Development and testing of a multi-criteria expert system for the real-time energetic optimization of wastewater treatment plants - EOS

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Concept of EOS

Indroduction

During the last decade, the optimization of energy consumption of wastewater treatment plants (WWTP) has focused more and more onto the operators. The main focal point of work was the optimization of consumption of technical aggregates as well as increasing the internal production of electricity by the plants using biogas.

Analysis → Realization → Evaluation
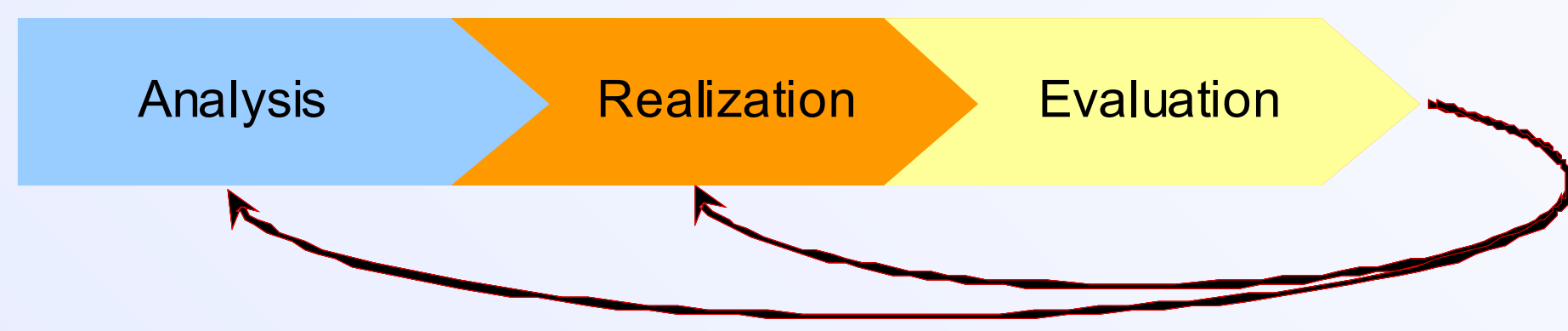
The approaches for an optimization of consumers are usually derived from historical operation data and there is often no evaluation of the energy saving measures. This is a disadvantage because there isn't a real-time component and there is no possibility for a prompt efficiency control.

Idea of the Energy Online Service Tool (EOS)

This system will be an all-purpose tool for the main process technologies used in municipal wastewater treatment. The system shall connect all relevant data on energy consumption and production on wastewater treatment plants in order to provide the operator with the required data and to assure a most energy-efficient treatment of the plant.

The multi-criteria expert system for the real-time energetic optimization of waste water treatment plants will be developed by the University of Luxembourg, the Cenre de Recherche Public Henry Tudor, SIDEN (Luxembourg) WiW mbH and Wupperverband (Germany).

The project is part of the European Interreg IVb project INNERS (INNovative Energy Recovery Strategies in the urban water cycle).

Scheme of EOS
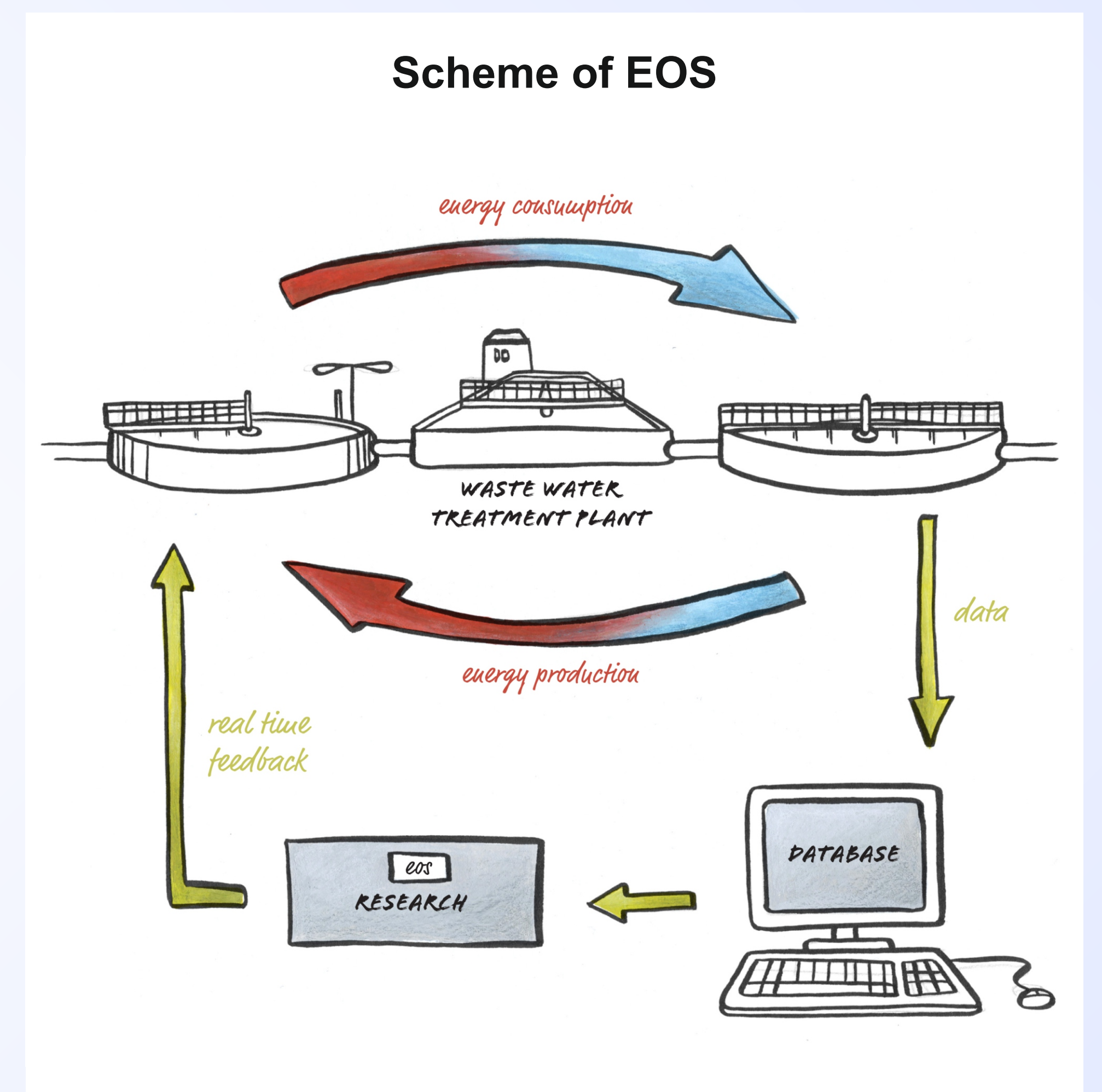
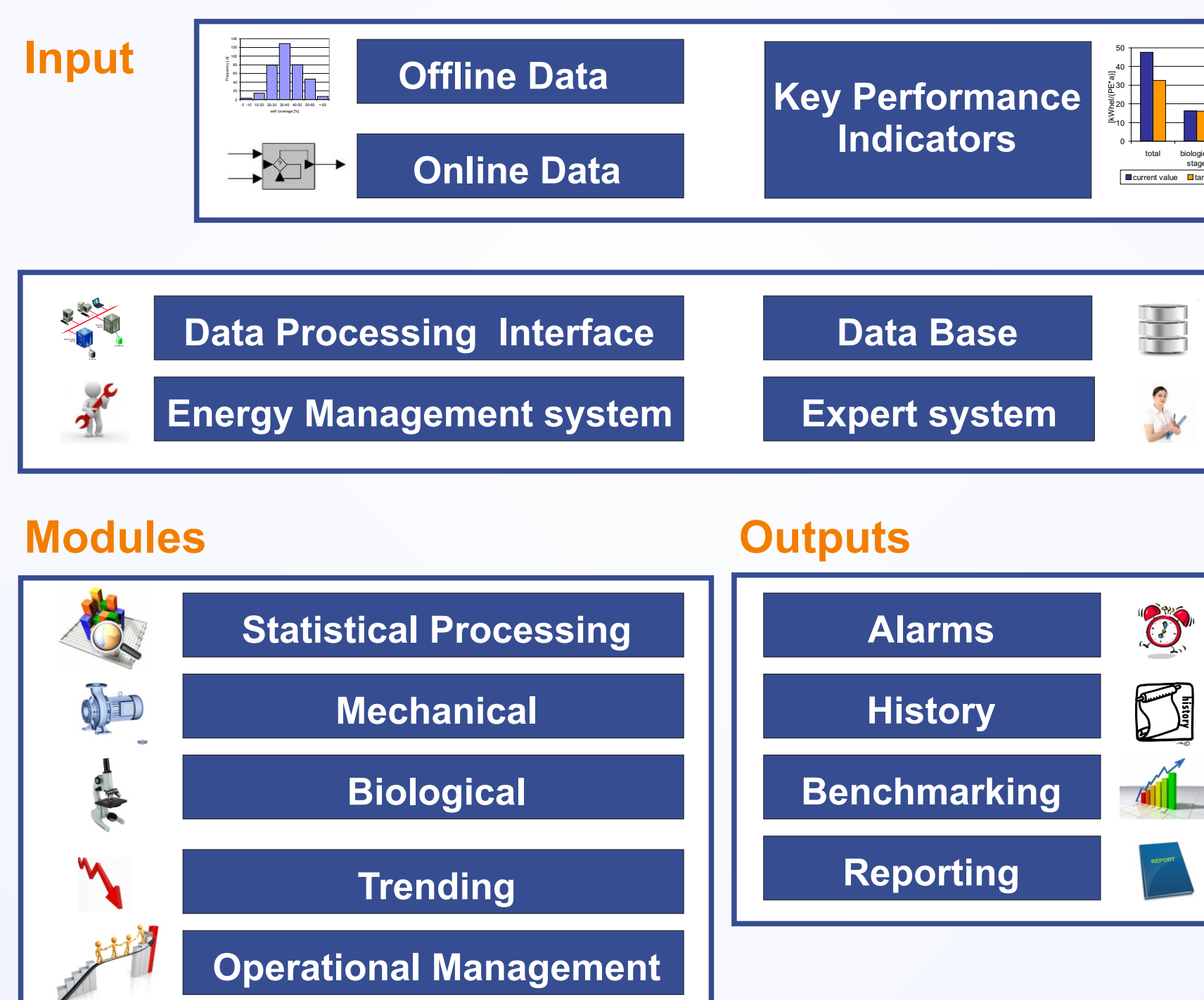## Features of EOS

Objectives

With the energy online service system the energy consumption of sewage plants shall be monitored and suggestions for the optimization of the treatment process shall be made.

The real-time energy consumption data shall be connected to the current inflow and the input load of the sewage treatment plant. This enables the implementation of a continuous improvement process for the energy consumption on sewage plants with the target of energy self-sufficiency.

In addition specific key performance indicators for aggregates like blowers, CHPPs or pumps can be derived from the energetic consumption data. This will allow operators to check the energy efficiency of those aggregates dominating the energy consumption in process.

Modules of the System

The sytem is based on an energy management tool and an expert system. For the evaluation of the data statistic tools are integrated.

Input

| Offline Data | Key Performance Indicators |
| Online Data | |

| Data Processing Interface | Data Base |
| Energy Management system | Expert system |

Modules

| Statistical Processing |
| Mechanical |
| Biological |
| Trending |
| Operational Management |

Outputs

| Alarms |
| History |
| Benchmarking |
| Reporting |

Key performance indicators

For evaluation of the energy consumption of the WWTP the following key performance indicators were defined:

- total energy consumption ($kWh/(E*d)$ / $kWh/(COD*d)$ / $kWh/(N_{eli}*d)$ / $kWh/(m^3*d)$)
- specific power consumption of the biological stage ($kWh_{el}/(PE*a)$)
- use of the produced digester gas (%)
- degree of digester gas transformation to power (%)
- specific digester gas production per kg organic matter feed ($l/kg\ VSS_0$)
- the self coverage of power and heat (%)
- efficiency of the CHPP (%)
- efficiency of the pumps ($kWh/(m^3*m)$)
- efficiency of the blowers ($kWh/m^3/bar$)
- efficiency of the aeration system ($kg\ O_2/kWh$)
- efficiency of the stirrer ($kWh/(m^3*m)$)

Results

Implementation of the system

The system will be installed and tested at Heiderscheidergrund WWTP, operated by SIDEN in Luxembourg, and Burg WWTP, operated by Wupperverband in Germany. The first plant is designed for simultaneous aerobic stabilisation and agricultural use of the produced sewage sludge, whereas at Burg WWTP the sludge is digested and incinerated. The produced digester gas is used for operation of two combined heat and power plants.

Currently, both plants are equipped with online measurement units for the larger aggregates like blowers and pumps in order to provide the required energy consumption data. The energy consumption of smaller and discontiously operated aggregates will be calculated by one-time measurement of the power and the hours of operation.

The start-up for programming was in March 2012. Testing of the system is assumed from Jan-Dec 2013 .

Outputs

- Continuous provision of energy consumption data of WWTP
- Compilation of monthly reports of energy consumption for plant managers
- Documentation of performance related to energy consumption of installations, equipment and devices
- Comparison of short and long term performance of energy consumption
- Forecast of energy consumption based on historical data
- Detection of abrasion / altering of aggregates
- Covering of peaks in electricity demand by in-house energy production
- Increasing the degree of capacity utilisation of devices
- Derivation of suggestions for the optimisation of the treatment processes (e. g. sludge age, O_2-set value, recirculation rate)

Luftaufnahme: Stadt Wuppertal, 2008
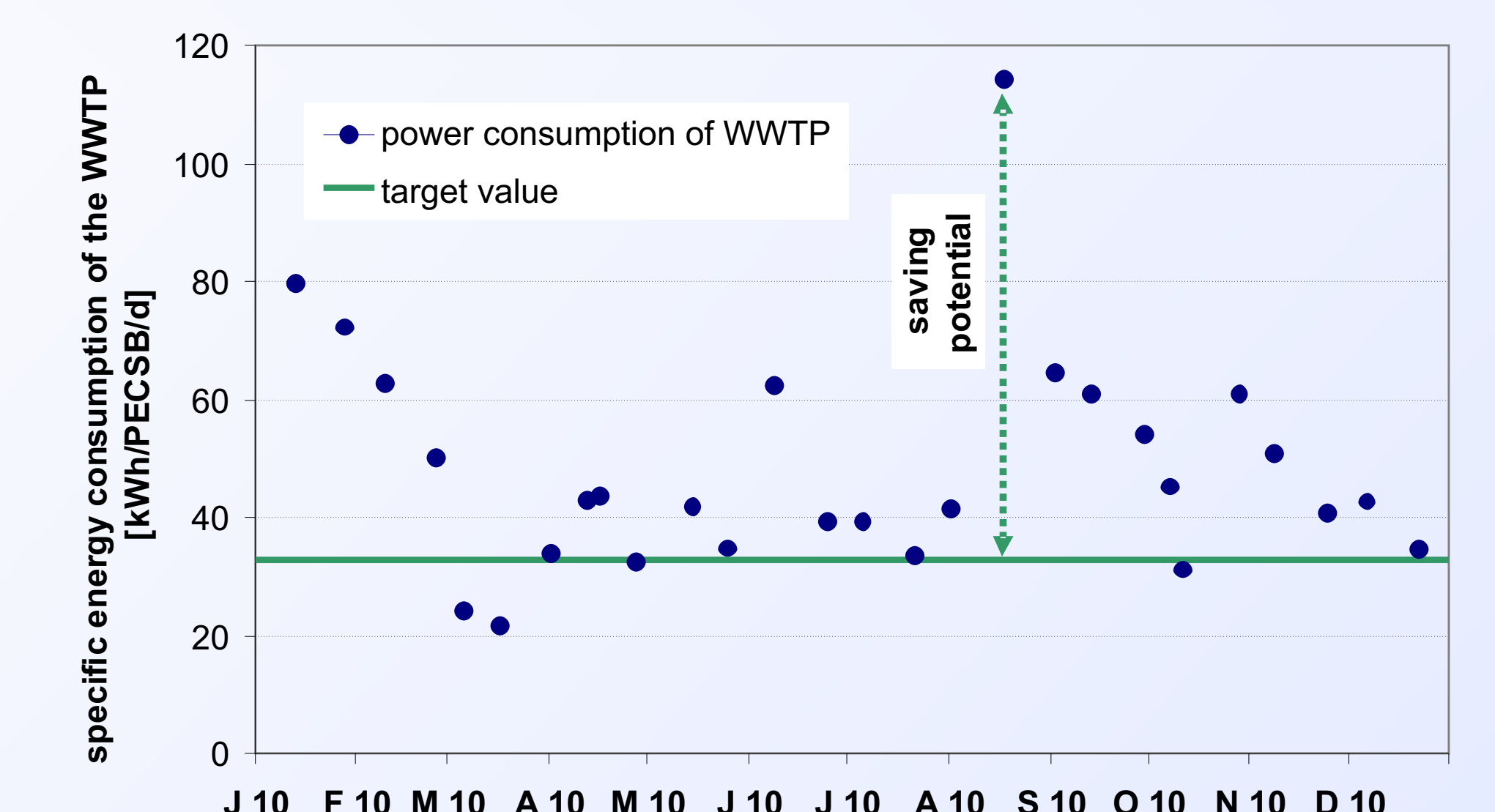
Energetic saving potential of the WWTP Burg related to the varying influent load

Contact and information

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