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# Every drop counts

## Digital solutions help protect water resources


## Summary

### Digitalization enables more efficient and more sustainable processes in the water industry

Companies in the water and waste water industry must adapt their systems and plants to climate, demographic, and structural change. In order to meet these challenges in a sustainable way, the industry must connect the demand and supply sides for both water supply and waste water disposal to an integrated data platform to achieve a circular water economy. In this context, digital solutions can help achieve savings and provide optimization opportunities in many areas, including data acquisition, assistance systems, the networking and integration of subsystems, distributed services, and even autonomous infrastructure systems.

### Use cases demonstrate the potential and benefits

Using three application scenarios, this whitepaper shows that digitalization can be successfully implemented already today. Digital applications help reduce energy consumption in water and waste water treatment, minimize non-revenue water, and enable optimal use of the buffer capacity in sewage networks. Each scenario is presented in detail, illustrating the benefits of digitalization for the water and waste water industry.

### Integrated solutions for the entire water cycle

To optimize operation, water and waste water plants and infrastructure systems require intelligent control and management systems. Siemens supports the industry with a comprehensive set of solutions for the entire water cycle.


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# Water in the 21st century: stressing resources

### Water shortage as a global and local issue

Access to clean water is a human right. However, in many regions, people lack a secure supply of drinking water. Additionally, climate change, urbanization, and contamination from agriculture and industrial production threaten water quality in lakes, rivers, and aquifers. Pollution is one of the key factors stressing water resources in developed countries, making clean water an increasingly scarce and valuable resource that requires special protection. For example, 36 river basins in Europe fail to meet the EU Resource Efficiency Roadmap targets that limit water extraction to 20% of renewable resources, even though water consumption has been reduced by 19% since 1990.

In 2015, as a result of hot and dry summer conditions, the share of people affected by water scarcity increased to 30% in Europe – up from 20% in 2014.[1] At the same time, urbanization has caused local consumption to exceed the regeneration capacities of natural water resources even in wet and precipitation-rich areas. In 2013, 60% of cities and metropolitan areas in Europe were overexploiting their groundwater resources.[2] On top of this, contamination from intensively used land and the release of insufficiently treated waste water have impaired water quality, so that increasingly complex methods of treatment are needed to produce drinking and process water of adequate quality.

Climate change, contaminants, urbanization: to protect the usable water resources in a sustainable manner, the water and waste water industry has to face numerous challenges

### Challenges for a sustainable water economy

Companies in the water and waste water industry need to address the challenge of adapting their systems to ongoing climate, demographic, and structural change. A growing number of both private and industry users are located in metropolitan areas, where the demand for water and the amount of waste water generated both continue to rise. To safeguard surface and groundwater quality, requirements for waste water treatment are becoming increasingly stringent. And finally, plant operators must protect natural water bodies from uncontrolled release of contaminated waste water through overflooding of waste water systems, even under extreme conditions caused by storms or heavy rainfall.

For sustainable water and waste water management, the industry must connect the demand and supply sides for both water supply and waste water disposal to an integrated data platform to achieve a circular water economy, focusing on three areas of action: optimization of energy consumption in the treating of water and waste water, reduction of non-revenue water by quickly detecting and eliminating leaks, and optimization of capacity management by improving the use of buffer capacities in sewage networks.

- Optimizing energy consumption:
  Based on real-time data, plant operators can make informed decisions that significantly improve plant efficiency, for example, by optimizing pump schedules to reduce energy costs using dedicated tools.
- Reducing non-revenue water
  Integrated monitoring of the supply network helps operators identify leakages in a timely and targeted way as well as ensure compliance with quality requirements and enable demand-driven water treatment.
- Reducing contamination of water bodies:
  Model-based optimization solutions enable plant operators to free up sufficient buffering capacity in their systems prior to a heavy rainfall event to hold the added water. These solutions also support operators in adapting the set points in their waste water treatment plants to the changed waste water composition.

[1] *Use of Freshwater Resources,* European Environment Agency Assessment, 2018

[2] *A Water Blueprint for Europe,* European Union, 2013

## Increasing efficiency and cutting costs drive digitalization efforts

The German Water Partnership e. V., the leading association for the German water sector, views digitalization as a major lever for savings and optimization in the water and waste water industry.[3] Digital solutions can be beneficial in many areas, including data acquisition, assistance systems, the networking and integration of subsystems, distributed services, and even autonomous infrastructure systems. Following are the three major drivers of digitalization:[4]

- Increasing efficiency in water and waste water treatment, water distribution, and waste water collection, as well as streamlining communication with users
- Cost savings through improved monitoring of water and waste water infrastructure systems and demand-driven operation of systems and plants
- Compliance with increasingly stringent regulatory requirements for water and waste water quality as well as for supply and treatment security and quality

## Networking, modeling, and simulation

By networking and integrating process, engineering, and operational data, the entire technical and organizational process and value chain of a water system can be represented in a digital model of buildings and plants. This results in a so-called digital twin, a data-based plant model that incorporates all design and operational data over the entire plant lifecycle. This digital twin supports the ongoing optimization of engineering, operation, and maintenance procedures. Intelligent linking of data from plant operation with global data such as weather reports, combined with advanced data analysis methods like machine learning, allows users to both optimize day-to-day plant operation and better respond to unusual events (e.g., heavy rainfall, pipe bursts). Such solutions are already available today to enable data integration and analysis, both as on-premises software solutions and as secure cloud solutions.


**Modeling and machine learning can help optimize and simplify industrial water management. For instance, sensor data can be acquired on-site and (pre-)processed with edge computing. The data are then used to develop and refine a matching model that incorporates advanced neuronal algorithms to predict scenarios and system behavior. The quality of the results depends on the time and data available for training the algorithm. Users can then access the results of the model via suitable applications.**

[3] *Water 4.0,* German Water Partnership, 2019

[4] *Market Research Report: Water's Digital Future: The Outlook for Monitoring, Control and Data Management Systems,* Global Water Intelligence, 2016

# Reducing energy consumption through optimized pump operation

### Situation
Pumping water during transport, buffering, or treatment requires many (often large) pumps that account for a major share of the energy consumed in the water and waste water industry. Therefore, optimizing the energy consumption of pumps can help significantly reduce energy costs – for example, by exploiting low-tariff times in flexible cost plans for electricity. Tanks and reservoirs can be filled when there is excess electricity in the grid and tariffs are low. Saving energy not only reduces costs but also helps reduce the carbon footprint of the water and waste water industry and decrease overall resource consumption. In addition, optimized plant operation reduces equipment stress and increases the availability and service life of pumps and other components.

### Solution
Energy- and cost-efficient operation must not, however, impair security of operation. That is why plant operators need to rely on and analyze current data in real time, both from their plants and from other sources: consumption patterns, available assets for base and peak load operation, buffer capacities, and demand forecasts. These data must be acquired and analyzed with powerful advanced algorithms, and the results must be presented to the operator in a meaningful dashboard. This information enables operators to identify the optimum trigger points for pumps and valves and the optimum pump combinations and speeds for the given hydraulic head and load curves for tanks based on current data – while ensuring continuous and secure operation.

For this purpose, smart applications such as SIWA Optim acquire data from the process control system and link them to data from public utilities, consumption forecasts, and other sources. The data can be analyzed both on the premises and in the MindSphere cloud. The results can be filtered and analyzed according to individual task (analysis, optimization, mode of operation) so that operators have immediate access to the relevant information for their requirements.

### Benefits
SIWA Optim integrates all parameters that are relevant to plant optimization. Pumps and valves can then be operated in a smart and demand-driven way, which helps reduce operational costs and resource consumption.

Plant operators benefit from

- lower energy consumption and lower costs,
- improved security of supply,
- streamlined operations and maintenance,
- shorter response times to unplanned events, and
- powerful modeling and simulation tools.

**Using applications such as SIWA Optim, plant operators can optimize pump and valve operation and schedules according to current plant data and consumption forecasts as well as daily tariffs for electrical energy. This results in energy and cost savings of up to 15% while ensuring security of supply.**

# Reducing non-revenue water through faster leak detection

## Situation

Globally, water that is fed into the pipe networks and then lost through leakage or theft is a major issue for the water industry. In some regions, more than 50% of processed water is lost during pipeline transport.[5] This non-revenue water not only impacts the economic performance of water supply companies; it also increases pressure on natural water resources, as more water is produced than is actually needed. Unaccounted-for losses of waste water, in contrast, are often a major source of contamination and can affect water quality. Major events such as pipe bursts can also damage infrastructure and neighboring properties. Therefore, plant and network operators need to detect and locate leaks quickly and precisely.

In addition to leaks, water theft and unbilled authorized consumption (e.g., for firefighting) can lead to high levels of non-revenue water, and metering inaccuracies can result in apparent losses in pipe networks. A leak detection solution must be able to discriminate between the various types of non-revenue water or unaccounted-for water loss and support a cost-benefit analysis for service and modernization projects

## Solution

Advanced tools help detect pipe leaks using data from existing metering and automation systems. The applications are able to combine different measuring methods (flow rates, mass balance, pressure wave analysis, pressure drops) and can detect both small or creeping losses and large or sudden leaks with minimal delay and high precision. The SIWA Leak application, for example, uses data from the automation systems and can be deployed at the plant level. The results of the analysis can be displayed directly in the SIMATIC PCS 7 process control system so that operators receive an immediate notification. Additionally, cloud-based applications such as SIWA LeakPlus *powered by BuntPlanet*[6] combine data from the water distribution network with cloud computing, artificial intelligence, and hydraulics simulations to detect hidden anomalies that point to leaks. The results are presented to operators via a dashboard.

## Benefits

Using digital tools, plant operators can detect leaks faster and with greater precision. This helps

- reduce leakage times and rates (by up to 50% with SIWA LeakPlus),
- reduce or eliminate the resulting damage through faster detection,
- decrease operational and maintenance costs through demand-driven asset management, and
- increase detection resolution and precision in identifying the location and size of leaks using AI.

**Digital solutions such as SIWA LeakPlus use current plant data and AI methods to detect losses in the water distribution network. Based on predefined criteria, the application detects leaks and pipe bursts in a district metered area or pressure management area.**

[5] "Non-revenue Water," Wikipedia, 2019

[6] A Siemens collaboration partner

# Reducing contamination of water bodies with optimized sewer management

### Situation

In many countries, surface runoff and sewage are collected in a mixed sewer system. This can result in an uncontrolled sewer overflow in the event of heavy rainfall, which releases untreated or contaminated water into the environment. As heavy rainfall events are predicted to occur with increasing frequency, especially in Europe, due to climate change, plant operators must enable their sewer systems to safely handle peak inflow events. In addition to the construction of additional buffers for surface runoff, flexible and predictive operation of existing capacities can improve plant and network performance in such events, especially since the inflow of large amounts of surface runoff can impair the performance of waste water treatment plants.

Climate change results not only in more frequent heavy rainfall events but also the exact opposite. Dry spells (and water conservation efforts) cause insufficient flushing of pipes and waste water systems, resulting in the scaling and blocking of pipes as well as odors from the sewer system. To avoid these problems, waste water must be pumped through the system to flush the sewers. Operators require demand-driven pump control and appropriate buffer capacities to address these issues.

### Solution

An intelligent central solution for sewer management and control can enable the buffer capacity in the sewer network to be used to relieve pipelines and even out the inflow to waste water treatment plants. Applications such as SIWA Sewer enable dynamic online optimization of sewer operation based on current levels in the sewers, holdup tanks, and overspill tanks as well as rainfall prediction from weather forecasts. The optimization algorithm runs continuously (three-minute intervals) and results in optimized schedules for pump and valve operation and optimized set points for affected plants and systems. Schedules and set points are transferred to the SCADA or distributed control system via OPC UA.

### Benefits

Digital tools help operate gates, locks, and pumps based on current rainfall forecasts to optimize sewer management as well as waste water treatment performance, thereby preventing uncontrolled release of sewage into the environment. Both plant operators and affected communities benefit from

- optimum sewer utilization,
- optimum waste water treatment performance,
- effective support for and relief of operators during normal and extreme operating conditions, and
- savings due to reduced investment in additional holdup tanks and structures.

**SIWA Sewer was developed specifically for operators of sewer networks and sewage treatment plants. The system controls the sewer network and regulates waste water flow. The result is a more even inflow to the sewage treatment plants, thus reducing energy costs and preventing discharge of untreated sewage into natural water bodies.**

# Digital solutions for the water industry

## Ready for the Digital Enterprise

Implementing Industry 4.0 strategies in the water industry to create Water 4.0 solutions entails the comprehensive networking and analysis of data across existing systems and organizations. The Siemens strategy for the Digital Enterprise addresses critical aspects of Industry 4.0 such as integrated engineering and integrated operations, cloud connectivity with the open Internet of Things (IoT) operating system MindSphere, and dedicated applications for data analysis and processing in the cloud.

## From integrated engineering to integrated operations

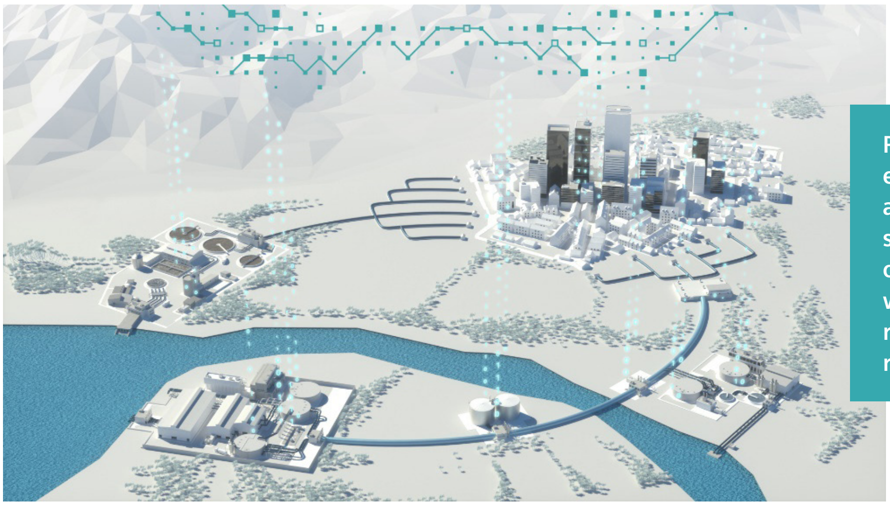
Siemens offers a comprehensive portfolio of software and automation solutions from integrated engineering to integrated operations that ensure consistent data transfer through all phases of the plant lifecycle. The COMOS plant engineering software ensures a consistent database from design and engineering to operation, improving engineering quality and yielding time and cost benefits for OEMs and plant operators alike, for example, though parallel engineering. Automation data can be transferred from COMOS directly to the SIMATIC PCS 7 process control system, saving up to 20% of engineering time in automation projects. The SIMIT simulation software works directly with data from SIMATIC PCS 7 and COMOS for the testing of all automation and process control routines, which supports streamlined commissioning through earlier troubleshooting and the elimination of problems. Using 3D and virtual reality in COMOS Walkinside, users can walk through a virtual model of their plant and train staff at an early stage. The high degree of integration between COMOS, SIMATIC PCS 7, and SIMIT results in a consistent solution from engineering to operation and maintenance.

## Horizontal integration of processes and plants

To ensure optimized operations, companies in the water and waste water industry need to control and manage their plants and infrastructure in an intelligent way. Siemens supports these efforts with a tailored set of solutions for the entire water cycle, from drinking water processing (including desalination), water transport, pump stations, and supply networks to sewer networks, pump stations, and sewage treatment systems.

## Siemens Industry Suite – smart apps for the water and waste water industry

The water industry of the future will control and manage plants and infrastructure in a smart and energy-efficient way. To support this vision, Siemens has developed the Siemens Industry Suite for the water and waste water industry. Through the full interaction of applications and comprehensive and flexible analysis of plant data in the virtual MindSphere environment, this offering increases information availability over the entire plant lifecycle. The suite also includes the Siemens Water (SIWA) apps developed specifically for the water and waste water industry. These apps help operators optimize energy efficiency, reduce non-revenue water, prevent overspills, and enable preventive maintenance. The benefits: better security of supply, reduced energy consumption, and lower operational costs. The applications and digital services of the Siemens Industry Suite for the water and waste water industry enable greater transparency and help identify efficiency and savings potential while safeguarding security of supply.



**Protecting the environment and efficient operation go hand in hand, as Siemens products, systems, and solutions help both OEMs and plant operators in the water and waste water industry prepare for coming requirements and protect water resources for future generations.**

# Abbreviations and terms

| | |
|---|---|
| **Edge-computing** | Distributed data processing at the edge of the network; a distributed computing paradigm that brings computation and data storage closer to the location where it is needed, e.g., within a plant or automation system |
| **Cloud-computing** | The on-demand availability of computer system resources, especially data storage and computing power and/or software as a service, without direct active management by the user; generally used to describe data centers available to many users over the Internet |
| **On-premises software** | Software that is installed and runs on computers on the premises of the person or organization using the software, rather than at a remote facility such as a server farm or cloud |
| **Machine learning** | A subset of artificial intelligence; the scientific study of algorithms and statistical models that computer systems use to perform a specific task without using explicit instructions, relying on patterns and inference instead |
| **AI** | Artificial intelligence; a discipline of computer science that deals with intelligence demonstrated by machines (machine intelligence) and includes (automated) machine learning |
| **DMA** | District metered area; a subnet in a distribution network |
| **PMA** | Pressure management area; a subnet in a distribution network |
| **SIWA** | Abbreviation for **Si**emens **Wa**ter; a family of apps (SIWA Optim, SIWA Leak, SIWA LeakPlus, SIWA Sewer) developed specifically for the water and waste water industry |

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