EEA Technical report | No 5/2014

Performance of water utilities beyond compliance

Sharing knowledge bases to support environmental and resource-efficiency policies and technical improvements

ISSN 1725-2237

European Environment Agency

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Cover design: EEA
Cover photo © BMLFUW/Alexander Haiden
Layout: EEA/Henriette Nilsson

Luxembourg: Publications Office of the European Union, 2014
ISBN 978-92-9213-428-0
ISSN 1725-2237
doi:10.2800/13253

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Executive summary

European policies are increasingly focused on preserving the Earth's limited resources in a sustainable manner, while minimising impacts on the environment. This is included in the resource efficiency and green economy agendas. In order to obtain knowledge on the actual pressure on the aquatic environment from water abstractions and emission of pollutants, and for assessing urban water management, we need to extend the knowledge base beyond compliance with current legislation.

With the aim of improving the European level knowledge base in urban water management in the resource efficiency context, the European Environment Agency (EEA) hosted an expert meeting jointly organised with leading water associations in Europe. This event framed the context and discussed topics related to the exploitation of data already available with water utility associations and benchmarking networks beyond what is currently reported via institutional frameworks for implementing legislation.

EU-level assessments of the resource efficiency or environmental performance of water utilities are not currently as holistic as they could be. There is considerable reporting of environmental data concerning water already in place, from the local to the EU level. However, these reporting obligations are primarily concerned with the water quality parameters applicable to drinking water and treated urban wastewater. The parameters are related to compliance with the EU directives pertaining to the achievement of drinking water standards, urban wastewater collection and treatment requirements, and receiving water quality objectives.

As outlined in the EEA report 'Towards the efficient use of water resources in Europe' ([1]), economic production cannot be sustained if it requires excessive water use and burdens natural resources. It is thus essential that water uses and efficiencies are also considered in water management practices, including: the actual pressures in the aquatic environment from water abstractions, the resulting emissions of pollutants, and the energy consumption/recovery from managing the urban water cycle.

This report follows on from the discussions in the expert meeting on how the organisations and networks involved in urban water management can share their knowledge bases to support environmental and resource efficiency policies, and technical improvements. The availability of this knowledge base could create a more comprehensive approach to assessing Europe's water resources and threats. It could also enable a comparison of the environmental performance of different water utilities, monitor progress over time, and aid the implementation of novel environmental technologies.

In its response to the European Citizen's Initiative 'Right2Water' , the European Commission committed to exploring the idea of benchmarking water quality and will cooperate with existing initiatives to provide a wider set of benchmarks for water services. This significantly contributes to improving the transparency and accountability of water service providers by giving citizens access to comparable data on the key economic, technical and quality performance indicators of water operators. The information provided in this report, although having a specific focus on environmental performance based on data from voluntary benchmarking exercises, can be a useful contribution to this debate.

([1]) http://www.eea.europa.eu/publications/towards-efficient-use-of-water.

Realising the potential of current knowledge bases

There is a vast amount of knowledge on urban water management, but this knowledge does not always allow for a meaningful collection and comparison of results on a European scale. Some of this knowledge is collated and held by water management actors including the utility operators and the different levels of environmental authorities; all of which may have their own distinct reference points and definitions. Advances in urban water management are frequently presented in events and different networks, but are not always shared and maintained in a systematic approach where all interested parties have access to the information.

Some national water associations publish assessments and indicators of water utilities' performance, but the underlying working databases are often targeted at water professionals and rely on *a priori* knowledge on the topics by the user. Benchmarking networks collect data from their members related to a number of technical and economic parameters used for performance comparison and discuss improvement opportunities. The data policies for the benchmarking networks are defined by the members and results are often presented in anonymous or aggregated form where the individual plants/utilities cannot be identified directly and the underlying data are considered confidential.

In European institutional frameworks, considerable information is also provided based on the reporting from countries, e.g. to EU directives, Eurostat Water Statistics, EEA 'State of the environment' (SoE) via Eionet, and to international river and sea conventions. Most of this information is made freely available through the Water Information System for Europe (WISE) which offers products such as interactive maps and underlying thematic and reference GIS datasets. As an example, basic data on about 28 000 urban wastewater treatment plants across Europe is available, with about 9 000 including data on emissions of organic matter and nutrients.

Specific cases on implementation of novel in environmental technologies are often presented and advertised at technical-scientific conferences, but there are currently no EU level databases providing a mapping of such infrastructure.

Developing relevant environmental indicators

Indicators play a very important role in effective policy development by providing the knowledge base to assess environmental challenges. They can supply information on the nature of the environmental problem, highlight key factors in the cause and effect relationship, monitor the effectiveness of existing responses, and provide a yardstick for geographical comparisons.

The use of indicators to measure the environmental performance of water utilities across Europe would significantly improve our understanding of the resource efficiency challenges involved. It could also help with creating effective policies and targets to foster improvements. However, for these aims to be realised, a systematic process for indicator selection, computation and communication will need to be developed.

At present there are some indicators in the public domain maintained by Eurostat and EEA for European-level comparisons and trends in water quality and sanitation infrastructure, but few that specifically address water utility performance. The performance indicators developed by the water industry itself as part of their benchmarking exercises may provide an already existing basis with technical definitions already in place.

To fulfil this need, water utility organisations decided to investigate opportunities to expand the use of existing, non-monetary performance indicators such as those outlined above, and to cooperate with the EEA to create a set of new publicly available resource efficiency indicators.

Based on a review between performance indicators used by two benchmarking networks, a few examples with similar definitions were selected as test cases. For drinking water management, these were distribution losses and specific residential water consumption, respectively. For wastewater management, these were the removal of nutrients in treatment plants as well as emission intensities. Energy efficiency has been addressed with indicators on electricity consumption for drinking water production and distribution as well as for wastewater treatment, respectively. Final choices of indicators for data sharing may deviate from these, however, the examples are considered relevant and realistic and serve as a good step on the way.

Water losses are an inevitable part of the practice of public water supply, which from a resource efficiency perspective should be minimised. The term includes production losses and distribution losses, which again includes real losses in the network, unbilled consumption (e.g. firefighting) and apparent losses. Data on distribution losses from a benchmarking exercise in Germany show mean values between 0.9 and 3.1 m^3/km/day, whereas mean values from 32 large water utilities in geographical Europe show levels around 8.5 m^3/km/day. Additional data provided from water associations in France, Sweden and Denmark show weighted mean values ranging from 1 to 10 m^3/km/day with the lowest in Germany, Denmark and France and the highest in Sweden.

Data on residential water consumption show quite comparable levels: 125 l/capita/day from benchmarking for Germany (2010); 135 declining to 129 l/capita/day (2010–2012) for 31 large utilities in geographical Europe and weighted mean from 3 700 utilities of 151 l/capita/day serving 32 million. people. For Germany, the numbers correspond with those from Eurostat's water statistics, however, as these cover the domestic sector with institutions and services included, the results are actually different.

Specific nutrient emissions from wastewater treatment plants depend very much on the type of treatment, but data also show, as expected, a size effect with relatively lower emissions for the larger plants. Since data are already publicly available at individual plant level, this dataset allows for further analyses and assessments on this performance indicator with comparison across countries, regions, size classes, etc.

The water-energy nexus is gaining more attention and energy consumption in water utilities and considerable measures are taken to reduce energy consumption and increase energy recovery. For drinking water, data from German benchmarking — as well as Danish and Swedish water and wastewater associations — show weighted mean values of about 0.75 kWh/m^3 (authorised consumption). Values from Germany and Denmark are apparently similar to the mean value from 31 large utilities across geographical Europe of 0.5 kWh/m^3, however, they are not directly comparable since the latter includes distribution losses in the normalisation.

For wastewater treatment, the data made available show values of around 35–40 kWh/year/p.e., except for Sweden which has a weighted mean of 95 kWh/year/p.e. The energy consumption depends on several factors, including type of treatment and size classes. Put in perspective, based on a rough calculation example with a net consumption of 88 kWh/y/person for the urban water management household component, this corresponds about 5.5 % of total electricity consumption, or that each person has a 10 W light-bulb constantly burning.

The examples underpin the importance of clarifying terminology and definitions of performance indicators as part of establishing European level indicators to ensure comparability

Considerations for future activities for improving the European level knowledge base

The role of water utilities, represented via their associations, could be to ensure that relevant and technically well-defined performance indicators are developed as a pre-requisite for comparisons — and to provide the data to support such indicators. The role of the EEA would be to facilitate the inclusion and integration of these data/indicators into the Water Information System for Europe (WISE) and maintaining, expanding and improving the existing tools in WISE. At the same time, better awareness of what information is already freely available as WISE products to the stakeholders of water professionals may foster new interest of their use in the daily work of urban water managers. Combined, this will support the resource efficiency and green economy agendas.

Based on this report and upcoming discussions in various committees and working groups of the water associations, the interests and commitments needed for taking further steps need to be confirmed. This work will include a selection and prioritisation of the most feasible performance indicators and organising the practical pathways for sharing the data at European level. As described, there are several options for doing this: via already established institutional frameworks or in a more direct way managed by the water associations.

The EEA and water utility stakeholders may also consider how they can contribute to the actions announced by the Commission in response to the first European Citizens Initiative 'Right2Water', and vice versa.

About the cooperation between EEA and water associations

More information from the expert meeting held 13–14 December 2012 is available with an extended summary and the presentations given ([2]).

This report was prepared in a cooperation between the EEA, the European Commission (DG ENV), benchmarking networks, and four leading water associations in Europe: International Water Association (IWA), European Water Associations (EWA), European Association of National Water Associations (EUREAU) and the Water Supply and Sanitation Technology Platform (WssTP). A brief profile of the four associations is included in this report.

([2]) http://projects.eionet.europa.eu/wise-tg/library/thematic-issues/water-utilities-resource-efficiency/european-water-utility-expert-meeting-13-14.12.2012-copenhagen.

1 Introduction

High-quality, safe, sufficient drinking water is essential for life: we use it for drinking, food preparation and cleaning. The European Union (EU) established a drinking-water policy over 30 years ago to ensure that water intended for human consumption is used safely on a life-long basis. Other EU directives set out requirements for urban wastewater collection and treatment, as well as receiving water-quality objectives. In this context, water utilities are the main players in urban water management. Not only do they deliver clean water to all citizens — making them an essential public service — they also collect and treat run-off rain water and urban wastewater from residential settlements and services.

European policies are increasingly focused on preserving the Earth's limited resources in a sustainable manner, while minimising impacts on the environment. This aim is included in resource efficiency and green economy agendas. However, if we are to obtain knowledge on actual pressures on the aquatic environment from water abstraction and pollutant emissions for assessing urban water management, we need to extend the scope of knowledge beyond compliance.

There is already a great deal of reporting of environment-relevant data, from national to EU level. Information portals such as the Water Information System for Europe (WISE) ([3]) provide a knowledge base for certain water-quality parameters applicable to drinking water and treated urban wastewater, as well as basic information on infrastructure development.

Against this background, water utilities and their networks possess a much broader knowledge base than what is reported for compliance assessment. It is the aim of this initiative to analyse the possibilities of including the most relevant parts of this information into the knowledge base at the European level. This relates both to the documented performance of water utility facilities (plants) beyond the minimum requirements defined in EU directives, and to environmentally relevant parameters in a resource efficiency context, e.g. energy consumption and nutrient recovery related to urban water management.

Furthermore, it should be recognised that on the whole in Europe, a high level of water services has been achieved. For example, the connection rates of households to public water supplies and sewer systems are very high. In nearly all big cities in Europe, parts of these installations are older than 100 years; the problem of ageing infrastructure is thus increasingly relevant. There are no existing Europe-wide technical requirements, and these measures are managed at the individual utility level.

Initiatives such as the European Innovation Partnership on Water (EIP Water) ([4]) have been launched to speed up developments in water innovation, contribute to sustainable growth and employment, and stimulate the uptake of water innovation by market and society — leading to improved resource efficiency.

Benchmarking conducted by the water utility sector itself has been developed as a utility management tool, focused on improving performance in the industry. Using these data can help increase transparency in the sector and satisfy the demands of the public, supervisory bodies and politicians. Furthermore, it can help improve the sector's image. Experience has shown that utilities participating in benchmarking projects acknowledge these advantages and are willing to continue the recurring cycle process in order to constantly improve. Some of the definitions and data used for benchmarking may be very useful for improving the knowledge base at European level as well: ensuring professional comparability, and

([3]) http://water.europa.eu.
([4]) http://ec.europa.eu/environment/water/innovationpartnership/index_en.htm.

providing good coverage and data that have been quality assessed by the benchmarking networks themselves.

The foundation for this report is based on the work of 25 delegates representing 19 organisations associated with water utilities in Europe.
They provided common ground for increased cooperation in the field of data exchange at a Copenhagen meeting in December 2012. Leading water utility associations agreed to collaborate to enhance mutual understanding between Europe's key stakeholders in urban water management.

The presentations and an extended summary of the meeting are available online ([5]). This report is based on the outcome and follow-up actions of the meeting.

([5]) http://projects.eionet.europa.eu/wise-tg/library/thematic-issues/water-utilities-resource-efficiency/european-water-utility-expert-meeting-13-14.12.2012-copenhagen.

2 The policy context

2.1 Water-resource efficiency

This report does not aim to assess water utility compliance with EU or national legal requirements. Instead, the focus is on resource efficiency — the resource consumption and environmental impacts that result from producing a given output. Water-resource efficiency relates not only to the quantity of water used in production, but also to the associated resource implications: energy efficiency, nutrient recovery and emission intensities in the water utility sector. The concept is described in more detail in the EEA report titled *Towards efficient use of water resources in Europe* ([6]).

A variety of incentive frameworks drive improvements in water-resource efficiency. These range from EU directives and national legislation (which can result in infringement cases, and sanctions in the event of non-compliance) to non-binding national, local and corporate targets.

2.2 EU water directives

During the last two decades, the EU directives for drinking water and urban wastewater treatment have been key drivers of infrastructure development and compliance with water-quality criteria, particularly in instances where similar legislation is lacking at national level. Related contextual frameworks, legal documents and implementation reports are available from the web-based policy pages in WISE ([7]).

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (known as the Water Framework Directive (WFD)) is also a driver for regulation of water utilities, albeit indirectly via River Basin Management Plans (RBMPs) and Programmes of Measures. The implementation of cost recovery though water pricing is highly relevant for utilities, something that has been studied recently by the EEA ([8]). Therefore, the present report will not deal directly with this economic dimension.

Where good ecological and chemical status of water bodies is not being achieved owing to significant pressure from discharges of treated wastewater, it may be necessary to further reduce the emissions of pollutants. According to the EEA report *European Waters — assessment of status and pressures*, more than half of the surface water bodies in Europe are reported as holding less than good ecological status or potential, and will require mitigation and/or restoration measures to meet the WFD objective ([9]).

Comprehensive documentation on the 2012 review of EU water policies (the communication *Blueprint to Safeguard Europe's Water Resources*) is available from the European Commission website ([10]). Water pricing, demand management, leakage control and maintenance of ecological flows are considered crucial in water efficiency management. Investment in reducing vulnerability to floods and droughts is needed to support natural water retention measures (e.g. green infrastructures and green Common Agricultural Policy (CAP)). Also, risk management plans for extreme water events and standards for water reuse need to move forward.

On the whole, EU water directives set minimum standards for installation of the urban water supply and for sanitation infrastructure and performance to be transposed into national legislation. However, the dimension of water-resource efficiency is not covered by these regulations.

([6]) http://www.eea.europa.eu/publications/towards-efficient-use-of-water.
([7]) http://ec.europa.eu/environment/water/water-drink/index_en.html and http://ec.europa.eu/environment/water/water-urbanwaste/index_en.html.
([8]) http://www.eea.europa.eu/publications/assessment-of-full-cost-recovery.
([9]) http://www.eea.europa.eu/publications/european-waters-assessment-2012.
([10]) http://ec.europa.eu/environment/water/blueprint/index_en.htm.

It is worthwhile mentioning that the Commission, in its response to the European Citizen's Initiative 'Right to Water'([11]), takes the commitment to explore the idea of benchmarking water quality and will cooperate with existing initiatives to provide a wider set of benchmarks for water services. 'This could significantly contribute to improving the transparency and accountability of water service providers by giving citizens access to comparable data on the key economic, technical and quality performance indicators of water operators'([12]).

2.3 EU Energy Efficiency Directive

Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC (also known as the EU Energy Efficiency Directive) ([13]) specifies that Member States should set an indicative national energy efficiency target, based on either primary or final energy consumption, primary or final energy savings, or energy intensity. They should also express those targets in terms of an absolute level of primary energy consumption and final energy consumption in 2020.

When setting those targets, Member States should take into account related information, such as the absolute target for the EU's 2020 energy consumption: it must not exceed 1 474 million tonnes of oil equivalent (Mtoe) of primary energy nor 1 078 Mtoe of final energy. The Directive focuses in particular on energy use in buildings, but also highlights that when tendering service contracts with significant energy content, Member States should encourage public bodies to consider long-term energy performance contracts that provide long-term energy savings.

Overall, the directive is an important driver for the national targets on energy efficiency, but it does not impose a specific regulation for the water utility sector. It is currently up to Member States to allocate energy efficiency targets across economic sectors.

2.4 Roadmap for resource efficiency; EIP Water

The communication *Roadmap to a Resource Efficient Europe* is one of the main building blocks of the resource efficiency flagship initiative ([14]). The Roadmap ([15]) sets out a framework for the design and implementation of future actions. It also outlines the structural and technological changes required by 2050, including milestones to be reached by 2020 ([16]).

For the field of water, the Roadmap specifies the following.

Milestone: by 2020, all WFD RBMPs have long been implemented. Good status — quality, quantity and use — of waters was attained in all EU river basins in 2015. The impacts of droughts and floods are minimised, with adapted crops, increased water retention in soils, and efficient irrigation. Alternative water supply options are only relied upon when all cheaper savings opportunities have been taken. Water abstraction should stay below 20 % of available renewable water resources.

The European Innovation Partnership on Water (EIP Water) ([17]) was established in 2012. It aims to speed up development of water innovation, contribute to sustainable growth and employment, stimulate the uptake of water innovation by market and society and support the implementation of EU water policy. Water-resource efficiency in its broader context is a high priority area of EIP Water. EIP Water has defined priority areas, including water and wastewater treatment technologies, the water-energy nexus and the inclusion of ecosystem services in decision-making. Following the European Commission's Call for Expression of Commitment for Action Groups (in April and November 2013), action groups have been selected to develop innovative solutions for these priorities. More information on EIP Water is available on the EIP Water 'online market place' ([18]).

([11]) http://www.right2water.eu.
([12]) http://europa.eu/rapid/press-release_IP-14-277_en.htm.
([13]) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:EN:PDF.
([14]) http://ec.europa.eu/resource-efficient-europe.
([15]) http://ec.europa.eu/environment/resource_efficiency/about/roadmap/index_en.htm.
([16]) http://ec.europa.eu/environment/resource_efficiency.
([17]) http://ec.europa.eu/environment/water/innovationpartnership.
([18]) http://www.eip-water.eu.

2.5 The EU climate and energy package and 20/20 targets

The EU climate and energy package ([19]) is a set of binding legislation which aims to ensure that the EU meets its climate and energy targets for 2020.

These '20-20-20' targets set three key objectives for 2020:

- a 20 % reduction in EU GHG emissions from 1990 levels;
- raising the share of EU energy consumption produced from renewable resources to 20 %;
- a 20 % improvement in the EU's energy efficiency.

The targets, put in force through the climate and energy package in 2009, were set by EU leaders in March 2007 when they committed to helping Europe become a highly energy-efficient, low-carbon economy. The EU is also offering to increase its emissions reduction to 30 % by 2020, if other major economies in the developed and developing world commit to undertake their fair share of a global emissions reduction effort.

The European Commission has also started work on developing a 2030 framework for EU climate change and energy policies ([20]). A green paper, adopted by the Commission in March 2013, launched a public consultation on what the 2030 framework should contain. This has now been described in a Communication (COM(2014) 15), where the Commission proposes to set a greenhouse gas emission reduction target for domestic EU emissions of 40% in 2030 relative to emissions in 1990 ([21]). The related Adaptation Strategy also provides comprehensive documentation on linkages with policy areas and guidelines on developing adaptation strategies ([22]).

It is recognised that there are strong linkages between the climate, water and energy policies and technical-scientific issues: they collectively influence urban water management. Although the 20-20-20 targets are set at EU and Member State levels, they could serve as a starting point for the water utility sector without necessarily implying direct down-scaling.

2.6 National targets

2.6.1 *National government level*

An overview of national targets at government level for a broad range of resource efficiency topics was presented in 2011 in the EEA report *Resource efficiency in Europe — Policies and approaches in 31 EEA member and cooperating countries* ([23]). Examples of how these targets have been formulated for society's efforts to achieve energy efficiency and reduce GHG emissions are shown in Table 2.1. The targets are often, but not always, formulated to show development from the 1990 level to 2020.

2.6.2 *National water utility association level*

Although there are no prescriptions from the Energy Efficiency Directive for the water sector, some associations and governments have taken the initiative to promote and eventually meet efficiency targets.

In Germany, the German Association for Water, Wastewater and Waste (DWA) has chosen not to set specific targets for energy efficiency at individual urban wastewater treatment plants (UWWTPs), but instead has proposed that energy checks and analyses be conducted.

2.6.3 *Local authority level*

At local level, resource efficiency targets may also be incorporated into policies by individual water utilities or, eventually, be included in service contracts between local authorities and a water utility as operators.

For example, local authorities in the French towns of Orleans and Hyeres have requested that their water operators fulfil certain energy efficiency improvements, often with bonus/penalties clauses. The indicator used for drinking water is the energy consumption (and emissions in CO_2 equivalent) per cubic metre of water produced (see Box 2.1).

([19]) http://ec.europa.eu/clima/policies/package/index_en.htm.
([20]) http://ec.europa.eu/clima/policies/2030/index_en.htm.
([21]) http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52014DC0015.
([22]) http://ec.europa.eu/clima/policies/adaptation/what/documentation_en.htm.
([23]) http://www.eea.europa.eu/publications/resource-efficiency-in-europe.

Table 2.1 Examples of national targets for energy efficiency and GHG emissions

Country	Target
Energy efficiency	
Austria	Improvement of energy intensity by at least 5 % until 2010 and at least 20 % until 2020 (as compared to the average of 2001–2005)
Cyprus	Increase energy efficiency by 1 % annually
Denmark	By 2020 Denmark should be among the three most energy-efficient countries in the OECD
Finland	Increase energy efficiency with 20 % by 2020
Germany	Doubling the energy productivity by 2020 as compared to 1990
Poland	Reducing the energy intensity of the Polish economy to the EU-15 level
Romania	1.2–1.5 % minimum reduction per year of the specific materials and energy consumption rates and production losses in the processing industries, power generation, residential sector, transport and construction
Slovenia	2.5 % reduction in the annual rate of growth of overall energy needs compares to the growth of GDP
Water	
Hungary	Building a drainage system serving 89 % of the population by 2015
Portugal	In ten years time, PT aims to attain: • 80 % of efficiency in water consumption in the urban sector; • 65 % of efficiency in water consumption in agriculture; • 85 % of efficiency in water consumption in industry sector.
GHG emissions	
Croatia	20 % decrease in greenhouse gas emissions (in comparison to 1990) up to 2020
Cyprus	20 % reduction (based on 1990) of GHG emissions until 2020
Denmark	Denmark must reduce total greenhouse gas emissions by 21 % in 2008–2012 compared to 1990 levels
Finland	The municipalities participating in the Carbon Neutral Municipalities (CANEMU) project, i.e. Kuhmoinen, Mynämäki, Padasjoki, Parikkala and Uusikaupunki, aim to achieve carbon neutrality, i.e. to decrease their greenhouse gas emissions by a minimum of 80 per cent from the 2007 level, by 2030. Uusikaupunki has adopted an even more ambitious objective: a 30 per cent reduction on the 2007 emissions level by 2012
France	Reduce greenhouse gas emissions by 20 % by 2020
Latvia	Main objective in the climate change sector is to ensure that between 2008–2010 total greenhouse gas emissions do not exceed 92 % of level in 1990
Lithuania	To ensure an 8 % reduction of greenhouse gases emissions from the level of 1990 in the period from 2008 to 2012.
Slovakia	Reduce GHG emissions by 8 % during the period 2008–2012 related to the base year (1990) level
Switzerland	Switzerland intends to reduce CO_2 emissions between 2008 and 2012 by an average of 10 % compared to 1990. The Federal Council aims at a long-term reduction target of 1–1.5 t CO_2-equivalent per capita by 2100. As an intermediate target, by 2050 greenhouse gas emissions are to be reduced by at least 50–85 %.

Source: EEA, 2011 — Annex 4.

Box 2.1 Example from France of inclusion of resource efficiency targets in water service contracts

Located on the French Riviera, the City of Hyères-les-Palmiers (60 000 permanent inhabitants) delegated the management of its water service to Eaux de Provence (a subsidiary of Lyonnaise des Eaux, Suez Environnement Group) in October 2011. By contract, Eaux de Provence is committed to reach specified targets by 2023, as measured by 12 indicators (listed in the table below). These will be assessed by a steering committee with elected officials, staff from the city's technical department and the operator.

The operational and environmental indicators related to climate/energy considerations, ecosystem quality and customer service are:

- 30 % reduction of the volume of water imported from neighbouring communities (capped at 1.4 % of the total demand), in the framework of the 'Aqua Renova' project;
- improvement of the leakage ratio by eight points, notably through implementation of smart metering (remote metering);
- decrease of GHG emissions by 13 %, and improvement of energy efficiency by 5 %, thanks to the implementation of a comprehensive climate/energy action plan (optimisation of pumping, reduction of transport, etc.)

Given the importance of this parameter in the economy and the sustainability of the service, it was decided to link part of the income of the operator to the indicator on imported water. Customer satisfaction and achievement of social goals (employment) have also been integrated in this bonus–malus system.

Table 2.2 The 12 performance indicators for Hyères-les-Palmiers' water service

Area	Indicator	Contractual target for 2023 (at the latest)
Climate/energy	Energy efficiency (kWh/m^3 of water produced)	0.36 kWh/m^3
Water efficiency	Reliance on local resources (% local resource/total)	98.6 %
	Network yield (%)	90 %
	Linear index of water unaccounted for (m^3/j/km)	4.31 m^3/j/km
	Leakage detection (km pipes surveyed/year)	470 km/year
	Delay for fixing leaks (% fixed in 24h and 72h)	75 % in 24 h, 100 % in 72 h
	Meter replacement (% replaced according to diameter and age in years)	100 % diam < 40 age > 18 100 % diam > 40 age > 10
Water quality	Compliance with bacteriological standard (%)	100 %
	Compliance with physico-chemical standard (%)	98 %
Service quality	Customer satisfaction (number of written complaints/year/1 000 customers)	0.85
	Collection of bills (part recovered for the municipality)	99.5 % after 12 months
Employment	Conversion of apprentices into permanent staff (%)	50 %

Source: Suez Environnement, quoted by Jacques Labre, 2014.

2.7 Water footprint in energy utilities

The energy sector notably uses water more intensively than other sectors. Energy-producing companies use water in most process steps: to run turbines in hydroelectric facilities; to extract and purify conventional and non-conventional oil, gas, coal and uranium; to produce biomass for biomass power plants; to cool down thermal power plants (including concentrated solar power); and to reheat liquid natural gas (LNG) in LNG terminals. If water management is difficult without energy, energy production is in most cases impossible without water. And without abundant and affordable energy, the entire modern economy is at risk.

In hydrological balances (physical water accounts), it is important to distinguish between total water use and water consumption. Typical values for water consumption fuel production vary widely: 0.5 l to 1 l of water per litre of gasoline for refining crude oil, or 1 100 l of water per litre of ethanol from biomass (Olsson, 2012).

Assessment tools and methodologies estimating use of water for human activity have been developed during the last years, alongside reporting guidelines and standards. All these initiatives have made interesting contributions, but none of the approaches have matched the specific situations and needs of the energy sector. An ambitious project was launched during the 6th World Water Forum in 2012, with the objective of developing a conceptual framework of energy impacts on water (Target 2.3.4). Energy production and electricity generation have water quality and quantity impacts which are not yet measurable.

A conceptual and analytical framework is being planned to define an efficient and sustainable way of better understanding and reporting the impacts of energy on water (water for energy), with a focus on practicality, consistency, and applicability. This framework is being developed under the leadership of Electricité de France (EDF), and will be overseen by the World Water Council and World Energy Council as advisory bodies. The aim is to present and report the energy impact on water at the 7th World Water Forum in 2015.

Apart from the EDF, other players are representative associations of different energy sectors, energy companies and various other stakeholders (international institutions, non-governmental associations (NGOs), universities, research institutes, etc.). The framework, currently named the Water for Energy Framework (W4EF), will be proposed for endorsement by the World Energy Council and the World Water Council to be used as their official water footprint methodology.

2.8 6th World Water Forum targets — utilities association and local targets

One of the outcomes of the 6th World Water Forum, held in Marseille (12–17 March 2012), was consensus on global targets for energy efficiency in water utilities ([24]).

Measures are implemented by public authorities and water utilities in cities totalling 500 million inhabitants, aiming at a minimal improvement of 20 % of energy efficiency of municipal water and wastewater systems by 2020, compared to 1990 levels.

The target has been endorsed by the International Water Association (IWA) on behalf of the sector, and has been included in the framework of the IWA's Water Climate and Energy programme (see Section 3.1).

Progress is to be monitored by the World Water Council and reported at the 7th World Water Forum in Korea 2015. This will call for application of an agreed methodology, including estimates of the 1990 level of energy efficiency for the same water utilities, as well as a data collection mechanism.

Although there are no penalties for failing to meet this target, it represents a commitment from the water utility sector, corresponding to that for the third EU 20-20-20 target.

([24]) http://www.worldwaterforum6.org/en/library/detail/?tx_amswwfbd_pi2[uid]=642.

3 European stakeholder organisation

Europe has several stakeholder organisations for urban water management by utilities. Four of these (the International Water Association (IWA), the European Water Association (EWA), the European Federation of National Associations of Water Services (EUREAU) and the European Technology Platform for Water (WssTP)) have been identified as the most relevant in the present context and are briefly described in this chapter. Despite not being exclusively European, the IWA is included because several of its activities have direct impact on — and are often influenced by — European members, including the major European water associations.

These four water utility associations were invited to the EEA expert meeting in December 2012, and have contributed to the follow-up actions described in this report.

3.1 International Water Association (IWA)

IWA ([25]) is a worldwide network for water professionals and companies; it is represented in 130 different countries through its 10 000 individual and 500 corporate members. The IWA network is structured to promote multilevel collaboration among its diverse membership groups, and to share the benefits of knowledge on water science, technology and management worldwide. Each year, the association organises and sponsors over 40 specialised conferences and seminars on a wide variety of water management topics, at the IWA World Water Congress, IWA Water, the Climate and Energy Conference and IWA Development Congress as well as annual leading-edge conferences. With approximately 40 staff members, headquarters in London and offices in The Hague (Netherlands), Singapore, Beijing and Nairobi, IWA works through partnerships and mobilisation of the extensive IWA network.

IWA publishes 12 scientific journals and more than 40 books per year on water management: the IWA membership magazine *Water21*, and a range of journals, books, IWA scientific and technical reports, manuals, reports and electronic services.

IWA develops innovations and synthesises these through the work of 52 self-managed specialist groups and a set of global programmes covering water, energy and climate change. The programme explores means of achieving energy neutrality while adapting to changing water availability.

Utilities membership

IWA has several 'segments' of members, including that of utilities. Along with research and industry, the utilities segment represents a 'mega-segment' of the association. Some 36 % of corporate members fall under the utilities umbrella, and a large number of corporate utilities are from Europe (47 % from western Europe, and 10 % from eastern Europe).

In addition, IWA holds 'utility leaders forums' at regional and global forums, bringing together C-Level executives and other key stakeholders. There are also IWA awards that recognise the achievements of utilities leaders.

One of the key specialist groups is the Benchmarking and Performance Assessment group. This covers a variety of topics including performance indicator systems and indicator comparison indicators, as well as benchmarking and performance improvement. Group members include practitioners, academics, regulators and consultants. Through the specialist groups, IWA produced the IWA Performance Indicator System for water services. The manual *Performance Indicators for Water Supply Services* was produced to address the needs of water companies worldwide, as expressed during the extensive field testing of the original system. IWA has also published the manual *Performance Indicators for Wastewater Services*, which provides guidelines for establishing a management tool for wastewater utilities based on the use of

([25]) http://www.iwahq.org/1nb/home.html.

performance indicators ([26]). These guidelines are often produced by water professionals from national water associations, individual utilities or university institutes.

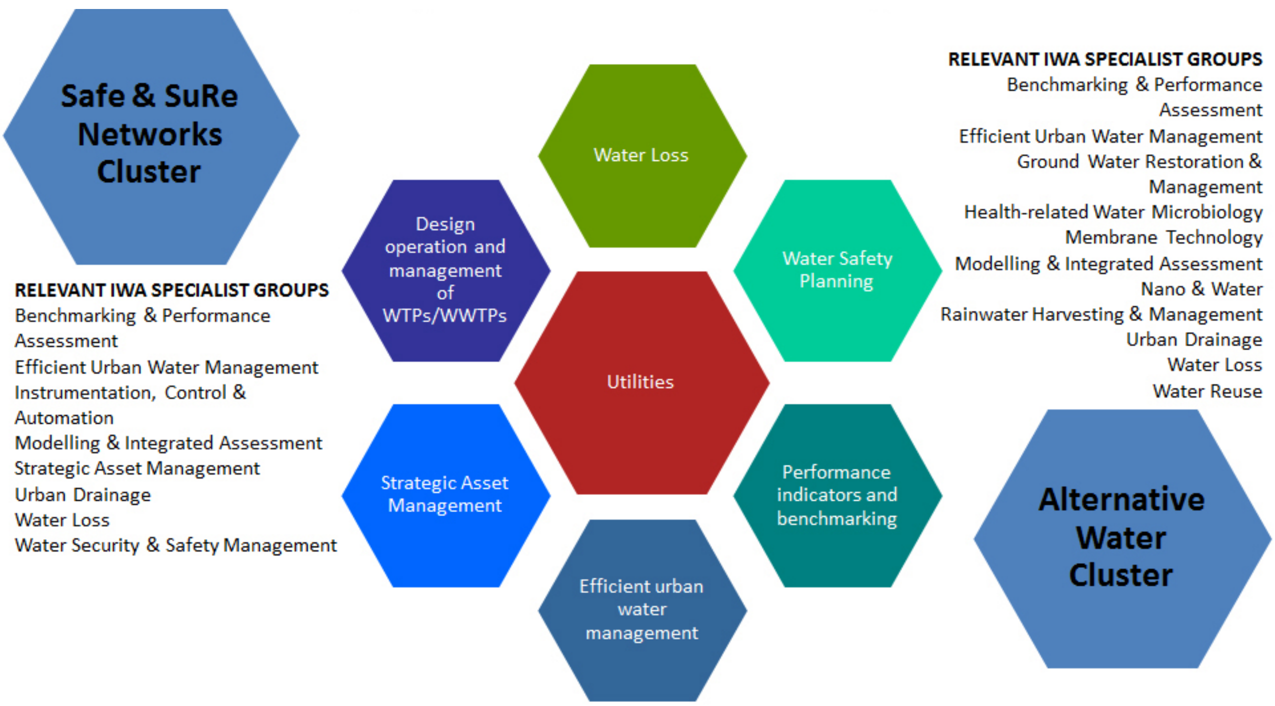
Other key specialist groups include: Water Loss; Water Safety Planning; Strategic Asset Management; Efficient Urban Water Management; Design, Operation and Management of Water Treatment Plants; and Design, Operation and Management of Wastewater Treatment Plants ([27]). These groups are illustrated in Figure 3.1.

Utilities and IWA programmes and projects

IWA has a series of thematic programmes which interact with utilities. These include Cities of the Future, Human Resources and Capacity Development, Water Supply Services, Urban Sanitation, Basins of the Future, and Water, Climate and Energy.

Another relevant IWA initiative is AquaRating. This is a comprehensive rating system for water and wastewater utilities which provides third-party auditing and certification, in partnership with Inter-American Development Bank (IDB) ([28]). The system offers detailed assessments of the various rating areas (access to services, quality of services, operational efficiency, planning and investment efficiency, management efficiency, financial sustainability, environmental sustainability, and corporate governance and accountability), an assessment of the reliability of the information provided, and recommendations for improving management practices.

Figure 3.1 Relevant IWA clusters and specialists groups for utility operation and management



Source: IWA, 2014.

([26]) More information on this group can be found at http://www.iwabenchmarking.com.
([27]) More information on these specialist groups and others can be found at http://www.iwahq.org/hf/communities/specialist-groups.html.
([28]) http://www.iadb.org/en/topics/water-sanitation/aquarating,3809.html.

3.2 European Water Association (EWA)

EWA comprises of 25 European national associations representing professionals and technicians in the fields of wastewater and water utilities, as well as academics, consultants and contractors. EWA's membership includes a growing number of corporate members and companies, bringing the number of total indirectly represented professionals to about 55 000.

As an independent, non-governmental and non-profit organisation that aims to cover the whole water sector (wastewater as well as drinking water and water-related waste), EWA was originally founded by professional associations from Germany, the Netherlands, the United Kingdom, France, Portugal and Scandinavia. Today, member organisations of EWA include most EU Member States, along with Norway, Russia, Serbia and Switzerland.

Founded in 1981, EWA provides a forum for discussing key technical and policy issues affecting water management in Europe and the European region, through conferences, workshops, meetings and special working groups of experts — all organised on an international basis and accompanied by regular publications.

EWA is headquartered in Hennef, Germany, and has close contacts with the European Commission's DG Environment, the European Committee for Standardisation (CEN), the EEA and the European Parliament.

EWA has established contacts with other international associations and organisations that work in the water sector: the Japan Sewage Works Association in Tokyo; the Water Environment Federation in Alexandria, United States; the London-based IWA; the Vienna-based Commission for the Protection of the Danube River; and the United Nations Water Decade Programme on Capacity Development in Bonn, Germany.

In 2012, EWA published the third issue of the *Water Manifesto* ([29]), a document aiming to spotlight important current water issues in Europe, and to propose their resolution via the sustainable management and use of water resources.

The current version of the water manifesto covers the following topics:

- implementation of EU water legislation
- climate change and water
- demographic changes and water safety
- water scarcity and droughts in Europe
- sustainable water supply and sanitation services
- changing cities and integrated urban water management
- flood resilience — a major and growing challenge
- water efficiency and agriculture
- water and biodiversity
- water and energy
- emerging pollutants
- water cost recovery and incentive pricing.

3.3 European Federation of National Associations of Water Services (EUREAU)

EUREAU represents water and wastewater operators at EU level. It is the 'voice' of 70 000 utilities, reflecting the full diversity of European water and sanitation services and representing public, private and mixed operators. EUREAU members collectively provide water services to more than 400 million people in Europe.

Membership in EUREAU is reserved for national associations of water service operators in EU and European Free Trade Association (EFTA) countries. Observer status is granted to representative associations of countries in accession negotiations with the EU.

Currently, EUREAU covers:

- 24 of the 28 EU member countries (all but Estonia, Latvia, Lithuania and Slovenia);
- 2 EFTA countries (Norway and Switzerland);
- 1 observer member (Serbia).

EUREAU promotes the common interests of its members within EU institutions and keeps its members informed of relevant developments in the European arena. The federation promotes the common interests of the European water service sector to the EU institutions and stakeholders, enables its members to adequately deal with opportunities and threats arising from EU policies and their national implementation, and supports members' networking activities.

([29]) http://www.ewa-online.eu/water-manifesto.html.

Three standing commissions (one on drinking water, one on wastewater and one on legislation, economics and management) are responsible for elaborating EUREAU policy positions which must be approved by the general assembly. The commissions comprise practitioners from drinking water and wastewater companies and national associations. They provide forums for sharing and exchanging experiences and views on implementation of existing directives as well as on policies relating to new directives, framework and strategies. These exchanges help formulate useful feedback and advice to the major European institutions, Member State governments, and regulators.

EUREAU positions are disseminated to EU decision-makers in Brussels and European capitals. EUREAU experts are represented in the Common Implementation Strategy of the WFD in the Steering and Coordination Group, as well as in all working groups. EUREAU contributes to international and national conferences and congresses with speakers, and also organises workshops and seminars on dedicated topics (e.g. the World Water Forum, Stockholm World Water Week, the IWA World Water Congress, and Green Week). Several research projects (PHARMAS ([30]), SOLUTIONS ([31]), TAPES ([32]), etc.) consult with EUREAU as a relevant stakeholder. Furthermore, EUREAU is the managing body of the European Parliament Water Group, chaired by MEP Richard Seeber.

3.4 European Technology Platform for Water (WssTP)

Initiated by the European Commission in 2004, the WssTP strives to promote coordination and collaboration of research and innovation in the European water sector, while at the same time boosting its competitiveness. The WssTP comprises 101 members and has a network of more than 700 individuals and 315 contributing organisations across 18 countries.

The WssTP aims to actively facilitate and encourage members' involvement in research and innovation projects whose outcomes contribute to resolving the water-related challenges Europe is facing, facilitate implementation of European water-related policy, and increase the competitiveness of the European water industry. Today, there is active involvement of 50 WssTP members in 186 EU-funded projects in environmental research.

The WssTP is an officially recognised European Technology Platform (ETP), i.e. an industry-led stakeholder platform, funded by both private and public sources, that develops short-to-long-term research and innovation agendas and roadmaps for action at European and national level.

Initially established in 2003, in the framework of Horizon 2020, ETPs are considered a key element in the European innovation ecosystem for helping Europe become an Innovation Union.

Considering the strategies for Europe 2020 and for an Innovation Union, the Commission's Horizon 2020 proposal for an integrated research and innovation framework programme recognises the role of ETPs as part of the external advice and societal engagement needed to implement Horizon 2020.

The ETPs' vision is to identify the pathway to commercial deployment of research, provide strategic insights into market opportunities and needs, and mobilise and network innovation actors across the EU, in order to enable European companies to gain a competitive advantage in global markets.

The WssTP's activities are aligned with the main rationale of ETPs, i.e. to ensure that EU research has a high impact in leading markets and technology areas; the overall objective is to close the gap via global innovation leaders and the boosting of jobs and growth in the EU.

The WssTP's goals are:

- to increase members' coordination and collaboration in water research;
- to create a strong EU water sector leadership, by overcoming fragmentation and providing an answer to increasing competition from outside Europe;
- to contribute to solving Europe's water-related societal challenges through strategic planning, lobbying, and coordinated research.

([30]) http://www.pharmas-eu.org.
([31]) http://www.solutions-project.eu.
([32]) http://www.tapes-interreg.eu.

Since its launch in 2004, the WssTP has succeeded in developing a water vision, a strategic research agenda ([33]), and an implementation document, complemented by many thematic publications.

Based on these three key documents, the WssTP has been proactive in identifying the key research activities and gaps to be filled throughout the water cycle, as well as in involving the European water sector and its supply chain in this common water vision.

The WssTP has an eight-year track record in acting as a catalyst for the formation and launch of EU projects that bring together cross-sector collaborators, who in turn will address water-related societal and economic challenges through innovative solutions. Examples are E4Water, TRUST, Prepared and ChemWater.

The WssTP also contributes to the development and implementation of key policy dossiers of the water sector by providing significant input on how to face major water challenges and achieve the core objectives of the European water sector. The WssTP is actively engaged in communication and advocacy to strengthen the position of water-related research and innovation in European policy.

The WssTP is a Belgium-based AISBL (international association without lucrative purpose) that supports its activities through membership fees. Its governance structure is explained below.

- The general assembly.

- The board of directors is the deliberative and decision-making body. It implements the strategy of the platform, as decided by the general assembly. The board is responsible for the Strategic Research Agenda, the vision document and the action plan to implement the vision document set up in the implementation document.

- The WssTP working groups (WG) are key to the functioning, objectives, and implementation of the WssTP strategy. They have emerged from the former WssTP Pilot and Task Force structure, which was in place between 2007 and 2012. Depending on their topic, they can have a strategic, thematic, or technological nature. The WGs are overseen and coordinated by the WssTP Innovation and Technology Advisory Board (*WssTP iTAB*).

The activities of WssTP working groups and collaboration with EU-funded projects are instrumental in stimulating communication between the different parties involved in water management across all levels in the European water sector, allowing research needs and barriers to innovation to be identified.

As of 2014, WssTP has the following 16 WG:

- Financing for EU Competitiveness
- Water & ICT
- Water-Energy-Food Biodiversity Nexus
- International Relations
- Water and Industry
- Techwatch
- Resource Recovery
- Membrane Technologies
- Emerging Compounds
- Urban Water Pollution
- Bathing Water
- Agriculture & Irrigation
- Eco-System Services
- Green Infrastructure
- Managing Hydroclimatic Extreme Events
- Shale Gas

The WssTP Members States Mirror Group (MSMG) is also an associated body of the WssTP. Interested EU Member States, Associated Candidate Member States and EU Research Framework Programme (FP) Associated States participate with one delegation each in the MSMG.

The MSMG aims to contribute to the objectives of the WssTP, particularly to that of a European R&D strategy with the aim of more sustainable protection and utilisation of water resources, and provision of water services in Europe and worldwide.

([33]) http://wsstp.eu/publications.

4 Current knowledge bases

There is much knowledge on urban water management: utility operators and planners are one source, and environmental authorities and the institutional side constitute another. Advances in urban water management are frequently presented at workshops, seminars, or conferences at regional, national European or international events organised by stakeholder organisations.

This does, however, rarely result in a regular collation and update of neither databases on the performance of water utilities, nor inventories and experiences from the new technologies implemented at full-scale installations in Europe.

4.1 Databases within water associations

As noted in Chapter 3, establishing and maintaining databases on urban water management is not a key activity of the European water associations. However, in some instances, such initiatives may be undertaken, e.g. by a specialist group within its topic area. An example is the IWA Specialist Group on Statistics and Economics ([34]), which collects and publishes data on typical tariffs for water supply and sanitation in a number of countries. The group has published data every two years since 2004; the latest version is available online ([35]).

Some national water associations publish reports including indicators of water utilities' performance ([36]). The underlying working databases are often aimed at water professionals and rely on a priori knowledge of the topics by the user.

Different data policies may limit the release of databases describing the main characteristics of urban water supply and sanitation infrastructure, as well as the performance of the utilities and the consumption patterns of customers. An example of an institution that made databases publicly available is the Swedish Water & Wastewater Association (SWWA, 2014).

4.2 Databases within benchmarking networks

Benchmarking networks collect data related to a number of technical and economic parameters used for performance comparison, and explore improvement opportunities. These data are intensely targeted, and in many cases, very detailed, intended for process benchmarking down to unit operations. Obviously, detailed process benchmarking data are required for normalising and enabling comparisons at unit operation level (e.g. pumping, aeration and filtration) for plant operators and technology providers; however, they hold little interest at European level. In this context, parameters for whole plant or community levels matching such spatial units (plants, water supply zones, agglomerations, and nomenclature of territorial units for statistics (NUTS) levels) are of higher interest. The terminology and definition of certain indicators in these databases may be directly applicable from these benchmarking networks to the European institutional level.

Data policies for the benchmarking networks are defined by the members. Because benchmarking programmes aim to offer safe learning environments, in the public domain results are often presented in anonymous or aggregated form, where individual plants/utilities cannot be identified directly.

([34]) http://www.iwahq.org/8h/communities/specialist-groups/list-of-groups/statistics-and-economics.html.
([35]) http://www.iwahq.org/contentsuite/upload/iwa/all/Specialist%20groups/Specialist%20groups/Statistics%20and%20Economics/Sg%20resources/IWA%20international%20stats%20LowResAW%200612.pdf.
([36]) Examples of these reports can also be downloaded from a number of utility associations' websites, e.g.for France: see http://www.fp2e.org/userfiles/files/publication/etudes/Etude%20FP2E-BIPE%202012_VA.pdf.

4.3 Databases at European level

In European institutional frameworks, considerable information is also provided based on country reporting: to EU directives, Eurostat Water Statistics, the EEA 'State of the environment' (SoE) via Eionet, and to international river and sea conventions.

Such reporting now takes place electronically at defined intervals. An overview of countries' reporting obligations to a number of European and international institutions can be viewed in the Reportnet system maintained by the EEA ([37]). By interactively selecting 'water' as issue in this system, an overview ([38]) is provided to all 'data flows', each with a description of the reporting context, guidance documents and repositories for the reported data.

4.3.1 Water Information System for Europe (WISE)

WISE is a partnership between the European Commission (DG Environment, the Joint Research Centre and Eurostat) and the EEA.

WISE addresses several user groups:

- EU institutions as well as Member States' national, regional and local administrations working in water policy development or implementation;
- professionals working in the water field from public or private organisations, with a technical interest in water;
- scientists working in the water field;
- the general public, including those working in private or public entities not directly related to water policy, but with an indirect interest in water (regular or sporadic).

WISE was launched for public use as a web-based service on 22 March (World Water Day) in 2007; it offered a web-portal entry point ([39]) to water-related information, from inland waters to marine waters.

The web portal is now grouped into sections for:

- EU water policies (directives, implementation reports and supporting activities);
- data and themes (reported data sets, interactive maps, statistics, indicators);
- modelling (for the present and forecasting services across Europe);
- projects and research (inventory for links to recently completed and ongoing water-related projects and research activities).

For users from EU institutions or other environmental administrations, WISE provides input to thematic assessments in the context of EU water-related policies. For water professionals and scientists, WISE facilitates access to reference documents and thematic data, which can be downloaded for further analysis. For all, including the general public, WISE presents a wide span of water-related information via visualisations on interactive maps and data viewers, graphs and indicators.

An example, related to total abstractions for the public water supply from fresh surface and groundwater sources, is shown in Table 4.1. It presents an overview from Eurostat's Water Statistics.

([37]) http://rod.eionet.europa.eu.
([38]) http://rod.eionet.europa.eu/obligations;jsessionid=1CE7BA3C316FE82FD4508A7254F03821?country=-1&id=&filter=GO&issue=15&client=-1&_sourcePage=DTS_rp9sPIf-4CwYsSCKJBcRmEtw0_Te&__fp=laOxIOeUrVGhfNHdb-7TGGAetEsAvCcLfVC5JJMQyyoKu-3enkbYfuInUU8SxlkE http://rod.eionet.europa.eu/obligations;jsessionid=1CE7BA3C316FE82FD4508A7254F03821?country=-1&id=&filter=GO&issue=15&client=-1&_sourcePage=DTS_rp9sPIf-4CwYsSCKJBcRmEtw0_Te&__fp=laOxIOeUrVGhfNHdb-7TGGAetEsAvCcLfVC5JJMQyyoKu-3enkbYfuInUU8SxlkE.
([39]) http://water.europa.eu.

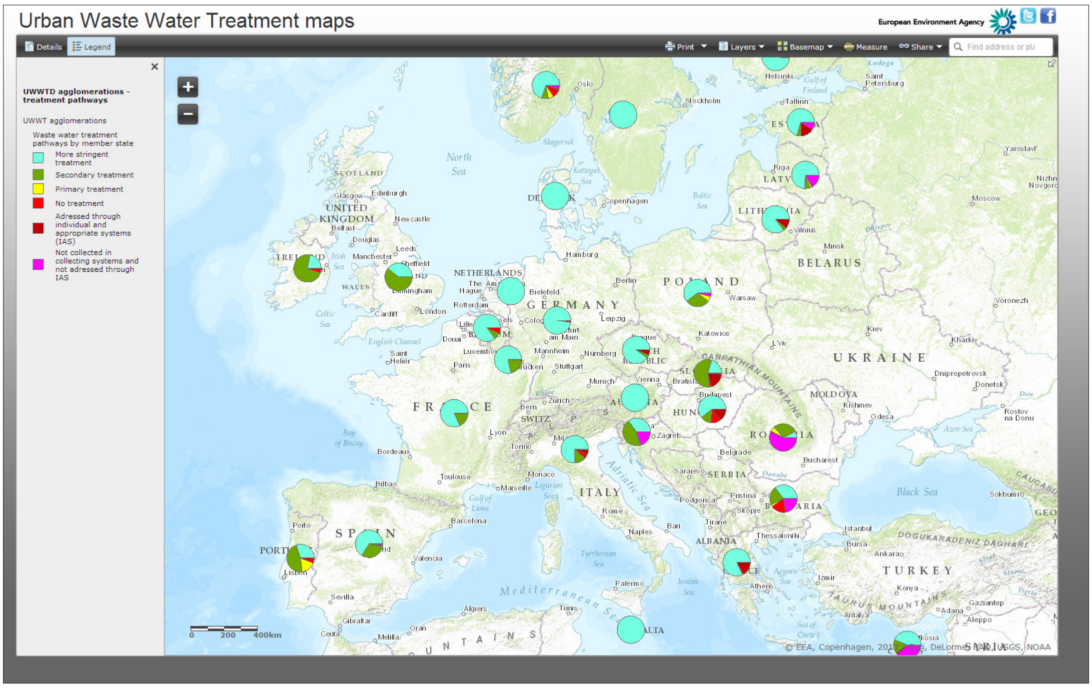
Table 4.1 Total abstractions for public water supply from fresh surface and groundwater sources (cubic metres per inhabitant)

GEO/TIME	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Belgium	71.06	72.89	71.23	70.54	70.5	68.82	65.37	65.71	:	:
Bulgaria	133.96	133.61	127.84	126.44	132.97	135.54	135.17	131.03	125.23	124.37
Czech Republic	74.9	75.31	72.41	69.53	69.06	68.43	65.88	64.47	63.32	60.83
Denmark	79.65	78.44	80.09	77.56	74.34	74.48	74.16	69.84	69.87	:
Germany (until 1990 former territory of the FRG)	:	:	65.09	:	:	62.29	:	:	62.11	:
Estonia	51.54	50.68	48.38	39.74	34.5	35.59	:	47.16	:	77.39
Ireland	148.73	:	:	161.01	:	140.35	:	:	:	:
Greece	69.89	77.03	78.79	78.43	82.16	75.93	:	:	:	116.25
Spain	129.13	136.75	136.89	136.04	129.54	129.29	126.23	117.87	115.09	:
France	97.13 ([a])	100.22 ([a])	96.62 ([a])	94.23 ([a])	92.7 ([a])	89.29 ([a])	86.22 (a)	87.73 ([a])	84.91 ([a])	:
Croatia	:	:	:	:	112.12	113.94	116.36	123.85	122.94	121.76
Italy	:	:	:	154.51	:	:	155.06	:	:	:
Cyprus	65.34	68.23	73.04	75.16	87.63	86.55	57.71	45.93	60.31	62.99
Latvia	:	:	:	:	:	:	88.47	93.35	104.31	:
Lithuania	22.87	38.32	38.98	40.09	40.88	40.77	42.99	40.8	40.13	40.72
Luxembourg	:	:	:	:	:	:	:	87.13	88.63	86.55
Hungary	78.81 ([a])	79.56	79.36	69.04 ([a])	65.63 ([a])	66.22	63.78	63.05	59.68	60.1
Malta	41.3	38.26	37.26	34.77	32.35	34.52	34.57	30.91	30.92	31.57
Netherlands	77.99	81.4	78.76	76.94	78.31	76.38	76.32	74.93	73.43	:
Austria	:	:	:	:	:	:	73.08	:	:	:
Poland	56.76 ([a])	57.02 ([a])	55.03 ([a])	55.15 ([a])	55.79 ([a])	54.7 ([a])	55.19	54.21	54.04	52.76
Portugal	:	:	:	103.49	86.84	92.69	85.9	88.38	:	:
Romania	101.91	91.97	82.01	78.85	72.59	70.66	74.92	73.63	50.36	49.51
Slovenia	93.83	89.57	81.4	81.85	82.96	83.27	82.92	81.24	81.19	82.48
Slovakia	71.63	71.41	65.94	63.79	62.22	59.46	59.37	59.14	57.32	:
Finland	77.77 ([b])	77.6 ([b])	77.4 ([b])	77.15 ([b])	77.9	:	:	76.6	76.62	74.41 ([b])
Sweden	103.6	103.23	102.83	98.87	98.48	97.77	:	:	97.1	:
United Kingdom	123.43	122.58	123.48	123.28	119.93	115.15	112.74	:	:	:
England and Wales	:	:	:	:	:	:	:	:	:	:
Iceland	275.67	273.86	271.88	269.09	:	:	:	:	:	:
Norway	178.6 ([a])	179.03 ([a])	179.14 ([a])	179.1 ([a])	179.52 ([a])	177.95 ([a])	174.15 ([a])	166.69 ([a])	165.29 ([a])	166.45 ([a])
Switzerland	147.33	148.35	139.73	135.4	131.52	127.85	129.06	125.55	120.86	121.22
Former Yugoslav Republic of Macedonia, the	104.04	108.91	107.99	106.62	109.44	110.87	112.9	133.65	:	:
Serbia	91.57 ([b])	90.24	95.11	92.81	93.06	93.52	91.55	93.35	91.27	92.77
Turkey	69.92 ([a])	70.5 ([a])	70.08 ([a])	72.17 ([b])	71.2 ([a])	73.55 ([b])	81.72 ([a])	79.82 ([b])	79.82 ([a])	:

Note: ([a]) definition differs, see metadata; ([b]) estimated; : not available.

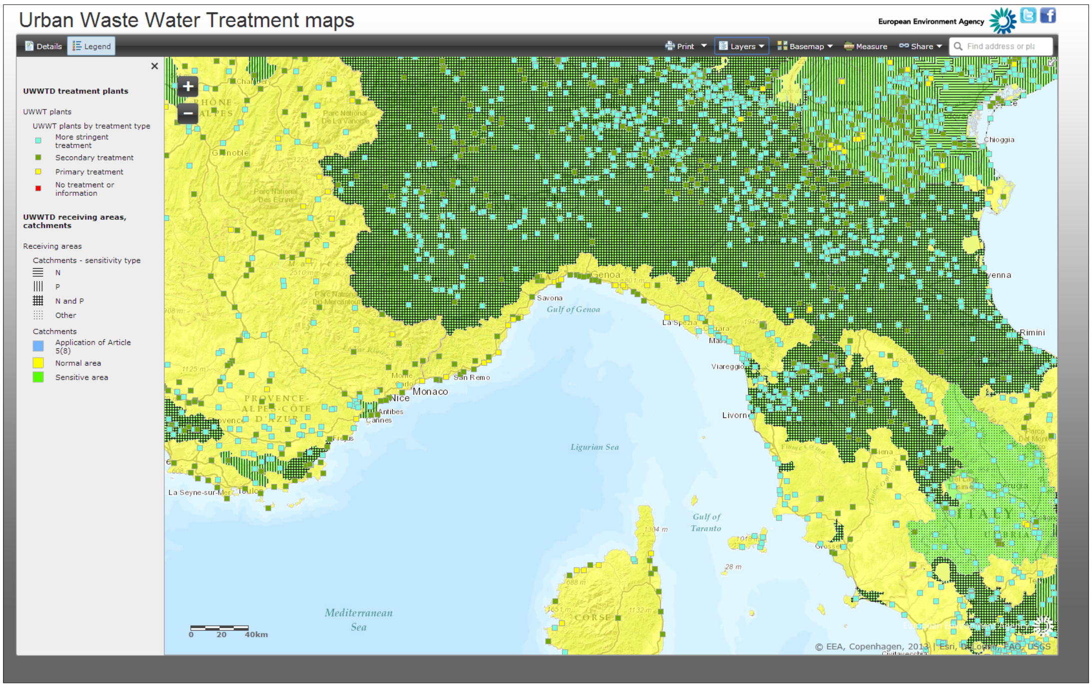
Source: Data from http://epp.eurostat.ec.europa.eu/portal/page/portal/environment/data/database (Annual freshwater abstraction by source and sector (env_wat_abs)), 24.03.2014.

Map 4.1 Overview of type treatment of generated pollution load (p.e.) from reported agglomerations



Source: Screenshot from WISE UWWTD map viewer: see http://www.eea.europa.eu/data-and-maps/uwwtd/interactive-maps/urban-waste-water-treatment-maps online. Layer: UWWTD agglomerations — treatment pathways.

Map 4.2 Zoomed in details from same UWWTD map viewer, with different selection of background layers



Source: Screenshot from WISE UWWTD map viewer: see http://www.eea.europa.eu/data-and-maps/uwwtd/interactive-maps/urban-waste-water-treatment-maps online. Layer: UWWTD treatment plants.

Another example of a visualization of UWWTPs across Europe is shown in Map 4.1 and Map 4.2. The maps show two zoom-levels from the same interactive map viewer. Further details are available for each of the approximately 22 000 UWWTPs reported under Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment (also known as the Urban Waste-Water Treatment Directive (UWWTD)).

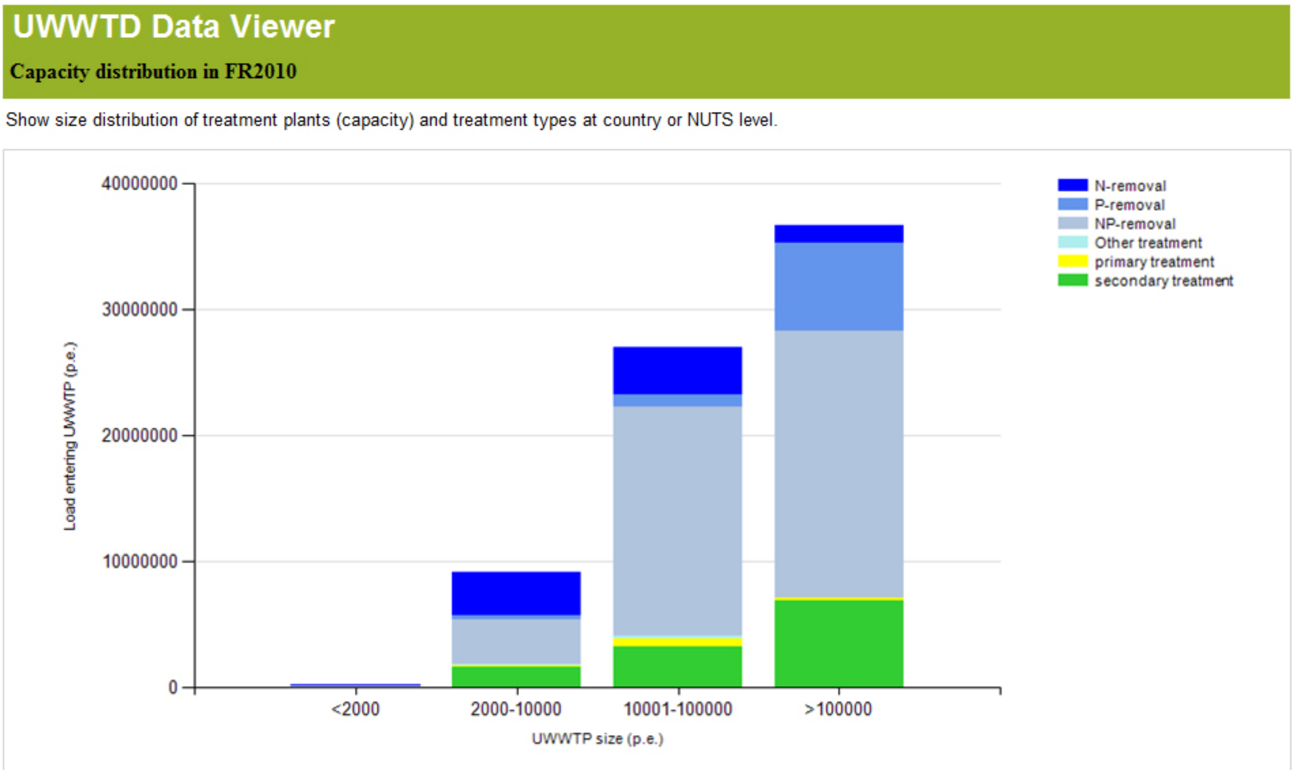
Finally, certain predefined tabular and graphical presentations can be made interactively from the UWWTD data viewer, e.g. distribution of types of treatment in size categories, as shown in Figure 4.1.

Country selection or NUTS 3-level aggregation of data can be made by the user at http://www.eea.europa.eu/data-and-maps/uwwtd.

Only data for UWWTPs serving agglomerations serving > 2 000 population equivalent (p.e.) have to be reported biannually, according to the UWWTD; this corresponds to about 18 000 plants. However, in some cases, smaller UWWTPs are also included in the reporting, which results in about 28 000 plants being included in the UWWTD Waterbase ([40]).

An overview of other freely available WISE products can be found at the EEA WISE water data centre web page ([41]).

Figure 4.1 Example of graphical display from UWWTD data viewer: distribution of types of wastewater treatment in size categories



Source: Screenshot from WISE UWWTD data viewer: see http://www.eea.europa.eu/data-and-maps/uwwtd/waste-water-infrastructure/urban-waste-water-treatment-plants online. Selection: France, 2010 data.

([40]) http://www.eea.europa.eu/data-and-maps/data/waterbase-uwwtd-urban-waste-water-treatment-directive-3.
([41]) http://www.eea.europa.eu/themes/water/dc http://www.eea.europa.eu/themes/water/dc.

5 Resource-efficient urban water management

Resource efficiency is expected to contribute to improved economic opportunities, enhanced productivity, lower costs and a boost in competitiveness — with reduced environmental pressures. When it comes to urban water management, resource efficiency includes not only the consumption and reuse of water volumes, but also the net consumption of energy and material resources, and emission intensities related to water utility operations. Improving efficiency will often require investing in an upgrade of ageing infrastructure, implementing novel technologies and continuous training of staff, along with awareness-raising campaigns. Return on these investments can reduce consumption of resources, alleviate pressures on the environment and help create jobs.

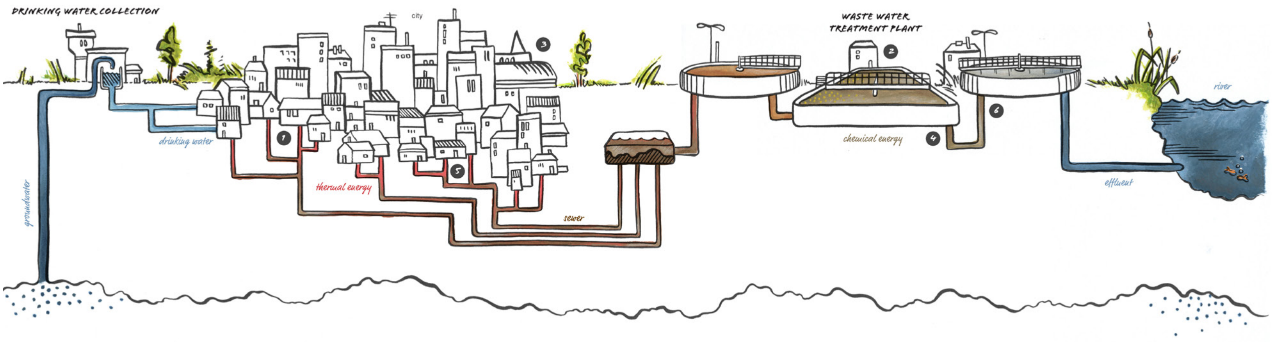
The urban water cycle includes:

- water abstraction from surface or groundwater sources;
- transport to water-treatment facilities;
- drinking-water production;
- water supply distribution;
- consumption by end users from the domestic sector (households, institutions and services) or industry sectors;
- collection and transport in sewerage networks;
- treatment in wastewater treatment plants (WWTPs), sometimes with local pre-treatment within industrial facilities);
- discharge of treated effluents (normally to surface water) or reuse (an emerging practice in water-scarce environments);
- intermittent discharges from separate storm-water sewers or combined sewer overflows (CSOs), often with no or only preliminary treatment; this category also includes bypasses under heavy rain from WWTPs or partially treated effluents.

From both water and wastewater treatment facilities, sludge residues are being generated and disposed of as solid waste, or re-used for nutrient, organic material or energy recovery.

When normalising performance data for water utility operations according to their size, e.g. by

Figure 5.1 Schematic framing of the urban water cycle



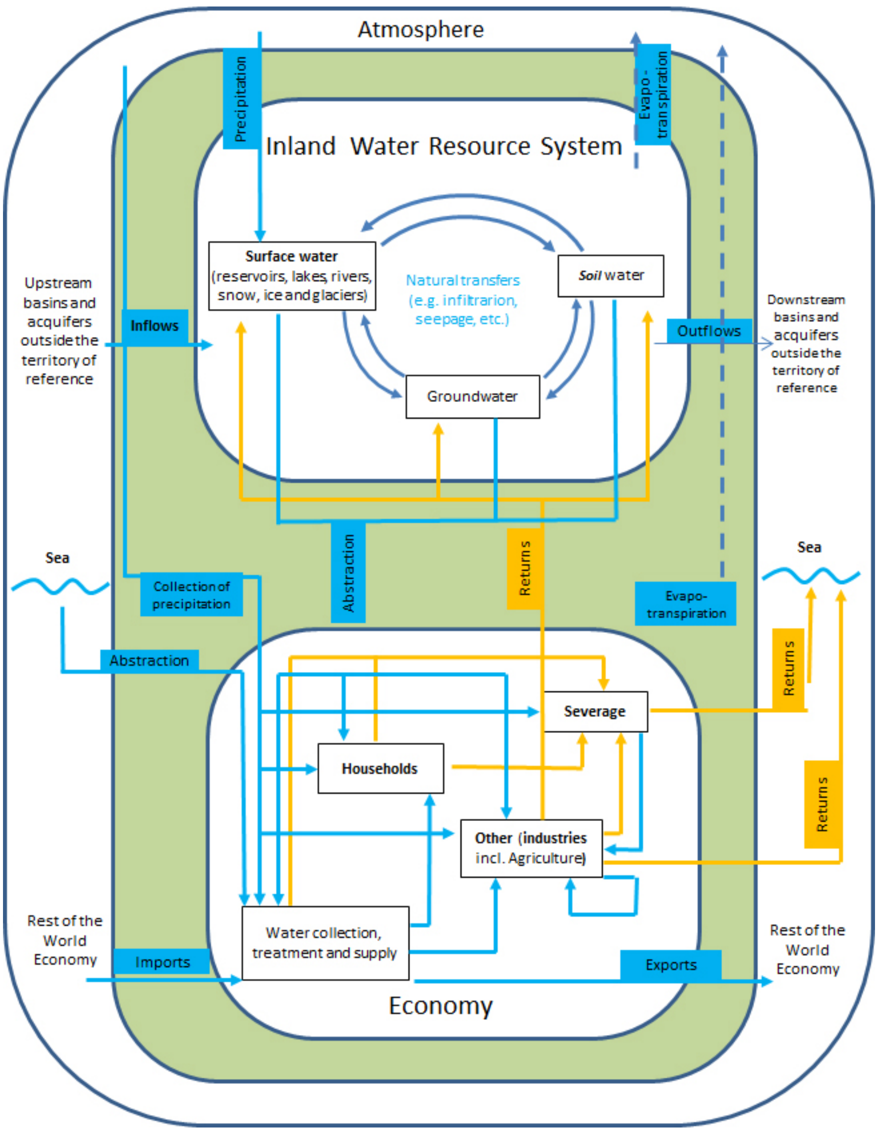
Source: Waterboard Groot Salland, the Netherlands, 2014.

volumetric water, it is important to distinguish if this refers to cubic metres abstracted, produced, metered by end-user, or influent of WWTPs, since these often differ due to losses or infiltration/ inflows; see more details in Figure 6.4.

5.1 Environmental-economic accounting concept

Resource efficiency represents the ratio between the economic activity (e.g. agricultural produce or manufactured products) and the resource required (e.g. water, energy, minerals or fossil fuels) or depleted (e.g. via emissions of pollutants). The United Nations Statistics Division (UNSD) Environmental-Economic Accounting for Water (SEEA-Water) ([42]) concepts bring together the 'resource system' (meaning the hydrological balance here) and 'economy' (simplified with water supply and sanitation in support of household and industrial/agricultural activities), as illustrated in Figure 5.2. The quantification of 'economy' is based not only on monetary vales; it might also be based on production units or inhabitants served.

Figure 5.2 Illustration of UNSD water accounting with relations between the 'resource system' and 'economy'



([42]) http://unstats.un.org/unsd/envaccounting/seeaw/seeawaterwebversion.pdf.

Several terms are used in the context of water-resource efficiency:

- water productivity (product unit per cubic metre of water) (Water use intensity)$^{-1}$, e.g. agricultural produce per cubic metre of irrigation water;
- economic water productivity (value of product, e.g. EUR per cubic metre of water);
- water accounting:
  - physical (hydrological balance)
  - economic (monetary value);
- emission intensity [tonnes of pollutants per year per gross domestic product (GDP), gross value added (GVA), inhabitants, etc.); this can also reflect nutrient recovery in the opposite direction.

In the current context, water use intensity in the household/domestic sector, physical urban water balances, and emission intensities — as well as energy use intensity related to water utility operations — are examples where the concept above is applied.

5.2 Green economy context

Embedding water management in a green economy ([43]) requires that it be managed from economic, social and environmental perspectives. The transition to a green economy presents a triple challenge. First, there is a need to focus on the economy, finding ways to increase prosperity without increasing resource use and environmental impacts — put simply, to be more resource-efficient. However, resource efficiency alone cannot guarantee steady or declining resource use or sustainability: users could become more efficient, but still place excessive demands on the environment. So the second challenge to achieve sustainability is the need to maintain the ecosystem's resilience, something governed by the status, trends and limits of natural systems. The third element is human well-being, including health, employment, job satisfaction, social capital and equity. This also includes a fair distribution of the benefits and costs of transition to a green economy. In balancing environmental, economic and social elements, the green economy concept evidently has much in common with some models of sustainable development: the triple challenge of economic efficiency, ecological sustainability and social equity (UNEP, International Resource panel, 2012) ([44]).

As a resource vital for both humankind and ecosystems, water is under increased pressure: the availability and quality of safe and secure water resources need to be accounted for, due to factors like deforestation, urbanisation, population and economic growth, and climate change. It is therefore critical that urban water management respects the natural limits of the ecosystem, both in terms of available resources from where it is abstracted, and in terms of capacity for maintaining good ecological status in water bodies receiving discharges. The Stockholm Statement (2011) ([45]) has already described water as the 'bloodstream of the green economy', highlighting how central water will be to the innovative thinking and effective solutions required to establish a green economy.

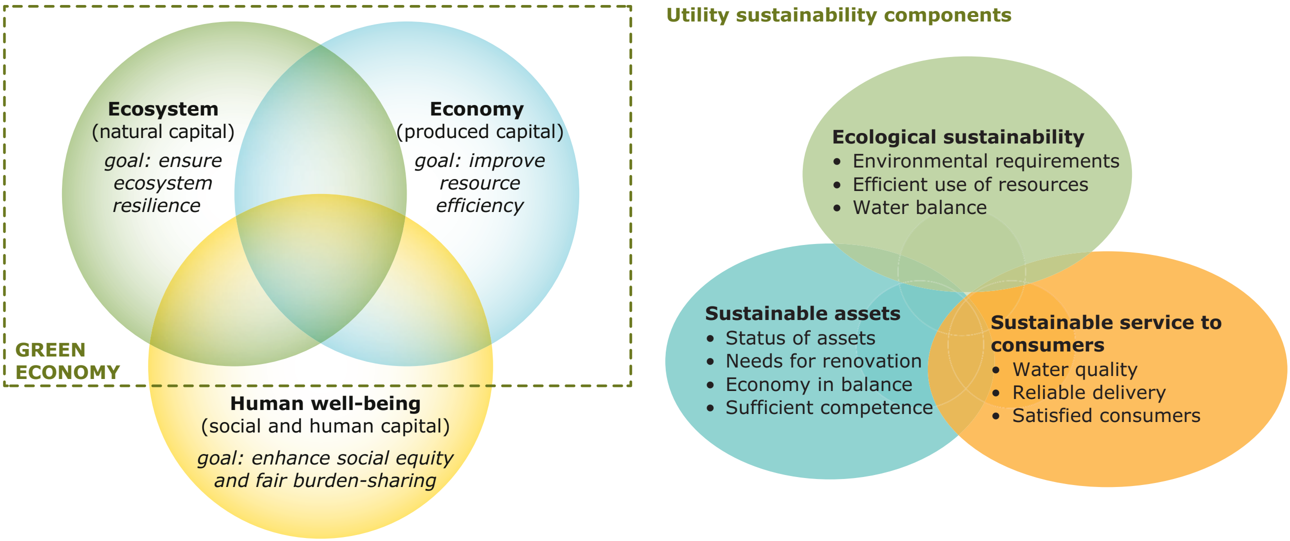
In the context of shifting towards this green economy, resource-efficient urban water management is essential if we are to achieve balance, in the light of greater demands from residential users, industry, farmers and electricity generation.

Water management operations conducted in a resource-efficient way can stimulate technological innovation at a time when there are opportunities to boost employment in the fast-developing 'green technology' sector. Like most activities and sectors that interact heavily with the environment, urban water management presents opportunities to use resources wisely, driving down their costs, and improving productivity — and corporate image — while boosting their competitiveness. Smarter resource use can result in environmental gains that improve people's quality of life directly.

Figure 5.3 illustrates how the SWWA has adapted green economy principles to urban water management.

([43]) http://www.gwp.org/gwp-in-action/News-and-Activities/New-Publication-Water-in-the-Green-Economy.
([44]) http://www.unep.org/publications/contents/pub_details_search.asp?ID=6255 http://www.unep.org/publications/contents/pub_details_search.asp?ID=6255.
([45]) http://www.worldwaterweek.org/documents/WWW_PDF/2011/2011-Stockholm-Statement.pdf.

Figure 5.3 Water utility resource efficiency in a green economy context — building on social, environmental and economic dimensions



Source: Left: from UNEP, International Resource Panel, 2012, and EEA, 2011. Measuring water use in a green economy.

Right: from Balmér, 2012. Present and planned activities in Sweden for improving efficiency and communication related to water utilities. Expert meeting presentation.

5.3 Social dimension: employment in the water sector

The social and human capital dimension is represented by the employment of 'water professionals' in the sector. Relevant European statistics are already in place as part of Eurostat's structural business statistics ([46]). In 2010, the number of persons employed were 376 000 and 139 100 for the subsectors 'water collection, treatment and supply' (NACE Division 36) and 'sewerage' (NACE Division 37), respectively (EU-27, 2010 data).

A further overview and breakdown of the statistics for water collection, treatment and supply is presented in Eurostat Table 5.1 ([47]), and a similar overview is available for sewerage ([48]). Seen from the perspective of total non-financial business economy, employment in NACE Divisions 36 + 37 only accounts for about 0.4 %, and the economic turnover was about 0.7 %. Nevertheless, water sector activities are essential for the functioning of modern society.

As an example of a national report, the French water sector is profiled with the same environmental, economic and social dimensions ([49]). The change of total number of jobs in the water sector shows a slight decrease: from 112 800 (2004) to 106 200 (2009). However, this covers an increase for some fractions (private operators for water and sanitation, and related product manufacturing) and a decrease for others (independent sanitation network, public works and buildings, and water and sanitation in all local regional authorities). According to the national report, there are around 65 000 jobs directly related to public water and sanitation services, corresponding to 60 % of the total number of jobs in the water sector. This is somewhat higher than the 42 000 employed persons reported to Eurostat, so apparently the same statistics are not being reflected.

Another important element in the social dimension is the full cost recovery for financing the water services delivered. This has already been addressed in another recent report (EEA, 2013) ([50]).

([46]) http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Water_supply,_sewerage,_waste_management_ and_remediation_ statistics_-_NACE_Rev._2.
([47]) http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Key_indicators,_water_collection,_treatment_and_ supply_(NACE_Division_36),_2010_A.
([48]) http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Sewerage_statistics_-_NACE_Rev._2.
([49]) http://www.fp2e.org/userfiles/files/publication/etudes/Etude%20FP2E-BIPE%202012_VA.pdf (pp.70–73).
([50]) http://www.eea.europa.eu/publications/assessment-of-full-cost-recovery.

Table 5.1 Overview of enterprises, employment and turnover for water collection, treatment and supply (NACE Division 36), 2010

	Number of enterprises	Number of persons employed	Turnover	Value added	Personnel costs	Investment in tangible goods
	(thousands)		(EUR million)			
EU-27	14.0	376.0	59 980	29 694	11 836	:
Belgium (1)	0.1	5.8	2 122.0	820.4	502.2	941.3
Bulgaria	0.1	17.6	281.6	164.3	93.3	18.5
Czech Republic	0.3	18.4	1 318.2	551.7	307.7	187.4
Denmark	2.0	2.3	790.3	294.0	59.8	419.8
Germany	1.7	35.7	9 083.0	:	1 644.3	1 814.7
Estonia	0.1	1.4	93.6	71.5	18.6	85.5
Ireland	0.0	0.0	11.4	2.8	1.6	0.1
Greece (1)	0.1	6.9	608.3	487.0	346.4	99.2
Spain	2.7	40.8	6 343.8	3 663.7	1 668.3	1 323.3
France (2)	0.2	42.0	12 312.3	3 464.0	2 049.2	:
Italy	0.9	29.2	6 558.6	2 616.3	1 333.8	948.9
Cyprus	0.0	0.4	154.6	66.5	17.1	39.2
Latvia	0.1	1.8	56.4	39.8	17.8	23.1
Lithuania	0.1	5.8	127.8	97.8	53.8	177.7
Luxembourg	0.0	0.1	43.6	21.0	10.0	22.9
Hungary	0.3	19.7	781.7	394.2	267.3	99.9
Malta	:	:	:	:	:	:
Netherlands	0.0	5.3	1 533.8	895.5	311.8	425.0
Austria	0.6	2.4	472.4	295.5	113.4	100.5
Poland	0.5	33.1	1 399.3	955.0	423.9	595.6
Portugal	0.1	13.0	1 246.7	641.2	280.3	209.8
Romania	0.2	34.9	563.1	424.7	243.8	568.0
Slovenia	0.1	4.2	336.8	129.6	97.7	34.1
Slovakia	0.0	11.7	459.3	252.1	152.2	162.0
Finland	0.7	2.7	780.1	464.9	130.1	327.9
Sweden	0.2	1.1	365.1	141.3	60.4	143.4
United Kingdom	0.1	:	11 817.7	8 256.7	1 589.1	3 899.9
Norway	0.4	0.3	50.0	22.7	22.2	12.0
Switzerland	0.1	1.1	394.7	188.7	79.5	86.5
Croatia	0.1	9.3	293.1	202.8	128.1	134.2
Turkey (1)	2.6	32.6	2 561.8	1 291.0	559.7	635.3

(1) 2009.
(2) Number of enterprises, 2009.
Source: Eurostat (online data code: sbs_na_ind_r2)

5.4 Environmental dimension: quantifying ecological sustainability with life cycle assessment (LCA)

While analysis of alternative scenarios for establishing and operating urban water infrastructure by means of economical (monetary) investment and pay-back periods is well-known, the quantification of ecological sustainability is frequently considered novel. LCA — and more precisely, the impact assessment part of it (LCIA) — is a methodology for systematic quantification of pros and cons of potential environmental impacts, including water and energy resource consumption. Several examples of the use of LCA related to water supply and sanitation are referenced in the EEA report *Towards efficient use of water resources in Europe* (EEA, 2012b)

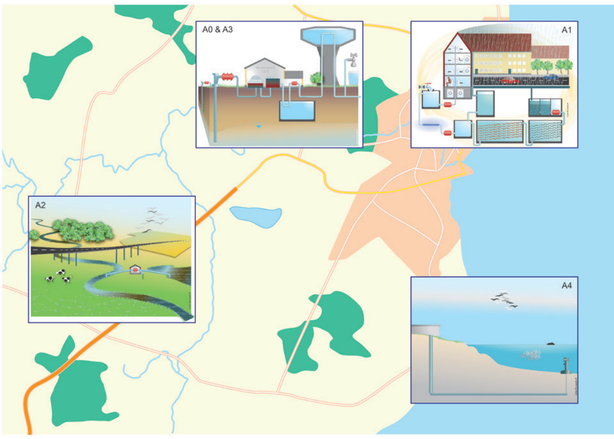
Figure 5.4 is an example presented at the expert meeting: four alternative scenarios are compared to a baseline, for extension of the water supply to Copenhagen. The scenarios include rain- and storm-water harvesting (A1), compensating actions to ensure environmental flows (A2), new well fields for groundwater abstraction, about 20 km from water-treatment plant (A3), and desalination of brackish water (A4). LCA profiles cover standard environmental impacts, freshwater withdrawal impacts (FWIs) and combinations.

The results indicate that rain- and storm-water harvesting are the most favourable alternatives for standard and combined LCA profiles. However, desalination ranks practically the same for combined LCA profiles, due to a positive contribution to the FWI. In Denmark, the drinking-water supply relies solely on groundwater abstracted and treated at waterworks before being distributed to the customers. The withdrawal of groundwater has an impact on the freshwater environment, and this study presents one way of integrating the impact into the standard LCA. Alternatives relying on non-freshwater

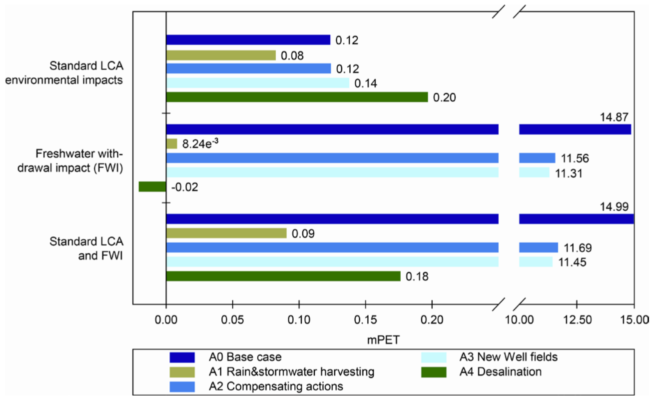
Figure 5.4 Example: applying LCA in analyses of four alternative scenarios for future extension of drinking-water supply to Copenhagen

LCA of water supply technologies

Four alternative cases which fulfil the water flow requirements of the EU Water Framework Directive



Results of LCA and FWI



Source: Godskesen et al., 2013. Expert meeting presentation.

options therefore obtain an advantage in the FWI category. This is where desalination of seawater and rainwater harvesting are preferable when combining the standard LCA with the FWI category. Although the FWI does not represent a standardised element in LCA methodology, the example illustrates the importance of setting the system boundaries and coverage of impact categories and parameters.

With the aim of further standardising LCA methodology related to water management, a draft ISO standard, ISO/DIS 14046, 'Environmental management — Water footprint — Principles, requirements and guidelines' ([51]) is under development. This standard combines both water quantity- and quality-related LCA impact categories into a 'water footprint', e.g. in parallel to 'carbon foot-printing'. Some methodologies and guidance documents for LCAs and carbon foot-printing, especially in water utility contexts, have also been developed in national contexts (UKWIR, 2012; Frijns, 2011; DANVA, 2012; Svensk Vatten Utveckling, 2014).

There is a potential synergy between the underlying European inventories developed in LCA contexts as proxy scenarios on water consumption and emissions to water, for instance, and similar European data sets in WISE.

5.5 Economic dimension: improving resource efficiency in practice

The economic dimension in a green economy context relates not only to monetary accounting, but also to activities across business sectors in a broader sense, resulting in use of resources or pressures on the environment. Water (volumetric), as accounted in water balances, is not the only element in urban water-resource efficiency — energy and material resource flows are also influenced by management of the urban water cycle.

([51]) http://www.iso.org/iso/catalogue_detail?csnumber=43263.

Box 5.1 Use case 1: Stockholm Biogas for vehicle transport

Two sewage treatment plants in Stockholm, Bromma (184 000 p.e.) and Henriksdal (750 000 p.e.), upgrade the biogas they produce to vehicle fuel quality. A pilot-scale upgrading plant started operating in Bromma as early as 1996. Large-scale upgrading started in 2000, and an upgrading plant began operating at Henriksdal in 2003. A number of biogas filling stations have opened and more and more biogas cars are being bought. Currently, 130 biogas buses are refuelled at a filling station connected via a direct supply line from nearby Henriksdal wastewater treatment plant.

Positive environmental and economic impacts:

- Carbon dioxide emissions have decreased by around 3 100 tonnes per year.
- Emissions of toxic carbon monoxide have decreased by 384 kg per year.
- Emissions of nitrogen oxides have decreased by around 21 tonnes per year.
- Particulate emissions have decreased by 311 kg per year.
- Biogas buses that replace diesel buses reduce traffic noise.
- The reduced emissions of hydrocarbons and nitrogen oxides indirectly result in reduced quantities of ground-level ozone.

Photo: © Anneli Waldén and Lennart Hallgren

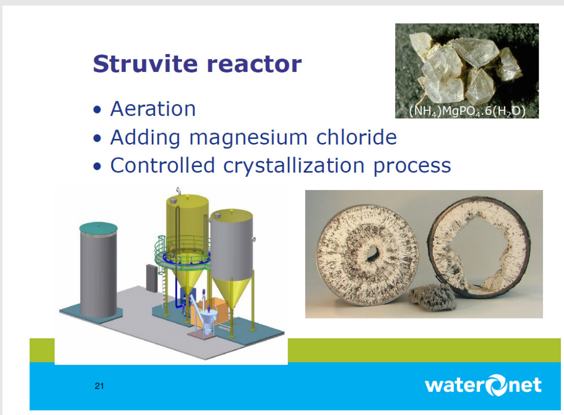
Source: Swedish Environmental Protection Agency, 2011. See also: http://sl.se/sv/om-sl/miljo/biogas.

Box 5.2 Use case 2: Amsterdam Struvite recovery

Waternet has taken a full-scale reactor for precipitation of struvite, in operation in 2013, at the Amsterdam — West WWTP. Based on the initial results, there will be recovery of 100 t of phosphorous per year as a high-quality fertiliser. This corresponds to 22 % of the incoming wastewater load at this 733 000 p.e. plant, however, sludge from other Waternet treatment plants is also treated here, contributing to high recovery.

At the same time, a frequently occurring operational problem of scaling/clogging in pipes is expected to be solved.

Calculations on LCA have shown a reduction of GHG emissions of 1 120 t CO_2-equivalent per year (Klaversma, van der Helm and Kappelhof, 2013).



Source: See (in Dutch): http://www.innovatie.waternet.nl/projecten/fosfaatverwijdering-door-struvietwinning-uit-slib.

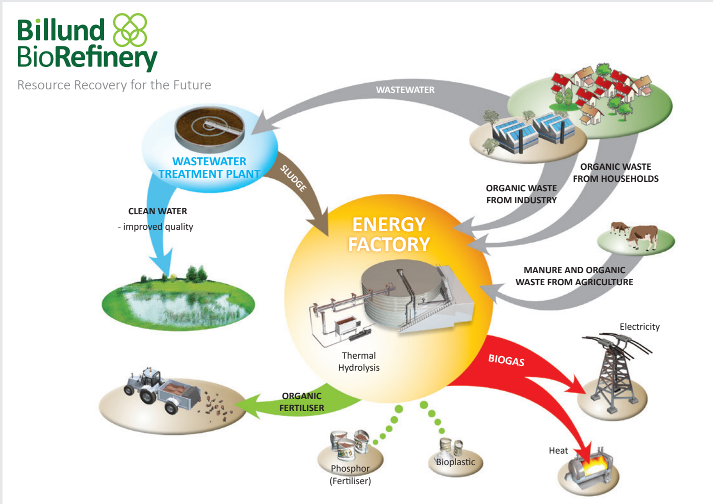
Box 5.3 Use case 3: Billund biorefinery

Grindsted WWTP (DK) has been practicing co-digestion of organic waste since 1997.

Increased biogas production used for power generation has resulted in 30 % higher electricity production than that used for the WWTP.

Further activities are ongoing, to expand the concept water–energy–food nexus for WWTPs, with improved resource efficiency.

Source: http://www.billundbiorefinery.dk.



Box 5.4 Use case 4: from wastewater to biofuel via algae

Large-scale demonstration work is ongoing in Chiclana, southern Spain in the FP7 project "All-gas". Researchers are producing algae in shallow ponds fed with pre- treated wastewater and transforming them to biomethane.

Biofuel production from a 25 000 p.e. WWTP may potentially supply between 200 and 250 cars (each running 20 000 km/y). Instead of consuming electricity between 0.3 and 0.5 kWh (electric)/m^3 treated wastewater, this approach will produce biofuel of 2 to 3 kWh (thermal)/m^3 and water for reuse.

Source: Read more: www.all-gas.eu.

A number of initiatives aimed at improving resource efficiency in practice were presented at the December 2012 expert meeting ([52]), to highlight the following.

- Work conducted by the DWA as well as the DWA Sewage Neighbourhood Programme in **Austria, Germany and Switzerland** on standardisation of energy consumption data in WWTPs ([53]). This work has led to the definition of comparable parameters, voluntary data collection to evaluate appropriateness, spreading discussion and information exchange on all levels, and the team are gradually gaining confidence.

- In **Sweden**, energy consumption in urban water management is now differentiating between various forms of energy (electricity or heat) through an 'exergy' concept. Similarly, a safe drinking-water index as well as a water utility sustainability index for customer service, and ecological and asset sustainability are under development ([54]).

- 'Innovative energy recovery strategies in the urban water cycle' INNERS ([55]) ([56]), an Interreg project funded by the EU's Cohesion Policy, is aiming to improve the energy balance of the urban water cycle — not only as a system that transports water, but also as a potential source of energy, acknowledging that valuable energy which is lost in the current situation. It involves 11 partners from **Belgium, Germany, France, Luxembourg, the Netherlands and the United Kingdom**.

- In the **Amsterdam** area, experience with energy and nutrient recovery from the water cycle of Amsterdam is ongoing ([57]): struvite recovery from wastewater, recovery of paper fibres from UWWTP sieve residues, reuse of FeCL-sludge residue from drinking-water treatment, cooling of the Schiphol airport via heat exchange with the raw water used for drinking-water production, heat exchange/heat pumping from sewerage networks to district heating, separation of fat from UWWTPs clogging material for anaerobic digestion, grinding of water plants from maintenance of ponds for energy and nutrient recovery, use of digester biogas for transport fuel, and synergy between large UWWTPs and neighbouring waste incineration plants.

The water–energy nexus is a central theme, gaining importance in several international forums through the working groups of relevant international associations. Since the first IWA international conference on Water and Energy in Copenhagen in 2009, this has continued as a series under the Water, Climate and Energy programme ([58]).

Other international organisations and forums have adopted this in their agendas: the World Water Forum ([59]), the World Bank ([60]), International Water Week (Amsterdam) ([61]), World Water Week (Stockholm) ([62]), and it is also theme of UN Water World Water Day 2014 ([63]):

If the green economy ([64]) is considered a vehicle for delivering sustainable development, rather than a destination in itself, **indicators are useful measures in the context of green economy policymaking aimed at achieving sustainable development.** The projects above reflect the interest of water utilities and public bodies in choosing environmental, economic or social issues as an entry point to adopting a green economy approach.

([52]) http://projects.eionet.europa.eu/wise-tg/library/thematic-issues/water-utilities-resource-efficiency/european-water-utility-expert-meeting-13-14.12.2012-copenhagen/presentations.
([53]) http://projects.eionet.europa.eu/wise-tg/library/thematic-issues/water-utilities-resource-efficiency/european-water-utility-expert-meeting-13-14.12.2012-copenhagen/presentations/4-benchmarking-energie-budewig.
([54]) http://projects.eionet.europa.eu/wise-tg/library/thematic-issues/water-utilities-resource-efficiency/european-water-utility-expert-meeting-13-14.12.2012-copenhagen/presentations/4-present-and-planned-activities-sweden-improving.
([55]) http://www.inners.eu.
([56]) http://projects.eionet.europa.eu/wise-tg/library/thematic-issues/water-utilities-resource-efficiency/european-water-utility-expert-meeting-13-14.12.2012-copenhagen/presentations/4-energy-balances-large-city-level.
([57]) http://projects.eionet.europa.eu/wise-tg/library/thematic-issues/water-utilities-resource-efficiency/european-water-utility-expert-meeting-13-14.12.2012-copenhagen/presentations/4-water_-energy-nutrient-recovery-amsterdam_waternet_motelica.
([58]) http://www.iwahq.org/1ws/programmes/water-climate-and-energy.html.
([59]) http://www.worldwaterforum6.org/en/commissions/thematic/priorities-for-action-and-conditions-for-success/priority-for-action-23.
([60]) http://water.worldbank.org/WPP-Energy-Security.
([61]) http://www.internationalwaterweek.com.
([62]) www.worldwaterweek.org.
([63]) http://www.unwater.org/wwd2014.html.
([64]) http://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=654&menu=35.

6 Development of relevant indicators

6.1 Environmental indicators

The term 'indicator' carries different meanings in different frameworks; likewise, 'policy' may also refer to company, national or EU policy.

An overview of **environmental indicators** was provided in an EEA report, with a focus on ecosystem resilience and resource efficiency in a green economy in Europe ([65]).

Environmental indicators play a crucial role in policymaking, by providing selected, aggregated and interpreted information at different stages in the policy cycle, with three major purposes (Stanners et al., 2007):

- to supply **information on environmental problems**, in order to enable policymakers to evaluate their seriousness (this is especially important for new and emerging issues);
- to support **policy development and priority-setting** by highlighting the key factors in the cause–effect chain that produce environmental pressures and that policy can target;
- to monitor the effectiveness of policy responses.

Environmental indicators may play very different roles, depending on which environmental challenge they address, and which stage of the policy cycle they aim to inform. It is useful to distinguish indicators that simply describe trends ('what is happening?') from those that assess progress in performance ('are we reaching targets?'), efficiency ('are we improving?'), effectiveness ('are measures and policies working?'), or total welfare ('are we better off overall?') (EEA, 2003; Stanners et al., 2007).

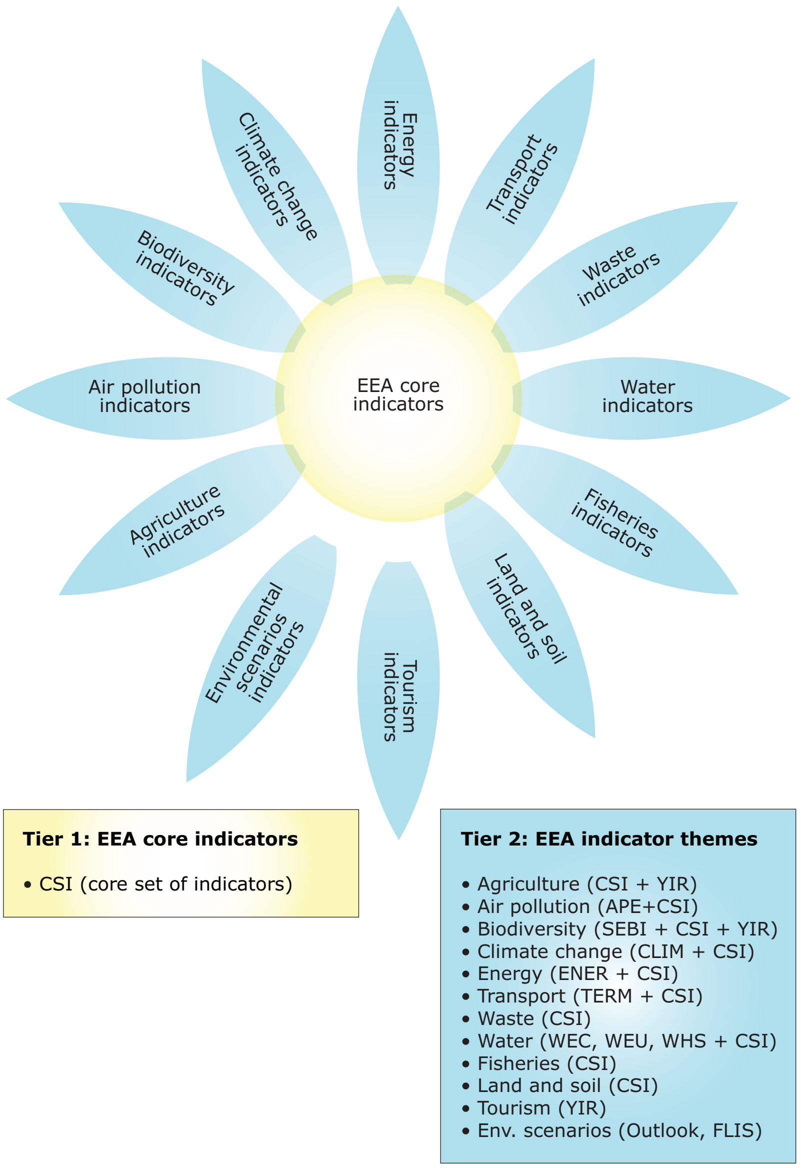
Box 6.1 What is an environmental indicator?

An environmental indicator is a measure, generally quantitative, that can be used to illustrate and communicate complex environmental phenomena simply, including trends and progress over time — and thus helps provide insight into the state of the environment (EEA, 2005).

Indicators play a particularly important role in assessing the 'distance to target' where quantifiable policy targets have been established. Setting environmental targets and identifying appropriate indicators to monitor progress towards these targets over time are closely linked. It is difficult to implement policy and management measures if they cannot be associated with corresponding indicators. It is worth noting, however, that while indicators can provide an accepted yardstick for benchmarking between different countries, regions or municipalities, they can also be misleading in their simplicity. The basis for indicator selection, computation and communication must therefore be kept continuously under review to capture current developments and maintain policy relevance.

([65]) http://www.eea.europa.eu/publications/environmental-indicator-report-2012.

Figure 6.1 Overview of indicators developed, maintained or hosted by the EEA, usually based on statistics from international organisations and national data



Source: EEA, 2012a.

6.2 Performance indicators and benchmarking in the water sector

The water industry itself has worked with performance indicators for a long time, and for different reasons and uses, as described in internationally developed manuals (see, for instance, Matos et al., 2003, and Alegre et al., 2006). These IWA manuals on performance indicators for water supply (second edition) and wastewater have 'become the international standard on the topic. The manuals provide a long list of indicators … [which] provide a useful shopping list that can be used by utility managers when designing their performance assessment system' (Cabrera et al., 2011).

There are several advantages to using performance indicators proposed by these manuals:

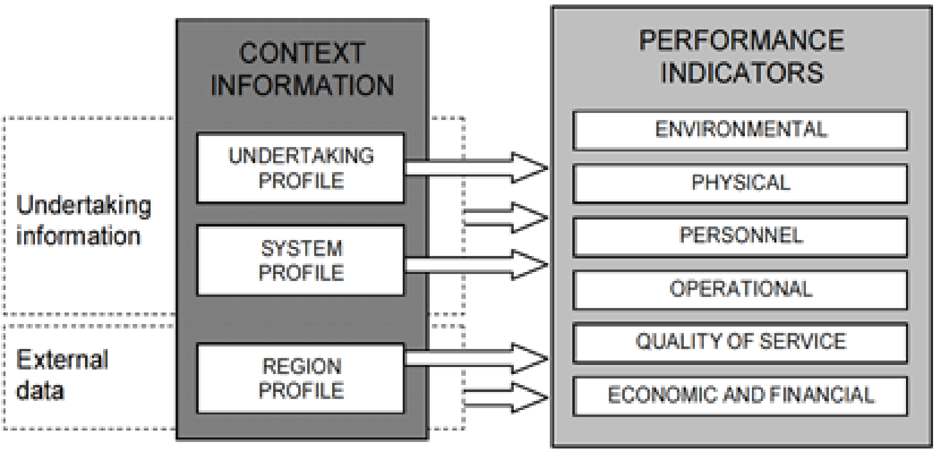
- the performance indicators have been through an intense revision process regarding their relevance and their definitions;
- they provide a flexible structure for a performance assessment system, which allows for adding, replacing and modifying of additional indicators;
- they are widely used and practised, which increases the probability of obtaining reference values.

Performance indicators in the IWA system are structured by performance areas and completed by context information (see Figure 6.2).

As in the case with the environmental indicators developed by the EEA, the selection of performance indicators for the water sector needs to be aligned with strategic objectives of the industry and its operators (see Figure 6.3).

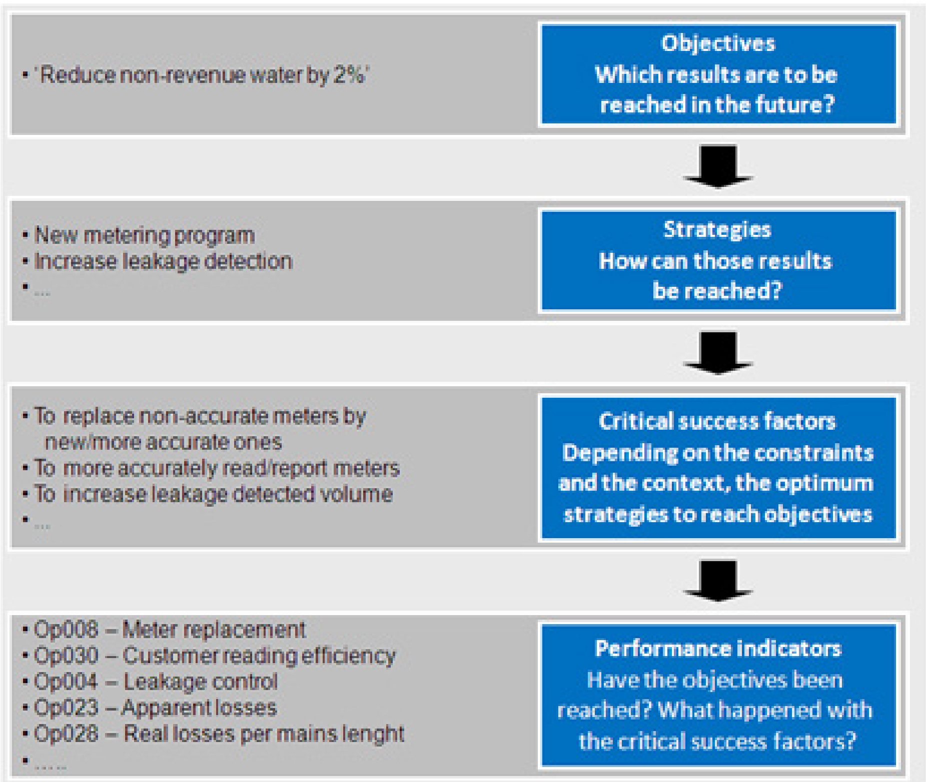
Benchmarking projects of industry in particular use performance indicators. The use of IWA indicators

Figure 6.2 Structure of wastewater context information and performance indicators in IWA system



Source: Matos et al., 2003.

Figure 6.3 Performance indicators as part of objectives and strategies of industry



Source: Adapted from Matos et al., 2003.

is widespread ([66]). A defining characteristic of the majority of such projects and data is the confidential and exclusively internal use of such data. 'Benchmarking is an individual process in the course of which confidential information also is exchanged between the partners. This is one of the reasons for the effectiveness of the method and it explains why the project results are reported on reluctantly.' (Möller et al., 2012).

Both nationally and internationally, water associations define the performance improvement of processes (e.g. of a technical and commercial nature) as the aim of benchmarking. The 'adoption of successful instruments, methods and processes' (DVGW/DWA, 2008), the 'adaptation of leading processes' (Cabrera et al., 2011) or, more simply, 'performance improvement', thus lies at the core of benchmarking. Since the mid-nineties, different benchmarking programmes in the water industry have proved the success of the method, and induced improvements in nearly all performance areas of the industry (see, for instance, Möller et al., 2012).

Nonetheless, a further aspect of the use of benchmarking and its performance indicators is added to many projects: 'with the requirements on the provision of information within the scope of the EU WFD and the discussion about prices in water supply, the requirements on the sector also increase. A meaningful performance assessment within the scope of a benchmarking project can be used for the information needs of politics, the public and companies. Benchmarking thus also supports the outward transparency of the performance of services' (Möller et al., 2012). This takes place in the form of public reports on the benchmarking projects, or regional or national reports (see the European Benchmarking Co-operation (EBC), 2013; and ATT et al., 2011), or individually in reports published by each operator to inform its local clients and boards. In regional or national public reports of industry, benchmarking projects' data are only published in aggregated and anonymous form. Reports in the regulation framework differ from this approach, e.g. the case in Portugal (ERSAR, 2012).

Associations from Austria, Germany and Switzerland cooperated in the past to provide a set of aggregated indicators on performance of wastewater services, ready for public comparison (see EWA, 2009). The results of this working group are a set of key performance indicators and requirements for the interpretation and application of the performance indicators. The need for expert interpretation is highlighted, e.g. to prevent misunderstandings due to the use of different statistical aggregations (average, mean, weighted average, etc.), and to understand the conditions for monetary indicators being independent of performance (depreciation basis, interest rates, expected infrastructure life-time, etc.). Being aware of limitations and transparency is considered an important skill for any interpretation of performance indicators (see EWA, 2009).

6.3 Water-resource efficiency indicators for urban water management

Environmental indicators and performance indicators in benchmarking projects differ due to their use, not their definitions. Benchmarking performance indicators predominantly address water operators and its managers as users, whereas the EEA environmental indicators have a broader user scope. Consequently, their use in projects consists of several components, such as assessments and communication of key messages as an integral part of the indicator management system, as well as public displays on the EEA website ([67]).

Discussions at the expert meeting in December 2012 resulted in a decision to investigate opportunities for expanding the use of already existing non-monetary performance indicators from the benchmarking networks, by further development into the EEA's new resource efficiency indicators. This could be a subject for future cooperation between water utility associations and the EEA.

Such development takes place in the following steps:

- determine the key policy questions;
- identify relevant indicators, including terminology/methodology;
- decide on assessment methods (targets, criteria) and data needed and/or available (both

([66]) Even if IWA indicators are explicitly used in benchmarking projects, relevant differences might still be found in specific definitions of the same indicator. The system allows a certain degree of freedom and space for regional developments. Additionally, most projects have added a considerable number of new, specific indicators. Thus, only with detailed examination of each indicator, is cross-border or cross-project comparison possible.

([67]) http://www.eea.europa.eu/data-and-maps/indicators/#c5=water&c7=all&c0=10&b_start=0.

horizontal — between utilities, and vertical — time trends for same utility):
    - data compilation and assessment (how indicators can be presented and displayed — which spatial units to use for aggregation; presentation by maps or graphs);

- conclude and communicate the key messages for preparation of the specification and assessment parts of the indicator.

A considerable number of performance indicators have been developed by benchmarking organisations. Many of these are designed for direct comparisons (unit–processes) within utility operations, which are essential for technical comparisons, but some have a broader meaning in a technology–policy interface. When making comparisons, it is essential that the same definitions are used, and for this reason, two of the participating benchmarking networks (aquabench ([68]) and the EBC ([69])) have conducted comparative analyses of some of the indicators.

Subsequently, the following were shortlisted as good use cases, with illustrations based on already available data. The indicator examples shown are not necessarily representative of a whole country or region. For further analysis, grouping facilities of similar sizes and characteristics would be a helpful approach to improve comparability.

6.3.1 *Drinking water*

An example of an indicator that would allow a key policy issue to be addressed is the measure of resource efficiency in drinking-water distribution and water consumption in urban areas.

From benchmarking networks, the relevant corresponding indicators have been identified:

- distribution losses ([70])
- residential water consumption ([71]).

Water losses are an inevitable part of the practice of public water supply. From a resource efficiency perspective, these losses should, of course, be minimised as much as possible.

Water utilities are responsible for the losses in their system, from abstraction at source to the delivery point with the customer. Water losses can be roughly divided into production losses and distribution losses. Production losses are losses from abstraction to the treatment processes. For instance, the process of backwashing filters consumes clean water that — even when recycled as much as possible — is at least partly not used for delivery to the customer.

The indicator 'Inefficiency of use of water resources' (%) ([72]) shows the total amount of water that is lost in the system, in relative terms. It is defined as the total production and distribution losses, compared to the amount of water that enters the system. In its simplicity, it indicates the proportion of water losses well for policy awareness However, in technical terms, a successful reduction of water consumption in a community would, with the same real losses in the distribution system, result in a 'negative' development using such an indicator.

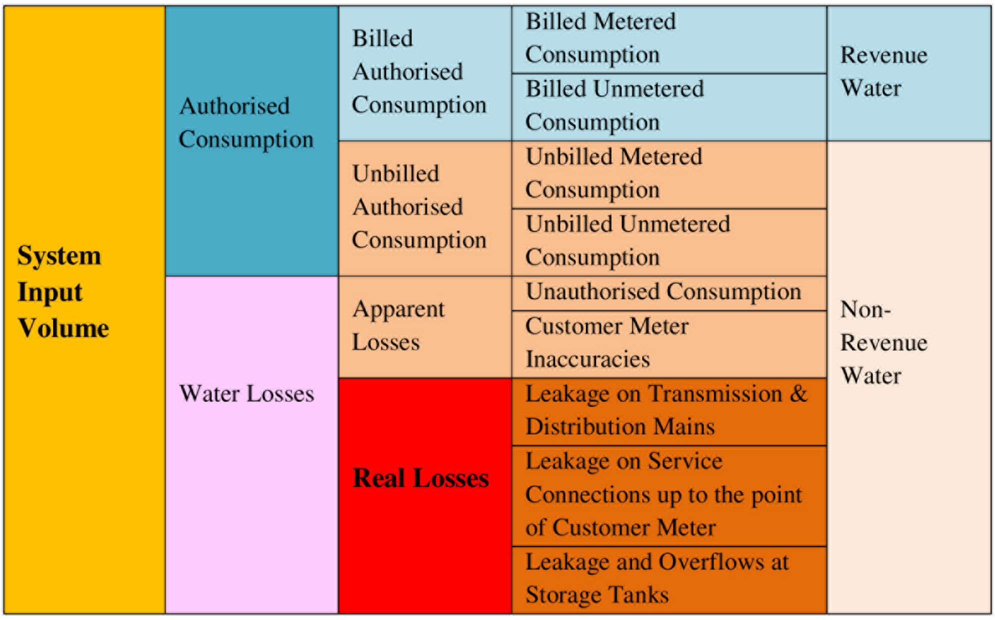
Typically, distribution losses (between 5 % and 50 %) are much larger than production losses (between 2 % and 10 %). Therefore, it is recommended that the initial focus be the distribution losses, which are the total of the real losses in the network and unbilled consumption (like fire-fighting) and apparent losses (like meter inaccuracies and illegal consumption). Figure 6.4 presents a schematic overview of generally accepted terms used for water losses in distribution systems.

Distribution losses can be derived from a water balance. Since unbilled consumption and apparent losses can only be determined through estimations, the real losses are an estimated value. For network improvement, these real losses are most relevant. From a resource efficiency perspective, the total of the distribution losses is considered to be a relevant indicator.

A wider review of indicators related to water distribution losses has been recently been conducted (European Commission, 2013a). This review

([68]) http://www.aquabench.de.
([69]) http://www.waterbenchmark.org.
([70]) Codes: EBC: zOp-028 = aquabench: zOp-028. Applied for 24 h/day operation and expresed for losses/day. Distribution losses is equal to real losses + unbilled consumption + apparent losses. The chosen indicator is based on one of many IWA performance indicator on water losses (IWA Op-028), but differs from the indicator by including unbilled water and apparent losses.
([71]) Codes: EBC: CI-071 = IWA: CI 71 = aquabench: Ki1132.
([72]) Code EBC: zWR-001 (adapted on IWA Indicator WR 001).

Figure 6.4 Schematic overview of terms used for water losses in distribution networks



Source: IWA Water Loss Task Force (73) and European Commission, 2013a (74).

includes the 'sustainable economic level of leakage' (SELL), which serves a purpose for economic prioritisation for utility managers.

Benchmark data for **water distribution losses** (m^3/km/day) have been processed and summarised for three federal states in Germany (Hesse, Rhineland-Palatinate and Schleswig-Holstein) (see Appendix 1). The mean values range from 0.9 m^3/km/day to 3.1 m^3/km/day, representing about 2.5 million persons served.

Aggregated benchmark data for the same indicator show a mean value level of 8.3–8.4 m^3/km/day for three consecutive years for a group of large water utilities participating in an EBC benchmarking exercise. Data for all years are based on the same 32 water utilities (not weighted), representing about 75 million persons served. The distribution losses in the group of utilities from around Europe are significantly higher than the benchmark data from Germany.

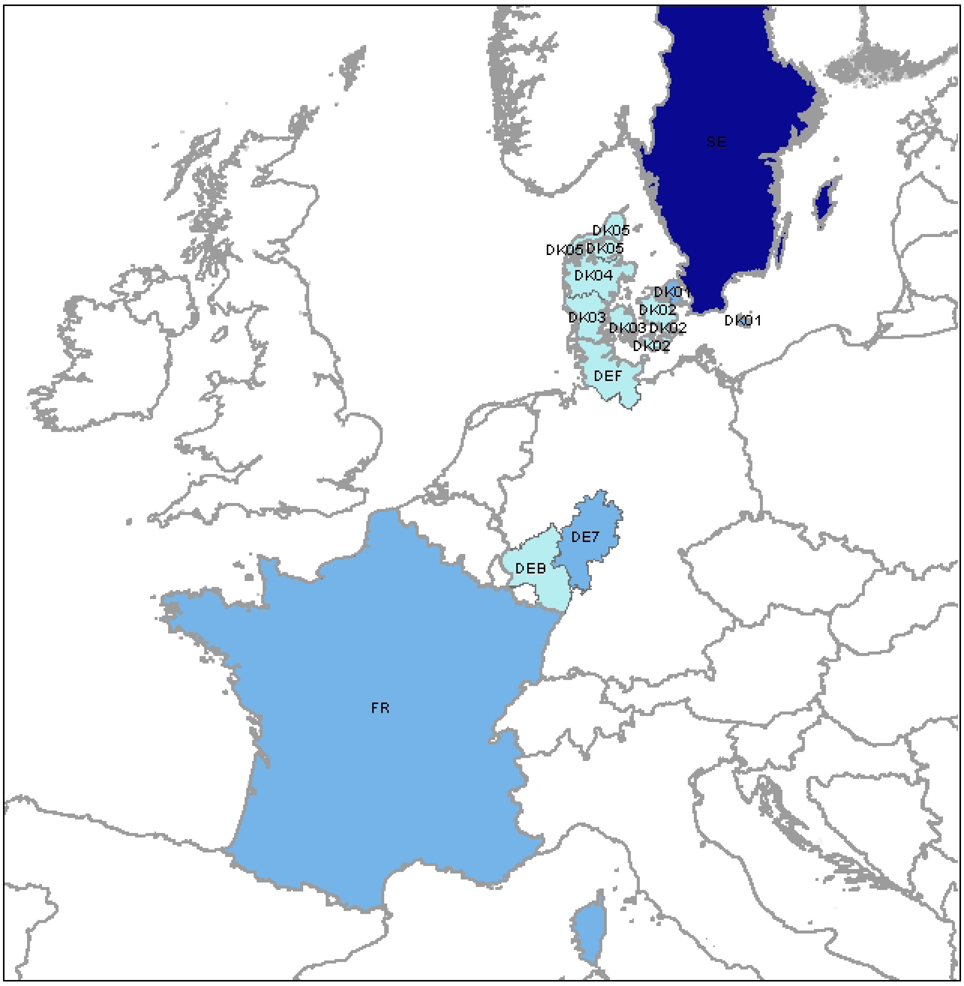
Additional data have been provided from water associations in France, Sweden and Denmark as shown in Map 6.1. The weighted mean values range from 1 to 10 m^3/km/day with the lowest in Germany, Denmark and France and the highest in Sweden.

For mean values, data from each utility included have the same weight independent of their size; for weighted mean values, the size of each utility is taken into account, in this case weighted according to mains length.

Benchmark data from 2010 for the same two federal states for **residential water consumption** are much more uniform, with mean values of 124 l/capita/day to 126 l/capita/day (about 45 m^3/capita/year) and upper 90 percentiles of 161 l/capita/day and 159 l/capita/day, respectively. For France, the mean values weighted by population were 151 l/capita/day for about 3 700 utilities serving about 32 million people. The shared data are included in Appendix 1. Eurostat data (75) on water use from the public

(73) http://www.iwapublishing.com/pdf/WaterLoss-Aug.pdf.
(74) http://ec.europa.eu/environment/water/quantity/pdf/Final%20REE%20Report%20Oct%202013.pdf.
(75) http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=ten00014.

Map 6.1 **Examples of distribution losses in water supply networks — weighted mean values (2010 data)**



Drinking water distribution losses, weighted mean (m^3/km/day)

w_mean

- 0–2
- 2–4
- 4–6
- 6–8
- 8–10

Note: Distribution losses include real losses per mains length plus unbilled consumption and apparent losses. Mean values are weighted by mains length. See Appendix 1 for more details on the data.

Source: Aquabench, Danish Water and Wastewater Association, Système d'Information sur les Services Publics d'Eau et d'Assainissement, and Swedish Water and Wastewater Association.

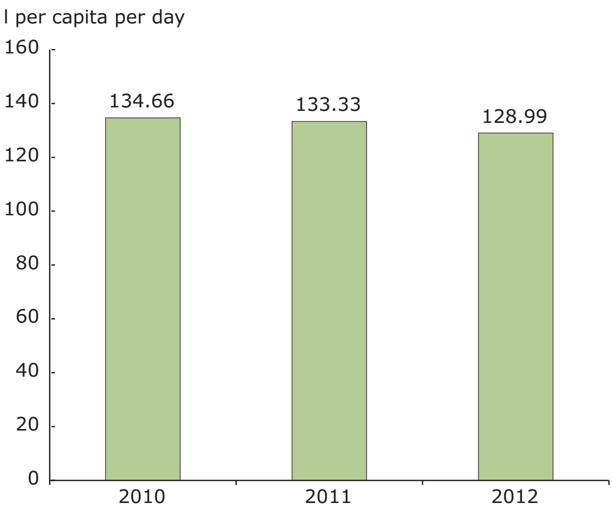
NUTS boundaries: Eurostat, © EuroGeographics for the administrative boundaries.

water supply by services and private households for Germany also show about 45 m^3/capita/year; however, this includes services, too, so is not exactly the same definition.

Aggregated benchmark data from the EBC for the same indicator are shown in Figure 6.5 for three consecutive years. Data for all years are based on the same 31 water utilities, representing about 77 million persons served. There seems to be a declining tendency — data are at the same level as for the above references.

More information is available in Appendix 2 on the drafting composition of indicators as practised for the EEA set of indicators.

Figure 6.5 Residential water consumption per capita for 31 large water utilities in geographical Europe



Source: EBC, 2013; EBC-code: CI-071 data in Appendix 1.

6.3.2 *Wastewater emissions*

Nutrient removal efficiency

Another policy issue that has been identified is the efficiency of nutrient removal from urban WWTPs.

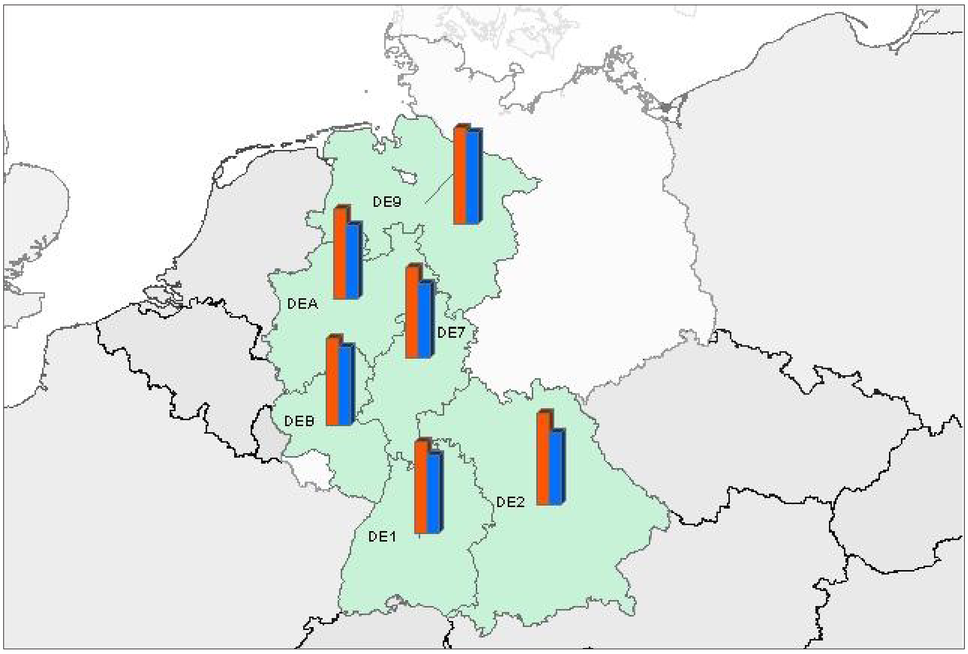
From benchmarking networks, the relevant corresponding indicators have been identified:removal efficiency of total nitrogen (N), total phosphorus (P) and biochemical oxygen demand (BOD) ([76]).

Benchmark data for nutrient removal efficiency presented as a percentage have been processed and summarised for two federal states in Germany (Hesse and Rhineland-Palatinate); see Map 6.2.

The aggregated weighted mean values for P removal range from 87 % to 95 %; ranges for the 90th percentile are between 65 % and 97 % for the roughly 150 utilities in the 7 federal states, serving about 40 million p.e. These relatively high and uniform removal efficiencies are expected, since most of the plants represented in the benchmark network members are > 100 000 p.e. with requirements for tertiary treatment — the entire German territory is considered a catchment of sensitive area for both N and P. For the same utilities, the aggregated weighted mean values for N are 72 % to 90 %, and ranges for the 90th percentile are between 50 % and 97 %.

([76]) No IWA code; EBC: wOp-EBC-001 N; wOp-EBC-002 P, wOp-EBC-003 COD, wOp-EBC-004 BOD = aquabench:KQA1, KQA05 KQA10= DACH: PI 2.7; PI 2.8.

Map 6.2 Nutrient removal efficiency, aggregated for six German federal states



Wastewater total nitrogen and total phosphorus removal efficiency (%)

Ptot_removal_efficiency

Ntot_removal_efficiency

Data specification	Underlying coverage for aggregated data				Statistical parameters for aggregation				
Reference year	NUTS1-code	NUTS1-name	Number of utilities (n)	Number of p.e. served by WWTP	Median (%)	Mean	Weighted mean ([a])	Lower 90%ile	Upper 90%ile
Total phosphorus removal efficiency									
2010	DE1	Baden-Württemberg	36	4 464 508	88.75	85.66	90.54	71.71	95.12
2010	DE2	Bayern	47	4 970 286	87.73	83.34	90.29	65.29	95.1
2011	DE3/5/6	Berlin/Bremen/Hamburg	3	8 981 908	---	94.8	---	---	---
2008	DE7	Hessen	12	824 179	85.89	85.37	88.72	78.69	95.43
2010	DE9	Niedersachsen	20	2 089 995	95.04	93.66	94.72	88.96	97.13
2010	DEA	Nordrhein-Westfalen	23	16 628 888	94.37	92.59	88.59	87.19	96.84
2010	DEB	Rheinland-Pfalz	12	2 004 937	88.18	84.38	86.87	68	92.55
Total nitrogen removal efficiency									
2010	DE1	Baden-Württemberg	36	4 464 508	74.75	74.78	76.99	59.75	88.45
2010	DE2	Bayern	46	4 970 286	82.83	81.64	71.47	66.12	94.3
2011	DE3/5/6	Berlin/Bremen/Hamburg	3	8 981 908	---	82.1	---	---	---
2008	DE7	Hessen	13	824 179	76.2	72.77	72.43	50.17	89.18
2010	DE9	Niedersachsen	19	2 089 995	91.74	89.6	89.62	81.34	96.95
2010	DEA	Nordrhein-Westfalen	22	16 628 888	83.65	82.71	72.51	70.89	92.46
2010	DEB	Rheinland-Pfalz	51	2 004 937	82.03	79.73	78.04	64.74	92.77

Note: ([a]) Weighted by: annual treated wastewater (abt50) (m^3).

Source: Aquabench, 2013; data in Appendix 1.

NUTS boundaries: Eurostat, © EuroGeographics for the administrative boundaries.

Decoupling of nutrient emission and population growth

An EEA water-resource efficiency indicator on 'Emission intensity of domestic sector in Europe' (WREI 002) ([77]) has recently been published. There is a key policy question: **is nutrient emission in water from the domestic sector decoupling from population growth?**

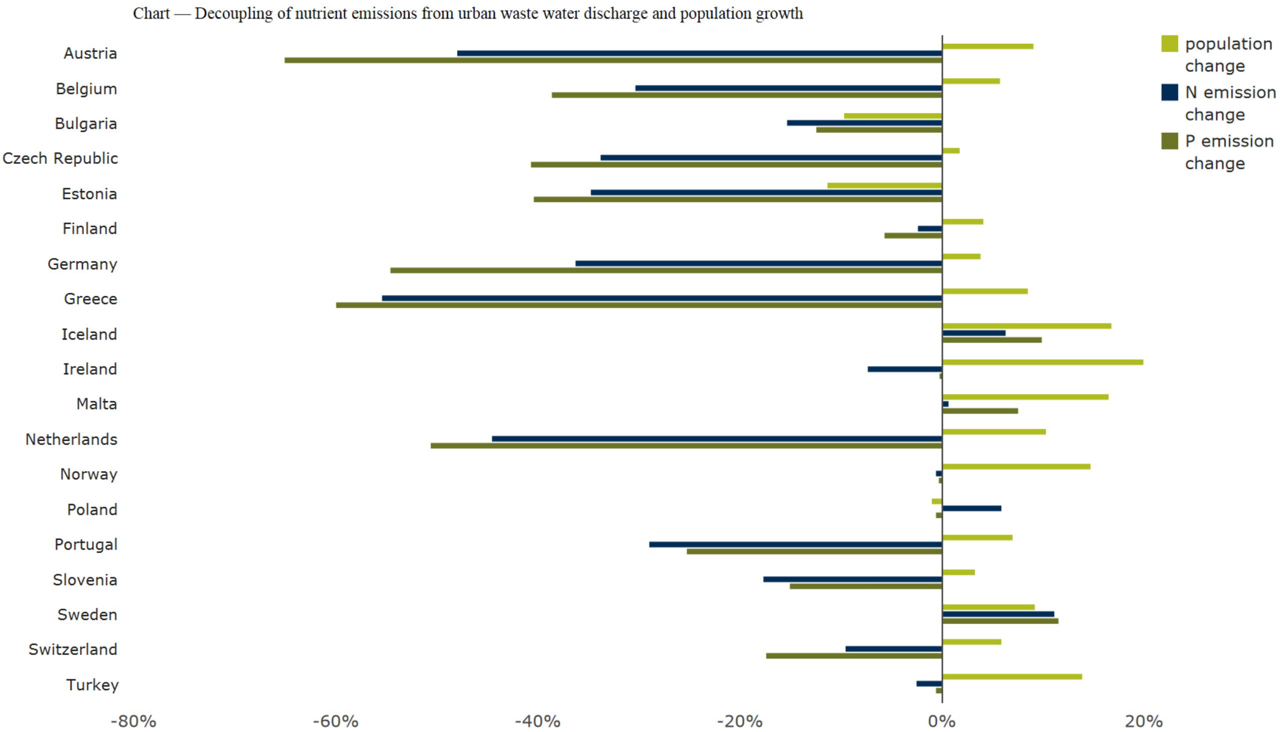
The indicator relates primarily to the changes in emission intensities and population growth as development between 1990, 2000 and 2009. As illustrated in Figure 6.6, overall this shows a good absolute decoupling, i.e. emissions decrease while the population increases.

But the absolute levels of emission intensities are just as important, as illustrated in Figure 6.7, where the same changes can be seen, albeit starting from very different levels.

For those countries, where four bars appear, the three from left have been calculated based on statistics for the percentages of population connected to various types of treatment, and the standard assumptions for corresponding removal rates (as described in the methodology section within the indicator system). Thus, the development over time reflects the infrastructure development.

The fourth column to the right (b) is based on actual emissions reported by several countries

Figure 6.6 Decoupling of nutrient emissions from UWWTPs and population growth between 1990 and 2009



Note: As part of the EEA indicator system, the user can interactively sort or reduce the display of the chart

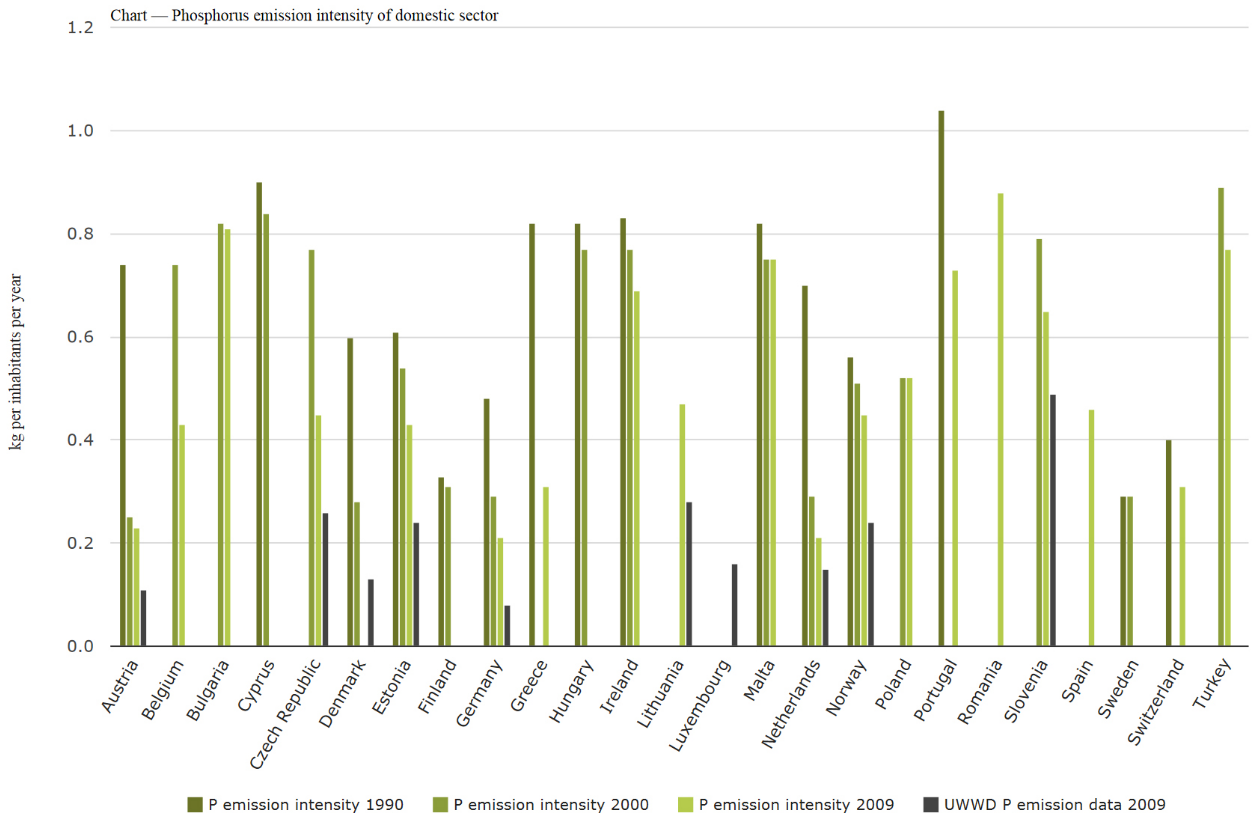
Source: EEA Indicator WREI002.

([77]) http://www.eea.europa.eu/data-and-maps/indicators/emission-intensity-of-domestic-sector/assessment.

under the UWWTD and show in all cases lower specific emissions than the 2009 data (a), based on calculations. This illustrates that the actual performance of treatment plants are often better than the standard assumptions or effluent standards in discharge permits. It is considered important for indicators on emission intensity at the European level to be able to base data on treatment plant performances on actual emissions, which can acknowledge optimisations implemented.

A similar tendency can be seen for nitrogen emission intensities on a similar chart in the WREI002 indicator.

Figure 6.7 Phosphorous emission intensity of domestic sector for 25 EEA member countries (1990, 2000 and 2009)



Note: The chart displays changes in phosphorous emission intensity in the domestic sector in 1990, 2000 and 2009. Phosphorous emission intensity is expressed as kilogram of nitrogen discharged in water per inhabitant and year. Two sets of values are displayed for emission intensity for 2009: (a) values calculated on the basis of population equivalents and default treatment efficiencies, and (b) values calculated as the sum of emission loads reported voluntarily under the UWWTD and the calculated load generated by population not connected to wastewater treatment.

Source: EEA WREI002.

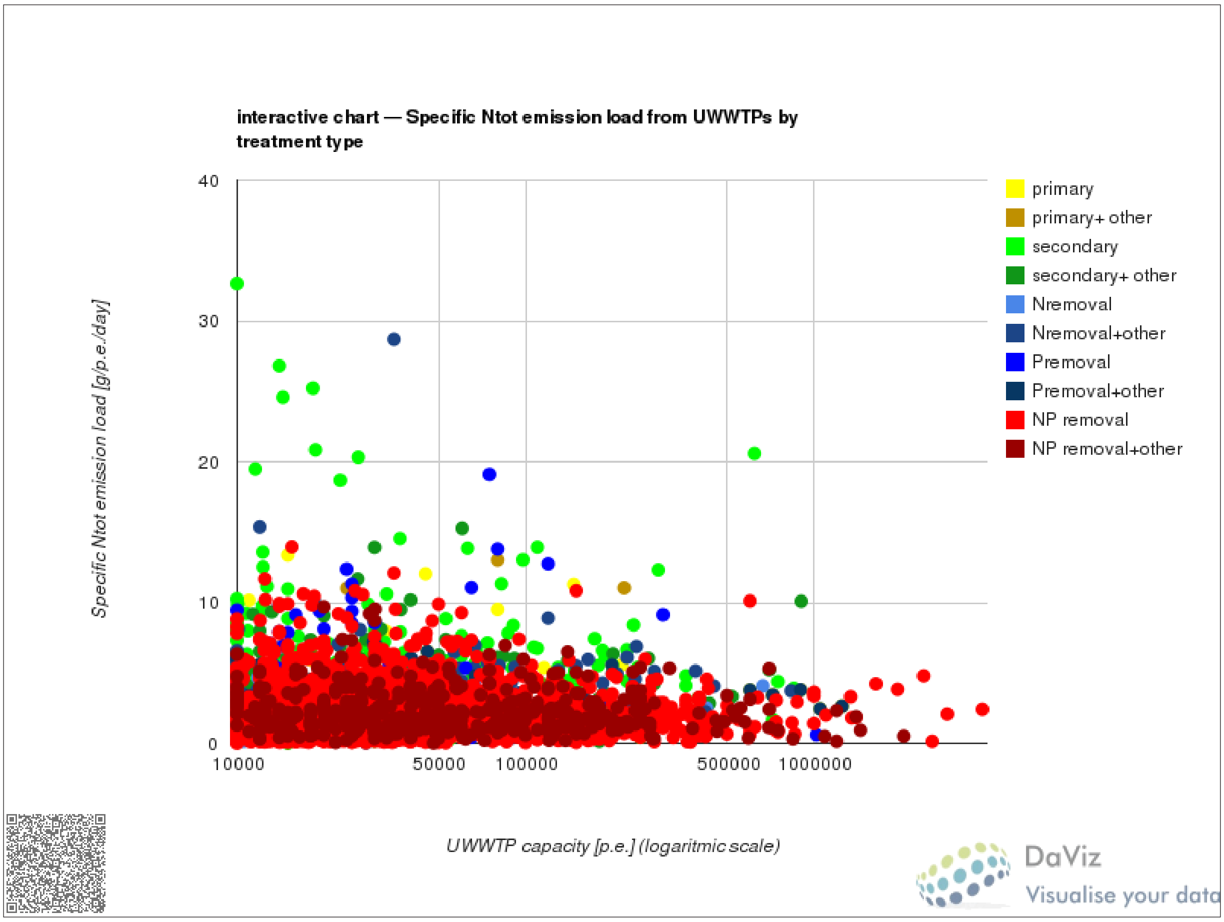
Specific nutrient emissions at plant level

Additional data on nutrient emissions have been reported by 13 countries as part of the UWWTD reporting; these are directly available from the Waterbase UWWTD ([78]). Simple processing has been conducted by normalising according to incoming p.e. load and display as a function of plant size (capacity) and treatment type, and by use of the interactive visualisation tool, DaViz, established by the EEA (a set of charts have been prepared and are included in Appendix 3). The interactive functionality in the DaViz applications enables users to filter data by selection and to highlight occurrences of hidden points by pointing at legends.

Figure 6.8, for example, shows specific emissions of nitrogen, sorted by treatment type. As expected, the plants with N, N&P and N&P and other (more advanced) treatment have the lowest specific emissions. Surprisingly, several plants with secondary treatment have higher emissions than those with primary treatment of similar size. Moreover, the expected effect of lower specific emissions of larger size plants can be seen (note the log-scale axis).

Another presentation of the same underlying data is made in Figure 6.9, with specific phosphorous emissions for treatment plants with N & P removal, but sorted by country.

Figure 6.8 Specific emission of total nitrogen (N) from UWWTPs according to treatment type (2010 data)



Note: As part of the EEA indicator system, the user can interactively sort or reduce the display of the chart.

Source: Waterbase UWWTD, 2012.

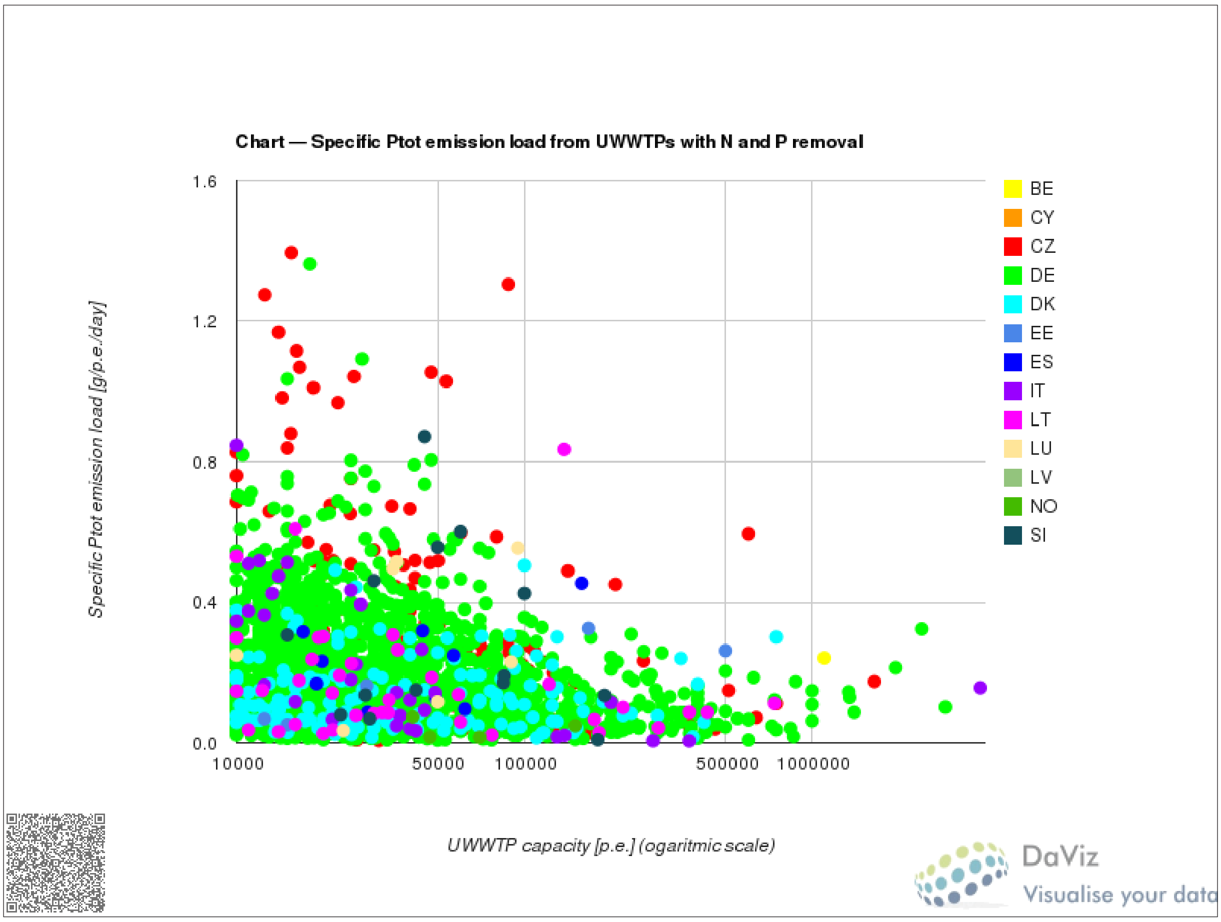
DaViz application included in gallery: http://www.eea.europa.eu/data-and-maps/daviz/uwwtd-data.

([78]) http://www.eea.europa.eu/data-and-maps/data/waterbase-uwwtd-urban-waste-water-treatment-directive-3.

Again, the data clearly show a plant-size dependency, with the larger plants showing a better resource efficiency. There is wide variability, but some countries tend to have higher specific emissions than others for same treatment type and similar sizes. This can be attributed to different emission standards, or to other incentives like economic charges based on actual emissions to water, which impact the treatment technology and optimisation of plant operation. The incoming loads may depend, for instance, on the use of phosphorus in detergents (via policies, water hardness and consumer awareness), which may also influence the emissions. The apparent outliers on the figure do not necessarily mean that those plants are not well operated, but they do indicate that there may be potential for further reduction. In exceptional cases, a less favoured position in the chart on the X-axis may be caused by a very high plant capacity compared to the average p.e. load, and on the Y-axis by a low BOD concentration level, relative to N and P concentrations.

The chart can be better explored using the interactive DaViz application, which allows the user to highlight data and select countries of interest for the displays.

Figure 6.9 Specific emission of total phosphorus from UWWTPs with N&P removal, sorted by country (2010 data)



Source: WISE Waterbase UWWTD, 2012.

DaViz application included in gallery: http://www.eea.europa.eu/data-and-maps/daviz/uwwtd-data.

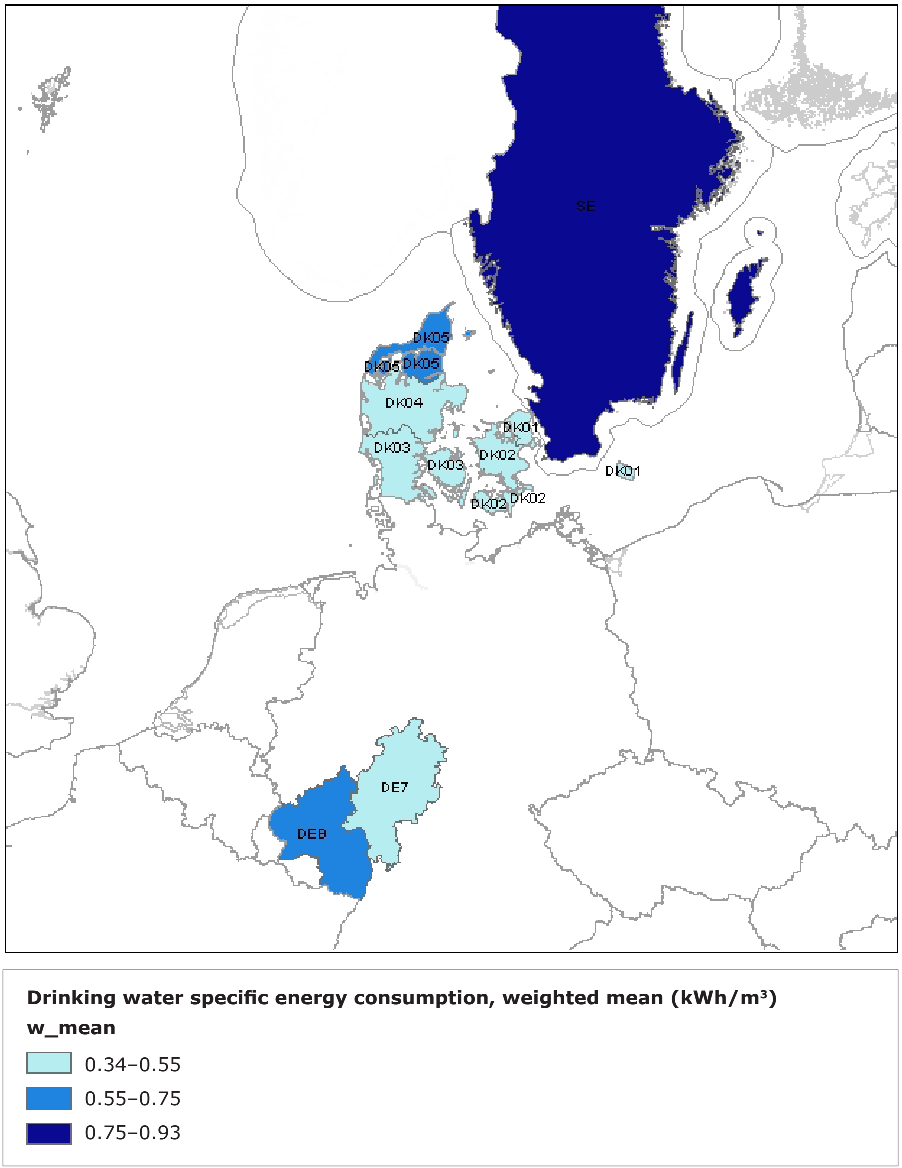
6.3.3 *Energy efficiency in urban water supply*

Furthermore, the energy efficiency of urban water supply operations can be assessed using the following indicator.

From benchmarking networks, the relevant corresponding indicators have been identified total electricity use for production + distribution, aggregated per country/region ([79]) (note different normalisation). Production includes abstraction, transport to water treatment and water-treatment plant drinking-water production.

Benchmark data for energy consumption for drinking-water production and distribution (kWh/m³) have been processed and summarised for two federal states in Germany (Hesse and Rhineland-Palatinate), as well as for five regions in Denmark and all of Sweden; see Map 6.3.

Map 6.3 Specific electric energy consumption for drinking-water production and distribution



Source: Aquabench, 2013; DANVA and SWWA, 2014.

NUTS boundaries: Eurostat, © EuroGeographics for the administrative boundaries.

([79]) No IWA code; EBC: zOp-EBC-001 & 056 (per m3 produced) <= aquabench Ph0171 & 01711 (per cubic metre of authorised consumption).

The aggregated weighted mean values from this German benchmarking for energy consumption are 0.5 kWh/m^3 to 0.7 kWh/m^3 (authorised consumption), and ranges for the 90th percentile have a wide range: between 0.06 and 1.1 kWh/m^3. This is based on data from a total of 85 utilities, serving a total of 2.2 million inhabitants. Similar weighted mean values from Denmark show 0.3 kWh/m^3 to 0.6 kWh/m^3, based on 57 utilities serving 3.0 million inhabitants. Data from Sweden for 181 utilities serving a total of 6.6 million inhabitants show higher values of 0.93 kWh/m^3 (authorised consumption). A weighted mean value from these data is 0.76 kWh/m^3 (authorised consumption).

Benchmark data from 31 large water utilities across geographical Europe serving about 71 million inhabitants show a mean value of 0.5 kWh/m^3; apparently alike, yet they refer to 'water produced'. Since this includes eventual distribution losses, this representation of energy consumption will give lower values in comparison with normalisation by cubic metre of authorised consumption.

More information on the data is included in Appendix 1.

A rough calculation shows that authorised consumption of 45 m^3/y/person and energy consumption for 0.76 kWh/m^3 corresponds to 34 kWh/y/person.

Energy consumption for drinking-water production and distribution depends to a large degree on the source water quality, as well as on the distance for transport and the elevation for pumping, so a high variation is expected. Benchmarking projects handle such underlying differences internally, by meaningful clustering and more detailed process benchmarking.

6.3.4 Energy efficiency in urban sanitation

A relevant benchmarking network indicator for energy efficiency in water sanitation operations has been identified:

- total electricity consumption for wastewater treatment, aggregated per country/region ([80]).

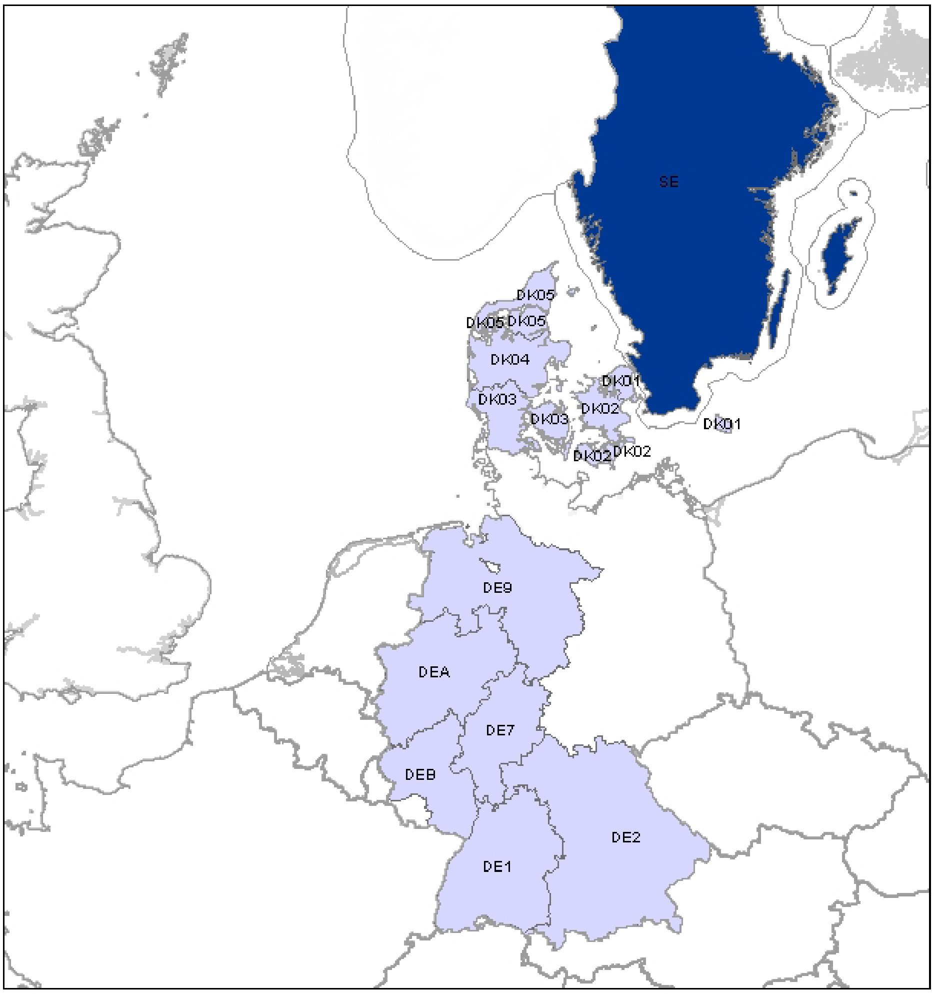
Benchmark data for energy consumption for urban wastewater treatment (kWh/year/p.e.) have been processed and summarised for six federal states in Germany; see also the five regions in Denmark and all of Sweden (Map 6.4).

The data, which reflect the situation in 2010, have a coverage of 43.3 million p.e. for this German benchmarking, of 6.9 million p.e. for Denmark, and of 6.1 million p.e. for Sweden. According to the Technical Assessment of the UWWTD implementation (European Commission, 2013b), the corresponding total generated load from agglomerations > 2 000 p.e. were 114 million p.e. (Germany), 11.5 million p.e. (Denmark) and 7.9 million p.e. (Sweden).

The sharing of similar data from more countries could provide a more extended map, preferably at comparable aggregation levels, and could improve the knowledge base for large treatment plants (at minimum) across Europe.

([80]) IWA code:wOp-018; EBC: wOp-018 = aquabench: KNA249 = DACH: No indicator.

Map 6.4 Specific energy consumption for urban wastewater treatment



WWTP specific energy consumption, weighted mean (kWh/(p.e.*y))
w_mean

- 29.02–50.00
- 50.00–75.00
- 75.00–94.70

Source: Aquabench, 2013, DANVA and SWWA, 2014.

NUTS boundaries: Eurostat, © EuroGeographics for the administrative boundaries.

Figure 6.10 Energy consumption (mean values) for wastewater treatment per i.e. for 18 large water utilities in geographical Europe

Source: EBC, 2013; EBC-code wOp-018 data in Appendix 1.

Aggregated benchmark data from EBC for the same indicator are shown in Figure 6.10 for 3 consecutive years. Data for all years are based on the same 18 water utilities representing about 51 million persons served.

The data from aquabench, DANVA and SWWA (Map 6.4) are weighted mean values, whereas EBC data (Figure 6.10) are mean values (may deviate +/– 10 %); otherwise, the data are comparable. The underlying conditions however, may be very different, since the EBC data probably represent larger treatment plant size classes and the type of treatments may differ as well. Further analyses to take such differences into account would require the availability of the underlying, disaggregated data.

The specific electricity consumptions are very much alike for the data sets — around 35 kWh/year/p.e. to 40 kWh/year/p.e.; however, for Sweden, there is a weighted mean of 95 kWh/year/p.e. The weighted mean for the German, Danish and Swedish data sets is 43 kWh/year/p.e. (see Appendix 1 for further details).

The above electricity consumptions represent total (gross) consumption and do not include any recovery, e.g. by cogeneration of electricity from digester biogas. As an order of magnitude, 16 of 29 participants operating treatment plants have reported cogenerated energy, for a median of 8.5 kWh per p.e. served.

Energy consumption for wastewater transport (pumping) in sewerage systems depends to a very high degree on the topography of the service area, but also on the technology installed (pumping yield efficiency and automated control). The average data for Sweden indicate approximately 20 kWh/year/person (Olsson, 2012; Lingsten et al., 2008).

Put in perspective, a rough calculation with energy consumption for the household sector for urban water management comprises:

- drinking-water production and supply: 34 kWh/year/person
- wastewater transport: 20 kWh/year/person
- wastewater treatment: total consumption 43 kWh/year/person
  - cogeneration of electricity: – 9 kWh/year/person
- total, net consumption: 88 kWh/year/person.

When addressing the household sector alone, the normalisation of wastewater-related consumptions in population equivalents will roughly correspond to the normalisation per person (inhabitant).

By comparison, the EU-27 average for electricity consumption in households is about 70 million tonnes of oil equivalent (toe) ([81]) or 814 TWh, which with a population of about 500 million people ([82]) corresponds to an average of about 1 600 kWh/y/person. In other words, the net annual electricity consumption for urban water management represents about 5.5 % for the household sector, and corresponds to each person constantly burning a 10 W light bulb. This does not include the management of industrial wastewater or storm-water run-off.

The full energy balance for water utilities goes beyond electricity consumption; heat recovery, for instance, may contribute significantly to energy savings if connected to district heating systems. The full energy balances may be taken into account by calculating 'carbon footprints' in the context of LCA.

([81]) http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tsdpc310&plugin=1.
([82]) http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Demographic_balance,_2011_(1)_(1_000).png&filetimestamp=20130129110805.

7 Contributions for improving the knowledge base

7.1 From EU institutional level to water utility associations and their members

Contributions for improving the knowledge base, from EU institutional level to the European and international water utility associations and their members, are made through the provision of policy implementation reports and thematic assessment reports on the state and outlook of the environment, as well as through WISE products. The UWWTD Waterbase in particular contains basic data for about 28 000 individual treatment plants across Europe.

This provides water professionals with easy access to such information of relevance to their work, enables downloading of data for their own further analyses, and places their own water utilities performance in a European perspective.

On a longer-term basis, the water associations may influence the content and functionality of WISE products to better satisfy their user needs. Also, joint use of data management tools and visualisation products maintained at the WISE water data centre may facilitate further processing of data and communication of information generated by activities of the associations.

7.2 From water utility associations to EU institutional level

As outlined in this report, the water associations including benchmarking networks are in possession of a great deal of relevant data, in addition to the data reported via EU directives and other frameworks in an institutional context.

The development of environmental performance indicators is considered a good means of monitoring towards certain targets (e.g. those set under the EU resource-efficiency agenda), and at the same time communicating messages as answers to key policy questions.

There are several options, both organisational and technical, for implementing a new mechanism on data sharing from water associations with the WISE water data centre.

A conceptual overview is presented in Figure 7.1.

Data on performance need to refer to a spatial unit. The spatial unit could be a drinking-water supply zone, a detailed NUTS unit (municipality), a service area for UWWTPs (wastewater collection system) or a treatment plant. Data for such a spatial unit is available at individual plant level and at utility level (in the case of operators of more than one plant). Data may be aggregated to higher-level spatial units, but will lose some specificity. However, in some cases, the data policy defined by the data owners may lead to such aggregations being required.

In principle (not shown), direct upload from individual utilities to a common platform is possible, e.g. as practised by the International Benchmarking Network for water and sanitation utilities (IBNET) ([83]). However, QA/QC may be an issue. The data coverage for IBNET in European countries is not so high.

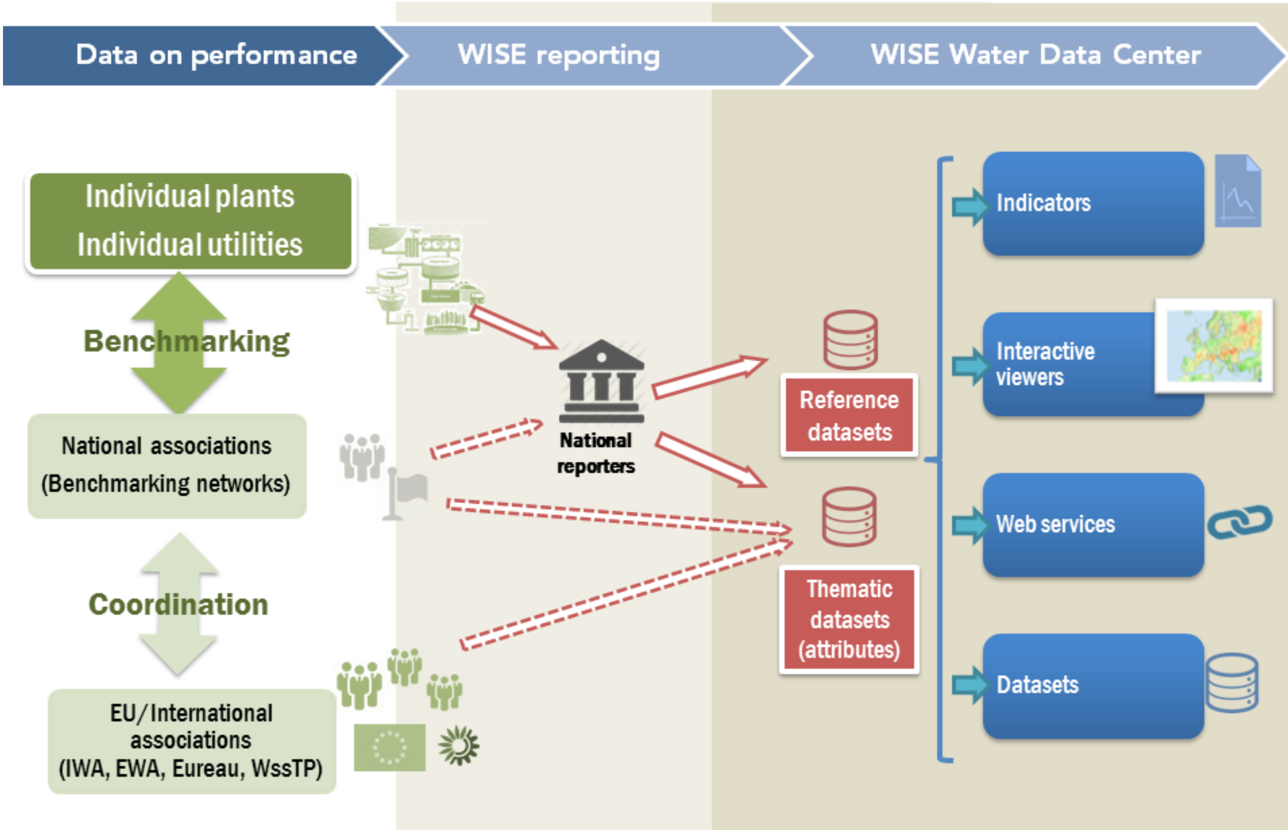
Data reported via current regular data flows are included in national databases by regional or national environmental authorities or by statistical offices. These data already have well-established transfer via electronic reporting to EU institutional level, with routines for data quality assurance and quality checks (QA/QC); from there, further processing and dissemination takes place within WISE.

The data of relevance to the current context are supplementary to the above reporting, with data mostly of a very technical nature, decoupled from compliance assessments to EU directives or regulations.

With this in mind, there are two main options for organising the sharing of such supplementary data

([83]) http://www.ib-net.org.

Figure 7.1 Conceptual overview of options for sharing data on performance beyond compliance



from inventories managed by national associations/ benchmarking networks to EU level:

- via the national reporters for established data flows as additional data to be included in national databases, and from there to be integrated with the reporting/sharing at EU level;
- directly from European/international associations — probably managed by a coordinating working group — to EU level.

Both options present advantages and disadvantages: the solution will need to be accepted by all stakeholders involved. From the WISE water data centre viewpoint, it is preferable that only one of the options is chosen and developed, for reasons of simplicity.

In a future context it may also be considered if a continuation of this work can contribute to the actions announced by the Commission in response to the first European Citizens Initiative 'Right2Water'.

Technically, there are also options concerning which additional data to share, and how to do so. The data may be the basic parameters (e.g. electricity consumption per treatment plant, MWh/year) to be used for calculation of indicator values, or the indicator value itself (kWh/year/p.e.). The means of sharing data may range from submission of thematic data sets, (e.g. as Excel sheets), to a web-based data exchange between servers hosted by the country/ organisation and by the EEA. In all cases, it is essential that the thematic data sets use the same identification codes for the spatial units, as are already used in the WISE reference geographic information system (GIS) data sets.

Acronyms

ATT	Association of Drinking Water from Reservoirs
BOD	Biochemical oxygen demand
CAP	Common Agricultural Policy
CEN	European Committee for Standardisation
CSO	Combined sewer overflows
DANVA	Danish Water and Wastewater Association
DG	Directorate-General
DWA	German Association for Water, Wastewater and Waste
EBC	European Benchmarking Co-operation
EDF	Electricité de France
EEA	European Environment Agency
EFTA	European Free Trade Association
EIP	European Innovation Partnership
ETP	European Technology Platform
EU	European Union
EUREAU	European Federation of National Associations of Water Services
EWA	European Water Association
FP	Framework Programme
FWI	Freshwater withdrawal impact
GDP	Gross domestic product
GHG	Greenhouse gas
GIS	Geographic information system
GVA	Gross value added
IBNET	International Benchmarking Network for water and sanitation utilities
IWA	International Water Association
LCA	Life cycle assessment
LNG	Liquid natural gas
MSMG	Members States Mirror Group
NGO	Non-governmental organisation
NUTS	nomenclature of territorial units for statistics
p.e.	population equivalent
RBMP	River Basin Management Plan
SELL	Sustainable economic level of leakage
SoE	State of the environment
SWWA	Swedish Water & Wastewater Association
UNEP	United Nations Environment Programme
UNSD	United Nations Statistics Division
UWWTD	Urban Waste Water Treatment Directive
UWWTP	urban wastewater treatment plant
WFD	Water Framework Directive
WISE	Water Information System for Europe
WWF	World Water Forum

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European Environment Agency

Performance of water utilities beyond compliance
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2014 — 58 pp. — 21 x 29.7 cm

ISBN 978-92-9213-428-0
doi:10.2800/13253

TH-AK-14-005-EN-N
doi:10.2800/13253

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