WAREG
European Water Regulators

AN ANALYSIS OF WATER EFFICIENCY KPIs IN WAREG MEMBER COUNTRIES

2017

A WAREG REPORT

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Executive Summary

Key Performance Indicators (KPIs) are systematic and consistent ways of measuring an organisation's performance against others in the same industry. They are widely used by organisations and industries for various reasons. KPIs assist organisations to understand how they are performing in relation to their strategic objectives and targets. They provide detailed information and quantitative analysis which permit organisations to make sound business decisions and monitor their progress. In addition they permit comparison of an organisation's performance against its peers.

KPIs are also increasingly used by regulatory bodies to analyse and review organisation's performance, compare organisations and measure progress against set targets. They are assessment tools which enable regulators to evaluate the performance of water supply services.

Various organizations, such as the International Water Association (IWA), the World Bank Group and a wide range of national regulators have established lists of key performance Indicators by which to evaluate utilities performances. Such lists however have been designed with different objectives and are not easily adaptable across the industry in different European countries.

This paper analyses the application of KPIs to describe efficiency of water services in WAREG member countries, with the aim to draw out commonalities as well as differences in monitoring of water efficiency measures and performance. It seeks to outline how different European regulators promote water efficiency within their regulated industries. It is noted that although various KPIs and benchmarking platforms exist in the water industry, there appears to be a lack of consistency in the definitions, descriptions, application and consistency of KPIs used to measure water efficiency across Europe. It is further noted that while some countries use KPIs for benchmarking purposes, this practice has still not been fully embraced by regulators in WAREG member countries.

WAREG Members

AEEGSI	*Autorità per l'energia elettrica il gas e il sistema idrico* – (Regulatory Authority for Electricity Gas and Water) – Italy
ANRE	*Agenţia Naţională pentru Reglementare în Energetică a Republicii Moldova* – (National Agency for Energy Regulation) – Moldova
ANRSC	*Autoritatea Națională de Reglementare pentru Serviciile Comunitare de Utilități Publice* – (Romanian Authority for Public Services) – Romania
CER	Commission for Energy Regulation – Ireland
ECA	Estonian Competition Authority – (*Konkurentsiamet*) – Estonia
RAE	*Regulatorna Agencija za Energetiku* – (Energy Regulatory Agency) – Montenegro
ERRU	*Enti Rregullator i Sektorit të Furnizimit me Ujë dhe Largimit e Përpunimit të Ujërave të Ndotura* – (Water Regulatory Authority) – Albania
ERSAR	*Entidade Reguladora dos Serviços de Águas e Resíduo*s – (The Water and Waste Services Regulation Authority) – Portugal
ERSARA	*Entidade Reguladora dos Serviços de Águas e Resíduos dos Açores* - (The Water and Waste Services Regulation Authority of Azores) – Portugal
EWRC	Energy and Water Regulatory Commission - (*Комисията за енергийно и водно регулиране*) – Bulgaria
GNERC	Georgian National Energy and Water Supply Regulatory Commission – Georgia
HEA	Hungarian Energy and Public Utility Regulatory Authority – (*Magyar Energetikai és Közmű-szabályozási Hivatal*) – Hungary
KFST	*Konkurrence- og Forbrugerstyrelsen* – (Danish Competition and Consumer Authority) – Denmark
MAPAMA	*Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente* – (Ministry of Agriculture, Food and Environment – Spain
MEDDE	*Ministère de l'Environnement, de l'Énergie et de la Mer* – (Ministry of Ecology, Sustainable Development and Energy) – France
NCC	National Commission for Energy Control and Prices - (*Valstybinė kainų ir energetikos kontrolės komisija*) - Lithuania
NIAUR	Northern Ireland Utility Regulation Authority – Northern Ireland
PUC	Public Utilities Commission – (*Sabiedrisko pakalpojumu regulēšanas komisija*) – Latvia
REWS	Regulator for Energy and Water Services – Malta
SSW	Special Secretariat for Water – (*ΕΙΔΙΚΗ ΓΡΑΜΜΑΤΕΙΑ ΥΔΑΤΩΝ*) – Greece
VMM	*Vlaamse Milieu maatschappij* – (Flanders Environment Agency) – Belgium/Flanders
VVU	*Vijeće za viodne usluge* – (Council for Water Services) – Croatia

WICS	Water Industry Commission for Scotland – Scotland
WSRA	Water Services Regulatory Authority of Kosovo – (*Autoriteti Rregullator për Shërbimet e Ujit, Regulatorni Autoritet za Usluge Vode*) – Kosovo

WAREG Observers

MSD	Ministry of Sustainable Development - Montenegro
OFWAT	The Water Services Regulation Authority - England and Wales
SWWA	*Svenskt Vatten* – (Swedish Water and Wastewater Association) - Sweden

List of Acronyms and Abbreviations

CARL	Current Annual Real Losses
EBC	European Benchmarking Co-operation
EEA	European Environment Agency
ELL	economic leakage level
hCEM	household Customer Experience Measure
HUF	Hungarian Forint
IBNET	International Benchmarking Network
ILI	infrastructure leakage index
INE	*Instituto Nacional de Estadistica* (Spanish Statistical Office)
IWA	International Water Association
KPI	key performance indicator
n.a.	not available
nhhCEM	non-household Customer Experience Measure
OPA	Overall Performance Assessment
PI	Performance Indicator
TF KPIs	WAREG Task Force on Water Efficiency Key Performance Indicators
SOSI	Security of Supply Index
UARL	Unavoidable Annual Real Losses
UWWTP	urban wastewater treatment plant
VAT	value added tax
WHO	World Health Organisation
WRF	Water Research Foundation
WSO	water and sanitation operator

Units

h	hours
$ktCO_2e$	kilo tonnes of carbon dioxide equivalent
kW	kiloWatt
kWh	kiloWatt hour
l	litres
m^3	cubic metres
ML/d	Million litres / day
Mm^3	million cubic metres
m^3/km/day	cubic metres per kilometre per day

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1. Introduction

Various benchmarking platforms exist in the water sector. The Danube Water Program Benchmarking, organized in Bucharest (Romania) in September 2013 noted that 3 different benchmarking platforms for water and wastewater services namely: the International Benchmarking Network (IBNET[1]), the European Benchmarking Co-operation (EBC[2]) and Sigma[3].

The IBNET platform provides direct access to the largest international database of performance indicators of water and sanitation operators (WSOs). The platform is funded by the Water and Sanitation Program of the World Bank and Department for International Development, UK. It currently contains information on more than 2000 WSOs in 85 countries. The platform provides guidance on indicators and definitions for them; helps to create national and regional benchmarking schemes and make a comparative analysis. The IBNET database indicates that information is available for the 8 of total 24 WAREG Members.

The EBC platform is organized by cooperation of national WSO associations of Denmark, Finland, Norway, Netherlands and IWA. It is aimed to support WSOs to improve their performance and visibility. The platform holds information about 100 WSOs. The EBC analyses five key performance areas, to provide a balanced view on utilities' performance: Water quality; Reliability; Service quality; Sustainability and Finance & Efficiency (EBS, 2012).

The Sigma platform, developed by Universitat Politecnica de Valencia, is based on the IWA software for performance indicators and permits upgrade with different indicators. Participants connect to the server by web-page, fill the data and the software calculates indicators and graphics.

Other benchmarking platforms exist, e.g. aquabench[4], which involves 800 national operator of water and wastewater management including European operators from Belgium, Poland, Switzerland and Austria and Germany. Federal and state ministries and specialist associations and organizations are reported to use the aquabench platform.

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1 The International Benchmarking Network for Water and Sanitation Utilities (IBNET) is an initiative started by the World Bank in the late 1990s. The World Bank regards benchmarking an important activity to improve the performance of water and sanitation utilities worldwide. In order to encourage and promote benchmarking the World Bank developed a suite of software tools and guidance documents to help utilities compile, analyze and share performance information. IBNET seeks to encourage water and sanitation utilities to compile and share a set of core cost and performance indicators, and thus meet the needs of the various stakeholders. It sets forth a common set of data definitions; a minimum set of core indicators, and provides software to allow easy data collection and calculation of the indicators, while it also provides resources to analyze data and present results. https://www.ib-net.org

2 EBC was initiated in 2005 by the national water utility associations of The Netherlands and the Nordic countries (DANVA, FIWA, Norsk Vann, Svenskt Vatten, Vewin) and several utilities of the 6-Cities Group (Copenhagen Energi, Helsinki Water, Oslo kommune VAV, Stockholm Vatten. EBC has developed a Performance Assessment Model. In it reports EBC also shows the main results from the annual benchmarking exercise in Western Europe. 45 utilities from 20 countries participated. Key indicators are clustered around the performance areas distinguished within the EBC benchmarking methodology: Coverage, Water quality, Reliability, Service quality, Sustainability and Finance & Efficiency. www.waterbenchmark.org

3 Sigma is a benchmarking and performance indicators software for drinking water and wastewater utilities. The software is based on the International Water Association (IWA) system of performance indicators. www.sigmalite.com

4 The benchmarking method of aquabench GmbH is widely used management instrument of the industry available for the water and sewage industry. This is based on recognized standards of the industry including:

- "DVGW, DWA Guidelines Benchmarking for Water Supply and Wastewater Disposal Companies" (2005)
- DVGW Leaflet W 1100 / DWA M 1100 - Benchmarking in water supply and sewage disposal (2008)
- DIN ISO 24523 "Guidelines for benchmarking of water utilities" www.aquabench.de

In 2004, the EEA identified a core set of 37 indicators.[5] The core set covers six environmental themes (air pollution and ozone depletion, climate change, waste, water, biodiversity and terrestrial environment) and four sectors (agriculture, energy, transport and fisheries) (EEA, 2005). While the indicators are mainly of an environmental nature, they also indicators on use of freshwater resources. In 2014 the EEA then published a technical report based on knowledge shared by water utilities associations and organisations associated with water utilities in Europe to support environmental and resource efficiency policies, and technical improvements. The focus of this report was environmental performance based on data from voluntary benchmarking exercises (EEA, 2014).[6]

At the same time, the European Commission appears to be exploring the idea of benchmarking water quality and to cooperate with existing initiatives to provide a wider set of benchmarks for water services. As noted by the EEA, this would 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. (EEA, 2014)

1.1 Scope and Objectives

This report is the result of a study carried out by WAREG on the compilation and use of KPIs in member countries. It originates from the decision taken at the 7th WAREG Assembly held in Tirana, on 16 March 2016, to set up a Task Force to investigate on water efficiency performance indicators in use in WAREG Member countries (TF KPIs[7]). Following a preliminary assessment by the TF KPIs of water efficiency performance benchmarking in some WAREG Members' countries and in European and international benchmarking platforms (8th WAREG Assembly, Fayal, Azores, 2 June 2016), the Assembly agreed to focalise the analysis on a specific set of water efficiency performance indicators (9th WAREG Assembly, St. Julian's, Malta, 27 September 2016) and finally to approve an internal survey for WAREG Members and Observers (10th WAREG Assembly, Tallinn, Estonia, 6 December 2016) in Annex 1. The main objectives of this report are:

1. To identify existing practices and regulatory approaches adopted in WAREG member countries towards performance measurement and in particular efficiency of water services;

2. To research and examine the drivers in the water industry and seek to draw comparisons between WAREG member countries;

3. Explore common concerns and issues facing regulators in promoting efficiency of the water industry.

5 The purpose of the core set of indicators is to: prioritise improvements in the quality and coverage of data flows, which will enhance comparability and certainty of information and assessments; streamline contributions to other indicator initiatives in Europe and beyond; provide a manageable and stable basis for indicator-based assessments of progress against environmental policy priorities. (EEA, 2005)

6 In its Technical Report, the EEA notes that benchmarking conducted by the water utility sector itself has been developed as a utility management tool, focused on improving performance in the industry. The data collected helps to 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. Moreover EEA notes that 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. (EEA, 2014).

7 The Task Force is composed of the following WAREG Members: EWRC (Bulgaria), ERSAR (Portugal), ERSARA (Azores), REWS (Malta).

It is not the aim of this study to rate or rank countries according to the data compiled on Performance Indicators. It is recognised that WAREG comprises a varied water industry sector with very different characteristics, external environmental factors and market structures. In view of such differences any direct comparisons of KPIs collated would be evidently superficial and lacks in depth analysis of such external factors and influencing drivers.

The overall aims of this study are therefore to share knowledge and provide an overview of the various regulatory approaches adopted and to stimulate discourse and ideas that may be taken up WAREG members.

1.2 Overview of the Water Sector

The water industry across WAREG member countries is highly varied and complex. External environmental factors which characterise and influence the industry set-up are widely different. Membership extends from Scotland, Sweden and the Baltic countries in the North of Europe to Mediterranean countries including Spain, Portugal, Italy Greece and Malta. It also extends from the Azores and Portugal on the Atlantic Ocean to Georgia on the Black Sea.

A brief analysis of the macro environmental factors immediately highlights differences that exist in the water industry in WAREG members. These include examples of differences outlined below:

Table 1: Macro Environmental Factors

External Environmental Factors	
Category	**Some Examples**
Political	• Governmental policies, • Regulatory frameworks and maturity of regulation, • Regional authorities and municipalities,
Economic	• Disposable income, • Cost realities, • Competitors and private suppliers • Ownership and cost structures
Socio-cultural	• Customer expectations, • Level of Stakeholder engagement, • Environmental organisations and pressures,
Technological	• Water sector technical characteristics; • Research facilities, Innovation and involvement / links established with private sector, research institutions etc. • New technologies adopted.
Environmental	• Hydro-climatologic and geo-physical characteristics; • Availability / Scarcity of resources; • Carbon footprint for production – dependency on energy;
Legal	• Consumer rights and laws, standards and guidelines regarding quality of services etc. • Legislative instruments on consumer protection and dispute resolution.

In the light of such varying and different macro environmental forces and influences, it is noted that direct comparison of the WSOs operating in these industries through comparison of KPIs is not only difficult but should be undertaken with caution. Therefore the data and KPIs presented should not be interpreted as a direct comparison of the performance of WSOs in the countries but only as a means of providing background information and overview top the characteristics, drivers and pressures such WSOs are operating in.

2. Defining Efficiency of Water Services

It is recognised that the term "efficiency" elicits different interpretations. In environmental terms resource efficiency is generally related to use of earth's limited resources in sustainable manner whilst minimising the impacts on the environment.

Cost efficiency of services is the provisions of such services in such a way of performing the activity in a better way. In this respect operational efficiency measures the capability of a WSO to provide water in the most cost-effective manner possible while still ensuring it meets set quality and customer standards.

As noted earlier the objectives of this paper are to understand how countries define efficiency and to examine the drivers in measuring and promoting efficiency. Whilst comparative efficiency analysis[8] is increasingly recognised as a useful tool for benchmarking and incentive regulation, detailed comparative efficiency analysis of WSOs operating in WAREG member countries is outside the scope of this study.

In Scotland, for example a number of tools have been used to measure cost efficiency and benchmark this against water companies in England and Wales. These included cost base econometric models for operational expenditure. The purpose of each econometric model was to establish a relationship between the costs reported by the companies and external cost drivers, which have a significant impact on costs but are outside the control of the management of the company. Regression analysis and unit cost calculations were used and models were adjusted to take into account for differences in company circumstances, (e.g. Scottish Water's PPP contracts, where operating costs at these works were recognised as being outside the control of Scottish Water).

This paper however is not intended to carry out any such or similar comparative efficiency measurement of WSOs or the countries' water industry, but presents a review of the different regulatory frameworks, methodologies adopted and metrics commonly used to assess and measure efficiency in WAREG member countries.

2.1 Resource Efficiency

EEA (2014) notes that resource efficiency contributes to improved economic opportunities, enhanced productivity, lower costs and a boost in competitiveness. This in turn reduces environmental pressures. With respect to urban water management, resource efficiency is generally considered to include not

8 Two main approaches to estimating relative efficiency across firms:

- Statistical (parametric) approach which specifies a particular functional form for the production or cost function. It is based on econometric techniques and includes simple regression analysis and Stochastic Frontier Analysis.
- Non-parametric approach which uses mathematical programming techniques (Data Envelopment Analysis) (Sarafidis, 2002)

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. EEA further notes that improved efficiency entails investment in infrastructure, implementation of novel technologies and continuous training of staff, along with awareness campaigns. At the same time the return on these investments can reduce consumption of resources, alleviate pressures on the environment and help create jobs.

EEA (2014) shortlists a number of good use cases and these include the following corresponding indicators for benchmarking resource efficiency:

- Distribution losses[9]
- Residential Water consumption
- Inefficiency of use of water resources expressed in % terms[10]
- Nutrient removal efficiency[11]
- Decoupling of nutrient emission from UWWTPs and population growth[12]
- Energy efficiency in urban water supply[13]
- Specific energy consumption for urban wastewater treatment[14]

2.2 Performance Indicators developed by IWA

The International Water Association (IWA) developed a set of 170 PIs – refer based on 232 variables that need to be monitored regularly (Alegre *et al.*, 2016). These were broadly categorised as follows:

- Water Resources
- Personnel
- Physical
- Operational
- Quantity of Water Supplied
- Economic and Financial

These are shown in Table 2.

Within these categories the main indicators related to efficiency of water services may be considered to include the PIs shown in Annex 2.

9 Applied for 24 hours/day operation and expressed for losses/day. Distribution losses are 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 (EEA, 2014)

10 Defined as the total amount of water that is lost in the system, in relative terms, i.e. the total production and distribution losses, compared to the amount of water that enters the system. (EEA, 2014)

11 Removal efficiency of total nitrogen (N), total phosphorous (P) and biochemical oxygen demand (BOD) EEA, 2014

12 Indicator relates to changes in emission intensities and population growth development

13 Drinking water specific energy consumption, weighted mean expressed in kWh/m3

14 WWTP specific energy consumption, weighted mean (kWh/(p.e))

Table 2: PIs developed by IWA

PIs/ Number	
Water Resources (WR) Indicators	**4**
Personnel (Pe) Indicators	**26**
Total Personnel	2
Personnel per main function	7
Technical services personnel per activity	6
Personnel Qualification	3
Personnel Training	3
Personnel Health and Safety	4
Overtime work	1
Physical (Ph) Indicators	**15**
Water Treatment	1
Water Storage	2
Pumping	4
Valve, hydrant and meter availability	6
Automation and Control	2
Operational (Op) Indicators	**44**
Inspection & maintenance of physical assets	6
Instrumentation calibration	5
Electrical and signal transmission equipment inspection	3
Vehicle availability	1
Mains/valves/ service connections rehabilitation	5
Pumps Rehabilitation	2
Operational Water Losses	7
Failure	6
Water Metering	4
Water Quality Monitoring	5
Quality of Service (QS) Indicators	**34**
Service Coverage	5
Public Taps & Standpipes	4
Pressure and continuity of Supply	8
Quality of water supplied	5
Service connection and meter installation and repair	3
Customer Complaints	9
Economic and Financial (Fi) Indicators	**47**
Revenues	3
Costs	3
Composition of running costs per type of costs	5
Composition of running costs per main function of the water utility	5
Composition of running costs per technical function activity	6
Composition of capital costs	2
Investment	3
Average water charges	2
Efficiency	9
Leverage	2
Liquidity	1
Profitability	4
Economic Water Losses	2

Source (Alegre *et al.* 2016)

2.2 Performance Benchmarking Framework proposed by Water Research Foundation

In 2014 the Water Research Foundation published a report on Performance Benchmarking for Effectively Managed Water Utilities". The research project developed a framework for utility management that would result in effectively managed water utilities and identified the following "Ten Attributes of Effectively Managed Water Sector Utilities":

1. Product Quality
2. Customer Satisfaction
3. Employee and Leadership Development
4. Operational Optimization
5. Financial Viability
6. Infrastructure Stability
7. Operational Resiliency
8. Community Sustainability
9. Water Resource Adequacy
10. Stakeholder Understanding and Support

WRF (2014) outlines the benchmarking framework, the system tools and a recommended approach for conducting a self-assessment . The research also outlines leading practice documentation used by participating utilities.[15]

2.3 IBNET Platform

The IBNET platform contains definitions of the indicators and context information contained in the IBNET data entry and indicator calculation files. These indicators were designed for utilities that distribute water and/or collect wastewater; and may also abstract and treat water and/or treat wastewater and have been grouped under 12 headings as follows:

- Service Coverage;
- Water consumption and production;
- Non revenue water;
- Metering Practices;
- Pipe Network Performance;
- Costs and Staff;
- Quality of Services;
- Billings and Collections;
- Financial performance;
- Assets;
- Affordability of Services;
- Process Indicators.

15 WRF reports that about 30 water sector utilities from the United States, Canada, UK and Australia participated in this project. They were of different sizes (from less than 100,000 customers to over millions of customers), geographies (different parts of North America), and types (water, wastewater, and stormwater).

This paper focuses primarily on water efficiency indicators and the following categories and main indicators were therefore selected for review:

Table 3: IBNET KPIs

Service area	KPI	Unit	IBNET Definition
Service coverage	**1.1. Water Coverage**	*%*	Population with easy access to water services (either with direct service connection or within reach of a public water point)/total population under utility's nominal responsibility, expressed in percentage.
Water Consumption and Production	**4.1. Total Water Consumption**	*litres/person/ day*	Total annual water sold expressed by population served by
Non Revenue Water	**6.1. Non Revenue Water**	*%*	Difference between water supplied and water sold (i.e. volume of water "lost") expressed as a percentage of net water supplied
	6.2. Non Revenue Water	*m^3/km/day*	Difference between water supplied and water sold (i.e. volume of water "lost") expressed per km of water distribution network per day
Network Performance	**9.1. Pipe Breaks**	*breaks/km/yr.*	Total number of pipe breaks per year expressed per km of the water distribution network
Costs and Staffing	**11.3 Unit Operational Cost – Water only**	*€ / m^3 sold*	Annual water service operational expenses (exclude depreciation, interest and debt service) / Total annual volume sold.
	12.3 Staff Water/'000 Water population served	*#/'000 W population served*	Total number of staff expressed as per thousand people served

2.4 A Preliminary Assessment of Water Efficiency KPIs

The TF KPIs, in a preliminary assessment[16] of water efficiency indicators used in a sample of WAREG member countries Bulgaria (EWRC), Denmark (KFST), Estonia (ECA), Ireland (CER), Latvia (PUC), Malta (REWS), Portugal (ERSAR), noted that water efficiency indicators used in these 7 countries may be broadly grouped under the following categories:

- Security and Reliability of Supplies (3 variants of KPIs indicated);
- Water Quality (4 variants of KPIs indicated);
- Customer Satisfaction, contacts and response (3 variants of KPIs indicated);
- Technical Performance, Capacity and condition of Networks (7 variants of KPIs indicated);
- Technical Performance – Real and apparent losses (4 variants of KPIs indicated);
- Technical Performance – Production and Treatment Facilities (5 variants of KPIs indicated);

16 The preliminary assessment was made by WAREG TF KPIs between April and June 2016, among a few WAREG Members.

- Technical Performance – Energy Efficiency (4 variants of KPIs indicated);
- Environmental performance (4 variants of KPIs indicated);
- Human Resources (2 variants of KPIs indicated);
- Affordability of Services (2 variants of KPIs indicated).

In this preliminary review it was noted that a common approach for comparative analysis of the different sets of KPIs, in different areas, and collated from WAREG countries is difficult to establish given that definitions and indicators vary widely between countries. In view of this, WAREG decided to review KPIs used in WAREG member countries based on categories defined the IBNET platform. The IBNET platform includes a reasonable proportion of information related to WAREG member countries. At the same time it was agreed that WAREG members would be given the opportunity to submit their own variants of KPIs according the categories defined in the IBNET Platform.

2.5 Analysis Methodology

Following the decision of the 10th WAREG Assembly (Tallinn, Estonia, 6 December 2016), the TF KPIs developed, a questionnaire to investigate compilation and use of water efficiency KPIs in WAREG member countries (refer Annex 1). Between January and April 2017, 19 WAREG members participated in this questionnaire as follows:

- Albania – ERRU - Water Regulatory Authority;
- Azores, Portugal – ERSARA - The Water and Waste Services Regulation Authority of Azores;
- Belgium (Flanders) – VMM – Water Regulator (drinking water);
- Bulgaria - EWRC -State Energy and Water Regulatory Commission;
- Denmark - KSST - Danish Competition and Consumer Authority;
- Estonia - ECA - Estonian Competition Authority;
- Georgia – GNERC - Georgian National Energy and Water Supply Regulatory Commission;
- Hungary - HEA - Hungarian Energy and Public Utility Regulatory Authority;
- Italy - AEEGSI - Regulatory Authority for Electricity Gas and Water;
- Kosovo - WSRA – Water services Regulatory Authority;
- Latvia - PUC- Public Utilities Commission;
- Lithuania - NCC - National Commission for Energy Control and Prices;
- Malta - REWS - Regulator for Energy and Water Services;
- Moldova - ANRE - National Agency for Energy Regulation;
- Portugal – ERSAR – The Water and Waste Services Regulation Authority;
- Republic of Macedonia – ERC – Energy Regulatory Commission of the Republic of Macedonia
- Romania – ANRSC - Romanian Authority for Public Services;
- Scotland – WICS – Water Industry Commission for Scotland;
- Spain – MAPAMA- Ministry of Agriculture, Food and Environment.

The data compiled and analysed was on a national (country) basis, and for the purposes of this analysis the national KPIs were calculated on the basis of weighted mean of WSOs data.

3. Regulation of the Water Industry and the Use of KPIs

Regulatory authorities have generally been established by Acts of Parliament, the oldest being enacted in 1994 in Italy, whilst the most recent was enacted in Moldova in 2013. Details of water specific legislation are provided in Table 4.

The functions and competencies of the regulatory authorities so established vary but generally include:

- Tariff approvals;
- Key performance indicators (KPIs) monitoring;
- Collection of economic data from utilities;
- Collection of technical data from utilities.

Other functions may include: tariff calculation, licensing of the utilities and business plans approval.

In Albania, Bulgaria, Hungary, Lithuania and Romania, KPIs are established by legislation whilst in Malta these are established through separate licences/ guidelines or regulatory documentation.

3.1 Use of KPIs

KPIs can be used to meet various objectives. In Albania, Belgium (Flanders)[17], Bulgaria, Lithuania and Portugal these are used as part of the tariff calculation process whilst in Albania, Bulgaria, Hungary, Georgia and Portugal, KPIs are used to set targets for WSOs.

Generally water efficiency is not defined specifically by a single KPI. It has been noted that countries adopt various indicators, many of which are normalised to account for size / population served by the WSO and/or volumes of water supplied and /or similar normalising factors.

17 In Flanders, efficiency is part of the tariff plans, but the regulatory authority does not 'fix' specific KPI's. The efficiency is monitored trough process benchmarking, and the results (KPI's) of this process benchmarking have to be followed up and can be integrated in the mandatory tariff plans.The regulator is also reporting in a very open way (transparency / sunshine regulation) about the drinking water sector.

Table 4: Water Regulatory Framework

Country	Water Act		Water Regulation Legislation		Scope and Competencies of Regulator						
	Water Act	Year Enacted	Legislation	Year	Tariff calculation	Tariff Approval	Licensing WSOs	Business Plans Approval	KPI monitoring	Collection of Economic Data	Collection of technical data
Albania	✓	1996	Law no 812 "on the Regulatory Framework of the Water Supply and Wastewater Disposal and Treatment Sector"	1996	✓	✓	✓	×	✓	✓	✓
Azores, Portugal	✓	2010	Act for regulation of water, sanitation and waste services	2010	×	✓	×	✓	✓	✓	✓
Belgium (Flanders)	✓	2002	Decree on water intended for human use of 24 May 2002	2002[18]	✓	✓	×	✓	✓	✓	✓
Bulgaria	✓	2000	Act for Regulation of Water and Sanitation Services (ARWSS)	2005	✓	✓	×	✓	✓	✓	✓
Denmark	✓	2009	"*Lov om vandsektoren*" (water act) and "*Bekendtgørelse om økonomiske rammer*" (special act about Price ceilings)	2009	×	×	×	×	×	✓	✓
Estonia	✓	1999	Public Water Supply and Sewerage Act	1999	×	✓	×	×	✓	×	×
Georgia	✓	1996	Rules on Supply and Consumption of Water Supply	2008	✓	✓	✓	✓	✓	✓	✓
Hungary	✓	2011	Act on Water Utility Supply	2011	✓	✓	✓	✓	✓	✓	✓
Italy	✓	1994	Law 214/2011	2012	✓	✓	×	✓	✓	✓	✓
Kosovo	✓	2004	Law Nr. 05/L-042 for regulation of water services	2004	✓	✓	✓	✓	✓	✓	✓
Latvia	✓	2001	Law on Water Management	2016	×	✓	×	×	✓	✓	✓

18 In Flanders, Regulation was enshrined in the law in 2002. The regulatory authority became operational in 2010 and in 2015 tariff regulation was added to the competences of the WaterRegulator.

Country	Water Act		Water Regulation Legislation		Scope and Competencies of Regulator						
	Water Act	Year Enacted	Legislation	Year	Tariff calculation	Tariff Approval	Licensing WSOs	Business Plans Approval	KPI monitoring	Collection of Economic Data	Collection of technical data
			Services								
Lithuania	✓	2006 – latest version 2014	Law on Drinking Water Supply and Wastewater Treatment; NCC Regulations;	2006	✓	✓	✓	×	✓	✓	✓
Malta	✓	2001	Water Supply and Sewerage Services Regulations	2004	×	✓	✓	×	✓	✓	✓
Moldova	✓	2013	Regulation No. 271 dated 16.12.2015 by approved by ANRE on the public service of water supply and sewerage	2015	✓	✓	✓	✓	×	✓	✓
Portugal	✓	2005	Statutes of the Water and Waste Services Regulation Authority (ERSAR)	2014[19]	✓	✓	×	×	✓	✓	✓
Republic of Macedonia	✓	2008	Law on Setting Prices of Water Services	2016	✓	×	×	×	✓	✓	✓
Romania	✓	2006	Law 241/2006 regarding water and sewage	2006	✓	✓	✓	×	×	✓	✓
Scotland	✓	1999	Water Industry Act (1999) and Water Industry (Scotland) Act (2002)	1999	✓	✓	✓[20]	✓	✓	✓	✓

19 This follows previous legislation which came into force in 1998, 2004 band 2009.

20 In Scotland, Scottish Water is a vertically integrated company. It does not require a licence to operate.
There is a competitive retail market for water and sewerage services in Scotland. The Water Industry Commission for Scotland is responsible for licensing all participants in the market.

Country	Water Act		Water Regulation Legislation		Scope and Competencies of Regulator						
	Water Act	Year Enacted	Legislation	Year	Tariff calculation	Tariff Approval	Licensing WSOs	Business Plans Approval	KPI monitoring	Collection of Economic Data	Collection of technical data
Spain	✖		See Note[21]		n.a	n.a	n.a	n.a	n.a	n.a	n.a

21 In Spain there is extensive legislation that forms the regulatory framework of water and the different responsibilities and competencies at different levels of government. There is a high fragmentation of competences in Spain, which are established by the following legislation:

- European legislation that sets the main guidelines on water;
- State regulation (through river basins), which covers certain aspects related to water services, but does not regulate them as such;
- Central government through Health and Consumption Ministry is responsible for monitoring drinking water supply;
- Extensive regional regulation that regulates water services, either incorporating them into broader water laws, such as Water Law / Law on water cycle / Law on water supply / Law on sanitation enacted in several regions.
- Law of Bases of Local Regime (Law 7/1985), state regulation that grants municipalities the competence of water services (drinking water and wastewater services). This implies political and administrative control carried out by each municipality with regards to prices, investments, water quality and service. This law was modified in 2013 to transfer local water services competences to the Diputación (Provincial Council) when the number of inhabitants is lower than 20,000.

Table 5: Definition of KPIs and their Use

Country	KPIs Defined at law		Use of KPIs		Data Collection	Definition
	KPIs defined	Details	Target Setting	Tariff calculations	By other institutions	Water efficiency Definitions
Albania	✓	Tariff Setting Guideline	✓	✓	National Agency of Water Supply & Sewage	×
Azores, Portugal	✓	DL 194/2009; DL 306/2007; DL 29/2011/A; Guide for evaluation of the quality of the Water and Waste services of Azores	✓	✓	Government of the Azores - Regional Environment Services (Waste services)	×
Belgium (Flanders)	×		×	×	×	× In Belgium (Flanders) a fixed set of data is collected annually such that KPIS can then be computed at will. However there is not a fixed (limited) set of KPI's since th Regulator does not want companies to focus on 1 (or more) specific indicator.
Bulgaria	✓	ARWSS - Ordinance for Regulation of Quality of Water and Sanitation Services	✓	✓	×	×
Denmark	×		×	×	×	×
Estonia	×		✓	✓	×	×
Georgia	×		✓	✓	×	×
Hungary	✓	Act on Water Utility Supply	✓	×	Hungary Water Utility Association	×
Italy	✓	DPCM 20 July 2012 empowering AEEGSI	✓	✓[22]	ISTAT, Local authorities, Universities/Research Bodies	Refer footnote [23]
Kosovo	✓		✓	✓	×	×
Latvia	×		×	✓	The Ministry of Environmental Protection and Regional Development	×
Lithuania	✓	NCC regulation on publication of average drinking water supply and wastewater treatment activities benchmarking indicators	✓	✓	×	✓ - According to the law, efficiency evaluated during licensing is the principle that indicates the ratio of the costs

22 In Italy's tariff calculation a limited set of KPIs is currently being used at this stage.

23 In Italy the process of KPIs definition is at an initial stage. The Regulator is currently applying a limited set of KPIs, and has consulted on a wide range of technical indicators, from which it will then select mandatory KPIs. Water Efficiency is addressed, from the economic point of view, in some single activities (costs of energy, wholesale consumption, other). Additional activity on this topic is currently ongoing.

Country	KPIs Defined at law		Use of KPIs		Data Collection	Definition
	KPIs defined	Details	Target Setting	Tariff calculations	By other institutions	Water efficiency Definitions
						needed for drinking water supply, wastewater treatment activities and the result
Malta	✓	Licences for the supply of water through the public distribution network and the provision of sewerage services using the public sewage collection system	×	×	National Statistics Office	×
Moldova	✓	Regulation No. 352 dated 27.12.2016 on quality indicators of the public service of water supply and sewerage	✓	×	×	×
Portugal	✓	Law no. 10/2014 of 6 March (Statutes of the Water and Waste Services Regulation Authority (ERSAR))	✓	✓	×	✓
Republic of Macedonia	✓		×	×	×	×
Romania	✓	A.N.R.S.C. Order 88/2006 regarding the framework for water and sewage	×	×	×	×
Scotland	×		✓		Drinking Water Quality Regulator (DWQR) and Scottish Environment	
Spain	×		×	×	National Statistics Institute (INE) Spanish National Water and Wastewater Association (AEAS)	×

4. Measuring Water Efficiency

4.1 Service Coverage

Service Coverage is a measure of the population which have access to water services.

The IBNET indicator defines service coverage as the population with easy access to water services (either with direct service connection or within reach of a public water point) expressed as a percentage of the total population. In the case of WSOs reporting this would translate to the population under the utility's nominal responsibility. However in this study this indicator would reflect the entire country's population.

IBNET notes that this requires estimates of the populations served by public water points. According to the WHO Global Water Supply and Sanitation Assessment 2000, reasonable access was defined as 'the availability of at least 20 litres per person per day from a source within one kilometre of the user's dwelling. The IBNET definition recommends the population with easy access should be considered when this is within 250m from a public water point.

Five countries collect and/or use data for this KPI such as to measure service coverage: Albania, Bulgaria, Italy, Lithuania and Malta and data for the period 2013-2015 is shown in Table 6.

Table 6: Service Coverage

Service Coverage	Population with easy access to water services (either with direct service connection or within reach of a public water point) expressed as a percentage of total population			
	Unit: %			
Country / Year	2013	2014	2015	Data Collected by Regulator – Notes
Albania	80.8	80.8	81	✓
Azores Portugal	≈ 90	≈ 90	100	✓
Belgium (Flanders)	98	98	98	✓ Combination of data collected by the regulator and national statistics. The entire territory of Flanders is covered by public water supply networks. A connection to a public drinking water network is enshrined as a right in the law (on condition that the connection costs are paid for). A connection can only be denied if public health would come at risk. A small % of the population chooses not to be connected (i.e. because they have own wells at their disposal).

Service Coverage	Population with easy access to water services (either with direct service connection or within reach of a public water point) expressed as a percentage of total population			
	Unit: %			
Country / Year	2013	2014	2015	Data Collected by Regulator – Notes
Bulgaria	99.2	99.3	99.0	✓
Denmark	n.a.	n.a.	n.a.	✗
Estonia	n.a.	n.a.	n.a.	✗ In WSO responsibility areas access to water services is ensured to 100 per cent of inhabitants. However, the whole territory of Estonia is not covered by WSO operational areas i.e. there are areas without public water supply systems.
Georgia	40	51	56	✗ - Non Official Data provided
Hungary	n.a.	n.a.	n.a.	✗ - Data collected by Hungarian Water Utility Association
Italy	n.a.	96	n.a.	✓ Data for resident population served with water supplies is generally estimated data. The calculated percentage refers to direct service connection, so the data results to be underestimated with respect to IBNET definition.
Kosovo	82	84	87	✓ - Defined as the total average number of households over the reporting period served with a piped water supply in the service area divided by the total average number of households (served and un-served) in the defined service area
Latvia	n.a.	n.a.	n.a.	✗ - Data collected by the Ministry of Environmental Protection and Regional Development
Lithuania	87.9	89	n.a.	✓ NCC does not calculate this indicator but collects the data on population with access to water services. Reference data provided according to IBNET indicator
Malta	100	100	100	✓
Moldova	n.a.	n.a.	n.a.	✗
Portugal[24]	95	95	96	✓ Applied to retail system operators ***Reference values for retail systems:*** *Predominantly urban intervention areas:* Good service quality: [95; 100]; Average service quality: [80; 95[; Unsatisfactory service quality: [0; 80[*Averagely urban intervention areas:* Good service quality: [90; 100]; Average service quality: [80; 90[; Unsatisfactory service quality: [0; 80[*Predominantly rural intervention areas:* Good service quality: [80; 100]; Average service quality: [70; 80[; Unsatisfactory service quality: [0; 70[
Republic of Macedonia	n.a.	n.a.	n.a.	✓
Romania	61.9	62.4	63.7	✓ In addition the population served per km of network is calculated at a national level (direct service connection)
Scotland	n.a.	n.a.	n.a.	✗ - Data is not collected in this format. Data collected according to number of properties
Spain	n.a.	n.a.	n.a.	✗

24 Figures presented are a proxy to the populations since these are based on the number of households with service available. Refer also Table 7.

Table 7: Other KPIs related to Coverage and Accessibility to Water Supplies

Accessibility to Water Supplies						
Indicator/ Year	**Unit**	**Country**	**2013**	**2014**	**2015**	**Notes**
Physical Accessibility of the service - Households that are connected or connectable to the distribution system expressed as a percentage of total number of households[25]	**%**	Portugal	***Retail:*** 95% ***Bulk:*** 93%	***Retail:*** 95% ***Bulk:*** 93%	***Retail:*** 96% ***Bulk:***: 92%	***Reference values for retail systems:*** *Predominantly urban intervention areas* Good quality of service: [95; 100] Average quality of service: [80; 95[Unsatisfactory quality of service: [0; 80[*Averagely urban intervention areas:* Good quality of service: [90; 100] Average quality of service: [80; 90[Unsatisfactory quality of service: [0; 80[*Predominantly rural intervention areas:* Good quality of service: [80; 100]; Average quality of service: [70; 80[; Unsatisfactory quality of service: [0; 70[***Reference values for bulk systems:*** Good quality of service: 100 Average quality of service: [85; 100[Unsatisfactory quality of service: [0; 85[
Connection to service - Households that service infrastructure is available or effectively provided expressed as a percentage of total number of households[26]	**%**	Portugal	***Retail:*** 85,4% ***Bulk:*** 91,5%	***Retail:*** 85,8% ***Bulk:*** 91,8%	***Retail:*** 85,8% ***Bulk:*** 92,9%	***Reference values for retail systems:*** Good quality of service: [95,0; 100,0] Average quality of service: [90.0; 95.0[Unsatisfactory quality of service: [0.0; 90.0[***Reference values for bulk systems:*** Good quality of service: 100,0 Average quality of service: [98,0; 100,0[Unsatisfactory quality of service [0,0; 98,0[

In 2015, service coverage in WAREG member countries varied between 56% in Georgia to 100% in Azores (Portugal) and Malta. This wide variation shows the widely different operating environments across Europe. At the same time various regulators reported difficulty in measuring this indicator as defined and data for this KPI is not always readily available to water regulators. Private suppliers and households with direct service to private supplies would be excluded from the definition of this KPI.

25 In Portugal this indicator is defined as the percentage of the total number of households located in the utility's intervention area for which there are bulk supply infrastructures that are connected or connectable to the retail system (concept to be applied to bulk operators) or as a percentage of the total number of households located in the utility's intervention area for which water supply service infrastructures are available (concept to be applied to retail system operators).
Concerning service coverage, ERSAR considers that the indicator should be defined in terms of the number of households supplied instead of population supplied, because the number of households is the most reliable and accurate information that utilities can provide and is easy to check when auditing (the data is provided by the customers management programme). ERSAR accepts that the value obtained can be equivalent to the percentage of the population with access to public water supply networks.
In Portugal, those for whom the water supply infrastructures are not available have their own water abstractions or have access to drinking fountains. In order to account the population with access to drinking fountains, rules should be defined (e.g. maximum distance from households to drinking fountains).

26 It is defined as the percentage of the total number of households located in the operator's intervention area for which the foreseen bulk service infrastructure is available and is effectively provided (concept to be applied to bulk system operators) or as a percentage of the total number of households located in the operator's intervention area for which the water distribution service infrastructure is available and is effectively provided (with the existence of a water connection and contract) (concept to be applied to retail system operators).

4.2 Water Consumption and Production

Water consumption per population served gives an indication of water sold and used by the population and hence an indication of the access to potable water. IBNET notes that the best water consumption indicator is the amount of water sold to customers expressed in terms of litres/person/day.

Table 8 shows the Water Consumption per population served (measured in litres/person/day) as reported by WAREG members for the period 2013- 2015. It is recognised that data problems may exist which would limit availability of such information.

It was noted that in some countries such information is not available due to various factors including lack of metering data.

Table 8: Water Consumption per population served

Water Consumption	Total annual water sold expressed by population served per day			
	Unit: litres/person/day			
Country / Year	2013	2014	2015	Data Collected by Regulator – Notes
Albania	83	80	80	✓
Azores, Portugal	n.a.	n.a.	234.2	✓
Belgium (Flanders)	99	100	100	✓ Actual invoices are used to calculate an 'average' consumption. Calculations are carried out according to family size. Data submitted refers to an average family size (2.3) with an average consumption.
Bulgaria	128.5	124.4	133.6	✓ Data indicates volume of water sold for number of population served
Denmark	n.a.	n.a.	n.a.	✗
Estonia	n.a.	n.a.	n.a.	✗
Georgia	107.7	109.2	154.9	✓ Data indicates volume of water sold for metered subscribers of water supply licensees expressed by the number of consumers
Hungary	n.a.	n.a.	n.a.	✗
Italy	236	206	n.a.	✓
Kosovo	115	105	107	✓
Latvia	n.a.	654	615	✓ Data collected in m^3/connection / year and converted accordingly. Latvia regulates water services until commercial meter which meters the total consumption of water and has been installed on the entry into a building. No information is available on the number of individual apartments. Connections include both domestic and non-domestic customers.
Lithuania	123.6	125.7	n.a.	✓ NCC does not calculate this indicator but collects the data. Reference data provided according to the IBNET indicator
Malta	110.9	112.9	113.8	✓
Moldova	n.a.	n.a.	n.a.	✗

Water Consumption	Total annual water sold expressed by population served per day			
	Unit: litres/person/day			
Country / Year	2013	2014	2015	Data Collected by Regulator – Notes
Portugal[27]	198	199	204	Authorised consumption (m^3/year) means the volume of metered and/or unmetered water taken by registered customers, the water supplier and others who are implicitly or explicitly authorized to do so by the water supplier, for residential, commercial and industrial purposes. It also includes water exported across operational boundaries. Authorised consumption may include items such as fire fighting and training, flushing of mains and sewers, street cleaning, watering of municipal gardens, public fountains, frost protection, building water, etc. These may be billed or unbilled, metered or unmetered. The data regarding the average number of inhabitants per household is provided by Statistics Portugal. The Portuguese Environment Agency collects data of water consumption in other sectors (agriculture, industry) that are not urban consumption
Republic of Macedonia	n.a.	n.a.	n.a.	✓
Romania	139.7	131.2	130.3	✓ - Data collected in m^3/person /year and converted to litres/person/day
Scotland	n.a.	n.a.	n.a.	✓
Spain	n.a.	n.a.	n.a.	✗

The data reported shows a range of values from 80 litres/person/day in Albania to 234 litres /person/day in Azores (2015 data). In comparison EEA 2014 reported that 125 l/person/day from benchmarking for Germany (2010); 135 declining to 129 l/person/day (2010–2012) for 31 large utilities in geographical Europe and weighted mean from 3,700 utilities of 151 l/person/day.

Other KPIs used in WAREG member countries include water supplied and/or billed volumes expressed in litres/connection /day or per month and in absolute volumes. These are shown in Table 9.

Table 9: Other KPIs related to Water Consumption and Water Supply

Water Consumption						
Indicator/ Year	Unit	Country	2013	2014	2015	Notes
Total water sold	Mm^3 /annum	Denmark	1,009.3	974.4	800.3	Danish Statistical Authority has an indicator to measure for water consumption
Total Volume of Wtaer billed / year	Mm^3/ annum	Belgium (Flanders)	348	348	360	

27 Water consumption" as such is not included in the 16 KPI used by ERSAR to assess and benchmark the quality of service provided by operators of water supply services. It is used as supporting data for profiling domestic water uses within the context of the broader water policy. Data from ERSAR only for the urban water cycle/services

Water Consumption						
Indicator/ Year	**Unit**	**Country**	**2013**	**2014**	**2015**	**Notes**
Total Volume of Water Sold / annum	**Mm^3 /annum**	Georgia	279.8	277.8	276.7	
Total Volume of Water Sold expressed per connection per month	**m^3 /connection /month**	Malta	10.15	10.36	10.49	
Total volume of water supplied expressed by water connections to the distribution network per day	**litres/ connection/ day**	Hungary	198.2	203	212	Data collected by Hungarian Central Statistical Office Non official data
Total water supplied expressed by population served per day	**litres /person/ day**	Malta	195.8	193.3	198.8	
		Spain	254	248		Data compiled by Spanish National Water and Wastewater Operators Association (AEAS)[28]
Potable water available	**litres /person / day**	Spain	291	287		Data compiled by Instituto Nacional de Estadistica (INE) (Spanish Statistical Office)
Water distributed	**litres /person / day**		254	252		Volume of water distributed is considered as inlet water from potable water plants and tanks in service
Water distributed and registered (metered)	**litres /person / day**		189	190		
Water distributed and registered (metered) for households	**litres /person / day**		130	132		

28 Additional data also published in Annual reports compiled by Asociación Española de Abastecimientos de Agua y Saneamiento (AEAS) and Asociación Española de Empresas Gestoras de los Servicios de Agua Urbana (AGA)

4.3 Non Revenue Water

Non-revenue water is a volume of water which enters the distribution system but does not give any revenue to the utility, loss of revenue.

Non revenue water therefore represents water that is produced and is "lost" before it reaches the customer. Non revenue water includes not only the real losses and apparent losses, but also the unbilled authorized consumption and thus includes: leakage, theft, and legal uses for which no payment is made. IBNET notes that the IWA further distinguishes between non revenue water (%) and unaccounted for water, with the latter not including legal usage that is not paid for.

Figure 1 gives an outline of the water balance as defined by IWA where Non revenue water is considered to comprise:

1. Unbilled authorised consumption consisting in Unbilled metered consumption (e.g. arising from billing errors) and unbilled unmetered consumption (e.g. water usage for fire hydrants etc. if unbilled);
2. Apparent losses consisting in unauthorised consumption (e.g. theft and illegal use); metering inaccuracies (misread meters, incorrect estimates of stopped meters, inaccurate calculations, errors arising from under/over registration of meters and data handling errors);
3. Real Losses consisting in leakages in transmission and distribution mains and services connections, overflows from water tanks etc.

Figure 1: International Standard Water Balance and Terminology – IWA

<table>
<tr><th colspan="5">International Water Balance</th></tr>
<tr><td rowspan="8">System Input Volume</td><td rowspan="4">Authorised Consumption</td><td rowspan="2">Billed Authorised Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorised Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="7">Non-Revenue Water</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="4">Water Losses</td><td rowspan="2">Commercial Losses (Apparent Losses)</td><td>Unauthorised Consumption</td></tr>
<tr><td>Metering Inaccuracies and Data Handling Errors</td></tr>
<tr><td rowspan="3">Physical Losses (Real Losses)</td><td>Leakage on Transmission and/or Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to Point of Customer Metering</td></tr>
<tr><td colspan="5">Sources: IWA and World Bank Institute</td></tr>
</table>

IBNET suggests three different units for measuring non-revenue water namely:

- %,
- m^3/connection/day and
- m^3/km/day.

It is argued that the percentage figure may show utilities with high levels of consumption, or compact networks, to be better performing than those with low levels of consumption or extensive networks. Similarly networks with a high density of connections would appear to fare well when measuring non-revenue water and leakage using the KPI expressed in m^3/connection/day and in comparison to similar network in rural areas.

Table 10 and Table 11 show Non Revenue Water, in percentage terms and in m^3/km/day respectively and as reported by WAREG members for the period 2013- 2015. Non revenue water data varies widely across WAREG members ranging between around 16% - 18% in Belgium (Flanders) and Estonia to 75% in Georgia.

Table 10: Non Revenue Water – Percentage Approach

Non revenue water	Difference between water supplied and water sold (i.e. volume of water "lost") expressed as a percentage of net water supplied			
	Unit: %			
Country / Year	2013	2014	2015	Data Collected by Regulator – Notes
Albania	67.4	67.2	67.0	✓
Azores, Portugal	n.a.	n.a.	62.3	✓
Belgium (Flanders)	16	15	17	✓ Defined as the difference between water input in distribution network and water delivered at (paying) customers expressed as a percentage of net water supplied – Source: Tariff plans 2017-2022
Bulgaria	61.1	61.2	60.5	✓
Denmark	n.a.	n.a.	n.a.	✗
Estonia	17.8	17.9	17.7	✓
Georgia	75	70	67	✓
Hungary	24.4	26.5	21.2	✓ - Unofficial data
Italy	40	44	n.a.	✗ - Unofficial data
Kosovo	57	58	56	✓
Latvia	n.a.	19	18	✓ - Volume of water lost related to emergencies, network servicing and measurement errors expressed as a percentage of water supplied to network. Water losses include the losses related to the liquidation of emergency situations, servicing of networks and measurement errors, excluding the water consumption for technological needs in water production process
Lithuania	24.9	24.3	24.1	✓ NCC does not calculate this indicator, but collects the data.
Malta	43.6	41.7	42.9	✓
Moldova	n.a.	n.a.	38.6	✓
Portugal[29]	***Bulk:*** 4.7	***Bulk:*** 4.7	***Bulk:*** 5.0	Data reported refers to bulk systems ***Reference values for bulk systems:*** Good service quality: [0,0; 5,0] Average quality of service:]5,0; 7.5] Unsatisfactory quality of service:]7.5; 100.0]
	Retail: 30.9	***Retail:*** 30.1	***Retail:*** 29.8	Data reported refers to retails systems ***Reference values for retail systems:*** Good service quality: [0,0; 20,0] Average quality of service:]20.0; 30.0] Unsatisfactory quality of service:]30.0; 100.0]
Republic of Macedonia	n.a.	n.a.	n.a.	✓

29 In Portugal this indicator is designed to assess the level of sustainability of the service management in economic and financial terms, with regard to economic losses corresponding to water which, despite being abstracted, treated, transported, stored and distributed, is not billed to users, and is defined as the percentage of water that enters the system and is not billed (concept to be applied to bulk and retail system utilities).

Non revenue water	Difference between water supplied and water sold (i.e. volume of water "lost") expressed as a percentage of net water supplied			
	Unit: %			
Country / Year	2013	2014	2015	Data Collected by Regulator – Notes
Romania	50	47	46	✓ - Volume of non revenue water amounting to 512 Mm^3/annum in 2015
Scotland	n.a.	n.a.	n.a.	✓
Spain	n.a	23	n.a	✗ - Data collected by AEAS - Non registered water

Table 11: Non Revenue Water - m^3/km/day

Non revenue water	Volume of Non Revenue water (Water "lost") per km of water distribution network per day			
	Unit: m^3/km/day			
Country / Year	2013	2014	2015	Notes
Albania	n.a.	n.a.	n.a.	✗
Azores, Portugal	n.a.	n.a.	n.a.	✗ KPIS cannot be collected in this format since WSOs have weak Information infrastructures of the water supply systems.
Belgium (Flanders)	2.98	2.78	3.06	✓
Bulgaria	21.0	20.0	20.5	✓
Denmark	n.a.	n.a.	n.a.	✗
Estonia	4.18	3.87	3.85	✗ Unofficial calculated data.
Georgia	191	170	181	✓
Hungary	3.85	5.12	4.90	✓ - Unofficial data Volume of Water input to the water supply network to quantity of water billed/length of pipe network. Data for the year 2013 excluding the biggest service provider (in terms of served population).
Italy	25.6	26.1	n.a.	✗ - Unofficial data
Kosovo	59	47	47	✓
Latvia	n.a.	7.9	6.8	✓
Lithuania	7.3	6.87	n.a.	✓ - NCC does not calculate this indicator, but collects the data. Reference data provided according to the IBNET indicator
Malta	15.7	15.0	15.6	✓
Moldova	n.a.	n.a.	n.a.	✗
Portugal	***Bulk:*** 5.8 ***Retail:*** 1.8	***Bulk:*** 6.1 ***Retail:*** 2.1	***Bulk:*** 6.3 ***Retail:*** 2.3	Data reported refers to bulk systems ***Reference values for bulk systems*** Good service quality: [0,0; 5,0] Average quality of service:]5,0; 7.5] Unsatisfactory quality of service:]7.5; +[Data for retail systems is only applicable to systems with a density of connections lower than 20 connections per km of network. For areas with more than 20 connections per km of network the indicator used for retail systems is measured in litres per connection per day (see table 13). ***Reference values for retail systems:*** Good service quality: [0,0; 3,0] Average quality of service:]3,0; 5.0] Unsatisfactory quality of service:]5,0; +[
Republic of	n.a.	n.a.	n.a.	✓

Non revenue water	Volume of Non Revenue water (Water "lost") per km of water distribution network per day			
	Unit: m^3/km/day			
Country / Year	2013	2014	2015	Notes
Macedonia				
Romania	n.a.	n.a.	n.a.	×
Scotland	n.a.	n.a.	n.a.	×
Spain	n.a.	n.a.	n.a.	×

Table 12: Other KPIs related to Non Revenue Water

Non Revenue Water						
Indicator/ Year	Unit	Country	2013	2014	2015	Notes
Volume of non revenue water per customer per day	m^3 / connection / day	Kosovo	1.28	0.73	0.69	
Volume of non registered water expressed per population served	litres /person /day	Spain	65	62	n.a.	Data compiled by INE – Non registered water is the difference between distributed water and registered and distributed water
Volume of non revenue water expressed per connection per day	m^3 /connection /day	Malta	0.26	0.24	0.26	
Apparent losses	litres /person /day	Spain	n.a.	25	n.a.	Data compiled by INE
Volume of apparent water losses expressed per population served	litres /person /day	Spain	25	24	n.a.	Data compiled by INE Calculated: includes meter errors, non authorised consumption and unbilled water

Alternative KPIs which measure one of the main components of non-revenue water i.e. physical (real) losses (leakage) and are expressed as:

(i) m^3 per km of network ;
(ii) litres (m^3) per connection per day;
(iii) litres per person per day;
(iv) in percentage terms of water supplied;
(v) the Infrastructure Leakage Index developed by IWA.

These are shown in Table 13.

Table 13: Real water losses KPIs

Physical (Real) Water Losses						
Indicator/ Year	Unit	Country	2013	2014	2015	Notes
Physical (Real) water losses (leakages)	**m^3/km /day**	Belgium (Flanders)	2.56	2.37	2.65	Real losses (CARL) / net length
		Estonia	3.09	2.74	2.40	Non official data
		Malta	4.67	4.21	3.98	
		Portugal	***Bulk:*** 5.8 ***Retail:*** 1.8	***Bulk:*** 6.1 ***Retail:*** 2.1	***Bulk:*** 6.3 ***Retail:*** 2.3	***Reference values for bulk systems:*** Good service quality: [0,0; 5,0] Average quality of service:]5,0; 7.5] Unsatisfactory quality of service:]7.5; +∞[***Reference values for retail systems :*** Good service quality: [0,0; 3,0] Average quality of service:]3,0; 5.0] Unsatisfactory quality of service:]5,0; +∞[Indicator is only applicable to retail systems with a density of connections less than 20 connections per km of network. Retails systems with a with a higher density of connections are assessed through the litres/connection/day indicator shown in the table 11.
	litres / connection / day	Malta	76.8	68.7	68.1	
		Portugal	139	127	126	Applied to retail system operators in areas where the density of connections equals or higher than 20 per km of network ***Reference values for retail systems:*** Good service quality: [0; 100] Average quality of service:]100; 150] Unsatisfactory quality of service:]150; +∞[
	%	Latvia	n.a.	19	18	Volume of water lost related to emergencies, network servicing and measurement errors expressed as a percentage of water supplied to network
		Malta	13.0	11.7	10.9	
		Spain	15.7	15.2	n.a.	Data compiled by INE
	litres / person /day	Spain	40	38	n.a.	Data compiled by INE

Physical (Real) Water Losses						
Indicator/ Year	Unit	Country	2013	2014	2015	Notes
Infrastructure Leakage Index[30]		Belgium (Flanders)	1.17	1.05	1.21	Weighted (over length of network) ILI indicator calculations
	No.	Malta	2.09	1.94	1.91	

In Scotland, the regulator (WICS) sets targets based on Scottish Water's economic leakage level (ELL). ELL is defined as the point where the costs incurred to reduce leakage further are higher than the benefits (value) of the ter lost through such leakage interventions.

EEA (2014) reports that benchmark data for water distribution losses (m^3/km/day) for three federal states in Germany (Hesse, Rhineland-Palatinate and Schleswig-Holstein) indicate mean values range from 0.9 m^3/km/day to 3.1 m^3/km/day. On the other hand in Estonia physical losses measured 2.40 m^3/km/day in 2015 while in Malta these were estimated at 3.98 m^3/km/day.

4.4 Pipe Network Performance

Pipe network performance may be measured through a number of indicators. IBNET suggests using the total number of pipe breaks per year expressed per km of the water distribution network since the number of pipe breaks, relative to the scale of the system, is a measure of the ability of the pipe network to provide a service to customers. It is further noted that the rate of water pipe breaks can also be seen as a surrogate for the general state of the network, while at the same time reflects operation and maintenance practices. The higher the number of pipe breaks the lower quality of service is provided to customers.

30 IWA has established the Infrastructure Leakage Index (ILI), a performance indicator for comparisons of leakage management in water supply systems. The Infrastructure Leakage Index (ILI) is defined as the ratio of Current Annual Real Losses (CARL) to system specific Unavoidable Annual Real Losses (UARL).
CARL = (MNF – LNF) x DF where:
MNF = Minimum Night Flow
LNF = Legitimate night consumption = [night consumption (NC) x number of connections (Nc)]
DF = Day factor
UARL (litres/day) = [(18 x Lm) + (Ns x 0.8) + (25 x Lp/1000)] x P where:
Lm = mains length (km),
Ns = number of service connections (main to property line)
Lp = average length, property line to meter (metres),
P = average pressure (metres)
As a water network ages, there is a tendency for natural increasing rate of real losses through new leaks and burst, some of which will not be reported to the utility. This tendency is controlled and managed by some combination of the four primary components, namely:
(i) pipeline and assets management,
(ii) pressure management,
(iii) speed and quality of repairs, and
(iv) active leakage control to locate unreported leaks.
The volume of UARL is the lowest technically achievable annual real losses for a well maintained and well managed system.
ILI is a measure of how well the three infrastructure management functions – repairs, pipelines and asset management, active leakage control – are being undertaken separates from the aspects of pressure management.

This indicator measures bursts include failures on mains, service pipes where they are the Utility's responsibility, i.e. inclusive of joints or fittings, and that are detected by visible signs of water. It excludes pipe breaks detected though active leakage control since a utility having a high active leakage control programme and thereby detecting substantially more bursts than one without active leakage control would appear to be under performing in comparison to the latter utility.

Table 14 shows the total number of breaks per km of water distribution network as reported by WAREG members for the period 2013- 2015.

There are various factors which affect real losses and hence the performance of the water distribution network. These include: length of mains, service connection density, length of customer service connection, average operating pressures.

Other KPIs used by water regulators within WAREG include:

(i) Recovery costs of pipe breaks expressed per km of network;
(ii) Total number of bursts expressed per km of network and excluding service connections;
(iii) Total number of pipe bursts per km of network (inclusive of all bursts on mains and services including those detected through active leakage control);
(iv) Number of main bursts per km of network (excluding bursts of service connections and bursts detected through active leakage control).

The rationale of combining these indicators provides for analysis and monitoring of a utility's efforts in detecting and controlling pie breaks and in the maintenance of the distribution network. These are shown in Table 15.

Table 14: Pipe Network Performance

Pipe Network Performance	Total number of breaks expressed per km of water distribution network (excluding breaks detected through active leakage control)			
	Unit: # breaks / km / year			
Country / Year	2013	2014	2015	Data Collected by Regulator – Notes
Albania	4.27	4.06	3.71	✗ - Data collected by the National Agency of Water Supply & Sewage – Official data
Azores, Portugal	n.a.	n.a.	n.a.	✓
Belgium (Flanders)	0.10	0.10	0.10	✓ - Total number of breaks per km per year - including breaks casued by third parties – Source: Tariff plans 2017 – 2022 Data for largest water company is estimated
Bulgaria	1.01	0.89	1.20	✓ Mains failures are reported in No / 100 km /year. The figures are recalculated to No/km/year. Failures on connections are not included.
Denmark	n.a.	n.a.	n.a.	✗
Estonia	n.a.	n.a.	n.a.	✗
Georgia	5.4	4.9	4.43	✓
Hungary	n.a.	n.a.	1.35	✓
Italy	n.a.	0.71	n.a.	✓
Kosovo	3.63	2.79	1.96	✗ Total number of repairs (not breaks) per year expressed per km of the water network (not excluding breaks detected through active leakage control)
Latvia	n.a.	n.a.	n.a.	✗
Lithuania	0.8	0.83	n.a.	✓ - NCC does not calculate this indicator, but collects the data. Reference data provided according to the IBNET indicator
Malta	3.58	3.54	3.13	✓
Moldova	n.a.	n.a.	n.a.	✗
Portugal[31]	11	14	15	Data reported refers to bulk systems in breaks /100 km/year Mains failures are reported in No / 100 km /year ***Reference values for bulk systems:*** Good service quality: [0; 15] Average service quality:]15; 30] Unsatisfactory service quality:]30; +∞ [
	40	37	41	Data reported refers to retails systems in breaks /100 km/year ***Reference values for retail systems:*** Good service quality: [0; 30] Average service quality:]30; 60] Unsatisfactory service quality:]60; +∞ [
	51	51	56	Data reported refers to total bulk and retails systems in breaks /100 km/year
Republic of Macedonia	n.a.	n.a.	n.a.	✓

31 In Portugal, ERSAR followed and adapted, whenever necessary, the methodology proposed by IWA regarding the performance indicators for the water services. According to IWA (OP31 - Mains failures) the metric should be "number of mains failures per 100 km per year". This indicator is designed to assess the level of sustainability of the service management in terms of infrastructure, with regard to the reduced frequency of mains failures.
It is defined as the number of mains failures per unit of length (concept to be applied to bulk and retail system operators).
This indicator excludes mains failures that were demonstrably caused by third parties to whom the repair was invoiced. When calculating this indicator, generally from the registration of work orders, repairs due to the active control of leaks should be excluded.

Pipe Network Performance	Total number of breaks expressed per km of water distribution network (excluding breaks detected through active leakage control)			
	Unit: # breaks / km / year			
Country / Year	2013	2014	2015	Data Collected by Regulator – Notes
Romania	2.08	2.02	1.80	✓
Scotland	n.a.	n.a.	n.a.	✓
Spain	n.a.	n.a.	n.a.	✖

In Scotland, WICS adopts a methodology termed OPA (Overall Performance Assessment) and within this target a parameter for the number of interruptions to supply is included. This parameter is correlated to pipe breaks, although is more of a customer focused measure.

Table 15: Other KPIs related to Network Performance

Network Performance						
Indicator/ Year	Unit	Country	2013	2014	2015	Notes
Total recovery cost of pipe breaks / km	HUF /number / km	Hungary	n.a.	n.a.	0.8	
Total number of bursts expressed per km of water network per year	# breaks / km /year	Malta	0.28	0.33	0.36	Excludes service connections
Total number of bursts expressed per km of water network per year	# breaks / km /year	Malta	6.49	6.21	5.89	Includes bursts on mains and service connections and those detected through active leakage control
Total number of mains bursts expressed per km of water network per year	# breaks / km /year	Malta	0.17	0.17	0.13	Excludes service connections and burst detected through active leakage control
Total number of breaks per year	# breaks /year	Romania	71,162	75,298	71,045	Applied only to Regional Operators with Benchmarking System
Number of interruptions to water supply	Hours lost due to water supply interruptions per total properties served	Scotland	n.a.	n.a.	n.a.	Parameter correlated to pipe breaks and included within OPA (Overall Performance Assessment)

4.5 Finance and Efficiency - Costs and Staffing

The unit operational cost of water gives a measure of the mix of resources used to achieve the outputs required. IBNET suggests the unit operational cost (excluding depreciation, interest and debt service) and normalised in relation to the total annual volume of water sold.

Table 16 shows the Annual Water Services Operational Expenses (excluding depreciation, interest and debt service) expressed by annual volumes of water sold as reported by WAREG members for the period 2013- 2015.

Table 16: Operational Unit Costs

Operational Unit Costs	Annual water service operational expenses (excluding depreciation, interest and debt service) expressed by annual volume of water sold			
	Unit: € /m^3 sold/year			
Country / Year	2013	2014	2015	Data Collected by Regulator – Notes
Albania	0.6	0.56	0.61	✓
Azores, Portugal	n.a.	n.a.	n.a.	✗
Belgium (Flanders)	1.54	1.54	1.53	✓ Source: Tariff plans 2017-2022
Bulgaria	0.52	0.54	0.52	✓ This KPI is not collceted by EWRC. Data is calculated in accordance with IB-NET definitions.
Denmark	0.94	0.89	0.91	✗ - Calculated data
Estonia	0.85	0.90	0.91	✓ - Annual water and waste water service operational expenses (exclude depreciation, interest and debt service) / Total annual volume sold (water and waste water)
Georgia	n.a.	n.a.	n.a.	✗
Hungary	283.1	271.8	277.1	✓ - Data provided in HUF/m^3/year
Italy	n.a.	1.26	1.30	✓ - Operational costs data include all water services (abstraction, water collection, water distribution, sewerage, treatment)
Kosovo	0.32	0.36	0.35	✓ - Note Defined as Total operating costs for water / Total of water sold in m^3
Latvia	n.a.	0.54	0.58	✓
Lithuania	0.50	0.58	n.a.	✓ - NCC does not calculate this indicator, but collects the data. Reference data provided according to the IBNET indicator
Malta	2.07	2.20	2.08	✓
Moldova	0.42	0.37	0.33	✓
Portugal[32]	0.64	0.65	0.64	This indicator is aimed at reflecting the costs incurred in the operation of the service to supply each m^3 of water supplied. It is defined as the total operational costs of a given operator divided by the number of m^3 of water inserted in the water supply system.
Republic of Macedonia	n.a.	n.a.	n.a.	✓
Romania	3.02	3.21	3.19	✓
Scotland	n.a.	n.a.	n.a.	✓ - A combined efficiency target on operating costs and capital expenditure is calculated.[33]

32 In Portugal this indicator is part of the economic and financial analysis set of KPIs which are not reflected in the system for quality of service assessment set of 16 indicators.

Operational Unit Costs	Annual water service operational expenses (excluding depreciation, interest and debt service) expressed by annual volume of water sold			
	Unit: € /m^3 sold/year			
Country / Year	2013	2014	2015	Data Collected by Regulator – Notes
Spain	n.a.	n.a.	n.a.	✖

Table 17 shows other KPIs used by regulatory authorities including:

(i) Operational costs normalised per km of distribution network per year;
(ii) Operational costs recovery expressed in % terms;
(iii) Total operational cost per unit billed (potable water supply and distribution) measured in € /m^3 sold/year;
(iv) Total operational cost per unit supplied in system measured in € /m^3 supplied/year;
(v) Total operational cost power unit supplied (potable water supply and distribution) excluding cost of power measured in € /m^3 supplied/year.

33 Econometric models were used in Scotland to measure cost efficiency and benchmark Scottish Water's performance with that of WSOs in England and Wales was carried out. WICS however notes that the gaps in the performance of water companies in the UK have narrowed considerably over time. Any observed performance gap can now be explained mainly by real differences between companies (which neither the regulator nor the regulated company are likely to understand fully). As such, the traditional approach of driving performance improvements through benchmarking has become more problematic. Increasing reliance is placed the accuracy of and consistency between the information provided by the regulated companies, as well as the robustness of the approach to comparing performance.
These issues become increasingly challenging to address given different operating models and that the time horizons of different managements and investors could influence the information collected and provided, as well as the difficulties in comparing different combinations of costs and levels of service. As a result, the scope for the regulatory framework to cope with measurement or modelling error is significantly reduced.
The focus of WICS is now more on customer outputs and outcomes rather than just inputs.

Table 17: Other KPIs related to Operational Costs

Operational Costs						
Indicator/ Year	**Unit**	**Country**	**2013**	**2014**	**2015**	**Notes**
Operational cost of water and waste water services excluding environmental & electricity costs	**€ /m^3 sold /year**	Estonia	0.53	0.56	0.58	Annual water services (includes water and waste water services) operational expenses (excluding depreciation, interest, debt service, environmental costs and electricity costs) / Total annual volume sold
Operating Costs for water production	**€ /m^3 produced /year**	Kosovo	0.14	0.16	0.16	
Operating costs per customer	**€ /water customer / year**	Kosovo	68	71	68	
Operational Costs expressed per km of distribution network	**€ /km /year**	Latvia	n.a.	6,573	6,656	
Operational Cost recovery	**%**	Latvia	n.a.	119	118	
Total operational cost per unit supplied in system	**€ /m^3 supplied /year**	Malta	2.72	2.89	2.61	
Total operational cost per unit billed	**€ /m^3 supplied /year**	Malta	1.53	1.69	1.49	
Total operational cost per unit supplied in system (excluding cost of power)	**€ /m^3 supplied /year**	Malta	1.05	1.14	1.06	
Drinking Water Cost	**€ /m^3**	Spain	1.09	1.10	n.a.	Data compiled by INE VAT is not taken into account. Cost includes : • amount paid by consumers for drinking water throughout the network. It comprises taxes and drinking water tariffs. • Amount charged for new investments in water abstraction carried out by different authorities ("regulation fee", "water use fee"). • Meters and connections maintenance costs. The unit cost is calculated by the division of the total amount charged for drinking water service divided by total amount of water distributed and metered.

In Scotland a suite of nine operating expenditure models were developed based on Ofwat's models as follows:

(i) Water resources and treatment,[34]
(ii) Water distribution,[35]
(iii) Water power,[36]
(iv) Water business activities,[37]
(v) Sewer network,[38]
(vi) Large sewage treatment works,[39]
(vii) Small sewage treatment works,[40]
(viii) Sludge treatment and disposal,[41]
(ix) Sewerage business activities.[42]

On the basis of the modified set of econometric and unit cost models, Scottish Water's relative efficiency was assessed.

IBNET suggests attention should also be given to staff costs since these are generally a major component of operating costs. Staffing levels may give indication on the levels of any over-manning and/ or optimisation of human resources in WSOs. It is suggested that an indicator to measure total number of water staff per 1000 service connections served.

Table 18 shows the staff levels for water only expressed by thousand of connections as reported by WAREG members for the period 2013- 2015.

34 Modelled Cost – water resources and treatment: Resources and treatment functional expenditure (£m), less power expenditure (£m), less Environment Agency or Scottish Environment Protection Agency charges (£m), divided by resident population (millions)
35 Modelled Cost – Water distribution: Log to base e of (distribution functional expenditure (£m), less power expenditure (£m), divided by number of connected properties at year end (£000))
36 Modelled Cost – Water power: Log to base e of power expenditure (£m)
37 Modelled Cost – Water business activities: Log to base e of (business activities expenditure (£m) plus doubtful debts (£m))
38 Modelled Cost – Sewer Network : Log to base e of (sewer network functional expenditure (£m), plus terminal pumping costs, less Environment Agency or Scottish Environment Protection Agency charges (£m), per kilometre of sewer for each area)
39 Modelled Cost = Large Sewage Treatment works: Log to base e of (functional expenditure on sewage treatment at large works (£000), less Environment Agency or Scottish Environment Protection Agency charges (£000) less terminal pumping costs (£000)).
40 Unit Cost Model for small sewage treatment works: unit cost model. Each company's annual functional expenditure on sewage treatment at small works (excluding Environment Agency or Scottish Environment Protection Agency costs), divided by the total load treated at each works is compared with the weighted average industry cost.
Weighted average industry unit cost £000s/(kg BOD5/day)
41 Unit cost model for sludge treatment and disposal. Each company's annual expenditure on sludge treatment and disposal (less Environment Agency or Scottish Environment Protection Agency costs) is divided by the amount of sludge disposed to each disposal route, and this is compared with the weighted average industry cost
Weighted average industry unit cost £000s/(thousand tones dry solids)
42 Unit cost model for sewerage business activities. Each company's annual business activities expenditure (plus doubtful debts) is divided by the number of billed properties. This is then compared with the weighted average industry cost.
£/billed property

Table 18: Staff Levels

Staff Levels	Total number of staff (water only) expressed per thousand of connections			
	Unit: No. / 000 connections			
Country / Year	2013	2014	2015	Data Collected by Regulator – Notes
Albania	9.5	8.9	8.64	✓
Azores, Portugal	n.a.	n.a.	n.a.	✗
Belgium (Flanders)	1.3	1.2	1.2	✓
Bulgaria	6.19	6.01	6.09	✓
Denmark	n.a.	n.a.	n.a.	✗
Estonia	n.a.	n.a.	n.a.	✗
Georgia	n.a.	n.a.	n.a.	✗
Hungary	3.08	2.58	2.48	✓ - Number of employees at the end of the fiscal year. Data for the year 2013 excludes the biggest service provider (in terms of served population).
Italy	n.a.	n.a.	n.a.	✗ - Collected data is only available as a global figure, i.e. Total number of staff (water and wastewater) expressed as per thousand population served.
Kosovo	5.89	6.00	5.00	✓ - Number of staff per thousand water billing points. This is gained when the total number of staff is divided with the total number of active connections and multiplied by one thousand. (number / 1000 connections))
Latvia	n.a.	n.a.	n.a.	✗
Lithuania	0.78	0.76	n.a.	✓ - NCC does not calculate this indicator, but collects the data. Reference data provided according to the IBNET indicator.
Malta	4.01	4.34	4.20	✓
Moldova	n.a.	n.a.	n.a.	✗
Portugal[43]	2.5	2.3	2.3	Data reported refers to average of retails systems
	4.0	3.6	3.7	Data reported refers to retailer operators in predominantly urban intervention areas **For retail systems:** ***Reference values for predominantly urban intervention areas*** Good service quality: [2.0; 3.0] Average service quality: [1,5; 2,0[or]3,0; 3,5] Unsatisfactory service quality: [0; 1,5[or]3,5; +∞ [
	2.1	2.1	2.0	Data reported refers to retailer operators in medium urban intervention areas ***Reference values for averagely urban intervention areas*** Good service quality: [2,0; 3,5] Average service quality: [1,5; 2,0[or]3,5; 4,3] Unsatisfactory service quality: [0; 1,5[or]4,3; +∞ [
	1.8	1.8	1.7	Data reported refers to retailer operators in predominantly rural intervention areas ***Reference values for predominantly rural intervention areas*** Good service quality: [2,0; 4,0] Average service quality: [1,5; 2,0[or]4,0; 6,0] Unsatisfactory service quality: [0; 1,5[or]6,0; +∞ [

43 This indicator is designed to assess the level of sustainability of the operator in terms of physical productivity of human resources, with regard to the existence of an adequate number of employees. It is defined as the equivalent of full-time employees of the water supply service per unit of volume of treated water exported (concept to be applied to bulk and retail system operators) or the equivalent of full-time employees of the water supply service per 1000 service connections (concept to be applied to retail system operators). This figure includes both operators own staff and outsourced staff.

Staff Levels	Total number of staff (water only) expressed per thousand of connections			
	Unit: No. / 000 connections			
Country / Year	2013	2014	2015	Data Collected by Regulator – Notes
Republic of Macedonia	n.a.	n.a.	n.a.	✓
Romania	8.60	8.05	7.41	✓ - Only for Regional operators. For the rest of the operators the number of connections is calculated at a national level
Scotland	n.a.	n.a.	n.a.	✓
Spain	n.a.	n.a.	n.a.	✗

Other KPIs is used by regulatory authorities include:

(i) Staff levels normalised per 1000 population served;
(ii) Staff levels normalised per m^3 of water supplied;
(iii) Staff costs normalised per m^3 of water supplied;
(iv) Staff costs normalised per km/year;
(v) Staff costs expressed as a percentage of operational costs.

These are shown in Table 19.

Table 19: Other KPIS related to Staffing Levels and Costs

Staff Levels and Associated costs						
Indicator/ Year	Unit	Country	2013	2014	2015	Notes
Staff costs per km / year	€/km /annum	Latvia	n.a.	2,912	2,966	Staff costs for service provider employees (including administrative staff), in proportion to their participation are involved in the provision of water management services.
Staff costs expressed as a % of operational costs	%	Latvia	n.a.	44	44	Indicator used with caution since some service providers outsource staff (e.g. network repair work) while other utilities carries out such work using their own staff.
Total number of staff (water only) expressed per thousand populations served	No. / 000 population	Malta	1.33	1.44	1.39	
Total number of permanent employees expressed per 100,000 population served	No. / 100,000 population	Spain	n.a	53	n.a.	Calculated by dividing the number of direct staff working on DW and WW services (Data from AEAS) by the population

Staff Levels and Associated costs						
Indicator/ Year	Unit	Country	2013	2014	2015	Notes
Equivalent full-time employees of the water supply service per unit of volume of treated water exported	**No / Mm^3 / annum**	Portugal[44]	2.4.	2.4	2.2	Data reported refers to average of bulk operators
			1.6	1.6	1.5	Data reported refers to bulk operators in predominantly urban intervention areas **For bulk systems:** ***Reference values for predominantly urban intervention areas*** Good service quality: [1.0; 2.0] Average service quality: [0,5; 1,0[or]2,0; 2,5] Unsatisfactory service quality: [0,0; 0,5[or]2,5; +∞
			2.6	2.6	2.5	Data reported refers to bulk operators in medium urban intervention areas **For bulk systems:** ***Reference values for averagely urban intervention areas*** Good service quality: [1,0; 2,5] Average service quality: [0,5; 1,0[or]2,5; 3,3] Unsatisfactory service quality: [0,0; 0,5[or]3,3; +∞ [
			5.7	5.3	4.8	Data reported refers to bulk operators in predominantly rural intervention areas **For bulk systems:** ***Reference values for predominantly rural intervention areas*** Good service quality [1,0; 3,0] Average service quality [0,5; 1,0[or]3,0; 4,5] Unsatisfactory service quality [0,0; 0,5[or]4,5; +∞ [

44 This indicator is designed to assess the level of sustainability of the operator in terms of physical productivity of human resources, with regard to the existence of an adequate number of employees. It is defined as the equivalent of full-time employees of the water supply service per unit of volume of treated water exported (concept to be applied to bulk and retail system operators) or the equivalent of full-time employees of the water supply service per 1000 service connections (concept to be applied to retail system operators).

4.6 Overall Performance Assessment – The Approach adopted in Scotland

In Scotland, a slightly different approach to traditional compilation of KPIs is adopted since it is considered that there may be several socio and geographic differences between companies that make comparing indicators potentially misleading. The Scottish water regulator, WICS, monitors Scottish Water's performance through a suite of metrics, which focus on the delivery of outputs rather than inputs.

An Overall Performance Assessment (OPA) has been developed based on a number of different factors. WICS implemented the Overall Performance Assessment which blends outputs and outcomes across a range of activities that directly affect the service provided to customers.

The OPA in Scotland has changed significantly over the years; it included 11 components in 2002-03, 13 in 2005-06 and 12 in 2008-09. Since 2010, OPA comprises 17 different indicators/performance measures that can be broken down into four categories: water supply levels of service, sewerage levels of service, customer service and environmental performance.

OPA was originally developed by WICS's equivalent in England and Wales (Ofwat). However Ofwat no longer collects data for the measure so benchmarking with companies in England and Wales is no longer possible. In Scotland, internal benchmarking has proven as effective as external benchmarking in incentivising SW's staff. The OPA is linked to the management team's remuneration schemes- both the Annual and the Long term Incentive Plans have OPA targets. Likewise, operational teams have OPA-related targets to catch.

Moving forward, ahead of the next Strategic Review of Charges, WICS considers changing the OPA as regards its components, as well as the adjacent scoring formulas. The most fundamental change considered is the removal of the customer service elements from the OPA. They overlap with a suite of more sophisticated customer specific measures (CEM & HET/UKCSI) that could function better in the role. Arguably, removing the customer service elements would transform the OPA from a measure of overall performance to a measure of service provision and asset performance.

Annex 2 provides further information on the OPA components and their definitions.

5. Processes, Data Quality Considerations, Publication and Use

WAREG assessed data collection and review processes. In six countries (Albania, Bulgaria, Denmark, Georgia, Hungary, Italy and Malta) the process for KPI review is dynamic and there are changes planned to the country's KPIs framework. In Denmark performance benchmarking is being planned to be introduced in 2018 by the Danish Environmental Agency.

Generally in the countries surveyed, the process for data collection is part of periodic submissions to the regulatory authority. Data may be reported either annually or on more frequent basis (e.g. Georgia) – refer Table 20.

Table 20: KPI Framework Development

Country	KPI Framework Development
Albania	✓- KPIs will be added to replace existing ones
Azores, Portugal	✓-ERSARA is considering changing KPIs based on new and emerging information. In it anticipated that in the future evaluation of the quality of services in Azores will be introduced.
Belgium (Flanders)	✖ Process benchmarking is imposed by the WaterRegulator. The sector have to execute and finance it. Each benchedmarked process will result into KPIs, that need to be followed up. Related 'action' plans need to be drawn up as well. The different processes to be benchmarked are captured in a five-year plan, and drawn up in consultation with the sector and the Regulator.
Bulgaria	✓- System is changed from 2017, with new KPIs (including new definitions of existing KPIs, and introduction of new KPIs). Information is provided for the new KPIs system.
Denmark	✓- The Danish Environmental Agency is planning to introduce performance benchmarking in 2018.
Estonia	✖
Georgia	✓- In process
Hungary	✓- In process
Italy	✓- Large number of technical indicators, consulted (especially on investments efficiency) and plans in place to introduce a more comprehensive regulation of technical quality, including KPIs and related mechanisms of rewards/penalties.
Kosovo	✓- WSRA for this year has planned to incorporate as a Key Performance Indicator the Non Revenue Water in % because this indicator was important for us and always has been in the reports but not as a KPI with the weight in order to estimate the utilities.[45]

45 Key Performance Indicator and Performance Measurement Structure used by WSRA (Kosovo)

Group	Performance measurement	Weight of heaviness of sub-group		Weight of heaviness of group		
Water supply	Drinking water quality	30%	100%		45%	100%
	Pressure	5%				
	Availability	35%				
	Service coverage	20%				
	Cost efficiency	10%				
Wastewater	Discharge quality	20%	100%		35%	
	Reliability	20%				
	Service coverage	50%				
	Cost efficiency	10%				
Financial / commercial	Profitability			10%	20%	
	Commercial efficiency			10%		

Country	KPI Framework Development
Latvia	✖
Lithuania	✖
Malta	✓ - KPIs and associated definitions reviewed annually and amended as necessary.
Moldova	✖
Portugal	✓ - The 1st generation of the assessment system was in place from 2004 to 2011, when was replaced by the 2nd generation indicators that has been implemented since 2012 to the present. This 2nd generation has been applied to all water and waste services operators in mainland Portugal, regardless of their ownership (State or municipal) and their governance model. Five years after the implementation of the 2nd generation and benefiting from the experience of five annual cycles of universal regulation, ERSAR is publishing the 3rd generation of the assessment system, where some concepts and indicators were reviewed and adapted. The main differences between the 2nd and the 3rd generation are listed below: - the infrastructure asset knowledge and management index was revised and divided into two indices: Infrastructure Knowledge Index (IKI) and Infrastructure Asset Management Index (IAMI). These indexes include the assessment of all buried and non-buried infrastructures (such as mains, sewers, water treatment plants, wastewater treatment plants, reservoirs, pumping stations, network accessories) and require detailed information regarding each infrastructure. The score will distinguish if the information support is paper, CAD or equivalent software or geographic information system; - the current Flow Measurement Index (FMI) for the wastewater systems was revised and it was developed an equivalent index for the water supply service; - a new index was introduced, the Infrastructure Value Index (IVI) that can be seen as a weighted average of the residual lives of the infrastructure components, where the weights are the component replacement costs; - a further step was taken regarding the determination of the water balance, namely through the mandatory report of some items of the water balance (unbilled unmetered consumption, unauthorized consumption and metering inaccuracies).
Republic of Macedonia	✖
Romania	✓ - The Romanian Regulator may be taking over the collection of data from Romanian Water Association after the 5 years of implementation
Scotland	Refer Annex 3 – Scotland Case Study
Spain	n.a

Table 21: Data Collection Process

Country	Process for Data Submission
Albania	WSOs are required to submit technical and economic data to regulator. Regulator collected data in relation to its functions i.e.: for tariff calculation and approval and for licensing purposes.
Azores, Portugal	Data is provided annually via an online platform.
Belgium (Flanders)	An annual (extensive) data-exchange is defined in a protocol between utilities and the regulator including detailed information concerning water quantity. Each water company has to provide a tariff plan (mandatory containing general, operational and financial data for 3 historical years, 1 actual year and 6 following years ➔ picture of 10 years) Additionally, an annual reporting (follow up) on the tariff plans (containing same data as tariff plan + 1 year rolling forecast) is mandatory.

Country	Process for Data Submission
Bulgaria	Data is provided once per year, in electronic (MS Excel) and paper format.
Denmark	WSOs report data to the Competition Authority.
Estonia	KPIs are calculated on the basis of the data submitted by companies during the tariff approval process.
Georgia	Quarterly reports submitted by Licensees.
Hungary	KPIs collected as part of annual data reporting from WSOs.
Italy	1. Annual efficiency and quality data collection by WSOs 2. Validation by local authorities and transmission to AEEGSI 3. Data analysis and quality assessment by AEEGSI 4. KPI calculation
Kosovo	Monthly reporting data from utilities is carried out according to a format prepared by WSRA, and from this information the WSRA (The Department of Performance Monitoring) calculates the KPIs.
Latvia	WSOs are required to submit information to the regulator about their performance including provided service amount, costs related to service provision and some technical information on annual basis. Information in the reports is structured in the same way as in the draft tariffs calculation; the report contains the same cost positions as in tariff calculation. Such report structure gives the Regulator the possibility to analyse changes that have been accrued after tariff approval; changes in each cost position and in service amounts. The aim of evaluation of annual reports is to supervise whether service provider can continue working with approved tariff or has to submit a new draft tariff.
Lithuania	WSOs submit data online, via web user interface. In total there are 30 indicators set by NCC (NCC regulation on publication of KPIs is approved annually.)
Malta	WSO is required to submit KPIs and additional information as part of licensing monitoring reporting obligations on an annual basis.
Moldova	n.a.
Portugal	The quality of service assessment system (KPI) is applicable to all water and wastewater service operators. In cases where the operation of the system is transferred to another operator during the reference year, the entry of data in the service quality module on the information system of ERSAR (Portal) is the responsibility of the operator that was active on 31 December, who should ensure the collection of the base-year data. Until March, the operators must: • Collect internal and external data, taking into account the service quality assessment indicators - depending on whether they provide a bulk or retail service. When collecting data operators should bear in mind the specifications of ERSAR's Technical Guide no. 19 - "Water and waste services quality assessment guide". • Perform a self-assessment of data quality in terms of data accuracy band and reliability band of the information source, according to the criteria set out in the Technical Guide no. 19. During the month of March, the operators must: • Enter the data into the ERSAR Portal. • Submit to ERSAR the data previously entered in the Portal. The operator's competent body must recognise the information submitted in advance.
Republic of Macedonia	✖
Romania	Operators report to ANRSC every 3 months. It is mandatory for WSOs to submit information according to Law 241/2006 regarding water and sewage. In addition there is a benchmarking systems designed which is managed by the Romanian Water Association.
Scotland	Scottish Water is required to submit annually a set of regulatory tables, the 'Annual Return'. These tables contain information on assets, finances, compliance, activities and levels of service of Scottish Water. Each data point has a clear definition and has a specific confidence grade, which provides an indication of the reliability of the data. All information is audited and is subject to close scrutiny by an independent reporter (usually an engineering consultancy). Scottish Water publishes annually a delivery plan setting out investment progress and financial performance. The Outputs Monitoring Group (OMG) meets every quarter to review the latest investment information and

Country	Process for Data Submission
	track Scottish Water's progress against its targets. A dashboard summarises Scottish Water's performance and provides a shared view of performance to both board of Scottish Water and the Commission. Annual Return submissions are published on our website and available here.
Spain	n.a.

Data validation, auditing and quality assessments are key issues to ensure the integrity of the reporting process. The vast majority of the countries surveyed reported some form of data validation and auditing to varying degrees. Albania reported that although this exists it is considered relatively weak and needs improvement. In Georgia data validation and auditing is on the other hand limited to financial information.

Table 22: Data Validation and Auditing

Country	Data Validation and Auditing
Albania	✓- Data validation exists but relatively weak and needs to be improved.
Azores, Portugal	✓-A data validation/auditing process (internal and external) is planned annually between April –September.
Belgium (Flanders)	✓- An independent auditor must certify the figures provided in the tariff plans. Data analysis and quality assessment is done in a systematic way by the regulator.
Bulgaria	✓- The data is checked and analysed by regulator. Utilities are contacted, and data is checked during on-site visits
Denmark	✓- Internal Data validation process includes contacting the utilities to ensure data is correct.
Estonia	✓- Data submitted by companies during tariff approval process is compared with their annual reports.
Georgia	✓- For financial information only.
Hungary	✓- Internal data revision following data collection process.
Italy	✓- External data validation by local authorities.
Kosovo	✓-The verification of data it is carried out through an ordinary annual process, whereby the utilities enclose their financial statements and usually this process is finished in April of the actual year. From the findings of data during the auditing process then the Auditing Reports are prepared for all utilities separately, which then are used to prepare different reports such as the Performance Report etc.
Latvia	✓- Annual reports checked and analysed and where significant differences noted, clarifications and explanations required from WSOs.
Lithuania	✓ - Internal data validation by NCC.
Malta	✓- WSO carries out it own internal control and data validation processes, Regulator reviews data for consistency, accuracy and raises requests for clarifications / amendments as part of the review process.
Moldova	✖
Portugal	✓- From April to June ERSAR: • Compiles and validates the data provided by all the operators. • Clarifies doubts with the operators, in particular any shortcomings or data inconsistencies. • Conducts audits among operators to validate the submitted information and verify their reliability. From July to August ERSAR: • Analyses the evolution over time (historical evolution) of the indicators by operator • (naturally only from the second year of application onwards).

Country	Data Validation and Auditing
	• Interprets the indicators by operator, taking into account the values and reference intervals defined by ERSAR and the context factors. • Promotes a contradictory period, allowing the operator to check the indicators and context factors used and submit them to the holder (predictably in July). • Consolidates the indicators by operator.
Republic of Macedonia	✗
Romania	✓- Validation is carried out by the Regulator at Regional offices and main offices.
Scotland	✓ - An independent auditor reviews most of Scottish Water's information submissions. This ensures the robustness of information, methodologies and processes within these submissions providing assurance that the information provided is suitable for regulatory purposes. The reporter is an independent professional appointed by Scottish Water and approved by the Commission. • Acts as a professional commentator and certifier of the regulated activities of Scottish Water ensuring that their regulatory information submission is consistent, reliable and accurate • ensures the robust monitoring of regulated firms, increases transparency and engenders an increase in the quality of information submissions • Should have thorough knowledge of the technical, operational, financial and regulatory aspects of the water industry • The reporter must be satisfied of the adequacy of regulated firm's methods and procedures to provide information that conforms to the regulators information requirements • The reporter should scrutinize and where appropriate challenge material assumptions There is also a queries process where WICS can formally seek explanations on the information included in the annual return through a 'query process' if information is unclear.
Spain	n.a

Table 23: Data Quality Assessment

Country	Data Quality Assessment
Albania	✓- Data quality assessment exists but relatively weak and needs to be improved.
Azores, Portugal	✓- Quality of information for each variable is assessed against 3 levels of reliability. For 1 level is a data with low reliability and 3 level, a data is reliable. The utilities classifies based on the data sources used.
Belgium (Flanders)	✓- Each year the Regulator checks on the consistency and 'evolution' of all data delivered against the historical data. When significant differences appear, companies are required to submit explanations and have to justify the differences.
Bulgaria	✓- Quality of information for each variable is assessed with 4 levels based on the data sources used. WSOs have to introduce certain registers and data bases in order to prove data quality.
Denmark	✓- In connection with benchmarking process.
Estonia	✓- Data submitted by companies during tariff approval process is compared with their annual reports and other public data submitted by the companies to different institutions.
Georgia	✓- A benchmark method is adopted.
Hungary	✗
Italy	✓- Data quality assessment by AEEGSI, based on available historical data records of water industry.
Kosovo	✓-
Latvia	✓- Annual reports checked and analysed and where significant differences noted, clarifications and explanations required from WSOs
Lithuania	✓- The degree to which a set of characteristics of data fulfils requirements of NCC is checked. Examples of characteristics are: completeness of data, validity, accuracy and consistency. The required characteristics of data submitted are set in the NCC's rules on accounting separation and information submission.

<table>
<tr><th>Country</th><th>Data Quality Assessment</th></tr>
<tr><td>Malta</td><td>✓- Data quality assessment carried out as part of review process</td></tr>
<tr><td>Moldova</td><td>✖</td></tr>
<tr><td>Portugal</td><td>✓- ERSAR assesses data quality according to Data Accuracy Bands defined in the Technical Guide no. 19 - " Water and waste services quality assessment guide".

The assessment of data quality should be complemented with an indication of the reliability of the information source according to the following criteria:

• Reliability band of the information source: ***
Associated concept: Data based on extensive measurements, reliable records, procedures and properly documented research or tests recognised as the best method of calculation.

• Reliability band of the information source: **
Associated concept: Similar to the previous one, but with some non-significant data gaps, such as part of the documentation missing, old calculations, or having relied on unconfirmed records, or some data having been included by extrapolation.

• Reliability band of the information source: *
Associated concept: Data based on estimates or extrapolations from a limited sample.</td></tr>
<tr><td>Republic of Macedonia</td><td>✖</td></tr>
<tr><td>Romania</td><td>✖</td></tr>
<tr><td>Scotland</td><td>✓- A confidence grade is assigned to the information provided in the annual return in order to give an indication of the quality and accuracy of data

<table><tr><th>Reliability Band</th><th>Description</th></tr><tr><td>A</td><td>Sound textual records, procedures, investigations or analysis properly documented and recognised as the best method of assessment</td></tr><tr><td>B</td><td>As A, but with minor shortcomings, Examples include old assessment, some missing documentation, some reliance on unconfirmed reports, some use of extrapolation</td></tr><tr><td>C</td><td>Extrapolation from limited sample for which Grade A or B data is available</td></tr><tr><td>D</td><td>Unconfirmed verbal reports, cursory inspections or analysis</td></tr></table>
<table><tr><th>Accuracy Band</th><th>Accuracy to or within +/-</th><th>But outside +/-</th></tr><tr><td>1</td><td>1%</td><td></td></tr><tr><td>2</td><td>5%</td><td>1%</td></tr><tr><td>3</td><td>10%</td><td>5%</td></tr><tr><td>4</td><td>25%</td><td>10%</td></tr><tr><td>5</td><td>50%</td><td>25%</td></tr><tr><td>6</td><td>100%</td><td>50%</td></tr><tr><td>x</td><td colspan="2">Accuracy outside +/- 100%, zero or small numbers or otherwise incompatible</td></tr></table></td></tr>
<tr><td>Spain</td><td>n.a</td></tr>
</table>

In Italy the external data validation is carried out by local authorities and then this is followed by quality assessment by the regulatory authority.

KPIs are published in Annual Reports compiled by the regulator in 9 out of 18 countries (Albania, Azores, Belgium, Bulgaria, Georgia, Italy, Kosovo, Portugal, Romania and Scotland). Furthermore KPIs are also

used for benchmarking purposes in 9 out of the 18 countries surveyed (Albania, Belgium, Bulgaria, Estonia, Georgia, Hungary, Kosovo, Latvia Lithuania, Portugal Romania and Scotland.)

Table 24: Publication of KPIs

Country	Publication of KPIs
Albania	✓- Published in Annual Performance Reports prepared by ERRU
Azores, Portugal	✓- In October or November, after analysis, KPIs of the management entities will be publish on the WWSRAA web-page.
Belgium (Flanders)	✓- A report entitled "Watermeter" is published annually. This report provides a complete statistical overview of drinking water production and supply in Flanders from source to tap (by company). https://en.vmm.be/publications/water-meter-2014-1 (ENG) (The most recent version is available at - https://www.vmm.be/publicaties/watermeter-2016-2017) Process benchmarking is imposed by the Water Regulator. The sector has to execute and finance it. The regulator is supervising it. The processes to be benchmarked are captured in a five-year plan. The plan is draw up in consultation with the sector and the regulatory Authority. Each process benchmark provides KPIs which are intended to be used in the future. A report on process benchmarking is compiled and published.
Bulgaria	✓- After analysis, KPIs of all utilities are published on the regulator's web-page in table format for all utilities and as Benchmarking reports.
Denmark	×
Estonia	×
Georgia	✓- Information on KPIs published in Annual Reports.
Hungary	×
Italy	✓- AEEGSI's annual reports include the most significant KPIs, presented as an aggregate. KPIs referred to single operators are not generally published.
Kosovo	✓
Latvia	×
Lithuania	×
Malta	✓- Selected KPIs published in Annual Reports.
Moldova	×
Portugal	✓- In September and October of each year ERSAR Prepares the annual report on the service quality assessment provided by the regulated water, wastewater service and municipal waste management operators (RASARP), which includes: 1. An ongoing assessment of the service quality provided where comparisons will be made among operators, preceded by the establishment of groups of operators comparable with each other and taking into account context factors; 2. An individual assessment of the service quality provided by each operator, where the results will be compared to the statistical parameters of the group of operators. In those cases, where the assessment process is being applied to an operator for the second or more consecutive years, their assessment will also include an analysis of the evolution of the service quality provided over time. 3. Submit the water, wastewater service and municipal waste management annual report to the operators. 4. Disseminate the water, wastewater service and municipal waste management annual report via the means deemed necessary. The schedule is provisional and may be adjusted each year to the existing reality.
Republic of Macedonia	×

Country	Publication of KPIs
Romania	✓- Published in Regulator's Annual Report.
Scotland	✓- Links to: Annual Return Tables and Performance Reports WICS website.
Spain	n.a.

Table 25: Use of KPIs

Country	Use of KPIs for Benchmarking
Albania	✓- KPIs used in benchmarking between utilities. Utilities divided into 3 groups according to the number of connections served.
Azores, Portugal	✓- KPIs will be use in benchmarking process with other management entities of Azores.
Belgium (Flanders)	✓- KPIs are used for benchmarking Flemish companies. Several companies also join international benchmarks.
Bulgaria	✓- In benchmarking reports.
Denmark	✗
Estonia	✓- KPIs are used during tariff approval process.
Georgia	✓
Hungary	✓- Benchmarking used for internal price calculations.
Italy	✗
Kosovo	✓
Latvia	✓- Regulator compares KPIs of WSOs during tariff evaluation and explanations may be requested in case of significant differences.
Lithuania	✓- Similar WSOs and grouped and benchmarked. Benchmarking results (KPIs) are taken into consideration during the price setting process.
Malta	✗
Moldova	✗
Portugal	✓- Refer also Table 24
Republic of Macedonia	✗
Romania	✓- Regional operators are obliged to formulate an Action Plan based on indicators submitted in order to improve their performance.
Scotland	Scottish Water's performance is monitored through a suite of metrics which focus on the delivery of outputs rather than inputs. – refer Annex 2
Spain	n.a.

6. Conclusions

In this first review of water efficiency KPIs and their use by regulatory authorities and entities in WAREG member countries, a number of conclusions may be drawn.

There are wide variations in the use and interpretations of KPIs in WAREG member countries. A comparative analysis of the different sets of KPIs, used is relatively complex since definitions and indicators vary widely.

There are a number of KPIs frameworks (e.g. IWA's lists of KPIs, IBNET etc.) which are used by water utilities. However their use remains largely voluntary and there is no single set of regulatory KPIs to measure water efficiency or other aspects of water utilities performance which are used consistently across Europe. This makes comparison of water efficiency KPIs data difficult and requiring extreme caution to ensure consistency in definitions and the methodology calculation are adopted.

Despite this lack of consistent KPI framework, KPIs are used by a number of regulatory authorities and entities to meet various objectives including in the tariff setting and approval processes, for benchmarking or comparing water utilities performance and for the publication of information purposes.

An overview of the analysis of data received for eacah of the seven KPIs analysed in detail in provided in

Table 26: Analysis of KPIs- 2015 data

KPI	Unit	Sample size	Mean Value (2015)	Median Value (2015)	Standard Deviation (2015)
Service coverage - Population with easy access to water services (either with direct service connection or within reach of a public water point) expressed as a percentage of total population	%	9	85.7	96.0	18.3
Water Consumption - Total annual water sold expressed by population served per day	litres/ person/day	10	187.3	132.0	157.6
Non-revenue water - Population with easy access to water services (either with direct service connection or within reach of a public water point) expressed as a percentage of total population	%	14	40.6	40.8	19.4
Non-revenue water - Volume of Non Revenue water (Water lost") per km of water distribution network per day	m^3/km/day	9	31.7	6.8	57.8

KPI	Unit	Sample size	Mean Value (2015)	Median Value (2015)	Standard Deviation (2015)
Pipe Network Performance - Total number of breaks expressed per km of water distribution network (excluding breaks detected through active leakage control)	# breaks / km / year	9	2.03	1.80	1.45
Operational Unit Costs - Annual water service operational expenses (excluding depreciation, interest and debt service) expressed by annual volume of water sold	€ /m^3 sold/year	13	1.06	0.89	0.81
Staff levels - Total number of staff (water only) expressed per thousand of connections	No. / 000 connections	8	4.67	4.60	2.62

In 2015, service coverage expressed as population with easy access to water services in WAREG member countries who report this KPI varies between 56-100% and this shows the widely different operating environments across Europe. At the same time various regulators reported difficulty in measuring this indicator as defined. On the other hand KPI measuring the total annual water sold expressed by population served per day shows more consistent and comparable reporting with data ranging between 80 litres/person/day in Albania to 234 litres /person/day in Azores (2015 data).

There is a relatively wide range in non-revenue water (defined as the difference between water supplied and water sold expressed as a percentage of net water supplied) in WAREG member countries. In 2015 this ranged between 17% - 67% of net water supplied in the countries where this KPI is measured and reported. Similar range of variations were reported for non-revenue water expressed in m^3/km/day and ranging between 2.3 m^3/km/day – 181 m^3/km/day. (2015 data)

The total number of breaks expressed per km of water distribution network as a measure of pipe network performance ranges between 0.1 breaks/km/year – 4.43 breaks /km /year (2015 data)

Operational unit costs are important KPIs used by economic regulators together with a myriad of other Performance Indicators. Operational costs vary between €0.3 –€ 3.19 /m^3 sold/year.

The number of staff (for water services only) employed by water utilities shows extreme variations and ranges between 1.2 – 8.64 employees per thousand connections.

KPIs framework in general appears to be under development in a number of WAREG member countries, as regulators acquire greater experience and more consistent data is reported by the regulated entities. At the same time data validation, auditing and quality assessments are key issues to ensure the integrity of the reporting process. The vast majority of the countries surveyed reported some form of data validation and auditing to varying degrees. Furthermore there are 10 regulators who currently publish the KPIs in Annual Reports while 9 countries also use the KPIs for benchmarking purposes.

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Annex 1 - WAREG Members Questionnaire

WAREG WORKING GROUPS - Task Force "Benchmarking"

Section 1: General Information

Country:

Regulatory Authority:

_____

2. Available water act in the country:

Since:

_____

3. Water regulation under special act:

Name:

Since:

_____

4. Scope of Regulation Authority competences:

4.1. Tariff calculation (Yes/No)

4.2. Tariff approval (Yes/No)

4.3. Licensing utilities (Yes/No)

4.4. Business plans approval (Yes/No)

4.5. Key performance indicators (KPIs) monitoring (Yes/No)

4.6. Collection of economic data from utilities (Yes/No)

4.7. Collection of technical data from utilities (Yes/No)

_____

5. Are KPIs defined in Law / Sub legislation / other legal documents (licences / instruments of appointment etc.): (Yes/No)

_____

6. Do you set KPIs targets to utilities? (Yes/No)

_____

7. Do you use KPIs in the tariff calculation process? (Yes/No)

8. Does any other institution collect technical data for KPIs calculation? (Yes/No)

Name:

_____

9. Is there a definition of 'Water Efficiency' in your country? (Yes/No)

Explain:

Section 2.1: KPI 1 - Water Service Coverage

10.1. Do you collect technical data for KPI 1: Water Service Coverage? (Yes/No)

Other institution collects? (Yes/No/Which ones?)

Definition IB-NET: Population with easy access to water services (either with direct service connection or within reach of a public water point)/total population under utility's nominal responsibility, expressed in percentage)

_____

10.2. Do you calculate KPI 1? (Yes/No)

Result 2013:

Result 2014:

Result 2015:

Metrics:

10.3. What is the definition of KPI 1?

_____

Comments:

Section 2.2: KPI 2 - Water Consumption

11.1. Do you collect technical data for

KPI 2: Water Consumption? (Yes/ No)

Other institution collects data? (Yes/No/ Which ones?)

Definition IB-NET: Total annual water sold expressed by population served per day (litres/person/day)

_____

11.2. Do you calculate KPI 2? (Yes/No)

Result 2013:

Result 2014:

Result 2015:

Metrics:

11.3. What is the definition of KPI 2?

11.3.1. Do you use other variant indicator for KPI 2 ''Total Water Consumption''?

_____

Comments:

Section 2.3: KPI 3.1 - Non Revenue Water

12.1. Do you collect technical data for KPI 3.1: Non Revenue Water (%)? (Yes/No)

Other institution collects data? (Yes/No/ Which ones?)

Definition IB-NET: Difference between water supplied and water sold (i.e. volume of water “lost”) expressed as a percentage of net water supplied (%)

12.2. Do you calculate KPI 3.1.? (Yes/ No)

Result 2013:

Result 2014:

Result 2015:

Metrics:

12.3. What is the definition of KPI 3.1.?

12.3.1. Do you use other variant indicator for KPI 3.1 ''Non Revenue Water''?

_____

Comments:

Section 2.4: KPI 3.2 - Non Revenue Water

13.1. Do you collect technical data for KPI 3.2: Non Revenue Water (m3/km/d)? (Yes/No)

Other institution collects data? (Yes/No/ Which ones?)

Definition IB-NET: Volume of water “lost” per km of water distribution network per day (m^3/km/day)

_____

13.2. Do you calculate KPI 3.2.? (Yes/No)

Result 2013:

Result 2014:

Result 2015:

Metrics:

13.3. What is the definition of KPI 3.2.?

13.3.1. Do you use other variant indicator for KPI 3.2 ''Non Revenue Water''?

_____

Comments:

Section 2.5: KPI 4 - Water Network Pipe Breaks

14.1. Do you collect technical data for KPI 4: Water Network pipe Breaks? (Yes/ No)

Other institution collects data? (Yes/No/ Which ones?)

Definition IB-NET: Total number of pipe breaks per year expressed per km of the water distribution network (breaks/km/year)

_____

14.2. Do you calculate KPI 4? (Yes/No)

Result 2013:

Result 2014:

Result 2015:

Metrics:

14.3. What is the definition of KPI 4?

14.3.1. Do you use other variant indicator for KPI 4 ''Water Network Pipe Breaks''?

_____

Comments:

Section 2.6: KPI 5 - Water Operation Costs

15.1. Do you collect technical data for KPI 5: Water Operational Cost? (Yes/ No)

Other institution collects data? (Yes/ No/ Which ones?)

Definition IB-NET: Annual water service operational expenses (exclude depreciation, interest and debt service) / Total annual volume sold (€/m^3 sold/year)

_____

15.2. Do you calculate KPI 5? (Yes/ No)

Result 2013:

Result 2014:

Result 2015:

Metrics:

15.3. What is the definition of KPI 5?

15.3.1. Do you use other variant indicator for KPI 5 ''Water Operational Cost''?

_____

Comments:

Section 2.7: KPI 6 - Water Staff

16.1. Do you collect technical data for KPI 6: Water Staff (per 1000 connections)? (Yes/ No)

Other institution collects data? (Yes/No/ Which ones?)

Definition IB-NET: Total number of staff expressed as per thousand people served (Nº / 1000 connections)

_____

16.2. Do you calculate KPI 6? (Yes/ No)

Result 2013:

Result 2014:

Result 2015:

Metrics:

16.3. What is the definition of KPI 6?

16.3.1. Do you use other variant indicator for KPI 6 ''Water Staff (per 1000 connections)''?

_____

Comments

Section 3: KPIs Additional Information

17. Are you planning changes in KPIs monitoring system (either to introduce it, or to change it)?

(Yes/ No)

Explain:

_____

18. What are the processes of data submission and KPI reporting by the utilities?

Explain:

_____

19. Is there a data validation / auditing process. (internal and / or external – Please specify)

(Yes/ No)

Explain:

_____

20. Is there data quality assessment? (Yes/ No)

Explain:

_____

21. Is information of utilities KPIs published publicly? (Yes/ No)

Explain:

_____

22. Are KPIs used in any benchmarking processes between utilities in your country or with other utilities? (Yes/ No)

_____

23. Do you allow the information submitted in this questionnaire, including KPIs results for the years 2013, 2014 and 2015, to be used in WAREG official report for Benchmarking?

(Yes/ No)

Annex 2 – Performance Indicators developed by IWA

Table 27: Selected PIs developed by IWA related to Efficiency of Water Services

Ref.:	Performance Indicator	Unit	IWA Definition	Methodology
WR1	Inefficiency of use of water resources	%	Real losses during the assessment period expressed as a percentage of the system input volume during the assessment period	$\mathrm{WR1} = \frac{\mathrm{A3}}{\mathrm{A19}}\ x\ 100$ A3 = System input volume (m^3) A19 = Real losses (m^3)
WR4	Reused Supplied water	%	Reused supplied water during the assessment period expressed as a percentage of the system input volume during the assessment period	$\mathrm{WR4} = \frac{(\mathrm{A3}\ x\ 365)}{(\frac{\mathrm{H1}}{\mathrm{A1}})}\ x\ 100$ A1 = Annual yield capacity of own resources (m^3/year) A3 = System input volume (m^3) H1 = Assessment period (day)
Pe1	Employees per connection	No. / 1000 connections	Number of full time equivalent employees of the water utility expressed with respect to 1000 service connections	$\mathrm{Pe1} = \frac{\mathrm{B1}}{\mathrm{C24}}\ x\ 1000$ B1= Total personnel (No.) C24 = Service Connections (No.)
Pe2	Employees per water produced	No. / (10^6 m^3/year)	Number of full time equivalent employees of the water utility expressed with respect to water produced during the assessment period	$\mathrm{Pe2} = \frac{\mathrm{B1}}{(\mathrm{A6}\ x \frac{365}{\mathrm{H1}})}\ x\ 10^6$ A6 = water produced (m^3) B1= Total personnel (No.) H1 = Assessment period (day)
Ph5	Standardised energy consumption	kWh /m^3/ 100m	Average pumping energy consumption in the system per 1 m^3 at 100m head	$\mathrm{Ph5} = \frac{\mathrm{D1}}{\mathrm{D3}}$ D1 = Pumping energy consumption (kWh) D3 = Standardisation factor (m^3x 100)

Ref.:	Performance Indicator	Unit	IWA Definition	Methodology
Ph7	Energy recovery	%	Percentage of total energy consumption for pumping that is recovered by the use of turbines of reverse pumps	$\text{Ph7} = \frac{\text{D5}}{\text{D1}}\ x\ 100$ D1 = Pumping energy consumption (kWh) D5 – Energy recovery (Wh)
Op4	Leakage control	% / year	Length of mains subject to active leakage control expressed as a percentage of the total mains length	$\text{Op4} = \frac{(\text{D9}\ x\ 365)}{(\text{H1}\ x\ \text{C8})}\ x\ 100$ C8 = mains length (km) D9 = leakage control (km) H1 = assessment period (day)
Op5	Active leakage control repairs	No / 100km/year	Number of leaks detected and repaired due to active leakage control expressed per 100 km of mains length	$\text{Op5} = \frac{(\text{D10}\ x\ 365)}{(\text{H1}\ x\ \text{C8})}\ x\ 100$ C8 = mains length (km) D8 = Leaks repaired due to active leakage control (No.) H1 = assessment period (day)
Op23	Water losses per connection	m^3 /connection /year	Water losses during the assessment period expressed by total number of service connections	$\text{Op23} = \frac{(\text{A15}\ x\ 365)}{(\text{H1}\ \ x\text{x}\ \text{C24})}$ A15 = Water losses (m^3) C24 = Service connections (No.) H1 = assessment period (day)
Op24	Water losses per mains length	m^3/km/day	Water losses during the assessment period expressed by total mains lengths	$\text{Op24} = \frac{\text{A15}}{(\text{H1}\ \ x\ \text{C8})}$ A15 = Water losses (m^3) C8 = mains length (km) H1 = assessment period (day)

Ref.:	Performance Indicator	Unit	IWA Definition	Methodology
Op25	Apparent losses	%	Apparent losses expressed as a percentage of the system input volume less any water exported	$$Op25 = \frac{A18}{(A3 - A5 - A7)}\ x\ 100$$ A18 = apparent losses (m^3) A3 = System input volume (m^3) A5 = exported raw water (m^3) A7 = Exported treated water (m^3)
Op26	Apparent losses per system input volume	%	Apparent losses expressed as a percentage of the system input volume	$$Op26 = \frac{A18}{A3}\ x\ 100$$ A18 = apparent losses (m^3) A3 = System input volume (m^3)
Op27	Real losses per connection (when system is pressurised)	l /connection /day	Real losses expressed in relation to the number of service connections and number of hours system is pressurised	$$Op27 = \frac{(A19\ x\ 365)}{(C4\ x\ H2\ x\ 24)}\ x\ 1000$$ A19 = Real losses (m^3) C24 = Service connections (No.) H2 = time system is pressurised (hour)
Op28	Real losses per mains length (when system is pressurised)	l /km/day	Real losses expressed in relation to the total length of water mains and number of hours system is pressurised	$$Op28 = \frac{A19}{(C8\ x\ H2\ x24)}\ x\ 1000$$ A19 = Real losses (m^3) C8 = mains length (km) H2 = time system is pressurised (hour)
Op29	Infrastructure Leakage Index when system is pressurised	-	Real losses expressed with respect to the technical achievable low level real losses (when system is pressurised)	$$Op29 = \frac{Op27\ x\ (\frac{D34}{10})}{\{(18\ x \frac{C8}{24}) + 0.8 + (0.025\ x\ C25)\}}$$ A19 = Real losses (m^3) C8 = mains length (km) C24 = Service connections (No.)

Ref.:	Performance Indicator	Unit	IWA Definition	Methodology
				C25 = Average service length (m) D34 = Average operating pressure (kPa)
Op32	Service connection failures	No/1000 connections /year	Service connection failures expressed per 1000 of connections per annum	$\text{Op32} = \frac{(\text{D29}\ x\ 365)}{(\text{C24}\ x\ \text{H1}\ )}\ x\ 1000$ C24 = Service connections (no.) D29 = Service connection failures (no.) H1 = assessment period (day)
Op36	Customer reading efficiency	-	Number of effective meter readings carried out expressed by the number of residential, industrial and bulk customer meters and respective meter reading frequencies	$\text{Op36} = \frac{(\text{D42}\ x \frac{365}{\text{H1}})}{[(\text{E7}\ x\ \text{D39}) + (E8\ x\ D40) + (E9\ x\ D41)]}$ D39 = Residential customer meter reading frequency (No / meter/year) D40 = Industrial customer meter reading frequency (No / meter/year) D41 = Bulk customer meter reading frequency (No / meter/year) E7 = Residential customer meters (No.) E8 = Industrial customer meters (No.) E9 = Bulk customer meters (No.) H1 = Assessment period (day)
QS3	Population coverage	%	Resident population served by water utility expressed as a percentage of the total population	$\text{QS3} = \frac{\text{F1}}{\text{E5}}\ x\ 100$ F1 = Resident population (person) E5 = Population supplied (person)
QS23	New connection efficiency	days	Total time spent to establish new connections expressed with respect to the number of new connections installed during the assessment period	$\text{QS23} = \frac{\text{F9}}{\text{F10}}$ F9 = new connections establishment time (day) F10 = New connections established (No.)

Ref.:	Performance Indicator	Unit	IWA Definition	Methodology
Fi4	Unit total costs	€/m^3	Total costs (running & capital) per cubic metre of authorised consumption	$\mathrm{Fi4} = \frac{\mathrm{G4}}{\mathrm{A14}}$ A14 = authorised consumption (m^3) G4 = Total Costs (€)
Fi5	Unit running costs	€/m^3	Running costs per cubic metre of authorised consumption	$\mathrm{Fi5} = \frac{\mathrm{G5}}{\mathrm{A14}}$ A14 = authorised consumption (m^3) G5 = Running Costs (€)
Fi6	Unit capital costs	€/m^3	Capital costs per cubic metre of authorised consumption	$\mathrm{Fi6} = \frac{\mathrm{G6}}{\mathrm{A14}}$ A14 = authorised consumption (m^3) G6 = Capital Costs (€)
Fi7	Internal manpower costs	%	Percentage of the running costs corresponding to internal manpower	$\mathrm{Fi7} = \frac{\mathrm{G8}\ x\ 100}{\mathrm{G5}}$ G5 = internal manpower costs (€) G8 = Running costs (€)
Fi8	External services costs	%	Percentage of the running costs corresponding to external services	$\mathrm{Fi8} = \frac{\mathrm{G9}\ x\ 100}{\mathrm{G5}}$ G8 = Running costs (€) G9 = External services costs (€)

Ref.:	Performance Indicator	Unit	IWA Definition	Methodology
Fi10	Electrical energy costs	%	Percentage of running costs corresponding to electrical energy	$\mathrm{Fi10} = \frac{\mathrm{G11}\ x\ 100}{\mathrm{G5}}$ G5 = Running Costs (€) G11 = Electrical energy costs (€)
Fi30	Total cost coverage ratio	-	Ratio between Total revenues and total costs	$\mathrm{Fi30} = \frac{\mathrm{G1}}{\mathrm{G4}}$ G1 = Total Revenues (€) G4 = Total costs (€)
Fi31	Operating cost coverage ratio	-	Ratio between Total revenues and running costs	$\mathrm{Fi31} = \frac{\mathrm{G1}}{\mathrm{G5}}$ G1 = Total Revenues (€) G5 = Running costs (€)
Fi32	Delays in accounts receivable	Days equivalent	Ratio between accounts receivable from drinking water at reference date and the sales revenue for the assessment period	$\mathrm{Fi32} = \frac{\mathrm{G38}\ x\ \mathrm{H1}}{\mathrm{G3}}$ G3 = Sales Revenues (€) G38 = Accounts receivable (€) H1 = assessment period (day)
Fi33	Investment ratio	-	Ratio between investment subject to depreciation and the investment costs for the assessment period	$\mathrm{Fi33} = \frac{\mathrm{G39}}{\mathrm{G28}}$ G28 = Depreciation Costs (€) G39 = Investments subject to depreciation (€)
Fi34	Contribution of internal sources to investment - CTI	%	Investments financed by cash flow expressed as a percentage of total	$\mathrm{Fi34} = \frac{\mathrm{G40}\ x\ 100}{\mathrm{G32}}$

Ref.:	Performance Indicator	Unit	IWA Definition	Methodology
			investments during the assessment period	G32 = Investments in water service assets (€) G40 = Investments financed by cash flow (€)
Fi35	Average age of water service assets	%	Depreciated historical value of water services assets expressed as a percentage of the historical value of water service assets during the year	$\mathrm{Fi35} = \frac{\mathrm{G41}\ x\ 100}{\mathrm{G42}}$ G41 = Depreciated historical value of water service assets (€) G38 = Historical value of water service assets (€)
Fi36	Average depreciation ratio	-	Ratio between depreciation costs and historical value of water	$\mathrm{Fi36} = \frac{\mathrm{G28}}{\mathrm{G42}}$ G28 = Depreciation Costs (€) G42 = Historical value of water service assets (€)
Fi37	Late payments ratio	-	Ratio of the annual debt from customers expressed with respect to the amount billed during the year	$\mathrm{Fi37} = 1 - (\frac{G43}{G44})$ G43 = Annual debt from customers (€/ year) G44 = Amount billed per year (€ / year
Fi38	Inventory value	-	Ratio of the value of overall inventory at end of fiscal year and the operating revenues during the year	$\mathrm{Fi38} = \frac{\mathrm{G51}}{\mathrm{G52}}$ G51 = Operating revenues (€) G52 = Inventories (€)
Fi46	Non revenue water by volume	%	Percentage of system input volume that corresponds to non revenue water	$\mathrm{Fi46} = \frac{\mathrm{A21}\ x\ 100}{\mathrm{A3}}$ A3 = System Input volume (m^3) A21 = Non- revenue water (m^3)

Ref.:	Performance Indicator	Unit	IWA Definition	Methodology
Fi 47	Non-revenue water by cost	%	Percentage of system input volume that corresponds to the valuation of non-revenue water components	$\text{Fi47} = \frac{[\{(\text{A13} + \text{A18})\ x\ \text{G57}\} + (\text{A19}\ x\ \text{G56})]\ x\ 100}{\text{G5}}$ A13 = Unbilled authorised consumption (m^3) A18 = Apparent losses (m^3) A19 = Real losses (m^3) G5 = Running costs (€) G57 = Average water charges for direct consumption (€/m^3) G58 = Attributed unit cost for real losses (€ /m^3)

Source (Alegre *et al.* 2016)

Annex 3 – Scotland – Case Study

A3.1 Overall Performance Assessment

Table 28 OPA components (2015-16), their maximum attainable scores and definitions.

All data to calculate the scores is included in the Annual Return tables apart from input provided by:

- DWQR (Water quality)
- SEPA (Water pollution incidents; Wastewater pollution incidents category 1&2; WW pollution incidents cat. 3; non-compliant WTW)

Table 28: OPA Components and Definitions

Categories of service	Indicator / Measure	Max score
Water service	• **Inadequate pressure** Refers to the number of connected properties in which the water pressure is insufficient, meaning that, under normal circumstances, water cannot delivered to a height of 10m at a rate of 9 litres/minute.	**37.50**
	• **Unplanned supply interruptions** Reflects the number of premises that have experienced an unplanned water supply interruption lasting more than 6 hours. The calculation uses the percentage of properties affected by interruptions lasting between 6 and 12 hours, between 12 and 24 hours, and beyond 24 hours, with respective weightings of 1, 2 and 4 to generate an interruptions score.	**37.50**
	• **Hosepipe restrictions** Refers to the percentage of the population that is subject to hosepipe restrictions	**12.50**
	• **Security of Supply Index (SOSI) absolute** This measure reflects the overall availability of water supply and is based on Level of Service (“*Dry Year Annual Average*”). Scotland is divided in different Water Resource Zones. Then the level of availability and the population of each one are taken into account in order to calculate SOSI.	**12.50**
	• **SOSI variance against target** This is based on measuring SW’s actual SoSI score against their SoSI target, expressed	**12.50**

Categories of service	Indicator / Measure	Max score
	as the percentage of the SoSI target not met.	
Environmental issues	• **Leakage** A target for leakage (measured in Ml/d) is set every year. The OPA points reflect the leakage (estimated) performance compared with the target level of leakage. The OPA points are based on the percentage corresponding to SW's expected leakage level not achieved (ΔL to target/Target in %).	**12.50**
	• **Drinking Water quality** This measure is based on total compliance of regulatory samples taken at customers' taps. All the samples are examined across 70 parameters; if a sample has any parameters above the predefined limit then it is non-compliant. The figure that is used for OPA score calculations is the percentage of the samples that are compliant.	**50.00**
	• **Water pollution incidents category 1&2** This measure relates to Category 1 and 2 pollution incidents resulting from water treatment and water distribution activities. Category 1 and 2 incidents are major and significant water pollution incidents respectively; 3 and 4 are for less severe incidents. SEPA determines the appropriate category for all pollution incidents following investigation with SW. The pollution incident factor is then calculated by dividing the number of Category 1 and 2 incidents by the resident winter population served (in millions). This will be the input to calculate the OPA score.	**12.50**
	• **Wastewater (WW) pollution incidents category 1&2** This measure relates to Category 1 and 2 pollution incidents resulting from wastewater treatment. Category 1 and 2 incidents are major and significant wastewater pollution incidents respectively. SEPA determines the appropriate category for all pollution incidents following investigation with SW. The pollution incident factor is then calculated by dividing the combined number of Category 1 and 2 incidents by the resident winter population served (in millions). This will be the input to calculate the OPA score.	**25.00**
	• **WW pollution incidents cat. 3** As above but for Category 3 (less severe) pollution incidents.	**12.50**
	• **Non-compliant WW treatment works (WWTW)** This reflects the number of non-compliant waste water treatment works. For each WWTW failing to comply with specified parameters in the SEPA's licenses for SW's wastewater treatment plants one, two or three points (there is an increasing marginal	**50.00**

Categories of service	Indicator / Measure	Max score
	impact of failing works on score) are subtracted from a maximum of 50 points.	
	• **Sewage sludge disposal** This measure reflects the percentage of sewage sludge that is disposed of unsatisfactorily. This refers only to the sludge handled by SW and not the PPP concessions.	**12.50**
Wastewater service	• **% of properties suffering sewer flooding due to inadequate capacity** This measure refers to only internal flooding incidents (that may involve more than one property) whose cause is inadequate capacity. The input used is found by dividing the number of incidents by the number of connected properties.	**25.00**
	• **% of properties suffering sewer flooding due to other causes** The same as above but for internal flooding incidents not caused by inadequate capacity.	**37.50**
	• **Properties at risk of sewer flooding** The score is calculated with the use of a fraction with the same denominator as above- total connected properties. The numeric part of it is the current at-risk numbers; these are based on new reported flooding incidents and historic reported flooding incidents, supported by surveys and other research.	**12.50**
Customer Service	• **Customer contact** This comprises four components: a. Written complaints responded to within 5 days: This is expressed as a percentage of the letters responded to within 5 days. It includes letters and emails to SW, WICS, the Scottish Government, MPs and MSPs. This component gets 50% of the total Customer Contact points. b. Telephone answering abandoned calls: This is the percentage of the calls that are abandoned before someone picks them up. This component gets 12.50% of the total Customer Contact points. c. Lines busy as a percentage of total calls received on customer contact lines: The score for percentage of telephone lines busy as a percentage of total calls received on customer contact lines. This component gets 12.5% of the total Customer Contact points. d. Telephone answering customer survey: Four times per year, a sample of customers who have contacted SW by telephone are subsequently contacted by the independent telephone survey company and asked a series of questions to	**18.75**

Categories of service	Indicator / Measure	Max score
	ascertain their (the customer's) experience of, and level of satisfaction with, the contact with SW. They are called to give a score between 1 (not satisfied at all) to 5 (absolutely satisfied). The average score is then used to generate the OPA score. This component gets 25% of the total Customer Contact points.	
	• **Assessed customer service** This is based on seven measures of customer service each of which has its own measurement methodologies. These measures are: revenue and debt collection; complaint handling; information to customers; telephone contact hours; compensation policy; supply pipe repair policy; and service for disabled and elderly customers. A more qualitative approach is followed for finding each sub-element's score.	**37.50**
	TOTAL (MAX)	**418.75**

A3.2 Customer focused measures

In the last price review WICS has focused on developing measures to assess Scottish Water's performance in terms of customer experience. These measures include:

- the household Customer Experience Measure (hCEM);
- the non-household Customer Experience Measure (nhhCEM); and
- the High Esteem Test

Both the hCEM and nhhCEM measures the quality of, and tracks changes in, the service experience provided to customers by Scottish Water, with an aim to drive an improvement to delivering a better customer experience to household and non-household customers. Performances against a number of quantitative and qualitative indicators are combined to produce an annual CEM score. The quantitative component is scored based on the contact between Scottish Water and its customers, whereas the qualitative component for household customers is based on customer experience surveys, and for non-household's surveys it accounts for the experience of Licensed Providers, developers and business users.

The high esteem test is used to compare Scottish Water's reputation among the public with those of other UK utilities, and also with the country's most trusted companies and brands across all sectors.[46]

[46] The following information note provides more background to both the OPA and the CEM: http://www.watercommission.co.uk/UserFiles/Documents/7-Measuring%20Customer%20Service.pdf

A3.3 Overall Measure of Delivery

The Outputs Monitoring Group (OMG) is multi-stakeholder group – includes WICS, the Drinking Water Quality Regulator, the Scottish Environment Protection Agency, Citizens Advice Scotland, Scottish Water and the Scottish Government – and monitors Scottish Water's progress in investment delivery. The OMG monitors Scottish Water's progress through the use of a single measure, the Overall Measure of Delivery (OMD) which summarises information on the current position of Scottish Water's capital enhancement programme across a wide range of investment projects.

At the beginning of the investment period the OMD score starts at zero and increases as the programme is delivered. A maximum 250-point score is achieved when all the outputs are completed.[47]

A3.4 Other indicators of service performance

Before the implementation of the CEM and the High Esteem Test measures, during the 2015-21 Strategic Review of Charges WICS reviewed Scottish Water's levels of service based on a set of key performance indicators to establish a total service performance score and compared them against the water and sewage services providers in England and Wales. The indicators are outlined in Table 29.

Table 29: Measures used in Total Service Performance Score (Scotland)

Indicators Used in Total Service Performance Scoring in Scotland	
Indicator	**Units**
Internal sewer flooding	incidents per million connected properties
Water supply interruptions	hours lost due to water supply interruptions per total properties served
Greenhouse gas emissions	$ktCO_2e$ per million connected properties
Serious pollution incidents	Total number of sewage pollution incidents
Discharge permit compliance (sewage treatment works)	% of registered discharges in compliance
Satisfactory sludge disposal	% of sludge disposal complying with relevant regulations
Water mean zonal compliance	% of guaranteed provision of level of service
Leakage	% of target
Hosepipe bans	% of domestic customers issued hosepipe bans
Quantitative components of SIM	Relevant score used in SIM

[47] Information note provides more background to the OMD: http://www.watercommission.co.uk/UserFiles/Documents/10-Overall%20measure%20of%20delivery.pdf

A3.5 Other initiatives

Water UK – the organisation that represents all water and wastewater companies in UK - launched DiscoverWater earlier this year. This is a collaborative water sector-wide project funded by water companies, but delivered by an independent third party. It contains industry level and company data (for England and Wales) covering water quality, prices, public health, customer service and environmental aspects of water and sewerage services. The main aim is to help improve trust and confidence in the sector by enabling customers and stakeholders to quickly and easily see how their water company is performing and compare it to other companies. Thereby helping them to engage with water companies and take full advantage of the ways they can set priorities and influence decisions on how their water services are run. The dashboard can be accessed at: www.discoverwater.co.uk.

In 2008, Ofwat conducted an assessment into the international comparison between the English water and sewage companies' relative performance in a number of key indicators against those exhibited by selected international companies.[48]

[48] Further details of the project may be accessed at:

http://webarchive.nationalarchives.gov.uk/content/20090306103114/http://ofwat.gov.uk/legacy/aptrix/ofwat/publish.nsf/Content/rpt_int_08intro.html


WAREG
European Water Regulators