisation	Spec. operating expenditure per PT COD120 (85% value) sludge stabilisation					X					X	[1] €80,000
26	Wastewater treatment plant	New construction CHP	(various key performance figures for energy consumption and electricity costs)			X							X	[1] €149,000
27	Wastewater treatment plant	Biogas production	(various key performance figures for energy consumption and electricity costs)			X						X	X	[1] €170,000
28	Material management	Central material management	Process costs per call or per ordering of low value commodities				X			X			X	[1] €1,315,000
29	Material management	Bereichsneuorganisation	Process costs per call or per ordering of low value commodities				X			X			X	[1] €449,000
30	Corporate	Investment plan	Substance investment wastewater discharge			X							X	[1] €2,000,000
31	Corporate	Power consumption sewer network	Spec. energy consumption discharge of wastewater	X						X				
32	(Various)	Input work on rules and standards	(various)	X						X	X			
33	Wastewater treatment plant	Various examples	(various)										X	[4] €5,225,800

Table 2: Success examples of benchmarking

tion of the measure. Here, however, the internal expenditure of time for the benchmarking is also to be taken into account. This, according to a customer survey, for example with the first-time participation in the sewer operation process benchmarking for the data acquisition and the participation with two persons in the two-day workshop is, on average, 15 working days. In the following years the expenditure sinks to, on average, 10 working days. With a state project for the data acquisition and the participation of one person in a project meeting on average 3.5 working days, for long-term participants the expenditure sinks to 2.5 working days. The benefit with the participants investigated outweighs, even taking into account this expenditure.

The examples show, also by means of the graphic key performance indicator sequences, the effectiveness of the formulated original idea of benchmarking from Figure 1: The key figures of the participants approximate to the best value or the “future actual value” (e. g. Figure 6 or Figure 7). The type of the achievements is limited not only to monetary savings but also extends to various areas which are characterised in Table 2 as “optimising fields”.

### 3.3.2 Decision principles for technical and commercial operational management

The acquisition of information for the technical and commercial operational management effected by benchmarking supports the quality of management and controlling in the company at various levels. Benchmarking represents a considerable gain in information for the management of companies and processes. Decisions on the basis of the information are more securely made, the planning gains in reliability (also with regard to longer time series of the projects) and the internal cost allocation can gain in quality (in-company transparency). For this there are available examples for various projects:

In the **wastewater treatment plant process benchmarking (Example 23)** a participant, through long standing participation, has put together quality assured and thus resilient data series for electricity costs with many comparative values. These values and the experiences of other participants have been discussed at great length and evaluated in workshops. The information thus gained is used inter alia in order to check the statements from consultants and advisers that, for example, the purchase on the energy exchange would be the most beneficial variant due to the liberalisation. The examination of these statements has shown that not every purchase

in the exchange represents the most economical solution for the purchase of electricity and an additional employee for the purchase of electricity in the exchange would be necessary.

For budget planning the accuracy of the cost planning is of great significance. In the **sewer construction process benchmarking (Example 7)** the accuracy of the cost planning is displayed at several points in time (cost assumption, cost calculation, cost estimate). Here an operator has used the large number of discontinued projects on the aquabench online platform for support with medium and long-term budget planning. The specific costs (€/m) for the respective type of project are aligned depending on various parameters (e.g. type of construction, depth, diameter and groundwater) to the findings from the online database and a higher planning reliability results. In this way the accuracy of cost planning could be increased within the scope of the draft planning. The deviation between calculated and actual costs has been reduced from 46 % to 3 % (Figure 6). Some operators additionally use the online assessment in order to carry out ad hoc assessments on completely different questions (e. g.: How high is the share of engineering services in the implemented investment volume? How many engineering services are outsourced? How are the construction tasks put together by other participants)? [19]

Frequently, there is a gain in information already from the improved, clearer cost allocation:

With a state project (**corporate benchmarking – Example 31**) a participant established that, following an extension of the road lighting system, an electric circuit had been connected inadvertently to the distribution box of a stormwater overflow tank. Therefore, a part of the electricity consumption of the street lighting was assigned to the wastewater disposal system. Through the correction, transparency about the actual electricity consumption was

achieved. On this basis future measures for energy optimisation can be reliably planned.

The benchmarking findings gain entry into the control system of the companies and, furthermore, also into the branch standards. The documented current operational practice about this goes into the work on rules and standards.

Thus anonymised and aggregated data for the specialist groups, who work on the subsequent advisory leaflets, are

in demand (**input work on rules and standards – Example 32**): DWA Standard A-147 [Betriebsaufwand für die Kanalisation – Betriebsaufgaben und Häufigkeiten [Operating expenditure for the sewer system – operating tasks and frequencies], ATV Advisory Leaflet M-271 Personalbedarf für den Betrieb kommunaler Kläranlagen [Personnel requirement for the operation of municipal wastewater treatment plants] and DWA Standard A-216 Energieanalysen von Abwasseranlagen [Energy analyses of wastewater facilities].

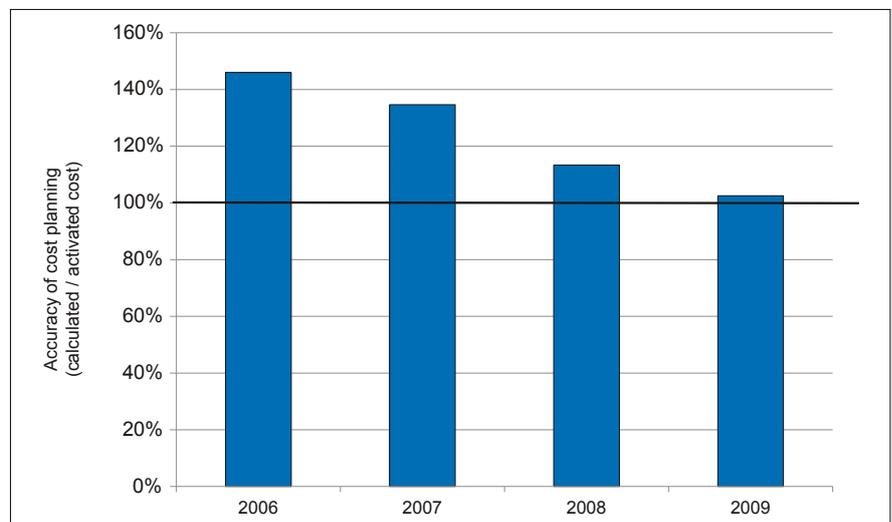


Figure 6: Improvement of the accuracy of cost planning in sewer construction of a benchmarking participant

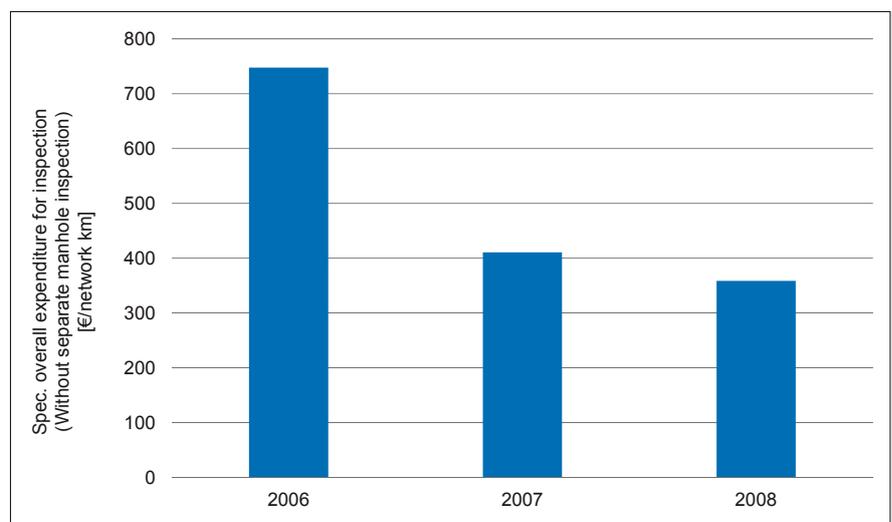


Figure 7: Change of the inspection strategy in water protective zones outside water catchment area

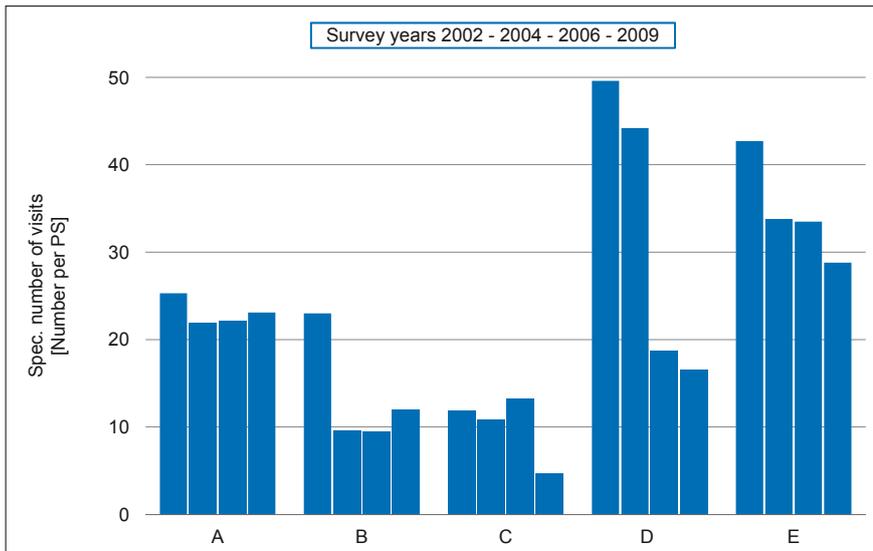


Figure 8: Change of the pumping station inspection intervals

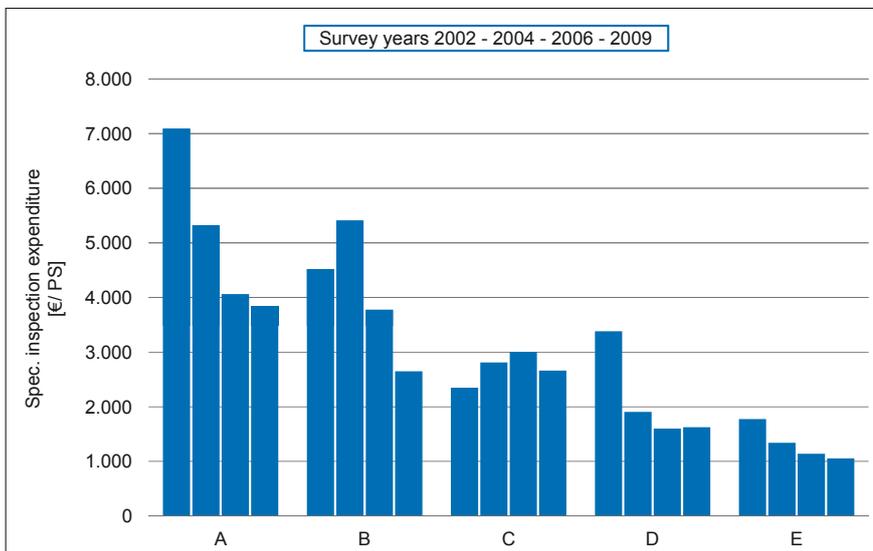


Figure 9: Savings in the inspection expenditure for pumping stations for participants with modified strategy.

### 3.3.3 Strategies of operation and maintenance

Companies establish recurring activities for the task fulfilment. This is essential basis of the operative work, in particular with the maintenance of facilities or the monitoring of processes. The laying down of intervals and strategies is based on experience as well as on technical and legal specifications. The systematic comparison in the benchmarking helps to scrutinise these specifications. Changes to these deter-

minations have been activated in all benchmarking projects:

On the basis of the recording of damage and of the exchange of experience with **sewer operation process benchmarking (Example 12)** a participant has reduced the expenditure for inspection for the sewers outside the water catchment area in the groundwater protective zones 2 (narrow protective zone) and 3 (wide protective zone). The frequency of the inspections lies, even after the reduction, still always above the official requirements. The future annual

saving is €320,000 in comparison to the base year 2006 (Figure 7).

Not only own facilities have to be inspected regularly, but also activities and third parties have to be monitored. Examples for this are to be found in the indirect discharger monitoring (Example 5, see below.) and construction supervision activities:

In the **Sewer operation process benchmarking (Example 30)**, the costs for planning and construction supervision are, for example, compared. Even if there is no clear optimum here in the sense of “the lower, the better”, an orientation is created for the participants. Thus a participant established that the resource input (share of planning and construction surveillance costs in the project costs) with several types of project in comparison with the other participants lay above the respective mean value. Therefore, inter alia with the involved employees, the sensitivity for the resource input is to be encouraged and a feedback system introduced which represents the provision of planned resources before the start of the project as well as the resources consumed during the project and at the end of the project. In opposition to this, another participant determined a comparatively smaller resource input. This at first had a favourable effect on the project costs but, however, with the background of a well-qualified construction supervision, also gave cause for critical debate with the subject. As measure, the reasons for the low intensity of the construction supervision are to be processed within the scope of an organisational expertise, in order, if necessary, to raise this within the sense of a well-qualified construction supervision. [19]

Comparable with the maintenance strategies of the sewers (Chapter 4, Figure 12) the maintenance strategy of pumping stations came into focus with many benchmarking participants through the sewer operation benchmarking:

With five participants of the sewer operation process benchmarking (Example 18) the intervals of the inspection activities are clearly adjusted against the background of the experiences in other large cities (Figure 8). One company thus has reduced the visit frequency per pumping station from 42 regular visits in 2002 to 29 visits in 2008. With another participant annually ca. 22 visits were carried out regularly (instead of 25 in 2002). With a further participant the frequency of 22 visits per year in 2002 was reduced to 12 visits per year in 2008. Other large cities show even more severe cuts. With none of the participants could any loss of quality (odour complaints, blockages, damage) be determined which were caused through this action.

Modifications of strategies are principally not aimed alone at economic savings. Frequently resources released are not completely saved but are employed for improvements in other key performance indicators:

With the example of the **sewer operation process benchmarking (Example 18)** with individual participants it amounts to an intensifying of the inspection activity despite lengthened intervals. Together with improvements in efficiency of the procedures (introduction of work scheduling, better vehicle management and reduction of crew strengths) it nevertheless, with four participants in this process, also amounts to significant savings. These lie between €105,000 and €230,000 annually compared with the base year 1999 (Figure 9).

How resources can be applied versatily and sophisticatedly in this process is clear from the example of indirect discharger monitoring:

Control levers for the modification of practice are to be found with the selection for the industries to be monitored, the type of monitoring (pure sampling, consultation and site inspection, requirement of verification, location of the monitoring with the industry and in one's own network as well with intervals). In the **indirect discharger monitoring process benchmarking (Example 5)** these diverse factors have been carved out and compared. With many participants this work has led to going more strongly for the quality of the activity, that is, for example, the consultation and site inspection as well as the monitoring of sewer nodes. Benchmarking has here effected large and also very different modifications of the varied monitoring activities. This has been described clearly by [20].

Resources which are released are used in particular for the challenges, which can accompany sustained maintenance:

In the **sewer operation process benchmarking (Example 17)** a participant has carried out a strategy modification of the cleaning of sewers. It was able to lead to marked improvements in the cost-performance ratio of the cleaning as well as free resources through changed procedures and cleaning intervals. The resources were used to intensify the upcoming

tasks of the sewer maintenance in the course of a sewer operation structure reform. Thus the inspection activities and the structural maintenance in the years 2005 to 2008 could be markedly increased and, since then, held at this level. Thus the sustainability could be improved.

### 3.3.4 Technology and facilities

The benchmarking process enables an insight into the advantages and disadvantages of alternative technologies and assesses their costs in comparison. The participants obtain, in particular in process benchmarking, a deeper insight into the status and development of different technologies of the sector from the aspect of the other participants and with the background of practical experience. Accordingly, many optimising efforts aim at the employment of innovative technologies and processes.

For the construction and operation of the sewer system the optimising of techniques is of fundamental significance:

One operator in the **sewer construction process benchmarking (Example 9)**, through analysis of the investment activities, has identified a relatively small share in renovation investments in comparison to other companies. Aim for him is to change the palette of the applied rehabilitation processes as a parameter of the rehabilitation strategy. Also, against the background of the achievable cost advantage, further renovation processes are to be checked for their possible applications and adopted, so far as relevant advantages compared with the technologies applied previously can be verified. This is to be achieved through a specific further training of the responsible project officer, the further exchange of experience with other cities and municipalities, a documentation of the additional renovation processes open to discussion, the solution and realisation of pilot sections and the analysis and documentation of the experiences with the pilot sections.

Likewise in the **sewer construction process benchmarking (Example 6)** a company, through the benchmarking, has modified specific parameters (DIN [German Industrial Standards] plus internal specifications) with regard to the reinforcement and climbing irons of the manholes. Through the reduction of these specifications on the standards of the DIN more bidders could take part in the request for tenders. With continuing high quality the average cost per manhole could be reduced from 2005 to 2007 by 20 %. Furthermore, through the exchange of experience there has been a motivation to increase the separation of manholes, as a new mechanical technique enables the operation of longer sewer reaches.

It is precisely with wastewater treatment plants that benchmarking: brings about various process changes:

**Example 21 from the wastewater treatment plant process benchmarking** refers to introduction of a load-depend-

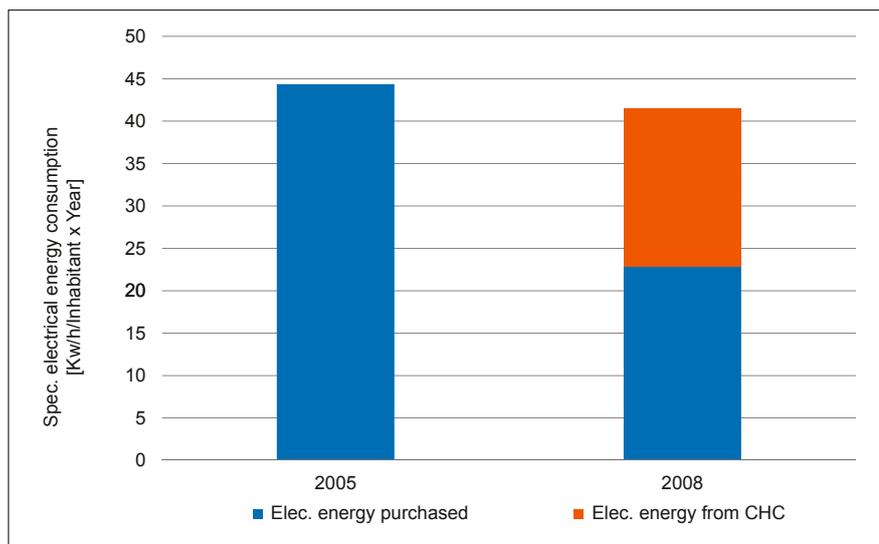


Figure 10: Increase of the energy generation through new construction of a combined heat and power plant (CHC)

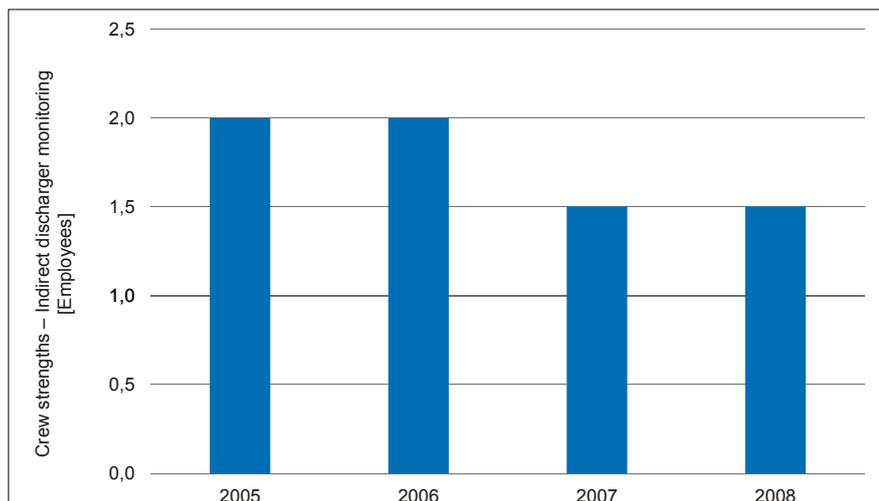


Figure 11: Indirect discharger monitoring process benchmarking: crew strength

ent operation mode for the biological stage of the wastewater treatment plant. This operation mode is traced back to an exchange in the circle of the participating wastewater treatment plants on the occasion of a benchmarking workshop. Using the load-dependent operation mode, mathematically, with one company, up to 1.1 million kWh/a of electrical energy for the aeration could be saved. The online measured ammonia nitrogen inflow load serves as dimension for the loading of the wastewater treatment plant. Under a set specified value, respectively two aeration tanks are shut down and thus no longer aerated. Dependent on the electricity price the

annual savings through this measure are between €150,000 and €180,000.

In the **wastewater treatment plant process benchmarking (Example 24)** there is a further example of the energetic optimising and modification of technical processes. In 2005 a wastewater treatment plant showed for the parameter “specific electrical energy consumption” in kWh per inhabitant and year, a high value within the comparative group and a significant exceeding of the corresponding guidance value according to a German energy manual. The process of the aerobic-thermophile sludge stabilisation (ATS process)

was identified as the cause for the high energy consumption (aeration). The decision for the new construction of a digester was based on this cause analysis as, through own energy generation and heating of the administration block using the waste heat of the CHC, with a considered duration of 20 years, lower costs result. The switching to anaerobic sludge stabilisation has led to a reduction of the specific electrical energy consumption of more than 4 kWh per inhabitant and year. In addition, since 2008, ca. 45 % of the electrical energy requirement is covered with the own energy generation in the CHC (Figure 10). The savings annually are €60,000.

### 3.3.5 Processes and personnel

Innovative modes of operation of the operators in benchmarking projects are understood as “Best Practice” solutions and through this find rapid dissemination within the sector. With this the operators undertake efforts for optimisation also without changes of frequency or intervals.

In the Indirect discharger monitoring process benchmarking (Example 4) one company has recognised that other companies also employ smaller crew strengths for sampling. An appropriate adjustment led to savings amounting to €230,000.

In the **Material management process benchmarking (Example 29)** the mixed structure of the ordering (decentralised and centralised) has been examined. With this, the unusually long routes with the processing of invoices (signatures / auditing) and the receipt of material stand out. As a result there was a new organisation within the finance area, a build-up of an accounting team and a revision of the organizational instructions (e.g. signature regulations). The savings resulting therefrom are annually €449,000. In addition, through the benchmarking, the introduction of new, central catalogues for the ordering (of, for example, protective working clothing and office material) and the checking of the increase of the standing order quota have been decided. Thus,

alongside the achieved savings, the quality of the provision of service has also been improved.

In the Laboratory process benchmarking (Example 2) a company has improved the laboratory organisation and, through qualification, has increased the size of the employment spectrum of members of staff, i.e. an employee can, on average, apply more methods of analysis than before the qualification. The number of methods per full-time equivalent, in the first year, has been increased by 12 % and in the second year by in total 20 %. This leads to a more flexible application in particular with illness and holidays of other employees as well as a performance improvement, as more determinations per day can be carried out and less idle times result. Furthermore, more samples can be determined promptly, whereby wastewater treatment plant operation, e.g. with regard to the dosing of chemicals, has become simpler and safer. Through this the customer service and in particular the quality of the wastewater disposal has been improved.

### 3.3.6 Contracted services and purchasing

Optimising possibilities regularly appear in benchmarking projects with the comparison of purchasing conditions and contracted services:

Through the participation in the **wastewater treatment plant process benchmarking (Example 22)** a company could document that it had almost the most expensive disposal system of all participants. On this basis the commitment to a local disposal business was cancelled by the municipal committee. Through the calling for tenders for the thermal utilisation ca. €270,000 are saved annually.

A further company had no digestion system for the treatment of excess sludge, but only a drying facility. In the comparison with companies with digestion the expenditure for the treatment steps allocated to sludge stabilisation should be small, but this was not confirmed in the **wastewater treatment plant process benchmarking (Example 25)**. Eventually, a more favourable leasing agreement for the mechanical drying of the excess sludge was concluded. Thus, since 2008, ca. €80,000 has been saved annually.

### 3.3.7 Summary of the effects

Benchmarking works at various levels. Here the operators must always take into account individually the effects of possible optimising measures on economic efficiency, security of supply and treatment, quality, customer satisfaction and sustainability. As described, the effects of benchmarking can be indicated for all key performance indicators.

The effects on economic efficiency can be consolidated into overall statements via the achieved savings. The savings result with the defined examples of success from the difference between the original expenditure in the basis year and the ex-

penditure following implementation of the measures. Here, different perspectives are possible:

- The sum of the annual savings represent up to 3 % of the annual operating expenditure of the total wastewater disposal of the participants in this study.
- The previously achieved savings can be summed over the years since the implementation of the measures. These are the “savings of the past”. For the 15 participants of this survey there results here a sum of accumulated savings of more than €100 million.
- The annual savings can be compared with the expenditure of the base year. They are described as “annual savings”. The measures for this have already been realised in the past. Annual savings of the participants add up to ca. €20 million/a.
- With the mentioned success examples the implementation of the developed measures has led retrospectively to annual savings in the (partial) processes considered of on average 40 %. Some key performance figures, compared to the initial savings, indicate savings of up to 70 %.
- The annual savings exceed the participant charges over all years by a multiple (between 2 and 10 times the participant charge is saved). The internal expenditure of the companies (data collection, participation in workshops etc.) is between 2.5 and 15 working days and depends strongly on the respective project and the experience of the participants. The benefit predominates with the participants investigated even taking this expenditure into consideration.

## 4 Success factors of the benchmarking

### 4.1 Essentials

The 15 year benchmarking practice in the water industry has produced a multitude of tools for central project management, which help to support the individual performance improvement of companies. Success factors for the execution are already integrated into the manuals of the specialist associations [8].

The declaration of the associations of the water industry in the actual profile of the German Water industry [21] fundamentally accentuates the voluntary nature of successful benchmarking and, furthermore, “as factor for the successful application and the broad acceptance of benchmarking”, mentions:

- continuous adjustment to the optimising aims,
- confidentiality of company data as this has to be disclosed in the project in order to identify innovative approaches,
- performance figure comparison and analysis in order to enable an increase in performance.

#### 4.2 Performance improvement as a result of benchmarking is an individual process and lies within the responsibility of the companies

A meaningful, clear performance assessment is an indispensable component and partial objective of the benchmarking projects as well as a prerequisite for the elaboration of improvements. This performance assessment is essentially supported through individualised reports and analyses aimed at individual companies. Performance figures are to be evaluated in conjunction with all available information and are to be classified with regard to the overall objective [6]. An individual glance at the performance figures is necessary here, therefore the individual analyses and individual company reports have from the beginning been part of the project [1, 22, 23] (com. also [8] for the significance of individual reports or [24] for general significance of individual analyses).

For the actual objective of the benchmarking, the performance improvement, individual analyses have an essentially even greater significance. This phase is barely conceivable without individual involvement of the participating companies:

“In the implementation of the results lies the greatest (real) use for the companies involved in benchmarking projects. This phase at the end of the project lies as a rule completely in the hands of the companies, however forms a compelling condition for a benchmarking. All projects which do not contain this phase are not benchmarking projects, rather solely (expanded) comparisons of characteristic figures.” [8]

The international expert group of the IWA comes to the same result – without active involvement of companies and their management, benchmarking does not lead to success: “At this point, utility management needs to step in.” [7]

Even the British central regulation authority, Ofwat, in its latest discussion paper, assumes that the central collection of data and their central evaluation – without the involvement of the companies – does not promise the desired success and therefore recommends that the

British companies should develop their own tools. The central data collection of the regulating authority is to be limited to a considerable extent:

“In the past, in fulfilling our duties, we have placed considerable weight on data collection and monitoring as a way of ensuring the companies complied with their regulatory obligations (“regulatory compliance”). But this approach does not necessarily get the best results for customers. It is costly in terms of regulatory resources and can mean the companies respond to the regulator rather than to their customers. Nor does it incentivise better performance.

Instead, we propose that they develop their own systems and assurance processes to enable their Boards to sign off a risk and compliance statement, verifying that the company is in compliance with its regulatory obligations.” [25]

The tool in one’s own hand leads more sustainably to performance improvement than highly aggregated external evaluations. Elaboration and integration of benchmarking results in operational reality demand, to a high degree, individual decisions by the companies and are dependent on their respective aims. They take into account external constraints and the development of new technologies and also internal factors such as existing resources and priorities up to and including the companies’ readiness to change.

Correspondingly, with none of the over 100 key performance figures evaluated for the present study is there a common tendency in the change in exclusively one direction. This is recognisable using the example of the different development of the cleaning strategies of the participants (Figure 12). The findings from 1999 of how, for example, the cleaned sections of one year differ, following analysis of the reasons lead to clearly different implications with the operators. Five operators have achieved a further economic optimisation through restructuring to a requirement-oriented cleaning and extension of technically unnecessary intervals. Two other operators have, on the other hand, shortened their intervals and clean more often than in the initial year. Here it is clear why the look at a single indicator and a single key performance indicator is not sufficient. The monitoring of faults and odour complaints has a high relevance for all participants and must be undertaken parallel to the economic considerations.

The consequences from performance assessment (in the above example the different cleaning strategies of participants) are also always to be determined and implemented for each participant individually. This cannot take place through a central report and only very seldom, without involvement of participants.

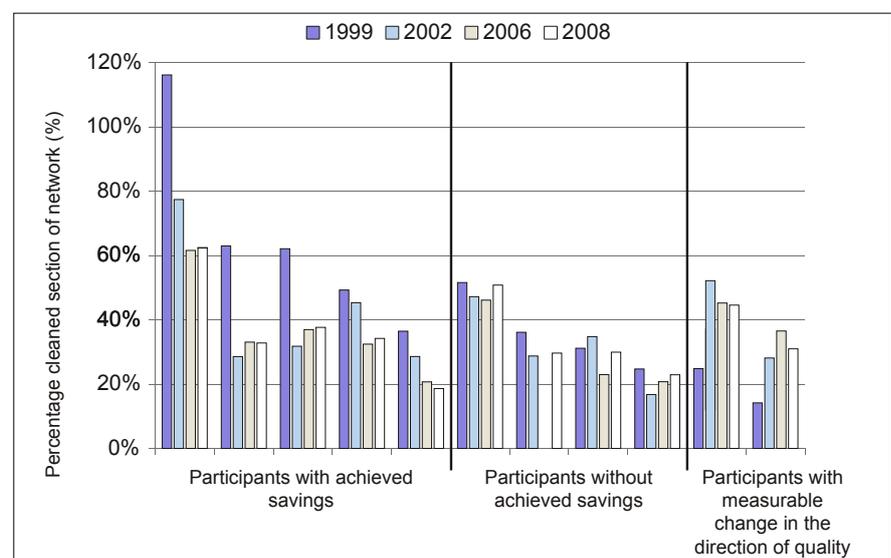


Figure 12: Key performance figure “Percentage of cleaned section”

#### 4.3 Tools for the performance improvement: objectives, key performance indicators at the level of the processes and derivation of courses of action

##### 4.3.1 Participants' objectives

From the above determination that the performance improvement is a company-individual process, and from the stipulation of the association declaration that the method of benchmarking is to be adjusted to the optimising objective, it follows that the performance improvement is to be linked with the objectives of the companies. In general the aims of the sector are defined with the five key performance areas. The specific objectives of the companies towards these key performance indicators are to be integrated, and this as precisely as possible, in the respective benchmarking process. This already concerns the preparation of the project and, above all, the analysis phase. Without a linking with the objectives and the strategy of the company benchmarking would trigger no performance improvement.

Municipal drainage location: Increase of productivity	
Formulation course of action	Status of implementation
2010	Completed
<p><b>Reason:</b> High cleaning expenditure in the sub-network ≤ DN 1200 in the comparison of participants</p> <p><b>Aim:</b> Aim is the increase of the cleaning performance per hour.</p> <p><b>Impact on performance figure(s):</b> [KKB205] cleaned stretch per vehicle hour large vehicle – cleaning – sewers ≤ DN 1200</p> <p><b>Course of action:</b> Through the introduction of a “Sewer information System”, which enables the degree of fouling of individual sewer reaches to be read-out, a cleaning tailored to the requirement is to be implemented, which is to increase the cleaning performance per hour (productivity). Following the introduction of the GIS system and the linking with the sewer information system, it is to be possible in the future to have the height of the fouling and the passed cleaning intervals shown and, by means of this lay down the next date for cleaning. Thus it is to be prevented, that sewers are cleaned whose condition still require no cleaning. However, attention should be paid that the cleaning of individual reaches is not delayed too long as, through this, levels of fouling can arise which can endanger the aim of increasing the cleaning performance. Due to the changeover to a tailor-made cleaning a positive development will appear, if anything, in the middle-term.</p> <p><b>Point in time:</b> Immediately</p> <p><b>Contact:</b> Name – position Tel.: E-mail:</p>	

Figure 13: Example for a course of action

Project	Project year	No. of participants	Optimising areas	Action-proposals
Sewer operation	2003 – 2010	23	Camera and flushing technology, work time models, crew strengths, cleaning intervals, management of vehicles and outside services, work preparation and management systems	92
Sewer operation – pumping stations	2004 – 2010	20	Modification cleaning technique, modification of cleaning and inspection intervals, differentiation of inspection activities, optimization of remote action and power consumption	72
WWTPs	2004 – 2010	24 (since 2009)	Each sub-process: investments plant technology, scheduled maintenance intervals, control of facilities, use of materials, controlling, insourcing	>200 (since 2009)
Laboratory	2006 – 2010	14	Scope of investigation, sampling efficiency, automation, laboratory capacity, procedures, quality assurance	37
Indirect discharger monitoring	2006 – 2010	17	Strategy (activities and frequencies), efficiency sampling and laboratories, employee qualification, price and charges models	39
Sewer construction	2004 – 2010	13	Time recording software, reduction of through times, improvement of cost determination, coordination with other pipeline agencies, raw material standards, manholes, shoring, award of contract practice	19
Material management	2004 – 2010	12	Contract specifications, change to building cleaning, introduction of e-procurement, centralisation, condition analysis toner, storage capital tie-up	24

Table 3: Number and areas of action proposals derived from seven benchmarking projects

#### 4.3.2 Key performance figures at the level of processes

The effectiveness of process considerations for the performance improvements shows itself in the implemented investigation. Through benchmarking, directly derivable and achieved economic successes are, with just two exceptions, traceable back to examples from process benchmarking. This confirms the significance of the process benchmarking as optimising instrument in the comparison of corporate benchmarking (comp. [6]).

The key performance figures for a change are to be found at the level of processes and are identified. Key perfor-

mance figures represent the actual influenceable lever for those responsible for the process, as their change is directly possible – without being overlain by other factors. Their number goes significantly beyond the performance figures mentioned in Table 2.

#### 4.3.3 Derivation of courses of action

Individual reports, individual analyses in workshops and, in particular, also the individual elaboration and documentation of courses of action are decisive tools and project components. The courses of action as final component of the joint project management here serve:

- to perceive, how (and whether) one can work practically with the results;
- to track, also in the sense of a controlling, the implementation of results
- to document the success of the project. (Which findings do we wish to implement?)

The documentation of the courses of action should – depending on the project in different form – take place centrally, e. g. through:

- detailed description of measures and cost estimation including determination of potential,
- documentation of the findings within the scope of expert workshops,
- written interrogation of the courses of action in the continuation of the project meetings (workshops) and report,
- individual annotation within the scope of the final documentation.

The courses of action have completely different levels of firm establishment and must not be combined mandatorily with a determination of potential (Figure 13). A course of action documents to which further activities the findings of the benchmarking project should lead.

In order to be able to estimate the scope of the courses of action, the aquabench projects have been evaluated as example: in the last eight years of process benchmarking 483 courses of action have been elaborated and documented (Table 3).

#### 4.4 Implementation of the benchmarking idea – in particular also in state projects at corporate level

A challenge with the implementation of the benchmarking idea exists in the flexible application of this instrument in projects at company level, as they are carried out in the majority of the German federal states (so-called “state projects”).

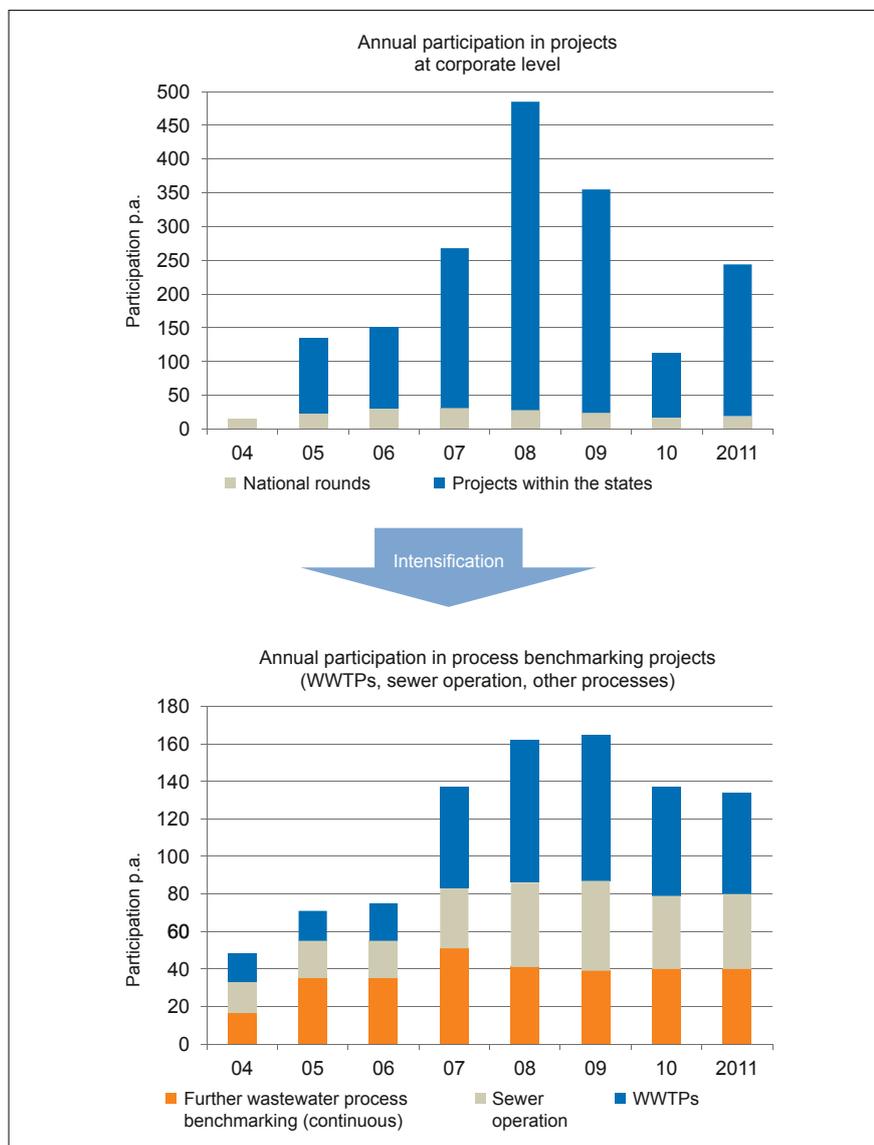


Figure 14: Intensification of comparison at corporate level through process benchmarking

Concrete steps of the performance improvement for many participants, in contrast to process benchmarking, are frequently not part of company-wide projects. It then stays essentially with a pure key performance indicator comparison at corporate level. Correspondingly, many participants see the uses of the projects at corporate level as committee and public relations work, that is, with the aims of performance assessment and provision of information (Figure 15).

Nevertheless, relevant areas of investigation can be identified in such projects. The derivation of necessary measures for the performance improvement then takes place in the subsequent process benchmarking (this idea of a two-stage procedure has thus been formulated in the rules and standards [6]). In Rheinland-Pfalz, for example, process benchmarking has been taken up as second step of the state-wide benchmarking project in the agreements of the bodies responsible for the project (specialist associations, municipal central associations and Ministry for the Environment, Forests and Consumer Protection). In other German federal states also, corporate and process projects are dovetailed. This is demonstrated in Figure 14. Through the participation in state projects (first carried out in 2005) and the discussion of the possibilities of benchmarking, since 2007 the number of participants in the continuous process benchmarking projects (sewer operation, wastewater treatment plant, analysis, indirect discharger monitoring, sewer construction, material management etc.) has increased.

The current surveys (from the state projects of Bayern, NRW and Rheinland-Pfalz), however, also indicate that more than  $\frac{3}{4}$  of the participants nevertheless use the instrument from their aspect of the performance improvement (Figure 15).

Indeed the connection to concrete measures with these projects is mainly given only indirectly. However, the performance assessment, the possibility for key performance-based exchange of experience and the identification of areas of optimisation are already an important step towards the performance im-

provement. Appropriately the majority of the projects also use the term “Corporate Benchmarking” (as also [8]).

Critical challenge of the project execution is to take further and as far as possible documentable steps with the participants for the performance improvement in the projects. Tools can be applied for this, which have proven themselves in process benchmarking:

- selected key performance indicators can be a part of a deepened exchange of experience and can also be integrated into the work in state projects.
- individual on-site visits for the explanation of the results are an essential part of the project in order to support the individual cause analysis and application of the results.
- process considerations can in the meantime also be applied flexibly. Along with the detailed investigation in the process benchmarking, for example operators in Rheinland-Pfalz take part in a simplified variant of the wastewater treatment plant process. In Sachsen and Thüringen the sub-process of decentralised wastewater disposal is investigated as part of the sewer operation process.

If the linking with the performance improvement and the cause analysis does not work, this has an effect also on the participant rhythm: a pure performance assessment, from the point of view of many participants, requires no annual or two-yearly rhythm. Therefore, also with state projects, the participant numbers are declining after the first project cycle, as many participants have obtained a performance assessment and want to recheck the position first in several years' time. For the participants of process benchmarking projects, who are working on a continuous performance improvement, annual projects are of fundamentally greater significance. Correspondingly these projects also experience a continuous participation (Figure 14).

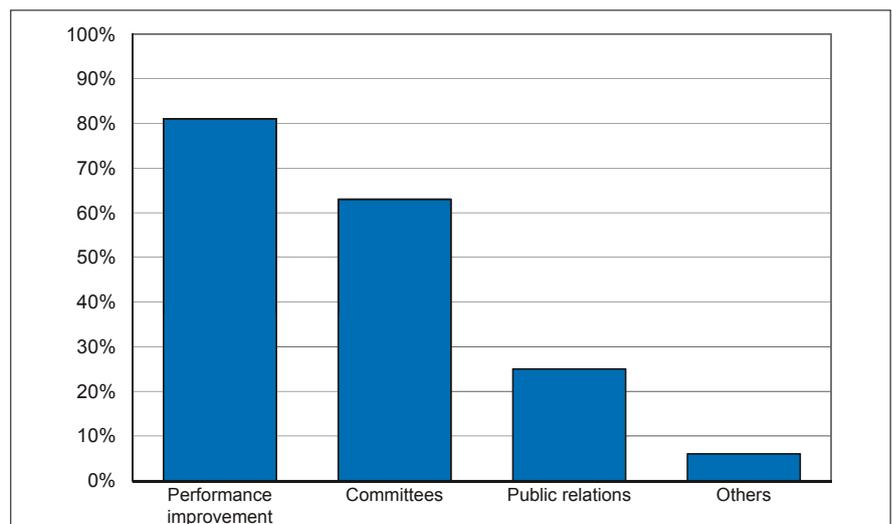


Figure 15: Use of the instrument Corporate Benchmarking in state projects (customer survey of 104 participants in Bayern, Nordrhein-Westfalen (NRW) and Rheinland-Pfalz)

## 5 Conclusion

Essential objective of the benchmarking is the performance improvement. The performance review of individual measures from process benchmarking projects is possible and is shown here. At the same time a contribution of the benchmarking to the general development of the company based on sufficiently large data sets is checked for feasibility. The presented survey underlines the success of benchmarking.

The objective of politics and specialist associations to achieve an implementation of benchmarking projects with a broad impact and, in addition, also a high transparency of the sector, is equally served through a consequent orientation on the original idea of benchmarking (performance improvement): In several projects it has been shown that the numbers of participants stabilise if the benefit in the daily routine of operation is visible. In particular in the state projects which, in the first instance, are used by some participants for the performance assessment. In future the focus therefore should be laid again more heavily on the performance improvement. The existing instruments here allow a flexible application of also selected elements of process benchmarking, so that matched procedures are available for the most varied sizes of company and depths of consideration, without the step into a process benchmarking having necessarily to be made.

The described experiences from 15 years of practice confirm the success of benchmarking at various levels and confirm the factors for successful benchmarking named in the associations' declaration (e.g. in [21]) and the rules and standards [6]:

- Operational optimising through benchmarking is an individual process and lies in the responsibility of the companies.
- The derivation of courses of action is indispensable component of the project implementation.
- Successful benchmarking is connected with the aims and strategies of a company.
- Improvements are achieved mainly at the process level.

For the companies this does not exclude continuously further developing the application of the method, such as the selection of sector and key performance figures, the easing of the data acquisition and the derivation and passing on of courses of action show.

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[A courtesy translation of the title of references in German is provided in square brackets.]

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## Authors

*Dipl.-Ing. Kay Möller*

*Dipl. oec. Filip Bertzbach*

*aquabench GmbH, Ferdinandstr. 6, 20095 Hamburg*

*Dr.-Ing. Sabine Nothhaft*

*Landeshauptstadt München, Münchner Stadtentwässerung,*

*Friedenstr. 40, 81671 Munich*

*Dipl.-Ing. Peter Waidelich*

*Stadtentwässerungsbetriebe Köln, AöR, Ostmerheimer Straße*

*555, 51109 Cologne*

*Prof. Dr.-Ing. Andreas Schulz*

*Emschergenossenschaft/Lippeverband, Kronprinzenstraße 24,*

*45128 Essen*

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