*10th Japanese-German Workshop on Water Technology*
*Berlin, October 9 - 10, 2006*

# Development of a Technical Controlling and Energy Management System within the Wupperverband – an Interim Report

**Dr.-Ing. Bernd Wiebusch**

## 1 Introduction

In view of the globalization of industry on the one hand and the growing debts of public bodies on the other hand, public bodies operating water and wastewater systems are increasingly adopting entrepreneurial management approaches and ways of thinking.

One of the objectives of modern management systems is to provide management with steering and decision-making tools. By developing a technical and economic controlling system including appropriate reports, it is possible to counteract the growing pressure on costs.

A further step is to consider significant operating cost items such as energy, consumables (precipitants and flocculants), repair and maintenance separately and to develop dedicated management systems for these items with a view to reducing expenditure. As regards energy, the objective of cost reduction is combined with the ecological objective of cutting emissions of the greenhouse gas carbon dioxide.

All system operators participate in this general development process in accordance with their size and their specific tasks. On the basis of general strategic goals, the main challenge is always to develop specific operational tasks and projects adapted to the size of the organization concerned and the resources available.

This presentation gives an interim report on the development of a technical controlling and energy management system at the Wupperverband.

## 2 The Wupperverband as an operator of water and wastewater facilities in the catchment area of the Wupper

The Wupperverband is one of the water associations of North Rhine-Westphalia, operating as a public body under a special statute. The association is responsible for the river basin of the Wupper, with a total area of 814 km². The River Wupper is about 114 km long, drains the northern part of the Bergisches Land region and flows into the Rhine near Cologne. Annual precipitation in the catchment area varies from 700 to 1400 mm and about 900,000 people live in the area.
Within the catchment area, the Wupperverband is primarily responsible for river maintenance, low water replenishment and flood management. In this connection, it operates nine reservoirs (one drinking water and eight industrial water reservoirs) and is responsible for waste water disposal and treatment in part of the catchment area.
The Wupperverband operates 70 stormwater tanks – the last tanks upstream from the waste water treatment plants, 60 km of sewers, 11 waste water treatment plants and a sewage sludge incineration plant. The population equivalent connected to these systems is about 1.1 million. The association has a workforce of 380 and receives contribution revenue totalling some 100 million euros.

# 3 Elements of technical controlling

A technical controlling system determines at regular intervals key figures which are made available to company management for steering purposes.
The prerequisites for the development of a technical controlling system are as follows:

- Initially, a central process data system of adequate performance is needed.
- Then, the technical data must be linked with commercial data from the accounting system.
- A reporting system must be established to present key technical and commercial data; and
- A system for the determination of key operating data must be introduced.

## 3.1 Modernization of central process data system

In 2004, the Wupperverband launched a project for the renewal of its central process data system. The old system is based on MS Access and was developed within the association step-by-step over a period of 16 years. On the one hand, this system features data selection mechanisms developed in accordance with operating experience. On the other hand, the system is entirely overloaded.
The new system is to represent an improvement and to meet the following criteria:

- Complete central process data system for the wastewater sector, allowing the simultaneous processing of continuous and laboratory data and integrating all data from processing plants, stormwater tanks, sewers, the central laboratory and external sources
- Easy-to-use evaluation tool with graphics modules designed to reach a large number of employees
- Capabilities for the rapid analysis of operating conditions for operational optimization
- Standard solution available on the marketplace with standard interfaces to external programs
- Rapid development and production of standard reports to support the reporting system and technical controlling.

The project, which was divided into three phases, is currently in progress and implementation is expected to take about one year for each phase (see Table 1). Phase I includes the selection of a consultant, the description of the actual situation, the definition of requirements in a working group throughout the association and obtaining budget proposals to give an indication of the total cost. Phase II includes the preparation of a tender specification and the official tendering procedure (in accordance with VOL, the standard conditions of contract for services to be provided for public bodies in Germany). As of 15 September 2006, this phase had been completed and the contract had been awarded. Phase III will now include the installation and commissioning of the system.
One interesting result of the tendering process was that the system required by the Wupperverband was not available on the market as a complete unit. The systems available could only meet about 80% of the specified requirements. Potential contractors considered the approach for laboratory data selection and evaluation adopted in the old system to be highly innovative. As a result, suppliers were prepared to invest in this aspect or to waive royalties with a view to making their own products more attractive.
The positive result of these developments for the Wupperverband was that the final price was about 70% below the price indicated in budget proposals. This clearly indicates that it can pay to work intensively on the design and tendering of a system of this type. The total cost breaks down into about 45% for system design and 55% for the system itself.

Table 1: Project milestones for the replacement of the central process data system

| Phase | Project milestones | Time frame |
|---|---|---|
| I | **Project definition and selection of consultat** | **3-4/2004** |
| | **Description of the status quo of the various existing data system, preparation of the catalogue of requirements / Development of the product specification with consultant and internal working group** | **7/2004 - 6/2005** |
| | **Presentation of potential bidders and budget proposals** | **5/2005** |
| II | **Preparation of detailed tender specifications describing the requirement catalogue** | **7/2005-4/2006** |
| | **Call for tenders** | **5-9/2006** |
| III | **Installation of the adapted standard system** | **10/2006 - 3/2007** |
| | **Scheduled commissioning** | **5/2007** |

Table 1 shows the time schedule for the various phases of the project.

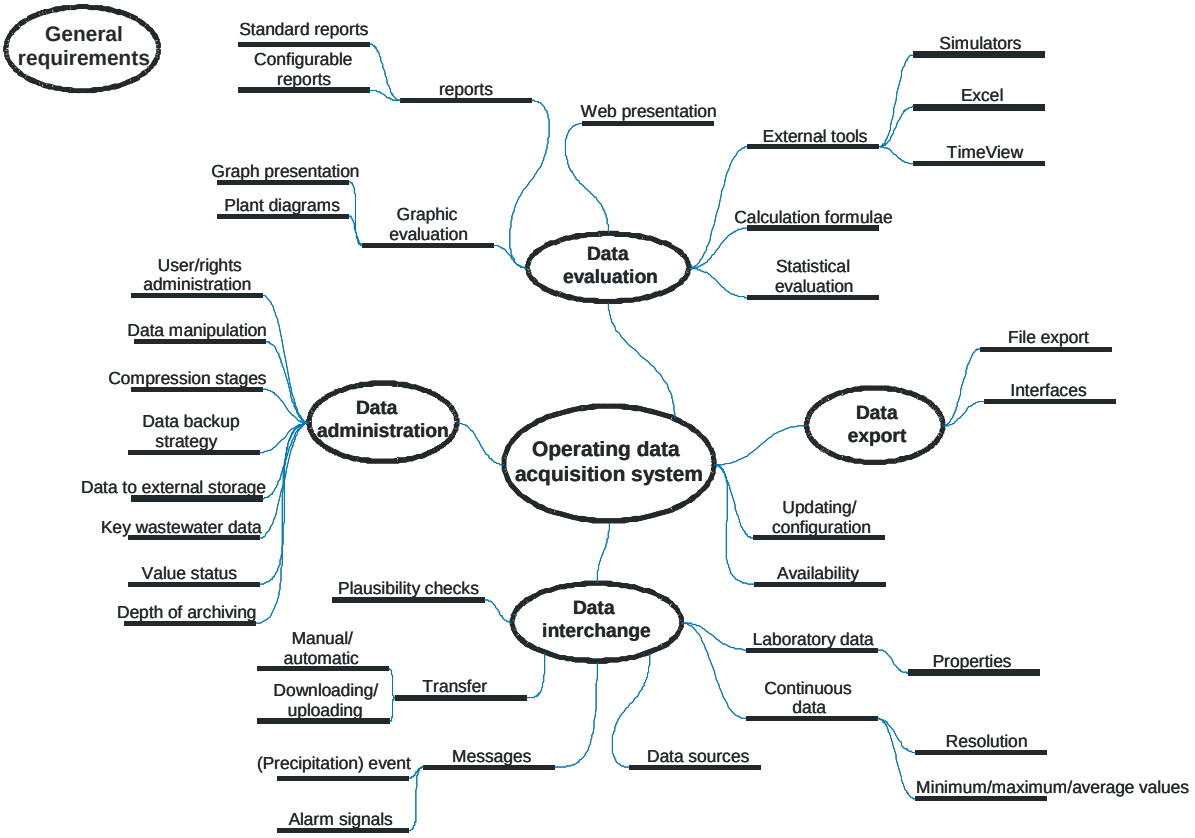


Fig. 1: Functional requirements for the design of the new central process data system (LeiKon, 2005)

Fig. 1 gives an overview of the general functional requirements to be met by the new central process data system.

### 3.2 Development of a reporting system

The reporting system for wastewater operations developed since 2003 has a three-stage structure. Monthly reports in accordance with DWA code of practice M 260 are generated by the process control systems of the waste water treatment plants and are used as a management tool by plant management.
On the basis of these monthly reports, two-page quarterly reports are produced for each treatment plant, using Excel. These reports cover the following items:

- Master data of treatment plant
- Human resources data (working times, absences, overtime worked)
- Calculated population equivalents
- Water flow rates, concentrations, pollution loads
- Nutrient conditions
- Key data of activated sludge process
- Effluent plots
- Digestion performance
- Key sludge treatment data
- Key energy data
- Precipitants and flocculants
- Wastewater accepted for treatment
- Disposal of residual materials and waste

These quarterly reports contain key technical data but no information on cost. The Wupperverband is currently working on the expansion of these reports to include cost information.

Once each year, a more comprehensive status report with about 100 pages is produced. This covers current and historic development of key technical and financial data. The association uses this report as a basis for its main wastewater business processes over the following year.

The Wupperverband sees potential for automating the reporting system within the new process data system, in the definition and annual updating of key technical and economic indicators for management and budgeting and in linking the technical process data system with the commercial data system. The Wupperverband already uses a presentation software package developed by MIK AG on the basis of SAP. In future, technical data from the operating data system are to be supplied to this package.

### 3.3 Participation in national benchmarking projects

As regards the conceptual design of an indicator system for wastewater treatment, the Wupperverband has accessed work carried out by 10 major German waste water treatment plant operators via service contracts. These utilities have established a service company, aquabench GmbH, which uses and develops a benchmarking process for waste water treatment plants together with its customers.

The main objective of these projects is to make business processes comparable for all concerned and to determine and compare key cost figures for each indicator of a sub-process. The benchmark is always the best value of a subprocess and not necessarily the lowest value (Fig. 2). Within the project, the resulting deviations must be analysed and any measures required must be defined.
The objective of this approach is to supplement the expertise developed within the association by the know-how available in the sector and to use it for cost optimization.

For the second time now, the association is using the existing treatment plant operation module and has already carried out benchmarking exercises on five waste water treatment plants. The measures resulting from the first project, which covered Burg and Hückeswagen waste water treatment plants, are currently being implemented and no final results of the project are available as yet. Other operators report average savings of up to 5% as a result of benchmarking.

For corporate benchmarking, the association also uses a method already developed for comparing key balance sheet indicators of similar companies.

For the projects “analysis and monitoring of indirect discharges" and “reservoirs”, the association is participating in the development of methods and will then carry out a comparison of key figures. In this way, the Wupperverband is actively involved in further development within the sector.

Fig. 2 shows the system and procedure for benchmarking projects. With annual data compilation, benchmarking can be used as a controlling tool. For this purpose, it is important to compile and evaluate the data automatically using an online portal.

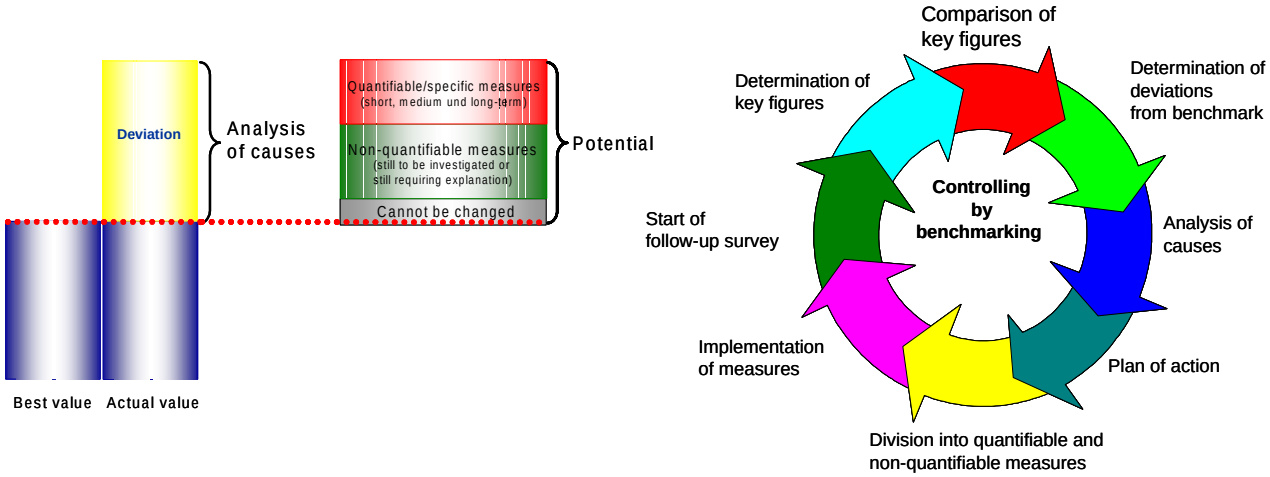


Fig. 2: System and procedure for benchmarking projects

## 4 Elements of energy management

One of the key challenges faced by manufacturing industry today is to secure energy supplies at economically acceptable conditions. Attempts by government in 1999 to liberalize the former quasi-monopoly situation in the energy industry only led to a reduction in energy costs for a limited period of time. Energy prices have now reached a very high level. The reasons are the general global increase in energy consumption on the one hand and the shortage of energy resources (for example, on the oil market) on the other hand. In Germany, taxes (levies under the Renewable Energy and CHP Acts, eco-tax and value added tax also account for a relatively large proportion of the price of energy.

The Wupperverband therefore decided to introduce energy management as a matrix process covering all the functional units of the association.
The objectives of the energy management process are to reduce energy costs on the one hand and to minimize carbon dioxide emissions (greenhouse effect) on the other hand.

The operational tasks resulting from the process are as follows:

- Transparent tracking and presentation of energy consumption and energy costs within the Wupperverband,
- Brief presentation of energy policy and legal developments,
- Further development of energy purchasing methods and contract systems,
- Proposal of measures to reduce energy consumption and costs at individual plants,
- Proposals concerning the expansion and optimization of power generation from renewable energy sources (CHP and hydropower plants),
- Development of innovative projects to reduce energy consumption.

### 4.1 Energy consumption and power generation

The Wupperverband uses 56.8 million kWh of energy per year. Of this figure, 40.4 million kWh are purchased from external sources. This energy includes electric power, fuel oil, natural gas and district heat. Table 2 below shows the percentage breakdown of energy consumption by the various sources of energy.

Table 2: Energy used by the Wupperverband

| Energy | Consumption WV per year | kWh / a | Share |
|---|---|---|---|
| Power (external) | approx. 25.6 Mio. kWh/a | 25,600,188 | 45% |
| Power (internal) | approx. 16.3 Mio. kWh/a | 16,348,818 | 29% |
| Fuel oil | approx. 1.22 Mio. l/a | 12,792,497 | 23% |
| Natural gas and propane | approx. 132,000 $m^3$/a | 1,200,000 | 2% |
| District heat | approx. 820,000 kWh/a | 820,000 | 1% |
| | | **56,761,503** | **100%** |

Energy expenses account for approx. 10% of the cost of materials used and approx. 50% of the cost of raw materials and consumables.
Since 2000, energy expenses have risen by an average of about 5 % per year. Among other things, this is a result of the expansion of waste water treatment plants to provide more effective treatment. In addition, the cost of electric power in 2007 will increase by about 25 % compared with 2005 if consumption remains constant.

The Wupperverband uses approx. 16.3 million kWh of power generated by the association itself using packaged CHP plants, hydropower plants and one steam turbine. In addition, the association's hydropower plants generate about 8.7 million kWh of power which is fed directly to the public grid. The association therefore generates power corresponding to about **60 %** of its own requirements from renewable sources! In addition, the above table shows that electric power accounts for two-thirds of the energy used by the association.

### 4.2 Development of an energy data management (EDM) system

The purpose of an energy data management system is to record the energy consumption data of individual plants and power generated by the association itself almost on a real-time basis. Initially, the project launched in July 2005 records power purchased from external sources for 17 power use points with special contracts in a central database as a load plot on the basis of 15-minute values. The data is presented using visualization software.

In the next stage of the project, there are plans to record the power generated by CHP and hydropower plants as well as power purchased under general tariffs. It is also planned to export the data to the future operating data system.
Using the EDM system, it is possible to create updated reports on energy consumption, load and power generated by the association's own plants. Where necessary, periods with high energy consumption (e.g. load peaks) will require more intensive analysis.
Fig. 3 shows the structure of the energy data management (EDM) system.

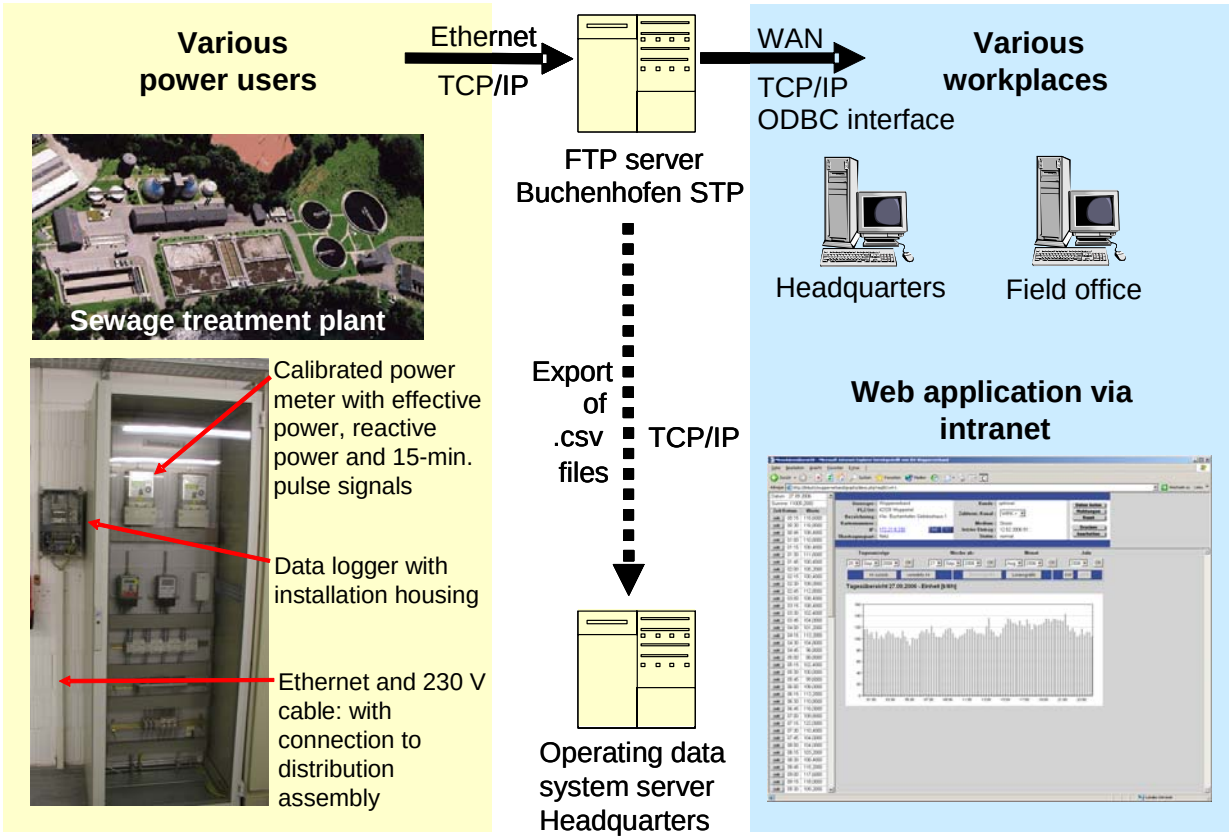


Fig. 3: Structure of an energy data management system for the Wupperverband

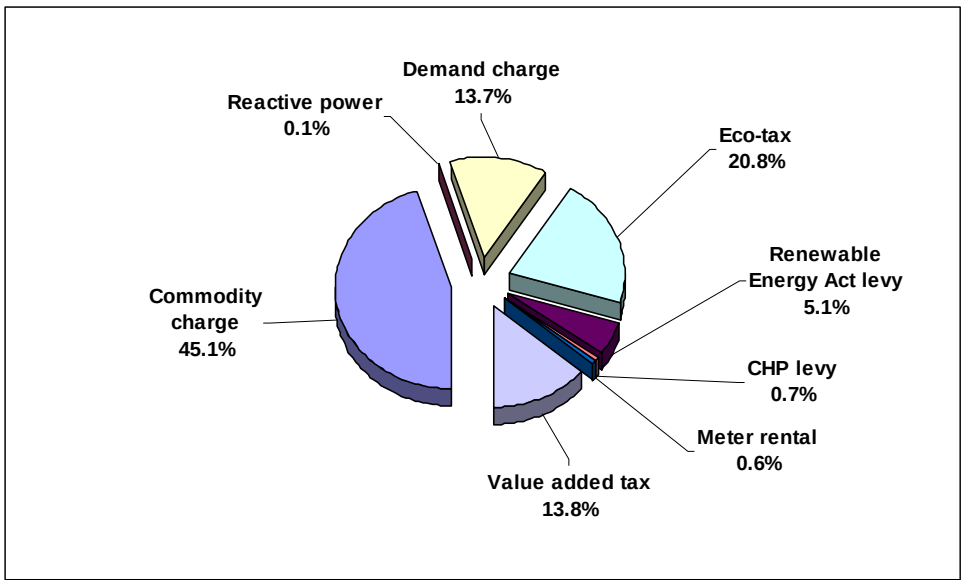


Fig. 4: Breakdown of electric power costs into energy components, taxes and levies

### 4.3 Purchasing of electric power

In 2004 and 2006, the Wupperverband issued calls for tenders for the supply of electric power in accordance with VOL. The contract was concluded on the basis of supply to the point of use. In other words, the power supplier concludes a contract with the network operator concerned and invoices the demand and commodity charges as well as network utilization fees. The term selected for the contract in both cases was two years.
The tendering process has brought definite benefits. Firstly, all 17 points of use with special contract now have a simple, standardized power supply contract. Secondly, the increase in electric power expenses was not as severe as expected, as a result of competition between suppliers. The association had to accept a 15% increase in electric power cost as of 1 January 2005 and a 25% increase as of 1 January 2007.
The price structure of these contracts indicates that the demand and commodity charges account for 59% and taxes and levies (Renewable Energy Act and CHP levies, electric power and value added taxes) for 41% of the price of electric power (see Fig. 4).

The association is now in the process of launching investigations concerning the applicability of new purchasing methods ("timetable purchasing") in cooperation with a power supplier. This involves the use of a forecast load curve to be covered by the power purchased. Any excess quantities purchased or deficits are balanced by the power supplier within a separate balancing account.

The unbundling of power suppliers has led to the establishment of separate companies for power sales and network operation. If this structure were reflected by power supply contracts, it would be necessary to conclude separate network connection and network utilization contracts. Contracts with network operators would cover the monopoly market of network utilization, while only the supply of electric power would be included in calls for tenders. This approach could have an advantage, in that more tenders would be received, especially from energy traders. As a disadvantage, there would be a slight increase in administration expenses.
The configuration of power supply contracts can have a significant effect on external power costs.

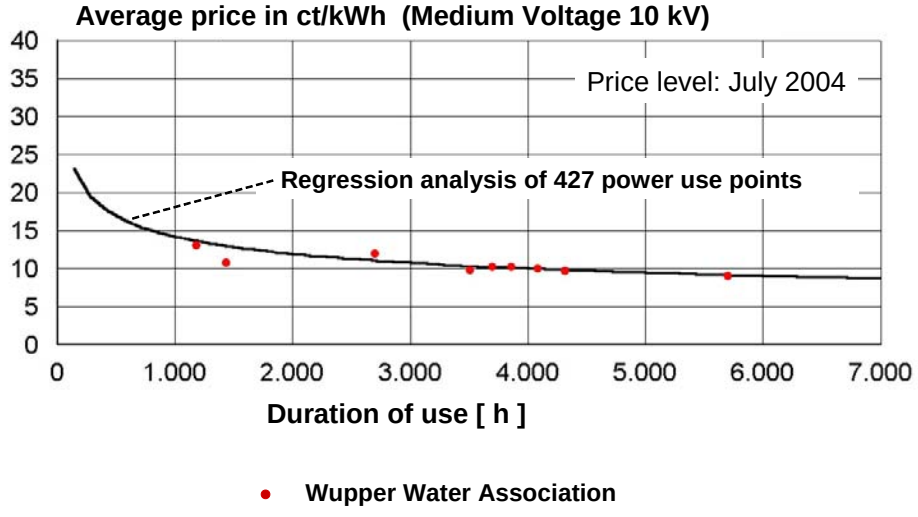


Fig. 5: Average price as a function of duration of use of supply points, for delivery and metering in the medium-voltage range (Specht, 2004)

Fig. 5 shows the relationship between the price of electric power and duration of use [h]. For this purpose "duration of use" is defined as the power consumption in [kWh] divided by the annual peak load [kW]. If electric power is taken at absolutely the same load figure over the entire year, the "duration of use" is 8,760 hours, corresponding to the number of hours in the year.

Waste water treatment plants with relatively even power consumption normally have a high duration of use in excess of 5,000 hours, while the duration of use of pumping stations is often below 1,000 hours. As the hours of use increase, the average price of electric power falls. Power suppliers reward relatively constant consumption as the peak load capacity to be made available is reduced and the load on power supply systems is more evenly distributed.
Load peaks have a greater detrimental impact on energy expenses with an annual demand charge than if a monthly demand charge has been agreed,

Another point to be considered is the feeding of power generated by the association from renewable sources to the public grid under EEG – the Renewable Energy Act. Consideration of the energy situation at Buchenhofen waste water treatment plant indicates a revenue potential of about € 100,000 per year. Since the end of May 2006, the compact CHP plants at Buchenhofen have been feeding power “virtually” to the public grid. However, it will be necessary to carry out a new viability analysis as a result of the severe increase in power prices from 1 January 2007.

Under the Oil Tax Act (MinöStG), Section 25 (exemption, reimbursement or tax credits in the tax area), there is a possibility of tax reimbursements if plants for the combined generation of heat and power have an annual degree of utilization of at least 70%.
This possibility of reimbursement has been used at the sewage sludge incineration plant for some time.

### 4.4 Optimization of energy consumption

Standardized **energy analyses** in accordance with the energy manual for North Rhine-Westphalia published by the State Ministry of Environmental Protection, Nature Conservation, Agriculture and Consumer Protection are a key tool for optimizing energy consumption. The state subsidized these analyses for many years and the Wupperverband has already analysed six waste water treatment plants. Although the subsidy program has been suspended, the continuation of these analyses is regarded as beneficial.
As a result of these analyses, measures are proposed and a general viability assessment is made. For a more detailed assessment and implementation if appropriate, the proposals are forwarded to the operating departments concerned.

Table 3: Savings potential as a result of energy analyses and realization

| **Total (without wwtp Odenthal)**<br>**Population equivalent: 191,376** | **Energy (power and heat)**<br>**[kWh/a]** | **Share in energy**<br>**[%]** | **Cost differential (AB - AC)**<br>**[€/a]** | **Share in cost**<br>**[%]** |
|---|---|---|---|---|
| Savings potential determined | 2,492,692 | 100% | 96,352 | 100% |
| **Of which:** | | | | |
| Already realized | 1,368,767 | **55%** | 85,313 | **89%** |
| Realization with expansion / modifcation | 983,727 | 39% | -499 | -1% |
| Realization not feasible | 31,565 | 1% | 1,217 | 1% |
| Other items (clarification required) | 108,633 | 4% | 10,323 | 11% |
| Abbreviations: AB = Annual Benefit, AC = Annual Cost, wwtp = waste water treatment plant | | | | |

Table 3 shows that 55% of the savings potential indicated by energy analyses conducted since 1999 in terms of energy savings and 89% in terms of cost savings have already been realized.

39% of the energy savings potential indicated will be realized in the long term in connection with modifications and expansions.

The connection between power supply contract, peak loads, duration of use and power cost or average power cost was already mentioned above.
The targeted shut-down or turning-down of individual units as part of a **load management** strategy may help in reducing peak loads and the resulting demand charges (see Figure 6). Where this is economically viable, an automated load management system is normally used.

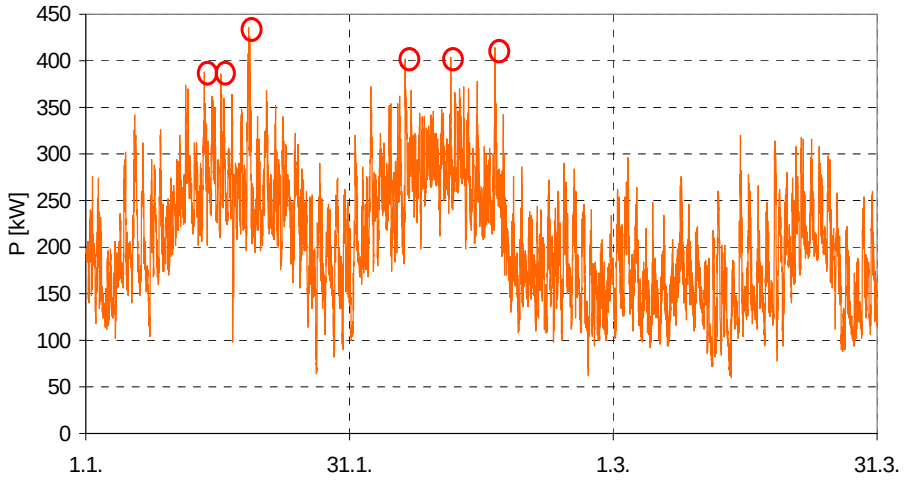


Fig. 4: Sample load curve for a waste water treatment plant (for a population equivalent of 50,000) showing load peaks

The Wupperverband is currently conducting studies to determine whether it will be economically viable to introduce automated load management systems at individual plants. Initial results show that such systems would have a cost:benefit ratio approaching 1 as a result of the monthly demand charge provisions. If load management at the plants is not automated, it will be necessary to manage loads manually using the energy data management system. This will only be possible in connection with a retrospective analysis of the data collected. The experience obtained could then be considered when selecting future modes of operation.

Table 4: Overview of studies concerning the feasibility of automated load management systems for the Wupperverband

| **wwtp** | **Annual hours of use** | | **Feasibility Study** | **Installation** |
|---|---|---|---|---|
| **Base year** | **2003** | **2005** | **2003** | |
| Buchenhofen | 5,702 | 5,131 | Amortisation in 7.5 years | Feeding into network in accordance with Renewable Energy Act |
| Hückeswagen | 3,699 | 3,660 | C/B = 0.8 | Together with the modifiation of the wwtp |
| Radevormwald | 4,083 | 2,665 | C/B = 0.9 | After expansion of wwtp |
| Schwelm | 2,699 | 2,415 | C/B = 1.1 | No installation |
| Burg | 4,319 | 3,340 | In progress | |
| Abbreviations: C = Cost, B = Benefit, wwtp = waste water treatment plant | | | | |

In addition, benchmarking projects include a technical and economic assessment of the energy situation. However, the technical assessment is very rough and is no substitute for an energy

analysis. An important addition by the benchmarking method is the economic assessment based on the determination of specific consumption costs and, in the case of packaged CHP plant operation, specific production costs.

### 4.5 Increasing the share of renewable energy

In order to ensure greater independence from the rising cost of energy purchased from external sources, it is necessary to increase the share of energy generated by the Wupperverband itself from renewable sources. In this connection, the Wupperverband can tap potential in the following areas:

- Construction and operation of further hydroelectric power plants on the reservoirs operated by the Wupperverband
- Increase in digestion gas production for power generation by the cofermentation of organic materials, using vacant capacities in digesters
- Installation of solar power facilities on the association's buildings

In future, depending on network transmission charges and electric power prices, it may become viable for the Wupperverband to transmit hydropower to its own waste water treatment plants for use at those plants instead of feeding it to the public power grid.

## 5 Conclusion and outlook

The basic structures of a technical controlling and energy management system have been developed within the Wupperverband since 2003. The current technical controlling tasks at Wupperverband are operating data processing, reporting of key technical and economic data and participation in external benchmarking projects.
Technical controlling activities in future will include the definition of key technical and economic indicators and integration in reporting for the management of operating processes and for budget planning.

Energy management, which will be a matrix process at Wupperverband in future, will have the environmental objective of reducing carbon dioxide emissions and the economic objective of cutting costs. The methods used for achieving these objectives will be the development of a purchasing and contract system adapted to energy markets, the central recording of all energy data on a real-time basis as part of the reporting system, the use of load management system to ensure even load factors and energy analyses to optimize energy consumption.
Although the Wupperverband already covers 60% of its energy requirements from renewable sources, there is still potential for increasing this share. In general terms, the power generated by hydropower facilities could be increased and greater use could be made of organic materials for cofermentation in the association's fermentation basins. A review of this potential is currently in progress.

## 6 Acknowledgements

The author wishes to thank his colleagues at the Emschergenossenschaft/Lippeverband and Ruhrverband for the constructive exchange of ideas and the impetus which they have given to his work.

## 7 Sources

Specht, 2004:
Support for the purchasing of electric power (call for tenders in accordance with VOL) by Ingenieurbüro für Energiewirtschaft und –technik Dr. Specht, Müden

LeiKon, 2005:
Specification for the project “Betriebliche Informationsverarbeitung T1/T2“ (operating data processing, parts 1/2) of Wupperverband, July 2005, Ingenieurbüro LeiKon, Herzogenrath

WIW, 2004
Report on load management for the wwtp Hückeswagen of the Wupperverband, Wupperverbandsgesellschaft für Integrale Wasserwirtschaft (WIW), Wuppertal

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für Wasser, Mensch und Umwelt

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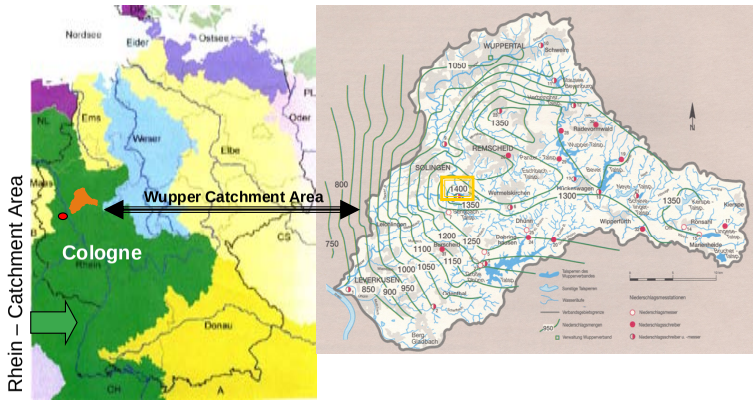
## The Wupperverband / Wupper Water Association

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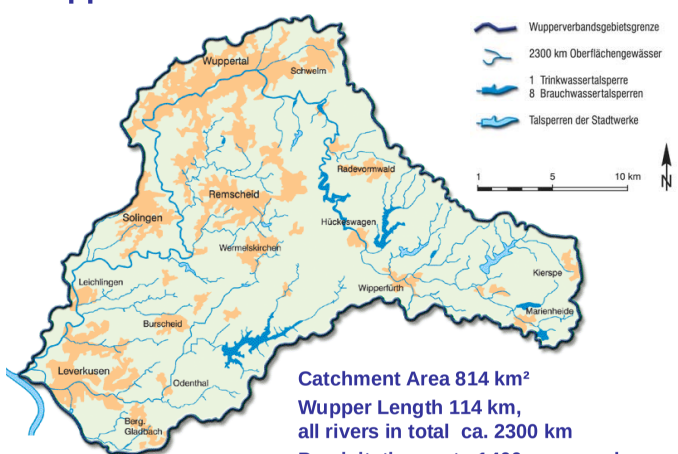
## The Wupper Water Association




Catchment Area 814 km²
Wupper Length 114 km,
all rivers in total ca. 2300 km
Precipitation up to 1400 mm yearly,
Population: ca. 1 Mio. people

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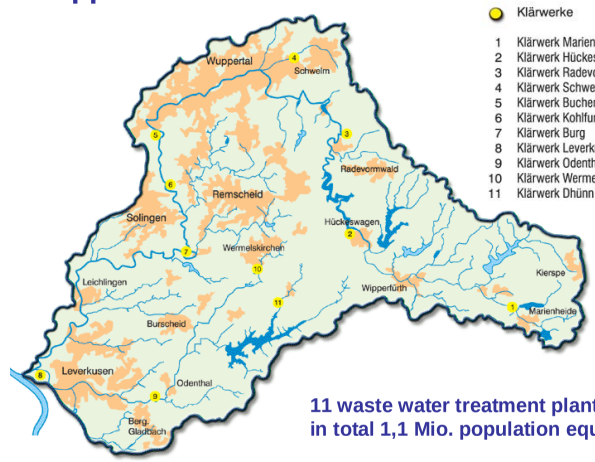
## The Wupper Water Association




Klärwerke

1 Klärwerk Marienheide
2 Klärwerk Hückeswagen
3 Klärwerk Radevormwald
4 Klärwerk Schwelm
5 Klärwerk Buchenhofen
6 Klärwerk Kohlfurth
7 Klärwerk Burg
8 Klärwerk Leverkusen
9 Klärwerk Odenthal
10 Klärwerk Wermelskirchen
11 Klärwerk Dhünn

11 waste water treatment plants
in total 1,1 Mio. population equivalents

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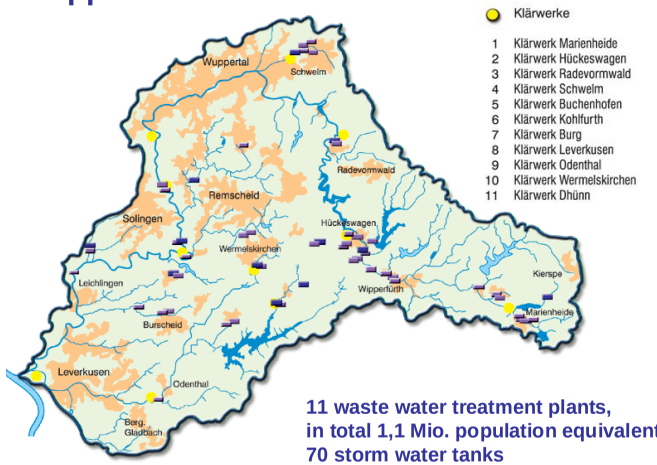
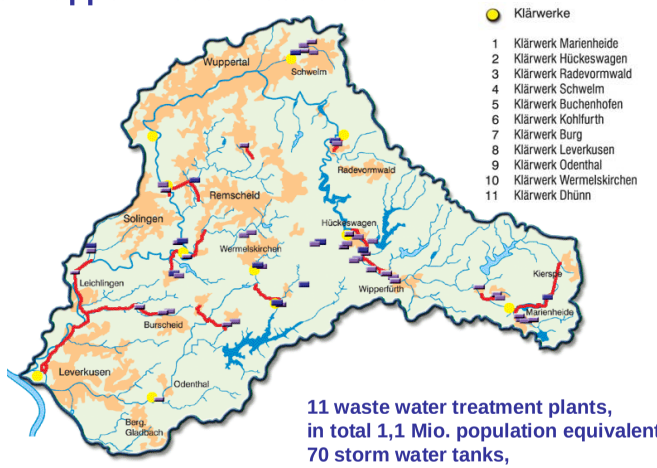
## The Wupper Water Association




**11 waste water treatment plants,**
**in total 1,1 Mio. population equivalents,**
**70 storm water tanks**



## The Wupper Water Association




**11 waste water treatment plants,**
**in total 1,1 Mio. population equivalents,**
**70 storm water tanks,**
**60 km large sewer pipes for waste water transportation**



## Responsibilities

- **Collection and storage of water for the drinking water supply**
- **Waste water collection and treatment**
- **River maintenance**
- **Regulation of the river flow**
- **Collection and evaluation of river and catchment area data**



## Issues

### Technical Controlling (since 2003)

- Central Process Data System
- Reporting System
- Benchmarking

### Energy Management (since 2005)

- Energy consumption and power production
- Energy Data Management
- Centralised purchase of energy (power)
- Optimisation of the energy consumption
- Management of power load peaks

# Technical Controlling within the Wupperverband

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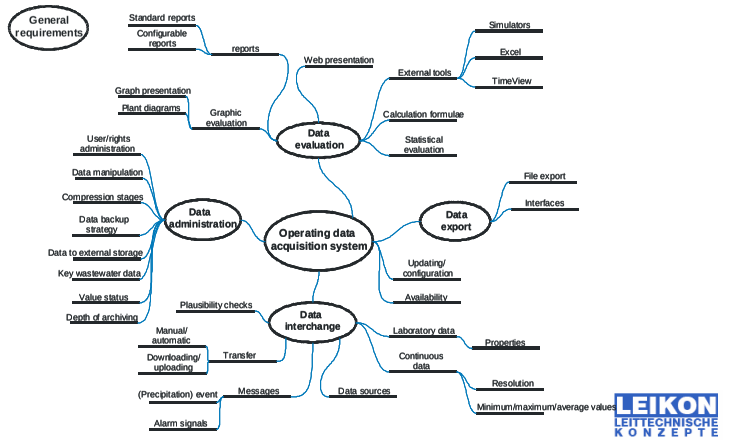
## Central Process Data System [CPDS] - (1)

**Modernisation of the central process data collection and evaluation in the waste water treatment department**

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## Central Process Data System [CPDS] - (2)

| Phase | Project milestones | Time frame |
|---|---|---|
| I | Project definition and selection of consultat | 3-4/2004 |
| | Description of the status quo of the various existing data system, preparation of the catalogue of requirements / Development of the product specification with consultant and internal working group | 7/2004 - 6/2005 |
| | Presentation of potential bidders and budget proposals | 5/2005 |
| II | Preparation of detailed tender specifications describing the requirement catalogue | 7/2005-4/2006 |
| | Call for tenders | 5-9/2006 |
| III | Installation of the adapted standard system | 10/2006 - 3/2007 |
| | Scheduled commissioning | 5/2007 |

→ **Run-time of the project: 3 years**

→ **Costs approx. 275 T€**

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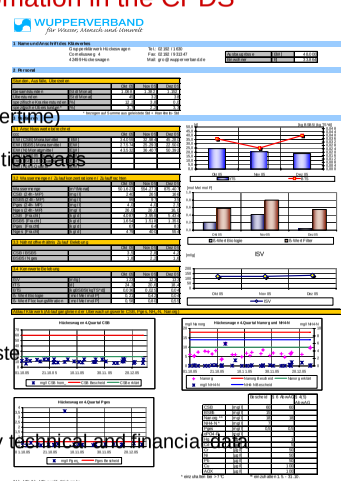
## Reporting System

- Monthly Reports → Automation in the CPDS
- Quarterly Reports
  (2 pages / MS Excel)
  - Master data of wwtp,
  - HR data (working times, absences, overtime)
  - Calculated population equivalents
  - Water flow rates, concentrations, pollution loads
  - Nutrient relations,
  - Key data of activated sludge process
  - Effluent plots
  - Treatment efficiency
  - Key sludge treatment data
  - Key energy data
  - Precipitants and flocculants
  - Wastewater accepted for treatment
  - Disposal of residual materials and waste
- Yearly Status Report
  (approx. 100 pages / MS Word)
  Current and historic development of key technical and financial data



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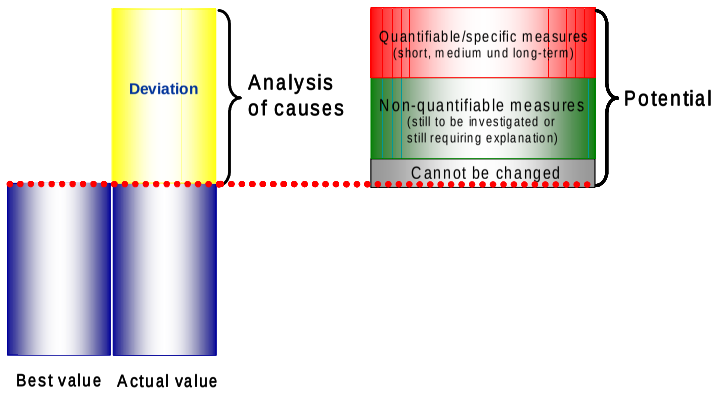
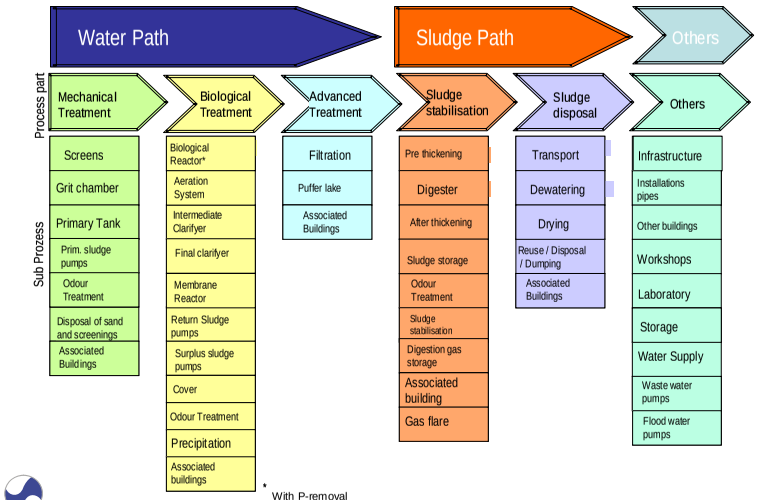
## Benchmarking

Comparison of Key Performance Indicators (KPI)





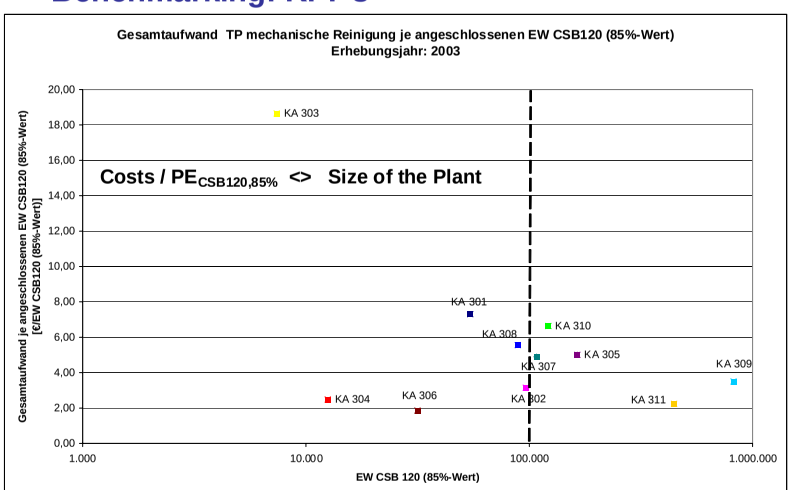

## Process Modell




* With P-removal



## Benchmarking: KPI´s






## Benchmarking: Cause Analysis

Ursachenanalyse Biologische Reinigung

Anlage: 301 Group All Datenstand: 14.10.2004

< 100.000 EW CSB120 (85%-Wert) letzte Textänderung: 14.10.2004

| lfd. Nr. | Kennzahl | Einheit Kennzahl | Ist- Wert | Zielwert | Ø-Wert | Abw. zum Zielwert abs. | ggf. Abw. zum Zielwert in % | ggf. Abw. zum Mittelwert in % |
|---|---|---|---|---|---|---|---|---|
| 1 | Betriebsaufwand/ ange. Einw. (CSB 85-Perc.-Wert) | € pro EW | 5,23 | 4,01 | 4,40 | 1,22 | 30,4% | 18,9% |
| 2 | Kosten Energie (540)/ ange. Einw. (CSB 85-Perc.-Wert) | € pro EW | 3,13 | 1,98 | 2,16 | 1,15 | 58,1% | 44,9% |
| 3 | Löhne und Gehälter (55) inkl. externe DL Instandh. (5471)/ ange. Einw. (CSB 85-Perc.-Wert) | € pro EW | 1,02 | 0,73 | 1,26 | 0,29 | 39,7% | -19,0% |
| 4 | Kosten Instandh. (=551/552+5471+5472+543b +549)/ ange. Einw. (CSB 85-Perc.-Wert) | € pro EW | 0,87 | 0,46 | 1,06 | 0,41 | 89,1% | -17,9% |
| | Mittlere Abweichung | | | | | | **54,3%** | **6,7%** |

## Benchmarking: Plan of Actions

| Nr. | Reinigungs-stufe (Mech., Bio. etc.) | Maßnahme (Benennung der Maßnahme die angedacht ist. Diese Spalte wird automatisch aus den Folgeseiten gefüllt) | kfm. Kenn größen (Nr. aus Erhebungs-bogen kfm. Kenngrößen) | quantifizierbar (Bitte zutreffendes ankreuzen) ja: erwartete Einsparung lässt sich konkret in EUR benennen | quantifizierbar (Bitte zutreffendes ankreuzen) nein: erwartete Einsparung lässt sich nicht beziffern | Voraussetzungen (Welche Bedingungen müssen erfüllt sein, um diese Maßnahmen umsetzen zu können?) | Zielsetzung (Was soll mit dieser Maßnahme bewirkt werden?) |
|---|---|---|---|---|---|---|---|
| 13 | biol. Reinigung | Stillegung / Ausbau von 10 (?) Rührwerken (siehe Energieanalyse) | 5472 | X | | keine | Nutzung der Rührwerke als Ersatzaggregate, d.h. Reduzierung von Instandhaltungsaufwand |
| 14 | biol. Reinigung | Überprüfung des Rührwerkbetriebes in den Denitrifikationszonen | 540 | | X | Probeweise Installation eines FU´s zur stufenweisen Herunterregelung bei gleichzeitiger Erfassung des Mischergebnisses Keine Nachrüstung von FU´s. Sondern Betrieb von nur 1 Rührwerk und zwar wechselnd. | Reduzierung der Stromkosten |
| 15 | biol. Reinigung | Optimierung des Rückführverhältnisses (s. Energieanalyse) | 540 | X | | Zuständiger Betriebsingenieur muß ein Zeitkontingent für dieses Projekt haben. | Reduzierung der Stromkosten |
| 16 | biol. Reinigung | Absenkung des Schlammalters in der biol. Stufe (s. Energieanalyse) | 540 | X | | Zuständiger Betriebsingenieur muß ein Zeitkontingent für dieses Projekt haben. | Reduzierung der Stromkosten |
| 17 | Schlammstabilisierung | Nutzung des zweiten Faulbehälters (Testprojekt! Siehe Energieanalyse) | 540 | X | | Gasmessung muß überprüft und ggf. in Ordnung gebracht sein. Zuständiger Betriebsingenieur muß ein Zeitkontingent für dieses Projekt haben. | Reduzierung der Energiekosten / Gewinnung von Wärme |
| 18 | | 0 | | | | | |

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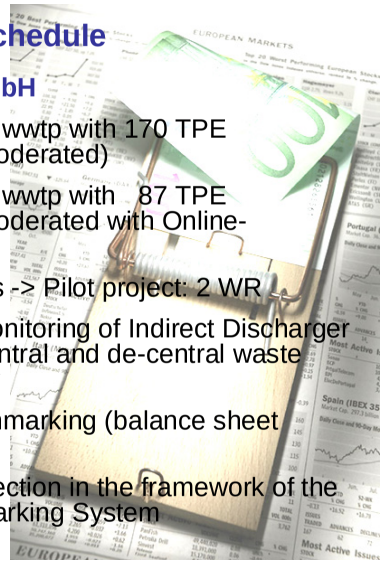
## Benchmarking: Time Schedule



- Partner: **aquabench GmbH**
- 2004: WWTP VII -> 2 wwtp with 170 TPE (Project type: moderated)
- 2005/06: WWTP VIII -> 3 wwtp with 87 TPE (Project type: Moderated with Online-Database)
- 2005/06: Water reservoirs -> Pilot project: 2 WR
- 2005/06: Analysis and Monitoring of Indirect Discharger Pilot project: Central and de-central waste water laboratory
- 2005/06: Company benchmarking (balance sheet indicators)
- Target: Yearly data collection in the framework of the Online-Benchmarking System

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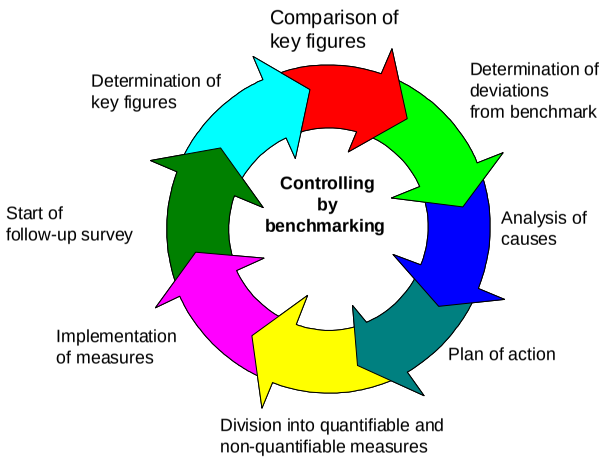
## Target: The Benchmarking - Loop

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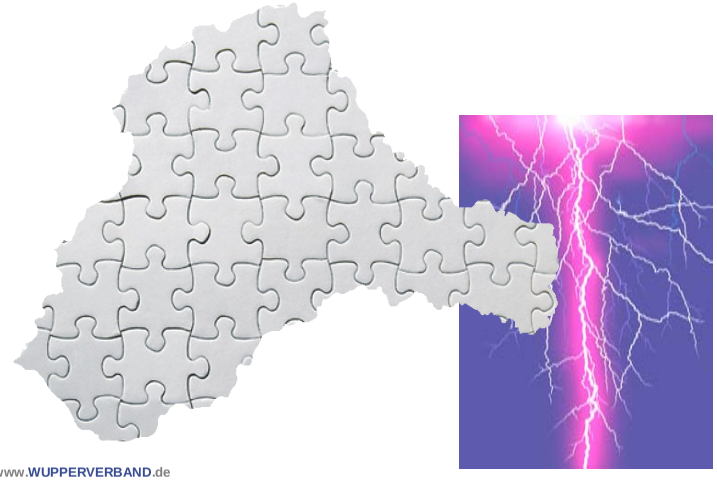
## The Energy Management System within the Wupperverband



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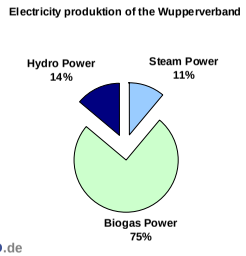
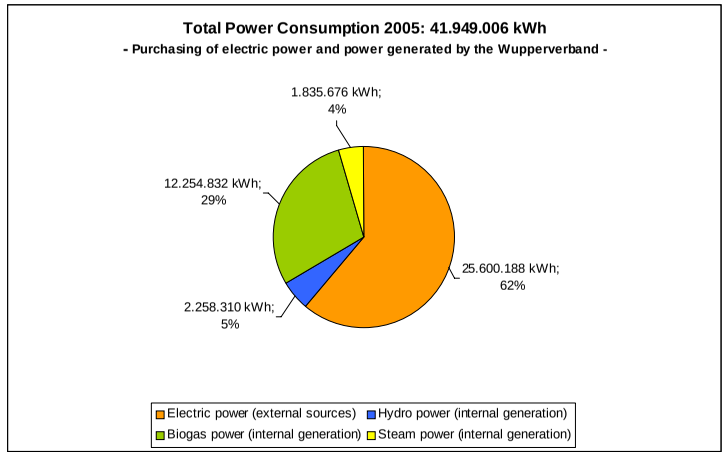
## Energy consumption, power production

| Energy | Consumption WV per year | kWh / a | Share |
|---|---|---|---|
| Power (external) | approx. 25.6 Mio. kWh/a | 25,600,188 | 45% |
| Power (internal) | approx. 16.3 Mio. kWh/a | 16,348,818 | 29% |
| Fuel oil | approx. 1.22 Mio. l/a | 12,792,497 | 23% |
| Natural gas and propane | approx. 132,000 $m^3$/a | 1,200,000 | 2% |
| District heat | approx. 820,000 kWh/a | 820,000 | 1% |
| | | **56,761,503** | **100%** |

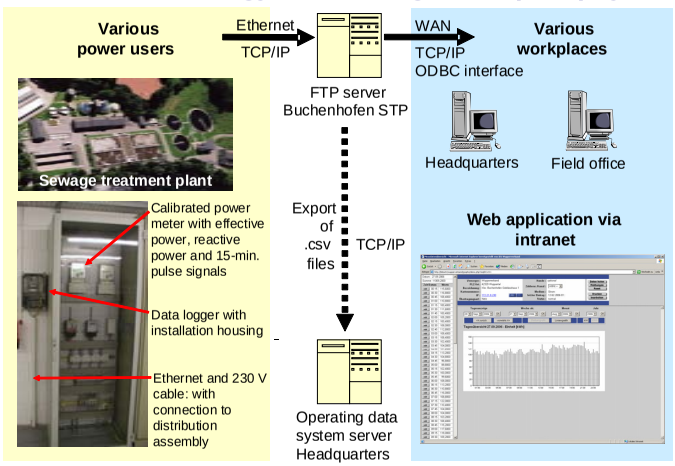




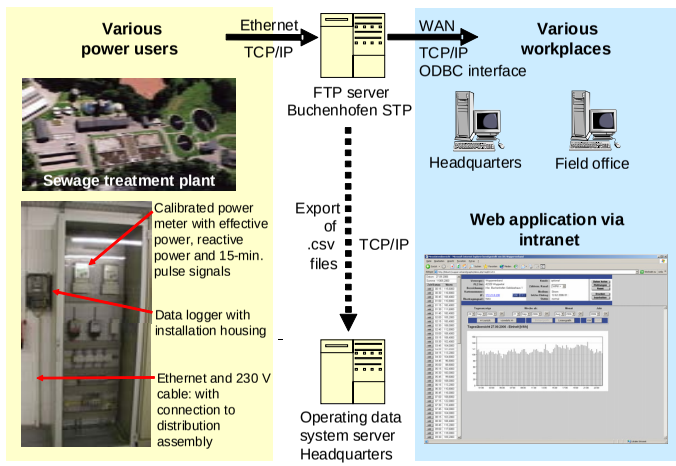






## Structure of an energy data management (EDM) system





## Targets and cost of the Energy Data Management

Targets of the EDM:

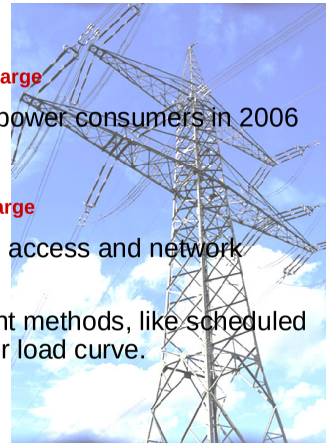
- Quick availability of data in a consistent format,
- Transparency of data, independence from the power supplier
- Automatically evaluation of the power consumption, the billing and the reporting
- Optimisation and flexibility of the energy purchasing

| Cost type | Total cost (gros) |
|---|---|
| Hardware and other materials | 14,729 € |
| Software | 8,796 € |
| Services | 13,147 € |
| In total | 36,672 € |
| **2.821 € / power consumer** | |
| 18 data logger: approx. 2.241 € / power consumer | |



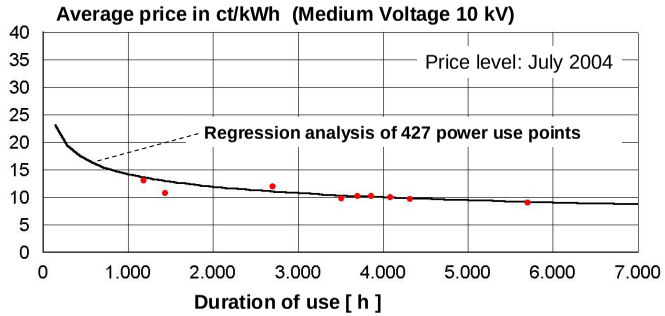
## Power Procurement

- First Call for tenders for Power purchase in 2004:
  Delivery period: 2005/06 +1 + 1
  Delivery quantity : 27.7 Mio. kWh
  18 power consumers
  Delivery „All inclusive“
  10 charges, 24 offers = **2 - 3 offers per charge**
- Second call for tenders with 13 power consumers in 2006
  Delivery period: 2007/08 +1 +1
  Delivery quantity: 21.5 Mio. kWh
  Delivery „All inclusive“
  5 charges, 19 offers = **3 – 5 offers per charge**
- Separated contracts for network access and network utilisation
- Investigation of new procurement methods, like scheduled purchase in relation to the power load curve.



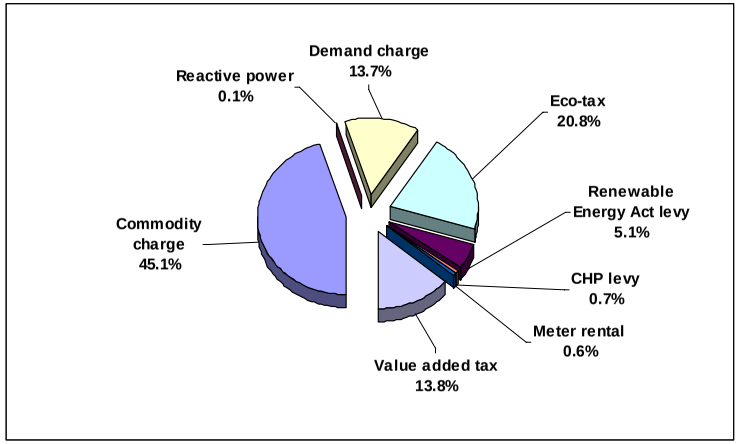


## Annual duration of use and average power cost






## Elements of the power costs in Germany (2005)



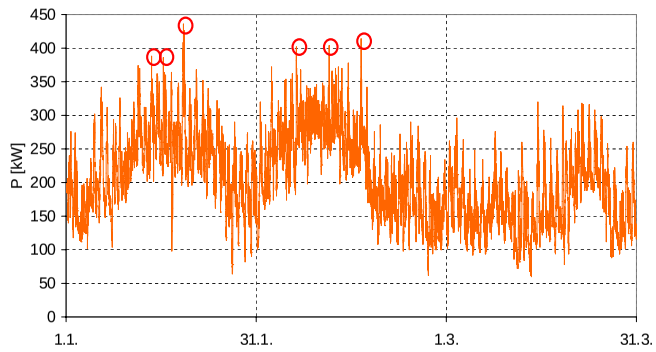
## Energy Analysis acc. to the “Manual NRW“

| Completion | WWTP | PE | Analysis |
|---|---|---|---|
| Apr 99 | Wermelskirchen | 12,700 | Rough Estimation Analysis |
| Feb 01 | Marienheide | 15,010 | Detailed analysis |
| Mrz 01 | Schwelm | 32,500 | Detailed analysis |
| Nov 01 | Odenthal | 13,500 | Rough Estimation Analysis |
| Feb 02 | Dhünn | 2,143 | Detailed analysis |
| Nov 04 | Hückeswagen | 39,007 | Detailed analysis |
| Mrz 06 | Burg | 90,016 | Detailed analysis |

| Total (without wwtp Odenthal) Population equivalent: 191,376 | Energy (power and heat) [kWh/a] | Share in energy [%] | Cost differential (AB - AC) [€/a] | Share in cost [%] |
|---|---|---|---|---|
| Savings potential determined | 2,492,692 | 100% | 96,352 | 100% |
| **Of which:** | | | | |
| Already realized | 1,368,767 | **55%** | 85,313 | **89%** |
| Realization with expansion / modifcation | 983,727 | 39% | -499 | -1% |
| Realization not feasible | 31,565 | 1% | 1,217 | 1% |
| Other items (clarification required) | 108,633 | 4% | 10,323 | 11% |
| Abbreviations: AB = Annual Benefit, AC = Annual Cost | | | | |



## Load Managment






## Load Management

| WWTP | Annual hours of use | | Feasibility Study | Installation |
|---|---|---|---|---|
| **Base year** | **2003** | **2005** | **2003** | |
| Buchenhofen | 5,702 | 5,131 | Amortisation in 7.5 years | Feeding into network in accordance with Renewable Energy Act |
| Hückeswagen | 3,699 | 3,660 | C/B = 0.8 | Together with the modifiation of the wwtp |
| Radevormwald | 4,083 | 2,665 | C/B = 0.9 | After expansion of wwtp |
| Schwelm | 2,699 | 2,415 | C/B = 1.1 | No installation |
| Burg | 4,319 | 3,340 | In progress | |
| Abbreviations: C = Cost, B = Benefit, wwtp = waste water treatment plant | | | | |

- Investigation of more wwtp´s
- Implementation and Adaptation is a big operational challenge



## Conclusion and outlook (1)

- With the installation of the new **Central Process Data System** the Wupperverband gets a modern, flexible and user-friendly tool for process optimisation and technical controlling.
- The **Reporting System** for the waste water treatment plants of the Wupperverband is developed and is available for the management. It needs – however – optimisation, especially for the use of technical and economical **Key Performance Indicators**.
- The Wupperverband is using the **Benchmarking – Method** in various business processes intensely. The aim of the process benchmarking of wwtp´s is to generate the key performance indicators on an online platform once a year (www.aquabench.de).
- The development of an **Energy Data Management System** is a new task in the business. It is using the online data transfer from local plants and is focusing on the collection and presentation of the power load curve. It will support the purchasing and consumption of electric power actively.

## Conclusion and outlook (2)

- The **Purchase of Electric Power** with fixed tender processes is in terms of the market conditions - influenced by the European Energy Exchange (EEX) - difficult and seems not to be economical.
  It is important to look at new methods which are on the one side faster and more flexible but have on the other side a limited risk and fulfil the regulations for purchasing by public companies.
- The reduction of power consumption by carrying out **Energy Analysis** of the Manual NRW is successful and will be continued.
- **Automatic Load Management Systems** are an effective tool to reduce energy costs. It is difficult to find a balance between power load reduction and an efficient waste water treatment process. The Wupperverband is not using automatic load management systems yet but will – however – install them und investigate further waste water treatment systems.



## “Domo Arigato” for your attention !