Performance of water utilities beyond compliance

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

Appendix 2

Template for EEA indicator

This appendix includes examples on how template for EEA indicators can be filled in for two examples:

- water losses in urban water supply systems
- energy efficiency in urban water supply and sanitation

The content in the two examples is not conclusive, but indicative for illustration, and can be further developed.

European Environment Agency

EEA indicator composition (draft template for illustration)

Indicator Set (if applicable) Water related Resource Efficiency Indicator (WREI)	**Date** .21.04.2014 **Author (s)** Petra Ronen, ETC/ICM Bo N Jacobsen, EEA

Indicator Title

(WREI005) Water losses in urban water supply systems

Indicator definition

The indicator illustrates specific daily distribution losses of drinking water in m^3 normalised per km of water mains. The indicator also includes losses associated with unbilled consumption and apparent losses.

Units
m^3/(km/day)

Policy Question(s)

Key policy question

Is drinking water distribution in urban areas resource efficient?

Specific policy question (s) (if applicable) NR

Key messages

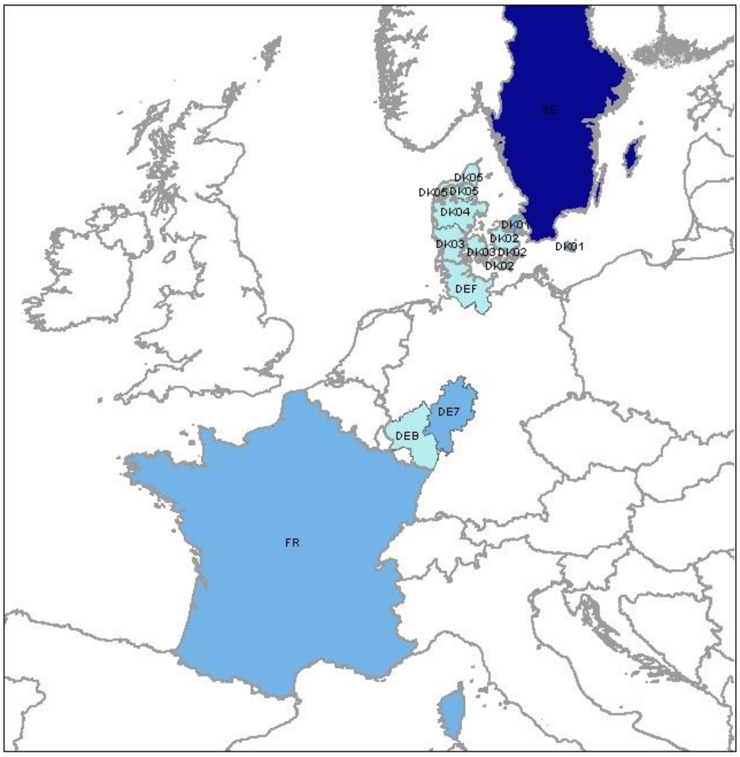
(inclusion of more data across Europe needed before key messages can be formulated)

Messages to include summary on:

- The relevance of the topic and the indicator parameter
- The levels, variance and differences for the parameter in comparison between countries, regions
- Main explanations for observed differences (demography, socio-economic factors, environmental and economic incentives,..)
- Relations to targets and any information on trend-line development

Key figure(s)

Figure 1 Distribution losses per mains length aggregated at NUTS1 level



reference year	NUTS-code	NUTS-name	No of utilities (n)	No. Of people served	median	mean	weighted mean	lower 90%ile	Upper 90%ile
					m3/km/day				
2010	DEF	Schleswig-Holstein	8	237 584	1,02	0,92	1,17	0,04	1,68
2008	DE7	Hessen	12	226 513	2,35	3,12	3,01	1,14	5,60
2010	DEB	Rheinland-Pfalz	72	2 061 490	1,34	1,65	0,15	0,51	3,09
2010	SE	Sweden	197	6 817 000	5,77	7,66	10,05	2,26	15,48
2011	FR	France	3424	32 274 028			3,40		
2010	DK	Denmark	57	3 010 180	1,42	1,87	1,79	0,66	3,54
2010	DK01	Hovedstaden	19	1 233 581	2,39	2,76	3,14	0,87	4,81
2010	DK02	Sjælland	7	225 494	1,63	1,84	1,56	1,13	2,80
2010	DK03	Syddanmark	14	612 768	1,39	1,40	1,53	0,64	2,09
2010	DK04	Midtjylland	12	664 613	0,97	1,10	1,27	0,35	1,53
2010	DK05	Nordjylland	5	273 724	1,36	1,68	1,60	0,84	2,66

Key assessment
Key assessment description to include: - The data coverage (utilities participating in benchmarking exercises / complete inventories) - The levels, variance and differences for the parameter in comparison between countries, regions - Main explanations for observed differences (demography, socio-economic factors, environmental and economic incentives.)

Justification for indicator selection (environmental context)

Surface and groundwater bodies in many parts of Europe are under water stress. Water use in areas under water stress may imply high economic and environmental cost. In order to ensure sustainable water use, which is a key driver of green growth, water efficiency and smart water demand management measures need to be implemented. Water supply represents one of the areas with potential for water efficient measures. Recovering some of the lost water through water loss reduction measures often represents an economic alternative to exploiting new resources through cost-intensive measures, such as new dams, deep wells or seawater desalination.

Water losses in European countries vary widely among different MS; in some countries the per cent value of water loss exceeds 20%. According to the study performed for the European Commission ***"EU Water saving potential"*** measures addressing reduction of water leakages in water supply systems can lead to a potential saving up to 33% of current abstraction.

Water losses in distribution systems are a clear obstacle to sustainability having the following potential impacts:

Ecological impacts: compensating water losses by further increasing water extraction places additional stress on water resources and requires additional water resources.

Economic impacts: costs for exploiting, treating and transporting water which is lost on its way to the customer without generating any revenue for the water utility. Pipe bursts and leaks necessitate expensive repair works and may also cause considerable damage to nearby infrastructure.

Technical impacts: leakage leads to reduced coverage of the existing water demand, possibly so much so that the system can no longer operate continuously. Intermittent supply will cause further technical problems by air intruding into the pipes and will tempt customers to install private storage tanks.

Social impacts: water losses result in customers being adversely affected by supply failures, such as low pressure, service interruptions and unequal supply, but also by health risks which may arise from the infiltration of sewage and other pollutants into pipe systems under low pressure or intermittent supply.

Over the past two decades, many intervention approaches have been developed for addressing namely the real water losses. They encompass approaches of infrastructure management, prompt and quality repairs, active leakages control and pressure management. Despite obvious benefits many water utilities have yet to implement water loss management strategies.

Improved information obtained via application of standardized methodology for assessing the water losses, clearly defined performance indicators and benchmarking (sharing of information and best practices) can foster the decision making towards improved performance of water utilities.

Policy context and targets

Policy context description

In March 2010, the European Commission issued the European Strategy for smart, sustainable and inclusive growth 'Europe 2020 strategy' . It highlights – among others - the need of a *more resource efficient* economy. The "Flagship initiative" under the Europe 2020 strategy, called "A resource efficient Europe" , establishes resource efficiency as the guiding principle for EU policies on energy, transport, climate change, industry, commodities, agriculture, fisheries, biodiversity and regional development. The Roadmap to a Resource Efficient Europe defines medium and long term objectives to achieve efficient resource use in the region. Decoupling, in the sense of breaking the linkage between economic growth and resource use, is a central concept of the strategy for making Europe resource efficient. The 2050 vision and objectives by 2020 are to be addressed in the sector initiatives that shall contribute to the resource-efficient Europe Flagship Initiative (the 7th EU Environmental Action Programme).

Targets/classification systems:

Reduction of non-revenue is a key issue in many water utilities regardless the availability and price of water resource.

Targets for water loss (non-revenue water) are often expressed as % of system input volume. Seen as an indicator, this is, however, influenced by the water consumption, itself, in the sense that a lower (sustainable) water consumption for the same water loss in the system will result in a higher indicator value.

Related policy documents

1. Guidelines for water loss reduction, prepared by consortium of VAG, GIZ, IWG-KIT and IEC-FHNW on behalf of Federal ministry of economic cooperation and development, 2011
2. PROWAT basic water loss book, A Guide to the Water Loss Reduction Strategy and Application PART 1, PROWAT project (project No. TR/06/B/F/PP/178065), 2008
3. EU Water saving potential (Part 1 –Report), ENV.D.2/ETU/2007/0001r, Ecologic, 2007
4. Water losses Management and Techniques, International report, A.O.Lambert, Water Science and Technology "Water Supply 2(4) 2002
5. Best practice performance indicators: a practical approach, Water loss, IWA Task Force, Water 21, 2004
6. CEPS Task Force on Which Economic Model for a Water-efficient, Europe? Efficient water distribution solutions, key to safeguarding Europe's water, presentation, T.Dossik, Grundfoss, 2012
7. Learning from International Best Practices, European Benchmarking Co-operation, EBC-2012 Water and Wastewater Benchmark
8. "A Study to Develop Strategies for Proactive Water-Loss Management" , Park, Hyun Jung (2007). *Public Management and Policy, Dissertations.* Paper 13.
9. Roadmap to a Resource efficient Europe, http://ec.europa.eu/environment/resource_efficiency/about/roadmap/index_en.htm
10. Europe 2020 strategy' http://ec.europa.eu/europe2020/index_en.htm
11. A resource-efficient Europe – flagship initiative under the Europe 2020 strategy, http://ec.europa.eu/resource-efficient-europe/pdf/resource_efficient_europe_en.pdf
12. Resource efficiency in Europe, Policies and approaches in 31 EEA member and cooperating countries, EEA Report, No 5/2011, http://www.eea.europa.eu/publications/resource-efficiency-in-europe
13. European Commission, 2013, *Resource and Economic Efficiency of Water Distribution Networks in the EU*, prepared by ERM and Solventa, http://ec.europa.eu/environment/water/quantity/pdf/Final%20REE%20Report%20Oct%202013.pdf

Methodology

Methodology for indicator calculation (including description of data used)

Standard terminology for the water balance according to the IWA defines water losses as a difference between **System input volume (**the measured system input to a defined part of the water) and the **Authorised consumption (**the volume of metered and/or un-metered water taken by registered customers, the water utility and other authorised parties. Real and apparent water losses together with unbilled authorised consumption (e.g. for flushing mains or firefighting) make up the amount of non-revenue water (NRW) in a water supply system.

System input volume Q_I	Authorised consumption Q_A	Billed authorised consumption Q_{BA}	Billed water exported	Revenue water
			Billed metered consumption	
			Billed unmetered consumption	
		Unbilled authorised consumption Q_{UA}	Unbilled metered consumption	Non-revenue water
			Unbilled unmetered consumption	
	Water losses Q_L	Apparent losses Q_{AL}	Unauthorised consumption	
			Customer meter inaccuracies and data handling errors	
		Real losses Q_{RL}	Leakage on transmission and distribution mains	
			Leakage and overflows at storage tanks	
			Leakage on service connections up to point of customer meter	

Source: IWA Water Loss Task Force and European Commission, 2013

The current indicator on Water losses in urban distribution systems is expressed as a sum of real water losses plus unbilled water and apparent losses divided by the length of water mains.

Distribution losses per mains length are calculated according to the following formula:

*[((A019*24 + (annual unbilled consumption+ annual apparent losses)/365) / C008]*

Where

A019 expresses the real water losses per hour, i.e. the physical quantity lost through leaks and burst pipes in the feeder, main and supply lines, tank overflows and house connection leaks.

C008 corresponds to the total length of the operating utilities, mains and feeder lines. Connecting cables are not included.

Methodology references

Aquabench, http://www.aquabench.de/
Indicator name: Distribution losses per mains length
Indicator code: zOp-028

SISPEA, Système d'Information sur les Services Publics d'Eau et d'Assainissement,
Indicator name: Distribution losses per mains length
Indicator code: P106.3

DANVA, Danish Water and Wastewater Association, http://www.danva.dk
Indicator name: Specific water loss, m^3/mains and distribution length
Indicator code: NDR4500-17=DR4500/AN3000/365

Data sources	
EEA data references	NR
External data references *provide dataset name, provider/owner, URL and path. – similar to information in Appendix 1* Data on NUTS statistical units: http://epp.eurostat.ec.europa.eu/portal/page/portal/gisco_Geographical_information_maps/popups/references/administrative_units_statistical_units_1 NUTS 2010-> table: NUTS_AT_2010	
Uncertainties	
Methodology Uncertainty	
Data sets uncertainty Aggregated datasets used for the indicator calculation does not include all utilities operating in particular NUTS1 regions. Clustering of aggregated utilities by size or other factors has not been done (comparability limited) Number of facilities par NUTS1 is listed in the table accompanying charts/map.	
General metadata	
Responsibility and ownership - EEA contact person - Ownership - Identification codes and versioning	

Indicator Specification (draft template for illustration)

Indicator Set (if applicable) Water related Resource Efficiency Indicator (WREI)	**Date** 13.03.2014 **Author (s)** Petra Ronen, ETC/ICM
Indicator Title (WREI006) -Energy efficiency of urban water supply and sanitation	

Indicator definition

Energy efficiency of water treatment and supply: The indicator illustrates specific electricity consumption for drinking water production (abstraction + treatment) and distribution , respectively in KWh normalised per m3 of produced water.
Energy efficiency of urban sanitation: The indicator illustrates specific electricity consumption for urban waste water treatment, in kWh normalised per population equivalent

Units
Energy efficiency of water treatment and supply: KWh/m^3
Energy efficiency of urban sanitation: KWh/p.e./year

Policy Question(s)

Key policy question
Is urban water supply and sanitation operated with high energy efficiency?

Specific policy question (s) (if applicable) **NR**

Key messages

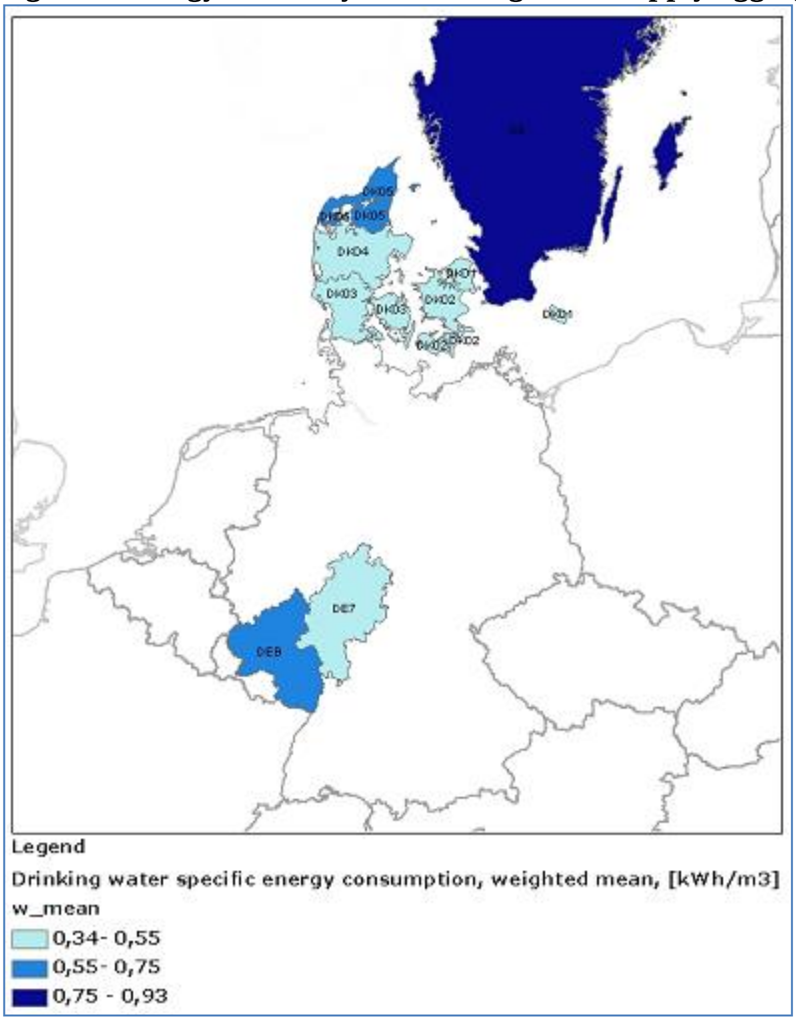
(inclusion of more data across Europe needed before key messages can be formulated)
Messages to include summary on:

- The relevance of the topic and the indicator parameter
- The levels, variance and differences for the parameter in comparison between countries, regions
- Main explanations for observed differences (demography, socio-economic factors, environmental and economic incentives,..)

Relations to targets and any information on trend-line development

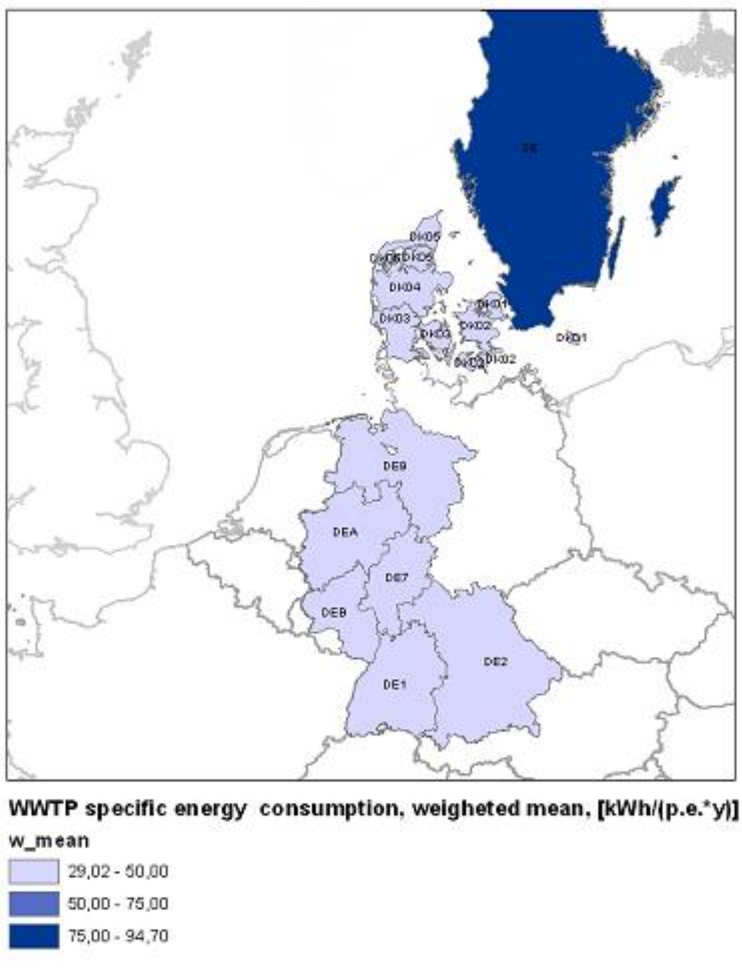
Key figure(s)

Figure 1 Energy efficiency of Drinking water supply aggregated at NUTS1 level



Ref.year	NUTS-code	NUTS-name	No of utilities (n)	No. Of people served	median	mean	weighted mean	lower 90%ile	Upper 90%ile
					kWh/m3				
2008	DE7	Hessen	13	226 513	0,56	0,55	0,49	0,14	0,87
2010	DEB	Rheinland-Pfalz	72	2 061 490	0,57	0,61	0,69	0,06	1,13
2010	SE0	Sweden	181	6 566 000	0,75	1,3	0,93	0,41	1,38
2010	DK	Denmark	57	3 010 180	0,49	0,46	0,46	0,20	0,64
2010	DK01	Hovedstaden	19	1 233 581	0,31	0,35	0,34	0,02	0,57
2010	DK02	Sjælland	7	225 494	0,53	0,49	0,50	0,37	0,58
2010	DK03	Syddanmark	14	612 768	0,53	0,51	0,48	0,44	0,58
2010	DK04	Midtjylland	12	664 613	0,47	0,51	0,54	0,38	0,67
2010	DK05	Nordjylland	5	273 724	0,63	0,62	0,60	0,48	0,76

Figure 2 Energy efficiency of urban sanitation at NUTS1 level



Ref.year	NUTS_code	NUTS1_name	No of utilities (n)	No. Of p.e. Served by WWTP	median	mean	weighted mean	lower 90%ile	Upper 90%ile
				p.e	kWh / p.e.				
2010	DE1	Baden-Württemberg	34	4 464 508	35,3	38,4	40,5	26,6	54,9
2010	DE2	Bayern	57	4 970 286	35,4	38,7	34,1	22,7	64,3
2008	DE7	Hessen	13	824 179	40,6	39,5	44,1	4,0	59,3
2010	DE9	Niedersachsen	20	2 089 995	34,0	36,2	29,0	26,6	48,1
2010	DEA	Nordrhein-Westfalen	24	16 628 888	37,1	40,3	38,2	28,4	51,5
2010	DEB	Rheinland-Pfalz	12	11 257 855	31,5	38,4	32,3	24,8	64,6
2010	SE	Sweden	183	6 081 000	91,1	104,4	94,7	48,3	172,0
2010	DK	Denmark	65	6 933	44,0	46,1	37,8	26,9	61,6

				939					
2010	DK01	Hovedstaden	23	2 245 600	49,0	52,3	35,0	31,0	69,6
2010	DK02	Sjaelland	8	625 823	39,7	43,7	39,8	23,0	68,0
2010	DK03	Syddanmark	12	1 276 589	44,0	46,4	39,2	33,8	59,9
2010	DK04	Midtjylland	15	1 993 771	40,2	41,7	36,6	30,0	54,1
2010	DK05	Nordjylland	7	792 156	51,8	48,0	44,4	29,4	60,0

Key assessment

Key assessment description to include:

- The data coverage (utilities participating in benchmarking exercises / complete inventories)
- The levels, variance and differences for the parameter in comparison between countries, regions

Main explanations for observed differences (demography, socio-economic factors, environmental and economic incentives,..)

Justification for indicator selection (namely environmental context)

The competition between water and energy needs represents a critical business, security, and environmental issue, but has not yet received the attention that it merits.

The links between water, energy and climate are important and complex: energy production requires vast quantities of water, and supplying water requires significant amounts of energy. Energy production and the CO2 emissions deriving from it is a major driver of climate change and, conversely, climate change has a strong impact on both the availability and quality of our water resources, and on the types of energy supplies that are environmental and economically feasible.

Despite these links, in existing policy frameworks energy and water policies are developed largely in isolation from one another - a fragmentation which is seeing erroneous developments in both sectors. Furthermore, policies adopted to tackle the challenges of climate change have the potential to produce technological and management decisions that exacerbate the energy-water nexus. Examples of the trade-offs between energy and water security include: the proliferation of desalination plants and inter basin transfers to deal with water scarcity; extensive groundwater pumping for water supplies; first generation biofuels; the proliferation of hydropower plants; decentralized water supply solutions such as rainwater tanks; and even some forms of modern irrigation techniques.

The evidence of a changing climate in Europe and elsewhere is driving extensive and fast policy reform in the energy and climate sectors but policy-makers are ill-equipped to make informed decisions based on empirical research and a comprehensive risk assessment: there is no coordination between the water and energy sectors and even less between the related sectors such as agriculture, forestry, trade and mining. Thus, at the heart of the problem, in Europe and elsewhere, is a lack of policy integration: the energy, water and more recently ‘climate’ sectors are highly developed within themselves but only limited effort is made to account for, and manage, the extensive links between them.

Incomplete information about how energy and water interact at different scales means that policies (whether they be education campaigns, economic subsidies, stringent regulation, new infrastructure, etc.) designed to increase efficiency in one sector may be creating additional demand in the other sector. With better data, utilities and governments can effectively strategize how they will plan to manage their energy and water use with minimal effect to their citizens.

There are several aspects of water energy nexus that deserve attention. They can be summarized as follows:

1. -3% of a city's energy demand is used to produce, treat & transport water. 15-20% to use the water

2. More advanced technology to treat impaired water requires more energy

3.Future supplies will require more energy

4. Declining reservoir levels reduce hydro generating capacity

5. Power generation requires large quantities of water

6. Large volumes of wastewater from energy exploration & production

This indicator sheet will address specifically those aspects that concern "energy for water" part of the nexus, specifically related to energy intensity of urban water supply and sanitation and to possibilities and best practices illustrating that amount of energy needed to supply, use, and treat water can be reduced by certain technologies and approaches.

Policy context and targets

Policy context description

In March 2010, the European Commission issued the European Strategy for smart, sustainable and inclusive growth 'Europe 2020 strategy' . It highlights – among others - the need of a *more resource efficient* economy. The "Flagship initiative" under the Europe 2020 strategy, called "A resource efficient Europe" , establishes resource efficiency as the guiding principle for EU policies on energy, transport, climate change, industry, commodities, agriculture, fisheries, biodiversity and regional development. The Roadmap to a Resource Efficient Europe defines medium and long term objectives to achieve efficient resource use in the region. Decoupling, in the sense of breaking the linkage between economic growth and resource use, is a central concept of the strategy for making Europe resource efficient. The 2050 vision and objectives by 2020 are to be addressed in the sector initiatives that shall contribute to the resource-efficient Europe Flagship Initiative (among others e.g. Energy 2020, a strategy for competitive, sustainable and secure energy, the 7th EU Environmental Action Programme).

Targets:

- Regional targets: EU 20-20-20 by year 2020: A reduction in EU greenhouse gas emissions of at least 20% below 1990 levels , 20% of EU energy consumption to one from renewable resources , a 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency
- Utility targets: e.g.WWF6 targets: 20% improvement in energy efficiency (1990 level - 2020)

Related policy documents

14. Water energy nexus-Adding Water to the Energy Agenda, A World Policy Paper , Diana Glassman,Michele Wucker, Tanushree Isaacman, and Corinne Champilou, March 2011
15. The Energy–Water Nexus: Managing the Links between Energy and Water for a Sustainable Future , Hussey, K., and J. Pittock. 2012*Ecology and Society* **17**
16. The Water and Energy Nexus – Framing the Context, G.Olsson, (presentation)
17. Energy demands on water resources, report to the Congress on the interdependency of energy and water , US department of Energy, 2006
18. Water and energy nexus: A literature review, A joint program of Stanford Woods Institute for the Environment and Bill Lane Centre for the American, 2013
19. Energy water nexus, in GAO Highlights a report to the Ranking Member, Committee on Science, Space, and Technology, House of Representatives, 2011
20. Energy water nexus, Position statement, ASME Board on Government Relations of Public Affairs and Outreach Center for Research and Technology of Knowledge & Community
21. Roadmap to a Resource efficient Europe, http://ec.europa.eu/environment/resource_efficiency/about/roadmap/index_en.htm
22. Europe 2020 strategy' http://ec.europa.eu/europe2020/index_en.htm
23. A resource-efficient Europe – flagship initiative under the Europe 2020 strategy, http://ec.europa.eu/resource-efficient-europe/pdf/resource_efficient_europe_en.pdf
24. Resource efficiency in Europe, Policies and approaches in 31 EEA member and cooperating countries, EEA Report, No 5/2011, http://www.eea.europa.eu/publications/resource-efficiency-in-europe
25. Energy 2020, a strategy for competitive, sustainable and secure energy, DG Energy, 2011

Methodology

Methodology for indicator calculation (including description of data used)

Energy efficiency of water treatment and supply:
Sum of total energy consumption of all pumps in water production, treatment and distribution system (Shuttle - main and supply lines, containers) during the survey period divided by volume of metered and unmetered water supplied to registered customers and all other water recipients who are entitled directly or indirectly to water supply.
The indicator is calculated according to the following formula:
D000 / A014
Where
D000 is expresses the total energy requirements for drinking and industrial water supply,and
A014 corresponds to overall volume of metered and unmetered water supply to registered customers and all other water recipients who are entitled directly or indirectly to water supply. Water supplied to distributors is included as well.

Energy efficiency of urban sanitation:
Sum of total energy consumption for waste water treatment and discharge of treated water discharged during the survey period divided by mean COD incoming load divided by a factor corresponding to the value of population equivalent for COD
The indicator is calculated according to the following formula:
(ABT150) / (ABT355 / 0,12)
where *ABT150* corresponds to the total consumed quantities of electrical energy in kWh

for wastewater disposal. The electrical energy from the natural energy generation and externally purchased electricity are included, however, even if the delivery expenses for the operator was free.
ABT355 is mean COD influent load during the assessment period. Mean COD influent load does not consider of internal circuits (eg return, circulation for denitrification, effluent sludge dewatering) from the sewage treatment plant.

Methodology references
Energy efficiency of water treatment and supply: Aquabench, http://www.aquabench.de/
Indicator name: Normalized energy consumption,
Indicator code: Ph0171

Energy efficiency of urban sanitation: Aquabench, http://www.aquabench.de/
Indicator name: Specific energy consumption WWTP per p.e.,
Indicator code: KNA249

Energy efficiency of water treatment and supply: DANVA, Danish Water and Wastewater Association http://www.danva.dk/
Indicator name: Electricity use/m3 authorized consumption
Indicator code: MK8000/OD7100

Energy efficiency of urban sanitation: DANVA, Danish Water and Wastewater Association http://www.danva.dk/
Indicator name: Electricity consumption on WWTP per p.e.
Indicator code: MK4000/DR3100

Energy efficiency of water treatment and supply: SWWA, Swedish Water and Wastewater Association http://www.danva.dk/
Indicator name: Electricity use for waterworks, booster pump stations and reservoirs (kWh / produced m3)
Indicator code: Nm101

Energy efficiency of urban sanitation: DANVA, Danish Water and Wastewater Association http://www.danva.dk/
Indicator name: Electricity use for waste water treatment plants (kWh/p.e./year)
Indicator code: Nm104

Data sources

EEA data references
NR

External data references –
provide dataset name, provider/owner, URL and path. – similar to information in Appendix 1

Data on NUTS statistical units:
http://epp.eurostat.ec.europa.eu/portal/page/portal/gisco_Geographical_information_maps/popups/references/administrative_units_statistical_units_1
NUTS 2010-> table: NUTS_AT_2010

Uncertainties
Methodology Uncertainty
Data sets uncertainty Aggregated datasets used for the indicator calculation does not include all utilities operating in particular NUTS1 regions. Clustering of aggregated utilities by size or other factors has not been done (comparability limited) Number of facilities par NUTS1 is listed in the table accompanying charts/map.
General metadata
Responsibility and ownership - EEA contact person - Ownership - Identification codes and versioning