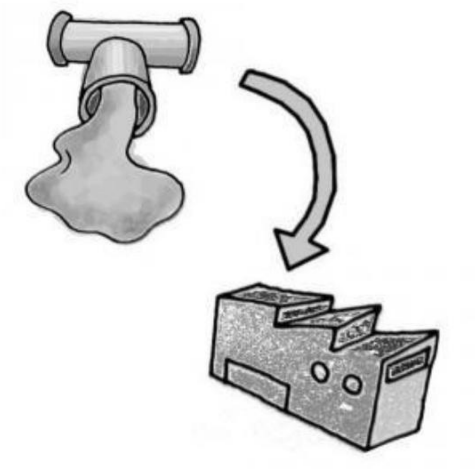
# Wastewater Reuse in Industry

**Author/Compiled by**
Andrea Pain (seecon international gmbh); Dorothee Spuhler (seecon international gmbh)



## Executive Summary

**Reusing water in industry has the potential to reduce the costs of water supply and wastewater treatment by industries and reduces pressure on water resources. Wastewater can be reused within a business itself, or between several businesses through industrial symbiosis. Depending on the type and quality of the wastewater, it may either be reused directly, or treated before reuse (i.e. recycled). The different technologies available for direct reuse as well as decentralised wastewater treatment for wastewater recycling are summarised in this factsheet.**

## Advantages

- Reduces the amount of water used.
- Reduces water bills.
- Reduces the volume of generated wastewater (no waste).
- Reduces costs through industrial symbiosis (by-product reuse, sharing management of utilities, sharing ancillary services).

## Disadvantages

- Requires high knowledge about quality of water for reuse.
- Requires financial investments.
- Requires a high level of trust between industries.
- Requires modification of current operations both for direct reuse and treat-and-reuse.

## Introduction

Industrial water consumption makes up 22% of global water use (UNWATER 2012). In 2009, European and North American industrial water use accounted for half of their total water use, whereas in developing nations industrial water use ranges from 4-12% of national water use. As industrialisation in developing nations increases, industrial water use could potentially increase by a factor of five, strongly increasing pressure on water resources (WWAP 2009).

One method of curbing water consumption in industry is through the reuse of wastewater. Reducing the amount of water use by industries can lower water withdrawals from local water sources thus increasing water availability and improving community relations, increasing productivity per water input, lowering waste water discharges and their pollutant load,

reducing thermal energy consumption and potentially processing cost.

Wastewater reuse in industry can take place within a business or between businesses and has the potential to reduce costs for businesses both on water bills as well as wastewater treatment. Depending on the contaminants present in wastewater and its future reuse, it can either be directly reused, or treated and reused (recycled).

## How Does it Work?

## Direct Reuse within a Business

A business can directly reuse wastewater that is clean enough for the purpose for which it is being reused. Process water is produced by industrial processes such as cooling and heating, and often contains few contaminants after use. In industry, both rainwater and process water can be reused for purposes such as:

- Irrigation (see also reuse of wastewater in agriculture, optimisation of water use in agriculture or WHO guidelines on reuse of wastewater in agriculture)
- Washing
- pH adjustment
- Fire protection

For more information about directly reusing water within a business, see reuse within a business.

## Direct Reuse between Businesses

Direct wastewater reuse can also be practiced between businesses. The exchange of waste products for the mutual benefit of two or more businesses is also known as "industrial symbiosis." In industrial symbiosis, all members profit from the arrangement by either reducing the inputs necessary in their production process (i.e. water, organic material) or by reducing the costs of wastewater treatment.

Industrial symbiosis can take place in three ways:

1. Exchange of by-products,
2. Sharing the management of utilities, and
3. Sharing ancillary services.

Some examples of direct reuse of wastewater in industrial symbiosis include:

- Exchange of process water from one business to another andsubsequent direct reuse as described above (such as irrigation, washing pH adjustment, fire protection, etc.)
- Reuse of organic waste or wastewater for largescale biogas production through anaerobic digestion, which can then be used to generate electricity)
- Reuse of wastewater for aquaculture of plants or animals
- Short rotation plantations
- Etc.

For more information on industrial symbiosis, see reuse between businesses.

## Treat and Reuse (Recycling)

If wastewater is not suitable for direct reuse, decentralised wastewater treatment systems may be employed to reduce the level of contaminants to a level that is safe for reuse. This can be done within a business for its own reuse, or between businesses. Wastewater treatment and reuse between businesses can lower the costs of treatment for all businesses, thus making reuse options more economical.

Some possibilities for decentralised wastewater treatment systems include:

- Waste stabilisation ponds
- Aerated ponds

- Constructed wetlands (see free-surface, horizontal, vertical, and hybrid constructed wetlands)
- Non planted filters
- Technologies making use of anaerobic digestion such as: anaerobic baffled reactors, biogas settlers, and anaerobic digestion
- More high-tech options: activated sludge, membrane bioreactors, advanced oxidation processes, ozonation, activated carbon, rotating biological contactors, and anammox

The choice for the specific treatment option depends on the quality required at the end. If water is to be used for gardening, a natural treatment such as a free surface constructed wetland where some nutrients remain in the water may be suitable, if space is available and loss of water through evapotranspiration is not important.

Some advanced options like membrane filtration and activated carbon may even produce treated wastewater of a better quality than freshwater, so that the treated wastewater can even be reused as process water where high water quality is required.

## How to Optimise?

To ensure that the quality of the (pre-treated) wastewater or greywater is appropriate for reuse, the water quality should be tested for chemical composition, including pH, nutrient concentrations, pathogens, etc.

## Costs

- Businesses can save money on water bills and wastewater treatment by reusing process water.
- Industrial symbiosis is mutually beneficial to all businesses involved by reducing input costs or wastewater treatment costs.
- Implementing reuse or treat-and-reuse measures requires initial investment which may be costly (depending on modifications required and technology).

## Applicability

Almost any business can incorporate measures for reuse of wastewater. While direct reuse measures may be relatively easy to implement, the cost of implementing wastewater treatment systems may prohibit wastewater recycling within a business.

Between businesses, wastewater reuse potential depends on factors such as the distance between the businesses (cost of transport) and the wastewater production volume and quality. If wastewater treatment is needed, the participation of several businesses may significantly reduce treatment costs and therefore enable its reuse.

## Library References

### Statistics. Water Use

UNWATER (2012): Statistics. Water Use. New York: United Nations URL [Accessed: 27.08.2012]

## Water in a Changing World - Overview of Key Messages of the United Nations World Water Development Report 3

*Key messages of the world water development report No. 3 (2009). The World Water Development Report (WWDR), the only report of its kind, provides a triennial, comprehensive review and authoritative picture of the state of the world's freshwater resources.*

WORLD WATER ASSESSMENT PROGRAMME WWAP (2009): Water in a Changing World - Overview of Key Messages of the United Nations World Water Development Report 3. Water in a Changing


World. Paris and London: UNESCO & Earthscan URL [Accessed: 19.10.2012]

## Further Readings

### The Future of Water Use in Industry. Global Ministerial Forum on Research for Health

*This paper gives an overview about the water use in Industry of the past years and makes a projection of future uses. Furthermore, the paper gives advices how to save water in the future.*

GROBICKI, A. (n.y): The Future of Water Use in Industry. Global Ministerial Forum on Research for Health. Geneva: World Health Organization URL [Accessed: 19.10.2012]

### Industrial Water Reuse and Wastewater Minimization

*This document explains how to reuse water and wastewater in Industry.*

MCYINTRE, J.P. (2006): Industrial Water Reuse and Wastewater Minimization. Trevose: GeWater URL [Accessed: 23.07.2010]

### The United Nations World Water Development Report 2018


The 2018 edition of the World Water Development Report (WWDR 2018) seeks to inform policy and decision-makers, inside and outside the water community, about the potential of nature-based solutions (NBS) to address contemporary water management challenges across all sectors, and particularly regarding water for agriculture, sustainable cities, disaster risk reduction and improving water quality.

(2018): The United Nations World Water Development Report 2018. United Nations Educational, Scientific and Cultural Organization (UNESCO) URL PDF

## Case Studies

### Industrial Symbiosis in Puerto Rico: Environmentally Related Agglomeration Economies

*This paper conceptualises the relationship between agglomeration economies and industrial symbiosis, nding that many negative environmental externalities can be reduced while increasing production efficiency. Four industrial regions of Puerto Rico, all with agglomeration economies, but only two with signi fi cant industrial symbiosis, highlight the contribution of symbiosis and how it can infl*

ASHTON, W. S. (2008): Industrial Symbiosis in Puerto Rico: Environmentally Related Agglomeration Economies. New Haven, CT: School of Forestry & Environmental Studies, Yale University URL [Accessed: 02.01.2012]

## Planning and Uncovering Industrial Symbiosis. Comparing the Rotterdam and Oestergoetland regions

*Academic discussion of the planned industrial symbiosis activities in Rotterdam Harbor around waste heat reuse and the unplanned industrial symbiosis and biogas activities in the forest*

## Industrial Symbiosis in the Australian Minerals Industry

*An academic review of industrial water reuse between mining industries in Australia. Barriers and triggers to cooperation are discussed.*

BEERS, D. van ; CORDER, G. ; BOSSILKOV, A. ; BERKEL, R. van (2007): Industrial Symbiosis in the Australian Minerals Industry. In: Journal of Industrial Ecology : Volume 11 , 55-72. URL [Accessed: 15.05.2012]

## Water conservation in textile industry

*This document explains how you can save water in textile industry. It contains good strategies how to conserve water in different process steps.*

SHAIKH, M. A. (2009): Water conservation in textile industry. Karachi: SFDAC URL [Accessed: 09.08.2010]

## Water Utilisation in African Beverage Industries: Current Practices and Prospects


*This document explains how you can save water in beverage industry. It contains good strategies how to conserve water in different process steps.*

UNEP (2007): Water Utilisation in African Beverage Industries: Current Practices and Prospects. Nairobi: UNEP, Division of Technology, Industry & Economics URL [Accessed: 09.08.2010]

*industry of Oestergoetland, Sweden.*

BAAS, L. (2011): Planning and Uncovering Industrial Symbiosis. Comparing the Rotterdam and Oestergoetland regions. In: Business Strategy & Environment, Special issue Industrial Ecology: Volume 20 , 428-440. URL [Accessed: 19.11.2012]

## Training Material

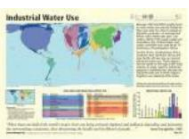
### The Hannover Principles. Design for Sustainability

*The Hannover Principles provide nine principles to create sustainable businesses for a healthier planet. The principles are simple and inspiring and can be incorporated into training materials within firms.*

MCDONOUGH, W. (2000): The Hannover Principles. Design for Sustainability. Charlottesville, VA: William McDonough Architects URL [Accessed: 15.05.2014]

## Awareness Raising Material

### Industrial Water Use




*This document illustrates the water use in industry around the world.*

SASI GROUP (2006): Industrial Water Use. Sheffield: SASI Group URL [Accessed: 09.08.2010]

### Freshwater use by sector at the beginning of the 2000s

UNEP (2002): Freshwater use by sector at the beginning of the 2000s. The Hague: United Nations Environment Programme (UNEP), GRID-Arendal URL [Accessed: 29.07.2010]

### Water for Business. Initiatives guiding sustainable water management in the private sector

*The future of any business depends on the sustainability of water resources, which are increasingly under pressure. At the same time, consumer awareness and investors' increased scrutiny of corporate water risks have resulted in stronger expectations that companies should reveal their 'water performance'. To respond effectively, the business community needs guidance, tools, standards and schemes to enable change to more sustainable practices. This is what this publication aims at providing.*

WBCSD (2009): Water for Business. Initiatives guiding sustainable water management in the private sector. Geneva: WBDSC and IUCN URL [Accessed: 19.10.2010]

**Business in the world of water: WBCSD Water Scenarios to 2025**

*The H2O scenarios offer three stories about the role of business in relation to the growing issue of water in the world. These stories do not try to cover everything but attempt to bring to life a limited number of alternative future environments that will challenge our economic viability, social legitimacy, and global fitness in the marketplace.*

WBCSD (2009): Business in the world of water: WBCSD Water Scenarios to 2025. Geneva: WBCSD URL [Accessed: 19.10.2012]

## Important Weblinks

## http://www.pollutionissues.com/

http://www.pollutionissues.com/Ho-Li/Industrial-Ecology.html#b [Accessed: 06.07.2012]
Industrial ecology aims to reduce the environmental impact of industry by examining material and energy flows in products, processes, industrial sectors, and economies. This web site provides more information on that topic.

## http://water.org/

http://water.org/water-crisis/water-facts/water/ [Accessed: 01.10.2012]
Water.org is a nonprofit organization that has transformed hundreds of communities in Africa, South Asia, and Central America by providing access to safe water and sanitation. Water.org works with local partners to deliver innovative solutions for long-term success. Its microfinance-based WaterCredit Initiative is pioneering sustainable giving in the sector.

## http://www.is4ie.org/

http://www.is4ie.org/ [Accessed: 15.05.2012]
International Society for Industrial Ecology, a research institute based out of Yale University in Connecticut, USA.

## http://www.zerilearning.org/

http://www.zerilearning.org/case_studies_pigs.htm [Accessed: 19.10.2012]
This initiative in rural Fiji includes reusing brewery waste to grow mushrooms, pig waste to produce methane gas and intensive pond management to raise fish and food crops. This website provides a brief overview.

## http://www.roi-online.org/

http://www.roi-online.org/ [Accessed: 15.05.2012]
The Resource Optimisation Initiative is a non-profit based in Bangalore, India providing planning tools for policy makers and case studies in developing countries.

## http://www.inderscience.com/

## http://www.symbiosis.dk/

http://www.symbiosis.dk/en [Accessed: 15.05.2012]

This website for Kalundborg's Centre for Industrial Symbiosis has a host of information on their projects, organisation and strategies. They describe what they think are the fundamental criteria for reuse between businesses.